



Models Covered:

SPD Plus

230V 1Ø Input 20-30 HP

230V 3Ø Input 40-60 HP

460V 40-100 HP

575V 40-100 HP



SPD Plus

VARIABLE SPEED PUMP CONTROL

INSTALLATION AND OPERATION MANUAL

SPD PLUS

Centrifugal Pump Controller

Quick Start Guide



Overview

The installation of the SPD PLUS adjustable speed drive follows the outline below.

- | Task |
|---------------------------|
| PREPARE for installation |
| UNPACK the drive |
| PREPARE mounting location |
| REMOVE the front cover |
| MOUNT the drive |
| INSTALL wiring |
| CHECK installation |
| REINSTALL the cover |
| APPLY power |
| START-UP Assistant |

Application

This guide provides a quick reference for installing SPD PLUS drives having a standard enclosure (NEMA 1).

NOTE: This guide does not provide detailed installation, safety or operational instructions. See the Installation Operation Manual for complete information.

Prepare for Installation

WARNING! The Aquavar should ONLY be installed by a qualified electrician.

Check

- Motor Compatibility - Motor type, nominal current, frequency and voltage range must match drive specifications (3 phase motor only).
- Suitable Environment - Drive requires heated, indoor controlled environment that is suitable for the selected enclosure below 122° F (50° C).
- Wiring - Follow local codes for wiring and fusing requirements. Refer to NEC, Local, State or Municipal codes.

Refer to the Installation Operation Manual and confirm that all preparations are complete.

Tools Required

Screwdrivers, wire stripper, tape measure, mounting screws or bolts, and drill.
Use the following chart to interpret the type code found on the drive label.

Single Pump Drive	SPD	4	0600	N1
Voltage	2 - 230 Volt	4 - 460 Volt	5 - 575 Volt	
Nominal Horsepower	0400 = 40 HP	0500 = 50 HP	0600 = 60 HP	0750 = 75 HP
Enclosure and Filter Options	Blank = NEMA 3R, no filter N1 = NEMA 1, no filter F = NEMA 3R, with filter			

NOTE: HP rating is for reference only, and is based on 3Ø input power.

Collect Motor Data

Collect the following data from the motor nameplate for later use in the Aquavar startup:

- Voltage _____
- Nominal Motor Current _____
- Nominal Frequency _____
- Nominal Speed _____
- Nominal Power _____

Unpack the Drive

NOTE: Lift the SPD PLUS by its chassis and not by its cover.

1. Unpack the drive.
2. Check for any damage and notify the shipper immediately if damaged components are found.

3. Check the contents against the order and the shipping label to verify that all parts have been received.

Prepare the Mounting Location

The drive requires a smooth, vertical, solid surface, free from heat and moisture, with free space for air flow - 200 mm (8 in.) above and below, and 25 mm (1 in.) around the sides of the drive.

1. Mark the mounting points.
2. Drill the mounting holes.

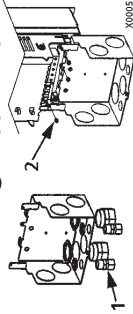
Remove the Front Cover

1. Remove the control panel (display), if attached.
2. Loosen the captive screw at the top.
3. Pull near the top to remove the cover.

Mount the Drive

1. Position the SPD PLUS and use screws or bolts to securely tighten all four corners.
2. Attach a warning sticker in the appropriate language on the inside plastic shell.

Install the Wiring (copper only)



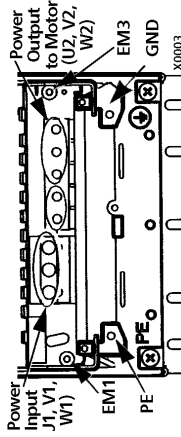
1. Install thin-wall conduit clamps (not supplied) in the conduit/gland box.
2. Install conduit/gland box.

Wiring Power

1. Connect conduit runs to box.
2. Route input power and motor wiring through conduits.

3. Strip wires.
4. Connect power, motor and ground wires to the drive terminals. See "Power Supply and Wiring" in the instruction manual.

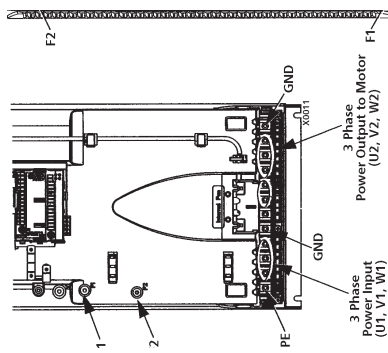
Frame Sizes R1...R4



* Single phase input power must use U1, W1 and PE for wiring.

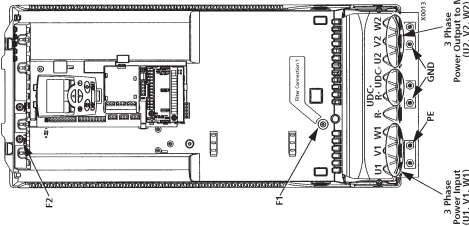
WARNING! For floating networks remove screws at EM1 and EM3 on Frame Sizes R1...R4.

Frame Size R5

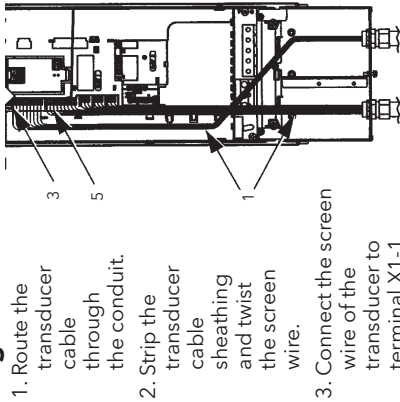


Frame Size R6

WARNING! For floating networks remove screws at F1 and F2 on Frame Sizes R5 or R6.



Wiring the Transducer



1. Route the transducer cable through the conduit.
2. Strip the transducer cable sheathing and twist the screen wire.
3. Connect the screen wire of the transducer to terminal X1-1.
4. Connect the power supply wire of the transducer (red or brown) to terminal X1-10.
5. Connect analog output wire from the transducer (white or black) to X1-5. See chart in next column.
6. Install the conduit/gland box cover (1 screw).

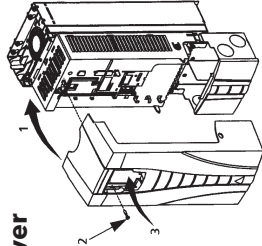
¹ Digital input impedance 1.5 kΩ. Maximum voltage for digital inputs is 30 V.

Check Installation

Before applying power, perform the following checks.

✓	Check
	Environment conforms to specifications.
	The drive is mounted securely.
	Proper cooling space around the drive.
	Motor and driven equipment are ready for start.
	Floating networks: Internal RF filter disconnected.
	Drives properly grounded, with pump/motor.
	Input power (mains) voltage matches the drive nominal input voltage.
	The input power (mains) terminals, U1, V1, W1, are connected and tightened as specified.
	The input power (mains) fuses / mains switch installed.
	The motor terminals, U2, V2, W2, are connected and tightened as specified.
	Motor cable is routed away from other cables.
	NO power factor compensation capacitors are connected to the motor cable.
	Control terminals are wired and tightened as specified.
	NO tools or foreign objects (such as drill shavings) are inside the drive.
	NO alternate power source for the motor is connected - no input voltage is applied to the output of the drive.

Reinstall the Cover



1. Align the cover and slide it on.
2. Tighten the captive screw.
3. Reinstall the control panel.

Apply Power

Always reinstall the front cover before turning power on.

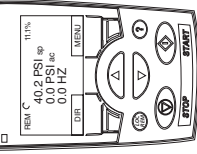


WARNING! The SPD PLUS will start up automatically at power up, if the external run command is on.

1. Apply input power.
When power is applied to the SPD PLUS, the green LED comes on.

NOTE! Before increasing motor speed, check that the motor is running in the desired direction.

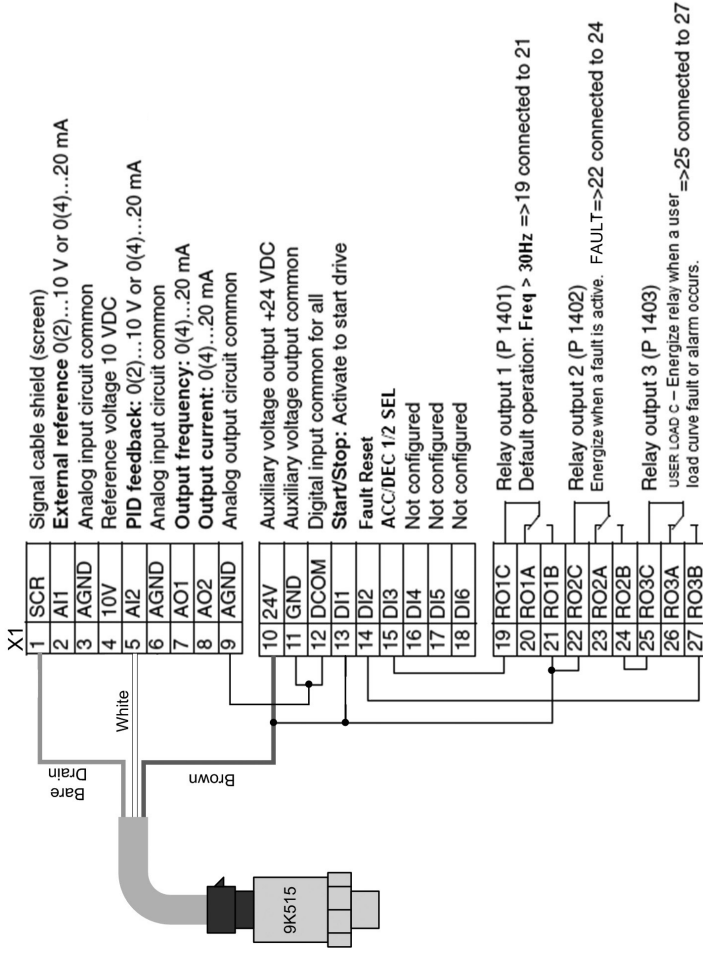
Start-Up



Run the Start-Up Assistant to configure the motor and system parameters. If this is the first time the drive has been powered, the display will prompt the user if they would like to run the Start-Up Assistant. Select Yes to run the Start-Up Assistant. If this is not the first time the drive has been powered, follow the steps below:

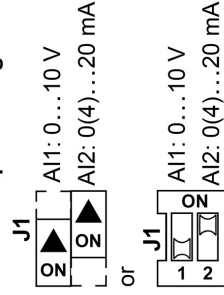
1. From the Main Screen press MENU to enter the MENU screen.
2. Select QUICKSTART
3. Select Start-Up
4. Follow the menu prompts to configure the drive.

NOTE! For common parameters and menu items, use the Help Key (?) to display descriptions. If you encounter Alarms or Faults, use the Help Key or refer to the Diagnostic section of the instruction manual.



Identification	RELAY OUTPUTS RO4 TO RO6
1 RO4C	Relay output Default operation: Started
2 RO4A	
3 RO4B	
4 RO5C	Relay output Default operation: Running
5 RO5A	
6 RO5B	
7 RO6C	Relay output Default operation: Fault
8 RO6A	
9 RO6B	

Jumper setting



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NOTE:

- Input and Output power connections require a minimum of 75°C rated Copper wire only.
- In order to maintain the environmental rating integrity of the enclosure, all openings must be closed by equipment rated Type 1 for Type 1 enclosures or Type 3R for Type 3R enclosures
- Maximum Ambient temperature range 5° F (-15° C) to 122° F (50° C).
- Maximum Humidity: 95% non-condensing.

SECTION 1: SAFETY INSTRUCTIONS

TO AVOID SERIOUS OR FATAL PERSONAL INJURY OR MAJOR PROPERTY DAMAGE, READ AND FOLLOW ALL SAFETY INSTRUCTIONS IN MANUAL AND ON EQUIPMENT.

THIS MANUAL IS INTENDED TO ASSIST IN THE INSTALLATION AND OPERATION OF THIS UNIT AND MUST BE KEPT WITH THE UNIT.



This is a **SAFETY ALERT SYMBOL**. When you see this symbol on the pump, the controller or in the manual, look for one of the following signal words and be alert to the potential for personal injury or property damage. Obey all messages that follow this symbol to avoid injury or death.



Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.



Used without a safety alert symbol indicates a potentially hazardous situation which, if not avoided, could result in property damage.

NOTICE:











INDICATES SPECIAL INSTRUCTIONS WHICH ARE VERY IMPORTANT AND MUST BE FOLLOWED.

THOROUGHLY REVIEW ALL INSTRUCTIONS AND WARNINGS PRIOR TO PERFORMING ANY WORK ON THIS CONTROLLER.


MAINTAIN ALL SAFETY DECALS.

All operating instructions must be read, understood, and followed by the operating personnel. CentriPro accepts no liability for damages or operating disorders which are the result of non-compliance with the operating instructions.

1. This manual is intended to assist in the installation, operation and repair of the system and must be kept with the system.
2. Installation and maintenance **MUST** be performed by properly trained and qualified personnel.
3. Review all instructions and warnings prior to performing any work on the system.
4. Any safety decals **MUST** be left on the controller and/or pump system.

5.  **Hazardous voltage** The system **MUST** be disconnected from the main power supply before attempting any operation or maintenance on the electrical or mechanical part of the system. Failure to disconnect electrical power before attempting any operation or maintenance can result in electrical shock, burns or death.
6.  **Hazardous Pressure** When in operation, the motor and pump could start unexpectedly and cause serious injury.
7.  **Hazardous voltage** Even when the motor is stopped, dangerous voltage is present at the Power Circuit terminals U1, V1, W1 and U2, V2, W2 and, depending on the frame size, UDC+ and UDC-, or BRK+ and BRK-.
8.  **Hazardous voltage** **WARNING!** Dangerous voltage is present when input power is connected. After disconnecting the supply, wait at least 5 minutes (to let the intermediate circuit capacitors discharge) before removing the cover.
9.  **Hazardous voltage** **WARNING!** Even when power is removed from the input terminals of the SPD Plus, there may be dangerous voltage (from external sources) on the power disconnect or terminals of the relay outputs R01...R03.
10.  **Hazardous voltage** **WARNING!** When the control terminals of two or more drive units are connected in parallel, the auxiliary voltage for these control connections must be taken from a single source which can either be one of the units or an external supply.
11.  **Hazardous voltage** **WARNING!** The SPD Plus is not a field repairable unit. Never attempt to repair a malfunctioning unit; contact the factory or your local Authorized Service Center for replacement.
12.  **Hazardous Pressure** **WARNING!** The SPD Plus will start up automatically after an input voltage interruption if the external run command is on.
13.  **WARNING!** The heat sink may reach a high temperature, in excess of 200° F. Severe burns are possible.
14.  **Hazardous voltage** **WARNING!** If the drive will be used in a floating network, remove screws at EM1 and EM3 (Frame size R4) or F1 and F2 (Frame size R5 or R6).

NOTE! For more technical information, contact the factory or your local SPD Plus representative.

15.  **Hazardous voltage** **WARNING!** Always consult your local, state, municipal or NEC codes for proper wiring, electrical installation of inverter drives and AC motors.

SECTION 2: SYSTEM COMPONENTS

Please review the SPD Plus Variable Speed Pump Controller components and ensure that you have all the parts and are familiar with their names. Be sure to inspect all components supplies for shipping damage.

SPD Plus Variable Speed Pump Controller Package:

- SPD Plus Variable Speed Controller
- Pressure Transducer with Cable
- Output Reactor (if ordered)
- Installation and Operation Manual

WARNING



DO NOT

power the unit or run the pump until all electrical and plumbing connections, especially the pressure sensor connection, are completed. The pump should not be run dry.

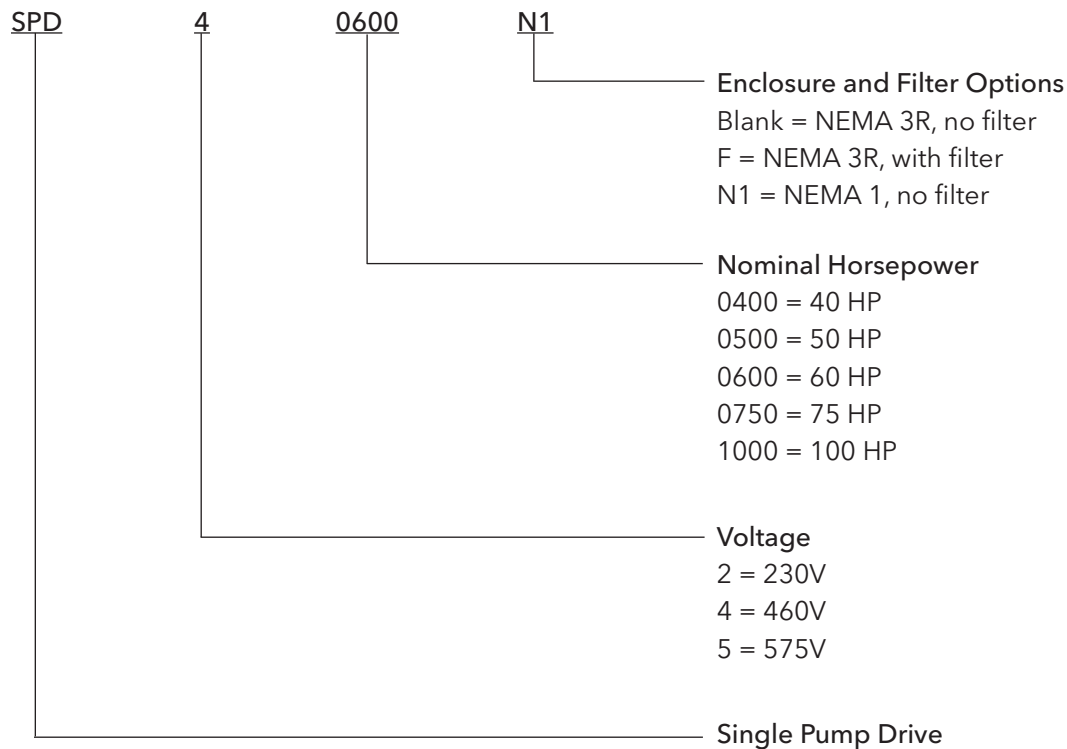


All electrical work must be performed by a qualified technician. Always follow the National Electrical Code (NEC), or the Canadian Electrical Code (CEC) as well as all local, state and provincial codes. Code questions should be directed to your local electrical inspector or code enforcement agency. Failure to follow electrical codes and OSHA safety standards may result in personal injury or equipment damage. Failure to follow manufacturer's installation instructions

may result in electrical shock, fire hazard, personal injury, death, damage to equipment, unsatisfactory performance and may void manufacturer's warranty.

SPD PLUS TYPE CODE AND PART NUMBER

Type Code:



NOTE: HP rating is for reference only, and is based on 3Ø input power.

PART NUMBERS

Supply Voltage	Model Number	Nominal HP Rating		Full Load Output Current (50C)		Full Load Output Current (40C)		Frame Size
		3 Phase Input	1 Phase Input	3 Phase Input	1 Phase Input	3 Phase Input	1 Phase Input	
208/230	SPD20400	40	20	103	51	114	57	N6
	SPD20400F	40	20	129	64	143	72	N6
	SPD20400N1	40	20	103	51	114	57	R4
	SPD20500	50	25	129	64	143	72	N6
	SPD20500F	50	25	160	80	178	89	N6
	SPD20500N1	50	25	129	64	143	72	R6
	SPD20600	60	30	160	80	178	89	N6
	SPD20600F	60	30	199	99	221	111	N6
	SPD20600N1	60	30	160	80	178	89	R6
460	SPD40400	40	–	53	–	59	–	N4
	SPD40400F	40	–	65	–	72	–	N4
	SPD40400N1	40	–	53	–	59	–	R4
	SPD40500	50	–	65	–	72	–	N4
	SPD40500F	50	–	87	–	97	–	N5
	SPD40500N1	50	–	65	–	72	–	R4
	SPD40600	60	–	87	–	97	–	N5
	SPD40600F	60	–	87	–	97	–	N5
	SPD40600N1	60	–	87	–	97	–	R4
	SPD40750	75	–	113	–	125	–	N6
	SPD40750F	75	–	113	–	125	–	N6
	SPD40750N1	75	–	113	–	125	–	R5
	SPD41000	100	–	141	–	157	–	N6
	SPD41000F	100	–	141	–	157	–	N6
	SPD41000N1	100	–	141	–	157	–	R6
575	SPD50400N1	40	–	47	–	52	–	R4
	SPD50500N1	50	–	69	–	77	–	R6
	SPD50600N1	60	–	69	–	77	–	R6
	SPD50750N1	75	–	89	–	99	–	R6
	SPD51000N1	100	–	130	–	144	–	R6

NOTES

- 1) Refer to Appendix C for frame size details.
- 2) Drive supplied with pressure transducer and manual.
- 3) Controllers with an N1 suffix have a NEMA 1 enclosure and are rated for indoor use only.

SECTION 3: SYSTEM DESIGN

SPD PLUS CENTRIFUGAL PUMP CONTROL SYSTEM

The SPD Plus pump controller is a simple, easy to use and commission Variable Speed Drive (VSD) designed specifically for use in submersible or above ground pump systems. The SPD Plus features an integrated Start-Up Assistant which simplifies system commissioning and setup.

The following diagrams show some typical system designs using the SPD Plus.

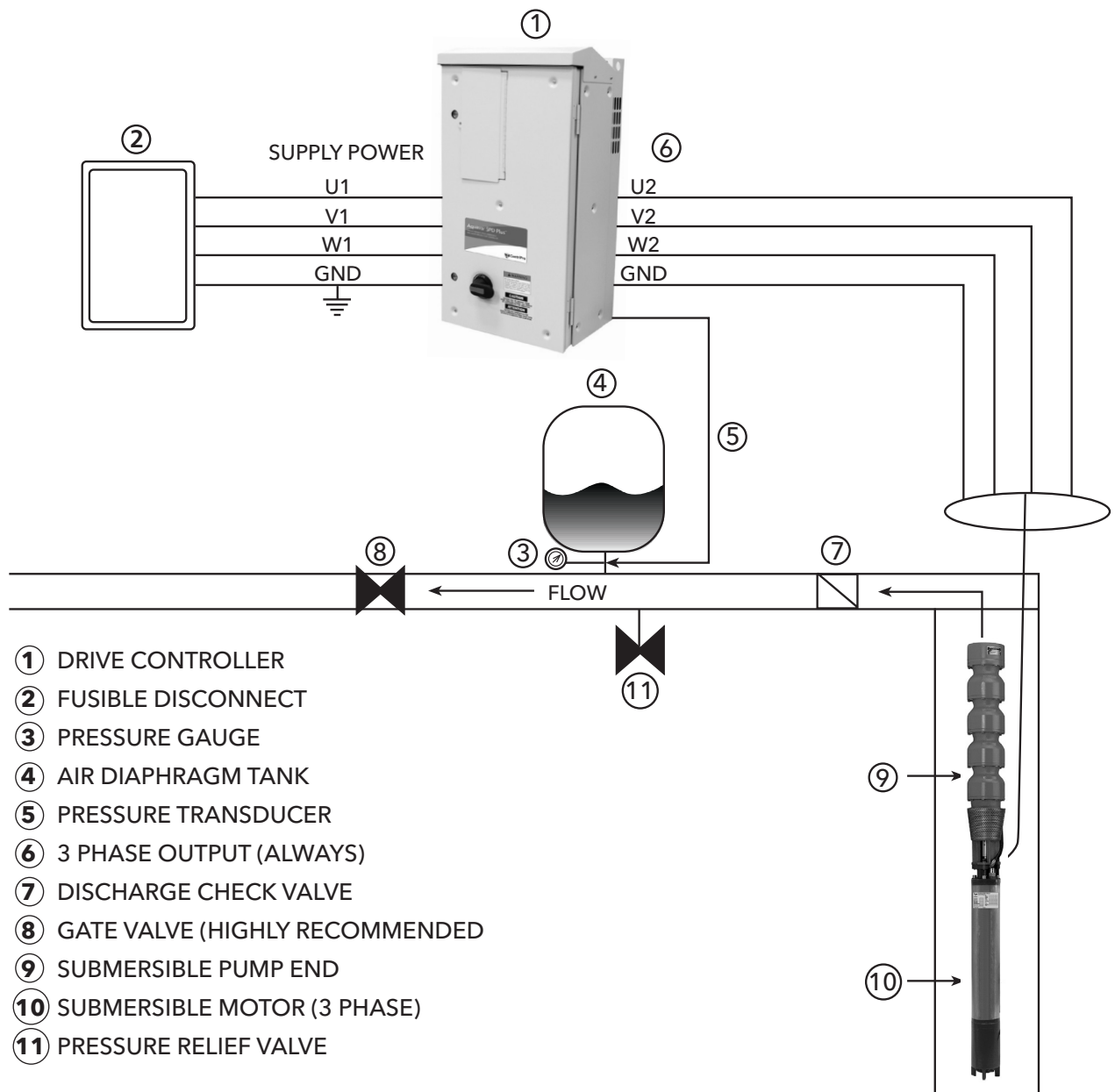
NOTE

The SPD Plus is not recommended for the residential well applications. Consult CentriPro for suitable Variable Speed Controllers designed for residential well pumps.

NOTE

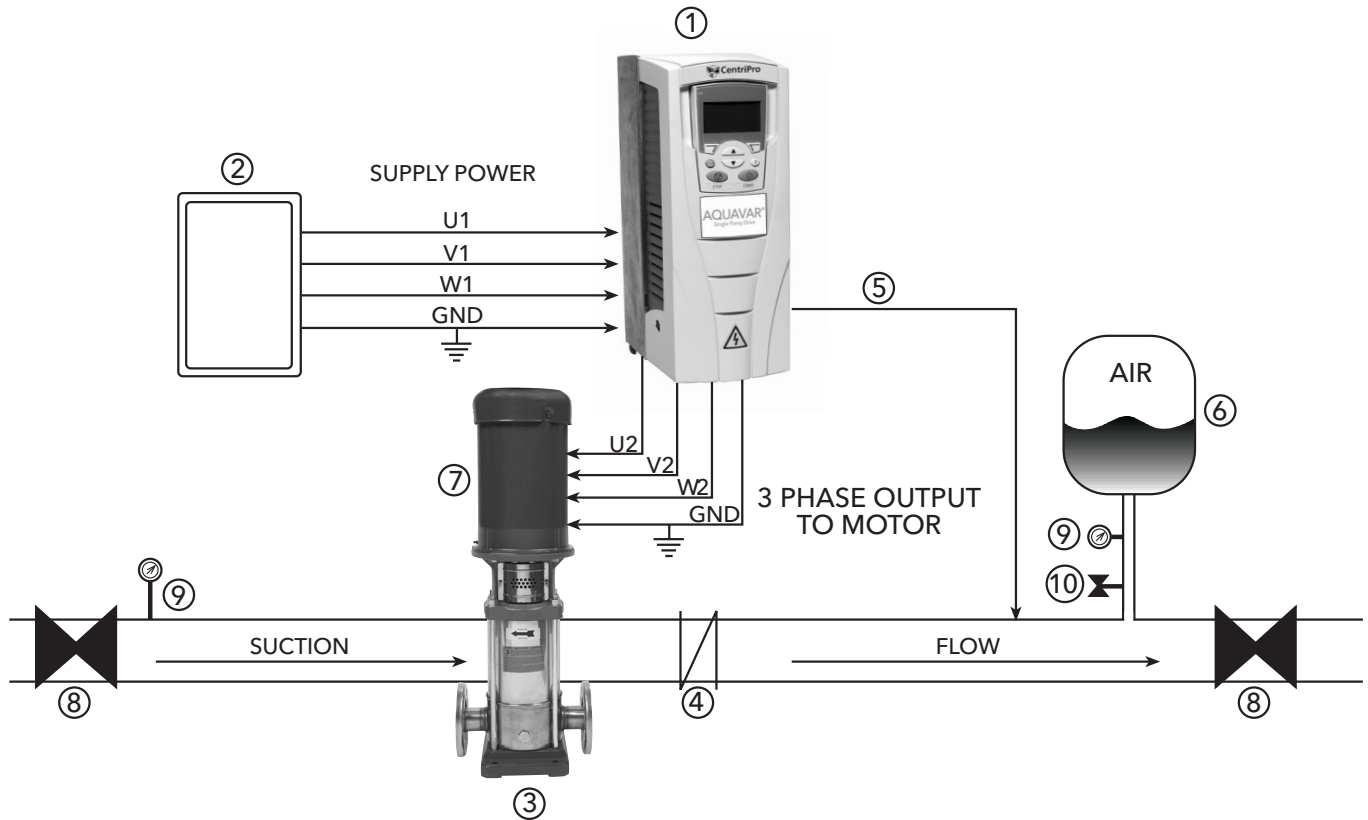
Systems MUST be designed by qualified technicians only and meet all applicable state and local code requirements.

DIAGRAM #1 shows a typical set up for a submersible pump and control system.



SECTION 3: SYSTEM DESIGN

DIAGRAM #2 shows a set-up for an Above Ground booster pump and control system.



- | | |
|--|---------------------------|
| ① SPD CONTROLLER | ⑥ AIR DIAPHRAGM TANK |
| ② FUSIBLE DISCONNECT | ⑦ 3 PHASE MOTOR |
| ③ CENTRIFUGAL PUMP | ⑧ GATE VALVE (BALL VALVE) |
| ④ CHECK VALVE | ⑨ PRESSURE GAUGE |
| ⑤ PRESSURE TRANSDUCER (CABLE ASSEMBLY) | ⑩ PRESSURE RELIEF VALVE |

SECTION 4: PIPING

GENERAL

NOTE

All plumbing work must be performed by a qualified technician. Always follow all local, state and provincial codes.

A proper installation requires a pressure relief valve, a 1/4" female N.P.T. threaded fitting for the pressure sensor, and properly sized pipe. Piping should be no smaller than the pump discharge and/or suction connections. Piping should be kept as short as possible. Avoid the use of unnecessary fittings to minimize friction losses.



Some pump and motor combinations controlled by the SPD Plus can create dangerous pressure. Select pipe and fittings according to your pipe suppliers' recommendation. Consult local codes for piping requirements in your area.

All joints must be airtight. Use PTFE thread seal tape or another type of pipe sealant to seal threaded connections. Please be careful when using thread sealant as any excess that gets inside the pipe may plug the pressure sensor.

Galvanized fittings or pipe should never be connected directly to the stainless steel pump discharge or casing as galvanic corrosion may occur. Barb type connectors should always be double clamped.

PRESSURE TANK, PRESSURE RELIEF VALVE AND DISCHARGE PIPING

Use only "pre-charged" tanks on this system. Do not use galvanized tanks. Select an area that is always above 34° F (1.1° C) in which to install the tank, pressure sensor and pressure relief valve. If this is an area where a water leak or pressure relief valve blow-off may damage property, connect a drain line to the pressure relief valve. Run the drain line from the pressure relief valve to a suitable drain or to an area where water will not damage property.

SECTION 4: PIPING (CONTINUED)

PRESSURE TANK, SYSTEM PRESSURE

Sizing - A bladder tank (not included) is used to cushion the pressure system during start-up and shut-down. It should be sized to at least 20% of the total capacity of your pump. Example: If your pump is sized for 100 GPM then size your tank for at least 20 gal. total volume, not draw down. Pre-charge your bladder tank to 15-20 PSI below your system pressure. Use the higher tank pre-charge setting if the system drifts over 5 PSI at a constant flow rate. **NOTE: Pre-charge your tank before filling with water!**

CAUTION



Maximum working pressure of HydroPro bladder tank is 125 psi.

INSTALLING THE PRESSURE SENSOR

The pressure sensor requires a ¼" NPT fitting for installation. Install the pressure sensor with the electrical connector pointing up to avoid clogging the pressure port with debris. Install the pressure sensor in a straight run of pipe away from elbows or turbulence. For optimum pressure control install the pressure sensor in the same straight run of pipe as the pressure tank. Ensure the pressure sensor is within 10 feet of the pressure tank. Installing the pressure sensor far away from the pressure tank may result in pressure oscillations. **Do not install the pressure sensor in a location where freezing can occur.** A frozen pipe can cause damage to the pressure sensor.

The pressure sensor cable must be wired to the controller control terminals. The pressure sensor cable wiring diagram is shown in Section 6. The cable can be shortened for a cleaner installation. Longer cable lengths are available, consult factory. Maximum recommended pressure sensor cable length is 300 feet. Avoid leaving a coil of pressure sensor cable as this can induce unwanted transient voltages and noise into the system. Do not run the pressure sensor cable alongside the input or output wiring for more than 1 foot. Maintain a distance of at least 8" between the pressure sensor cable and input or output wiring.

Ensure the pressure sensor cable is connected as follows: Brown to terminal 10 (24VDC SUPPLY), White to terminal 5 (AI2, TRANSDUCER FEEDBACK), Drain to SCR Terminal 1. Connecting the Drain wire to the SCR Terminal electrically connects the sensor case to the chassis of the controller. In some cases this drain wire must be disconnected from the controller chassis. In cases where there is grounded metal piping which is continuous between the transducer and the motor or the transducer is installed in grounded metal piping, a ground loop can result so the drain wire must be disconnected from the chassis. In cases where there are sections of nonmetallic piping between the transducer and motor or the transducer is installed in ungrounded piping this drain wire should be connected to the controller chassis.

SECTION 5: MOUNTING THE CONTROLLER

GENERAL

Mount the controller in a ventilated, shaded area. The controller must be mounted vertically. Be sure to leave 8 inches of free air space on every side of the unit. The controller must be in an area with an ambient between 5 °F (-15 °C) and 122 °F (50 °C). If installation is above 3300 feet above sea level, ambient temperatures are derated 1% per 330 feet above 3300 feet. The altitude limit for this controller is 6600 ft. Do not install above 6600 ft.

NOTE

Do not block the heat sink (fins) and fans and do not set anything on the units.

WARNING



The controller access cover should always be securely fastened to the control box due to the dangerous voltage/shock hazard inside the unit.

NOTE

Controllers with an N1 suffix have a NEMA 1 enclosure and are rated for indoor use only.

SECTION 6: POWER SUPPLY AND WIRING

POWER CONNECTION DIAGRAMS

The following diagrams show the power connection layout for each frame size.

- For sizes R4 and N4

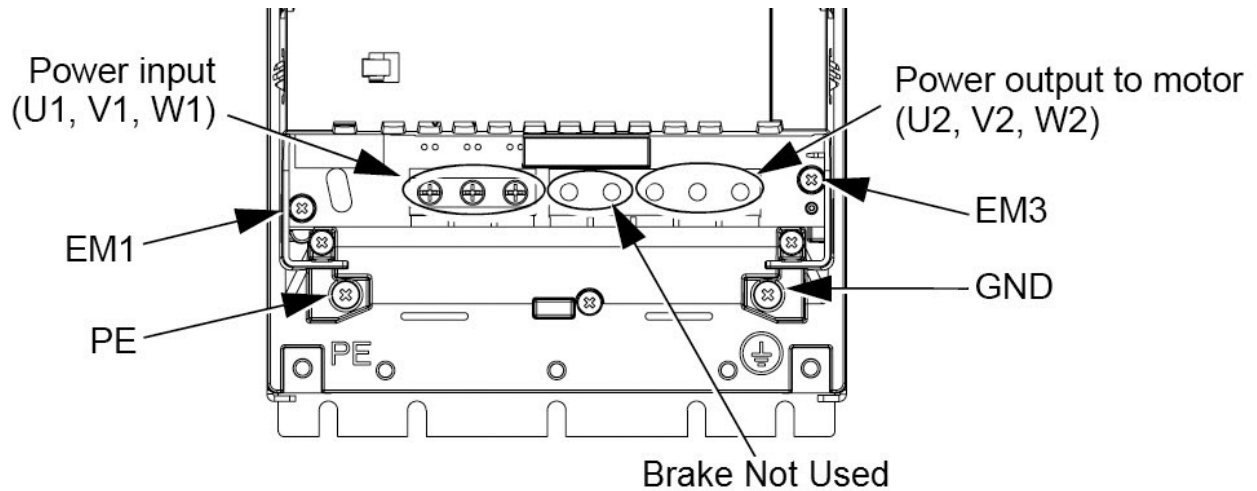


FIGURE 1

WARNING

▲WARNING
Hazardous
voltage

If the secondary of the transformer is a delta with a grounded leg (corner grounded delta) or floating network, the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result. Remove screws EM1 and EM3 for frame sizes R4/N4 to disable line to ground EMC filter and MOV protection.

SECTION 6: POWER SUPPLY AND WIRING (CONTINUED)

POWER CONNECTION DIAGRAMS

The following diagrams show the power connection layout for each frame size.

- For sizes R5 and N5

- For sizes R6 and N6

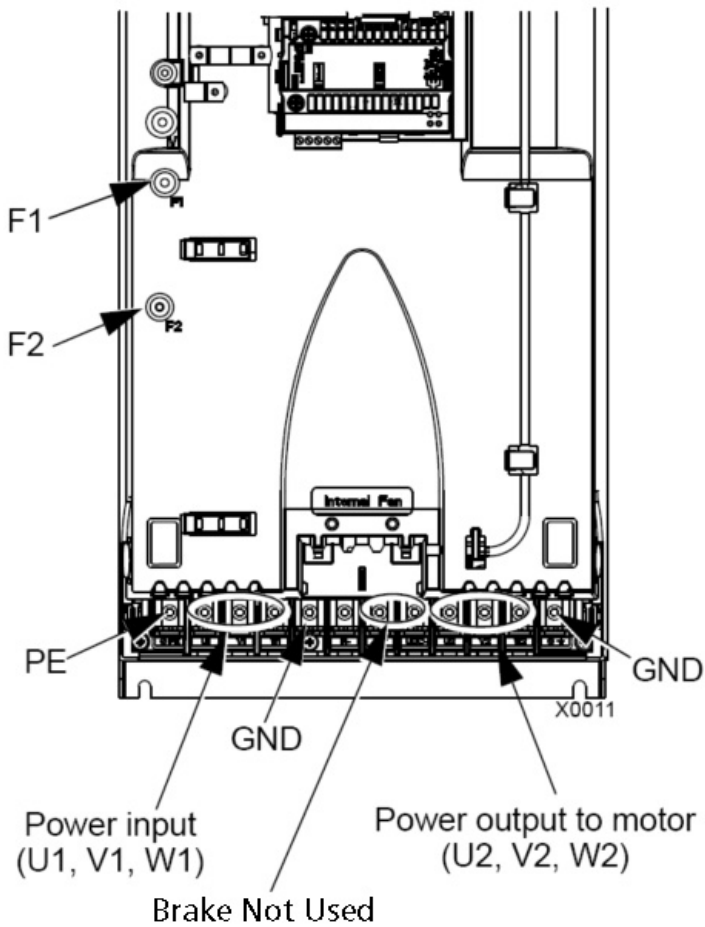


FIGURE 2

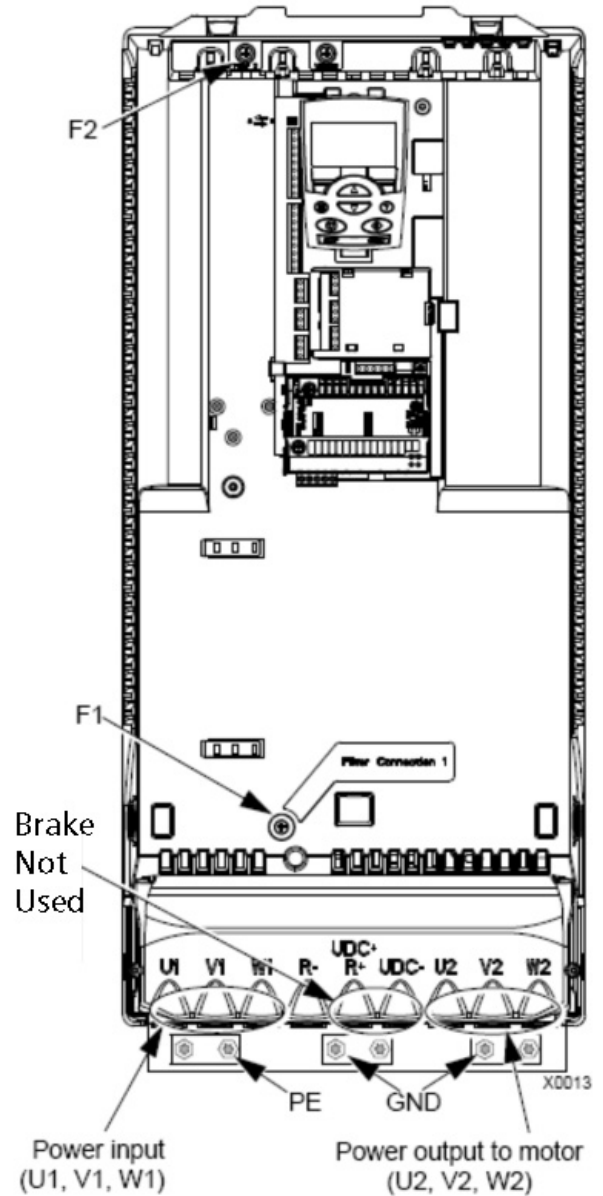


FIGURE 3

WARNING

WARNING
Hazardous
voltage

If the secondary of the transformer is a delta with a grounded leg (corner grounded delta) or floating network, the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result. Remove screws F1 and F2 for frame sizes R5/N5 and R6/N6 to disable line to ground EMC filter and MOV protection.

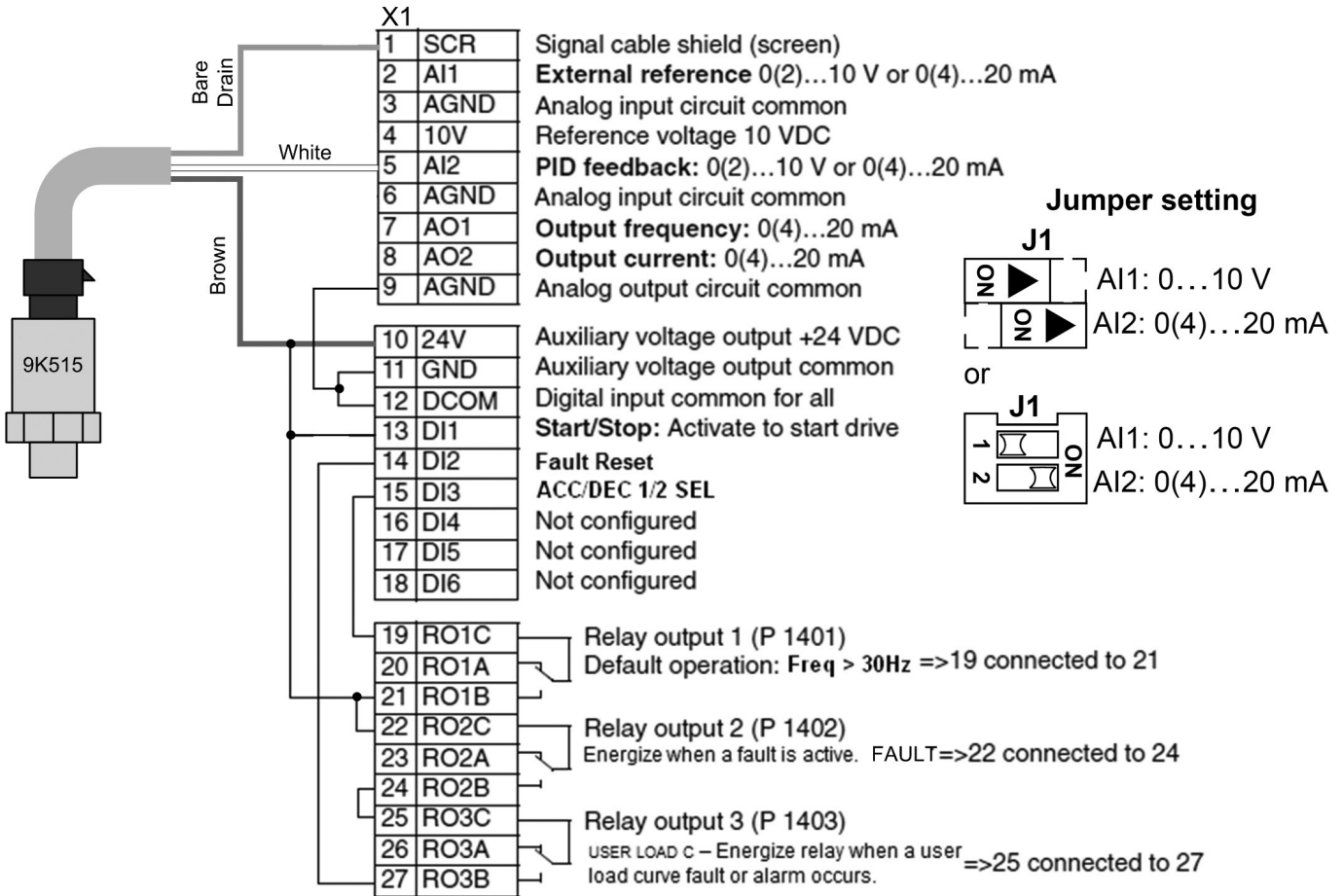
NOTE

For single phase input power, use input power terminals U1, W1 and PE (ground).

SECTION 6: POWER SUPPLY AND WIRING (CONTINUED)

CONTROL TERMINAL CONNECTION DIAGRAM

The diagram below describes the control terminal connections.



NOTE

Pressure sensor cable must be wired during installation. All other connections are wired at the factory.

Identification		RELAY OUTPUTS R04 TO R06	
1	RO4C		Relay output Default operation: Started
2	RO4A		
3	RO4B		
4	RO5C		Relay output Default operation: Running
5	RO5A		
6	RO5B		
7	RO6C		Relay output Default operation: Fault
8	RO6A		
9	RO6B		

FIGURE 4

NOTE

A jumper wire is installed between DI1 and +24V at the factory. To remotely start and stop the drive while in REM mode, replace the jumper wire with a non-powered switch.

SECTION 6: POWER SUPPLY AND WIRING

(CONTINUED)

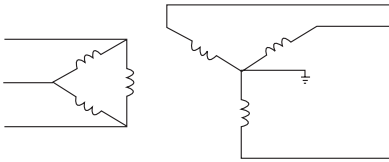
INPUT POWER AND LINE TRANSFORMER REQUIREMENTS

NOTE

Installation and maintenance MUST be performed by properly trained and qualified personnel. Always follow the National Electrical Code (NEC) or Canadian Electric Code (CEC), as well as all state, local and provincial codes when wiring the system.

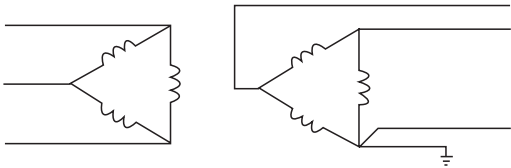
The type of transformer and the connection configuration feeding a drive plays an important role in its performance and safety. The following is a brief description of some of the more common configurations and a discussion of their virtues and shortcomings. Always ask what type of power system the site has before sizing the drive.

DELTA/WYE WITH GROUNDED WYE NEUTRAL:



This configuration is one of if not the most common. It provides rebalancing of unbalanced voltage with a 30 degree phase shift. Depending on the output connections from the drive to motor, the grounded neutral may be a path for common mode current caused by the drive output.

DELTA/DELTA WITH GROUNDED LEG

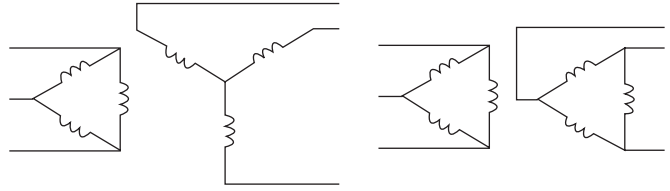


Another common configuration providing voltage rebalancing with no phase shift between input and output. Again, depending on the output connections from the drive to motor, the grounded neutral may be a path for common mode current caused by the drive output.

WARNING

⚠ WARNING Hazardous voltage If the secondary of the transformer is a delta with a grounded leg (corner grounded delta) or floating network, the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result. Remove screws EM1 and EM3 for frame sizes R4/N4 or F1 and F2 for frame sizes R5/N5 and R6/N6 to disable line to ground EMC filter and MOV protection. Refer to Figures 1, 2 and 3 for screw locations.

UNGROUND SECONDARY

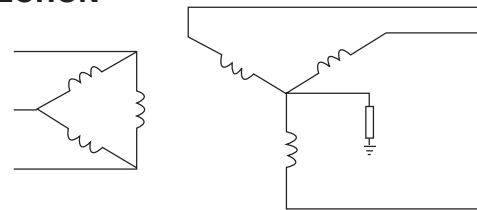


Grounding of the transformer secondary is essential to the safety of personnel as well as the safe operation of the drive. Leaving the secondary floating can permit dangerously high voltages between the chassis of the drive and the internal power structure components. In many cases this voltage could exceed the rating of the input MOV protection devices of the drive causing a catastrophic failure. In all cases, the input power to the drive should be referenced to ground. If the transformer can not be grounded, then an isolation transformer must be installed with the secondary of the transformer grounded.

WARNING

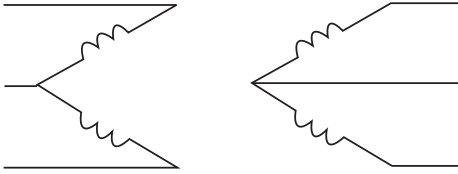
⚠ WARNING Hazardous voltage If the secondary of the transformer is a delta with a grounded leg (corner grounded delta) or floating network, the line to ground EMC filter components and line to ground MOV protection must be disconnected or damage to the controller can result. Remove screws EM1 and EM3 for frame sizes R4/N4 or F1 and F2 for frame sizes R5/N5 and R6/N6 to disable line to ground EMC filter and MOV protection. Refer to Figures 1, 2 and 3 for screw locations.

RESISTANCE GROUNDING AND GROUND FAULT PROTECTION



Connecting the Wye secondary neutral to ground through a resistor is an acceptable method of grounding. Under a short circuit secondary condition, any of the output phases to ground will not exceed the normal line to line voltage. This is within the rating of the MOV input protection devices on the drive. The resistor is often used to detect ground current by monitoring the associated voltage drop. Since high frequency ground current can flow through this resistor, care should be taken to properly connect the drive motor leads using the recommended cables and methods. In some cases, multiple drives on one transformer can produce a cumulative ground current that can trigger the ground fault interrupt circuit.

OPEN DELTA (CONSULT FACTORY)



This type of configuration is common on 230 volt systems. From time to time it may be encountered where only single phase power is available and three-phase power is required. The technique uses two single phase transformers to derive a third phase. When used to power a drive this configuration must be derated to about 70% of the single phase rating of one transformer. This system provides poor regulation and it is possible that only the two line connected phases will provide power. In this case the drive must be derated to 50 % of its rating. (Ex. A 20 HP 230 volt drive now becomes a 10 HP 230 volt drive.)

WARNING

▲WARNING
Hazardous
voltage

"Open Delta" power systems should be sized using the 50% derate factor. Consult factory.

SINGLE PHASE CONNECTION

For drives with a diode rectifier front end it is possible to run a three phase output with a single phase input. Only part of the three phase input bridge is used. Ripple current becomes 120 Hz rather than 360. This places a greater demand on the DC filter components (capacitor bank and DC choke). The result is that the drive must be derated to 50% current. Single phase will not work with an SCR front end drive.

LINE TRANSFORMER

The line input voltage and transformer power must meet certain phase and balance requirements. **If you or your installing electrical contractor is in doubt of the requirements, the following provide guidelines for the SPD Plus installation. When in doubt contact the local power utility or the factory.**

If an isolation transformer is used, the best choice is ONE three phase, six winding transformer. A delta primary is best for third harmonic cancellation. A wye secondary avoids circulating current problems and provides the very desirable option of grounding the secondary neutral for minimum voltage stress and ripple to ground. The transformer should have a KVA rating at least 1.1 times the maximum connected HP. A K factor of 6 is sufficient if transformer impedance is greater than 2%. A K Factor of 5 is sufficient if transformer impedance is greater than 3%. The transformer manufacturer may provide derating for non K Factor rated transformers to operate at the drive produced K Factor levels.

Other transformer configurations are acceptable. **Three single phase transformers can be used if they are identical for phase to phase symmetry and balance.** A wye connected primary neutral should never be grounded. Great care should be taken with delta primary delta secondary configurations. Any lack of phase to phase symmetry could result in circulating currents and unacceptable transformer heating.

WARNING

▲WARNING
Hazardous
voltage

Never use phase converters with drives as nuisance tripping and possible damage may occur. Instead, use single phase input power and 50% derate factor.

INPUT POWER SPECIFICATIONS

Input Power (mains) Connection Specifications	
Voltage (U_1)	208/220/230/240 VAC 3-phase or 1-phase - 15% ...+10% for SPD2XXXX 380/400/415/440/460/480 VAC 3-phase -15%...+10% for SPD4XXXX 500/525/575/600 VAC 3-phase -15%....+10% for SPD5XXXX
Prospective Short-Circuit Current (IEC 629)	Maximum allowed prospective short-circuit current in the supply is 100 kA providing that the input power cable of the drive is protected with appropriate fuses. US: 100 000 AIC.
Frequency	48...63 Hz
Imbalance	Maximum $\pm 3\%$ of nominal phase to phase input voltage
Fundamental Power Factor ($\cos \phi_1$)	0.98 (at nominal load)

SECTION 6: POWER SUPPLY AND WIRING

(CONTINUED)

CONDUIT, WIRE AND FUSE SIZING

When selecting the input power cable follow the rules below:

- Do not use aluminum wires
- The cable must be able to carry the drive load current
- The cable must be rated for at least 75°C
- A four conductor cable (three phases and ground) or four insulated conductors routed through conduit may be used. Shielding is not required. The use of metal conduit with metal conduit connectors is recommended for all electrical connections. Use the NEC or CEC to determine the required conduit size for the application.

Refer to the wire sizing tables in Appendix B to determine the maximum length for the input and output cables. The maximum recommended total voltage drop on both input and output cable combined is 5%. Standard wire sizing table provides maximum cable lengths for input or output cables.

Because of this the lengths given in the table must be adjusted so the total voltage drop does not exceed 5%. For example, if the input wire sizing chart in the appendix gives the maximum length of 400' and only 100' is used then only 25% of the total voltage drop (1.25% drop) is used. The maximum output cable length must then be adjusted to 75% of its value so that the maximum voltage drop of 5% is not exceeded.

Provide a dedicated fused disconnect rated for drives input current rating. (Fused disconnect included for NEMA3R enclosures.) No other equipment should be used for this disconnect. Use fast acting class T fuses. The recommended fuse sizes for each model are listed below.

INPUT POWER CONNECTIONS

Before making this connection, measure and verify the site voltage phase to phase and phase to ground. In the case of high line to ground voltage it may be necessary to disconnect the line to ground EMC and MOV protection. See Figures 1, 2 and 3 for details. Ensure the ground wire is connected back to the service entrance ground and that the service entrance ground is bonded to a proper ground rod.

Input Voltage	Model Number	Input Current (Arms)	Mains Fuse Size (UL Class T)
230V	SPD20400	114	150
	SPD20400F	143	200
	SPD20400N1	114	150
	SPD20500	143	200
	SPD20500F	178	250
	SPD20500N1	143	200
	SPD20600	178	250
	SPD20600F	221	300
	SPD20600N1	178	250
460V	SPD40400	59	80
	SPD40400F	72	90
	SPD40400N1	59	80
	SPD40500	72	90
	SPD40500F	96	125
	SPD40500N1	72	90
	SPD40600	96	125
	SPD40600F	96	125
	SPD40600N1	96	125
	SPD40750	124	175
	SPD40750F	124	175
	SPD40750N1	124	175
	SPD41000	157	200
	SPD41000F	157	200
	SPD41000N1	157	200
575V	SPD50400N1	52	60
	SPD50500N1	77	100
	SPD50600N1	77	100
	SPD50750N1	99	150
	SPD51000N1	144	200



Ensure disconnect switches are locked in the OFF position before making this connection. For models with an N1 (NEMA 1) suffix, connect conduit to the conduit box supplied with the controller. For all other models (NEMA 3R), drill a hole that is properly sized for the conduit used in the bottom of the enclosure.

NOTE: Drilling in to the side or top of the enclosure will violate the NEMA 3R rating. Use metal conduit and metal conduit connectors. Size the conduits according to the NEC, CEC or local codes. Use the wire sizing chart in Appendix B to determine the size of the input power wires.

Connect the conduit and insert the wires into the controller or enclosure. Connect wires to the "INPUT" terminal block. For N1 models, this terminal block is on the controller and the terminal locations are as shown in Figures 1, 2 and 3. For all other models, this connection is made to the input side of the fused disconnect that is included in the enclosure. The connections from the output side of the disconnect to the controller are made at the factory. Connect the ground wire to the terminal labeled GND. For three phase input, connect the input phase wires to U1, V1 and W1. For single phase input, connect the input wires to U1 and W1.

WARNING

Measure and verify site voltage phase to phase and phase to ground prior to connected power to the controller.

NOTE

Verify that there is at least 8" between input and output connections or input connections and control wiring.

DANGER

▲WARNING Hazardous voltage The controller has a high leakage current to ground. The input terminals marked "GND" must be directly connected to the service entrance ground. Failure to properly ground the controller or motor will create an electrical shock hazard.

NOTE

Do not use GFCI protection with this controller. Nuisance tripping will result.

NOTE

A single phase power input is designated only on 230 V specifically, and the corresponding SPD Plus pump controllers are derated to 50%.

DANGER

▲WARNING Hazardous voltage Status Code Indicator Light and Control Panel Display are not voltage indicators! Always turn off disconnect switch and wait 5 minutes before servicing.

DANGER

▲WARNING Hazardous voltage The controller will remain electrically charged for 5 minutes after power is turned off. Wait 5 minutes after disconnecting power before opening controller access cover as there is a severe shock hazard.

OUTPUT POWER CONNECTIONS

▲DANGER Hazardous voltage Ensure input power disconnect is locked in the off position before making the output power connections. Run the motor lead wire from the motor or conduit box through metal conduit to the bottom of the controller. Use metal conduit and metal conduit connectors. Size the conduits according to the NEC, CEC or local codes. Connect conduit and insert the wires through the bottom of the enclosure or controller conduit box extension. For frames N4, N5 and N6, it may be necessary to drill a hole in the bottom of the enclosure for conduit and wire entry.

Consult motor manual to determine the wire size for the application. Ensure the ground connection to the motor is continuous. Connect wires to the output terminal block on the controller labeled U2, V2, W2, and GND. Connect the ground wire to the terminal labeled GND.

If a reactor is used for a submersible motor, connect drive output terminal block U2, V2, W2 and GND to the corresponding input terminals of the load reactor. Connect the output terminals of the reactor to the motor leads and GND. When wiring the load reactor ensure all input connections from the controller are on the same side of the reactor terminal block.

NOTE

A load reactor or load filter is required in installations where the output motor leads exceed 50 ft.

NOTE

It is recommended to use a load reactor with all 575V installations.

NOTE

Models with 'F' suffix include a load reactor prewired to the controller.

NOTE

Ensure you have a three phase motor and verify the motor voltage matches input power supply voltage. Verify that the motor service factor amps do not exceed the drive output at rated ambient temperature. Ensure the ground is continuous between the controller and the motor. Ensure there is at least 8" between the output wires and any other wires.

For CentriPro motors, connecting U2 to Red, V2 to Black and W2 to Yellow will give the correct rotation. To change rotation, swap any two motor leads U2, V2 or W2.

Motor power and type are to be specified in Start-Up Menu on drive keypad before running pump system.

DANGER

▲WARNING Hazardous voltage The controller has high leakage current to ground. The output terminals marked "GND" or "⊥" must be directly connected to the motor ground. Failure to properly ground the controller or motor will create an electrical shock hazard.

SECTION 7: CONTROL INPUT AND OUTPUT FUNCTIONS

The control terminals allow for a variety of control functions. Some of the terminals are prewired by the factory. Removing prewired connections can disable some controller functions. Refer to the information below before removing prewired connections.

▲ WARNING Turn off all power to the controller before wiring devices to the control terminals.

▲ WARNING All the DI inputs are switch inputs. Do not connect external power to these inputs or damage to the controller will result. Only connect non-powered switch contacts to these inputs.

START/STOP (DI1,13): The DI1 input allows the pump/motor to be turned on and off by an external switch while in REM mode. The input is pre-wired to +24V terminal 10.

For external control of this input, use only a non-powered external switch. Connect the contacts of the switch to terminals 10 (+24VDC Supply) and 13 (DI1-START/STOP). When the switch is closed the controller is in START mode (output to motor is enabled). When the switch is open the controller is in STOP mode (output to motor is disabled).

TRANSDUCER INPUT (AI2, 5) and +24VDC (10): These terminals are the transducer feedback and transducer power supply. The controller is configured with a 300 PSI 4-20mA output pressure transducer.

Connect the 3-wire pressure transducer cable with white wire of signal to terminal AI2/5, brown wire of +24 VDC transducer power supply to the drive terminal 10, and shield/drain wire to terminal 1/SCR. Refer to Section 4 for pressure transducer installation details.

RELAY OUTPUTS (RO1-R03, 19-27): Relay outputs RO1 through RO3 (terminals 19 to 27) are used to perform motor control and fault functions inside the controller. These functions are described below.

Start Ramp: Submersible motors require a start ramp function that ramps from 0Hz (stopped) to 30Hz in 1 second. DI3/15 ACC/DEC SEL and RO1/19-21 Ramp Select are used to implement this function.

WARNING

Disabling the Start Ramp function by removing the prewired connections can result in damage to the submersible motor and will void the motor and controller warranty.

No Water Restart Time: The No Water Restart Time is used to automatically restart the controller after a No Water/Loss of Prime (dry well) Fault is detected. This function is implemented using DI2/14 Fault Reset, RO2/22-24 Fault Output and RO3/25-27 Under Load Output.

WARNING

Disabling the No Water Restart Time function by removing the prewired connections will prevent the controller from automatically restarting after a No Water/Loss of Prime Fault is detected.

ANALOG OUTPUTS (AO1, 7 and AO2, 8): These terminals provide 0-20mA output signals that can be used to control auxiliary equipment. These outputs are configured in the application software. Analog Output 1 (AO1/7) is preconfigured to output a 0-20mA signal based on the output frequency of the controller. Where 0Hz corresponds to 0mA and 60Hz corresponds to 20mA. Analog Output 2 (AO2/8) is preconfigured to output a 0-20mA signal based on the output current of the controller. Where 0A corresponds to 0mA and 100% of controller rated output current corresponds to 20mA. The external device used with the Analog Outputs must have an impedance less than 500Ω.

RELAY OUTPUTS (RO4-RO6, 1-9): The relay outputs RO4-RO6 have been configured for Ready, Running and Fault functions respectively. The operation of relay outputs RO4-RO6 is described below.

Controller Ready Relay (RO4, 1-3): This relay output is configured to energize when the controller is ready to function. The controller is ready when no faults exist and the input supply voltage is within range.

Run Relay (RO5, 4-6): This relay output is configured to energize when the controller is running the motor. The relay is de-energized when the controller stops the motor.

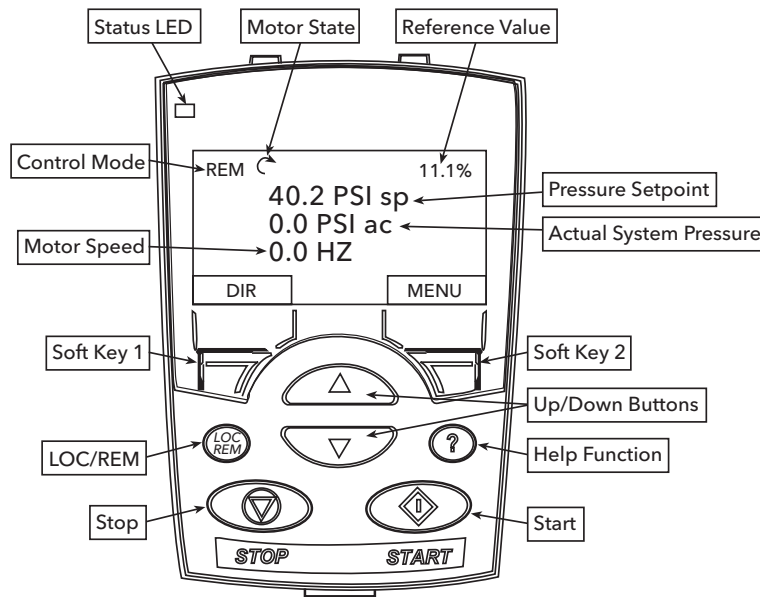
Fault Relay (RO6, 7-9): This relay output is configured to energize when the controller is faulted. The relay is de-energized when there is no system fault or after a fault clears.

SECTION 8: STARTING THE SYSTEM

APPLY POWER

When power is applied to the SPD Plus Controller, the status LED turns green.

SPD Plus Drive keypad functionality and Main Screen display is described below:

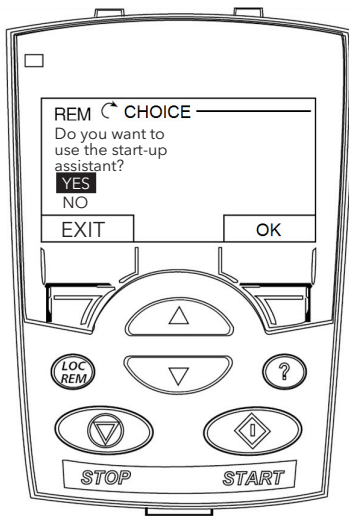


Name	Function
Status LED	Displays Drive Status: Green Constant = Not Faulted/No Alarm Green Flashing = Alarm Red Constant = Faulted (Auto-restart fault) Red Flashing = Faulted (Locked Out)
Motor State	Rotating = Drive is Running the Motor Stationary = Drive has Stopped the Motor
Control Mode	Displays the current control mode of the drive. In local mode (LOC) the drive ignores the pressure sensor feedback and speed is set with the up and down buttons. In remote mode (REM) the drive uses the pressure sensor feedback signal to control the system pressure.
Reference Value	In REM: Displays the pressure setting in %. In LOC: Displays the speed reference in Hz.
Pressure Setpoint	Displays the system pressure setpoint in PSI.
Actual System Pressure	Displays the actual system pressure in PSI as indicated by the pressure transducer.
Motor Speed	Actual motor speed in Hz.
Soft Key 1	Function of this button changes according to the state of the display panel.
Soft Key 2	Function of this button changes according to the state of the display panel.
LOC/REM	Toggles the drive control mode between local (LOC) and remote (REM). See Control Mode above.
Up/Down Buttons	In REM: Changes the pressure setting. In LOC: Changes the speed reference. In sub menus: changes parameters
Help Button	Displays information about the parameter or screen shown on the display.
Start	In REM: Button is disabled In LOC: Initiates operation of the drive.
Stop	In REM: Button is disabled In LOC: Stops operation of the drive.

SECTION 8: STARTING THE SYSTEM

(CONTINUED)

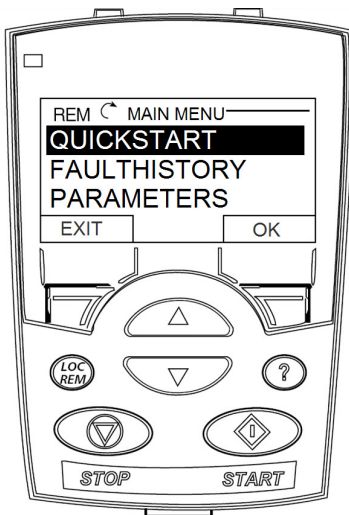
START-UP ASSISTANT



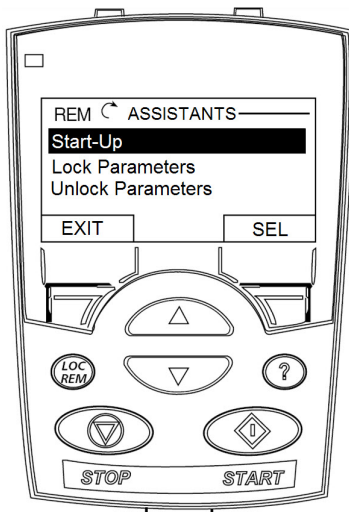
If this is the first time that the drive has been powered or the Start-Up Assistant has not been run, the display will prompt the user if they would like to run the Start-Up Assistant. Select Yes using the up and down arrows then press OK to run the Start-Up Assistant.

NOTE

The Start-Up Assistant can be entered at any time by following the procedure below:

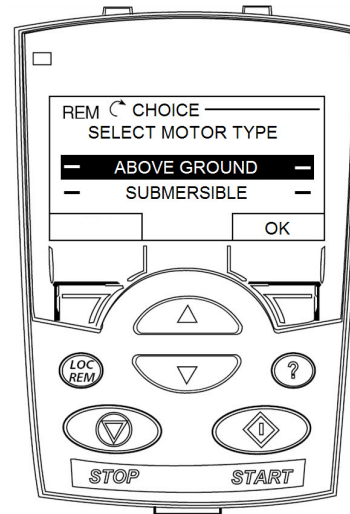


QUICKSTART: From the Main Screen press MENU key to enter MENU as shown below and choose QUICKSTART.



START-UP: Select Start-Up with the up and down arrows and press SEL.

The Start-Up Assistant will prompt the user for information about the application, motor information and fault response. The prompt screens are shown below:

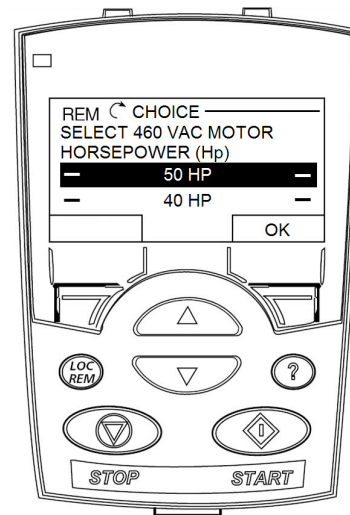


MOTOR TYPE SETTING: Select the motor type used in the application using the up and down arrows and press OK.

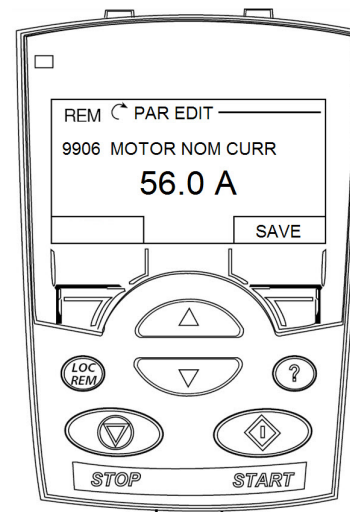
The minimum frequency is set to 30Hz for the Submersible setting and 15Hz for the Above Ground setting.

The next prompt will be for either to enter the motor horsepower

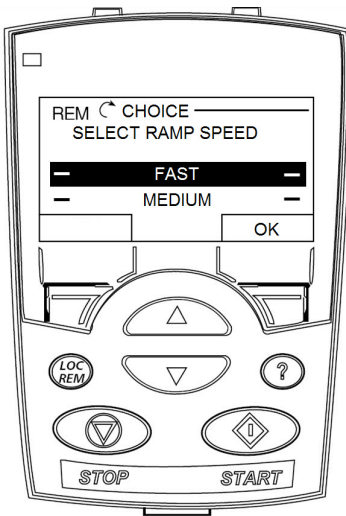
rating or the motor nominal current rating. The prompt displayed will depend on the controller size.



MOTOR HORSEPOWER SETTING: Select the motor HP used in the application. The controller lists only the valid HP selections based on the controller size. If there is only 1 valid selection based on the drive size and motor type, this screen is skipped. Note that the prompt will also change based on the controller voltage rating.



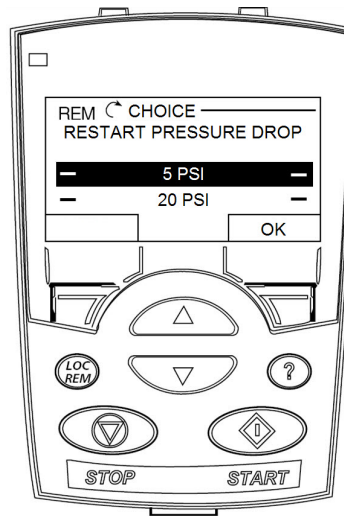
MOTOR NOMINAL CURRENT SETTING: The display will initially show a default current based on the previous selections. Enter the nominal motor current rating using the up and down arrows on the keypad. This is the full load current rating for the motor.



RAMP SPEED SETTING: Select the ramp speed based on the system requirements. The ramp speed sets the acceleration and deceleration time for the motor. The acceleration time is the time for the motor to transition from 0Hz (stopped) to 60Hz (full speed). The deceleration time is the time for the motor to transition

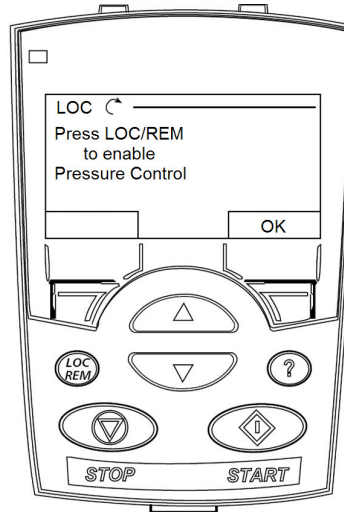
from 60Hz (full speed) to 0Hz (full stopped). The FAST ramp selection sets the acceleration ramp to 5 seconds and the deceleration ramp to 8 seconds. The MEDIUM ramp selection sets both the acceleration and the deceleration ramp to 25 seconds. The SLOW ramp selection sets both the acceleration and the deceleration ramp to 60 seconds.

WARNING
 Setting the Ramp Speed too fast can result in unstable operation and can damage pump, motor and piping.



RESTART PRESSURE DROP SETTING: The Restart Pressure Drop Setting allows the user to select the amount of pressure drop allowed in the system before the pump restarts after a No Water Demand condition is detected. A No Water Demand condition exists when the pump has satisfied the desired system pressure and reached the minimum frequency. If the

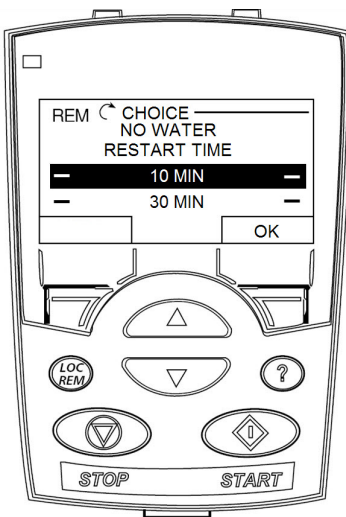
Restart Pressure Drop is set to 5 PSI and the pump has satisfied the desired system pressure and turned off on no demand, the controller will turn the pump back on after the system pressure has dropped 5 PSI below the system pressure setting.



START REMINDER SCREEN: This is a reminder screen. This screen is shown only if the controller is set to local mode (LOC). To change to remote mode (REM) and enable pressure control, press the LOC/REM button.

CAUTION
 The controller ignores the pressure sensor feedback signal and Start Signal on DI1 when operated in local (LOC) mode. Hazardous pressure can result.

The controller is now set up and is ready to be started.



NO WATER RESTART TIME SETTING: The No Water Restart Setting sets the time between detection of a No Water/Loss of Prime fault and the restart of the system. For example, if the No Water Restart Time is set to 10 MIN, the system will restart 10 minutes after a Water/Loss of Prime fault has been detected. This parameter is typically set according to the

recovery rate of the water source. The restart time can be set to 10 minutes, 30 minutes or 1 hour using the Start-Up Assistant.

SETTING THE CONTROL MODE

The Control Mode can be set to either local (LOC) or remote (REM). The Control Mode is indicated in the upper left hand corner of the display screen. Use REM for pressure control mode. This mode uses the pressure transducer feedback on AI2 to control the system pressure. Note that the start and stop buttons on the display are disabled in REM mode. The start enable on DI1 can be used to remotely start and stop the motor. Use LOC for fixed speed mode. The speed can be set with the up and down buttons on the keypad. The motor can be started and stopped using the start and stop buttons on the keypad. The in LOC mode the start enable on DI1 is disabled.

SETTING PRESSURE SETPOINT

When in REM mode, set the desired pressure setpoint by pressing the Up or Down arrow keys on keypad. Push and hold the Up or Down arrow keys until the desired pressure setting is obtained. The pressure setpoint is displayed on the first row of the Main Screen display with units of 'PSI SP'. The actual system pressure reported by the pressure transducer is displayed on the second row of the Main Screen display with units of 'PSI AC'.

DRIVE STATUS LED

The status code indicator light or LED displays the status of the controller. The status indicator is located in the upper left hand corner of the display keypad. A constant green status indicates that the pump is in normal operation. A blinking green status code indicates the unit has an alarm. A constant red status code indicates the unit is faulted and will attempt to automatically restart. A blinking red status code indicates the unit is faulted and will not attempt to restart. See Section 9 for Troubleshooting.

DANGER

⚠ DANGER Hazardous voltage The status code indicator light is not a voltage indicator! Always turn off disconnect switch and wait 5 minutes before servicing.

MOTOR ROTATION DIRECTION

NOTE

Before increasing motor speed, check that the motor is running in the desired direction.

If the pressure/flow seems low or the system is indicating Motor Overload error check the motor rotation direction. Turn the disconnect switch to the off position and wait 5 minutes. Switch any two output leads on the controller, U2, V2 or W2. Turn the disconnect switch to the on position. Observe pressure and flow. If the pressure or flow still seems low check plumbing. For CentriPro Motors, connecting U2 to Red, V2 to Black and W2 to Yellow will give the correct rotation.

NOTE

It is possible for the pump to maintain constant pressure with a low flow or a high suction head even if the pump is rotating backwards. While the pump is running use an amp probe on one of the output power leads connected to the motor and compare the current draw between the two rotation directions. The lowest current reading typically indicates the pump is running in the correct direction.

SECTION 9: TROUBLESHOOTING

DANGER

⚠ DANGER Hazardous voltage Disconnect power, lock-out all switch disconnects then wait 5 minutes before attempting to service the unit. **Use caution as there may still be hazardous voltage on the input side of the switch disconnect powering the unit.**

⚠ WARNING

Do not attempt any measurement, parts replacement or other service procedure not described in this manual. Such action will void the warranty, may endanger correct operation and increase downtime and expense.

⚠ WARNING

All electrical installation and maintenance work described in this chapter should only be undertaken by qualified service personnel. The Safety instructions on the first pages of this manual must be followed.

GENERAL

The SPD Plus is a self-diagnosing controller. If a problem occurs, observe the Fault or Alarm messages on the control panel display as well as the Status LED on the keypad.

STATUS INDICATOR

The Status Indicator is located in the upper left hand corner of the keypad display. The chart below describes the possible states of the Status Indicator.

Drive State	LED Color	Constant/ Flashing
Not Faulted/ No Alarm	Green	Constant
Alarm	Green	Flashing
Faulted (Auto-restart fault)	Red	Constant
Faulted (Locked Out)	Red	Flashing

RED - FAULTS:

The drive signals that it has detected a severe error, or fault, by:

- Enabling the red LED on the drive according to the table above.
- Overriding the control panel display with the display of a fault code.
- Stopping the motor (if it was on).

SECTION 9: TROUBLESHOOTING (CONTINUED)

The fault code on the control panel display is temporary. Pressing any of the following buttons removes the fault message: MENU, ENTER, UP button, or DOWN button. The message reappears after a few seconds if the control panel is not touched and the fault is still active.

FLASHING GREEN - ALARMS:

For less severe errors, called alarms, the diagnostic display is advisory. For these situations, the drive is simply reporting that it had detected something "unusual." In these situations, the drive:

- Flashes the green LED on the drive (does not apply to alarms that arise from control panel operation errors).
- Overrides the control panel display with the display of an alarm code and/or name.

The alarm messages disappear from the control panel display if/when any of the following are pressed on the control panel: MENU, ENTER, UP button or DOWN button. The message returns periodically as long as the alarm condition exists.

CORRECTING FAULTS

The recommended corrective action for faults is:

- Use the "Fault Listing" table below to find and address the root cause of the problem.
- Reset the drive by pressing RESET on keypad.
- **NOTE: It may be necessary to remove and reapply the Start Signal on DI1 to start the drive after a fault is reset by pressing RESET on the keypad.**
- Turn the power off for 5 minutes then turn on.

FAULT LISTING

Fault Code	Fault Name In Panel	Description and Recommended Corrective Action
1	OVERCURRENT	Output current is excessive. Check for and correct: <ul style="list-style-type: none"> • Excessive motor load, pump overload • Insufficient acceleration time • Faulty motor, motor cables or connections • Bound pump or locked rotor
2	DC OVERVOLT	Intermediate circuit DC voltage is excessive. Check for and correct: <ul style="list-style-type: none"> • Static or transient overvoltages in the power supply. • Deceleration time is too fast • Power wires routed too close to each other. Ensure at least 8" between power wires and all other wiring.
3	DEV OVERTEMP	Controller heatsink is overheated. Temperature is at or above 115°C (239°F). Check for and correct: <ul style="list-style-type: none"> • Fan failure • Obstructions in the air flow • Dirt or dust coating on the heatsink • Excessive ambient temperature • Excessive motor load • Ambient temperature • Altitude
4	SHORT CIRC	Fault current. Check for and correct: <ul style="list-style-type: none"> • A short-circuit in the motor cable(s) or motor. • Supply disturbances
6	DC UNDERVOLT	Intermediate circuit DC voltage is not sufficient. Check for and correct: <ul style="list-style-type: none"> • Missing phase in the input power supply. • Blown fuse • Undervoltage on mains
7	AI1 LOSS	Fault not enabled

SECTION 9: TROUBLESHOOTING (CONTINUED)

FAULT LISTING

Fault Code	Fault Name In Panel	Description and Recommended Corrective Action																
8	TRANSDUCER LOSS	<p>Signal from the pressure transducer is out of range. Check for and correct:</p> <ul style="list-style-type: none"> • Source and connection for analog input. • Vacuum in the system. Remove sensor from piping to release vacuum. • Failed pressure transducer. To diagnose this failure a meter capable of reading milliamperes (mA) and DC voltage (VDC) is required. <ul style="list-style-type: none"> - Set the meter to read DC voltage (VDC) - Place the black lead on terminal 11 (GND) and the red lead on terminal 10 (+24VDC SUPPLY) - If functioning properly, the DC voltage will be 24VDC +/- 10%. If this voltage is not present, disconnect all control terminals and repeat the measurement. If voltage does not recover, replace controller. - Disconnect the White wire in the sensor cable from terminal 5. - Set the meter to read DC current (mA) - Connect the black lead from the meter to terminal 5 (AI2, TRANSDUCER INPUT) - Connect the red lead from the meter to the White wire in the sensor cable. - The meter will display the output of the sensor. If functioning properly, the output of the sensor will be between 4mA and 20mA depending on the pressure in the system. Refer to the chart below to determine the sensor feedback at various pressures. <div data-bbox="553 940 1485 1354" style="border: 1px solid black; padding: 5px;"> <p style="text-align: center;">Pressure Transducer Output vs. Applied Pressure for a 300 PSI, 4-20mA Output Transducer</p> <table border="1" style="margin-top: 10px; width: 100%; border-collapse: collapse;"> <caption>Data points from the Pressure Transducer Output vs. Applied Pressure chart</caption> <thead> <tr> <th>Pressure (PSI)</th> <th>Transducer Output (mA)</th> </tr> </thead> <tbody> <tr><td>0</td><td>4</td></tr> <tr><td>50</td><td>6</td></tr> <tr><td>100</td><td>8</td></tr> <tr><td>150</td><td>10</td></tr> <tr><td>200</td><td>12</td></tr> <tr><td>250</td><td>14</td></tr> <tr><td>300</td><td>16</td></tr> </tbody> </table> </div> <p>NOTE: The controller is programmed to automatically reset the Transducer Loss Fault every 10 seconds for 1 minute. If the fault is not corrected in this time the fault must be reset by pressing reset on the keypad or by cycling power to the controller.</p>	Pressure (PSI)	Transducer Output (mA)	0	4	50	6	100	8	150	10	200	12	250	14	300	16
Pressure (PSI)	Transducer Output (mA)																	
0	4																	
50	6																	
100	8																	
150	10																	
200	12																	
250	14																	
300	16																	
9	MOT OVERTEMP	<p>Motor is too hot, based on the controller's estimate.</p> <ul style="list-style-type: none"> • Check for overloaded motor. • Enter the Start-Up Assistant and ensure motor parameters are set correctly. 																
10	PANEL LOSS	<p>Panel communication is lost drive is in local control mode (LOC). Check for and correct:</p> <ul style="list-style-type: none"> • Communication lines and connections 																
12	MOTOR STALL	<p>Motor stall. Motor is operating in stall region. Check for and correct:</p> <ul style="list-style-type: none"> • Excessive motor load. • Insufficient motor power. • Bound pump. 																

SECTION 9: TROUBLESHOOTING (CONTINUED)

FAULT LISTING

Fault Code	Fault Name In Panel	Description and Recommended Corrective Action
16	EARTH FAULT	Possible ground fault detected in the motor or motor cables. The drive monitors for ground faults while the drive is running the motor and while the motor is stopped. Detection is motor sensitive when the drive is not running and can produce false positives. Possible corrections: <ul style="list-style-type: none"> • Check for/correct faults in the input and output wiring. • Verify the controller uses a recommended load reactor for long output cable runs. • A delta grounded input power supply and motor cables with high capacitance may result in erroneous error reports during non-running.
18	THERM FAIL	Internal fault. The thermistor measuring the internal temperature of the drive is open or shorted. Contact factory.
19	OPEX LINK	Internal fault. A communication related problem has been detected on the fiber optic link between the control and OINT boards. Contact factory.
20	OPEX PWR	Internal fault. Exceptionally low voltage detected on the OINT power supply. Contact factory.
21	CURR MEAS	Internal fault. Current measurement is out of range. Contact factory.
22	SUPPLY PHASE	Ripple voltage in the DC link is too high. Check for and correct: <ul style="list-style-type: none"> • Missing mains phase • Blown fuse • Input wiring/connections • High voltage unbalance on the input power supply
26	DRIVE ID	Internal fault. Configuration Block Drive ID is not valid. Contact factory.
27	CONFIG FILE	Internal configuration file has an error. Contact factory.
34	MOTOR PHASE	Fault in the motor circuit. One of the motor phases is lost. Check for and correct: <ul style="list-style-type: none"> • Motor fault • Motor cable fault • Internal fault
35	OUTP WIRING	Possible power wiring error detected. When drive is not running it monitors for an improper connection between the drive input power and the drive output. Check for and correct: <ul style="list-style-type: none"> • Proper input wiring - line voltage is NOT connected to drive output. • The fault can be erroneously declared if the input power is a delta grounded system and motor cable capacitance is large.
36	INCOMPATIBLE SW	The drive cannot use the software. Internal fault. Contact factory.
37	CB OVERTEMP	Drive control board is overheated. The fault trip limit is 88°C. Check for and correct: <ul style="list-style-type: none"> • Excessive ambient temperature • Fan failure • Obstructions in the air flow.
38	NO WATER/LOSS OF PRIME	This fault is detected when the pump load on the motor is lower than expected. Check for and correct: <ul style="list-style-type: none"> • Adequate well level or water supply • Plugged suction screen • Restriction in piping. • Air bound pump. • Deadheaded pump, pump running against a closed valve. • Incorrect setting of motor parameters. Run the Start-Up Assistant and verify motor settings. <p>NOTE: The controller will automatically restart after this fault is detected when the No Water Restart Time set in the Start-Up Assistant expires.</p>

SECTION 9: TROUBLESHOOTING (CONTINUED)

FAULT RESETTING

⚠ WARNING

If an external source for start command is selected and it is active, the SPD Plus may start immediately after fault reset.

FLASHING RED LED

To reset the drive for faults indicated by a flashing red LED:

- Turn the power off and wait 5 minutes. Turn the power back on

CONSTANT RED LED

To reset the drive for faults indicated by a constant (not flashing) LED, correct the problem and do one of the following:

- Press RESET from the control panel.
- Turn the power off and wait 5 minutes. Turn the power back on.

CORRECTING ALARMS

The recommended corrective action for alarms is:

- Determine if the Alarm requires any corrective action (action is not always required).
- Use "Alarm Listing" below to find and address the root cause of the problem.

ALARM LISTING

Fault Code	Fault Name In Panel	Description and Recommended Corrective Action
2001	OVERCURRENT	Current limiting controller is active. Check for and correct: <ul style="list-style-type: none"> • Excessive motor load, pump overload. • Insufficient acceleration time • Faulty motor, motor cables or connections. • Bound pump or locked rotor.
2002	OVERVOLTAGE	Overvoltage controller is active. Check for and correct: <ul style="list-style-type: none"> • Static or transient overvoltages in the power supply. • Deceleration time is too fast. • Power wires routed too close to each other. Ensure at least 8" between power wires and all other wiring.
2008	PANEL LOSS	Panel communication is lost and the drive is in local control mode (LOC). Check for and correct: <ul style="list-style-type: none"> • Communication lines and connections
2009	DEVICE OVERTEMP	Drive heatsink is hot. This alarm warns that a DEVICE OVERTEMP fault may be near. Check for and correct: <ul style="list-style-type: none"> • Fan failure • Obstructions in the air flow • Dirt or dust coating on heatsink • Excessive ambient temperature • Excessive motor load
2010	MOTOR OPERATING IN SERVICE FACTOR RANGE	Motor is too hot, based on the controller's estimate. This alarm warns that a MOT OVERTEMP fault trip may be near. <ul style="list-style-type: none"> • Check for overloaded motor • Enter the Start-Up Assistant and ensure motor parameters are set correctly.
2013	AUTORESET	This alarm warns that the drive is about to perform an automatic fault reset which may start the motor.
2018	NO WATER DEMAND	This alarm warns that the controller has turned off the pump due to lack of demand. The speed of the pump has dropped below the minimum speed.
2025	FIRST START	Signals that the drive is performing a First Start evaluation of motor characteristics. This is normal the first time the motor is run after the motor parameters are entered or changed.
2027	NO WATER/LOSS OF PRIME	This alarm is issued to warn that a No Water/Loss of Prime fault may be near. See Fault Code 38, No Water Loss of Prime for details.
2028	START DELAY	Shown during the Start Delay. The start delay time is set to 1 second.

SECTION 9: TROUBLESHOOTING (CONTINUED)

TROUBLESHOOTING FAULTS, ALARMS AND PERFORMANCE PROBLEMS

In Troubleshooting, always consider the following possibilities:

- Faults – Press Reset key first, enter Start Up Assistant and verify the settings are appropriate.
- Electrical supply/ motor/ wiring/grounding – check your supply voltage, motor wiring, transducer wiring, and grounding.
- Mechanical/Pump/ Rotation – check pump rotation, rubbing or other mechanical problems; pump “run out”.
- Hydraulic System/ Piping – check to ensure proper suction and discharge piping layout, proper NPSHa, air entrainment, vortex, friction loss, system curve compensation etc.
- Environment – protect from high temperatures, direct sun, freezing temperatures, high altitude, dust, vibration, lack of air flow.

APPENDIX A: INPUT POWER SPECIFICATIONS

⚠ WARNING

Do not operate the drive outside the nominal input line voltage range. Over-voltage can result in permanent damage to the drive.

SOMETIMES DRIVE INPUT ISOLATION TRANSFORMERS ARE SPECIFIED TO DEAL WITH ONE OR MORE OF THE FOLLOWING ISSUES:

- 1) **Short Circuit Protection:** Input transformers are sometimes used to provide impedance to reduce the available short circuit current to levels that the input clearing devices, such as fuses or circuit breakers, are rated to handle. **Line reactors can perform this impedance function much more cost effectively.**
- 2) **Transient Protection:** Input transformers are sometimes used to provide transient surge impedance. All the SPD Plus drives have capacitors and MOV's (Metal Oxide Varistor transient protectors) providing 120 to 360 joules, line to line
- 3) **Harmonic Mitigation:** Input transformers are sometimes used to provide impedance to reduce the harmonic currents generated in the drive. **Line reactors can perform this function much more cost effectively.**

to ground transient protection. Isolation transformers are not required for this protection within those energy levels. Additional distribution transformer primary transient surge arrestors may be required if the potential transient energy reflected to the drive exceed those levels. MOV's are rated to handle high levels of one shot transient energy. MOV's are not meant to handle continuously recurring transients. A problem of continuously recurring transients should be corrected before connecting a drive.

INPUT POWER SPECIFICATIONS

Input Power (mains) Connection Specifications	
Voltage (U_1)	208/220/230/240 VAC 3-phase or 1-phase - 15% ...+10% for SPD2XXXX 380/400/415/440/460/480 VAC 3-phase -15%...+10% for SPD4XXXX 500/525/575/600 VAC 3-phase -15%....+10% for SPD5XXXX
Prospective Short-Circuit Current (IEC 629)	Maximum allowed prospective short-circuit current in the supply is 100 kA providing that the input power cable of the drive is protected with appropriate fuses. US: 100 000 AIC.
Frequency	48...63 Hz
Imbalance	Maximum $\pm 3\%$ of nominal phase to phase input voltage
Fundamental Power Factor ($\cos \phi_1$)	0.98 (at nominal load)


APPENDIX A: INPUT POWER SPECIFICATIONS (CONTINUED)

4) **Power Factor Capacitor Isolation:** Input transformers are sometimes used to provide impedance to isolate drives from line connected power factor correction capacitors. PWM drive inputs do not require power factor correction capacitors as drive power factors are generally greater than 92% and cannot be significantly improved with power factor correction capacitors which only correct for fundamental. However drives should be isolated from power factor correction capacitors by about 3 to 6% additional impedance with respect to the drives. Line reactors can perform this function much more cost effectively than isolation transformers. SPD Plus drives have either an internal 3% line reactor or an equivalent 3 to 5% bus reactor.

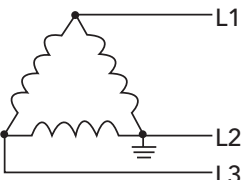
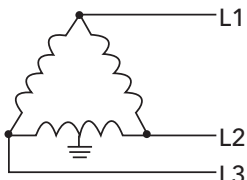
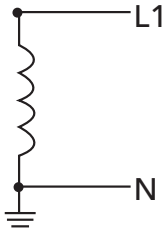
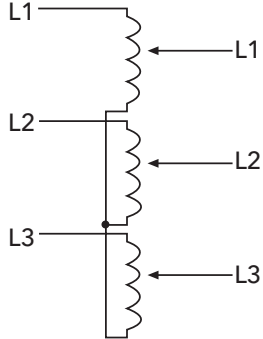
5) **RFI/EMI Mitigation:** Neither input isolation transformers nor line or bus reactors provide good high frequency filtering although an isolation transformer with a static shield will provide some RFI mitigation. If RFI/EMI mitigation is required, an RFI/EMI filter mounted inside the drive should be used together with all the proper wiring and grounding techniques. Some RFI/EMI filters may operate only on a power source with a grounded neutral. Establishing a local neutral ground may require the use of an input isolation transformer.

CORNER GROUNDED TN SYSTEMS

WARNING

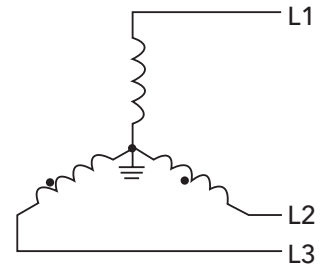
 Do not attempt to install or remove the EMC filter screws EM1, EM3, F1 or F2 while power is applied to the drive's input terminals.

Corner grounded TN systems are defined in the following table. In such systems, disconnect the internal ground connection through the EMC filter

Corner Grounded TN Systems – EMC Filter must be disconnected			
Grounded at the corner of the delta		Grounded at the mid point of a delta leg	
Single phase, grounded at an end point		Three phase "Variac" without solidly grounded neutral	


capacitors (do this also if the grounding configuration of the system is unknown), see SECTION 6: POWER SUPPLY AND WIRING for details.

The EMC filter capacitors make an internal ground connection that reduces electro-magnetic emission. Where EMC (electro-magnetic compatibility) is a concern, and the system is symmetrically grounded, the EMC filter may be connected. For reference, the diagram on the right illustrates a symmetrically grounded TN system (TN-S system).



FLOATING NETWORKS

WARNING

 Do not attempt to install or remove the EMC filter screws EM1, EM3, F1 or F2 while power is applied to the drive's input terminals.

For IT systems (an ungrounded power system or a high-resistance-grounded [over 30 ohm] power system):

- Disconnect the ground connection to the internal EMC filter, see SECTION 6: POWER SUPPLY AND WIRING for details.
- Where EMC requirements exist, check for excessive emission propagated to neighboring low voltage networks. In some cases, the natural suppression in transformers and cables is sufficient. If in doubt, use a supply transformer with static screening between the primary and secondary windings.
- Do NOT install an external RFI/EMC filter. Using an EMC filter grounds the input power through the filter capacitors, which could be dangerous and could damage the drive.

APPENDIX B: FUSE AND WIRE SIZING

FUSES

Branch circuit protection must be provided by the end user and sized per national and local electric codes. The following tables provide fuse recommendations for short circuit protection on the drive's input power.

The rated fuse currents given in the tables are the maximums for the mentioned fuse types. If smaller fuse ratings are used, check that the fuse Arms current rating is larger than the input current.

Check that the operating time of the fuse is below 0.5 seconds. The operating time depends on the fuse type, the supply network impedance as well as the cross-sectional area, material and length of the supply cable. In case the 0.5 seconds operating time is exceeded with the gG or T fuses, ultra rapid (aR) fuses will in most cases reduce the operating time to an acceptable level.

Input Voltage	Model Number	Input Current (Arms)	Mains Fuse Size (UL Class T)
230V	SPD20400	114	150
	SPD20400F	143	200
	SPD20400N1	114	150
	SPD20500	143	200
	SPD20500F	178	250
	SPD20500N1	143	200
	SPD20600	178	250
	SPD20600F	221	300
	SPD20600N1	178	250
460V	SPD40400	59	80
	SPD40400F	72	90
	SPD40400N1	59	80
	SPD40500	72	90
	SPD40500F	96	125
	SPD40500N1	72	90
	SPD40600	96	125
	SPD40600F	96	125
	SPD40600N1	96	125
	SPD40750	124	175
	SPD40750F	124	175
	SPD40750N1	124	175
	SPD41000	157	200
	SPD41000F	157	200
	SPD41000N1	157	200
575V	SPD50400N1	52	60
	SPD50500N1	77	100
	SPD50600N1	77	100
	SPD50750N1	99	150
	SPD51000N1	144	200

APPENDIX B: FUSE AND WIRE SIZING (CONTINUED)

WIRE SIZING

The tables below show the maximum recommended cable lengths for each model. Note that the tables show the cable length which will produce a 5% voltage drop on the cable. The recommended total voltage drop across all system cables is 5%. Because of this the lengths given in the table must be adjusted so the total voltage drop does not exceed 5%. For

example, if the input wire sizing chart gives the maximum length of 400' and only 100' is used then only 25% of the total voltage drop (1.25% drop) is used. The maximum output cable length must then be adjusted to 75% of its value so that the maximum voltage drop of 5% is not exceeded.

SPD PLUS INPUT WIRE SIZING CHARTS

				Maximum Allowable Conductor Length (50°C Ambient, 5% drop)																
Controller Ratings				Conductor Size for 75°C Rated Wire (Lengths in Bold Require 90°C Rated Wire)																
Controller Input	Motor HP	Motor FLA	Input Current	6	4	3	2	1	1/0	2/0	3/0	4/0	250	300	350	400	500	600	750	1000
230V 1Ø Input, 3Ø Output	20	54	95.4					393	505	648	826	1050	1247	1501	1760	2018	2518	3036	3810	
	25	68	120.2							501	642	820	978	1179	1385	1591	1989	2398	3015	3997
	30	82	144.9								519	668	799	966	1137	1308	1639	1976	2490	3300
230V 3Ø Input, 3Ø Output	40	96	169.7									558	670	812	958	1106	1389	1675	2116	2804
	50	116	205.0											655	776	899	1135	1368	1736	2300
	60	130	229.8													792	1002	1208	1538	2038
460V	40	53	54.1		816	1043	1331	1690	2146	2723	3447									
	50	70	71.4			765	984	1256	1601	2040	2588	3277	3882							
	60	80	81.6				846	1084	1386	1772	2251	2855	3385							
	75	96	98.0					881	1133	1456	1855	2359	2802	3374	3957					
	100	127	129.6									1363	1745	2083	2514	2955	3398			
575V	40	43	43.8	784	1286	1636	2080	2634	3337											
	50	54	55.3		995	1273	1625	2064	2621	3327										
	60	64	65.7			1052	1349	1719	2187	2783	3528									
	75	76	77.6				1121	1434	1832	2338	2969	3763								
	100	101	103.1						1335	1719	2193	2792	3320							

APPENDIX B: FUSE AND WIRE SIZING (CONTINUED)

SPD PLUS OUTPUT WIRE SIZING CHARTS

		Maximum Allowable Conductor Length (50°C Ambient, 5% drop)																	
		Controller Ratings		Conductor Size for 75°C Rated Wire (Lengths in Bold Require 90°C Rated Wire)															
Controller Output	Motor HP	Motor FLA	6	4	3	2	1	1/0	2/0	3/0	4/0	250	300	350	400	500	600	750	1000
230V	20	54		408	522	667	846	1075	1364	1726	2181	2580	3100	3627					
	25	68			404	519	662	843	1074	1362	1723	2041	2454	2873	3289				
	30	82				420	539	689	881	1120	1420	1684	2026	2374	2720	3392			
	40	96					450	579	743	947	1204	1430	1722	2019	2316	2890	3484		
	50	116							603	771	984	1172	1413	1659	1906	2382	2871	3610	
	60	130								679	869	1038	1253	1472	1693	2118	2553	3214	
460V	40	53		834	1066	1360	1726	2191	2780	3519									
	50	70			782	1005	1283	1635	2083	2643	3346	3963							
	60	80				865	1108	1416	1809	2298	2914	3455							
	75	96					901	1158	1487	1894	2408	2861	3444						
	100	127							1087	1393	1783	2128	2568	3018	3469				
575V	40	43	802	1315	1671	2124	2689	3407											
	50	54		1017	1301	1661	2108	2676	3396										
	60	64			1076	1379	1756	2234	2842	3602									
	75	76				1146	1466	1871	2388	3032	3842								
	100	101						1366	1758	2242	2853	3391							

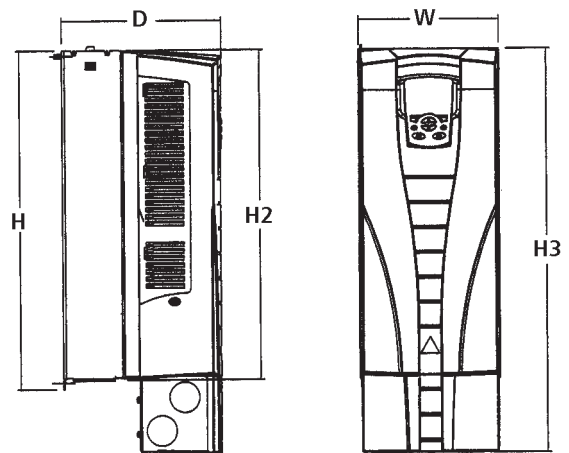
APPENDIX C: WEIGHTS AND DIMENSIONS

CONTROLLER DIMENSIONS

NEMA 1 Enclosures

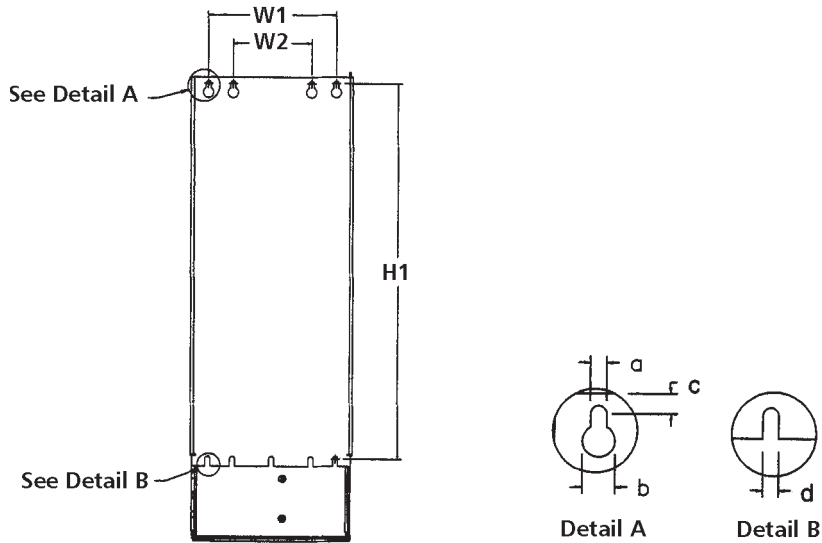
NOTE

Controllers with an N1 suffix have a NEMA 1 enclosure and are rated for indoor use only.



NEMA 1 Enclosure Dimensions						
Ref.	R4		R5		R6	
	mm	in	mm	in	mm	in
W	203	8.0	265	10.4	300	11.8
H	596	23.4	602	23.7	700	27.6
H2	583	23.0	578	22.8	698	27.5
H3	689	27.1	739	29.1	880	34.6
D	262	10.3	286	11.3	400	15.8

APPENDIX C: WEIGHTS AND DIMENSIONS (CONTINUED)



NEMA 1 Mounting Dimensions						
Ref.	R4		R5		R6	
	mm	in	mm	in	mm	in
W1*	160	6.3	238	9.4	263	10.4
W2*	98	3.9	—	—	—	—
H1*	578	22.8	588	23.2	675	26.6
a	6.5	0.25	6.5	0.25	9	0.35
b	13	0.5	14	0.55	14	0.55
c	8	0.3	8.5	0.3	8.5	0.3
d	6.5	0.25	6.5	0.25	9	0.35

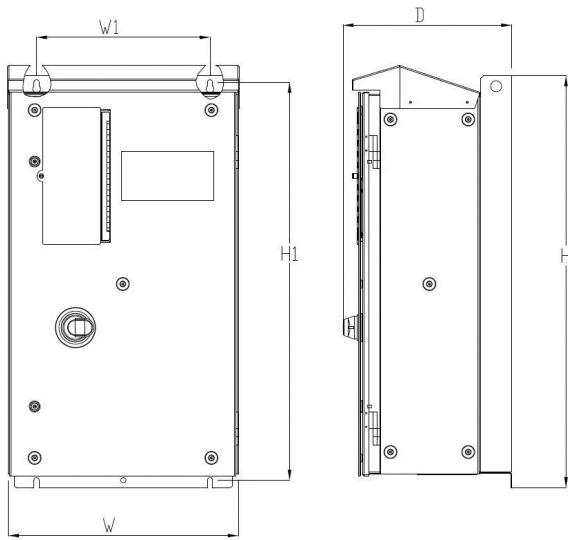
*Center to center dimension.

NEMA 1 Weights					
R4		R5		R6	
kg	lb.	kg	lb.	kg	lb.
22.8	50.2	37	82	78	176

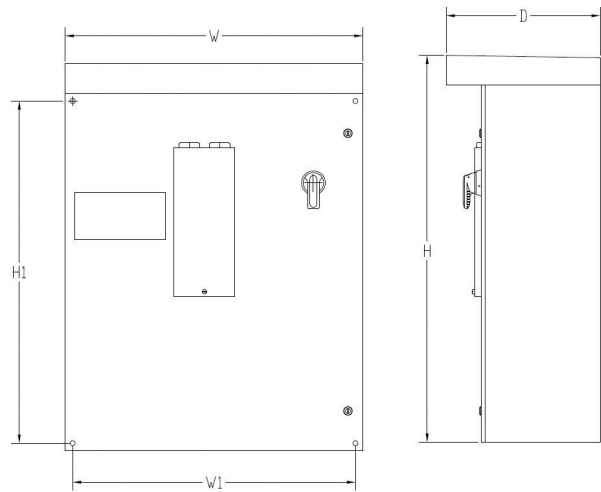
APPENDIX C: WEIGHTS AND DIMENSIONS (CONTINUED)

NEMA 3R Enclosures

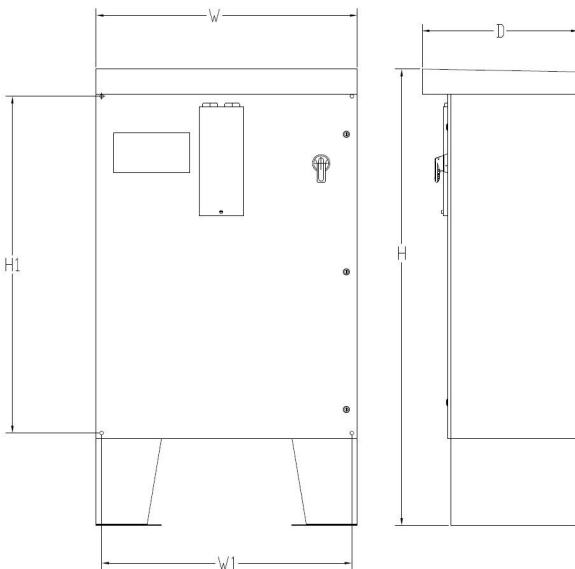
Frame Size N4



Frame Size N5



Frame Size N6



NEMA 3R Enclosure Dimensions

Ref.	N4		N5		N6	
	mm	in	mm	in	mm	in
W	530.9	20.9	762.0	30.0	914.4	36
H	967.7	38.1	990.6	39.0	1590.0	62.6
D	388.6	15.3	33.7	15.5	546.1	21.5

NEMA 3R Wall Mounting Dimensions

Ref.	N4		N5		N6	
	mm	in	mm	in	mm	in
W1	398.8	15.7	723.9	28.5	Not Applicable Self Standing Unit	
H1	916.9	36.1	876.3	34.5		

NEMA 3R Weights – Without Filter

N4		N5		N6	
kg	lb.	kg	lb.	kg	lb.
87.5	193	92.1	203	178.7	394

NEMA 3R Weights – With Filter

N4		N5		N6	
kg	lb.	kg	lb.	kg	lb.
98.9	218	107.0	236	204.1	450

NOTES

NOTES

LIMITED WARRANTY

This warranty applies to this Xylem Inc. product.

Any part or parts found to be defective within the warranty period shall be replaced at no charge to the dealer during the warranty period. The warranty period shall exist for a period of twenty-four (24) months from date of installation or thirty (30) months from date of manufacture, whichever period is shorter.

A dealer who believes that a warranty claim exists must contact the authorized Xylem Inc. distributor from whom the equipment was purchased and furnish complete details regarding the claim. The distributor is authorized to adjust any warranty claims utilizing the Xylem Inc. Customer Service Department.

The warranty excludes:

- (a) Labor, transportation and related costs incurred by the dealer;
- (b) Reinstallation costs of repaired equipment;
- (c) Reinstallation costs of replacement equipment;
- (d) Consequential damages of any kind; and,
- (e) Reimbursement for loss caused by interruption of service.

For purposes of this warranty, the following terms have these definitions:

- (1) "Distributor" means any individual, partnership, corporation, association, or other legal relationship that stands between Xylem Inc. and the dealer in purchases, consignments or contracts for sale of the subject equipment.
- (2) "Dealer" means any individual, partnership, corporation, association, or other legal relationship which engages in the business of selling or leasing equipment to customers.
- (3) "Customer" means any entity who buys or leases the subject equipment from a dealer. The "customer" may mean an individual, partnership, corporation, limited liability company, association or other legal entity which may engage in any type of business.

THIS WARRANTY EXTENDS TO THE DEALER ONLY.



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