

# Wall-Mounted Variable Frequency Drive

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The following instructions are for installing a wall-mounted variable frequency drive (VFD) for a Powerfoil®X2.0 or Powerfoil®X2.0 Plus fan. Consult the complete PowerfoilX2.0 Installation Guide for all other aspects of fan installation.



**WARNING:** To reduce the risk of electric shock, wiring should be performed by a qualified electrician! Incorrect assembly can cause electric shock or damage the motor and the controller! Hazard of electrical shock!

**WARNING:** The installation of all Big Ass Fan models covered under this manual must be in accordance with the requirements specified in this installation manual and with all national and local electrical codes. Code compliance is ultimately YOUR responsibility!

**WARNING:** The fan controllers contain high voltage capacitors that take time to discharge after removal of mains supply. Before working on the fan controller, ensure isolation of mains supply from line inputs at the fan controller's disconnect if installed. Wait three (3) minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Note: Darkened display LEDs are not an indication of safe voltage levels.

**CAUTION:** It is the sole responsibility of the installer to verify the operating voltage of the fan system prior to installation! It is also mandatory that the installer verify that airfoils, motor hub assemblies, and fan controllers are matched properly at the time of installation, especially if multiple fan systems will be installed.

**CAUTION:** An incorrectly installed controller can result in component damage or reduction in the fan's life. Wiring or application errors such as under-sizing the controller, incorrect or inadequate AC supply, or excessive ambient temperatures may result in a malfunction of the fan system. Verify correct voltage, phase, and horsepower before beginning installation!

**WARNING:** Exercise caution and common sense when powering the fan. Do not connect the fan to a damaged or hazardous power source. Do not attempt to resolve electrical malfunctions or failures on your own. Contact Big Ass Fans if you have any questions regarding the electrical installation of this fan.

**CAUTION:** For use with manufacturer-supplied variable frequency drive only. Not for use with other speed control devices!

**CAUTION:** Shielded cable, if applicable, must be landed on motor's ground terminal!

**CAUTION:** To avoid a short circuit, be very careful not to get metal chips in the controller!

**CAUTION:** The Big Ass Fans product warranty will not cover equipment damage or failure that is caused by improper installation.

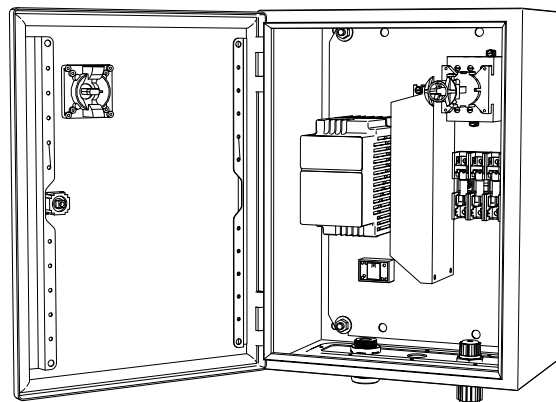
**CAUTION:** If it was determined that a motor frequency less than 60 Hz is optimal for maximum performance of your particular fan model, under no circumstances should the factory programmed maximum frequency command limits be changed. Damage to the fan assembly or loss of warranty coverage can result.

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## Parts Included

- NEMA 4 enclosure, 12 in. x 16 in. x 8 in. (30.5 cm x 40.6 cm x 20.3 cm)
- Variable frequency drive
- Fire relay
- Load switch actuator
- Mounting screws

*Note: Wiring not shown.*



## 2

## Pre-Installation

## Mounting location guidelines

Mount the VFD enclosure on a flat surface that meets the following requirements:

- Readily accessible with enough clearance for door to fully open
- Free from vibration
- Shaded from direct sunlight
- Ambient temperature between 14°F (-10°C) and 122°F (50°C)
- Not adjacent to or above a heat source such as heat-producing equipment
- Within line of sight of the fan
- At least 6 in. (15 cm) from any other fan controller

## Input power conditioning

Install line reactors if the AC supply is subject to any of the following issues:

- Low line impedance
- Frequent power interruptions
- Phase-to-ground voltage in excess of 125% nominal phase-to-phase voltage
- Distribution system exceeds the established kVA limit for your specific model (for more information, contact Big Ass Fans)
- Power factor correction capacitors
- Intermittent noise spikes (lightning)

## Conduit and piping guidelines

- ⚠ CAUTION: The presence of foreign signals on a drive's output wiring greatly reduces the controller's ability to control current and speed regulation of the fan. Any wiring practice that would allow this kind of "cross-talk" must be avoided. Failure to do so may result in nuisance tripping and/or premature equipment failure. Sources of foreign signals that could induce such signals include another VFD's output circuit, long "across-the-line" motor circuits, and lighting circuits.**
- ⚠ CAUTION: Recommendations for fan controller output/motor lead routing deem some conventional wiring practices "unacceptable." National and/or local code does not differentiate between solid-state and electromechanical systems; however, due to the nature of the Big Ass Fan system, there are additional requirements that must be met to ensure proper operation.**

Due to high frequency electrical noise on the output side of the fan controller, measures must be taken to ensure that wires and cabling are routed in a manner consistent with recommendations made in this section. Big Ass Fans controllers rely on "motor feedback" through the cabling to sense motor speed, slip, etc.

## Controller AC supply

Most conventional methods of power distribution and branch circuit installation apply to all models of fan controllers. Installation must comply with specifications regarding wire types, conductor sizes, branch circuit protection, and disconnecting devices. Failure to do so may result in personal injury and/or equipment damage. Refer to the table below for specific ampacities.

- AC supply feeds for one fan controller can share the same conduit with AC supply feeds for one or more additional controllers.
- AC supply feeds for a fan controller and output/motor leads for the same fan controller cannot share a conduit.
- AC supply feeds for one fan controller cannot share conduit with output/motor leads from one or more additional controllers/VFDs.
- Any unused conductors that share a conduit with an AC supply feed should be grounded on both ends to prevent risk of electric shock due to induced voltages.
- Output/motor leads for a fan controller and AC supply feeds for the same fan controller cannot share a conduit.
- Output/motor leads for one fan controller cannot share conduit with AC supply feeds or output/motor leads from one or more additional fan controllers.
- Any unused conductors that share a conduit with fan controller output/motor leads should be grounded on both ends to prevent risk of electric shock due to induced voltages.

Fan model and diameter		Minimum required supply circuit size
Powerfoil X2.0	Powerfoil X2.0 Plus	
8 ft (2.4 m) 10 ft (3 m) 12 ft (3.6 m)	10 ft (3 m)	20 A @ 200–250 V, 1 $\Phi$ 10 A @ 200–250 V, 3 $\Phi$ 10 A @ 400–480 V, 3 $\Phi$ 10 A @ 575–600 V, 3 $\Phi$
14 ft (4.3 m) 16 ft (4.9 m) 18 ft (5.5 m) 20 ft (6.1 m) 24 ft (7.3 m)	12 ft (3.6 m) 14 ft (4.3 m) 16 ft (4.9 m) 18 ft (5.5 m) 20 ft (6.1 m) 24 ft (7.3 m)	30 A @ 200–250 V, 1 $\Phi$ 20 A @ 200–250 V, 3 $\Phi$ 10 A @ 400–480 V, 3 $\Phi$ 10 A @ 575–600 V, 3 $\Phi$

## Power supply and motor wiring guidelines

**In order to satisfy some code requirements, it may be necessary to install a manual disconnect at the fan motor location when the fan assembly is not within “line-of-sight” from the fan controller. A non-fused, 600 V 3-phase, blade style disconnect should be used to satisfy this “line-of-sight” requirement.**

- ⚠ WARNING:** Installation must comply with specifications from National Electrical Codes and standards (NEC, VDE, BSI, etc.) regarding wire types, conductor sizes, branch circuit protection, and disconnecting devices.
- ⚠ WARNING:** To avoid a possible shock hazard and/or nuisance tripping caused by induced voltages, unused wires in the conduit must be grounded at both ends. For the same reason, fan controller output wires should not share a conduit with another fan controllers output leads, or other power circuits (lighting, motors, etc.).
- ⚠ CAUTION:** MC or “Metal clad” cable cannot be used for controller output/motor leads. Both stranded and solid core varieties must be avoided. Do not use solid core cable of any size or insulation class for motor wiring. Use of such types of cabling may result in nuisance tripping or premature equipment failure.

A variety of cable types are acceptable for VFD installations. *For many installations, unshielded cable is adequate if it can be separated from sensitive circuits.* In all cases, parallel runs of control and motor cabling should be avoided when unshielded cable is used. Do not use cable with an insulation thickness of less than 15 mils.

- UL installations in 50°C ambient must use 600 V, 75°C or 90°C wire.
- UL installations in 40°C ambient should use 600 V, 75°C or 90°C wire.

### Acceptable unshielded types

THHN, THNW, or similar wire is acceptable for drive installations in dry environments if adequate free air space and/or conduit fill rate limits are provided. *Do not use THHN or similarly coated wire in wet areas.* Any wire chosen must have a minimum insulation thickness of 15 mils and should not have large variations in insulation concentricity.

### Acceptable shielded types

The drain conductor included with shielded cables must be connected to both the motor frame and the PE/Ground terminal of the VFD.

Location	Rating / Type	Description
Standard (Option 1)	600 V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	<ul style="list-style-type: none"> <li>• Four tinned conductors with XLPE insulation</li> <li>• Foil shield and tinned copper drain wire with 85% braid coverage</li> <li>• PVC Jacket</li> </ul>
	Belden 29501-29507 or equivalent	
Standard (Option 2)	Tray rated 600 V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	<ul style="list-style-type: none"> <li>• Three tinned copper conductors with XLPE insulation</li> <li>• 5 mil single helical copper tape (25% overlap minimum) with three bare copper grounds in contact with shield</li> <li>• PVC Jacket</li> </ul>
	Shawflex 2ACD/3ACD or equivalent	
Class I & II Division I & II	Tray rated 600 V, 75°C or 90°C (167°F or 194°F) RHH/RHW-2	<ul style="list-style-type: none"> <li>• Three bare copper conductors with XLPE insulation with impervious corrugated continuously welded aluminum armor</li> <li>• Black sunlight resistant PVC jacket overall</li> <li>• Three copper grounds on #10 AWG and smaller</li> </ul>

### Maximum cable lengths

To prevent nuisance trips, the distance between the controller and the fan should not exceed 400 ft (122 m).

### Output disconnects

A device, such as a contactor, that routinely disconnects and reapplies output power to the motor for the purpose of starting and stopping the motor cannot be used.

### Recommended wire size


A minimum of 14 AWG is acceptable for motor leads. *14 AWG applies to motor leads only.* Power feeders to controllers must be governed by the fuse size included with the fan controller and/or required circuit breaker.

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## Pre-Installation (cont.)

## Grounding

The nature of VFD systems must be considered prior to and during the installation of Big Ass Fans. Due to high frequency content on the output side of the fan controller, measures must be taken to ensure that all grounding connections conform to the recommendations made in this section.

The fan controller's safety ground  (PE) must be connected to system ground. Ground impedance must conform to the requirements of national and local industrial safety regulations and/or electrical codes. The integrity of all ground connections should be periodically checked. All ground leads for downstream conduit boxes must be kept separate from the motor ground and terminated on the fan controller's PE terminal.

### Motor ground

The motor ground must be connected to a ground terminal on the VFD to aid in keeping high frequency electrical noise off of the building's ground grid.

### Shielded motor cable terminations

Either of the safety ground terminals on the drive provides a grounding point for the motor cable shield. The motor cable shield connected to one of the drive terminals must also be connected to the motor frame. If no drain lead is present, the cable must be stripped back so that the braid can be twisted and soldered to a pigtail for proper termination.

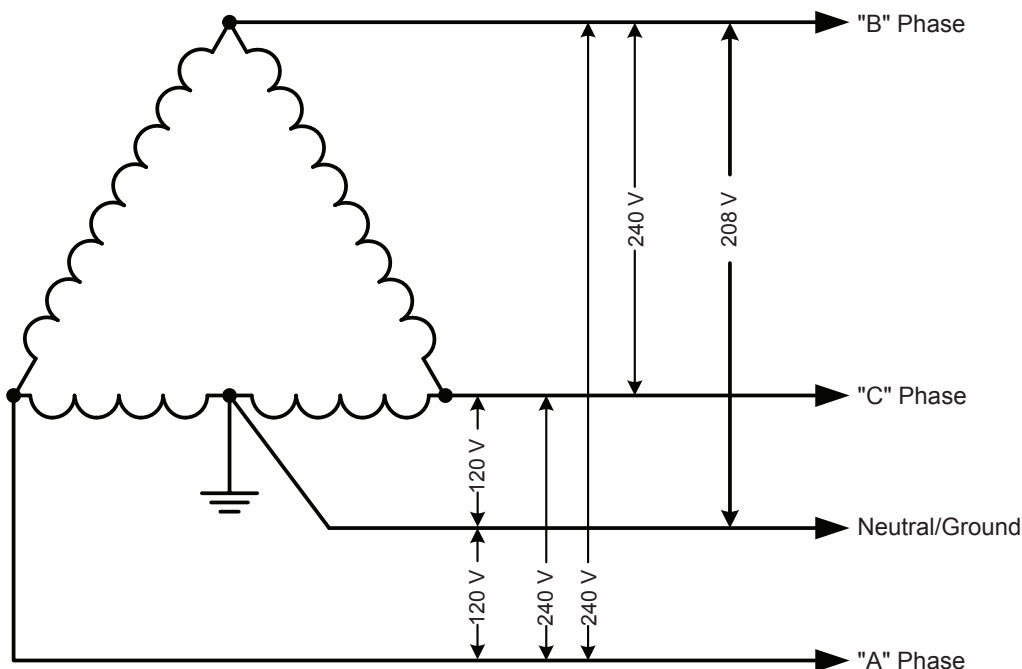
## Delta secondary

**⚠ CAUTION: Care must be taken when connecting to a three-phase 240/120 V secondary as shown below. All fan controller models rely on internal references made between each incoming phase and ground. To prevent nuisance tripping such as Overvoltage and Undervoltage faults, 200–250 V, three phase fan controllers should be connected so that the High leg, or "phase B," terminates on "L2" of the fan controller's input power terminals.**

**⚠ CAUTION: Avoid installations utilizing supply transformers with a 480 V delta secondary (ungrounded, corner grounded, open). Proper fan operation cannot be guaranteed due to a lack of proper phase-to-ground voltage references.**

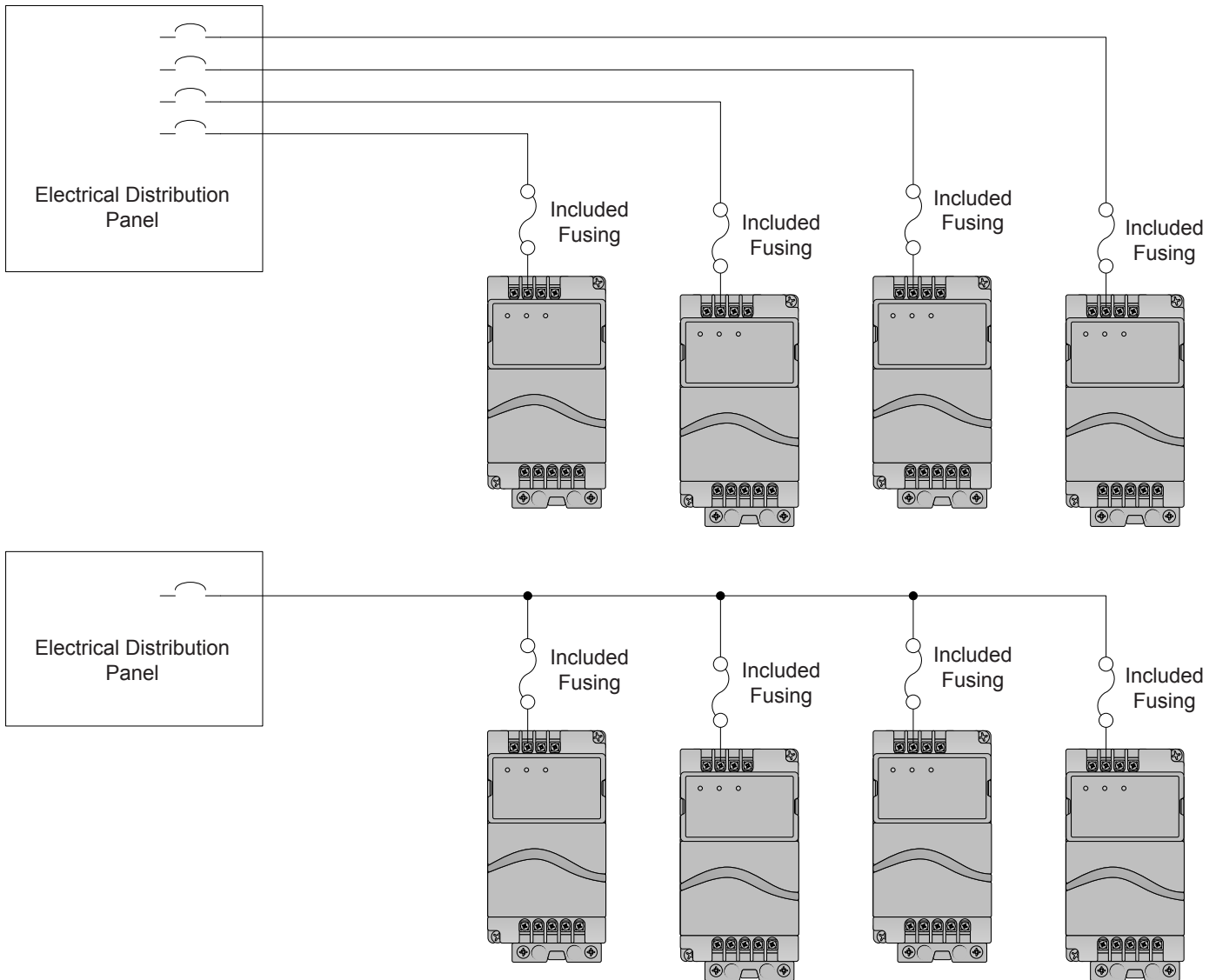
There are many different arrangements available for industrial and commercial power distribution. The most common are the following:

- **575 V / 330 V Three-Phase (Wye Secondary).** Provides 575 V between phases, and 330 V from each phase to Neutral/Ground.
- **480 V / 277 V Three-Phase (Wye Secondary).** Provides 480 V between phases, and 277 V from each phase to Neutral/Ground.
- **208 V / 120 V Three-Phase (Wye Secondary).** Provides 208 V between phases, and 120 V from each phase to Neutral/Ground.
- **240 V / 120 V Three-Phase (Delta Secondary).** Provides 240 V between phases for three-phase loads, 120 V from phase "A" and "C" to Neutral/Ground, and 208 V from phase "B" to Neutral/Ground as shown below. In this transformer arrangement, phase "B" is commonly referred to as a "Wild Leg" or "High Leg," and shall be marked accordingly with an orange finish or other effective means per national and local electrical codes.



## Branch circuit protection

The fan controllers include fuses for branch short circuit protection. If desired, these fan controller models can be installed with a dedicated fusible disconnect and/or input circuit breaker. National and local industrial safety standards and/or electrical codes may determine additional requirements for these installations.

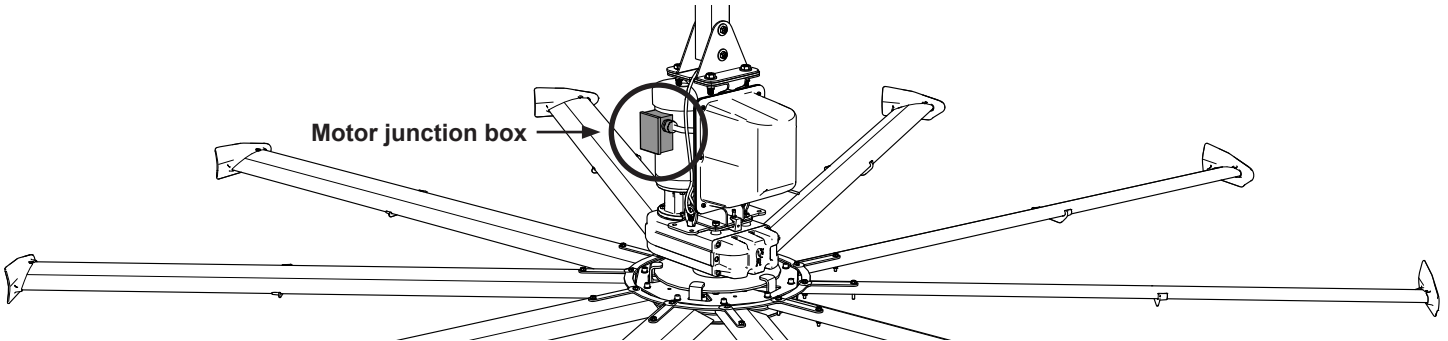


## 6 Uninstalling the Onboard VFD

**⚠ WARNING:** The fan controllers contain high voltage capacitors that take time to discharge after removal of mains supply. Before working on the fan controller, ensure isolation of mains supply from line inputs at the fan controller's disconnect if installed. Wait three (3) minutes for capacitors to discharge to safe voltage levels. Failure to do so may result in personal injury or death. Note: Darkened display LEDs are not an indication of safe voltage levels.

### 1. Disconnect the motor wiring

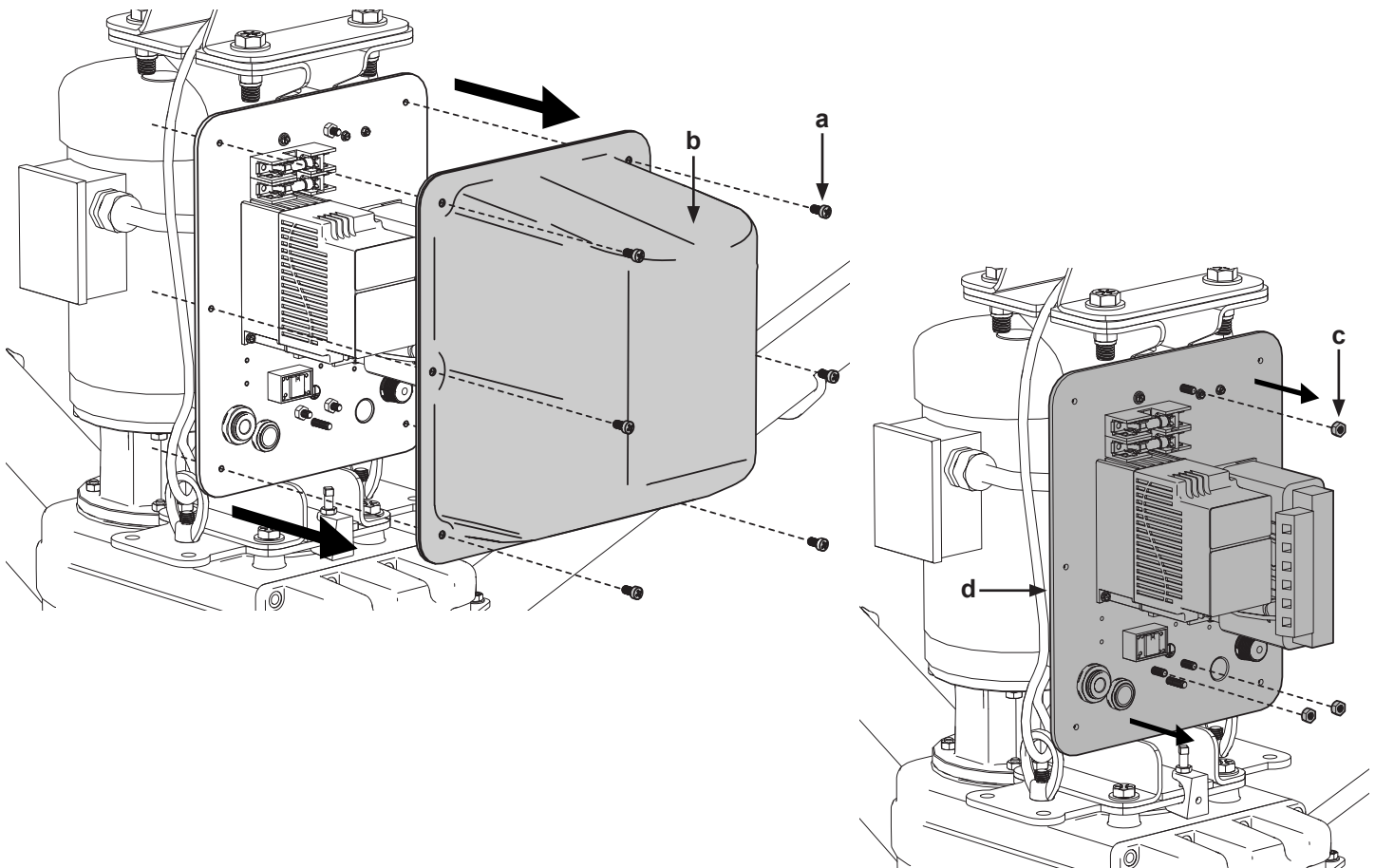
Open the motor junction box and disconnect the motor output wiring to the onboard VFD.



### 2. Remove the onboard VFD (optional)

Remove and discard the six screws (a) securing the VFD cover, and then remove the VFD cover (b). Remove and discard the three nuts (c) securing the VFD mounting plate, and then remove the mounting plate (d).

*Note: Wiring not shown.*



# Installing the wall-mounted VFD

- ⚠ **WARNING:** Ensure power is disconnected before installing the VFD!
- ⚠ **WARNING:** To avoid damaging VFD and fan controller, test the VFD and fan controller with a test cable!
- ⚠ **CAUTION:** To avoid a short circuit, be very careful not to get metal chips in the control! The VFD enclosure does not provide conduit knockouts. Big Ass Fans recommends using a hole punch to create conduit knockouts in the most accessible locations on the enclosure.

## 1. Select a mounting location

Select a mounting location according to the guidelines on page 2.

## 2. Predrill the VFD enclosure

Drill appropriately sized holes in the VFD enclosure to accommodate the conduit connectors. Position the holes where the conduit can most accessibly exit the enclosure. *Note: Use appropriately rated connectors (IP56) to protect against foreign matter from entering the enclosure.*

## 3. Mount the VFD enclosure to the wall

Mount the VFD enclosure to the wall using the screws provided with the enclosure.

## 4. Wire the fan

Refer to the wiring diagrams on the following pages for your fan controller. Refer to page 12 for the motor wiring.

## 5. Change the PWM frequency

For long motor lead installations, the fan controller's pulse width modulation (PWM) frequency **must be reduced** from 15 kHz to 4 kHz. Change the PWM frequency according to instructions on page 13.

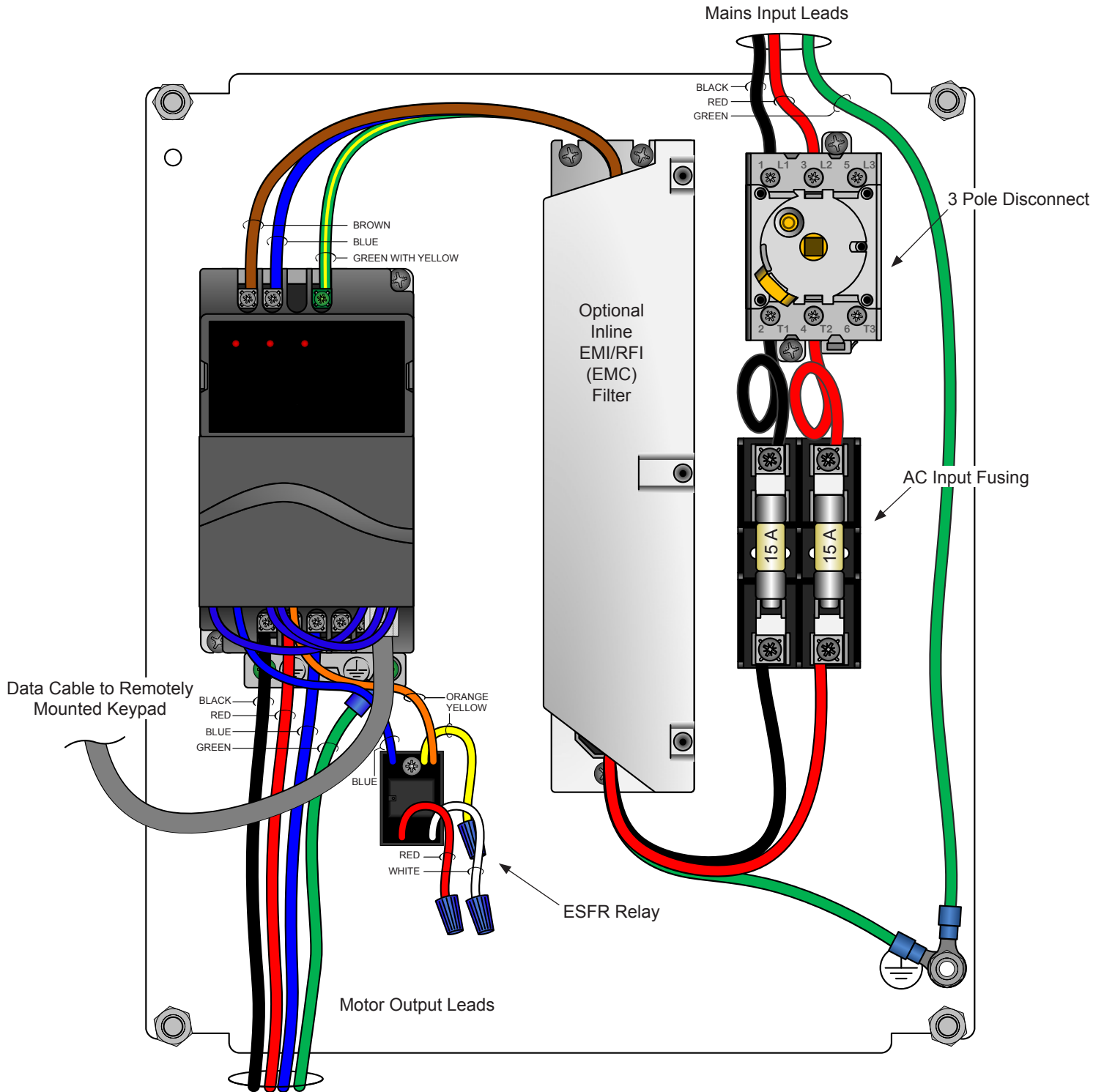
# 8

## Installing the wall-mounted VFD (cont.)

### Wiring: Fan Controller (200–250 V, 1 Φ, 1 hp)

- ⚠ **WARNING:** Wait three minutes after disconnecting before servicing!
- ⚠ **WARNING:** Improper installation can cause electric shock or damage to the motor and controller! A qualified electrician should perform the installation.

The diagram below shows a standard fan controller (200–250 V, 1 hp) using single-phase input from AC power supply. See pages 2–3 for detailed voltage, current, and circuit breaker/fuse requirements.





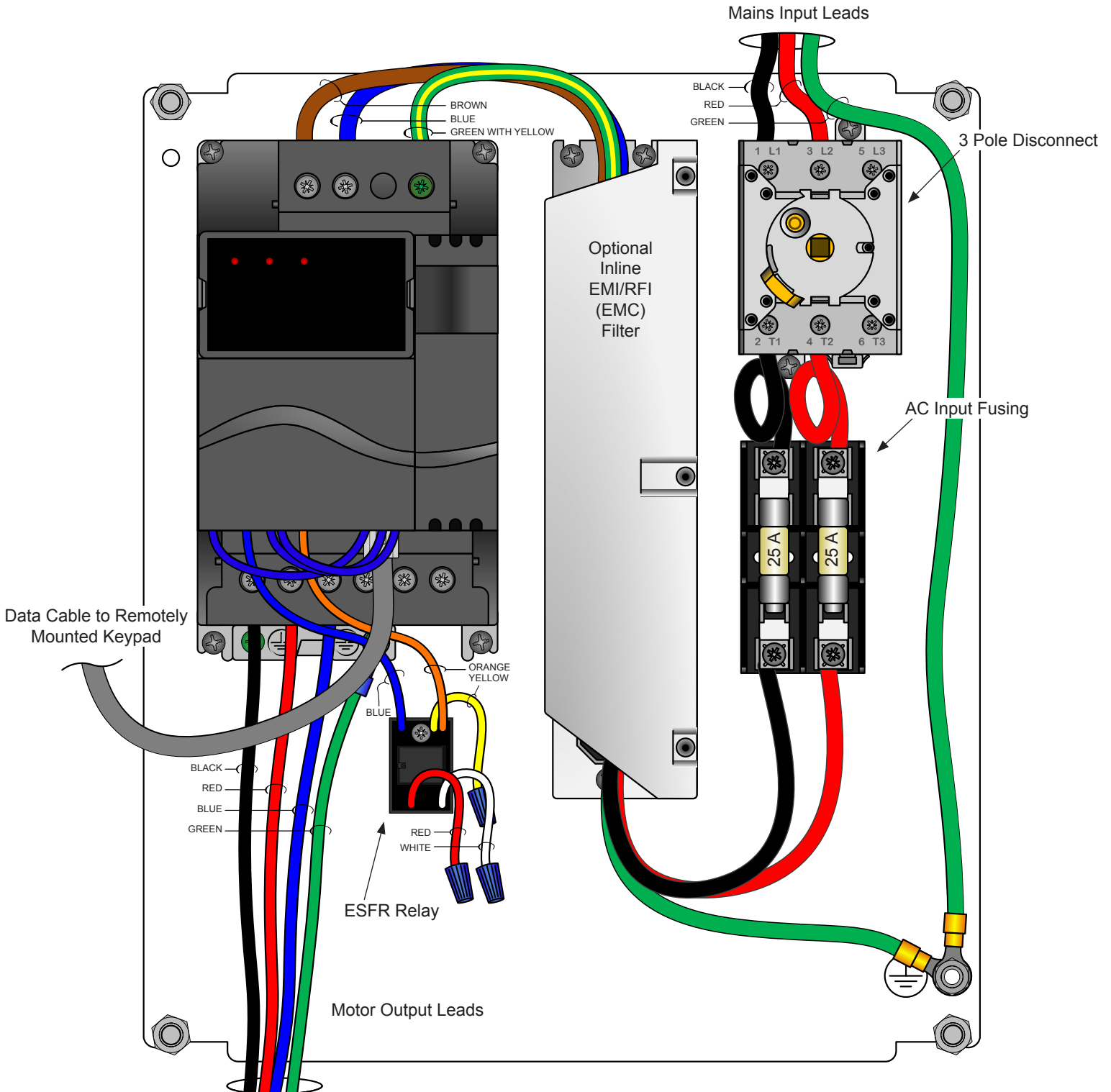
## Installing the wall-mounted VFD (cont.)

### Wiring: Fan Controller (200–250 V, 1 Φ, 2 hp)

**⚠ WARNING: Wait three minutes after disconnecting before servicing!**

**⚠ WARNING: Improper installation can cause electric shock or damage to the motor and controller! A qualified electrician should perform the installation.**

The diagram below shows a standard fan controller (200–250 V, 1 hp) using single-phase input from AC power supply. See pages 2–3 for detailed voltage, current, and circuit breaker/fuse requirements.



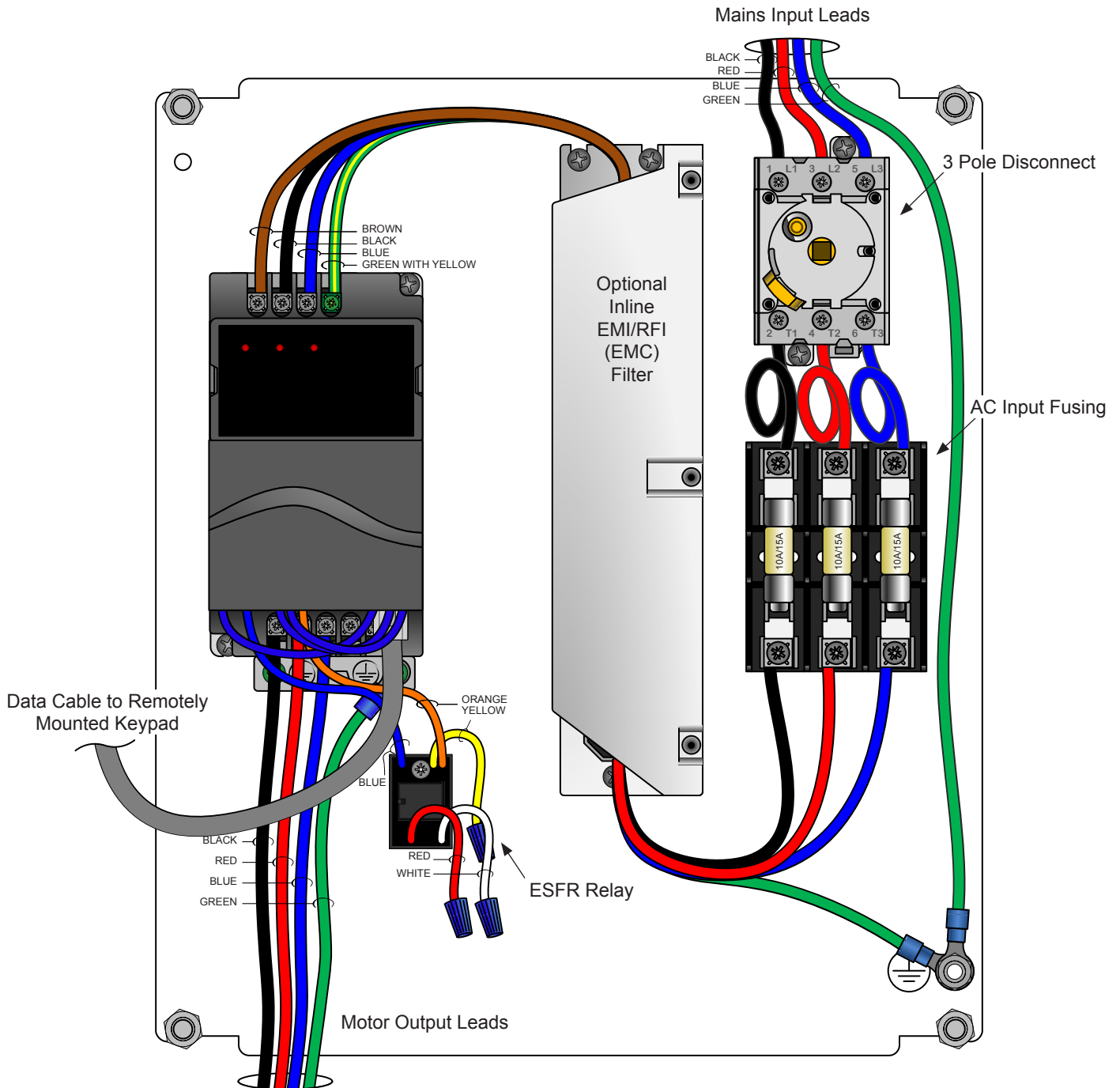
# 10

## Installing the wall-mounted VFD (cont.)

### Wiring: Fan Controller (200–250 V, 3 Φ, 1 hp and 2 hp)

- ⚠ **WARNING:** Wait three minutes after disconnecting before servicing!
- ⚠ **WARNING:** Improper installation can cause electric shock or damage to the motor and controller! A qualified electrician should perform the installation.

The diagram below shows a standard fan controller (200–250 V, 1 hp and 2 hp) using three-phase input from AC power supply. See pages 2–3 for detailed voltage, current, and circuit breaker/fuse requirements.

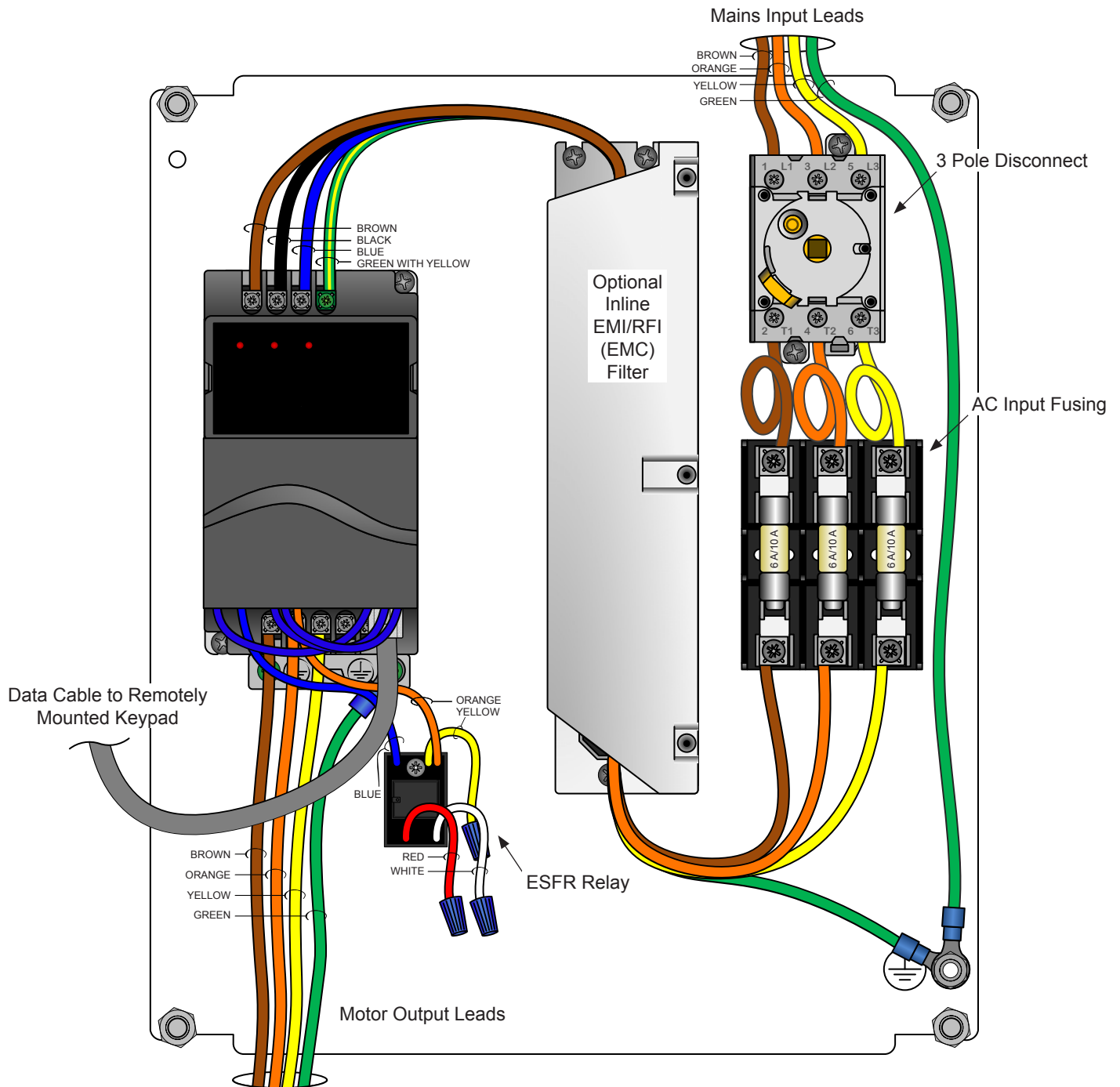


## Installing the wall-mounted VFD (cont.)

### Wiring: Fan Controller (400–480 V, 3 Φ, 1 hp and 2 hp)

- ⚠ **WARNING:** Wait three minutes after disconnecting before servicing!
- ⚠ **WARNING:** Improper installation can cause electric shock or damage to the motor and controller! A qualified electrician should perform the installation.

The diagram below shows a standard fan controller (400–480 V, 1 hp and 2 hp) using three-phase input from AC power supply. See pages 2–3 for detailed voltage, current, and circuit breaker/fuse requirements.



# 12

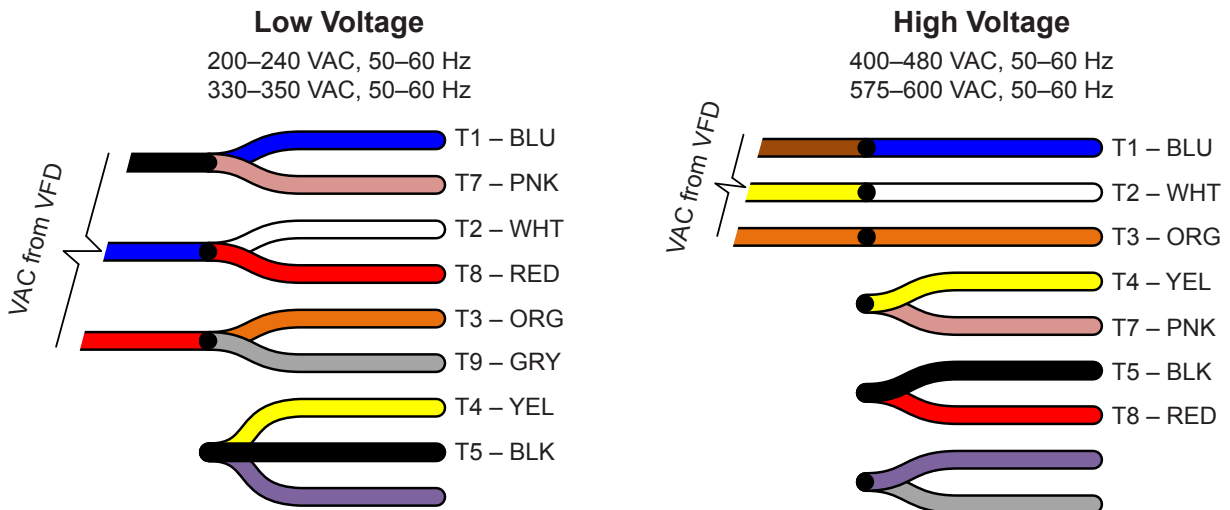
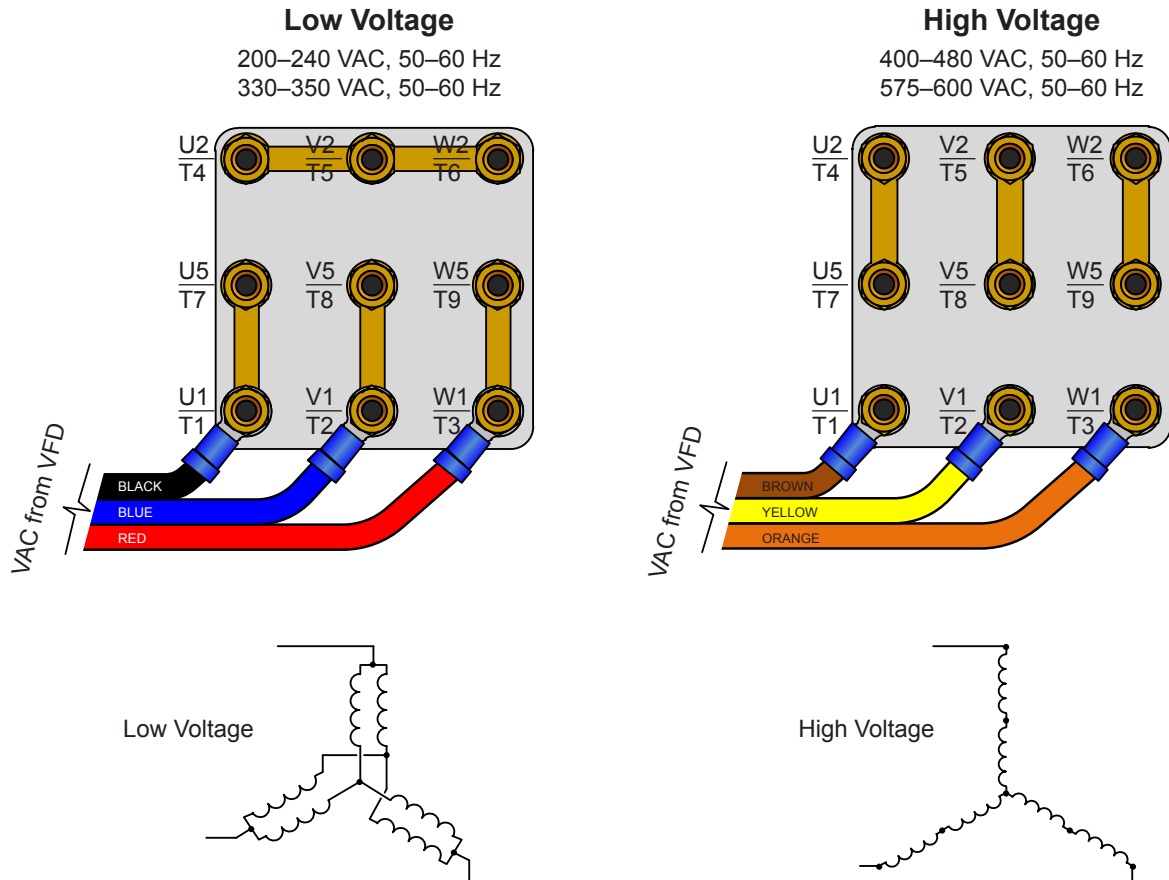
## Installing the wall-mounted VFD (cont.)

### Wiring: Fan Motor

- ⚠ WARNING: Wait three minutes after disconnecting before servicing!**
- ⚠ WARNING: Improper installation can cause electric shock or damage to the motor and controller! A qualified electrician should perform the installation.**

The diagrams below show wiring for low voltage and high voltage systems. These diagrams include L2 and L3 swap to yield proper motor rotation. Motors with terminal blocks require ring terminals and a 7 mm nut driver for termination.

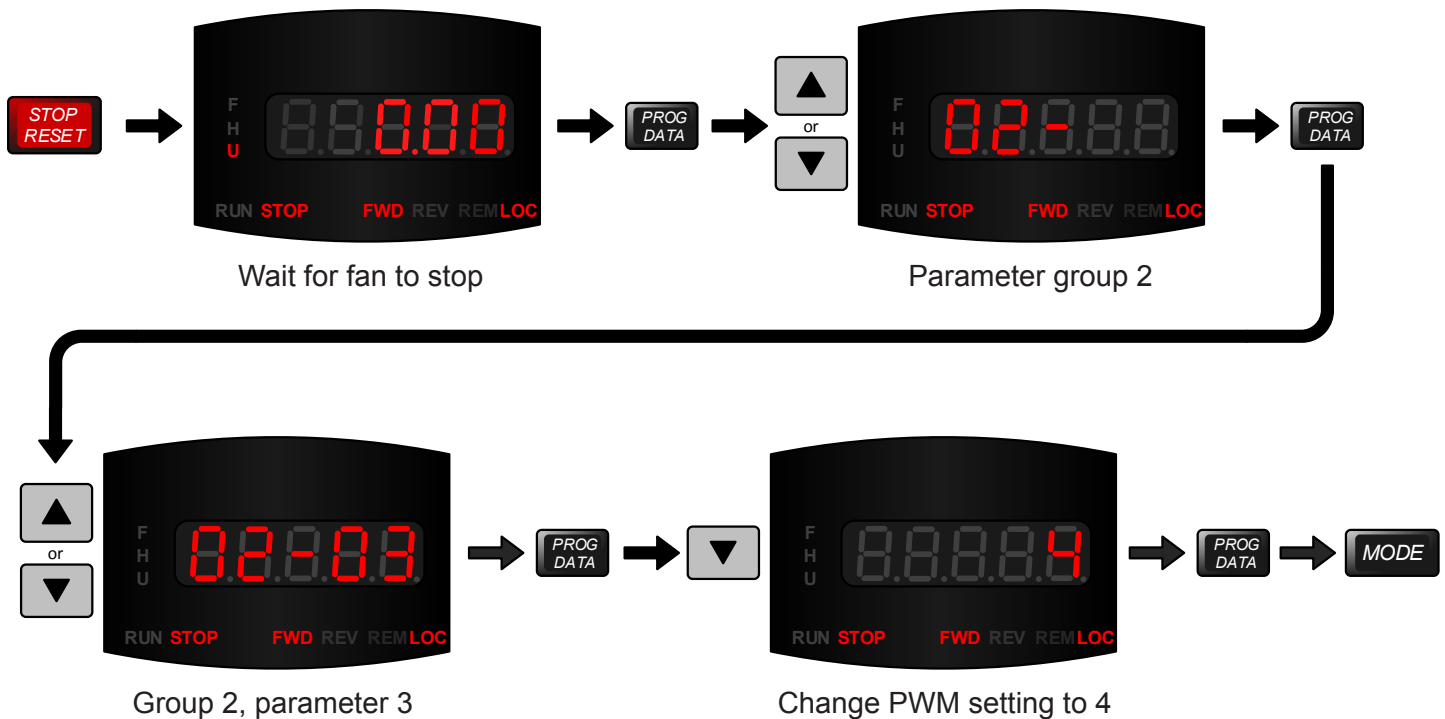
Consult the motor wiring nameplate or wiring placard for verification of required wiring connections. See pages 2–3 for detailed voltage, current, and circuit breaker/fuse requirements.



## Setting the pulse width modulation (PWM) frequency

For long motor lead installations, the fan controller's PWM frequency **must be reduced** from 15 kHz to 4 kHz.

1. Press STOP/RESET to stop the fan. Wait for the fan to come to a complete stop.
2. Press PROG/DATA.
3. Using the UP or DOWN keys, change the parameter group to 2.
4. Press PROG/DATA
5. Using the UP or DOWN keys, select parameter number 3.
6. Press PROG/DATA
7. Using the DOWN key, change the PWM setting from 15 to 4.
8. Press PROG/DATA to save the setting.
9. Press MODE twice to exit to the User Display.



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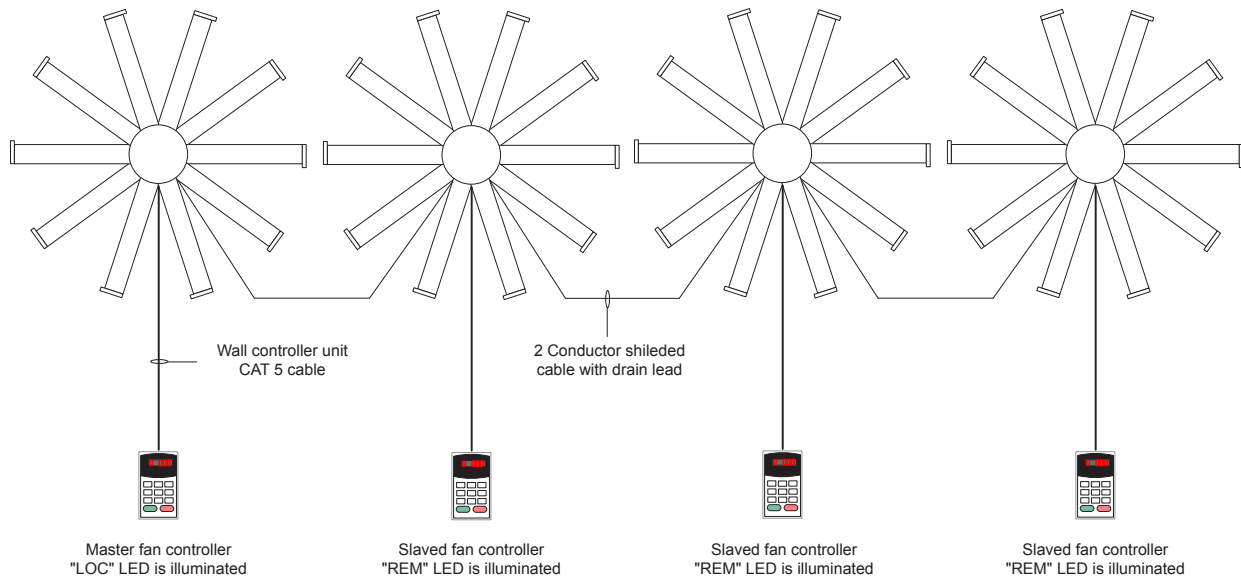
## Installing the wall-mounted VFD (cont.)

## Daisy Chaining

The Powerfoil®X2.0 fan is preprogrammed to operate in Master/Slave or Daisy Chain mode. Starting, stopping, and speed control signals are transmitted by the master fan controller to remaining slaved fans via 0–10 VDC analog outputs. The wall controller for the slaved fans remains active as a display so that the operator can still view any fault messages, toggle between output frequency and fan RPM displays, or operate the fan via the LOCAL/REM button.



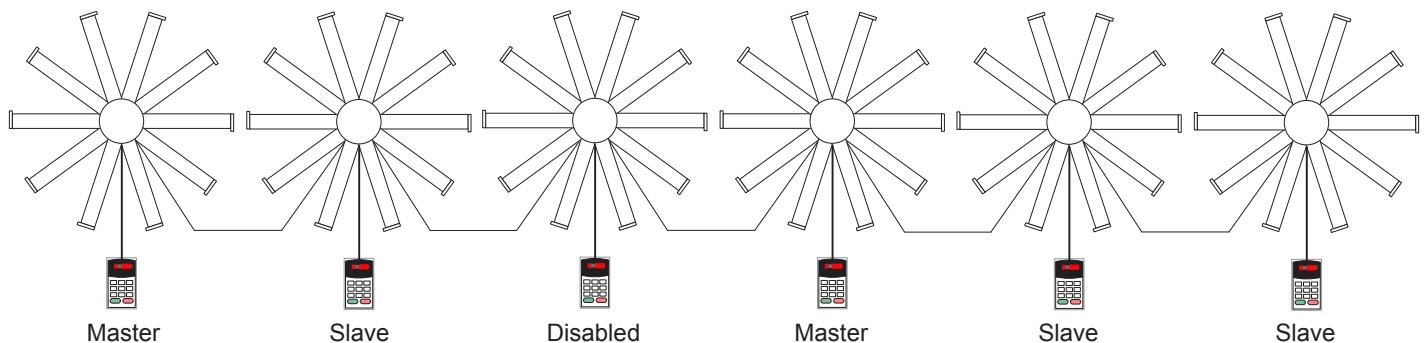
The LOCAL/REM button toggles the fan's command sources between the wall controller (LOC LED illuminated) and external sources (REM LED illuminated). In a daisy chained installation, the master fan controller will operate via the wall controller (local mode), and the Slaved fan controller(s) will operate via the 0–10 VDC command reference provided by the master fan controller (REM mode). *Note: To access the LOCAL/REM button, the controller cover must be removed.*



In the example above, the first controller is the master controller (local mode). The remaining fans (REM mode), when connected with a two-conductor shielded cable, will follow command references provided by the master controller. See the following page for detailed wiring diagrams. Limit two-conductor shielded cable runs to 200 ft (61 m) or less. Consult Big Ass Fans Customer Service Department for conversion to 4–20 mA current loop.

## System redundancy

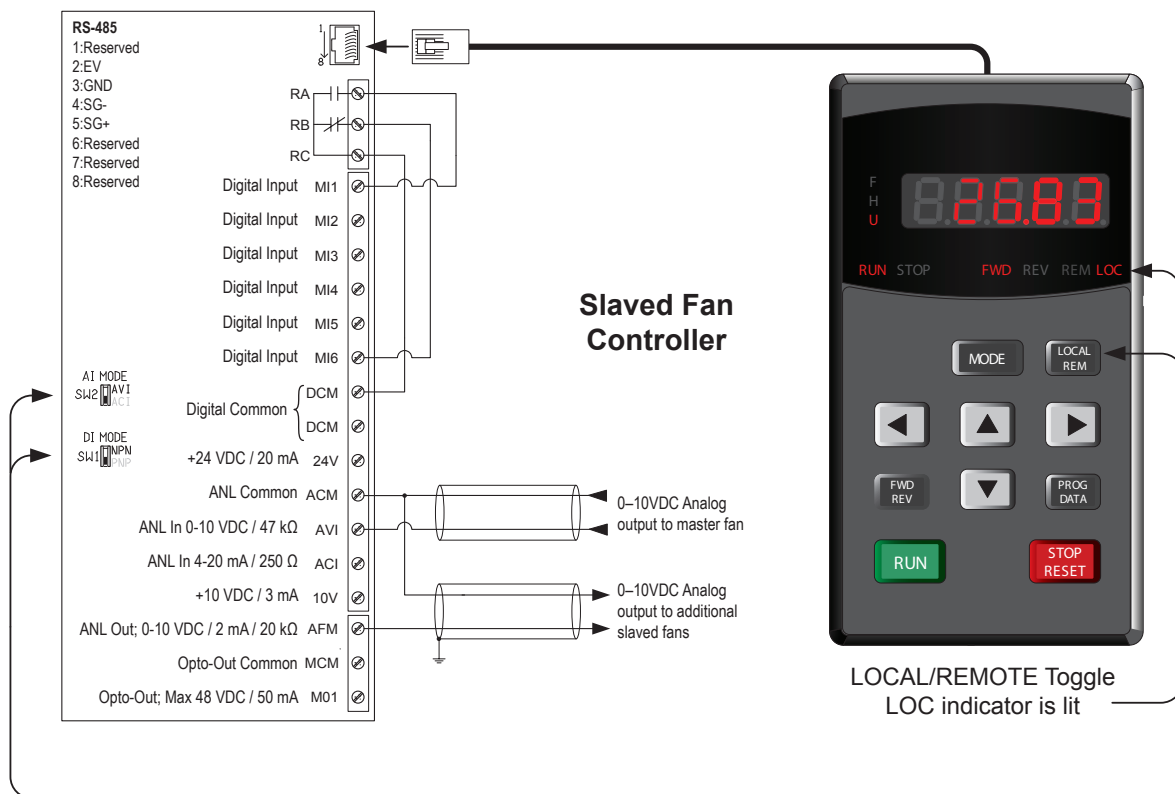
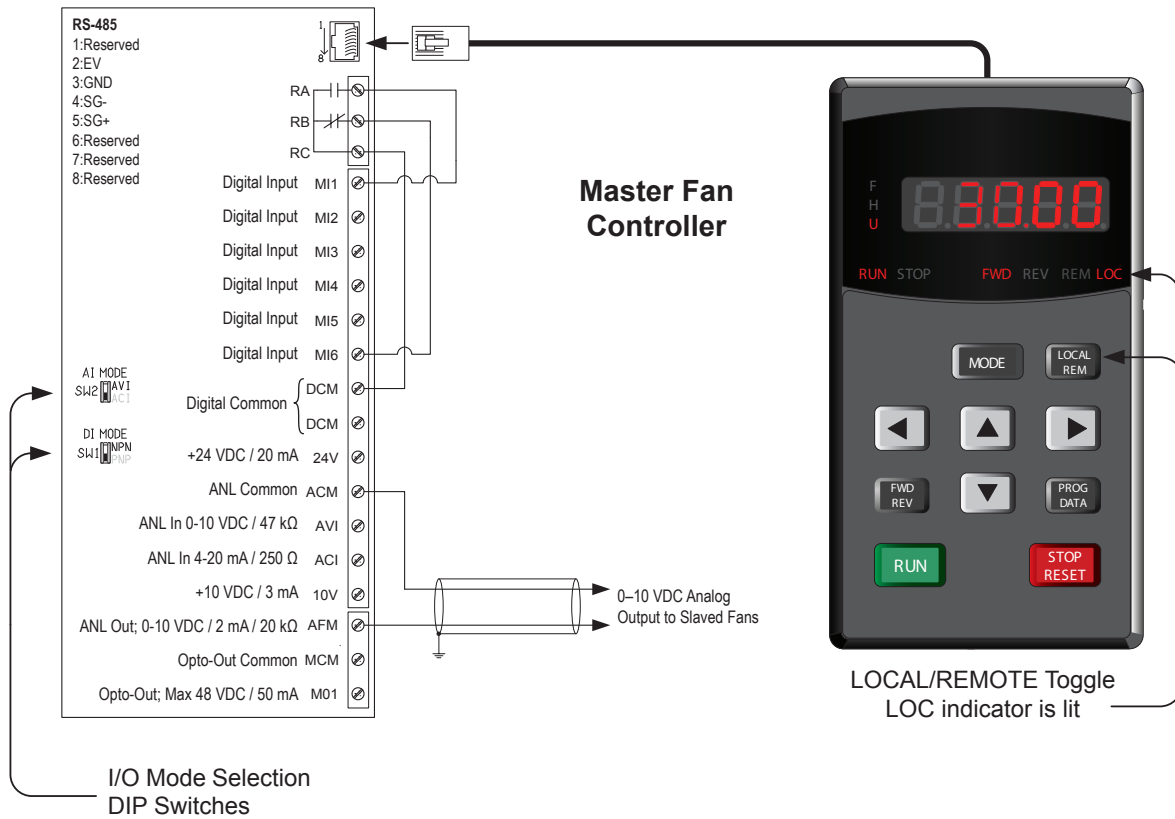
If one of the fans in the chain is disabled, the next fan controller in the chain can become the master controller for all remaining fans by pressing the LOCAL/REM button on that fan's wall controller.



# Installing the wall-mounted VFD (cont.)

## Daisy chaining (cont.)

Reverse fan rotation is disabled when the fan is operated as a slaved unit. *Note: To access all buttons on the controller, the controller cover must be removed.*

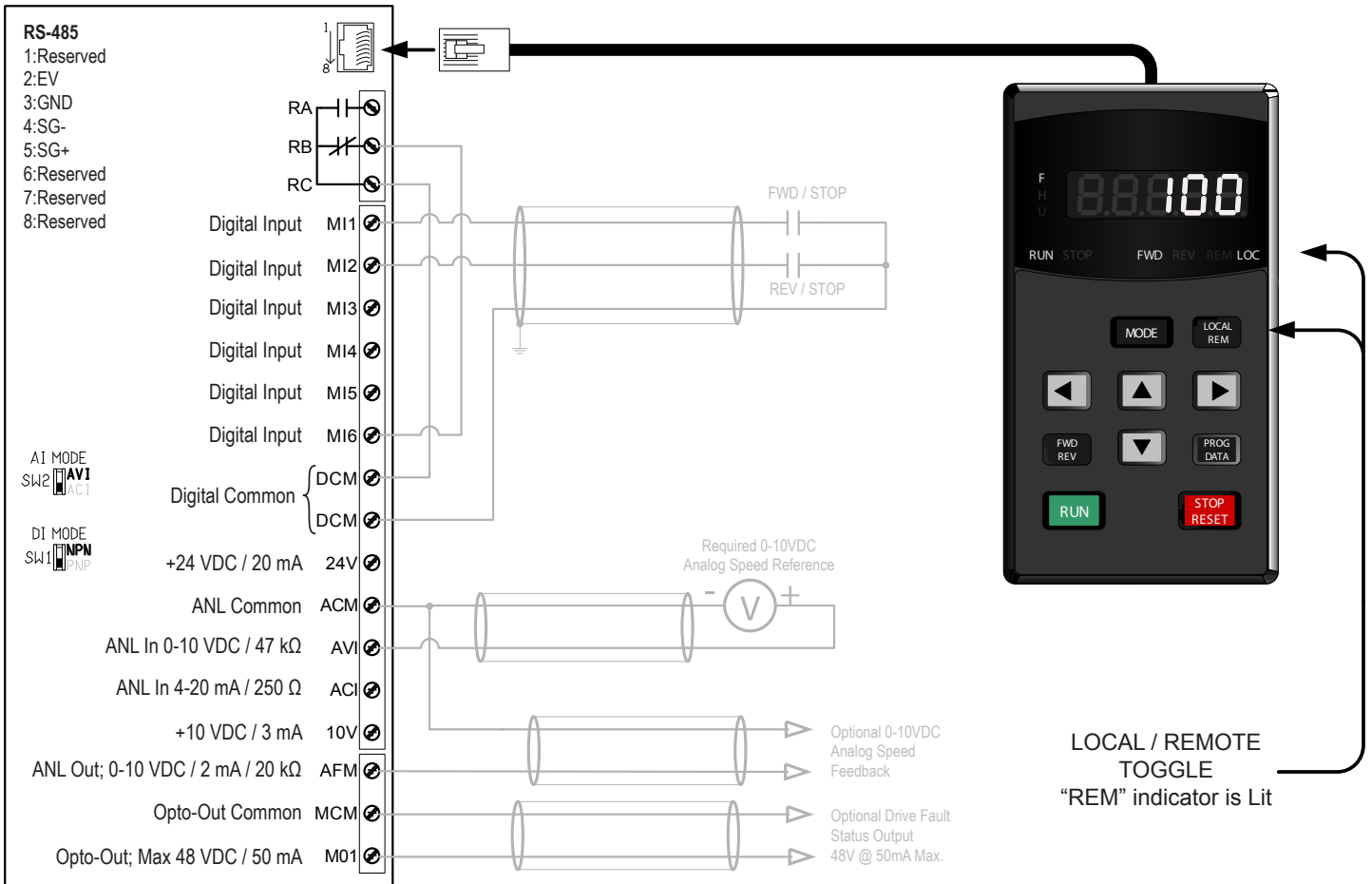


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## Installing the wall-mounted VFD (cont.)

### Basic Distributed I/O Interface; LOCAL Control

Note: RA to Digital Input #1 jumper removed.



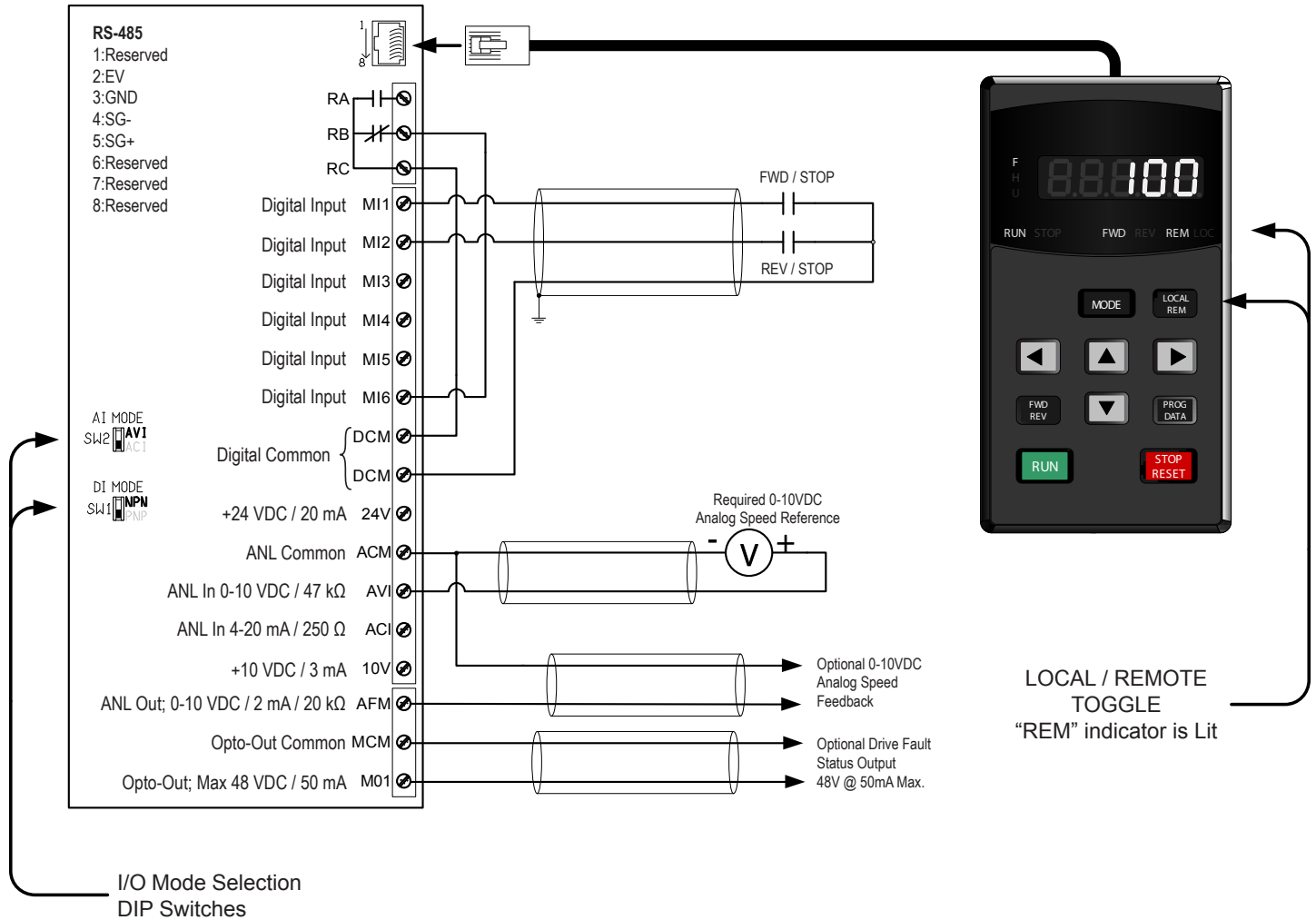
The Powerfoil® X2.0 fan is programmed to be controlled via the included wall controller, which starts, stops, and performs speed control duties for the fan. Fault messages and toggling between output frequency and fan RPM displays are also controlled by the wall controller. This mode of operation is commonly referred to as “local control.”

**\*For the wall control unit to be active, the LOC indicator light must be illuminated by pressing the LOCAL/REM button.**



**Basic Distributed I/O Interface; EXTERNAL Control**

Note: RA to Digital Input #1 jumper removed.



The Powerfoil® X2.0 fan is also programmed to be controlled by an Energy Management System or Building Automation System. Starting, stopping, and speed control duties are handled by the distributed I/O (2 N.O. contacts, 1 analog) provided by the installer. The wall controller remains active as a display so that fault messages can still be viewed, and toggling between output frequency and fan RPM displays can still be performed. This mode of operation is commonly referred to as "external control."

**\*For distributed I/O to be active, the REM indicator light must be illuminated by pressing the LOCAL/REM button as shown above.**

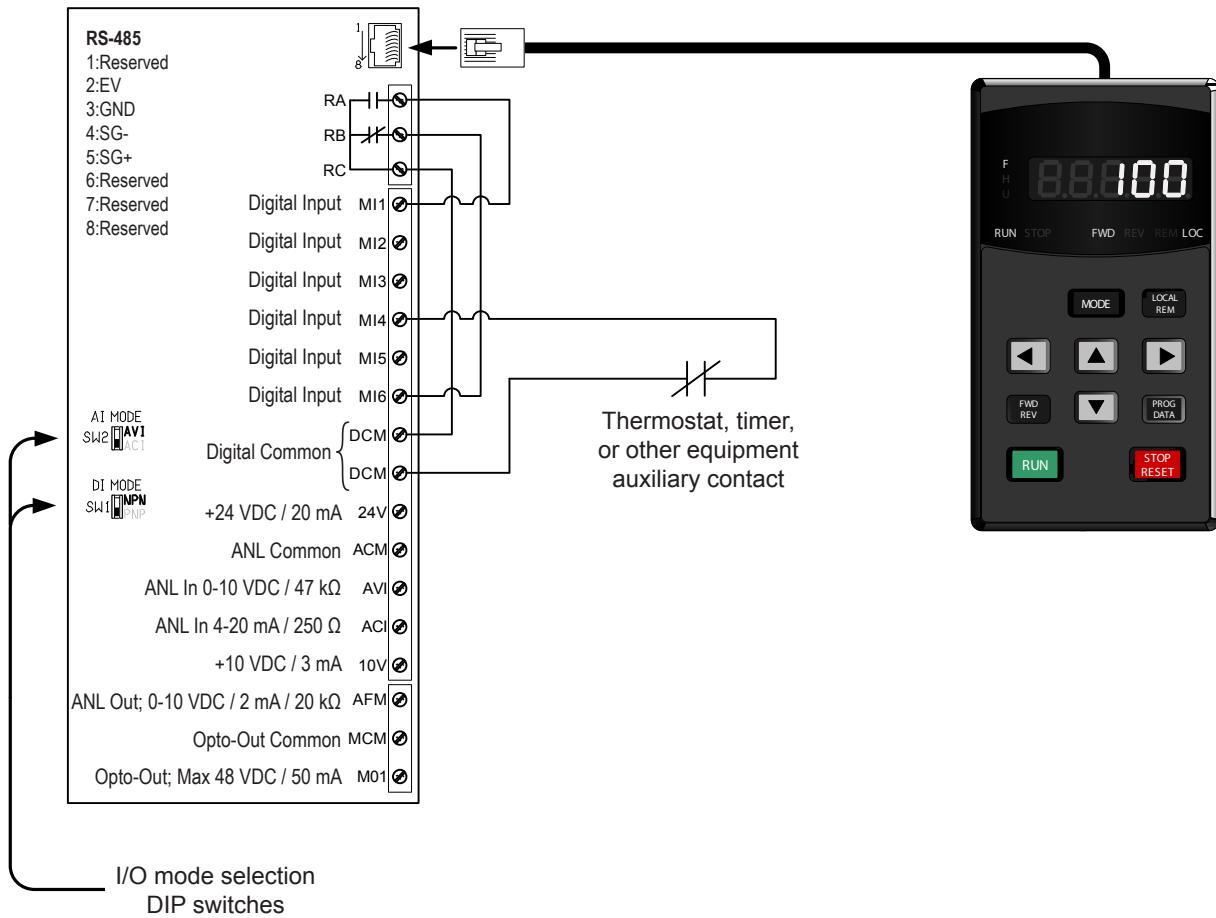
**About I/O Mode Selection**

Big Ass Fans factory defaults for analog and digital inputs are ACI (4-20 mA) and NPN (inputs pulled down to DC Common). If required, these may be switched to AVI (0-10 VDC as shown above) and PNP (inputs pulled up to 24 VDC) via the dip switches shown above. If required, a diagram can be provided to reflect these alternate connection schemes.

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## Installing the wall-mounted VFD (cont.)

## Interfacing with basic timers, thermostats, and other equipment



When a contact closure is seen across Digital Input #4 (MI4) and DC Common (DCM), the fan is pre-programmed to issue a base-block code and initiate fan shutdown. This is essentially turning off the fan controller's output terminals, while leaving the fan controller in Run mode.

Auxiliary contacts can be associated with basic timers and thermostats, as well as equipment such as overhead cranes, in order to initiate fan shutdown simultaneously with equipment shutdown when contact closure is seen.

**After the auxiliary contact has reopened, the fan will return to its previous operating mode.**





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