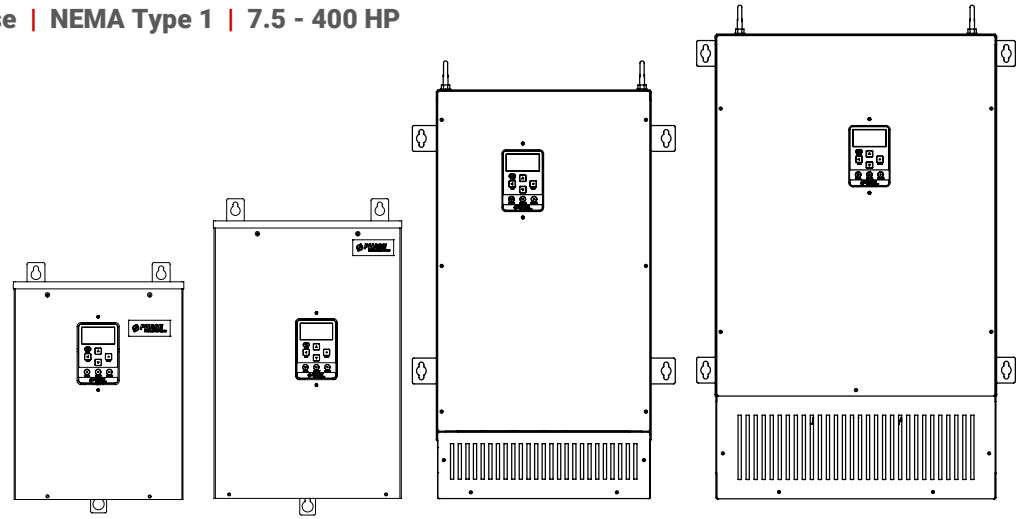
Product Manual

Variable Frequency Drives

DXL SERIES

Six-Pulse | NEMA Type 1 | 7.5 - 400 HP



DXL410
7.5 HP to 15 HP

DXL450
20 HP to 50 HP

DXL4250
60 HP to 250 HP

DXL4400
300 HP to 400 HP

PHASE TECHNOLOGIES

CONTACT INFORMATION

Address: 222 Disk Drive, Rapid City, SD 57701

Phone: 605-343-7934
Fax: 605-343-7943
Toll Free: 866-250-7934

www.phasetechnologies.com

#3187280

MADE IN U.S.A

SAFETY MESSAGES AND WARNINGS

To ensure safe and reliable operation of Phase Technologies variable frequency drives, it is important to carefully read this manual and to read and observe all warning labels attached to the drive before installing the equipment. Please follow all instructions exactly and always keep this manual with the equipment for quick and easy reference.

Definitions of Warning Signs and Symbols

CAUTION: Indicates a potentially hazardous situation that could result in injury or damage to the product.

WARNING: Indicates a potentially hazardous situation that could result in serious injury or death.

HIGH VOLTAGE: Indicates high voltage. The voltage associated with the procedures or operations referenced could result in serious injury or death. Use caution and follow instructions carefully.

READ THESE WARNINGS BEFORE INSTALLING OR OPERATING EQUIPMENT!

WARNING: Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait 10 minutes for internal charges to dissipate before servicing the equipment.

HIGH VOLTAGE: This equipment is connected to line voltages that can create a potentially hazardous situation. Electric shock could result in serious injury or death. This device should be installed only by trained, licensed, and qualified personnel. Follow instructions carefully and observe all warnings.

WARNING: This equipment should be installed and serviced by qualified personnel familiar with the type of equipment and experienced in working with dangerous voltages.

WARNING: Installation of this equipment must comply with the National Electrical Code (NEC) and all applicable local codes. Failure to observe and comply with these codes could result in risk of electric shock, fire, or damage to the equipment.

CAUTION: The **AUX1** through **AUX4** terminals are galvanically isolated, with approximately 5V potential between them. DO NOT apply a voltage to the terminals. Use dry contacts only.

CAUTION: Circuit breakers or fuses, proper ground circuits, disconnect and other safety equipment and their proper installation are not provided by Phase Technologies, LLC, and are the responsibility of the end user.

⚠ **CAUTION:** Long leads between the unit and the motor with an unfiltered PWM voltage can lead to dangerous voltage rise from reflected harmonics. Very long leads, such as in deep well submersible pump applications, may require the use of a sine wave filter to remove most of the harmonics from the waveform. Consult the factory or a knowledgeable source on motor protection filters if your application has more than 50 feet between the drive and the motor.

⚠ **CAUTION:** Failure to maintain adequate clearance for free flow of cooling air may lead to overheating of the unit and cause damage or fire.

⚠ **WARNING:** Suitable for use in a circuit capable of delivering not more than 10 kA RMS symmetrical amperes, 480 VAC.

⚠ **WARNING:** Wire used within the motor circuit and all field wiring terminals must be rated at least 75 °C.

⚠ **WARNING:** Use wire size suitable for Class 1 circuits.

⚠ **WARNING:** Input power connections should be made by a qualified electrician into a nominal 480V circuit for models with 460V input, with adequate current carrying capacity. Branch circuit protection to the drive should be provided by appropriate size fuses or circuit breaker. Circuit breaker and fuse ratings for each model are listed in **Table 3**.

⚠ **WARNING:** These devices are equipped with integral solid-state short circuit protection. Integral solid-state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.

⚠ **CAUTION**: Use 600 V vinyl-sheathed wire or equivalent. The voltage drop of the leads needs to be considered in determining wire size. Voltage drop is dependent on wire length and gauge. Use copper conductors only.

⚠ **CAUTION:** Wires fastened to the terminal blocks shall be secured by tightening the terminal screws to a torque value listed in
Table 2.

⚠ **CAUTION:** The maximum wire gauge for the input and output terminals is listed in
Table 2.

⚠ **CAUTION:** Never allow bare wire to contact the metal surfaces.

⚠ **CAUTION:** Never connect AC main power to the output terminals U/T1, V/T2, and W/T3.

⚠ **WARNING:** Under certain conditions, the motor may automatically restart after a fault has stopped it. Make sure power to the drive has been disconnected before approaching or servicing the equipment. Otherwise, serious injury may occur.

⚠ **CAUTION:** Use caution when applying power to the main input terminals of the unit. If the drive is programmed to allow automatic restarts, the drive will initialize in AUTO mode and the motor load may start as soon as the drive is energized.

⚠ **CAUTION:** The AC motor load must be connected directly to the output terminals of the drive. Do not install relays, disconnect switches, or wire nuts between the drive and the motor load.

⚠ **CAUTION**: Before the motor is connected to the output terminals, check all output lines for line-to-ground faults using a megger. There is a direct path through the drive circuitry for ground fault currents that can be triggered when power is applied to the input terminals, even though the output switches are not activated. These currents can cause serious damage to drive circuitry and are not covered under warranty.

⚠ **CAUTION**: Before touching any printed circuit board, place a hand on a bare metal surface of the unit to discharge any static electricity. Electrostatic discharge (ESD) can damage printed circuits and their components.

⚠ **CAUTION:** When the parameter, ***ENABLE RESTARTS,*** is set to YES, the drive will energize in AUTO mode. The motor load may automatically run as soon as the drive is energized. To stop the motor, push the STIOP/OFF key until the display indicates MANUAL or OFF, or open AUX1 or AUX2. The RUN and STOP keys only work when in MAN mode. Refer to the section on Keypad and Display for instructions on operating the keypad.

⚠ **CAUTION**: Operating the system in MANUAL mode on the keypad overrides remote signals from any remote controls. Operating the system in this mode may lead to dangerous pressures in closed plumbing systems.

TABLE OF CONTENTS

1 INTRODUCTION

Phase Technologies' variable frequency drives (VFDs) are inverter-based devices that convert AC power to a three-phase variable frequency output which provides speed control for three-phase AC motors. The drives offer advanced motor control features through an intuitive, easy to use interface.

The simplified block diagram below demonstrates how the DX Series drive converts the incoming three-phase AC power to DC and utilize an inverter module to generate three-phase variable voltage and frequency output to control the speed of the motor.

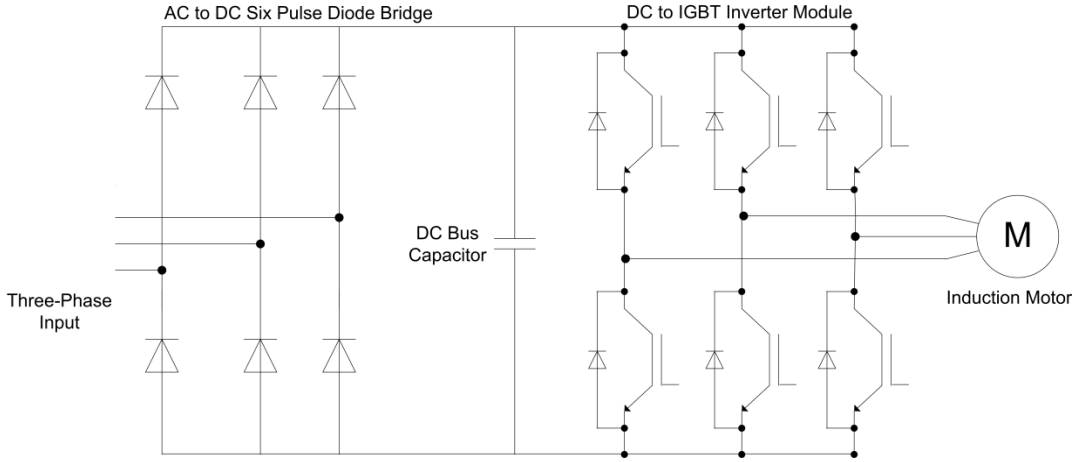


Figure 1 – DXL Series Block Diagram

2 INSTALLATION

2.1 Mounting

The drive must be mounted in an upright position with adequate clearance for cooling and maintenance access. The mounting surface must be sturdy, non-flammable, and capable of bearing the weight of the unit. Fasten the unit to the mounting surface using screws or bolts of an appropriate size through the holes on the mounting brackets. Lifting hooks are provided on the top of some enclosures.

To allow for proper cooling and air circulation around the enclosure, maintain minimum clearance of 3 inches on the sides and top and 6 inches below. The drives are cooled by fans with ventilation openings on the sides or bottom of the enclosure. The surface around the enclosure should be of a non-flammable material and clear of obstacles. Locate the drawing of your drive model in **Section 9** for determining dimensions, hole mounting location and clearance.

⚠ **CAUTION:** Failure to maintain adequate clearance may lead to overheating of the unit and cause damage or fire.

⚠ **CAUTION:** These drives are intended for use in an ambient temperature no higher than 40˚C.

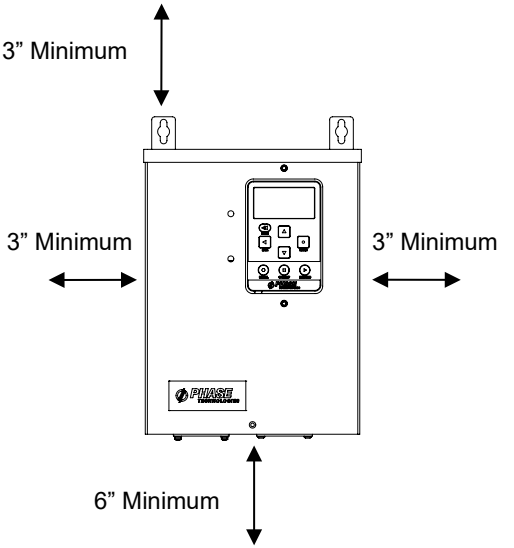


Figure 2 – Minimum Clearances

Ambient Temperature Rating

DXL drives are intended for use in ambient temperatures of 40˚C (104°F). Operation up to 50˚C (122˚F) is permissible with 2% de-rate per 1˚C.

2.2 General Wiring Considerations

Installations must comply with all NEC and local electrical code requirements.

Table 1 – Power Terminal Descriptions

Terminal Name	Description
L1, L2, L3	Input power terminals
U, V, W	Output power terminals
GND	Earth safety ground

Table 2 – Field Wiring Power Terminal Specifications – Input/Output Terminals

Input Power Terminals							
Model							
DXL007 DXL010 DXL407 DXL410 DXL415		DXL015 DXL020 DXL025 DXL030 DXL415R DXL420 DXL425 DXL430 DXL440 DXL450		DXL460 DXL475 DXL4100 DXL4125 DXL4150		DXL4200 DXL4250 DXL4300 DXL4350 DXL4400	
Wire Size	**Torque**	**Wire Size**	**Torque**	**Wire Size**	**Torque**	**Wire Size**	**Torque**
20 – 6 AWG	10.5 in-lb	20 – 2 AWG	17.5 in-lb	2 AWG – 250 kcmil	375 in-lb	4 AWG – 262 kcmil	375 in-lb
				6 – 2 AWG	275 in-lb		

For a given terminal, **do not** use conductors larger than the maximum allowable size indicated in **Table 2** above.

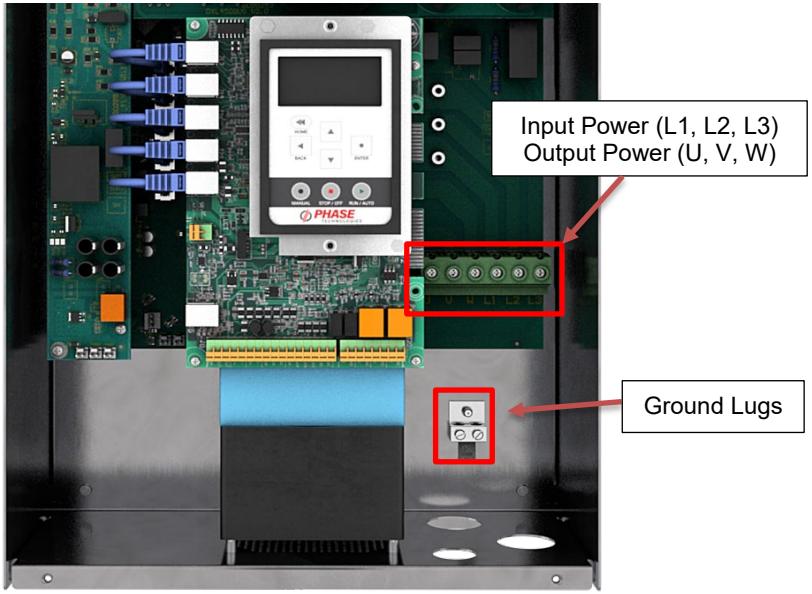


Figure 3 – DXL007-030 and DXL407-450 Power Terminal Location

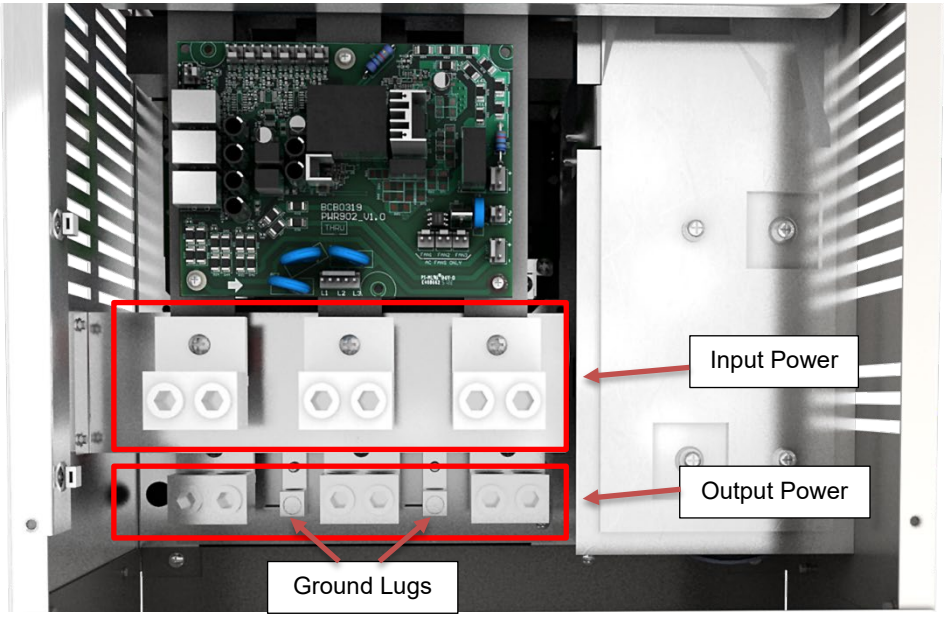


Figure 4 – DXL460-4250 Power Terminal Location

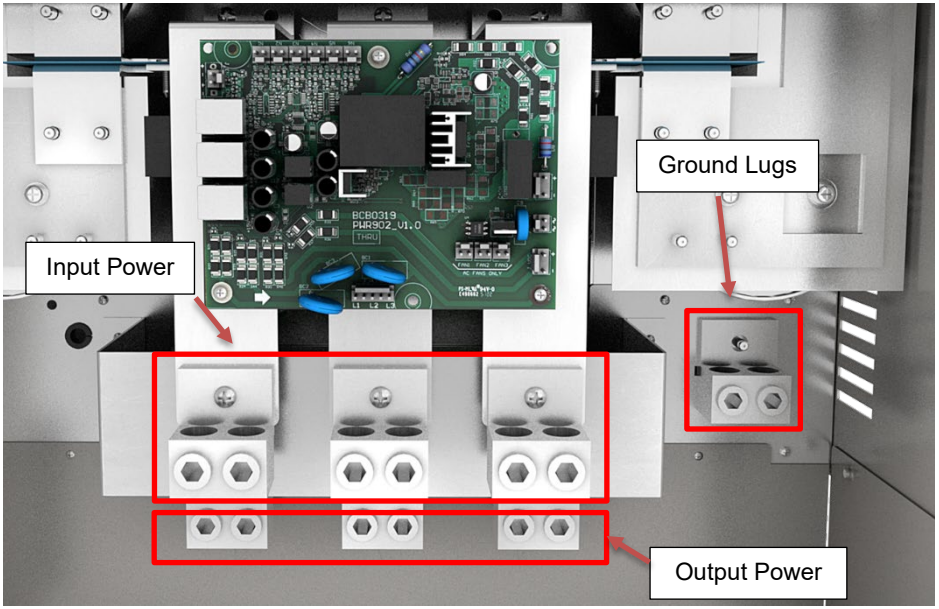


Figure 5 – DXL4300-4400 Power Terminal Location

Table 3 – Input Circuit Breaker and Fuse Ratings (Inverse Time Circuit Breaker)

Model	Maximum Fuse Rating Class J	Maximum Circuit Breaker Rating Amps*
DXL Series		
DXL007	30 A, 600 V	30 A
DXL010	40 A, 600 V	40 A
DXL015	60 A, 600 V	60 A
DXL020	80 A, 600 V	80 A
DXL025	100 A, 600 V	100 A
DXL030	125 A, 600 V	125 A
DXL407	20 A, 600 V	20 A
DXL410, DXL415	30 A, 600 V	30 A
DXL420	40 A, 600 V	40 A
DXL425	40 A, 600 V	40 A
DXL430	50 A, 600 V	50 A
DXL430	60 A, 600 V	60 A
DXL440	80 A, 600 V	80 A
DXL450	100 A, 600 V	100 A
DXL460	125 A, 600 V	125 A
DXL475	150 A, 600 V	150 A
DXL4100	200 A, 600 V	200 A
DXL4125	225 A, 600V	225 A
DXL4150	250 A, 600 V	250 A
DXL4200	350 A, 600 V	350 A
DXL4250	400 A, 600 V	400 A
DXL4300	500 A, 600 V	500 A
DXL4350, DXL4400	600 A, 600 V	600 A

2.3 Installing Power Cables

⚠ **CAUTION:** Continuous metal conduit should be used on all power cables, both line and load side, to reduce conducted and emitted radiation of electromagnetic interference (EMI). The conduit must be securely grounded to the enclosure of the drive and the motor case. If any conduit holes remain unused, they must be covered with a 3R hole plug to maintain the NEMA 3R rating.

Mitigating Electromagnetic Interference (EMI)
Devices that utilize power switching electronics, such as VFDs, produce high frequency emissions commonly known as electromagnetic interference (EMI). These emissions can be conducted on power cables or emitted (radiated) through the air. Conducted and emitted noise can sometimes interfere with radio signals or sensitive electronic equipment near the installation. The use of shielded cables and rigid metal conduit on the output lines between the drive and the motor is recommended to help reduce EMI.

When it is not practical to use continuous metal conduit, special shielded cables can be used. The shielded cable should be constructed with symmetrical conductors and a copper or aluminum shield covered with an insulating jacket. A good shield results in lower EMI and lower motor bearing currents.

Routing Power Cables

Power cables should enter only through the bottom of the drive enclosure directly beneath the power terminals. Enclosures are supplied with conduit openings.

Do not install line-side power cables in the same conduit or cable tray with load side power cables. Also, do not route control cables through the same conduit or cable tray as power cables. Unused conduit holes must be covered with a conduit hole plug.

Routing Control Wires
A separate, smaller conduit opening is supplied for control cables. If the control cables must intersect the power cables, make sure they cross at right angles.

⚠ **CAUTION:** Avoid routing control cables near power cables to avoid coupling EMI onto control cables.

⚠ **CAUTION** Use an appropriately sized hole punch. Do not use a hole saw to create openings! Metal filings may damage the drive and void the warranty.

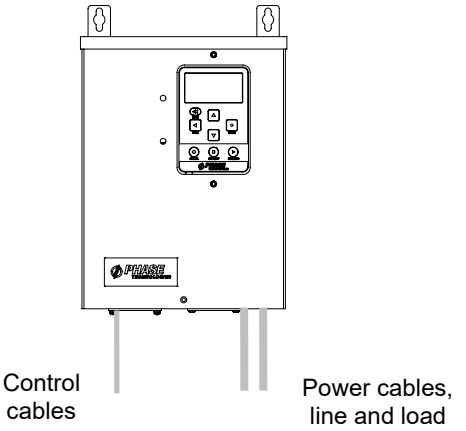


Figure 6 – Routing Power Cables

2.4 Backup Generator

If using a backup generator and automatic transfer switch to power the VFD, a delay timer must be used when switching between power sources. The delay must be long enough for the VFD screen to go dark before re-applying power – approximately 15 – 30 seconds.

Output Filters

Some installations may require a dV/dt filter or sine wave filter between the drive and the motor. **Output filters are typically only necessary when motor leads exceed 50 ft.** Without filters, long leads allow reflected harmonics to create dangerous voltage spikes that can exceed the insulation rating of the motor cables and windings. Over time, these voltage spikes will degrade the insulation and result in motor failure.

An output filter reduces harmonics in the PWM output voltage, smoothing the waveforms to reduce vibration in the motor. Filters also reduce common mode currents in the motor windings that can discharge through motor bearings, causing pitting and premature motor failure.

⚠ **CAUTION**: Long leads between the unit and the motor with an unfiltered PWM voltage can lead to dangerous voltage rise from reflected harmonics. Very long leads, such as in deep well submersible pump applications, may require the use of a sine wave filter to remove most of the harmonics from the waveform. Consult the factory or a knowledgeable source on drive filters if your application has more than 50 feet between the drive and the motor.

2.5 Control Terminals

The drives are equipped with Control Terminals that allow several control functions, including remote ON/OFF control, digital output signals, remote notification, and operation of constant pressure water systems. **The correct *SYSTEM CONFIG* must be selected for proper operation of the different types of control systems!** See **Table 18** for details.

⚠ **WARNING:** Do not connect Control Terminals to external circuits with voltage greater than that specified for each Control Terminal in **Table 4**. Disconnect all incoming sources of power, and then wait 10 minutes for internal charges to dissipate before servicing the equipment.

⚠**CAUTION:** The AUX1 – AUX4 terminals are galvanically isolated, with approximately 5 V potential between them. DO NOT apply a voltage to the terminals. Use dry contacts only.

Customer terminals are located on the Control Board of each drive. **Figure 8** shows where the control terminals are located on the Control Board for each system. See **Table 4** for information on the function of control terminals.

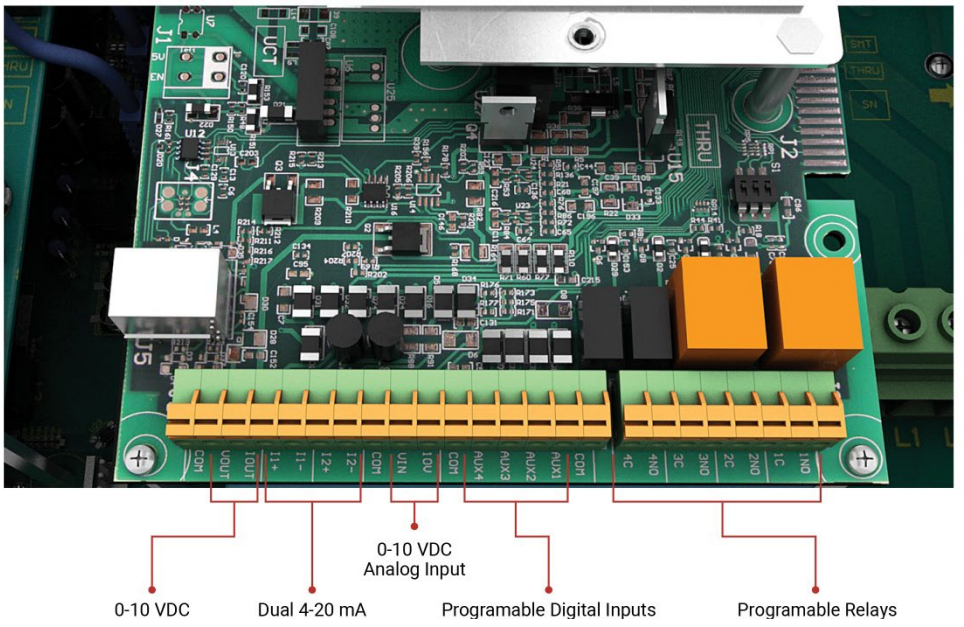


Figure 7 – DXL Control Terminals

Table 4 – Control Terminal Ratings and Descriptions

Terminal Designator	Description	Rating	Comments
1NO	Normally Open Relay	0-30 VDC or 120VAC, 10A	Normally open relay controlled by the conditions set in Parameter ***PROGRAM RLY 1***. See **Table 18** for instructions on programming this relay.
1NC	Normally Closed Relay		
1C	Common		Common terminal for ***1NC*** and ***1NO*** terminals. **CAUTION:** Do not use as common for other terminals.
2NO	Normally Open Relay		Normally open relay controlled by the conditions set in Parameter ***PROGRAM RLY 2***. See **Table 18** for instructions on programming this relay.
2NC	Normally Closed Relay		Normally closed relay controlled by the conditions set in Parameter ***PROGRAM RLY 2***. See **Table 18** for instructions on programming this relay.
2C	Common		Common terminal for **2NC** and **2NO** terminals. **CAUTION:** Do not use as common for other terminals.
3NO	Normally Open Relay	0-30 VDC or 120VAC, <250mA	Normally open relay controlled by the conditions set in Parameter ***PROGRAM RLY 3***. See **Table 18** for instructions on programming this relay.
3C	Common		Common terminal for **3NO** terminal. **CAUTION:** Do not use as common for other terminals.
4NO	Normally Open Relay		Normally open relay controlled by the conditions set in Parameter *PROGRAM RLY 4*. See **Table 18****Table 18** for instructions on programming this relay.
4C	Common		Common terminal for **4NO** terminal. **CAUTION:** Do not use as common for other terminals.
AUX1	Auxiliary 1	< 5 Volts galvanically isolated	Programmable digital input. Commonly used for RUN/STOP command. See **Table 18.**
AUX2	Auxiliary 2		
AUX3	Auxiliary 3		
AUX4	Auxiliary 4		
COM	Common	-	Common for all terminals except programmable relays.
I 1+	4-20 mA Positive	4-20 mA	Analog transducer connection for analog constant pressure or proportional motor speed control from a current source. See **Figure 9** for a connection diagram to control terminals.
I 1–	4-20 mA Negative		
I 2+	4-20 mA Positive		
I 2–	4-20 mA Negative		
10 V	0-10 VDC Output	0-10 VDC	10 VDC supply to provide power to a potentiometer. See **Figure 10** for a connection diagram to control terminals.
V In	0-10 VDC Input		Analog input for motor speed control for 0-10 VDC. Speed is relative to scale of signal from 0 Hz to ***Maximum Frequency*** as set in Adjustable Parameter menu (default 60 Hz). Connect the wiper terminal of a potentiometer to this terminal. See **Figure 10** for a connection diagram.
COM	Common		Common for 0-10 VDC. See **Figure 10** for a connection diagram to control terminals.
IOUT	4-20 mA Output	500 Ω, 12-bit resolution	4-20 mA analog output. Programmable via ***Analog Output Control***, found under PID Parameters. See **Table 21**.
VOUT	0-10 VDC Output	20 mA	0-10 VDC analog output. Programmable via ***Analog Output Control***, found under PID Parameters. See **Table 21**.
COM	Common	-	Common for analog output signals, ***IOUT*** and ***VOUT***.

4-20 mA Analog Input

Motor speed can be controlled with 4-20 mA analog input through control terminals **I1** and **I2**. A 4-20 mA pressure transducer is also commonly used for constant pressure control through these terminals.

4-20 mA Transducer Connection:

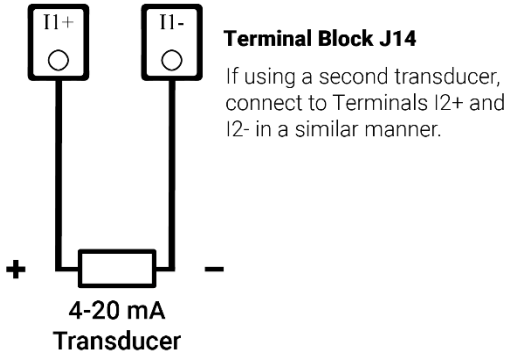
1. Using the keypad, set the value of parameter ***SYSTEM CONFIG*** to 2, 3, 4 or 6 depending on the desired mode of operation. See **Table 18**, and **Section 5.5** for details.
2. Connect the positive lead of the transducer to terminal I1+ or I2+
3. Connect the negative lead of the transducer to terminal I1- or I2-
4. AUX terminals must be closed to run.

4-20 mA Transducer with External Voltage Source Connection:

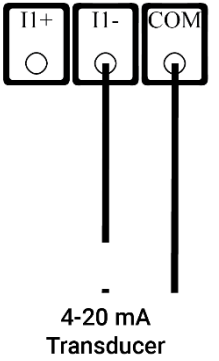
Using the keypad, set the value of parameter ***SYSTEM CONFIG*** to 2, 3, 4 or 6 depending on the desired mode of operation. See **Table 18** and **Section 5.5** for details.

1. Connect the positive lead of the transducer to terminal I1- or I2-
2. Connect the negative lead of the transducer to COM
3. AUX terminals must be closed to run.

⚠ **CAUTION**: A 4-20 mA transducer with the parameter ***SYSTEM CONFIG*** set at 6 results in linear speed control of the motor based on the analog signal from the transducer. This setting will not provide control of a constant pressure water system. For constant pressure control with 4-20mA transducer, refer to **Section 6.1** for more information.



a. 4-20 mA Transducer Connection



b. 4-20 mA Transducer with External Voltage Source

Figure 8 – Control Terminal Connection Diagram for 4-20 mA Control

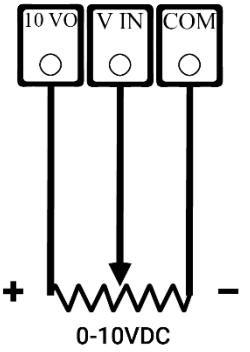
0-10 VDC Analog Input

Motor speed can be controlled with a 0-10 VDC signal through control terminals **10 V**, **V IN** and **COM**. When using a speed potentiometer (variable resistor) the drive provides a DC source voltage. Speed control can also be accomplished with an external DC voltage signal.

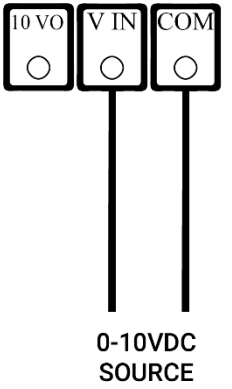
Potentiometer connection:
1. Using the keypad, set the value of parameter ***SYSTEM CONFIG*** to 5 or 7. Refer to **Figure 18** for details.
2. Connect the negative lead of the potentiometer to COM
3. Connect the wiper terminal of the potentiometer to V IN
4. Connect the positive lead of the potentiometer to 10 V
5. AUX terminals must be closed to run

External DC voltage signal:
1. Set parameter ***SYSTEM CONFIG*** to 5.
2. Connect negative lead to COM
3. Connect positive lead to V IN

⚠ **CAUTION**: The resistance value of the potentiometer must be from 5,000 ohms to 20,000 ohms. Resistance below 5,000 ohms will produce a high current in the circuit and may damage components in the circuit.



a. Potentiometer Connection Diagram



b. External DC Voltage Connection Diagram

Figure 9 – Control Terminal Connection Diagram for 0-10 VDC Control

PID Control with Potentiometer and HOA Switch

The drives can be configured with a HOA switch that allows the user to either turn the motor off, control motor speed with a potentiometer, or operate in constant pressure mode. Access to the keypad is not required to operate in this mode.

Using the keypad, set the value of parameter ***SYSTEM CONFIG*** to 7. See **Table 18** for details.

1. Connect the potentiometer and 4-20 mA transducer as in **Figure 11**.
2. Connect a double pole, triple throw HOA switch to AUX1 and AUX3 as depicted in **Figure 11**.
3. Using the keypad, set the drive to operate in AUTO mode.
4. AUX2 and AUX4 must be closed to run.

The mechanical HOA switch allows the user to select between OFF, manual speed control with the potentiometer or analog constant pressure. In the H (Hand/Manual) position, motor speed is controlled by the potentiometer. In the O (Off) position the motor will stop. In the A (Auto) position motor speed will be controlled by constant pressure parameters.

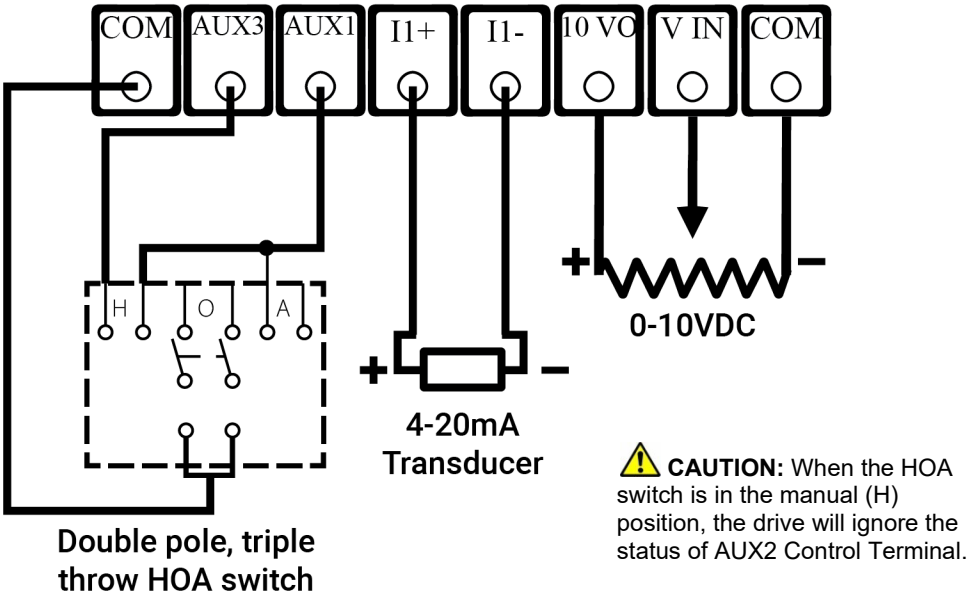


Figure 10 – Connections for PID Control with Potentiometer and HOA Switch

3 KEYPAD & DISPLAY

Before operating the motor load, several basic settings and procedures must be completed. If desired, extensive features for special operating conditions and for protection of the motor load are available through the keypad. Before initial power up, it is advisable to become familiar with setting motor overload protection and setting ***SYSTEM CONFIG*** with basic operation of the keypad and display.

3.1 Using the Keypad and Display

The DXL is capable of many advanced, easy-to-use features that allow the user to protect the motor load from damage, monitor load conditions, log motor run time, troubleshoot the system, and more. The keypad and graphic display offer an intuitive interface specifically tailored for pumping applications.

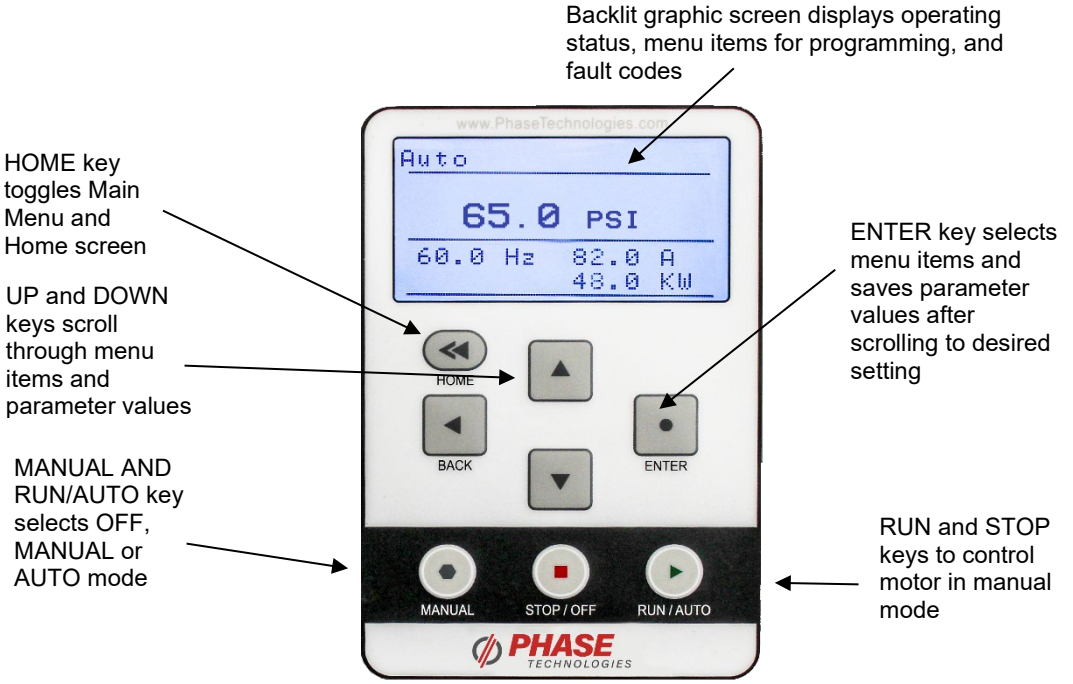


Figure 11 – Keypad and Graphic Display

Display Modes
After two minutes of keypad inactivity, the display will revert to the default display mode. Information on the display will vary based on the operating mode of the drive. When operating in AUTO mode with the factory default ***SYSTEM CONFIG*** set to 0, the display will indicate output kilowatts (kW), output amps (A), output frequency (Hz) and the status of the AUX1 and AUX2 inputs.

Password Protecting the Keypad
The keypad can be set up with a password to prevent unauthorized changes in adjustable parameters. The parameter ***PASSWORD SETUP*** (**Table 18**) is used to protect the keypad. When this parameter is set to 0 the keypad is not protected. Contact customer service at 605-343-7934 if you lose or forget the password.

Keypad Display Messages
Several messages will appear on the display when the unit is initially energized. When the unit has completed its start-up routine, the default display indicating the status of the OFF, AUTO, MAN mode will appear. Start-up display messages are detailed in **Table 5** below.

Table 5 – Display of Operating Modes

MODE	DESCRIPTION
AUTO	The factory default operating mode is OFF. The adjustable parameter, ***ENABLE RESTARTS*****,** must be set to 1 to allow automatic re-starts. See *** - Parameters must be enabled by navigating to** INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.** **Table** 17, for details. ⚠ **CAUTION**: In AUTO mode, the motor load will automatically run if both AUX1 and AUX2 remote switches are closed. Open AUX1 or AUX2 to stop the motor or push STOP/OFF key. ⚠ **CAUTION**: **By default, AUX1 and AUX2 are programmed to be always ON.** See ***AUX1 SELECT*** and ***AUX2 SELECT*** to change this setting.
MANUAL	Activate MANUAL mode by pushing the MANUAL key until ***MANUAL*** appears on top left of the display. In MANUAL mode the motor load is controlled by using the RUN and STOP keys, which will override all external control signals. Manual control of the drive through the keypad can be disabled through the parameter ***DISABLE MANUAL***. See Table 18, for details. ⚠ **CAUTION**: Operating the system in MANUAL mode on the keypad overrides signals from all external controls, including pressures switches. Operating the system in this mode may lead to dangerous operating conditions such as extreme pressure in closed plumbing systems.
OFF	The factory default operating mode is OFF. The adjustable parameter, ***ENABLE RESTARTS***, must be set to 1 to allow automatic re-starts. To exit AUTO mode, press the STOP/OFF key until ***OFF*** appears on top left of the display. If the motor us running, it will stop. To restart the motor, revert to either AUTO mode or MANUAL mode. Certain faults can also be cleared by pressing the up and down arrow keys at the same time and holding for one second.

3.2 Keypad Main Menu Items

The HOME key toggles between the Home screen (operating status screen) and the Main Menu items. Use the UP and DOWN arrows to scroll through the Main Menu items. Press ENTER to view or edit a Main Menu item. **Table 6** contains a brief description of Main Menu items, followed by in-depth instructions on the use and function of each Main Menu item.

Table 6 – Main Menu Items

DISPLAY MESSAGE	DESCRIPTION
CHANGE PARAMETER VALUES	Allows the user to set values for functions such as motor overload settings, under current, time to restart after a fault, etc.
FILE SYSTEM	Opens the SD card menu for importing and exporting settings
READ MEASURED VALUES	Displays measured values such as output current, input voltage, load power factor, etc.
READ TIMERS	Records motor run time and drive on time.
RESTART LOG	A re-settable fault log that records the number of times a particular fault has occurred. The number of faults counted in this log can be cleared through the CLEAR MEMORY menu.
FAULT LOG	Records the number of times a particular fault has occurred and records the time and date of the 20 most recent faults. FAULT LOG cannot be reset by the user.
CLEAR MEMORY	This function clears the Restart Log and Timers. All fault counters in the Restart Log will be reset to zero. If any number of automatic restarts have been allowed through parameters in the Auto Restart Parameters (*** - Parameters must be enabled by navigating to** INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.** **Table** 17), the counter on these faults will be set to zero.
SETUP WIZARD	This allows the user to quickly setup common control schemes: Constant Pressure Control, Flow Control, Tank Level Control, Pump Down Control, and Suction Pump Control. Using these wizards will allow adequate control of most systems, but if additional fine-tuning is needed, see lists of adjustable parameters in **Section 3.9**.

3.3 Change Parameter Values

The Main Menu item, ***CHANGE PARAMETER VALUES***, leads to several sub-menus that contain adjustable operating parameters. These parameters provide basic functions such as motor overload protection and advanced features that allow you to customize operation of the drive to fit your application.

Section 4, starting on page 24, contains a complete list of the parameters along with a description of their function and instructions on setting them.

3.4 Read Measured Values

The display can provide a variety of measured values related to the performance of the drive and its load, such as currents, horsepower, and power factor. To read measured values:

1. Press the HOME key to access Main Menu items, and then scroll with arrow keys until ***READ MEASURED VALUES*** appears on the display.
2. Press ENTER to access this menu item.
3. Use the up and down arrow keys to scroll through the various values that you wish to read.

Table 7 – Measured Values

DISPLAY MESSAGE	DESCRIPTION OF MEASURED VALUE
Iu Iv Iw	Three-phase currents on the output
OUTPUT HP	Output measured in horsepower
OUTPUT kW	Output measured in kilowatts
OUTPUT kVA	Output measured in kilovolt amperes
OUTPUT PF	Power factor of the motor load
BUS CAP VOLTAGE	Voltage of the DC bus
INPUT VOLTAGE	Input voltage AC
AUX1 AUX2	ON/OFF status of the remote switch circuits AUX1 and AUX2
AUX3 AUX4	ON/OFF status of the remote switch circuits AUX3 and AUX4
FREQUENCY	Output frequency in Hz
MODEL NUMBER	Indicates model number of the product. DXL450 is a 480 V input/output, 50 HP, 6-pulse drive.
V 10VDC Input	Measures the 0-10 VDC analog control voltage between Control Terminals for 0-10VDC input.
I_1 4-20mA Input	Measures 4-20 mA analog control current on I_1 Control Terminals for analog current input.
I_2 4-20mA Input	Measures 4-20 mA analog control current on I_2 Control Terminals for analog current input.
TIME UNTIL START	Displays a timer that counts down the time left to start when the drive is in a time delay due to a fault condition.
REAL-TIME CLOCK	Date/Time
IGBT CASE TEMP	Insulated-gate bipolar transistor (IGBT) case temperature.
NEXT RUN TIMERS	Time until next restart if drive is waiting for a timer to expire.

3.5 Read Timers

The timer function records motor run time in hours, and the time the drive has been energized. There are two timers for each function, one can be reset, and one permanent. To view and reset the timers:

1. Press MENU to scroll through menu items until ***READ TIMERS*** appears on the display.
2. Press ENTER to enter this menu item.
3. Use the up and down arrows to scroll through the clock functions.
4. To reset the clock timers, navigate to the Main Menu item, ***CLEAR MEMORY***, press ENTER, and then use arrow keys to select ***RESET TIMERS***. Press ENTER to reset the timers.

Table 8 - Timers

TIMER	DESCRIPTION
Motor Run Time	Logs motor run time in hours.
Drive On Time	Logs time in hours the drive is energized
All Motor Hours	Logs total motor run time. Not resettable.
All Drive Hours	Logs total time the drive is energized. Not resettable.

Programming Tip

To reset the timers, navigate to the Main Menu item, ***CLEAR MEMORY***, use arrow keys to select ***RESET TIMERS***, and then press ENTER

3.6 Restart Log

The Restart Log records the number of times each fault has occurred. The faults counters in the Restart Log are resettable and are tied to faults that allow programmable automatic restarts. These automatic restarts are programmed through the ***AUTO RESTART PARAMETERS***, which is a sub-menu of the ***CHANGE PARAMETER VALUES*** Main Menu item.

For instance, in a water well pump application, it might be useful to protect the pump from dry well condition by setting the ***UNDER CURRENT*** parameter (found in the ***OPERATING PARAMETERS*** menu) so that the drive shuts down and registers a ***UNDER CURRENT*** fault in the Restart Log.

The drive can also be programmed to automatically restart after a delay to allow the well to recover. Both the delay time and number of restarts can be programmed in ***AUTO RESTART PARAMETERS***. The Restart Log allows the user to monitor the type and number of faults that have occurred. If the number of ***UNDER CURRENT*** faults exceeds the number of automatic restarts allowed, the drive will remain OFF until the Restart Log is cleared, which resets ALL resettable fault counters.

To view the Restart Log:

1. Press the HOME key, then BACK key to scroll through menu items until ***RESTART LOG*** appears on the display.
2. Press ENTER to access this menu item.
3. Use the up and down arrows to scroll through the faults.
4. The fault will appear on the first row of the display, followed by the number of times that fault has occurred.

To clear the Restart Log and reset all Auto Restart fault counters:

1. Press the HOME key, then BACK key to scroll through the Main Menu items until ***CLEAR MEMORY*** appears on the display.
2. Press ENTER.
3. Use the up and down arrows to find ***CLEAR RESTART LOG***.
4. Press ENTER to clear the Restart Log and reset all Auto Restart fault counters.

⚠ **CAUTION**: Clearing the Restart Log through the ***CLEAR MEMORY*** menu will clear ALL faults in the Restart Log and all fault counters in the will be reset to zero. If any number of automatic restarts is allowed through parameters in the Auto Restart Parameters (*** - Parameters must be enabled by navigating to** INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.**
Table 17); the counter will be set to zero.

When the drive has faulted and is programmed to automatically restart after a time delay, the display will count down the remaining time to start. Press both up arrow and down arrow for one second to interrupt the countdown and start the motor.

If the drive has faulted and no auto restart is allowed, the display will indicate the type of fault that has occurred on the top line and the second line will read ***RESTART? ENTER***. Press ENTER to clear the fault and restart the load.

The number and type of faults are also recorded in the Fault Log. In this Log each fault is recorded with a time and date stamp (up to the most recent 20 faults). The Fault Log is permanent and cannot be cleared. See the following section for more information on the Fault Log.

3.7 Fault Log

The Fault Log is a permanent record of drive faults. The number of faults cannot be reset by the user. Faults will be stamped with the time and date the fault occurred, up to a total of 20 times for each fault. After the 20th fault, the oldest time-stamped fault will be replaced with the most recent.

The Fault Log is a Main Menu item. Navigate through the Main Menu items by pressing the MENU key repeatedly until FAULT LOG appears. Press ENTER to view the list of faults, using the arrow keys to scroll through the list.

Programming Tip
A maximum of 20 time and date stamps can be applied to any given fault. After the 20th fault, the oldest fault time stamp will be erased and replaced by the most recent. The drive will continue to count faults up to a maximum of 9,999.

3.8 Clear Memory

The ***CLEAR MEMORY*** function in the Main Menu allows you to reset the timers that record motor run time and drive on time, and to reset the Restart Log which counts the number of each fault.

1. Press MENU to scroll through menu items until ***CLEAR MEMORY*** appears on the display.
2. Press ENTER to enter this menu item.
3. Use the up and down arrows to find either ***RESET TIMERS*** or ***CLEAR RESTART LOG***.
4. Press ENTER to reset the selected function.

3.9 Setup Wizards

Setup Wizards allows users to quickly setup commonly used control schemes: Constant Pressure Control, Flow Control, Tank Level Control, Pump Down Control, and Suction Pump Control. The wizards will guide users through a list of commonly used parameters for the control method selected.

The Setup Wizard selection will be shown upon the first initialization of the VFD and can be accessed through the keypad at any time by scrolling through the Main Menu Items.

Using these wizards will allow adequate control of most systems, but if additional fine-tuning is needed, see lists of adjustable parameters in **Section 4**. See **Table 9 - Table 14** for Setup Wizard walkthroughs.

Table 9 – Constant Pressure Wizard

PROMPT	DESCRIPTION
Run Constant Pressure Wizard?	Press the "**Enter**" key to go through the wizard. Press "**Home**" key to return to Home screen.
4-20 mA PSI Sensor Range	This is the maximum value of the psi sensor being used. Phase Technologies sensors have a maximum value of 150 psi.
PSI Setpoint 1	The pressure, in psi, that the drive will attempt to maintain.
Sleep PSI	This value is added to the value ***PSI SETPOINT 1***. The combined pressure is the value the drive will stop the motor load at and enter sleep mode.
PSI Measurement Offset	This is used to calibrate the pressure that the VFD registers from transducer if a manual pressure measurement is not equal to VFD reading.
Wake Up PSI	This value is subtracted from ***PSI SETPOINT 1*** and is the pressure when the VFD will start the motor load again.
Sleep Frequency	As Hz. This parameter value is added to the frequency set by the parameter ***MINIMUM FREQ***. The combined value is the frequency at which drive will enter sleep mode when pressure is controlled at the set point.
Submersible Pump	**ENABLE THIS FEATURE WITH SUMBERSIBLE PUMPS.** Frequency will ramp from stop to the value set by parameter ***MIN FREQUENCY*** in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second.
Enable Restarts	Controls the ability of the drive to automatically restart after a fault.
Disable Manual Mode	Disables manual operation of the drive through the keypad.
Overcurrent Limit	Setting for motor overload protection, Trip Class 10 curve.

Table 10 – Flow Control Wizard

PROMPT	DESCRIPTION
Run Flow Control Wizard?	Press the "Enter" key to go through the wizard. Press "Home" key to return to Home screen.
GPM Measurement Multiplier	This value allows the ***GPM SETPOINT 1*** to be increased by a factor of 10 or a factor of 100. If the ***GPM SETPOINT 1*** is set to 20 GPM, you can increase it to 200 GPM or 2,000 GPM by increasing this parameter.
4-20 mA Sensor Range	This is the maximum value of the GPM sensor being used.
GPM Setpoint 1	The flow, in Gallons Per Minute (GPM), that the drive will attempt to maintain.
Sleep Flow	This value is added to the value ***GPM SETPOINT 1***. The combined flow is the value the drive will stop the motor load at and enter sleep mode.
GPM Measurement Offset	This is used to calibrate the flow that the VFD registers from transducer if a manual flow measurement is not equal to VFD reading.
Wake Up Flow	This value is subtracted from ***GPM SETPOINT 1*** and is the flow when the VFD will start the motor load again.
Sleep Frequency	As Hz. This parameter value is added to the frequency set by the parameter ***MINIMUM FREQ***. The combined value is the frequency at which drive will enter sleep mode when GPM is controlled at the set point.
Submersible Pump	**ENABLE THIS FEATURE WITH SUMBERSIBLE PUMPS.** Frequency will ramp from stop to the value set by parameter ***MIN FREQUENCY*** in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second.
Enable Restarts	Controls the ability of the drive to automatically restart after a fault.
Disable Manual Mode	Disables manual operation of the drive through the keypad.
Overcurrent Limit	Setting for motor overload protection, Trip Class 10 curve.

Table 11 – Tank Level Control Wizard

PROMPT	DESCRIPTION
Run Tank Level Control Wizard?	Press the "Enter" key to go through the wizard. Press "Home" key to return to Home screen.
Ft Measurement Multiplier	This value allows the ***Ft SETPOINT 1*** to be increased by a factor of 10 or a factor of 100. If the ***Ft SETPOINT 1*** is set to 20 ft, you can increase it to 200 ft or 2,000 ft by increasing this parameter.
4-20 mA Ft Sensor Range	This is the maximum value of the sensor being used.
Ft Setpoint 1	The height, in feet, that the drive will attempt to maintain.
Sleep Height	This value is added to the value ***Ft SETPOINT 1***. The combined height is the value the drive will stop the motor load at and enter sleep mode.
Ft Measurement Offset	This is used to calibrate the height that the VFD registers from transducer if a manual height measurement is not equal to VFD reading.
Wake Up Height	This value is subtracted from ***Ft SETPOINT 1*** and is the height when the VFD will start the motor load again.
Analog I1 Inverted	Inverts the scale of the Analog I1 terminals.
Sleep Frequency	As Hz. This parameter value is added to the frequency set by the parameter ***MINIMUM FREQ***. The combined value is the frequency at which drive will enter sleep mode when level is controlled at the set point.
Submersible Pump	**ENABLE THIS FEATURE WITH SUMBERSIBLE PUMPS.** Frequency will ramp from stop to the value set by parameter ***MIN FREQUENCY*** in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second.
Enable Restarts	Controls the ability of the drive to automatically restart after a fault.
Disable Manual Mode	Disables manual operation of the drive through the keypad.
Overcurrent Limit	Setting for motor overload protection, Trip Class 10 curve.

Table 12 – Pump Down Setup Wizard

PROMPT	DESCRIPTION
Run Pump Down Setup Wizard?	Press the "Enter" key to go through the wizard. Press "Home" key to return to Home screen.
Ft Measurement Multiplier	This value allows the ***Ft SETPOINT 1*** to be increased by a factor of 10 or a factor of 100. If the ***Ft SETPOINT 1*** is set to 20 ft, you can increase it to 200 ft or 2,000 ft by increasing this parameter.
4-20 mA Ft Sensor Range	This is the maximum value of the sensor being used.
Ft Setpoint 1	The height, in feet, that the drive will attempt to maintain.
Sleep Draw Down Level	This value is subtracted from the value ***Ft SETPOINT 1***. The resulting height is the value when the drive will stop the motor load at and enter sleep mode.
Ft Measurement Offset	This is used to calibrate the height that the VFD registers from transducer if a manual height measurement is not equal to VFD reading.
Wake Up Well Recovery	This value is added to ***Ft SETPOINT 1.*** The combined value is the height when the VFD will start the motor load again.
Analog I1 Inverted	Inverts the scale of the Analog I1 terminals.
Sleep Frequency	As Hz. This parameter value is added to the frequency set by the parameter ***MINIMUM FREQ***. The combined value is the frequency at which drive will enter sleep mode when GPM is controlled at the set point.
Submersible Pump	**ENABLE THIS FEATURE WITH SUMBERSIBLE PUMPS.** Frequency will ramp from stop to the value set by parameter ***MIN FREQUENCY*** in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second.
Enable Restarts	Controls the ability of the drive to automatically restart after a fault.
Disable Manual Mode	Disables manual operation of the drive through the keypad.
Overcurrent Limit	Setting for motor overload protection, Trip Class 10 curve.

Table 13 – Suction Pump Setup Wizard

PROMPT	DESCRIPTION
Run Suction Pump Setup Wizard?	Press the "Enter" key to go through the wizard. Press "Home" key to return to Home screen.
Suction Pressure Level	In psi. Used only for transducers wired to 1_2. The pressure setting where any value lower will trigger a fault.
Suction Pressure Time	In seconds. The time at which the pressure must remain below ***SUCTION PRESSURE LEVEL*** before triggering a fault.
Suction Pressure 4-20 mA Sensor Range	This value should be set to the maximum value of the 4-20 mA transducer being used for suction pressure control. i.e. if the transducer has a range of 0-150 psi, the parameter should be set to 150.
Analog I2 Inverted	Inverts the scale of the Analog I2 terminals.

Table 14 – Exhaust Fan Setup Wizard

PROMPT	DESCRIPTION
Fan Control Mode	Select how fan speed is controlled. **START/STOP** = fan will ramp to ***MAX FREQUENCY*** when AUX1 is closed **4-20 mA** = fan speed will be controlled based on 4-20 mA input **0-10 VDC** = fan speed will be controlled based on 0-10 VDC input
Fan RPM	Specify fan RPM at ***MAX FREQUENCY***. Used for fan RPM calculations.
Maximum Frequency	Maximum frequency allowed, or target frequency at start-up ramp. This value cannot be lower than ***MIN FREQUENCY***.
Startup Ramp Time	Time in seconds from ***MIN FREQUENCY*** to ***MAX FREQUENCY***. Ramp speed is linear.
Coast To Stop	Selects between coast to stop or ramp to stop. Ramp profile is controlled by parameter ***SHUTDOWN RAMP***. YES = coast to stop, NO = ramp to stop.
Shutdown Ramp Time	Time in seconds from ***MAX FREQUENCY*** to ***MIN FREQUENCY*** when motor receives a STOP command. Ramp time is linear. Factory default setting enables the **COAST TO STOP** parameter which disables the **SHUTDOWN RAMP** parameter.
Enable Restarts	Controls the ability of the drive to automatically restart after a fault.
Disable Manual Mode	Disables manual operation of the drive through the keypad.
Overcurrent Limit	Setting for motor overload protection, Trip Class 10 curve.

4 ADJUSTABLE PARAMETERS

4.1 Changing Parameter Values

⚠ **WARNING**: When the drive is set to automatically restart after a fault, the output terminals can energize and the load can start without warning, exposing the user to risk of serious injury. Make certain the input is de-energized before approaching the equipment.

The Change Parameter Values function allows the user to set values for a variety of functions including motor overload settings, number of restarts after a fault, and more. To change parameter values:

1. Press the HOME key until ***CHANGE PARAMETER VALUES*** appears on the display.
2. Press ENTER to access this menu item.
3. Use the UP and DOWN arrows to scroll through the sub-menu to find the item desired, then press ENTER. See **Parameter Tables**

4. Table 16 through **Table 21** for a list of parameters.
5. Use the UP and DOWN arrow keys to scroll to the desired parameter, press ENTER, then use the UP and DOWN arrows to change the value.
6. When the value you want appears on the display, press ENTER to set the value or BACK to cancel.

4.2 Restore Default Parameter Settings

To restore **ALL** adjustable parameters (except for **REVERSE ROTATION, USER PASSWORD, and SWITCHING FREQUENCY**) to their default value, press and hold the BACK and ENTER keys at once and hold for three seconds. If a User Password is configured, you will first be prompted to enter the Password. You will then be prompted to press ENTER for yes or BACK for no.

IMPORTANT: Make certain the motor is stopped before resetting.

⚠ **CAUTION**: To reset an individual parameter to its default value, you must refer to the appropriate table of Adjustable Parameters, find the default value, re-enter that value and save it. See **Section 4** for a complete list of parameters, their description, and default/minimum/maximum values.

4.3 Auto Restarts

The drive can be programmed to automatically restart after certain faults. Using the Auto Restart Parameters (*** - Parameters must be enabled by navigating to** INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.**
Table 17), you can set a time delay before the drive starts after a fault and select the number of automatic restarts allowed before the unit will remain OFF after a fault.

> *Example*: You wish to allow 10 automatic restarts after a fault but want the drive to wait for one hour, to allow the well to recover, before restarting. When the drive is counting down the time to restart after a fault, the display will indicate the time until restart in seconds.

Programming Tip

To interrupt the countdown and allow a restart, push and hold both the UP and DOWN keys for one second. The load will start immediately.

When the drive reaches the limit of faults set by the adjustable parameter, it will remain OFF and the display will indicate the type of fault on the top line. The second line will read ***RESTART? ENTER***. Press ENTER to clear the fault and restart the load. The fault counters in the Restart Log will all be reset to zero. See **Section 3.6** for more information. Some faults do not allow auto restart. The display will read ***NO AUTO RESTART***. See **Section 3.7**, *Fault Log*, for more information.

4.4 All Parameters List

To aid in troubleshooting, a numbered parameter list containing all parameters is available for use. Some parameters are visible that are not always used. In this case, the word “Disabled” is shown, and programming functionality is disabled for that parameter.

4.5 Changed Parameter List

This is a list of all parameters that have been changed from their default values. This allows for quick and easy programming of previously changed parameter values. The total number of changed parameters and the index of changed parameters will be displayed at the top of the screen. If there are no changed parameters, then “No Changed Parameters” will be shown.

4.6 SD Card Reader

DXL and LHX products are equipped with an SD card terminal that can be used to Import and Export Parameters as well as install firmware upgrades or custom firmware. SD cards must be Micro SD or SDHC type and formatted as FAT16 or FAT32. Firmware files will be .hex format and parameter data files will be saved as a .CSV file.

CAUTION: SD card must be inserted while drive is **powered off**. Failure to do so may result in injury or damage to the product. Power may be applied while SD card is inserted, but as with inserting card, power to the system must be off before removing the card from the SD terminal. Turn power to the system off and wait for the time specified on the front sticker to allow the DC bus to discharge before working in the enclosure.

With the power to the drive turned off, locate the SD card terminal on the control board. **Figure 13** below shows the SD card terminal on a DXL control board. Insert the SD card into the terminal, replace the enclosure cover, and apply power to the drive.

Figure 12 – SD Card terminal on DXL control board

Export Parameter Data

1. From the HOME screen, press ENTER, then scroll down to ***FILE SYSTEM*** and press **ENTER**.
2. Use the up and down arrows to select ***EXPORT PARAMETER DATA*** on the display and press **ENTER**.
3. Parameter data will be exported to a .CSV file on the SD card. If the export was successful, the display will show **EXPORT SUCCESSFUL**.
4. The file can now be used to import parameters to another VFD. The file can also be opened on a personal computer using an SD Card Reader to view and troubleshoot parameter settings.

The file format of the parameter data will be a .CSV file, which can be opened by Microsoft Excel. **Table 15** below shows the format of the exported parameter data. Information about the drive model and the export date will be shown in the top left. Next, Adjustable Parameters will be listed, along with their current, default, minimum, and maximum values. A column on the far right will denote whether the parameter has been changed or if it remains at the default setting.

Table 15 – Exported Parameter Data

Model Info: 3PH LH420 SW 12.0.1.0					
Drive Family: LHDX					
Firmware Family: Production					
Date/Time: 25/20/2064 33:83:24					
Boot Firmware: 01.00					
Boot CRC: 0xB63E5EFF					
All Parameters					
Name	Current	Default	Minimum	Maximum	Changed
Output Voltage	480	480	200	530	
Overcurrent Limit	30	30	3	32	
Dry Well Current	0	0	0	30	
Current Unbalance	80	80	1	100	
Min Frequency	33	30	5	120	Yes
Restart Delay	60	60	0	9999	

Farther down in the file, Measured Parameters will be the next set of data shown. These are values measured at the time of data export. Continuing down, Changed Parameters will be shown followed by the number of times the control board has been reprogrammed via SD card and a software version history. Last, the Fault Log will show any stored faults and their associated date and time stamp.

Import Parameter Data

The exported Parameter Data files can be used to apply the same parameters to other drives. This will exclude any parameters that are model-specific, such as ***OVERCURRENT LIMIT***. To export parameter data:

1. From the HOME screen, press ENTER, then scroll down to ***FILE SYSTEM*** and press **ENTER**.
2. Use the up and down arrows to select ***IMPORT PARAMETER DATA*** on the display and press **ENTER**.
3. Use the up and down arrows to select the file of parameters to be applied and press **ENTER**.
4. If the parameter import is successful, the display will show **IMPORT SUCCESSFUL**.

Reprogram Firmware

If needed, the SD card terminal can be used to reprogram the firmware of the VFD for software upgrades or custom features. Depending on the model, there may be one or two Digital Signal Processors (DSPs) that contain the firmware to control the system. DXL and 1LHX models have two DSPs that will both require reprogramming. Firmware files will have a suffix of “M” for Master or “S” for slave.

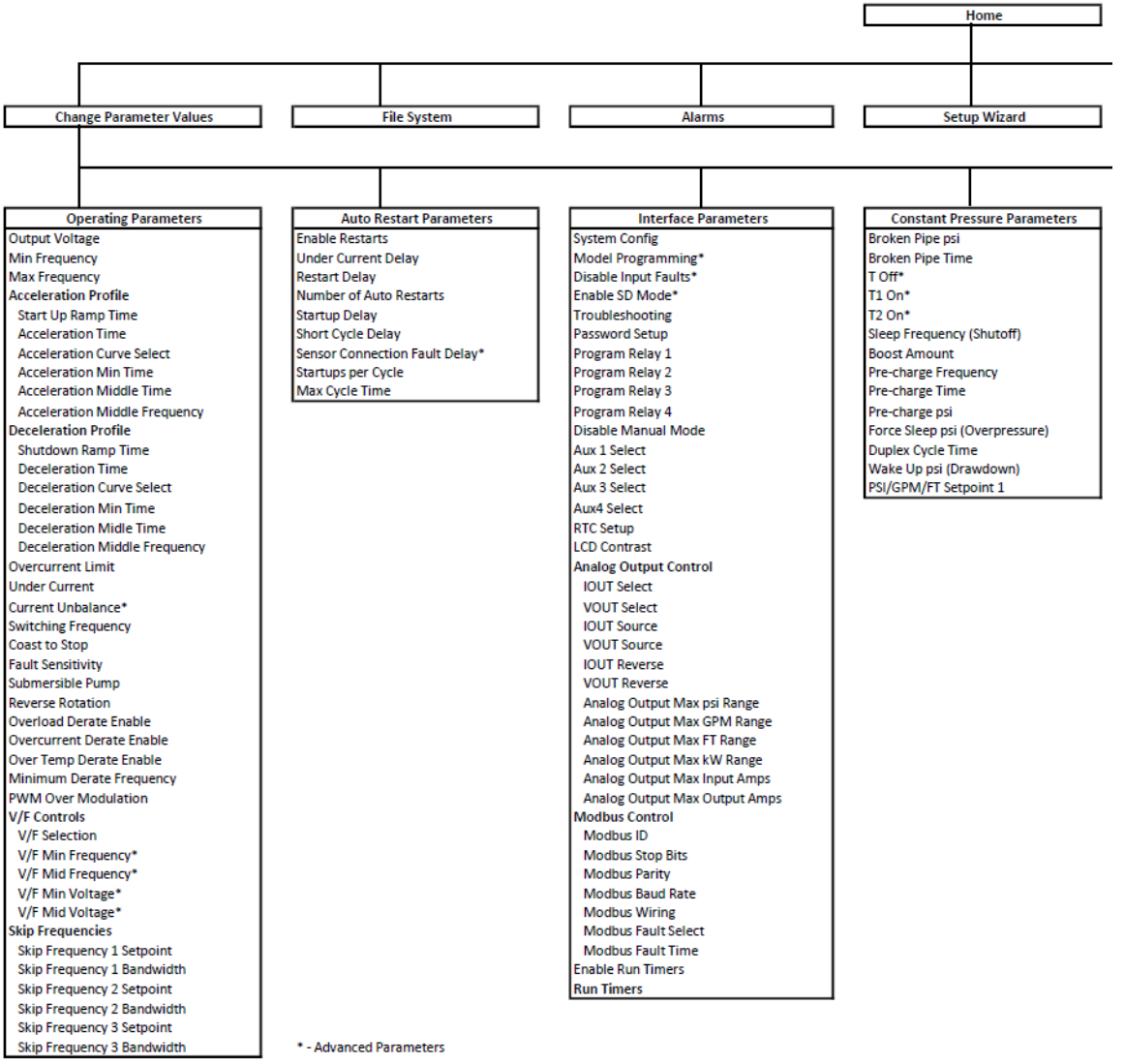
The firmware version of Phase Technologies drives can be found by pressing **ENTER** on the home screen and then scrolling up or down to ***READ MEASURED VALUES (RMV)*** and pressing **ENTER**. Under ***RMV***,

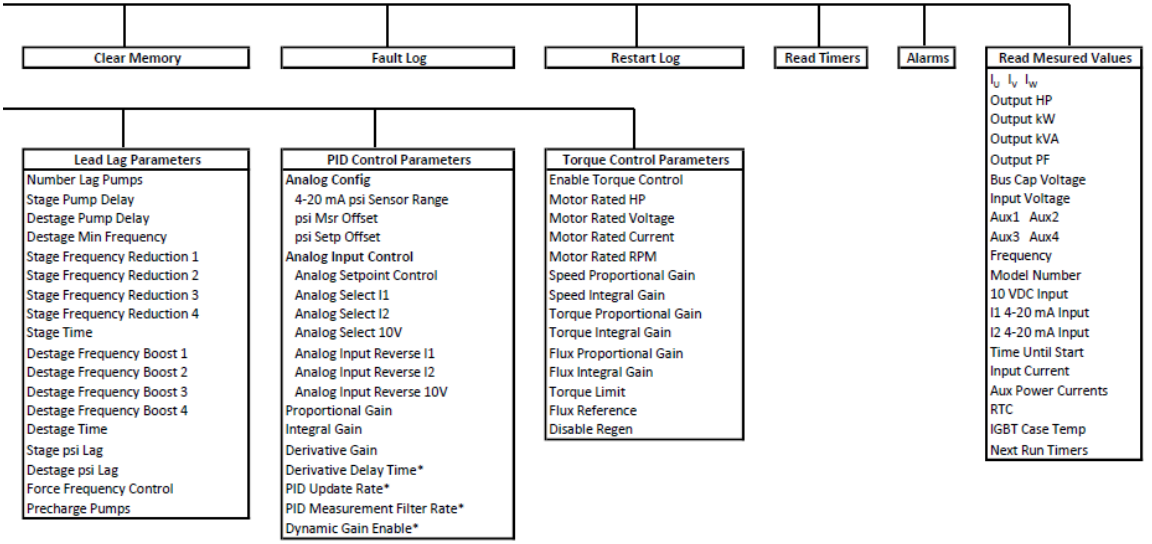
there will be a heading called ***MODEL NUMBER***, which will show the VFD model and current firmware version. To reprogram a drive:

1. From the HOME screen, press ENTER, then scroll down to ***FILE SYSTEM*** and press **ENTER**.
2. Use the up and down arrows to select ***REPROGRAM FIRMWARE*** on the display and press **ENTER**.
3. Use the up and down arrows to select the firmware file for reprogramming and press **ENTER**.
4. If the file chosen contains the proper firmware for the VFD model, reprogramming will begin. This may take several minutes.
5. If the reprogram is successful, the display will show ***SUCCESSFUL, PRESS ENTER TO RESET***.
6. Press **ENTER** and the drive will reboot with the new software version.

LH and DX models only have one DSP so if the model being reprogrammed is one of these, the process is complete. If a second DSP needs to be reprogrammed, like on a DXL or LHX, repeat steps 1 – 6 to reprogram the second DSP, selecting the “M” or “S” file that was not chosen the first time. After reprogramming the second DSP, the drive will reboot with the new firmware. The firmware version can be verified by going to ***READ MEASURED VALUES***.

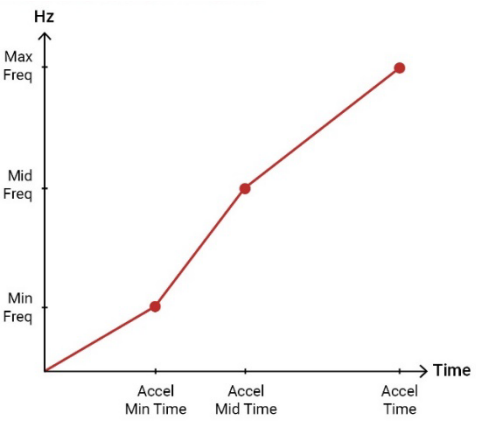
4.7 Menu Structure Overview

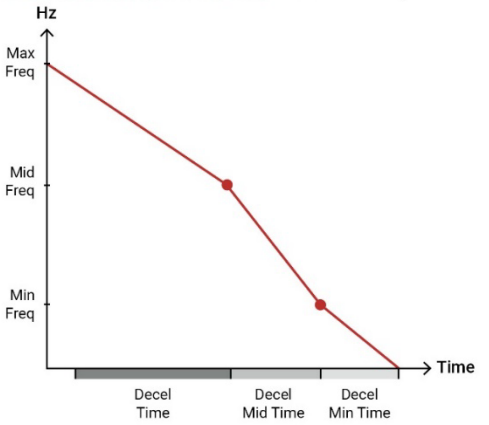



Clear Memory
Fault Log
Restart Log
Read Timers
Alarms
Read Mesured Values
I_U I_V I_W
Output HP
Output kW
Output kVA
Output PF
Bus Cap Voltage
Input Voltage
Aux1 Aux2
Aux3 Aux4
Frequency
Model Number
10 VDC Input
I1 4-20 mA Input
I2 4-20 mA Input
Time Until Start
Input Current
Aux Power Currents
RTC
IGBT Case Temp
Next Run Timers
Lead Lag Parameters
Number Lag Pumps
Stage Pump Delay
Destage Pump Delay
Destage Min Frequency
Stage Frequency Reduction 1
Stage Frequency Reduction 2
Stage Frequency Reduction 3
Stage Frequency Reduction 4
Stage Time
Destage Frequency Boost 1
Destage Frequency Boost 2
Destage Frequency Boost 3
Destage Frequency Boost 4
Destage Time
Stage psi Lag
Destage psi Lag
Force Frequency Control
Precharge Pumps
PID Control Parameters
Analog Config
4-20 mA psi Sensor Range
psi Msr Offset
psi Setp Offset
Analog Input Control
Analog Setpoint Control
Analog Select I1
Analog Select I2
Analog Select 10V
Analog Input Reverse I1
Analog Input Reverse I2
Analog Input Reverse 10V
Proportional Gain
Integral Gain
Derivative Gain
Derivative Delay Time*
PID Update Rate*
PID Measurement Filter Rate*
Dynamic Gain Enable*
Torque Control Parameters
Enable Torque Control
Motor Rated HP
Motor Rated Voltage
Motor Rated Current
Motor Rated RPM
Speed Proportional Gain
Speed Integral Gain
Torque Proportional Gain
Torque Integral Gain
Flux Proportional Gain
Flux Integral Gain
Torque Limit
Flux Reference
Disable Regen

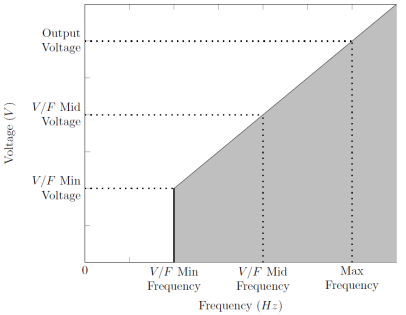
4.8 Parameter Tables

Table 16 – Operating Parameters

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Output Voltage	Output voltage on main motor terminals. Cannot be increased past 240 VAC or 480 VAC depending on model number.	230/180/240 460/380/480
Min Frequency	Minimum output frequency allowed except during startup ramp. When SUBMERSIBLE PUMP parameter is enabled, frequency will ramp from stop to ***MIN FREQUENCY*** in one second. Important in protecting thrust bearing in submersible pumps.	30/5/120
Max Frequency	Maximum frequency allowed, or target frequency at start-up ramp. This value cannot be lower than ***MIN FREQUENCY***.	60/5/300
Acceleration Profile	Press ENTER to see the following parameters related to Acceleration Profile.	
Start Up Ramp Time	Time in seconds from ***MIN FREQUENCY*** to ***MAX FREQUENCY***. Ramp speed is linear.	12/1/120
Acceleration Curve Select	Select how many points occur on the startup ramp profile.	Default: Min – Max
Acceleration Time	Use these parameters to set a multi-speed acceleration profile according to the chart below. 	12 s/0/120
Acceleration Min Time		1 s/0/120
Acceleration Middle Time		6 s/0/120
Acceleration Middle Frequency		45 Hz/5/120
Deceleration Profile	Press ENTER to see the following parameters related to Deceleration Profile.	
Shut Down Ramp Time	Time in seconds from ***MAX FREQUENCY*** to ***MIN FREQUENCY*** when motor receives a STOP command. Ramp time is linear. Factory default setting enables the **COAST TO STOP** parameter which disables the **SHUTDOWN RAMP** parameter.	5/1/120
Deceleration Curve Select	Select how many points occur on the deceleration ramp profile.	Default: Max - Min
Deceleration Time	Use these parameters to set a multi-speed deceleration profile according to the chart below. ***COAST TO STOP*** must be NO.	6 s/0/120
Deceleration Min Time		6 s/0/120

<table>
<tr><td>Deceleration Middle Time</td><td rowspan="2"> 
</td><td colspan="2">6 s/0/120</td></tr>
<tr><td>Deceleration Middle Frequency</td><td colspan="2">45 Hz/5/120</td></tr>
<tr><td rowspan="2">Overcurrent Limit</td><td rowspan="2">Setting for motor overload protection, Trip Class 10 curve.</td><td>240 V Output</td><td>480 V Output</td></tr>
<tr><td>7 HP: 27/3/32
10 HP: 31/3/34
15 HP: 46/3/48
20 HP: 61/3/66
25 HP: 76/3/78
30 HP: 92/3/96</td><td>7 HP: 13/3/13
10 HP: 18/3/22
15 HP: 24/3/26
20 HP: 30/3/32
25 HP: 38/3/46
30 HP: 46/3/48
40 HP: 61/3/66
50 HP: 76/3/78
60 HP: 92/3/96
75 HP: 107/3/112
100 HP: 142/3/145
125 HP: 172/3/178
150 HP: 198/3/200
200 HP: 264/3/268
250 HP: 304/3/313
300 HP: 362/3/372
350 HP: 415/3/427
400 HP: 478/3/530</td></tr>
</table>

Under Current	Unit shuts down when output current goes below the set value (commonly used for dry well protection). Drive must be stopped to adjust this value. Max Freq. must be greater than 57 Hz to engage this protection.	**240 V Output** 7 HP: 0/0/26 10 HP: 0/0/27 15 HP: 0/0/46 20 HP: 0/0/61 25 HP: 0/0/76 30 HP: 0/0/92	**480 V Output** 7 HP: 0/0/14 10 HP: 0/0/20 15 HP: 0/0/26 20 HP: 0/0/30 25 HP: 0/0/38 30 HP: 0/0/46 40 HP: 0/0/61 50 HP: 0/0/76 60 HP: 0/0/92 75 HP: 0/0/107 100 HP: 0/0/142 125 HP: 0/0/172 150 HP: 0/0/198 200 HP: 0/0/264 250 HP: 0/0/304 300 HP: 0/0/362 350 HP: 0/0/415 400 HP: 0/0/478
Current Unbalance*	% current unbalance allowed on output phases. Only available on 2- HP and larger models.		80/1/100
Switching Frequency	Switching frequency of the IGBT inverter module. Range varies based on the rated HP of the drive.		2-100 HP: 4k/2k/5k 125-400 HP: 2k/2k/5k
Coast to Stop	Selects between coast to stop or ramp to stop. Ramp profile is controlled by parameter ***SHUTDOWN RAMP***. YES = coast to stop, NO = ramp to stop.		Default: Yes
GND Fault Detect Fault Sensitivity	Detects fault between any output line and earth. Sensitivity to fault detection is adjustable to avoid nuisance trips. Lower value equals lower sensitivity to fault detection.		Disabled/1/9
Submersible Pump	**ENABLE THIS FEATURE WITH SUMBERSIBLE PUMPS.** Frequency will ramp from stop to the value set by parameter ***MIN FREQUENCY*** in one second. Submersible pumps suffer damage to the thrust bearing if operated below 30 Hz for more than 1 second. YES = one second ramp time from stop to minimum frequency NO = linear ramp from stop to ***MAX FREQUENCY***. ***MIN FREQUENCY*** is observed while motor is running.		Default: Yes
Reverse Rotation	Reverses motor direction by changing sequence of output phase rotation.		Standard ABC / Reverse ACB
Overload Derate Enable	During heavy startups, drive frequency will slow down to avoid Output Overload fault. Screen will say OVERLOAD DERATE when conditions apply. Setting can be disabled or set to react SLOW, MEDIUM, or FAST.		Default: Medium Disabled Low High
Overcurrent Derate Enable	Drive frequency will slow down to avoid motor overcurrent fault. Frequency will not go below ***MIN DERATE FREQUENCY.*** Screen will say OVERCURRENT DERATE when conditions apply.		Default: Yes
Over Temp Derate Enable	Drive frequency will slow down to avoid drive over temperature fault. Frequency will not go below ***MIN DERATE FREQUENCY.*** Screen will say OVER TEMP DERATE when conditions apply.		Default: Yes
Minimum Derate Frequency	Output frequency will not go below this value when derating.		45/30/60

PWM Over Modulation*	Output voltage may be lower than the input voltage because of losses from a sinewave filter or input reactor. Monitor output voltage and use this parameter to boost if necessary.	0/0/25
V/F Controls	**Press ENTER to see the following parameters related to V/F Control.**	
V/F Selection	Controls the relationship between voltage and frequency when starting a motor for different applications. **Standard**: Voltage and frequency are proportional. Torque is constant. **Soft Start 1**: Limits voltage during initial ramp to reduce inrush current. Torque is reduced. **Soft Start 2:** Exaggerated **Soft Start** ramp to reduce inrush current and torque more than **Soft Start 1**. **Soft Start 3:** Exaggerated **Soft Start** ramp to reduce inrush current and torque more than **Soft Start 2**. **Torque Boost**: Boosts voltage during initial ramp to increase startup torque.	Default: Standard
V/F Mid Voltage*	Use these settings to customize the V/F ramp profile based on the following graph. These settings can only be used when V/F Selection is set to **5 = Custom**.  	240 V: 120/0/240 480V: 240/0/480
V/F Min Voltage*		240 V: 30/0/240 480 V: 60/0/480
V/F Mid Frequency*		30/3/55
V/F Min Frequency*		15/3/55
Skip Frequencies	**Press ENTER to see the following parameters related to Skip Frequencies.**	
Skip Frequency 1 Setpoint	Sets the first frequency to skip during acceleration and deceleration ramps.	Disabled/0/MAX FREQUENCY
Skip Frequency 1 Bandwidth	Sets the width of the frequency band to be skipped. Skipped frequencies will center around **Skip Frequency Setpoint 1**.	0/0/30
Skip Frequency 2 Setpoint	Sets the second frequency to skip during acceleration and deceleration ramps.	Disabled/0/MAX FREQUENCY
Skip Frequency 2 Bandwidth	Sets the width of the frequency band to be skipped. Skipped frequencies will center around **Skip Frequency Setpoint 2**.	0/0/30
Skip Frequency 3 Setpoint	Sets the third frequency to skip during acceleration and deceleration ramps.	Disabled/0/MAX FREQUENCY
Skip Frequency 3 Bandwidth	Sets the width of the frequency band to be skipped. Skipped frequencies will center around **Skip Frequency Setpoint 3**.	0/0/30

* - Parameters must be enabled by navigating to **INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.

Table 17 – Auto Restart Parameters

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Enable Restarts	Controls the ability of the drive to automatically restart after a fault. NO = no auto restarts and unit will initialize in OFF mode YES = Auto mode on initialization and auto restarts allowed	Default: No
Under Current Delay	Time in seconds Under Current is allowed before unit trips.	4/0/9999
Restart Delay	Delay in seconds before unit restarts after a fault trip.	60/0/9999
Number of Auto Restarts	Number of automatic restarts allowed after a fault trip.	10/0/9999
Startup Delay	Delay (in sec.) before a restart after an input power OFF/ON cycle.	0/0/9999
Short Cycle Delay	Delay, in seconds, before motor starts after a RUN command. Prevents the drive from engaging the motor when it is spooling down during coast-to-stop operation. Delay affects both manual RUN command and RUN command from external signal in auto mode. Display will count down seconds until RUN.	3/0/300
Sensor Connection Fault Delay*	Delay in seconds when the 4-20mA signal is lost before ***Sensor Conn Fail*** fault is triggered.	10/0/9999
Startups Per Cycle	Number of startup sequence attempts the drive will perform after power is cycled, before requiring power to be cycled again.	0/0/10
Max Cycle Time	Maximum amount of time the drive will attempt to perform the startup sequence before requiring power to be cycled again.	1hr/0/7 days

Table 18 – Interface Parameters

<table>
<tr><th>DISPLAY MESSAGE</th><th>DESCRIPTION</th><th>DEFAULT/MIN /MAX VALUE</th></tr>
<tr><td>System Config

(see Section 5.5, System Configuration for detailed information)</td><td>Sets the system configuration.
0 = ON/OFF control using AUX1 and AUX2. Both AUX1 and AUX2 must have a contact closure to run. By default, jumper wires will be installed, closing AUX1 and AUX2.
1 = Digital Constant Pressure control.
2 = Analog Constant Pressure control.
3 = Analog Constant Pressure with redundant sensors and up to four psi setpoints. Control setpoint will change based on the states of AUX3 and AUX4, as shown in the table below.
<table>
<tr><th>AUX3</th><th>AUX4</th><th>Psi Setpoint</th></tr>
<tr><td>Open</td><td>Open</td><td>1</td></tr>
<tr><td>Closed</td><td>Open</td><td>2</td></tr>
<tr><td>Open</td><td>Closed</td><td>3</td></tr>
<tr><td>Closed</td><td>Closed</td><td>4</td></tr>
</table>
4 = Analog Constant Pressure with dual sensors and two psi setpoints. Control setpoint will change based on the states of AUX3 and AUX4.
5 = Speed control proportional to 0-10VDC analog signal (speed potentiometer).
6 = Speed control proportional to 4-20mA analog signal.
7 = Analog constant pressure (4-20 mA only) with HOA switch and motor speed control by potentiometer.

See Section 5.5, for more details.</td><td>0/0/7</td></tr>
<tr><td>Troubleshooting</td><td>Used to access Advanced Parameters and clear memory.
0 – 2 = Reserved for factory use
3 = Advanced Parameters
4 = Clear Run Timers
5 = Clear Fault Log</td><td>0/0/5</td></tr>
<tr><td>Password Setup</td><td>Allows keypad function to be password protected. When keypad is locked, it will prompt for a user-defined four-digit password. A parameter value of “0000” disables password protection. Each digit can go from 0 to F: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, F. Press enter to select the next digit.</td><td>0000/0000/FFFF</td></tr>
<tr><td>Program Relay No. 1</td><td>Programmable normally open / normally closed relay. Control Terminals 1NC, 1NO, and COM. The relay can be programmed to change state for the following conditions:
0 = System Fault: State will change when drive faults.
1 – 3 = Reserved
4 = Pump Fault e.g. motor overload, under current, etc.
5 = Minimum Frequency. Relay changes state when motor frequency is greater than the value set by parameter MIN FREQUENCY. (see Note 1 at end of table)
When lead/lag pump control has been selected, it will override programmable Relays 1,2,3 and 4.
6 = Jockey Pump. Relay will not participate in lead/lag or multiplex pump control. Instead, relay will change states when motor frequency is greater than 0, and open when it is exactly 0. This setting is only available for Relay 1.</td><td>0/0/6</td></tr>
</table>

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Program Relay No. 2	Programmable normally open / normally closed relay. Control Terminals 2NC, 2NO, COM. The relay can be programmed to change state for the following conditions: 0 = System Fault; State will change when drive faults. 1 – 3 = Reserved 4 = Pump Fault e.g. motor overload, under current, etc. 5 = Minimum Frequency. Relay changes state when motor frequency is greater than the value set by parameter ***MIN FREQUENCY***. (see Note 1 at end of table) When lead/lag pump control has been selected, it will override programmable Relays 1,2,3 and 4.	0/0/5
Program Relay No. 3	Programmable normally open relay. Control Terminals 3NO, 3C. See Parameter ***PROGRAM RLY 2*** above for description of values.	0/0/5
Program Relay No. 4	Programmable normally open relay. Control Terminal 4NO, 4C. See Parameter ***PROGRAM RLY 2*** above for description of values.	0/0/5
Disable Manual Mode	Disables manual operation of the drive through the keypad. Operating states are limited to AUTO and OFF. YES = MANUAL mode disabled	Default: No
AUX1 Select AUX2 Select	Programmable digital inputs. Generally used for motor Run/Stop control. 0 = RUN/STOP (closed = RUN, open = STOP) 1 = Always in RUN mode (no jumper or switch required) 2 = Latching relay. When the connection between the AUX terminal and COM is opened the drive will stop the motor and display a fault on the screen. The motor will remain stopped even if the connection is closed. The fault must be cleared by pressing the ENTER key. 3 = Function Disabled for AUX1. 4 = Reverse Latching Relay. When the connection between the AUX terminal and COM is **closed** the drive will stop the motor and display a fault on the screen. The motor will remain stopped even if the connection is opened. The fault must be cleared by pressing the ENTER key. 5 = Reset Drive Fault. Turning AUX ON will reset VFD fault. If AUX is ON when fault happens, AUX must be turned OFF then back ON to reset fault. Function of these inputs can change when certain System Configuration settings are chosen. See **Section 5.5.**	0/0/5 0/0/5

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
AUX3 Select AUX4 Select	Programmable digital inputs. Generally used for motor Run/Stop control. 0 = RUN/STOP (closed = RUN, open = STOP) 1 = Always in RUN mode (no jumper or switch required) 2 = Latching relay. When the connection between the AUX terminal and COM is opened the drive will stop the motor and display a fault on the screen. The motor will remain stopped even if the connection is closed. The fault must be cleared by pressing the ENTER key. 3 = Reverse Rotation. When the circuit closes the motor will reverse rotation. 4 = Reverse Latching Relay. When the connection between the AUX terminal and COM is **closed** the drive will stop the motor and display a fault on the screen. The motor will remain stopped even if the connection is opened. The fault must be cleared by pressing the ENTER key. 5 = Reset Drive Fault. Turning AUX ON will reset VFD fault. If AUX is ON when fault happens, AUX must be turned OFF then back ON to reset fault. Function of these inputs can change when certain System Configuration settings are chosen. See **Section 5.5**.	1/0/5 1/0/5
RTC Setup	Real-Time Clock 022421 20:58:46 MO/DD/YR H:M:SS Enter button moves the character to the right, use UP and DOWN keys to select the number.	Date and Time
LCD Contrast	Used to adjust the contrast of the graphic display.	40/30/59
Analog Output Control	**Press ENTER to see the following parameters related to Analog Output Control.**	
IOUT Select	Used to turn on and select the range of the IOUT signal.	Disabled
VOUT Select	Used to turn on and select the range of the VOUT signal.	Disabled
IOUT Source	Used to select what variable the IOUT signal corresponds to (Output Amps, kW, analog input, etc).	Hz
VOUT Source	Used to select what variable the VOUT signal corresponds to (Output Amps, kW, analog input, etc).	Hz
IOUT Reverse	Reverses the scale of the IOUT signal.	No
VOUT Reverse	Reverses the scale of the VOUT signal.	No
Analog Output Max Range	Sets the maximum value corresponding to the IOUT and VOUT signals.	50/0/500
Modbus Control	**Press ENTER to see the following parameters related to Modbus.**	
Modbus ID	Address of the drive for a modbus network.	1/0/1000
Modbus Stop Bits	Number of bits transmitted after each character to detect the end of the character.	1/1/2
Modbus Parity	Sets how the parity bit of the character's data frame is set.	None/Odd/Even
Modbus Baud Rate	Serial baud rate or the rate at which information is transferred.	19200/4800/ 19200

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Modbus Wiring	Select between using 2-wire or 4-wire Modbus configuration.	Default: 4-wire
Modbus Fault Select	Select how the drive responds when serial communication is lost. Options are to fault or stop the output of the VFD without faulting.	Stop Output
Modbus Fault Time	In seconds. Select how long serial communication loss persists before Modbus Fault Select state takes effect.	0/0/120
Enable Run Timers	Enables command scheduler using Run Timers listed below.	No
Run Timers	**Press ENTER to see the following parameters related to Run Timers.**	
Run Timer 1	The first of four scheduling functions. Can be used to give commands at certain times throughout the day or week.	
Run Timer 1 Reference	Choose what happens during scheduled times. Can be used to select control method or stay on or off.	Analog Control
Run Timer 1 Days	Choose when the schedule repeats. Options include: Daily, Monday-Friday, Sat-Sun, or a specific day of the week.	Disabled
Run Timer 1 Times	Choose up to 6 time periods for scheduled task to take effect.	1/1/6
Run Timer 2	See description for **Run Timer 1**. Used to schedule multiple commands.	
Run Timer 3	See description for **Run Timer 1**. Used to schedule multiple commands.	
Run Timer 4	See description for **Run Timer 1**. Used to schedule multiple commands.	

Note 1: This setting is typically used to control ancillary equipment in concert with motor RUN/STOP commands. *For example*, to control a chlorinator so that it operates only when the motor is pumping water.

Table 19 – Constant Pressure Parameters

Programming Tip

Constant Pressure parameters are only displayed when System Configuration has been set for constant pressure. The parameter ***SYSTEM CONFIG*** is in the Interface Parameters sub-menu. See **Table 18** for details. Changing the parameter, ***CONTROL METHOD***, will change the parameters that are visible, for instance, if ***CONTROL METHOD*** is set to ***FLOW***, parameters associated with ***CONSTANT PRESSURE*** and ***TANK LEVEL*** control will not be displayed.

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Broken Pipe psi	Dependent on Control Method selected. Level at which drive will determine there is a broken pipe. Value of zero disables this feature.	0/0/150
Broken Pipe Time	In minutes. Specifies the time that psi must remain below the value set by ***BROKEN PIPE PSI*** to trigger a fault.	0/0/9999
T OFF*	In seconds. Used to prevent short cycling in CP systems. If the motor was off during the last cycle for a period greater than ***TOFF***, the minimum on time of the motor is ***T1ON***. If the motor was off for a period less than ***TOFF***, the minimum on time of the motor is ***T2ON***. Default values give a minimum cycle time of about 1 minute.	30/0/1000
T1 ON*	In seconds. See ***T OFF*** above. Must be set to be less than ***T2ON***.	15/0/1000
T2 ON*	In seconds. See ***T OFF*** above. Must be set to be less than ***T2ON***.	60/0/1000

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Sleep Frequency (Previously Shutoff Frequency)	As Hz. This parameter value is added to the frequency set by ***MIN FREQ*** (**Table 16).** The combined value is the frequency at which drive will enter sleep mode when pressure is controlled at the set point.	7/0/300
Boost Amount	As a % of ***MAX FREQUENCY*** for digital CP systems, or as psi for analog CP systems. In digital CP systems, this increases motor speed by the % of the parameter value, for a specified time before the motor shuts down in sleep mode. In analog CP systems the parameter value specifies a pressure increase in psi before sleep mode.	-
Boost Time*	In seconds. Length of time the drive will increase motor speed based on the parameter ***BOOST AMOUNT*** before entering sleep mode. Only used for Digital Constant Pressure.	3/0/300
Precharge Frequency	In Hz. Sets the frequency applied during the precharge interval.	30/1/120
Precharge Time	In seconds. Sets the maximum time for pre-charge regardless of any sensor inputs. A setting of zero disables the pre-charge mode.	0/0/30000
Precharge psi	Used only for analog CP systems. Pre-charge will be terminated when pressure reaches this set point. Should be set less than ***psi SETPOINT***.	20/0/200
Force Sleep psi (Previously Overpressure psi)	This value is added to the value set by parameter ***psi SETPOINT.*** The combined value is the pressure at which drive will stop the motor load. Motor will restart when the pressure falls to the value set by parameter ***WAKE UP PSI***.	20/0/500
Duplex Cycle Time	In hours and minutes. Determines the run time for each cycle of both primary and secondary pump	0/0/9999 hours
Wake Up psi (Previously Draw Down psi)	As psi. Provides hysteresis during sleep mode. Controls the pressure drop below ***psi SETPOINT*** to start motor in sleep mode, e.g. if ***WAKE UP psi*** = 5 and motor sleeps at 50 psi, motor will restart at 45 psi.	5/0/50
Setpoint 1	This sets the level at which the pressure will be controlled. Must be set as a psi value within the range of the 4-20 mA transducer. Make sure the value of the parameter ***4-20mA psi RANGE*** is set to the maximum psi value of the sensor you are using. Up to four psi set points can be used depending upon the System Configuration.	50/0/500
Setpoint 2		50/0/500
Setpoint 3		50/0/500
Setpoint 4		50/0/500

* - Parameters must be enabled by navigating to **INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.

Note 1: The restart counter must be cleared to begin counting the number of restarts from zero. Main Menu item, Clear Memory, resets the fault counters. See **Section 3.2**, *Keypad Main Menu Items,* for more information.

Note 2: Push the up-arrow key and down arrow key simultaneously to interrupt the countdown delay and allow an auto restart.

Table 20 – Lead/Lag Parameters

Programming Tip

Lead/Lag parameters are only displayed when System Configuration has been set for constant pressure. The parameter ***SYSTEM CONFIG*** is in the Interface Parameters sub-menu. See **Table 18** and **Section 5.5**, for details. More information on can also be found in **Section 6.6**.

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Number Lag Pumps	Sets the number of auxiliary pumps that are connected to the relays on the control board. The relays will be called for in order, starting with Relay 1.	0/0/4
Stage Pump Delay	In Seconds. Delay before the system will call for a pump to be staged in.	4/0/3600
Destage Pump Delay	In Seconds. Delay before the system will destage a pump when pressure is maintained at ***MIN FREQUENCY*** of the primary pump.	4/0/3600
Stage Freq Reduction 1	In Hz. Reduces frequency of primary pump for the duration of the ***STAGE TIME*** when the specified pump is staged in.	Lag #1: 5/0/120
Stage Freq Reduction 2		Lag #2: 5/0/120
Stage Freq Reduction 3		Lag #3: 5/0/120
Stage Freq Reduction 4		Lag #4: 5/0/120
Stage Time	In Seconds. This is the interval for which the system will reduce its frequency by ***STAGE FREQ REDUCTION.***	4/0/3600
Destage Freq Boost 1	In Hz. Increases frequency of primary pump for the duration of the DESTAGE TIME when the specified pump is destaged.	Lag #1: 5/0/120
Destage Freq Boost 2		Lag #2: 5/0/120
Destage Freq Boost 3		Lag #3: 5/0/120
Destage Freq Boost 4		Lag #4: 5/0/120
Destage Time	In Seconds. This is the interval for which the system will increase its frequency by **DESTAGE FREQ BOOST**.	4/0/3600
Stage psi Lag	In psi. Allows the system to fall below the control psi by this amount before the system starts counting ***STAGE TIME.*** Assumes max Hz.	5/0/200
Destage psi Lag	In psi. Allows the system to exceed the control psi by this amount before the system starts counting ***DESTAGE TIME.*** Assumes min Hz.	3/0/200
Destage Min Frequency	In Hz. ***MIN FREQUENCY*** of primary pump plus this amount to destage.	5/0/120
Precharge Pumps	Sets the number of auxiliary pumps that will assist the primary pump during a pre-charge interval. **CAUTION!** This number should never be greater that the total number of lag pumps as it will activate the associated programmable relay which may be used for other functions.	0/0/4

Table 21 – PID Control Parameters

DISPLAY MESSAGE	DESCRIPTION	DEFAULT/MIN /MAX VALUE
Analog Config	**Press ENTER to access the following Analog parameters:**	
4-20 mA psi Sensor Range	This value should be set to the maximum value of the 4-20 mA pressure transducer being used for constant pressure control. i.e. if the transducer has a range of 0-150 psi, the parameter should be set to 150. This parameter is critical for accurate pressure control.	150/50/500
psi Msr Offset	This is used to calibrate the pressure that the VFD registers from pressure transducer if a manual pressure measurement is not equal to what VFD is reading. For instance, if VFD reads 40 psi, but manual measurement shows 50 psi, this setting should be set to +10.	0/-50/+50
psi Setp Offset	Used to calibrate an analog input signal if the VFD registers a value different than expected from a speed pot or PLC.	0/-50/+50
Analog Input Control	**Press ENTER to access the following Analog Input parameters:**	
Analog Setpoint Control	Determines how the VFD is controlled based on analog input. **Analog Control** = Analog input will control the control setpoint. **Frequency** = Analog input will control VFD output frequency.	Default: Disabled
Analog Select I1	Selects the function of the I1 terminal. **Measurement** – use I1 as primary reference for speed control. **Setpoint** – use I1 to change the control setpoint. **Backup** – use I1 as backup measurement if main measurement fails.	Default: Measurement
Analog Select I2	Selects the function of the I2 terminal. **Measurement** – use I1 as primary reference for speed control. **Setpoint** – use I1 to change the control setpoint. **Backup** – use I1 as backup measurement if main measurement fails.	Default: Disabled
Analog Select 10V	Selects the function of the 10VDC terminal. **Measurement** – use 10VDC as primary reference for speed control. **Setpoint** – use 10VDC to change the control setpoint. **Backup** – use 10VDC as backup measurement if main measurement fails.	Default: Disabled
Analog Input Reverse I1	Reverses the scale of the I1 input.	Default: No
Analog Input Reverse I2	Reverses the scale of the I2 input.	Default: No
Analog Input Reverse 10V	Reverses the scale of the 0-10 VDC input.	Default: No
Proportional Gain	Multiplier for the analog error signal in an analog CP system. When parameter is set to zero, the keypad displays **SIMPLE MODE** and the controller switches to an algorithm which does not require a gain setting. When using PI control, best results will be obtained by starting with a value of 5.	5/0 (Simple Mode)/60
Integral Gain	Multiplier for the integral term in PI control of analog CP. Used to fine tune control of unstable systems. Parameter is disabled when ***PROPORTIONAL GAIN*** is set to **SIMPLE MODE.**	12/0/100
Derivative Gain	Used to reduce overshoot and oscillation. Should be used only when necessary because it tends to amplify noise in the transducer signal. It may cause the system to become unstable.	2/0/50
PID Filter Gain*	Controls the rate of frequency increase in response to the error term.	0/0/100
PID Filter Time*	In seconds. Sample interval for the PID Filter Gain.	1/0/10

* - Parameters must be enabled by navigating to **INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.

5 OPERATION

5.1 Commissioning the Unit

It is always advisable to check the operating status of the drive and its load before commencing regular operation.

Initial Operation
Verify the following:

1. The unit is securely attached to the proper mounting surface.
2. The unit's input terminals are connected to an appropriate power source.
3. An appropriately rated motor is connected to the output terminals.
4. The motor is secured and properly mounted.

Setup Wizard
Upon the first initialization of the unit (or after restoring factory defaults of all parameters) the drive will prompt the user to select or decline a Setup Wizard. Setup Wizards allows users to quickly setup commonly used control schemes: Constant Pressure Control, Flow Control, Tank Level Control, Pump Down Control, and Suction Pump Control. The wizards will guide users through a list of commonly used parameters for the control method selected. Use the UP and DOWN keys to select which control method you would like to set up then press ENTER. If you would rather program the drive manually, press HOME to skip this step.

5.2 VFD Setup Procedure

1. If remote or automatic ON/OFF function is required, connect remote switch leads to the AUX1 and COM terminals. An additional remote switch or jumper wire may be connected to the AUX2 and COM terminals. The **AUX1 to COM and AUX2 to COM jumper wires will already be installed by the factory, remove as needed for pressure switches or remote ON/OFF switches.**

2. If a Constant Pressure (CP) water system will be operated, connect the pressure sensors to the appropriate Control Terminals. See **Section 5.5**, *System Configuration,* and **Section 6**, *Constant Pressure Systems* for details.

3. Apply power to the input terminals of the drive by turning on the input circuit breaker or disconnect switch.

4. The graphic display will scroll through several start-up sequence messages.

5. If the ***ENABLE RESTARTS*** parameter is set to allow restarts, the drive will initialize in AUTO mode and the motor will run when control signals call for a motor run condition. To prevent the motor from running at start-up, immediately after initialization, press the STOP/OFF key until ***OFF*** appears on the display or open AUX1 or AUX2.

6. Confirm that the unit has properly energized, and the display indicates the OFF mode.

7. Using the keypad and display, navigate to the Main Menu item, ***CHANGE PARAMETER VAULES,*** to set the following parameters for basic operation:

- ***INTERFACE PARAMETERS > SYSTEM CONFIG*** This parameter is critical to the operation of the system. The default setting is for simple ON/OFF operation. See **Section 5.5**, *System Configuration*, for complete information.

- ***OPERATING PARAMETERS > OVERCURRENT LIMIT*** This parameter sets the motor overload protection. See **Section 5.4**, *Motor Overload Protection,* for complete information.

- ***AUTO RESTART PARAMETERS > ENABLE RESTARTS*** This parameter enables the drive to initialize in AUTO mode and to restart automatically after a fault. Factory default allows auto restarts.

8. Push the MANUAL key until ***MANUAL*** appears on the display for manual mode, then push RUN to start the motor. In manual mode, the RUN key will override an open AUX terminal or other external control signal. Push the STOP key to stop the motor in manual mode.

   ⚠ **CAUTION**: In manual mode, pushing the RUN key will override all external control signals, including constant pressure sensors. Dangerous pressure rise in closed plumbing systems is possible.

9. The motor will start with the default acceleration ramp time of 0-30 Hz in one second, then 30-60 Hz in twelve seconds.

10. Confirm that the motor rotation is correct. Swapping any two of the output leads will reverse the motor rotation.

11. After initial power-up, use the keypad and display to navigate to ***CHANGE PARAMETER VALUES*** to set any other adjustable parameters you wish to be different from the factory defaults.

5.3 Ground Fault Detection

These drives are equipped with a feature to detect a fault between any of the output lines and earth. If a ground fault is strong enough to trigger the parameter ***GND FAULT DETECT***, the drive will not allow the IGBTs to switch. However, this does not protect the drive from damage in all situations. **If a ground fault occurs, immediately disconnect the input power!** Long motor leads and a dV/dt filter can cause nuisance indications of a ground fault. If a megger does not indicate a ground fault, the sensitivity of the ground fault detection may need to be reduced by reducing the value of parameter ***GND FAULT DETECT.***

⚠ **CAUTION**: Before the motor is connected to the output terminals, check all output lines for line-to-ground faults using a megger. There is a direct path through the drive circuitry for ground fault currents that can be triggered when power is applied to the input terminals, even though the output switches are not activated. These currents can cause serious damage to drive circuitry and are not covered under warranty.

⚠ **WARNING!** The default operating mode when the unit is energized is OFF. If the parameter ENABLE RESTARTS has been set to allow restarts, the unit will energize in AUTO mode. If the external controls are calling for a motor run condition, the motor will start. Make sure either external controls are off before energizing the input, or as soon as the unit has initialized, push the STOP/OFF key until ***OFF*** appears on the display. Refer to **Section 3.1**, *Using the Keypad and Display*, for instructions on operating the keypad.

5.4 Motor Overload Protection

These drives are equipped with adjustable solid-state motor overload protection. Protection is based on a Class 10 trip curve. Motor overload settings are selected by navigating to the appropriate menu item using the keypad and display.

Thermal Memory and Thermal Memory Retention
The motor overload protection is equipped with thermal memory and thermal memory retention capabilities.

THERMAL MEMORY is the ability of an overload protective system to approximate the heating cooling of a protected motor during operation.

THERMAL MEMORY RETENTION maintains the thermal memory upon shutdown or power loss. This includes retention of the last thermal value and may include an ongoing reduction of this thermal value to reflect the cooling of the motor. This information will be used by the overload protective system to approximate the thermal state of the motor upon restart.

⚠ **CAUTION**: Do not attempt to restart the motor immediately after a motor overload fault. The motor overload protection system uses a timer to approximate motor cooling and may trigger an immediate overload fault if the motor is restarted too soon.

If the drive loses power immediately after a motor overload fault, it will not begin counting down the time that approximates motor cooling until the drive is energized. If the drive faults with a motor overload, it may be necessary to allow time for this countdown before the motor is operated even though the motor has been off for an extended period.

Setting Motor Overload Protection with Keypad
To set motor overload protection with the keypad, navigate to the Main Menu item ***CHANGE PARAMETER VALUES > CHANGE OPERATING PARAMETERS > OVERCURRENT LIMT***.

5.5 System Configuration

The drive can operate several types of systems, including constant pressure water systems, and simple ON/OFF control from remote switches. **The correct system configuration must be selected for proper operation of the different types of control systems!**

System configuration is set by navigating to the keypad Main Menu item ***CHANGE PARAMETER VALUES > CHANGE INTERFACE PARAMETERS > SYSTEM CONFIG***. Refer to **Section 4.1**, *Changing Parameter Values,* **Table 18**, *Interface Parameters,* for detailed instructions. Below is a brief description of each configuration setting:

- **System Configuration = 0**: **Basic RUN/STOP operation**. This is the factory default configuration for basic operation of the drive that allows RUN/STOP control of the motor in AUTO mode using a dry contact on AUX1 and/or AUX2. Both AUX1 and AUX2 must have a contact closure to run. AUX3 and AUX4 can be enabled if needed.

- **System Configuration = 1**: **Digital Constant Pressure**. Use this setting to operate digital constant pressure systems. Refer to **Section 6.3**, for more information on operating the drive in this mode.

- **System Configuration = 2**: **Basic Analog Constant Pressure**. Use this setting to operate analog constant pressure systems with a 4-20 mA transducer. Refer to **Section 6.4**, *Analog Constant Pressure Systems*, for more information on operating the drive in this mode. Refer to **Figure 9** for a diagram illustrating connection of the transducer to Control Terminals.

- **System Configuration = 3**: **Analog Constant Pressure with redundant sensors and up to four PSI Setpoints**. This configuration allows the use of two 4-20 mA transducers. The primary sensor is

connected to the *I1*+ and *I1*- Control Terminals, with the backup sensor connected to the *I2*+ and *I2*- Control Terminals. If the primary sensor fails, the backup sensor will automatically take over control of constant pressure at the same settings.

Multiple control setpoints can also be used in this configuration. Enter the value of these setpoints in the Constant Pressure menu item, ***CONTROL SETPOINTS***. Signature and Performance drives can use up to four setpoints, while Enterprise drives can only control based on two setpoints.

The tables below shows what set point the system will follow based on the configuration of the **AUX3** and **AUX4** terminals for Signature and Performance drives. For Signature and Performance drives, **AUX1 and AUX2 must also be closed for the system to run.**

Table 22 – System Configuration Setpoints – Signature and Performance drives

AUX3	AUX4	Psi Setpoint
Open	Open	1
Closed	Open	2
Open	Closed	3
Closed	Closed	4

System Configuration = 4: **Analog Constant Pressure with dual sensors and two psi set points**. In this configuration a 4-20 mA transducer connected to Control Terminals I1+ and I1- controls pressure equal to the first setpoint (***psi1, GPM1, Ft1***), and a second sensor connected to the I2+ and I2- Control Terminals controls pressure equal to the second setpoint (***psi2, GPM2, Ft2)***. Enter the value of these set points in the Constant Pressure parameter, ***CONTROL SETPOINTS***.

The digital input on Control Terminals AUX2 control selection of the different set points when the pump is operating. AUX1 functions as a RUN/STOP input where AUX1 closed = RUN, AUX1 open = STOP. The control scheme for the two psi set points is as follows:

1. If AUX2 is open the sensor on *I1* will be in control and set point will be equal to ***psi1/FPM1/Ft1***, depending on which option is selected for ***CONTROL METHOD***.
2. If AUX2 is closed the sensor on *I2* will be in control and psi set point will be equal to ***psi2/GPM2, Ft2***, depending on which option is selected for ***CONTROL METHOD***.

- **System Configuration = 5**: **Speed control with 0-10 VDC analog signal.** Use this setting for motor speed control by a potentiometer or an external 0-10 VDC source connected to the 0-10 VDC Control Terminals. Refer to **Figure 10** for a diagram illustrating connection of the potentiometer or the voltage source to Control Terminals. The drive will ignore the DC analog signal until it reaches a value proportional to the speed set by the parameter, ***MIN FREQUENCY***, which has a factory default setting of 30 Hz. For speed control across the full-scale range of the analog signal, set ***MIN FREQUENCY*** to the minimum value of 5 Hz. AUX1 and AUX2 must be closed to run in this System Configuration.

- **System Configuration = 6**: **Speed control with 4-20 mA analog signal**. Use this setting for motor speed control proportional to a 4-20 mA analog signal. The drive will ignore the analog signal until it reaches a value proportional to the speed set by the parameter, ***MIN FREQUENCY***, which has a factory default setting of 30 Hz. For speed control across the full-scale range of the analog signal, set ***MIN FREQUENCY*** to the minimum value of 5 Hz. Refer to **Figure 9** for a diagram illustrating connection of the transducer to Control Terminals. When using an external 4-20 mA source, connect the leads to *I1*- and COM. AUX1 and AUX2 must be closed to run in this System Configuration.

⚠ **CAUTION**! This is not a constant pressure control mode. Motor speed will be controlled in a linear fashion proportional to the analog signal.

System Configuration = 7: Analog constant pressure with HOA and speed potentiometer. This setting allows the user to either turn the motor off, control motor speed with a potentiometer or operate in analog constant pressure mode using an HOA switch. Access to the keypad is not required to operate in this mode. A mechanical HOA switch changes the state of AUX1 and AUX3 Control Terminals to change to mode of operation in this configuration. A potentiometer is connected to the 0-10 VDC control Terminals, a 4-20 mA analog transducer is connected to the I+ and I- Control Terminals, and a double pole, triple throw HOA switch is connected to AUX1 and AUX3 Control Terminals.

- AUX1 controls for motor run and stop. When the switch is in the OFF position AUX1 is open and the motor will stop. When it is closed (either HAND or AUTO position) the motor will run. AUX3 toggles between analog constant pressure and motor speed control by the potentiometer. When the switch is in the AUTO position and AUX3 is open the drive will operate in analog constant pressure mode. When the switch is in the HAND position it is closed, and the potentiometer will control motor speed.

- Refer to **Figure 9** for a diagram illustrating connection of the transducer to Control Terminals. AUX2 must be closed to run in the Analog CP Mode (Auto), and AUX 2 is ignored when the speed potentiometer is used (Hand).

The System Configuration must be in any of the constant pressure modes to enable Pre-Charge of the plumbing system or Lead/Lag pump control. See **Section 6.5**, *Pre-Charge* and **Section 6.6**, *Lead/Lag Pump Control* for more information.

5.6 Start-Up and Shut-Down Ramp Times

Start-up and shut-down ramp times specify the time required to go from Minimum Frequency to Maximum Frequency or vice versa. Ramp times and profiles are adjustable by changing Operating Parameters through the keypad and text display. **The factory default setting for *START UP RAMP*** is 12 seconds and ***SHUTDOWN RAMP*** has been disabled through the ***COAST TO STOP*** parameter to reduce nuisance tripping from high inertia loads.

***SUBMERSIBLE PUMP* Parameter and Minimum Frequency**
Most submersible pump motor manufacturers require the motor to reach 30 Hz within one second to protect the pump from damage. The parameter, ***SUBMERSIBLE PUMP***, limits the time the motor runs below 30 Hz to one second.

When ***SUBMERSIBLE PUMP*** is set to YES, the motor speed will ramp to minimum frequency in one second, then ramp to the maximum frequency in a total of 12 seconds. The ramp times can be changed through the adjustable parameter, ***START UP RAMP***. The default ramp is shown in **Figure 14**. **The factory default setting for *SUBMERSIBLE PUMP* is YES and for *MIN FREQUENCY* it is 30 Hz.**

When the ***SUBMERSIBLE PUMP*** parameter is set to NO, the motor will ramp from stop to the maximum frequency in 12 seconds in a linear fashion as depicted in **Figure 15**.

To set the minimum frequency, navigate to the keypad Main Menu item, ***CHANGE PARAMETER VALUES > CHANGE OPERATING PARAMETERS > MIN FREQUENCY > 30 Hz***.

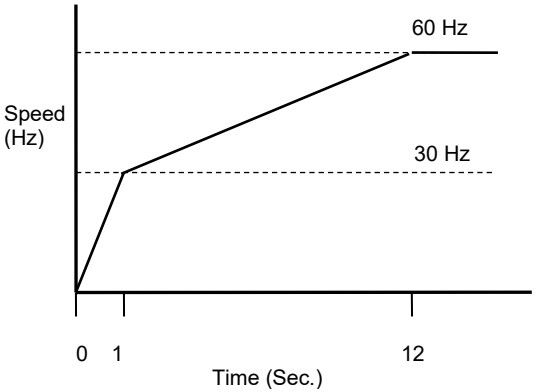


Figure 13 - Default Start-Up Ramp (SUBMERSIBLE PUMP parameter enabled)

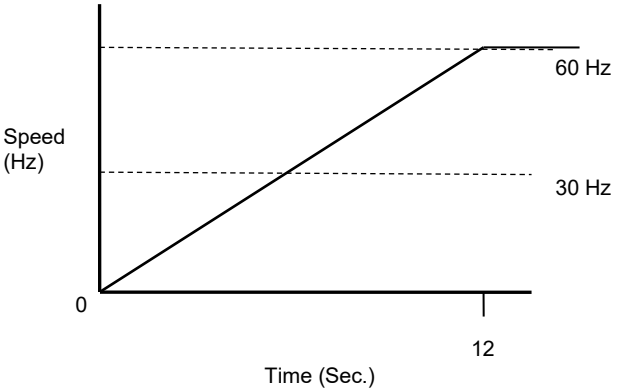


Figure 14 – Start-Up Ramp with SUBMERSIBLE PUMP parameter disabled

⚠ **CAUTION:** Most submersible pump motor manufacturers require the motor to reach 30 Hz within one second to protect the motor from damage. Factory default ramp time is 0-30 Hz in one second, followed by the selected ramp time from 30 Hz to maximum frequency.

5.7 Motor Control Methods (V/f vs. Torque Control Specific To V-Series Products)

Advanced motor control methods can be selected through Operating Parameters found in **Table 21**.

V/f Control
V/f, or volts per Hertz, control is the simplest motor control method and is the default operating mode of the drive. V/f control requires limited motor data to the drive and is the only control method that will allow multiple motors to be operated by one drive. If multiple motors are operated, they must all stop and start together.

Compared to open loop vector torque control, V/f control has limited starting torque. Even so, this method is adequate for most variable torque applications such as fans and pumps.

The simplicity of V/f control results in speed regulation approximately 2-3% of maximum frequency compared to about 0.2% for open loop vector control. Again, this level of speed regulation is adequate for most applications.

Open Loop Vector Control
Open loop vector control independently controls motor speed and torque much like DC motors. Compared to V/f control, the motor can develop higher torque at lower speeds. Open loop vector control has a quicker speed response for better control of dynamic loads and superior speed regulation when precise control is required.

It is important that accurate motor information is provided to the drive for open loop vector control. Be sure to enter the motor nameplate values for the parameters ***Motor Rated Voltage***, ***Motor Rated Current*** and ***Motor Rated RPM*** when this mode is selected.

Torque Limit
This parameter allows the user to select a motor torque limit that is less than or greater than 100% of motor torque. Torque limits can be used to prevent damage to the motor and the loads it operates. This parameter is applicable for both motoring mode (positive torque) and regenerative mode (negative torque). The drive will reduce motor speed to avoid exceeding the torque limit.

Flux Reference
Torque is equal to flux times current. Flux reference to the motor is automatically calculated by the inverter using the motor parameters. Users can adjust the flux reference from 10% to 200% of the calculated flux reference. This parameter might be used when the drive experiences overcurrent trying to start a heavy load. At light loads, using the rated flux values decreases the efficiency of the drive. By using flux optimization, the efficiency of the drive increases when operating below rated load.

Flux reference can greatly affect the performance of the system. A flux reference that is too low results in smaller torque production in the motor with large stator currents. If flux reference is too higher, the result is high ripple in torque, large stator currents and low efficiency. Caution should be exercised when adjusting this parameter. Make changes in small increments and monitor motor performance.

6 Constant Pressure Systems

DXL drives can be configured as constant pressure (CP) water systems using either an analog pressure transducer (analog constant pressure system) or pressure switches (digital constant pressure system). A CP water system includes a pressure tank, a pressure gauge to observe system pressure, and pressure switches or sensors.

6.1 Control Principles of Constant Pressure Systems

In a CP system, a target pressure for the system is set on the switch itself (digital CP) or through the keypad (analog CP). Signals from the sensors interact with firmware to control the motor speed and maintain constant water pressure.

In a strict definition of a constant pressure system, the pump would never turn off. If the pressure differential between pump-on and pump-off was zero, the noise fluctuations of the transducer output would cause the motor to cycle constantly between the on and off states. For this reason, most applications will want to accept a small differential pressure in the system to prevent either continuous running of the motor or constant on/off cycling of the motor.

Three basic conditions must be met for the pump to shut down and enter sleep mode:

1. The pressure in the system must be at the pressure control point set by the parameter ***psi SETPOINT*** or at the pressure determined by the setting on the digital pressure switch.
2. The frequency is below ***SLEEP FREQUENCY*** (as defined as ***MIN FREQUENCY*** + input value) or measured pressure is above ***OVERPRESSURE psi*** (defined as ***psi SETPOINT*** + the input value**.**
3. The time expired since the pump started after the last OFF cycle must be greater than parameter ***T1ON*** or ***T2ON.***

Preventing Short Cycling During Low Flow Conditions

When a CP system is in a low flow state, it may be desirable to turn the motor off (sleep mode) to conserve energy and preserve the motor. The adjustable parameters ***TOFF***, ***T1ON***, ***T2ON, SLEEP FREQUENCY, SLEEP psi, WAKE UP PSI, and BOOST AMOUNT*** control when the motor is turned off, how long it is off, and prevent short cycling of the motor at low flow rates. More information including default values for these parameters can be found in **Table 19**.

WAKE UP PSI* and *BOOST AMOUNT

The primary method to prevent short cycling is to allow a differential between the pressure at which the pump turns off and the pressure at which it restarts. Two parameters, ***WAKE UP PSI*** and ***BOOST AMOUNT***, control this differential. ***BOOST AMOUNT*** specifies the increase in pressure above ***psi SETPOINT*** just before the pump shuts down to enter sleep mode, while ***WAKE UP PSI*** specifies the pressure drop below ***psi SETPOINT*** at which the pump restarts. For example, assume ***psi SETPOINT*** = 50, ***BOOST AMOUNT*** = 5, and ***WAKE UP PSI*** = 5. When the pump is ready to enter sleep mode, the pump will boost to 55 psi, then restart when the pressure falls to 45 psi. These two parameters can be used together or independently to create a dead band in pressure control***. SLEEP PSI*** and ***SLEEP FREQ*** can also be set to tell the drive when to enter sleep mode. ***SLEEP psi*** (analog CP only) is the system pressure at which the drive will go to sleep. ***SLEEP psi*** is additional system protection in analog CP. This is a value (entered) + the ***psi SETPOINT.*** The default value for ***SLEEP psi*** is 20. For example, if the ***psi SETPOINT*** is 50psi, the drive will stop if pressure reaches 70 psi.

Similarly, ***SLEEP FREQUENCY*** can be used to put the drive to sleep (for analog or digital constant pressure systems). ***SLEEP FREQUENCY*** is defined as a value (entered) + ***MIN FREQUENCY.*** As constant pressure is achieved and the drive slows down, the unit will go to sleep when ***SLEEP FREQUENCY*** is achieved. It is recommended that ***WAKE UP psi*** and ***SLEEP FREQUENCY*** values be entered when using digital or analog systems.

Digital CP systems cannot utilize the ***WAKE UP PSI*** parameter because the drive receives information from the sensor only when the pressure crosses the pressure set point of the digital sensor. Digital CP systems create a dead band in pressure by relying only on the ***BOOST AMOUNT*** parameter. Unlike analog systems that can measure pressure during the boost, digital systems rely on a specified increase in motor speed for a specified time to achieve a boost in pressure prior to sleep mode. When the System Configuration is set for Digital CP, the value for ***BOOST AMOUNT*** is equal to a per cent increase in maximum allowable motor speed for a specified time. For example, if ***MAX FREQUENCY*** = 60 and ***BOOST AMOUNT*** = 5, the motor speed will increase to 63 Hz (60 x (1+.05) for a time that varies based on boost amount. The user must observe an external pressure gauge to determine if this produces the desired boost amount.

ON/OFF Cycle Timers

The controls also record the length of time the motor remained in the OFF cycle and compare that time to the parameter, ***TOFF***. If the motor-off time during the last OFF cycle was greater than the value of **TOFF,** then the minimum motor-on time will be equal to **T1ON**. If the motor-off time was less than **TOFF**, the minimum motor-on time will be equal to **T2ON**.

In other words, the time of the last OFF cycle determines whether the next ON cycle should be relatively long or relatively short. **Figure 16** demonstrates how the system adjusts the motor-on time in response to motor-off time.

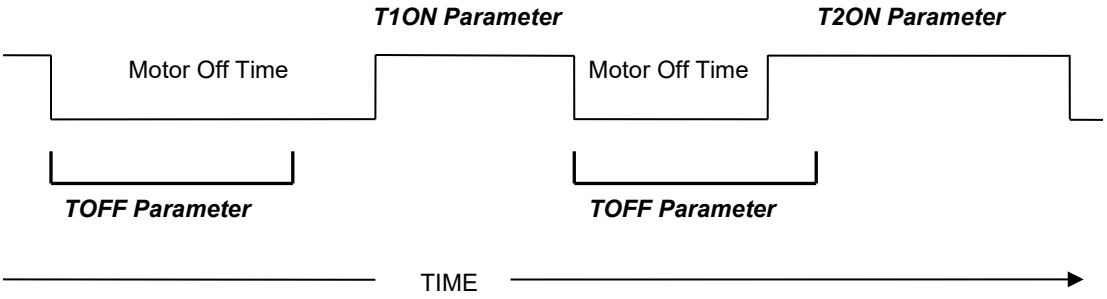


Figure 15 – Motor On and Motor Off Times

Fine Tuning with PI Control

PI control is not available when operating in Digital CP mode.

When operating in analog CP mode, if the parameter ***PROPORTIONAL GAIN*** is set to a value less than 1, the keypad displays ***SIMPLE MODE*** and the controller uses an algorithm that is not PI control. Simple Mode requires less fine tuning than PI control, but in some applications may not provide the control and stability desired. The stability of the constant pressure system (i.e., its tendency **not** to exhibit pressure oscillations) is determined by parameters set on the keypad, the flow rate of the pump, and the volume of the pressure tank. Stability of a system with a large maximum flow rate and a small pressure tank will be more difficult to control and may require de-tuning the system to accept larger variations in the system pressure and longer response times.

Analog constant pressure systems with PI (proportional integral) control provide more options to fine tune pressure control than digital constant pressure systems or analog systems in Simple Mode. Systems that are not adequately controlled with the Simple Mode may require fine tuning by switching to PI control. Increasing the value of ***PROPORTIONAL GAIN*** to any value greater than ***SIMPLE MODE*** will initiate PI control. Pressure control is achieved by adjusting the values of ***PROPORTIONAL GAIN*** and ***INTEGRAL GAIN.*** Larger values for ***PROPORTIONAL GAIN*** and ***INTEGRAL GAIN*** give smaller error in the pressure, but also make the system more susceptible to oscillation. The following pages of this Section will provide more information on tuning PI control.

Emergency Over-Pressure Limit Switch

Both digital and analog CP systems have the option of connecting an emergency over-pressure limit switch to the AUX2 terminals in case the main pressure control system fails. The emergency over-pressure setpoint should be at least 10 psi higher than the system control pressure to prevent nuisance tripping.

SIMPLE MODE **Control in a Digital CP System**

Phase Technologies has developed a proprietary controller which involves fewer parameters to tune constant pressure performance. When the ***PROPORTIONAL GAIN*** parameter is set at the lowest value, the display will read "***SIMPLE MODE***". In ***SIMPLE MODE*** a set of control equations is used which may not require the user to tune the system to obtain acceptable performance. A well-tuned PI controller will result in smoother pressure control but may not be required. When the controller is in simple mode the only parameters which affect the pressure control loop are the ***psi SETPOINT, STARTUP RAMP, SHUTDOWN RAMP*** and ***BOOST AMOUNT***, which function in the same way as they do in the PI control mode. Adjusting ramp times may smooth out any oscillation or overshoot in simple mode. If pressure is not adequately controlled, switch to PI control by increasing parameter ***PROPORTIONAL GAIN.***

Using PI Control in an Analog CP System

When using an analog pressure transducer for control in constant pressure water systems, it may be desirable to use a proportional-integral (PI) controller in the feedback loop. This type of controller has a proportional gain and integral gain which can be tuned by the user to obtain optimum performance for each application. Increase parameter ***PROPORTIONAL GAIN*** to switch control from Simple Mode to PI control. It is recommended to start with a parameter value of 5. A proportional gain value too low will result in slow response time to reach the psi setpoint. A value too high will result in overshoot of the psi setpoint and may create wild oscillation of pressure.

First, attempt to control pressure by adjusting parameter ***PROPORTIONAL GAIN***, leaving parameter ***INTEGRAL GAIN*** at the default value of 50. If adequate control cannot be obtained by adjusting proportional gain, set proportional gain at the value that gives the best control, then adjust integral gain to improve pressure control.

For difficult to control systems, a derivative term can be introduced for PID control, which can help control pressure oscillation and overshoot. Increase the value of parameter DERIVATIVE GAIN to a value greater than zero to enable PID control. This parameter should be used only when necessary as it tends to amplify noise in the transducer signal. The system may become unstable. The parameters ***PID FILTER GAIN*** and ***PID FILTER TIME*** help to prevent overshoot. It may be advisable to contact the factory for assistance when using PID control for the first time.

In general, conceptual terms, proportional gain impacts how quickly the system responds to pressure changes and integral gain impacts the accuracy of pressure tracking. Adjusting ramp times can also be considered. Increasing ramp time will damp response to pressure changes, while decreasing ramp time will quicken the response.

⚠ **CAUTION:** Long ramp times can interfere with PI control of constant pressure. It is advisable to start with factory default ramp times.

Pressure Control at Minimum Speed

There is a possibility of conflict between the minimum pump speed setting, controlled by the parameter ***MIN FREQUENCY***, and the pressure setting of the transducer. That is, if under no-flow conditions the pump at its minimum speed setting produces a pressure greater than the desired set-point, either the minimum speed will have to be reduced (not an option with submersible pumps) or the pressure set-point will have to be increased. Most pumps should not produce enough pressure head at 30Hz for this to be an issue.

Boost in a Digital Constant Pressure System

In a digital CP system, the drive can only determine the pressure of the system at the set-point. Based on the characteristics of the on/off signals from the switch, which occur at the set-point, it maintains pressure. The parameter ***BOOST AMOUNT*** in a digital system is a per cent increase in speed, not in pressure, because the digital switch cannot determine a pressure beyond its set-point.

In an analog system the ***BOOST AMOUNT*** is a specified psi, so the user can accurately control the boost pressure through the parameter setting on the keypad. For example, if boost of 5 psi above control pressure is desired, simply set parameter ***BOOST AMOUNT*** to 5.

In a digital system ***BOOST AMOUNT*** is an increase in speed for a given time as a per cent of the speed the pump was running when the switch last opened at the set-point. For example, if pressure is controlled at a speed of 30 Hz, a ***BOOST AMOUNT*** value of 10 would be 10% of 30 Hz or 3 Hz. In low flow systems where the pressure is controlled at low speed, the ***BOOST AMOUNT*** value may need to be significantly higher than it would be set in an analog system under the same conditions.

6.2 PerfectPressure™ Setup – Analog Constant Pressure

Upon the first initialization of the unit (or after restoring factory defaults of all parameters using the Two Button Reset Procedure, page 24) the drive will prompt the user to select or decline a quick setup for constant pressure. The display will read ***SETUP CONST PRES YES(ENTER)/NO(HOME)***. Press the ENTER key to set up PerfectPressure or the HOME key to decline. Basic parameters for analog constant pressure can be set without navigating through the complete menu options.

Follow this procedure to set up PerfectPressure:

1. ***SETUP CONST PRES YES (ENTER) / NO (HOME)*** - Press the ENTER key to proceed.
2. **4-20mA psi RANGE** - This parameter sets the range of the 4-20mA pressure sensor. The factory default is 150 since the standard sensor provided by the factory has a maximum range of 150 psi. If necessary, use the arrow keys to change the value, then press ENTER, or simply press ENTER to proceed.
3. **psi SETPOINT -** This value determines the pressure you want to maintain. The factory default is 50 psi. Use the arrow keys to change if desired. Press ENTER to proceed.
4. **SUBMERSIBLE PUMP** - This parameter sets the ramp profile for a submersible pump. **YES = submersible pump, NO = vertical pump.** For submersible pumps, the frequency accelerates from 0-30 Hz in one second, then follows the ramp time from 30 Hz to maximum frequency. If NO is selected the frequency will increase in a linear fashion from zero to max frequency.
5. **ENABLE RESTARTS –** ***YES (ENTER) / NO (HOME)*** **–** enabling restarts controls the ability of the drive to automatically restart after a power failure. The drive will initialize in **AUTO** mode after power is restored if **YES** is selected. If **NO** is selected, the drive will remain **OFF** when power is restored.
6. **OVERCURRENT LIMIT –** Setting for motor overload protection (service factor amp rating for the motor).

⚠ **CAUTION:** Most submersible pump motor manufacturers require the motor to reach 30 Hz within one second to protect the pump from damage. Selecting NO for the parameter above will override the factory default ramp time of 0-30 Hz in one second.

This quick setup of constant pressure should provide good pressure control in most situations. It is advisable to read the entire section on constant pressure control for a complete explanation of constant pressure control methods in DXL Series drives. Refer to **Table 19**, for expanded menu options to fine tune the constant pressure system.

6.3 Digital Constant Pressure Systems

The digital CP system uses a digital pressure switch connected to the AUX1 terminals (see **Figure 17** and **Figure 18** for one-line and wiring diagrams). For digital CP systems, the factory default settings will be satisfactory for most CP applications.

Adjusting Parameters in Digital CP Systems
There are several parameters which can be adjusted to fine tune digital CP systems. These are ***MAX FREQUENCY***, ***MIN FREQUENCY***, ***TOFF***, ***T1ON***, ***T2ON***, ***SLEEP FREQUENCY***, and ***BOOST AMOUNT***. The use of these parameters has been discussed in the previous section. **Table 19** provides more detail.

Digital Constant Pressure Installation Procedures:

1. Install the digital pressure switches in the water line
2. Remove protective rubber boot from each switch, insert factory provided duplex cable through the boot, and connect a twisted pair of wires to the normally closed (NC) and common (C) terminals of the emergency over-pressure switch

⚠ **CAUTION**: The use of shielded cable is recommended. Unshielded cable may induce capacitance in the line and corrupt the signals from the pressure switches.

3. Attach the cable shield to the Control Terminal Ground post located in the DXL enclosure adjacent to the Control Terminals
4. Connect the emergency over-pressure limit switch to the AUX2 Control Terminal and COM (common). Use a jumper between AUX2 and COM if no limit switch is present.
5. Navigate through the keypad Main Menu item ***CHANGE PARAMETER VALUES > INTERFACE PARAMETERS > SYSTEM CONFIG***. Select ***1*** to set the system configuration for a digital CP system.
6. To set the emergency over-pressure limit switch, remove the rubber boot from the switch and pry the plastic plug from the top of the switch housing to access the pressure adjustment screw. Use an Allen wrench to adjust the pressure setting of the switch – jumper the AUX1 terminals and run the pump in the AUTO mode, and observe the pressure gauge, turning the Allen screw to adjust the pressure shut-off point. **The emergency over-pressure limit switch should be set at least 10 PSI higher than the desired constant pressure set point**.
7. Remove the jumper from AUX1 and connect the remaining twisted pair of wires in the shielded cable to the normally closed (NC) and common (C) terminals of the control pressure switch. Connect the switch to the AUX1 Control Terminals, and adjust the constant pressure set point using the same procedure as the emergency over-pressure limit switch.
8. Set the keypad to AUTO mode to operate the system.

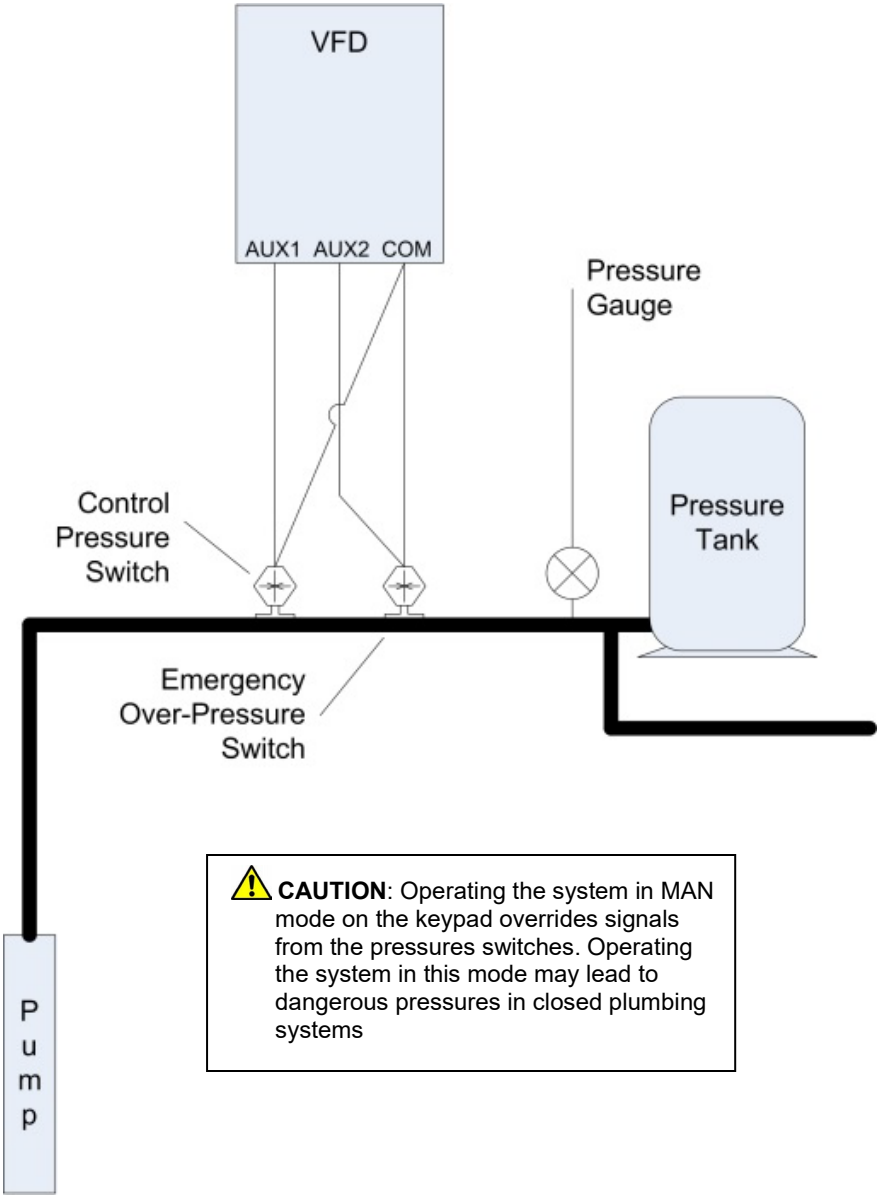


Figure 16 – Digital Constant Pressure Diagram

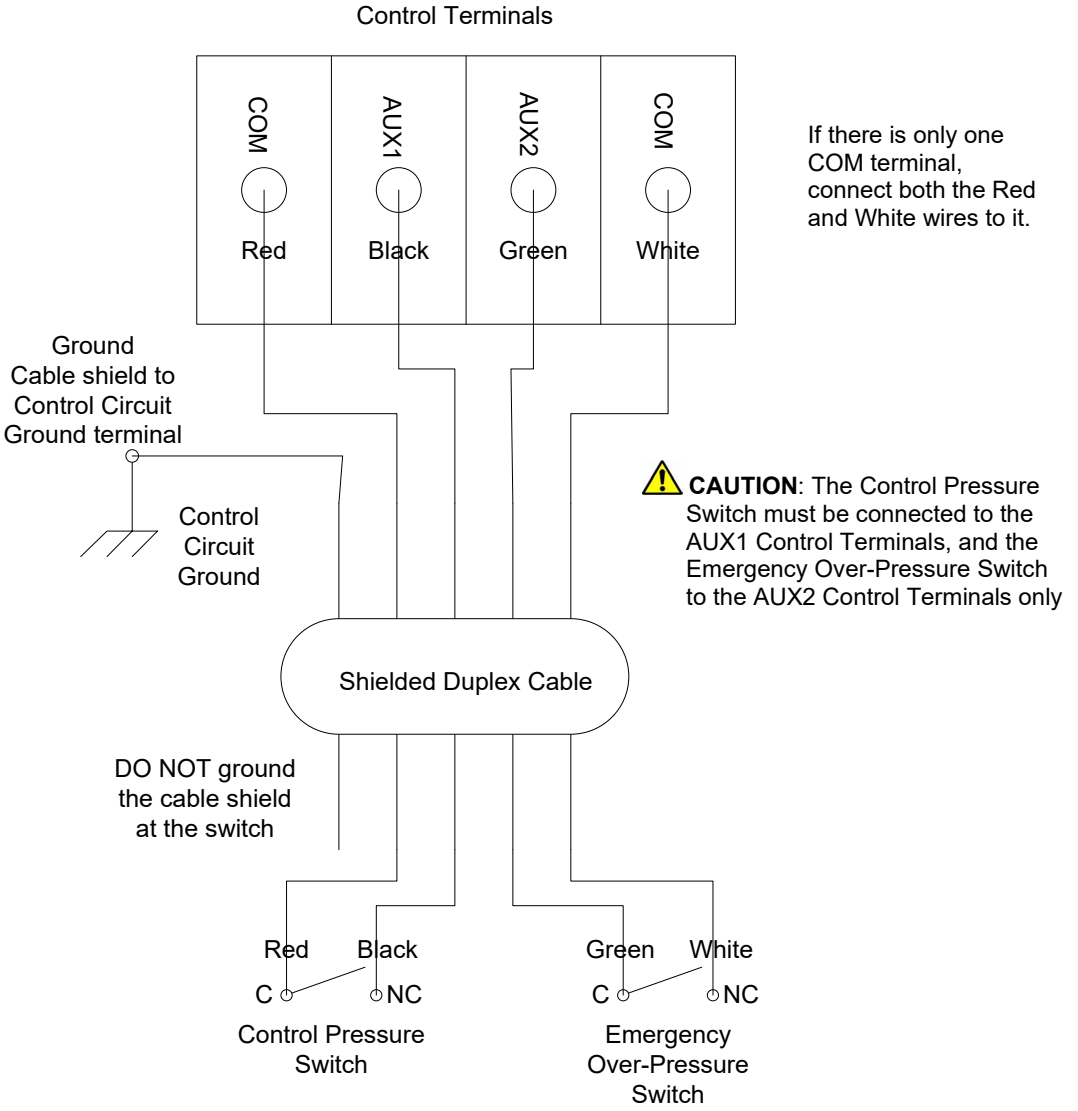


Figure 17 – Digital Constant Pressure System Schematic

6.4 Analog Constant Pressure Systems

The analog CP system uses an analog pressure transducer connected to the analog input on the Control Terminals (see **Figure 19** and **Figure 20** for one-line and wiring diagrams). A normally-closed emergency over-pressure switch connected to the AUX2 terminals is also recommended. These are used in conjunction with the internal firmware of the drive to implement a constant pressure water system.

When using an analog pressure transducer for control in constant pressure water systems, it is very common for the system controller to use a proportional-integral (PI) or proportional-integral-derivative (PID) controller in the feedback loop. This type of controller has a gain adjustment which must be tuned by the user to obtain optimum performance for each application. DXL Series drives have this type of controller incorporated in them. However, Phase Technologies has also developed a proprietary controller, Simple Mode, which requires minimal tuning. When the ***PROPORTIONAL GAIN*** parameter is set at the lowest value, the display will read "***SIMPLE MODE***".

In Simple Mode a set of control equations is used which usually requires minimal tuning of the system to obtain acceptable performance. A well-tuned PI or PID controller will give smoother pressure control and may be necessary to control unstable systems. When the controller is in Simple Mode, the only parameters which affect the pressure control loop are ***psi SETPOINT, STARTUP RAMP, SHUTDOWN RAMP*** and ***BOOST AMOUNT***.

In PI control mode the analog signal from the pressure transducer is compared to the parameter ***psi SETPOINT***, which controls the motor speed to maintain constant pressure in the system. In this control scheme, the error signal between the pressure transducer and the internal signal determined by the ***psi SETPOINT*** value is multiplied by the ***PROPORTIONAL GAIN***. This signal is then used to determine the motor frequency. If the pressure transducer signal and the internal set-point value were the same, then the motor speed would be zero. High ***PROPORTIONAL GAIN*** and ***INTEGRAL GAIN*** values give smaller error in the pressure, but also make the system more susceptible to oscillation.

Additional adjustable parameters found in the Constant Pressure menu help to optimize the performance of the system. The use of these parameters was discussed in the previous section. The unit is shipped with default settings which will work in many applications with no adjustment. As with all systems of this type there are tradeoffs between maintaining a tightly controlled set-point, achieving high motor efficiency, and maintaining system stability.

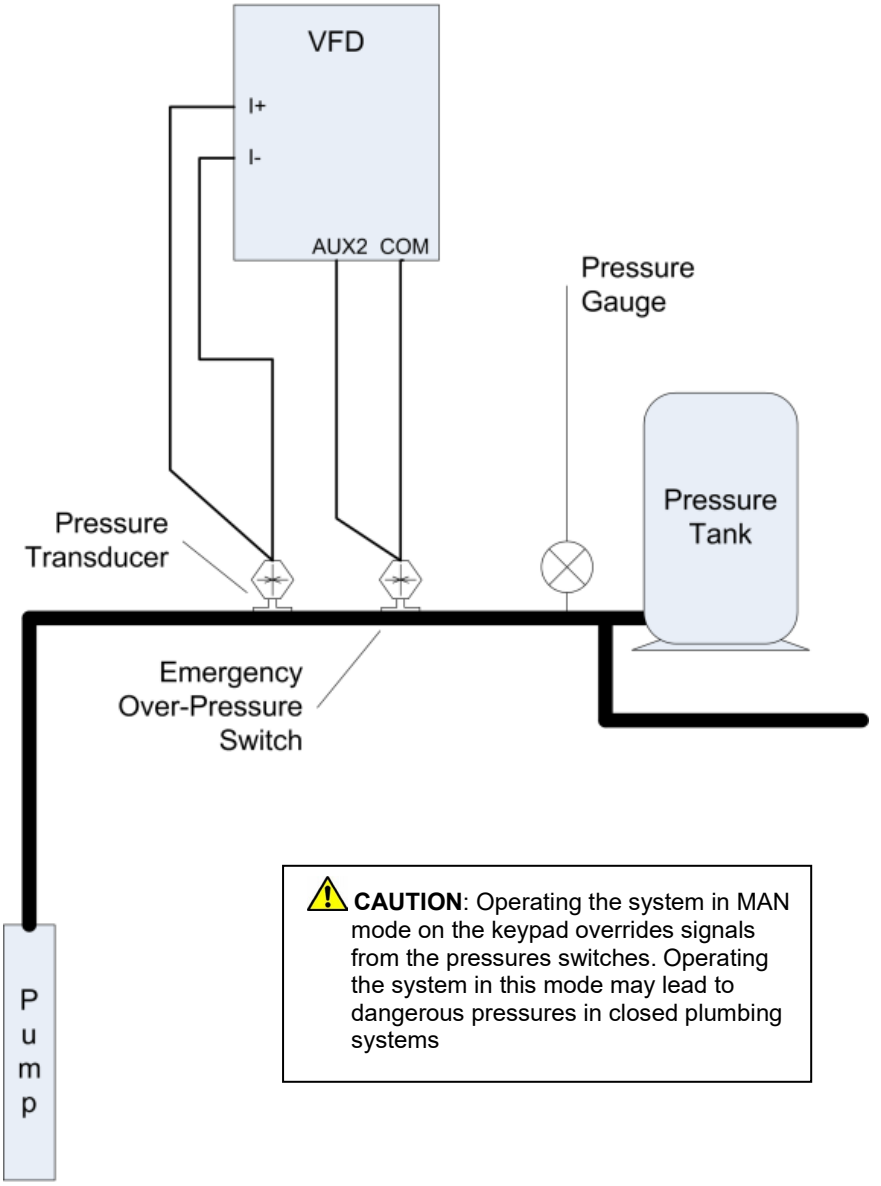


Figure 18 – Analog Constant Pressure One-Line Diagram

Basic Analog Constant Pressure Installation Procedures:

1. Install the analog pressure transducer and emergency over-pressure switch in the water line.
2. Remove protective rubber boot from the over-pressure switch, insert factory provided duplex cable through the boot, and connect a twisted pair of wires to the normally closed (NC) and common (C) terminals of the switch.

⚠ **CAUTION**: The use of shielded cable is recommended. Regular wire may induce capacitance in the line and corrupt the signals from the pressure switches.

3. Attach the cable shield to the Control Terminal Ground post located in the drive enclosure adjacent to the Control Terminals.
4. Connect the emergency over-pressure limit switch to the AUX2 Control Terminal and COM (common). Use a jumper wire to connect AUX2 and COM if no limit switch is present. Also, jumper AUX1 to COM if no external switch is connected to it.
5. Navigate through the keypad Main Menu item ***CHANGE PARAMETER VALUES > INTERFACE PARAMETERS > SYSTEM CONFIG***. Select ***2*** to set the system configuration for an analog CP system (see **Table 19** for details).
6. To set the emergency over-pressure limit switch, remove the rubber boot from the switch and pry the plastic plug from the top of the switch housing to access the pressure adjustment screw. Use an Allen wrench to adjust the pressure setting of the switch – jumper the AUX1 terminals and run the pump in the AUTO mode, and observe the pressure gauge, turning the Allen screw to adjust the pressure shut-off point. **The emergency over-pressure limit switch should be set at least 10 PSI higher than the desired constant pressure set point**.
7. Connect the remaining twisted pair of wires to the + and – terminals of the transducer.
8. Connect the positive terminal of the transducer to the I1+ Control Terminal, and the negative terminal to the I1- Control Terminal.
9. If a redundant analog transducer is used, connect it to the I2+ and I2- Terminals in likewise fashion. See **Section 5.5**, *System Configuration*, for instructions on using an additional analog sensor.

⚠ **CAUTION**: It is critical that the positive terminal of the transducer is connected to the + terminal of the 4-20mA Control Terminal, and likewise for the negative terminals.

10. Set the ***psi SETPOINT*** on the keypad (see **Table 19** for details)
11. Set the keypad to AUTO mode to operate the system.

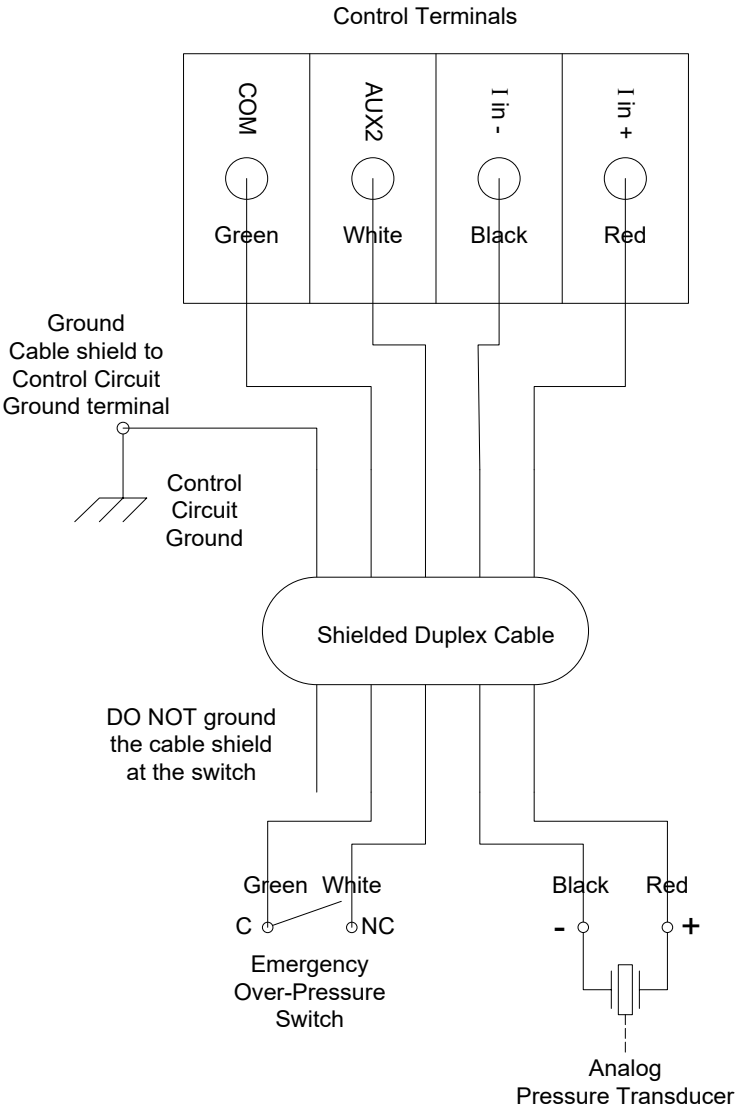


Figure 19 – Analog Constant Pressure System Schematic

6.5 Pre-Charge Mode

When filling a large plumbing system with water, it may be desirable to fill at a slow pump speed so that when the system reaches the full point, water hammer does not cause damage such as sprinkler head blow-off or burst pipes. To achieve this, DXL drives are equipped with a pre-charge feature.

Both the digital and analog constant pressure systems can implement a low-flow pre-charge of the system plumbing before the pump is allowed to come to full speed. This feature is disabled if the ***PRECHARGE TIME*** parameter is set to zero. For both types of CP systems, the frequency of the pump will not exceed the value set by the ***PRECHARGE FREQUENCY*** parameter during the pre-charge interval.

In a digital CP system, the pre-charge interval is terminated if either the ***PRECHARGE TIME*** is exceeded or the control pressure is reached.

An analog CP system has the same features with the added option that the pre-charge interval will terminate when the system pressure exceeds the setting of the ***PRECHARGE psi*** parameter. In this case, the ***PRECHARGE psi*** must be lower than the ***psi SETPOINT.***

In both CP systems the pre-charge interval occurs whenever the drive is switched from OFF to AUTO or MANUAL > RUN.

Pre-charge Mode Setup:

1. Navigate through the keypad menu to ***CHANGE PARAMETER VALUES > CONSTANT PRESSURE PARAMETERS > PRECHARGE FREQUENCY*** Enter the Pre-charge frequency

2. Navigate through the keypad menu to ***CHANGE PARAMETER VALUES > CONSTANT PRESSURE PARAMETERS > PRECHARGE TIME***. Enter the Pre-charge time in seconds

3. For analog CP systems only, navigate through the keypad menu to ***CHANGE PARAMETER VALUES > CONSTANT PRESSURE PARAMETERS > PRECHARGE psi***. Enter the pre-charge pressure in psi. This value must be lower than the ***psi SETPOINT***

4. Set the keypad to AUTO mode to operate the system.

6.6 Lead/Lag Pump Control

When any analog constant pressure system configuration is selected, the Lead/Lag menu is available. See **Table 20**Table 20, Lead/Lag Parameters, for lead/lag control options. Up to four additional pumps can be controlled through programmable relays on the main control printed circuit board. When the parameter ***NUMBER LAG PUMPS*** is greater than 0, all four relays will convert to control of lead/lag constant pressure.

⚠ **CAUTION**: Activation of lead/lag control overrides the function of all programmable relays. Any function of these relays set up through the Interface Parameters (**Table 18**) will be disabled.

Lead/lag control in pumping systems is a common practice to maintain pressure with highly variable flow. The system is typically configured with a master pump controlled by a VFD operating in constant pressure mode, and with auxiliary pumps that are controlled by the drive. The auxiliary pumps typically operate across-the-line at 60 Hz. They may be equipped with a soft starter to mitigate inrush currents.

If the master pump cannot maintain system pressure it will call for an auxiliary pump by closing a relay on the Control Terminals. DXL Series drives can control up to four auxiliary pumps. There are features to reduce oscillations and ensure smooth staging and destaging pumps.

Lead/Lag Set-up
System Configuration must be set to one of the constant pressure modes when using lead/lag control. See **Section 5.5**, *System Configuration* for details. Lead/lag control is enabled when the number of lag pumps is set to a value greater than zero in the parameter ***NUMBER LAG PUMPS***.

Programming Steps:

1. Use the keypad to navigate to the Main Menu item, ***CHANGE PARAMETER VALUES***, then to sub-menu ***LEAD LAG PUMP PARAMETERS***. Find the parameter ***NUMBER LAG PUMPS*** and use the arrow keys to set the number of auxiliary pumps in the system.
2. If necessary, adjust the remaining Lead/Lag parameters after reading the following description of their functions, or after operating conditions dictate.

Lag pumps are turned on and off, or "staged" and "destaged", by programmable relays accessed through the Control Terminals. The drive calls for lag pumps in ascending order, beginning with Relay 1. **Figure 21**, *Lead/Lag Schematic*, provides a wiring diagram.

Lead/lag parameters (**Table 20**) are used to smoothly stage the pumps in and out, mitigating pressure oscillation, short cycling, and water hammer. When the master pump cannot maintain pressure, the drive will stage in an auxiliary pump. The drive will destage the pump when flow increases pressure beyond the control point.

Two conditions must be met to stage a pump:

1. The system psi has decreased to a pressure equal to ***psi SETPOINT*** minus ***STAGE PSI LAG***. For example, if the ***psi SETPOINT*** is 50 psi and you want to stage a pump in at 45 psi, ***STAGE PSI LAG*** should be set to a 5.
2. The time set by ***STAGE PUMP DELAY*** has expired. This delay allows momentary drop in system pressure without calling for a pump to stage in.

Pumps are staged in the following sequence:

1. The relay will open to destage the pump.
2. The speed of the master pump will increase to a value equal to ***MIN FREQUENCY*** plus ***DESTAGE FREQ BOOST***. For example, if ***MIN FREQUENCY*** is 30 Hz and ***DESTAGE FREQ BOOST*** is 5 Hz, the pump speed will be reduced to 35 Hz.
3. The master pump will operate at increased speed for a period set by ***DESTAGE TIME***.
4. When ***DESTAGE TIME*** has expired the system will resume normal constant pressure control.

Pumps are destaged when the drive has slowed the master pump to maintain control pressure and the auxiliary pump(s) causes a rise in pressure.

Three conditions must be met to destage a pump:

1. The system psi has increased to the value set by ***DESTAGE PSI LAG*** above ***psi SETPOINT.*** For example, if ***psi SETPOINT*** is 50 and ***DESTAGE PSI LAG*** is 5 the pump will destage at 55 psi.

2. The time set by ***DESTAGE PUMP DELAY*** has expired. This delay prevents destaging the auxiliary pump due to momentary pressure overshoot.
3. The drive frequency to the master pump is between ***MIN FREQUENCY*** and the value of ***DESTAGE MIN FREQ*** plus ***MIN FREQUENCY***. For example, if ***MIN FREQUENCY*** is 30 Hz and ***DESTAGE MIN FREQ*** is 5 Hz, the pump will destage at 35 Hz.

Pumps are destaged in the following sequence:

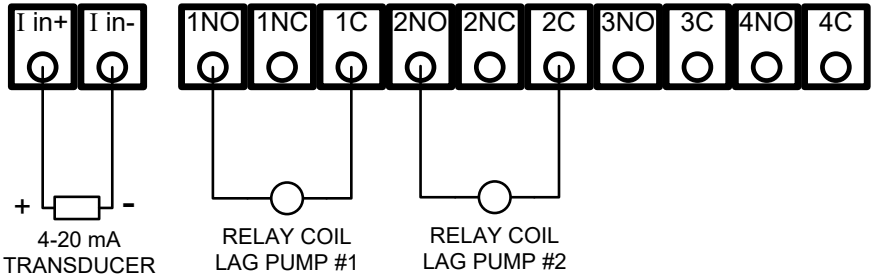
1. The system pressure will increase by the value set by ***DESTAGE FRQ BOOST***. This boost in pressure allows the PI constant pressure loop to react faster to the drop in pressure when the pump turns off.
2. The system will destage the pump
3. The system will continue to boost the pressure set by ***DESTAGE FRQ BOOST*** for a period set by ***DESTAGE TIME***.
4. The system will resume normal constant pressure control.

Pre-charge Pumps Feature

In some systems the primary pump may not have the capacity to pre-charge the system on its own. The ***PRECHARGE PUMPS*** parameter will set the number of auxiliary pumps that will be called on to pump during the pre-charge interval. When the pre-charge interval is terminated, normal lead/lag control of the pumps will resume.

⚠ **CAUTION**: This number should never be greater that the total number of lag pumps as it will activate the associated programmable relay which may be reserved for other functions.

6.7 Duplex / Multiplex Control



Use the relays in order, beginning with Relay 1.

CAUTION: The relays are rated 0-30 VDC or 120VAC, 0.5 amp. Direct control of the coil on a magnetic motor starter will likely cause damage to the relay and the main control printed circuit board. Use of a secondary control relay, such as an ice cube relay, may be necessary to control the lag pump motor starter.

Figure 20 – Connecting Duplex/Multiplex Systems

When any analog constant pressure system configuration is selected, the CONSTANT PRESSURE and LEAD/LAG menus are available. Up to four additional VFDs can be controlled through the relays. When the parameter ***NUMBER LAG PUMPS*** is greater than 0, relays will convert to control of lead/lag or duplex/multiplex constant pressure in sequence. *Example: If 2 lag pumps are entered, Relay 1 & Relay 2 will now be used for Lead/Lag pump control.* In addition, the parameter ***DUPLEX CYCLE TIME*** must be greater than 0 for Multiplex control to be active.

When operating in Multiplex Control, the main VFD will assume the role of Master, and all auxiliary VFDs controlled through the relays are known as Slaves. The Master and Slave VFDs will operate in constant pressure mode.

If the Master VFD senses that system pressure cannot be maintained, it will call for a Slave VFD by closing a relay on the Control Terminal. DXL Series drives can control up to four auxiliary VFDs.

In Multiplex control, the Master VFD might not always be the drive that is operating. The point of a multiplex system is to rotate the use of each available VFD. This is done so that a single drive or pump does not degrade at a faster rate than other drives or pumps in that system. The Master VFD will decide when to stage or destage a VFD. The first pump to be staged in, and the last pump to be destaged, is called the Default VFD.

Multiplex Setup
System configuration must be set to one of the constant pressure modes when using multiplex control. See **Section 5.5**, *System Configuration*, for details. Multiplex control is enabled when ***NUMBER LAG PUMPS*** is greater than 0, and ***DUPLEX CYCLE TIME*** is greater than 0.

Programming Steps:

1. Use the keypad to navigate to the Main Menu item, CHANGE PARAMETER VALUES, then to sub-menu LEAD LAG PUMP PARAMETERS. Find the parameter ***NUMBER LAG PUMPS*** and use the arrow keys to set the number of auxiliary drives in the system.
2. Navigate to CONSTANT PRESSURE PARAMETERS and find the parameter ***DUPLEX CYCLE TIME***, use the arrow keys to set how often the Default drive position will change.
3. If necessary, adjust the remaining Lead/Lag parameters after reading the following description of their functions, or after operating conditions dictate.

In Multiplex control, the Master VFD will utilize the Lead/Lag Parameters and logic similar to lead/lag control in order to decide when to turn on/off a VFD. More detail on the logic behind these decisions will be given in a later section.

It is recommended to run all auxiliary pumps on VFDs, otherwise pressure instability may occur. The Primary Auxiliary Pump could turn on/off resulting in the system pressure oscillating from **(*psi SETPOINT – STAGE PSI LAG*)** to **(*psi SETPOINT + DESTAGE PSI LAG*).**

The Master VFD stages in VFDs in a different order depending on which VFD is the Primary. When the Master VFD is not the Primary, it will ALWAYS be the second drive to be staged in. The tables below will illustrate the order of the VFDs to be staged or destaged for different values of ***NUMBER LAG PUMPS***.

The Primary drive position will rotate based on the parameter ***DUPLEX CYCLE TIME***.

Master + 1 Slave VFD		
Rotation	**Primary Drive**	**VFD Order**
1st Rotation	Master	M <=> 1
2nd Rotation	Slave VFD 1	1 <=> M

Master + 2 Slave VFD		
Rotation	**Primary Drive**	**VFD Order**
1st Rotation	Master	M <=> 1 <=> 2
2nd Rotation	Slave VFD 1	1 <=> M <=>> 2
3rd Rotation	Slave VFD 2	2 <=> M <=> 1

Master + 3 Slave VFD		
Rotation	Primary Drive	VFD Order
1st Rotation	Master	M <=> 1 <=> 2 <=> 3
2nd Rotation	Slave VFD 1	1 <=> M <=> 2 <=> 3
3rd Rotation	Slave VFD 2	2 <=> M <=> 3 <=> 1
4th Rotation	Slave VFD 3	3 <=> M <=> 1 <=> 2

Master + 4 Slave VFD		
Rotation	Primary Drive	VFD Order
1st Rotation	Master	M <=> 1 <=> 2 <=> 3 <=> 4
2nd Rotation	Slave VFD 1	1 <=> M <=> 2 <=> 3 <=> 4
3rd Rotation	Slave VFD 2	2 <=> M <=> 3 <=> 4 <=> 1
4th Rotation	Slave VFD 3	3 <=> M <=> 4 <=> 1 <=> 2
5th Rotation	Slave VFD 4	4 <=> M <=> 1 <=> 2 <=> 3

Two conditions must be met to stage in a VFD:

1. The system has decreased to a pressure equal to ***psi SETPOINT*** minus ***STAGE PSI LAG***. ***NOTE:*** Primary Slave VFDs and Primary Master Drives will ignore the ***STAGE PUMP DELAY*** parameter, and immediately stage in if the system pressure drops below the threshold.
2. The time set by ***STAGE PUMP DELAY*** has expired. This delay allows a momentary drop in system pressure without calling for a drive to stage in.

Steps To Stage A Drive:

1. The selected drive will be staged in. The selected drive is based on the order given in the tables above. This will either close the Slave VFD's corresponding relay or move the Master VFD out from sleep mode.
2. The speed of the master pump will decrease to a value equal to ***MAX FREQUENCY*** minus the corresponding ***STAGE FREQ REDUCTION***.
3. The Master VFD will operate at a reduced speed for a period set by ***STAGE TIME***.
4. When ***STAGE TIME*** has expired the system will resume normal constant pressure control.

   Note: The Master VFD does NOT have corresponding ***STAGE FREQ REDUCTION*** or ***STAGE TIME*** parameters.

Destaging:

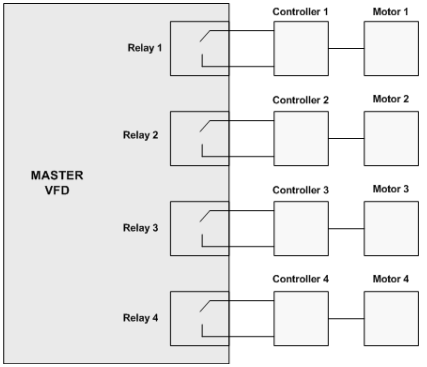
Drives are destaged when the drive has slowed the master pump to maintain control pressure and the Slave VFD(s) causes a rise in pressure.

Three conditions must be met to destage a VFD:

1. The system psi has increased to the value set by ***psi SETPOINT*** plus ***DESTAGE PSI LAG***.
2. The time set by ***DESTAGE PUMP DELAY*** has expired. This delay prevents destaging VFDs due to momentary pressure overshoot.
3. The Master drive frequency is between ***MIN FREQUENCY*** and the value of ***MIN FREQUENCY*** plus ***DESTAGE MIN FREQ***.

Steps To Destage A Drive:

1. The selected drive will be destaged. The selected drive is based on the order given in the tables above. This will either open the Slave VFD's corresponding relay or set the Master VFD to sleep mode.
2. The frequency of the master pump will increase by ***DESTAGE FREQ BOOST***.
3. The Master VFD will operate at an increased speed for a period set by ***DESTAGE TIME***.
4. When ***DESTAGE TIME*** has expired the system will resume normal constant pressure control.



Note:
Only one controller is necessary for Lead/Lag or Multiplex but up to four are available.

Figure 21 – Lead/Lag or Multiplex Block

Note: Setting ***PROGRAM RELAY 1*** to setting 6, Jockey Pump, will cause Relay 1 to not participate in lead/lag or multiplex control. The order pumps are staged or destaged will remain the same, except the Master will skip Relay 1. Relay 1 will also never become the Primary when it is set to Jockey Pump.

6.8 Troubleshooting Constant Pressure Systems

A variety of conditions in a plumbing system can lead to less than optimum performance of constant pressure control while using the factory default settings. The default settings are designed to operate a range of plumbing systems, but there can be many variables in a plumbing system that requires adjustment of the constant pressure parameters.

For the drive to enter sleep mode while operating in CP mode, three conditions must be met:

1. The pressure in the system must be at the pressure control point set by the parameter ***psi SETPOINT*** (for analog systems) or at the pressure determined by the setting on the digital pressure switch
2. The frequency is below ***SLEEP FREQ*** (as defined as ***MIN FREQUENCY*** + input value) or measured pressure is above ***WAKE UP psi*** (as defined as ***psi SETPOINT*** + the input value).
3. The time expired since the pump started after the last OFF cycle must be greater than parameter ***T1ON*** or ***T2ON***

When these conditions have been met, the drive will go to sleep. The duration of which the drive is asleep depends on the rate at which the system bleeds down and the width of the dead band. When setting and testing a constant pressure system, try to operate as close as possible to the normal operating conditions. Low flow in a high-capacity system (and vice versa) usually requires some adjusting of the parameters.

7 TROUBLESHOOTING

This section provides information on fault codes and troubleshooting tips for potential system problems.

⚠ **WARNING!** In some instances, the unit will shut down, then automatically restart when conditions allow. Always disconnect input power from the unit and wait for internal electrical charges to dissipate before performing service on the unit or its connected loads.

⚠ **WARNING:** Risk of electric shock. De-energize the unit by disconnecting all incoming sources of power, then wait 5 minutes for internal charges to dissipate before servicing the equipment.

⚠ **HIGH VOLTAGE:** This equipment is connected to line voltages that can create a potentially hazardous situation. Electric shock could result in serious injury or death. This device should be installed and serviced only by trained, licensed, and qualified personnel. Follow instructions carefully and observe all warnings.

Always check the display for fault codes if the drive or its load is not operating. Disconnecting the input power could potentially clear any fault code indication, possibly losing valuable information for troubleshooting.

7.1 Fault Codes

Fault codes are indicated on the graphic display. See **Table 23**, on page 71, for a list of fault codes.

The drive can be programmed to automatically restart after certain faults and a time delay can be programmed before the restart is allowed. To interrupt a time delay countdown and allow auto restart, press both arrow keys on the keypad and hold for one second. The load will start immediately. The Restart Log is a resettable fault log that can be used to monitor faults that allow auto restart. Use the Clear Memory function to reset the Restart Log and set all fault counters to zero. See Section 4.2, Keypad Main Menu Items, for more information on Restart Log and Clear Memory function.

⚠ **WARNING:** Certain faults do not allow an auto restart. These faults generally indicate the possibility of damage to the drive and/or the load or indicate the possibility of a dangerous condition. When this type of fault occurs, the display will read ***NO AUTO RESTART***. Refer to **Table 23**, *Fault Codes*, to determine if the fault allows an auto restart. The number 1 in the notes column indicates that auto restart is not allowed. When this type of fault occurs, contact the factory for assistance before restarting or troubleshoot the system thoroughly. **These faults can be cleared only by cycling input power OFF/ON or by pressing both arrow keys for 3 seconds.**

⚠ **WARNING:** Unit may restart automatically without warning after a fault when operating conditions permit. Make certain input power is disconnected before servicing the unit or its connected loads.

7.2 Clearing a Fault

If the unit is programmed to automatically restart after a particular fault, the display indicates that the unit will restart and will count down the seconds remaining to restart on the display. The countdown can be interrupted by pressing and holding the UP and DOWN arrow keys. The load will immediately restart.

For faults that allow an automatic restart, the default number of restarts after a fault is zero. If the end user desires the unit to automatically restart after a fault, the number of restarts allowed and the time between fault and restart must be programmed in the ***CHANGE PARAMETER VALUES > AUTO RESTART PARAMETERS > NUMBER OF AUTO RESTARTS***.

If the drive has exceeded the programmed number of auto restarts, or if auto restarts have not been enabled, the display will indicate the fault on the top line and the second line will read ***RESTART? ENTER***. Press ENTER to clear the fault and restart the load. The fault counters in the Restart Log will all be reset to zero. See **Section 3.6**, *Restart Log*, for more information.

The ***ENABLE RESTART*** parameter allows the drive to restart automatically after a fault. This parameter also enables to drive to initialize in AUTO mode when the input power has been cycled OFF/ON and the drive is energized. The factory default setting does not allow auto restarts. Navigate to this parameter via ***CHANGE PARAMETER VALUES > AUTO RESTART PARAMETERS > ENABLE RESTART***. See *** - Parameters must be enabled by navigating to** INTERFCAE PARAMETERS > TROUBLESHOOTING > ADVANCED PARAMETERS**.**
Table 17 for values in setting the parameter.

Certain faults do not allow an auto restart. These faults generally indicate the possibility of damage to the drive and/or the load or indicate the possibility of a dangerous condition. When this type fault occurs, the display will read ***NO AUTO RESTART***. When this type fault occurs, contact the factory for assistance before restarting or troubleshoot the system thoroughly. **These faults can be cleared only by cycling input power OFF/ON or by pressing the UP and DOWN arrow keys for 3 seconds.**

There are several conditions where the drive will indicate a fault, but the fault will not be recorded in the fault log. These faults occur only when the drive is energized from utility mains and is initializing. If any condition including ground fault, pre-charge fail, high input voltage or low input voltage is detected, the display will indicate the fault and wait for the condition to resolve before entering normal operating mode. If these conditions occur after the drive has initialized, a fault will be logged and can be cleared in the normal manner.

⚠ **WARNING:** The drive may start automatically without warning when operating conditions permit. Make certain input power is disconnected before servicing the unit or its connected loads.

Table 23 – Fault Codes

TEXT MESSAGE	DESCRIPTION / COMMENTS	NOTES
15 V Power Supply Overload	Customer terminal power supply has been overloaded. Cycle power or wait for fault delay to reset. (**Restart Delay 2**)	1
AUX1 Latch Fault	Switch connected to AUX1 input has opened. Drive will remain off until fault is cleared. No auto restart allowed. See parameter ***AUX1 SELECT*** in Table 18 for details.	P,1
AUX2 Latch Fault	Switch connected to AUX2 input has opened. Drive will remain off until fault is cleared. No auto restart allowed. See parameter ***AUX2 SELECT*** in Table 18 for details.	P,1
AUX3 Latch Fault	Switch connected to AUX3 input has opened. Drive will remain off until fault is cleared. No auto restart allowed. See parameter ***AUX3 SELECT*** in Table 18 for details.	P,1
AUX4 Latch Fault	Switch connected to AUX4 input has opened. Drive will remain off until fault is cleared. No auto restart allowed. See parameter ***AUX4 SELECT*** in Table 18 for details.	P,1
Broken Pipe Fault	Indicates the possibility of a broken pipe. Fault is triggered by a large drop in pressure. Check the settings of the parameter ***Broken Pipe psi*** to eliminate the possibility of nuisance fault.	1
Bus Overvoltage	Sudden and severe regenerative power under high line voltage conditions may result in bus overvoltage. Check line voltage or consider increasing ramp up and ramp down times.	2
Bus Voltage Unbalance	The DC bus voltages are more than 10% unbalanced. Can be caused by bus cap failure.	1
CM Connection Fail	Cables to current measurement boards have been disconnected. Check RJ45 cables.	
Current Unbalance	Motor current unbalance has exceeded the limit set by parameter ***Current Unbalance***. Check motor load for normal operation or increase current unbalance limit.	P, 2
Defect Hall Snsr	This is likely a connection issue with the hall sensor board. Power the system down, check the connections to the hall sensor PCB (blue cubes with wires/bus bars running through them). Power up the system. If this does not clear the fault, please contact customer service. A Hall PCB may need to be replaced.	
Under Current	Motor current has fallen below the value set by parameter ***Under Current***. Commonly used to detect dry well condition.	P, 2
Under kW	Real power in kW consumed by the motor load has fallen below the limit set by parameter ***Under KW***. Commonly used to detect dry well condition.	P, 2
Ground Fault	A fault between an output line and earth has been detected. Immediately disconnect input power and check output lines with a megger to verify a fault. Nuisance trip is a possibility. Sensitivity of fault detection can be adjusted by the Operating Parameter ***Ground Fault Detect Sensitivity***. See **Table 16** for details.	1

TEXT MESSAGE	DESCRIPTION / COMMENTS	NOTES
High Input Voltage	Input voltage has exceeded a level for safe operation. Reduce input voltage. General purpose buck/boost transformers are compatible with DXL Series drives.	2
Input 1Ph Fault	Single-phase input fault. Indicates a loss of phase on the input 3-phase lines, or severe voltage unbalance.	2
Input Fault	Sudden high input current or internal fault. Contact factory	1
Input Overload	Current on the input module has exceeded safe levels. Check for reduced input voltage as this may increase input current. May also be caused by high current in the motor circuit.	1
Line Cap Fail	Indicates failure of a filter capacitor on the input L/C filter. Contact factory for assistance.	
Low Input Voltage	Input voltage has fallen below a level for safe operation of the drive.	2
Motor Overload	Output current has exceeded the value set by parameter ***Overcurrent Limit***. Check status of motor load. If output current limit is increased, make sure it is within the limit of the motor nameplate. Automatic restarts are set by ***Restart Delay*** and ***Number of Restarts*** in the AUTO RESTART PARAMETERS menu.	P, 2
OP Hall Sense Hi	A current on the output module large enough to exceed the maximum current rating of the hall effect sensor. May indicate a fault in the motor circuit or internal fault.	2
Output Fault	Indicates short in motor circuit. Check for short circuit on output lines and load. Contact factory	1
Output Overload	Indicates a large and sudden overcurrent event on the output module. Check the motor circuit for faults. The overcurrent event may be of a very short duration that cannot be captured by amp meters.	
Over Temperature	Internal temperature of the drive exceeded safe limits. Check fans and ventilation openings for obstruction. Reduce ambient temperature.	2
Pre-charge Fail	Indicates that the bus voltage was not charged to an adequate level by the pre-charging circuit. Contact factory for assistance.	1
Sensor Connection Fail	4-20mA analog signal is not present on Control Terminals I_1 and I_2. This could indicate failure of the 4-20mA sensor or that the cables from the sensors have been disconnected.	2
Sensor Fault	Indicates a fault on the I_1 or I_2 control circuit	2
Temp Sense Fault	Solid state temperature sensor on the heat sink has failed or its cable is disconnected. Contact factory.	1

P = Fault may be related to an adjustable parameter. Always check the value of the parameter to eliminate nuisance tripping.

1 = Drive has shut down due to a potentially dangerous condition. Drive will remain OFF until fault is cleared. Use caution if the drive is restarted. Thoroughly troubleshoot the system and/or contact the customer service for assistance.

2 = ⚠ **WARNING:** Auto restart allowed for this fault. Motor may restart automatically without warning after a fault when operating conditions permit. Make certain input power is disconnected before servicing the unit or its connected loads.

Fault Log

The Fault Log records the number of times a particular fault has occurred. To access the Fault Log, press the MENU key until the Main Menu item, ***FALUT LOG***, appears.

Press ENTER key to access the list of faults. The Fault Log will continue to log the number of faults that have occurred until it is reset through the Main Menu item ***RESTART LOG or CLEAR MEMORY***. The Fault Log is not to be confused with the restart counter. The restart counter is associated with the automatic restart function and is reset whenever the input power is cycled OFF/ON.

Table 24 – Troubleshooting

PROBLEM	POTENTAIL CAUSE	SOLUTION
Unit does not power up	Circuit breaker tripping	If incoming circuit breaker continually trips when VFD starts, the breaker and cable sizes should be sized by a certified electrician. Increase breaker size is recommended by electrician.
Motor not running	Is a fault code indicated?	Based on the fault code, resolve any factors that are likely causing the fault. Clear the fault by pressing both arrow keys on the keypad or by cycling input power OFF/ON.
	Are the remote switches AUX1 and AUX2 closed?	Check the status of the switches or jumpers connected to AUX1 and AUX2 on the Control Terminals. The LCD display indicates the status of AUX terminals in the default display mode. All AUX terminals must be closed for the motor to run in AUTO mode.
	Are the signals to the Control Terminals corrupted?	Shielded cable is required for AUX terminal switch leads longer than 20 ft. Regular wire will induce capacitance in the line and corrupt control signals. Shielded cable is recommended for all Control signal cables.
	Is the keypad in MAN or OFF mode?	The keypad will override signals on the Control Terminals when OFF or MAN is selected. Keypad must be in AUTO mode for external control signals to control the motor.
	Is the maximum frequency set at 0 Hz?	Check the maximum frequency by using the keypad to navigate ***MAIN MENU>CHANGE PARAMETER VALUES>OPERATING PARAMETERS>MAX FREQUENCY***.
	Are the input terminals L1 and L2 energized?	Green LED D9 on the Master Control printed wiring board should be on to indicate board is powered. Green flashing D16 indicates the program is running. If no LEDs are lit on the PWB, check the main input fuses or breaker, then check secondary fuses. See **Section 0** for fuse locations.
Motor is turning the wrong direction	Phase sequence on output terminals U/T1, V/T2, W/T3 is out of order	Swap any two of the three motor leads on the output terminals **OR** use parameter ***REVERSE ROTATION*** via keypad.
Real Time Clock (RTC) clearing or not providing fault time stamps	Dead battery	Replace CR2032 battery, located on Control Board beneath graphic display.

8 ROUTINE INSPECTION AND MAINTENANCE

The unit should be inspected and cleaned at least annually or more frequently if it is in an excessively warm or dusty environment.

Overall: Perform a visual inspection checking for things such as discolored wires or terminals, evidence of arcing, loose mounting screws, physical damage to the enclosure, etc.

Power terminals: Inspect for loose connections and tighten to specifications in **Table 2**.

Capacitors: Check for leakage or deformation.

Fans and heatsinks: Excessive dust buildup on the heatsink and cooling fan impellers may lead to overheating. Lightly brush and vacuum clean. Contact Customer Service for assistance in replacing the cooling fan in the event it should fail. Use only fans approved by Phase Technologies. Unapproved fans may not be able to move enough air to properly cool the unit, leading to component damage.

Battery
The drive is equipped with a battery that provides power to a real-time clock. The clock allows faults to be stamped with time and date. The battery is located on the control printed circuit board. It is a button cell lithium battery rated at 3.0V, type CR2032. The battery should last many years under normal operating conditions. If the battery fails, the drive will continue to operate normally; losing only the ability to timestamp faults and provides timed operation of programmable relays.

9 MODELS AND RATINGS

9.1 Model Nomenclature

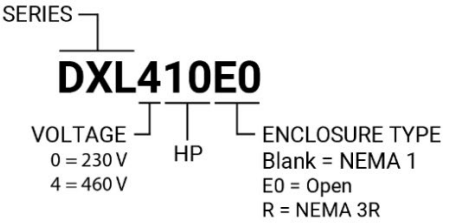


Figure 22 – DXL Series Nomenclature

Table 25 – DXL Ratings

	DXL Series						
Model	**Rated HP/kW**	**Rated Input Voltage**	**Rated Output Voltage**	**Rated Input/Output Current***	**1-Phase Output Current**	**Switching Frequency****	**Weight†**
DXL007/R	7.5/5	120-240 V, 3-phase	$V_{OUT} = V_{IN}$, 3-phase	24 A	12 A	2-5 kHz	19 lbs
DXL010/R	10/7.5			31 A	15.5 A		20 lbs
DXL015/R	15/11	200-240 V, 3-phase		46 A	23 A		20 lbs
DXL020/R	20/15			61 A	30 A		21 lbs
DXL025/R	25/18.5			75 A	37.5 A		22 lbs
DXL030/R	30/22			91 A	45.5 A		22 lbs
DXL407/R	7.5/5	200-480 V, 3-Phase		13 A	6.5 A		19 lbs
DXL410/R	10/7.5			18 A	9 A		20 lbs
DXL415R	15/11			24 A	12 A		23 lbs
DXL420/R	20/15			31 A	15.5 A		23 lbs

DXL425/R	25/18.5	200-480 V, 3-Phase	$V_{OUT} = V_{IN}$, 3-phase	38 A	19 A	2-5 kHz	24 lbs
DXL430/R	30/22			46 A	23 A		26 lbs
DXL440/R	40/30			61 A	30.5 A		28 lbs
DXL450/R	50/37			77 A	38.5 A		30 lbs
DXL460/R	60/45			91 A	45.5 A		136 lbs
DXL475/R	75/55			107 A	53.5 A		138 lbs
DXL4100/R	100/75			142 A	71 A		141 lbs
DXL4125/R	125/90			172 A	86 A		144 lbs
DXL4150/R	150/110			198 A	99 A		146 lbs
DXL4200/R	200/150			250 A	125 A		148 lbs
DXL4250/R	250/185			304 A	152 A		148 lbs
DXL4300/R	300/220			365 A	182.5 A		163 lbs
DXL4350/R	350/260			415 A	207.5 A		163 lbs
DXL4400/R	400/299			478 A	239 A		167 lbs

*Rated output current for 7.5-75 HP models based on typical full load current for submersible motors. Rated output current for 125 HP models based on 110% of values in NEC table 430.150 Full Load Current, Three-Phase Alternating Current Motors.

**Switching Frequency is an adjustable parameter set through the keypad.

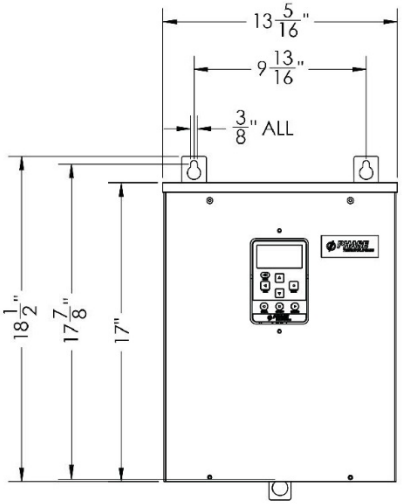
†Weight is for NEMA 1 version and will vary based on enclosure and optional equipment selected.

9.2 Dimensional Drawings

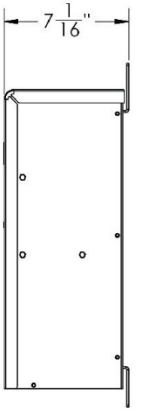
9.2.1 DXL410

410

Model Number
DXL007
DXL010
DXL407
DXL410
DXL015



FRONT
TYPE 1
NEMA 3R



SIDE
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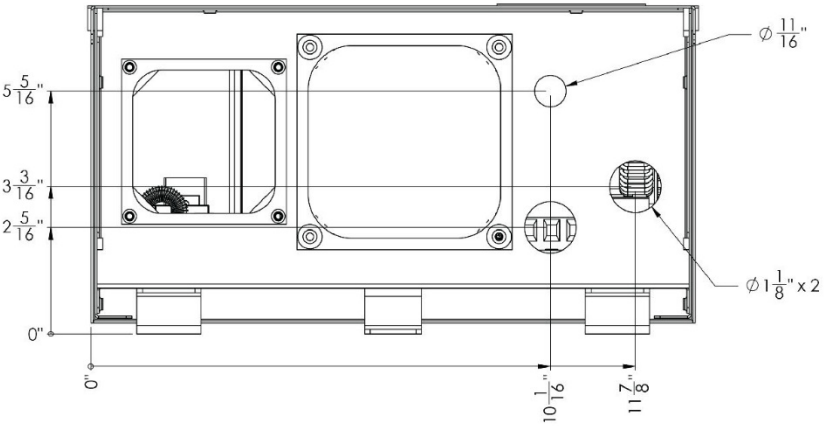
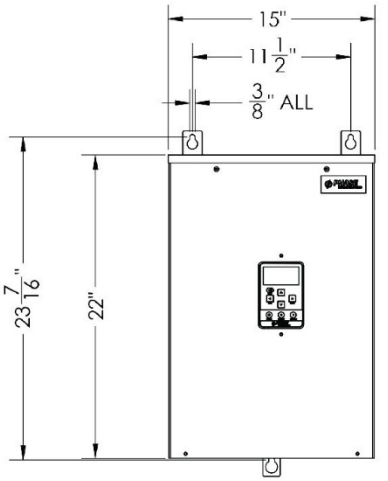
NEMA 3R



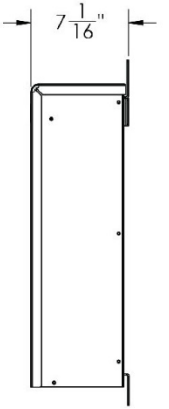
9.2.2 DXL450

450

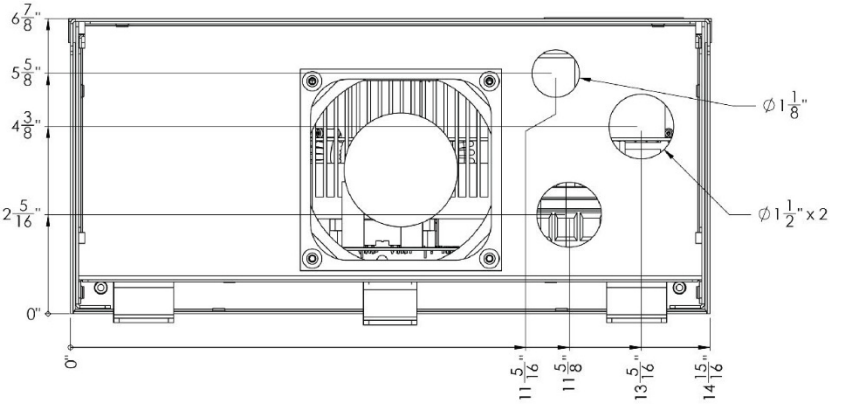
Model Number
DXL020
DXL025
DXL030
DXL415
DXL420
DXL425
DXL430
DXL440
DXL450



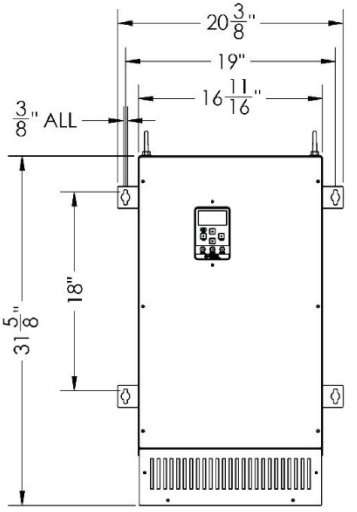
FRONT
TYPE 1



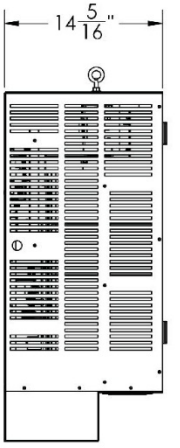
SIDE
TYPE 1



9.2.3 DXL4250



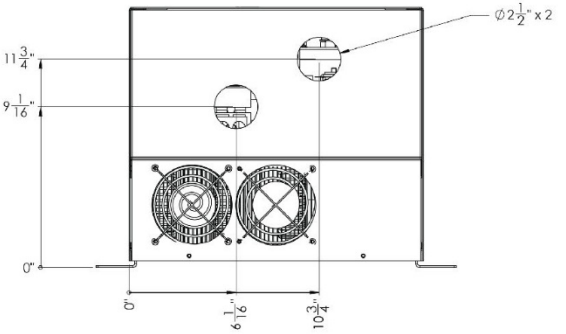
FRONT
NEMA 1



SIDE
NEMA 1

4250

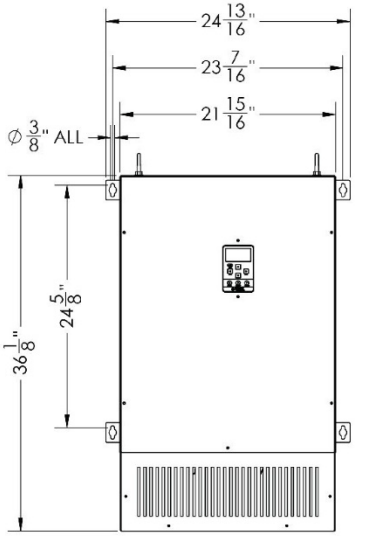
Model Number
DXL460
DXL475
DXL4100
DXL4125
DXL4150
DXL4200
DXL4250



9.2.4 DXL4400

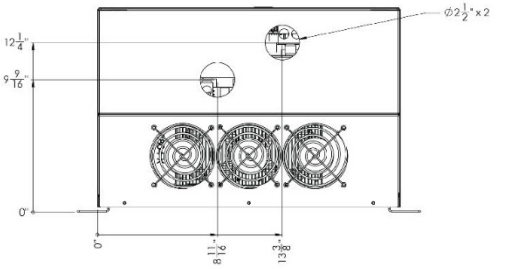
4400

Model Number
DXL4300
DXL4350
DXL4400



FRONT
NEMA 1

SIDE
NEMA 1



Notes

LIMITED WARRANTY

Phase Technologies' DXL Series drives are warranted against defects in material and workmanship for a period of two years. This warranty covers both parts and labor (at Phase Technologies) for two years from the date of purchase by the original owner. Phase Technologies will repair or replace (at our option), at no charge, any part(s) found to be faulty during the warranty period specified. The warranty repairs must be performed by/at a Phase Technologies Authorized Service Center or at Phase Technologies LLC, Rapid City, SD.

Obligations of the Original Owner

1. The original Bill of Sale must be presented to obtain "in-warranty" service.
2. Transportation to Phase Technologies or an Authorized Service Center is the responsibility of the original purchaser. Return transportation is provided by Phase Technologies.
3. Installations must comply with all national and local electrical codes.

Exclusions of the Warranty

This warranty does not cover any of the following: accident, misuse, fire, flood, and other acts of God, nor any contingencies beyond the control of Phase Technologies, LLC, including water damage, incorrect line voltage, improper installation, missing or altered serial numbers, and service performed by an unauthorized facility. Phase Technologies' liability for any damage caused in association with the use of Phase Technologies' equipment shall be limited to the repair or replacement only of Phase Technologies' equipment. No person, agent, distributor, dealer, or company is authorized to modify, alter, or change the design of this merchandise without express written approval of Phase Technologies, LLC.

Forum Selection

Any suit, claim, or cause of action arising from this document or any Phase Technologies product, will be governed by the laws of the State of South Dakota. It is agreed that jurisdiction and venue for all disputes will be the federal or state courts of South Dakota.

INSTALLATIONS MUST COMPLY WITH ALL NATIONAL AND LOCAL ELECTRICAL CODE REQUIREMENTS.