VFD68 Variable Frequency Drives

Technical Bulletin

VFD68Bxx, VFD68Cxx, VFD68Dxx

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VFD68 Variable Frequency Drives

Introduction

The VFD68 Variable Frequency Drives are designed to provide three-phase motor speed control in a variety of HVACR applications. The VFD68 drives are factory-configured for condenser fan speed control on HVACR condensing units. You can quickly and easily reconfigure the VFD68 drives to control variable speed pumps in cooling and heating applications, or to drive variable speed supply fans in VAV applications.

Note: The VFD68 drive cannot drive motors in conveyor systems or robotic applications.

Do not attempt to install, operate, maintain, or inspect the VFD68 drive until you have read through this document carefully and can use the equipment correctly. Do not use this product until you fully understand the equipment, safety information, and instructions.

IMPORTANT: Use this VFD68 Variable Frequency Drive only as an operating control. Where failure or malfunction of the VFD68 Drive could lead to personal injury or property damage to the controlled equipment or other property, additional precautions must be designed into the control system. Incorporate and maintain other devices, such as supervisory or alarm systems or safety or limit controls, intended to warn of or protect against failure or malfunction of the VFD68 Drive.

IMPORTANT : Utiliser ce VFD68 Variable Frequency Drive uniquement en tant que dispositif de régulation. Lorsqu'une défaillance ou un dysfonctionnement du VFD68 Drive risque de provoquer des blessures ou d'endommager l'équipement contrôlé ou un autre équipement, la conception du système de contrôle doit intégrer des dispositifs de protection supplémentaires. Veiller dans ce cas à intégrer de façon permanente d'autres dispositifs, tels que des systèmes de supervision ou d'alarme, ou des dispositifs de sécurité ou de limitation, ayant une fonction d'avertissement ou de protection en cas de défaillance ou de dysfonctionnement du VFD68 Drive.

North American Emissions Compliance

United States

This equipment has been tested and found to comply with the limits for a Class A digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when this equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area may cause harmful interference, in which case users will be required to correct the interference at their own expense.

Canada

This Class (A) digital apparatus meets all the requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de la Classe (A) respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

Agency Standards Compliance

Agency Standards Compliance for VFD68Bxx and VFD68Cxx Drives

- North America: cULus Listed; UL 508C, USA File: NMMS.E244421; Canada File: NMMS7.E244421
- Europe: CE Mark – Conforms to the provisions of the Low Voltage Directive and the EMC Directive when an EMC-compliant line filter is attached to the power supply.[1]
- Australia: Regulatory Compliance Mark (RCM)

1. For more information, see *Appendix 5: EMC Line Filter Selection Chart* on page 107.

Agency Standards Compliance for VFD68Dxx Drives

- North America: cULus Listed; UL 508C, USA File: NMMS.E244421; Canada File: NMMS7.E244421

Installation

Checking the Rating Plate

Before you install the VFD, check the rating plate on the side to verify that the voltage, kW (horsepower), and output current ratings are correct for your application. See Figure 1, Table 1, and *Selecting the Correct VFD68 Drive for Your Fan Motor* on page 20.

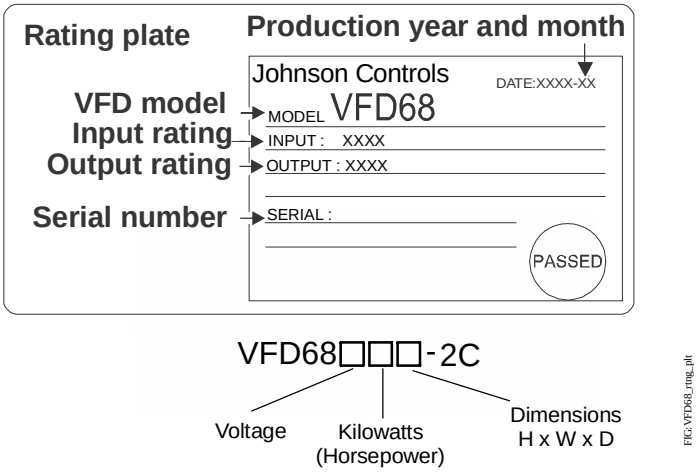


Figure 1: Rating Plate

Table 1: VFD68 Drive Model Information

	Voltage	kW (Horsepower)	Dimensions, H x W x D, mm (in.)
B	200–240 VAC, 50/60 Hz	0.1 (1/8)	128 x 68 x 81 (5 x 2-11/16 x 3-3/16)
C	400–480 VAC, 50/60 Hz	0.2 (1/4)	128 x 68 x 113 (5 x 2-11/16 x 4-7/16)
D	575 VAC, 60 Hz	0.4 (1/2)	128 x 68 x 133 (5x 2-11/16 x 5-1/4)
F		0.75 (1)	128 x 108 x 130 (5 x 4-1/4 x 5-1/8)
G		1.5 (2)	128 x 108 x 136 (5 x 4-1/4 x 5-5/16)
H		2.2 (3)	128 x 108 x 156 (5 x 4-1/4 x 6-1/8)
J		3.7 (5)	128 x 108 x 166 (5 x 4-1/4 x 6-1/2)
K		5.5 (7-1/2)	128 x 170 x 142 (5 x 6-11/16 x 5-5/8)
L		7.5 (10)	150 x 220 x 155 (5-15/16 x 8-11/16 x 6-1/8)
M		11 (15)	150 x 140 x 136 (5-15/16 x 5-1/2 x 5-5/16)
N		15 (20)	150 x 220 x 148 (5-15/16 x 8-11/16 x 5-13/16)
P			260 x 220 x 190 (10-1/4 x 8-11/16 x 7-1/2)

For example, a VFD68BGG would be rated for 200–240 VAC and 2 horsepower.

IMPORTANT: Frequently starting and stopping the VFD shortens the lifespan of the VFD68 drive. In applications where the drive will start or stop frequently, select a VFD which has an output current rating that is 1.5 to 2 times greater than the FLA current rating of the three-phase motor.

Selecting a Motor

IMPORTANT:	When selecting the motor, do not exceed the maximum ampere rating of the VFD68 drive.

Motors used with the VFD68 drive must:

- be AC induction three-phase motors that are UL Recognized and CSA Certified, or equivalent
- be rated for: 230 VAC at 50/60 Hz; 460 VAC at 50/60 Hz; or 575 VAC at 60 Hz
- have an Inverter Rating (460 VAC motors)
- have Insulation Class F or better

The VFD68 drive is intended for use with variable speed motors that are rated for 40:1 operation.

Selecting a VFD68 Drive for Controlling Multiple Motors

IMPORTANT:	Do not control both single-phase and three-phase motors with the same VFD68 drive.

A VFD68 drive can control multiple motors; however, the sum of the Full Load Amperes (FLA) ratings for the motors must not exceed the maximum output amperage rating of the VFD68 drive, including any de-rating due to altitude. See Table 3 on page 9 for de-rating information.

Selecting a VFD68 Drive for Use with Single-Phase Supplied Power

When using a single-phase power supply, the VFD68 drive requires more single-phase power to create three-phase power for the motor. Therefore, you must select a VFD68 drive with a higher maximum output current rating as follows:

- R = Current (Ampere) rating of the controlled single-phase motor (or sum of ratings, if using multiple motors)
- 2*R = minimum required output current for VFD68 drive

Select a VFD68 drive such that **Maximum Output Current (Ampere) > 2*R** (see Table 2).

Table 2: Maximum Current Output by VFD68 Drive Model

VFD68Bxx Models	Maximum Output Current (Amperes)	VFD68Cxx Models	Maximum Output Current (Amperes)	VFD68Dxx Models	Maximum Output Current (Amperes)
VFD68BBB	0.8	**VFD68CDF**	1.2	**VFD68DFM**	1.7
VFD68BCB	1.4	**VFD68CFF**	2.2	**VFD68DGM**	2.7
VFD68BDC	2.5	**VFD68CGG**	3.6	**VFD68DHM**	4.0
VFD68BFD	4.2	**VFD68CHH**	5.0	**VFD68DJN**	6.1
VFD68BGG	7.0	**VFD68CJJ**	8.0	**VFD68DKN**	9.0
VFD68BHG	10.0	**VFD68CKL**	12.0	**VFD68DLN**	12.0
VFD68BJK	16.5	**VFD68CLL**	16.0		
VFD68BKL	23.8	**VFD68CMP**	23.0		
VFD68BLL	31.8	**VFD68CNP**	29.5		
VFD68BMP	45.0				
VFD68BNP	58.0				

Location Considerations

WARNING: Risk of Fire or Electric Shock.
Install the device in an environment relatively free of contaminants such as dust, condensation, or chemical agents. A dirty or damp environment may cause an electric arc across contaminated terminals.

AVERTISSEMENT : Risque de décharge électrique ou incendie.
Installer l'appareil dans un environnement présentant une quantité réduite de contaminants tels que de la poussière, de la condensation ou des agents chimiques. Un environnement pollué ou humide risque d'entraîner la formation d'un arc électrique entre des bornes contaminées.

CAUTION: Risk of Property Damage.
The VFD68 Drive can generate and dissipate significant heat. Mount the VFD68 Drive on a metal, concrete, or cinder block mounting surface. Mounting the VFD68 Drive on surfaces made of wood or other heat-sensitive material may result in damage to the mounting surface.

MISE EN GARDE : Risque de dégâts matériels.
Le VFD68 Drive peut générer et émettre une chaleur importante. Installer le VFD68 Drive sur une surface de montage en métal, en béton ou en parpaings. L'installation du VFD68 Drive sur une surface en bois ou composée de matériaux sensibles à la chaleur risque d'endommager la surface de montage.

Observe the following location guidelines:

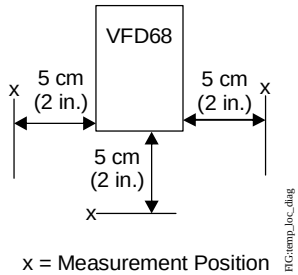
- Ensure that the mounting surface can support the VFD, mounting hardware, and any user-supplied panel or enclosure.
- Mount the VFD on flat, even surfaces.
- Allow sufficient space for wires and connections.
- Do not mount the VFD on surfaces that are prone to vibration or in locations where radio frequency or electromagnetic emissions may cause interference.
- Do not install the VFD in an airtight enclosure.
- Do not install heat-generating devices that may cause the temperature to exceed the ambient operating limit in the same enclosure as the modules.

The VFD68 drive has been approved for use in an enclosure. Approval tests were conducted under the conditions in Table 3.

When mounting the VFD68 drive in an enclosure, ensure that the specified space around the drive is maintained, and that the ambient conditions are within the specified limits.

IMPORTANT: The VFD68 Drive is intended to be mounted in an enclosure that only allows access by trained and authorized personnel, and that prevents the ingress of contamination. It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

Table 3: Environmental Considerations

Surrounding Air Temperature[1]	-40 to 50°C (-40 to 122°F) as measured 5 cm from the VFD	
Ambient Humidity	90% RH or less (Non-condensing)	
Storage Temperature	-40 to 65°C (-40 to 149°F)	
Atmosphere	Indoors (no corrosive and flammable gases, oil mist, dust and dirt.)	
	Altitude Limit[2]: Below 1,000 m (3,280 ft) above sea level	
	Vibration Limit: 5.9 m/s^2 (19.4 ft/s^2) or less at 10–55 Hz (directions of x, y, z axes)	

1. Surrounding air temperature is a temperature measured at a measurement position in an enclosure. Ambient air temperature is a temperature outside an enclosure. The VFD68 is designed to operate above 50°C by following the maximum output current derating limits show in Table 4 and Table 5 and Figure 2.
2. Altitude limit given is for standard operation of the VFD. For operation at higher altitudes, derate by 3% for each 500 m (1,640.4 ft), up to a maximum of 2,500 m (8,202 ft) (91% derating).

Table 4: Maximum Current Output Derating above 50°C by VFD68Bxx Drive Model

VFD68Bxx Models	Rated Capacity kW (HP)	Maximum Output Current at 50°C (Amperes)	Maximum Output Current at 60°C (Amperes)	Maximum Output Current at 70°C (Amperes)
VFD68BBB	0.1 (1/8)	0.8	0.6	0.5
VFD68BCB	0.2 (1/4)	1.4	1.1	0.9
VFD68BDC	0.4 (1/2)	2.5	2.1	1.7
VFD68BFD	0.75 (1)	4.2	3.5	2.9
VFD68BGG	1.5 (2)	7.0	5.9	4.9
VFD68BHG	2.2 (3)	10.0	8.5	7.0
VFD68BJK	3.7 (5)	16.5	14.0	11.5
VFD68BKL	5.5 (7-1/2)	23.8	20.2	16.6
VFD68BLL	7.5 (10)	31.8	27.0	22.2
VFD68BMP	11 (15)	45.0	38.2	31.5
VFD68BNP	15 (20)	58.0	49.3	40.6

Table 5: Maximum Current Output Derating above 50°C by VFD68Cxx Drive Model

VFD68Bxx Models	Rated Capacity kW (HP)	Maximum Output Current at 50°C (Amperes)	Maximum Output Current at 60°C (Amperes)	Maximum Output Current at 70°C (Amperes)
VFD68CDF	0.4 (1/2)	1.2	1.0	0.8
VFD68CFF	0.75 (1)	2.2	1.8	1.5
VFD68CGG	1.5 (2)	3.6	3.0	2.5
VFD68CHH	2.2 (3)	5.0	4.2	3.5
VFD68CJJ	3.7 (5)	8.0	6.8	5.6
VFD68CKL	5.5 (7-1/2)	12.0	10.2	8.4
VFD68CLL	7.5 (10)	16.0	13.6	11.2
VFD68CMP	11 (15)	23.0	19.6	16.1
VFD68CNP	15 (20)	29.5	25.0	20.6

Table 6: Maximum Current Output Derating above 50°C by VFD68Dxx Drive Model

VFD68Dxx Models	Rated Capacity kW (HP)	Maximum Output Current at 50°C (Amperes)	Maximum Output Current at 60°C (Amperes)	Maximum Output Current at 70°C (Amperes)
VFD68DFM	0.75 (1)	1.7	1.4	1.1
VFD68DGM	1.5 (2)	2.7	2.3	1.8
VFD68DHM	2.2 (3)	4.0	3.4	2.8
VFD68DJN	3.7 (5)	6.1	5.1	4.2
VFD68DKN	5.5 (7.5)	9.0	7.6	6.3
VFD68DLN	7.5 (10)	12.0	10.2	8.4

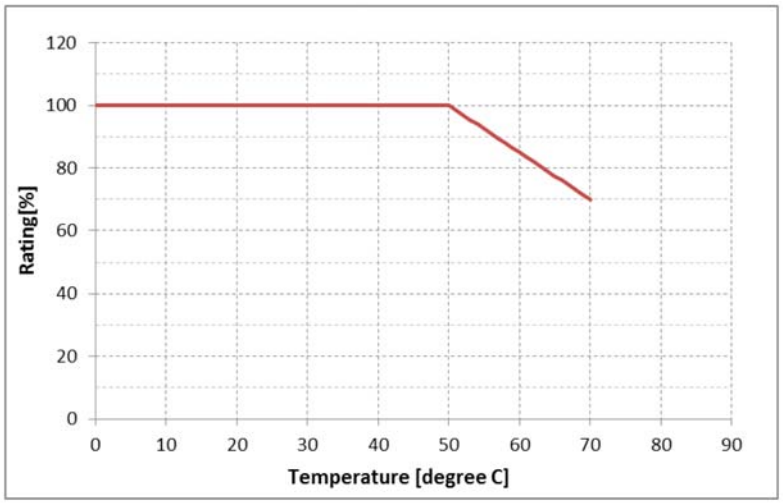


Figure 2: VFD68Bxx, VFD68Cxx, and VFD68Dxx Maximum Current Output Derating above 50°C

Dimensions for VFD68Bxx and VFD68Cxx Drives

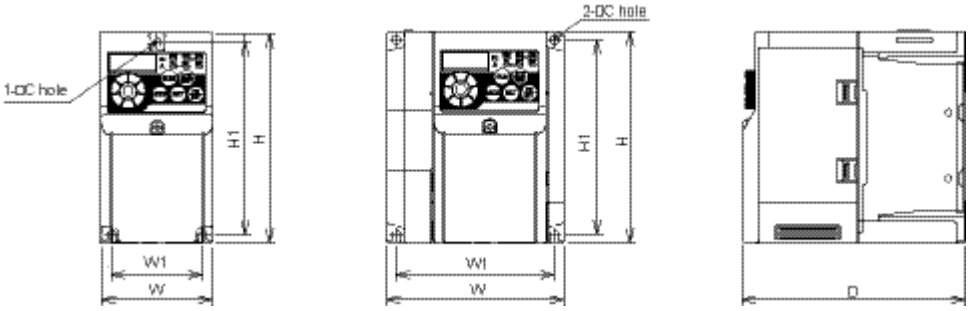


Figure 3: Dimensions for VFD68 Drives, 230–460 VAC Models

Table 7: Three-Phase 230 VAC Models, mm (in.)

VFD Model	H	H1	W	W1	D
VFD68BBB	128 (5.04)	118 (4.65)	68 (2.68)	56 (2.20)	80.5 (3.17)
VFD68BCB					
VFD68BDC					112.5 (4.43)
VFD68BFD					132.5 (5.22)
VFD68BGG			108 (4.25)	96 (3.78)	135.5 (5.34)
VFD68BHG					
VFD68BJK			170 (6.69)	158 (6.22)	142.5 (5.61)
VFD68BKL	150 (5.91)	138 (5.43)	220 (8.66)	208 (8.19)	155 (6.10)
VFD68BLL					
VFD68BMP	260 (10.23)	244 (9.61)	220 (8.66)	195 (7.68)	190 (7.48)
VFD68BNP					

Table 8: Three-Phase 460 VAC Models, mm (in.)

VFD Model	H	H1	W	W1	D
VFD68CDF	128 (5.04)	118 (4.65)	108 (4.25)	96 (3.78)	129.5 (5.10)
VFD68CFF					
VFD68CGG					135.5 (5.34)
VFD68CHH					155.5 (6.12)
VFD68CJJ					165.5 (6.52)
VFD68CKL	150 (5.91	138 (5.43)	220 (8.66)	208 (8.19)	155 (6.10)
VFD68CLL					
VFD68CMP	260 (10.23)	244 (9.61)	220 (8.66)	195 (7.68)	190 (7.48)
VFD68CNP					

Dimensions for VFD68Dxx Drives

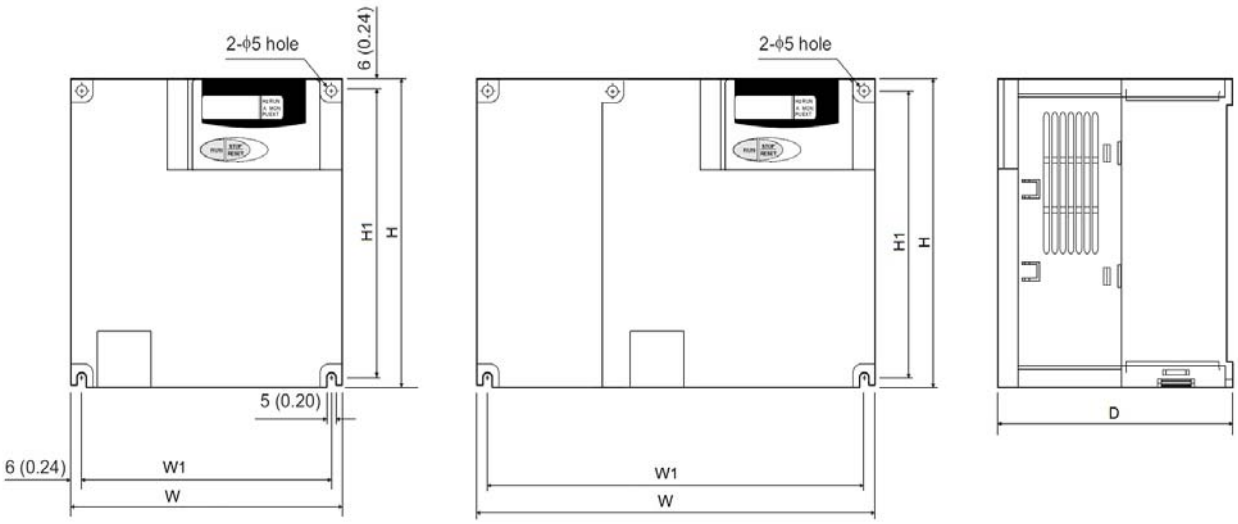


Figure 4: Dimensions for VFD68Dxx Drives, mm (in.)

Table 9: Dimensions for VFD68Dxx Drives, mm (in.)

VFD Model	H	H1	W	W1	D
VFD68DFM	150 (5-15/16)	138 (5-7/16)	140 (5-1/2)	128 (5-1/16)	136 (5-3/8)
VFD68DGM					
VFD68DHM					
VFD68DJN			228 (8-11/16)	208 (8-3/16)	148 (5-13/16)
VFD68DKN					
VFD68DLN					

Mounting

Mounting the VFD68Bxx and VFD68Cxx Drives

1. Loosen the screws on the front cover and remove the cover (Figure 5).

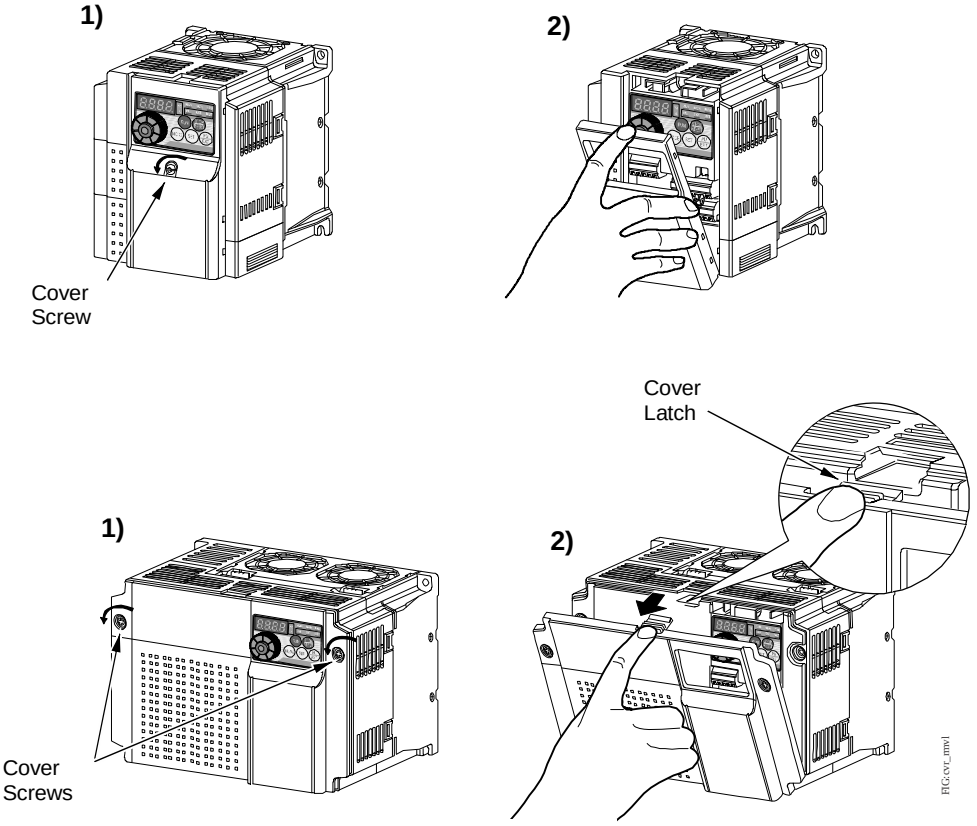


Figure 5: Loosen the Cover Screws and Remove the Front Cover

2. Remove the high-voltage wiring cover at the bottom of the VFD68 drive (Figure 6).

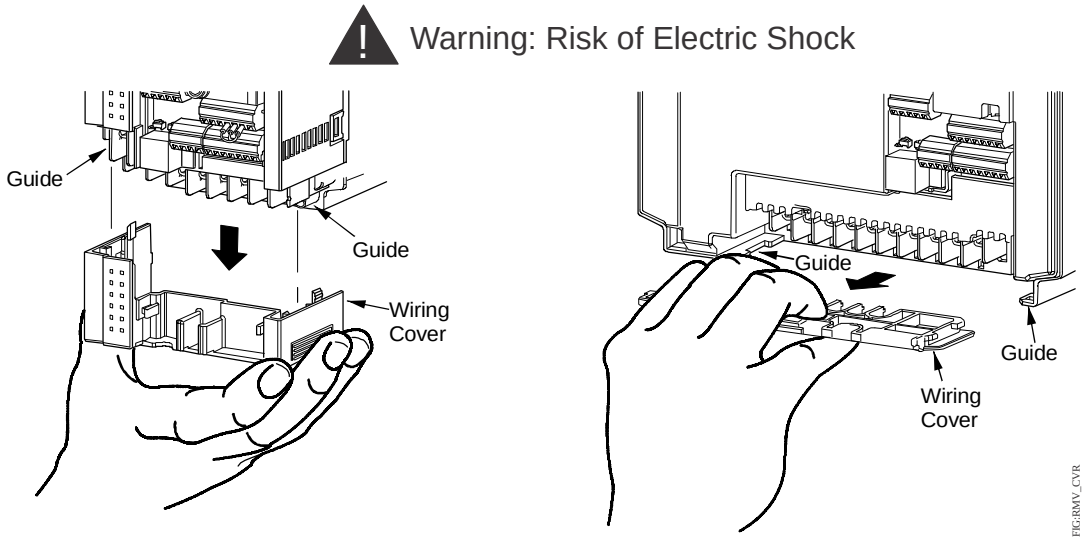


Figure 6: Remove the High-Voltage Wiring Cover

Mount the VFD vertically (Figure 7) in an acceptable NEMA-rated enclosure on a non-flammable surface. When you drill mounting holes and mount the VFD, ensure that you do not allow metal chips or other material to enter the VFD housing.

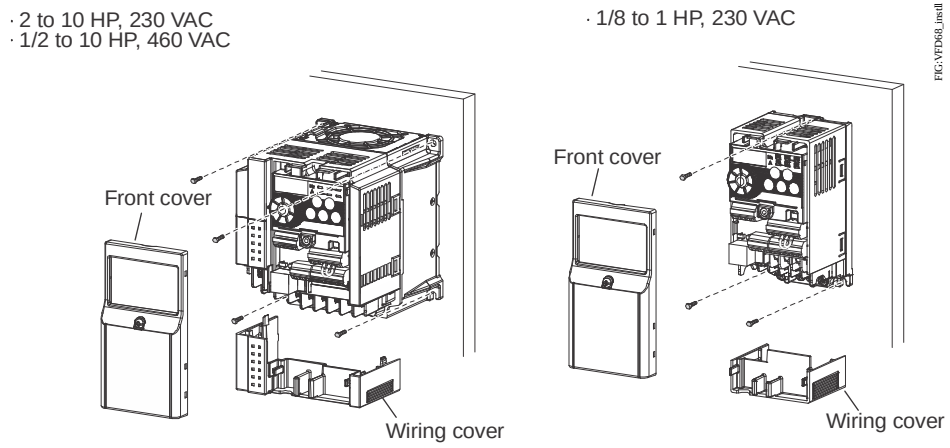


Figure 7: Mount the VFD68 Drive

See Figure 8 and Table 10 for mounting space requirements.

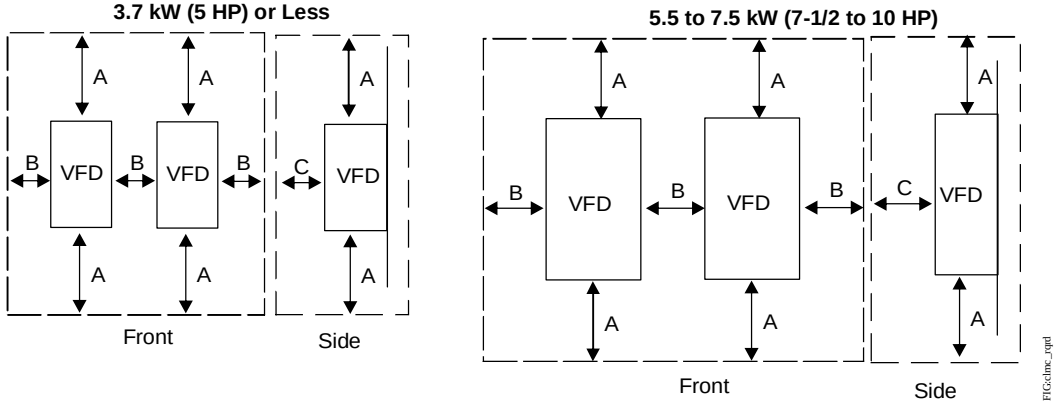


Figure 8: Required Clearance for Mounting Inside an Enclosure

Table 10: Required Clearance

Dimension	3.7 kW (5 HP) or Less	5.5–7.5 kW (7-1/2–10 HP)
A	100 mm (4 in.) or more	100 mm (4 in.) or more
B	10 mm (7/16 in.) or more	50 mm (2 in.) or more
C		

Mounting the VFD68Dxx Drives

1. To remove the front cover, push down on the hooks at Position A and Position B and pull the front cover away from the VFD68 drive, using the hooks at Position C as supporting points (Figure 9).

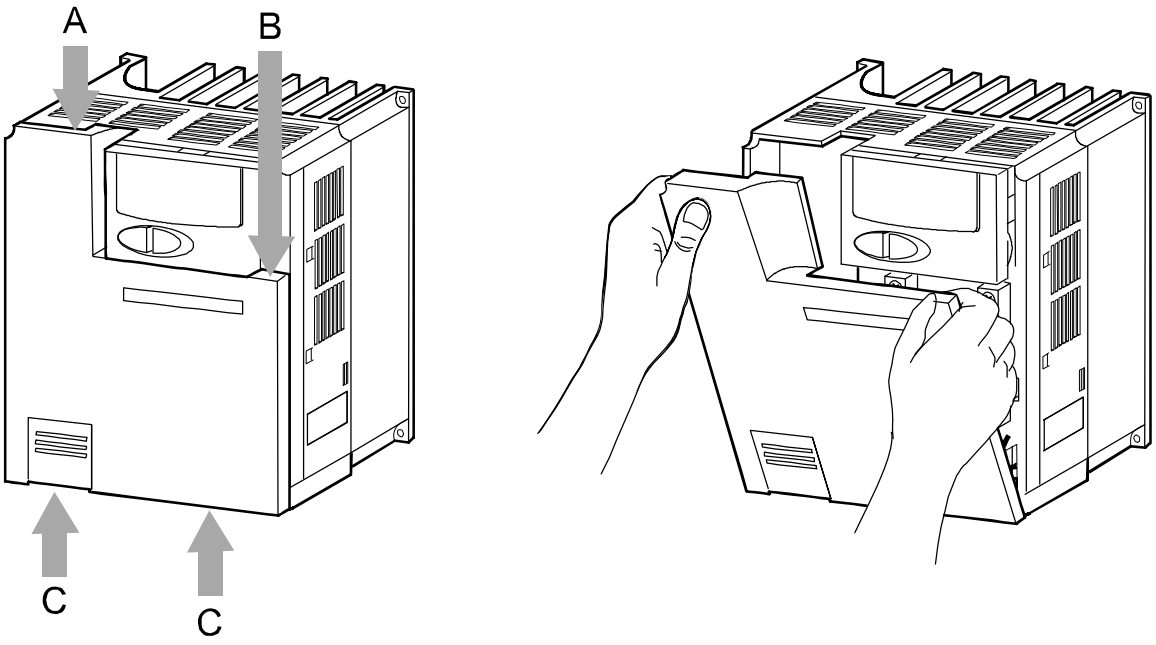


Figure 9: Release the Hooks and Remove the Front Cover

2. Remove the high-voltage wiring cover at the bottom of the VFD68 drive by pulling in the direction of Arrow A (Figure 10).

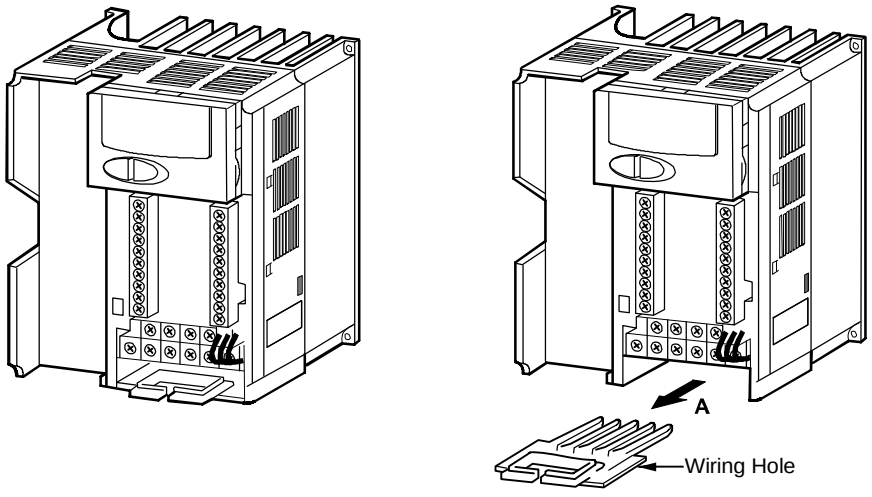


Figure 10: Remove the High-Voltage Wiring Cover

Mount the VFD vertically in an acceptable NEMA-rated enclosure on a non-flammable surface. When you drill the mounting holes and mount the VFD, ensure that you do not allow metal chips or other material to enter the VFD housing.

See Figure 11 and Table 11 for mounting space requirements.

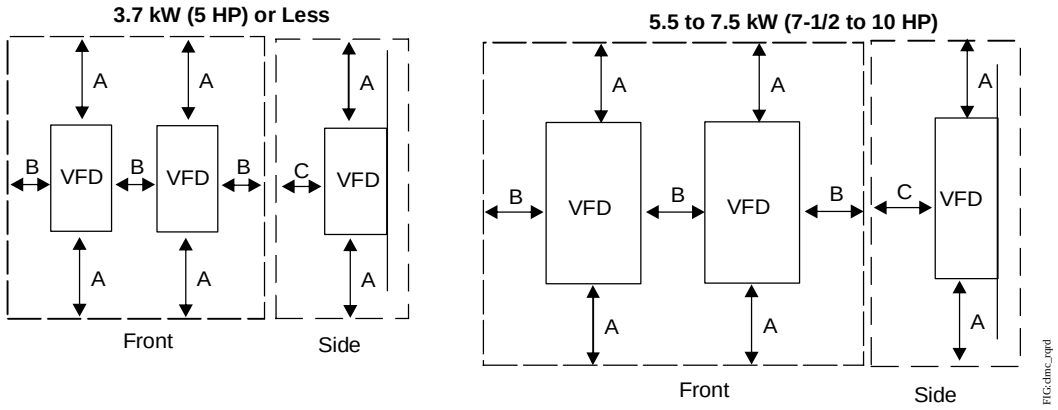


Figure 11: Required Clearance for Mounting Inside an Enclosure

Table 11: Required Clearance

Dimension	3.7 kW (5 HP) or Less	5.5 to 7.5 kW(7-1/2 to 10 HP)
A	100 mm (4 in.) or more	100 mm (4 in.) or more
B	10 mm (7/16 in.) or more	50 mm (2 in.) or more
C		

Wiring

WARNING: Risk of Electric Shock.
Disconnect the power supply before making electrical connections. Contact with components carrying hazardous voltage can cause electric shock and may result in severe personal injury or death.

AVERTISSEMENT: Risque de décharge électrique.
Débrancher l'alimentation avant de réaliser tout branchement électrique. Tout contact avec des composants porteurs de tensions dangereuses risque d'entraîner une décharge électrique et de provoquer des blessures graves, voire mortelles.

WARNING: Risk of Electric Shock.
Do not touch any exposed metal parts with anything other than properly insulated tools or insulated probes of the digital voltage meter. Failure to use properly insulated tools and probes may result in severe personal injury or death.

AVERTISSEMENT: Risque de décharge électrique.
Ne jamais toucher une partie métallique exposée avec tout élément autre que des outils correctement isolés ou les sondes isolées du voltmètre numérique. L'utilisation d'outils et de sondes incorrectement isolés risque de provoquer des blessures graves, voire mortelles.

WARNING: Risk of Electric Shock.

To avoid possible electric shock, wait at least 10 minutes after the AC supply power has been disconnected from the VFD68 Drive before servicing the device. The VFD68 Drive remains electrically charged for a period of time after power is removed. Failure to wait until the VFD68 Drive fully discharges could cause electric shock, personal injury, or death.

AVERTISSEMENT: Risque de décharge électrique.

Afin d'éviter tout risque de décharge électrique, attendre au moins 10 minutes après la déconnexion de l'alimentation CA du VFD68 Drive pour intervenir sur l'appareil. Le VFD68 Drive reste chargé électriquement pendant un certain temps après la coupure de son alimentation. Le non-respect du délai de décharge électrique complète du VFD68 Drive peut entraîner une décharge électrique provoquant des blessures graves, voire mortelles.

CAUTION: Risk of Property Damage.

Do not apply power to the system before checking all wiring connections. Short circuited or improperly connected wires may result in permanent damage to the equipment.

MISE EN GARDE: Risque de dégâts matériels.

Ne pas mettre le système sous tension avant d'avoir vérifié tous les raccords de câblage. Des fils formant un court-circuit ou connectés de façon incorrecte risquent d'endommager irrémédiablement l'équipement.

CAUTION: Risk of Property Damage.

Do not run low-voltage cable in the same conduit or wiring troughs with high-voltage wires. Running low- and high-voltage wires in the same conduit or wiring troughs may damage the equipment or cause system malfunction.

MISE EN GARDE: Risque de dégâts matériels.

Ne pas faire courir un câble basse tension dans les mêmes gaines ou goulottes électriques que des câbles haute tension. L'installation de fils basse tension et haute tension dans les mêmes gaines ou goulottes électriques risque d'endommager l'équipement ou de provoquer des dysfonctionnements du système.

IMPORTANT: Use copper conductors only. Make all wiring in accordance with local, national, and regional regulations.

IMPORTANT: Do not exceed the VFD68 drive's electrical ratings. Exceeding the drive's electrical ratings can result in permanent damage to the drive and void any warranty.

IMPORTANT: Run all low-voltage wiring and cables separate from all high-voltage wiring. Shielded cable is strongly recommended for input (sensor) and analog output cables that are exposed to high electromagnetic or radio frequency noise.

IMPORTANT: Electrostatic discharge can damage VFD68 drives. Use proper electrostatic discharge (ESD) precautions during installation and servicing to avoid damaging VFD68 drives.

IMPORTANT: Do not connect supply power to the VFD68 drive before finishing wiring and checking all wiring connections. Short circuits or improperly connected wires can result in damage to the drive and void any warranty.

Precautions

Before you apply power to the VFD68 drive and controlled motor, always recheck the following items:

- Connect the VFD only to three-phase induction motors. Connecting the VFD to other electrical equipment may cause damage.
- Applying power to the output terminals (U, V, W) of the VFD will damage the VFD. Never connect supply power to the drive's output terminals.
- If you wire multiple motors to the VFD output, run separate wires to each motor. Do not use daisy-chain wiring.
- Do not install a power factor correction capacitor, surge suppressor, or capacitor type filter on the VFD output side. These devices can cause the VFD to trip, or they can damage the capacitor and surge suppressor.
- A high voltage charge remains in the VFD electronic components for a short time after the power is switched off.

  Wait at least 10 minutes after the power supply has been switched off to allow the electric charge and heat to dissipate. Using a voltmeter, make sure that the voltage across the main circuit terminals P/+ and N/- of the VFD is no more than 30 VDC.
- A short circuit or earth (ground) fault on the VFD output side can damage the VFD.
  - Check the insulation resistance of the circuit before you operate the VFD; repeated short circuits may damage the VFD. These short circuits may be caused by peripheral circuit inadequacy, an earth (ground) fault due to wiring inadequacy, or reduced motor insulation resistance.
  - Check the ground (to-earth) insulation and phase-to-phase insulation of the VFD output side before applying power.

    Carefully check the motor insulation resistance, especially when the VFD is used with an old motor or a motor located in unfavorable conditions.
- Do not exceed the permissible voltage to the VFD I/O signal circuits.

  Application of a voltage higher than the permissible voltage to the VFD I/O signal circuits, or applying voltage of opposite polarity, may damage the I/O devices.
- Do not short circuit the +VDC excitation voltage outputs (terminals 10 and PC) to common (terminals: 5 and SD). Shorting the excitation voltage outputs to common may damage the VFD.
- Prevent VFD-generated EMI from causing functional problems.
  - Do not run the low-voltage signal cables and the high-voltage power cables in parallel with each other, and do not bundle them together.
  - Run low-voltage signal cables as far away as possible from high-voltage power cables.
  - Use shielded cables for the low-voltage signal cables. Connect the sensor cable shield at only one point and that one point is the same terminal as the sensor's common wire.
  - Install a ferrite core on the signal cable (for example, ZCAT3035-1330 TDK).

Terminal Screw Torque Specifications

Tighten the terminal screw to the specified torque. Overtightening the terminal screws may damage the terminal blocks and screw threads. Loose terminal screw connections can result in a short circuit or malfunction.

Table 12: Torque Specifications for VFD66Bxx Drives

Rated Capacity, kW (HP)	Terminal Screw Size[1]	Tightening Torque, N•m (lb•in.)
0.1–0.75 (1/8–1)	M3.5	1.2 (10.6)
1.5–3.7 (2–5)	M4	1.5 (13.3)
5.5–11 (7.5–15)	M5	2.5 (22.2)
15 (20)	M6 (M5)	4.4 (39)

1. The terminal screw size indicates the terminal size for R/L1, S/L2, T/L3, U, V, W, PR, P/+, N/-, P1, and earthing (grounding). The terminal screw size for earthing (grounding) appears in parenthesis if it is a different size.

Table 13: Torque Specifications for VFD68Cxx Drives

Rated Capacity, kW (HP)	Terminal Screw Size[1]	Tightening Torque, N•m (lb•in.)
0.4–11 (1/2–15)	M4	1.5 (13.3)
15 (20)	M5	2.5 (22)

1. The terminal screw size indicates the terminal size for R/L1, S/L2, T/L3, U, V, W, PR, P/+, N/-, P1, and earthing (grounding). The terminal screw size for earthing (grounding) appears in parenthesis if it is a different size.

Table 14: Torque Specifications for VFD68Dxx Drives

Rated Capacity, kW (HP)	Terminal Screw Size[1]	Tightening Torque, N•m
0.75–7.5 (1–10)	M4	1

1. The terminal screw size indicates the terminal size for R/L1, S/L2, T/L3, U, V, W, PR, P/+, N/-, P1 and a screw for earthing (grounding).

Branch Circuit Protection

Integral solid-state short circuit protection does not provide branch circuit protection. The installer must provide branch circuit protection in accordance with the National Electrical Code for the U.S. or the Canadian Electrical Code for Canada and any additional codes.

As specified, UL Class T fuses (or any faster acting fuse with the appropriate rating) or Listed UL 489 Molded Case Circuit Breaker (MCCB) must be employed in accordance with Table 15 and Table 16.

Table 15: VFD68Bxx Drives Electrical Ratings

230 VAC	kW (HP)										
	0.1 (1/8)	**0.2 (1/4)**	**0.4 (1/2)**	**0.75 (1)**	**1.5 (2)**	**2.2 (3)**	**3.7 (5)**	**5.5 (7.5)**	**7.5 (10)**	**11 (15)**	**15 (20)**
Rated fuse voltage (V)	240 V or more										
Fuse maximum allowable rating (A) (without power factor improving reactor)[1]	15	15	15	20	30	40	60	70	80	150	175
Molded case circuit breaker (MCCB) Maximum allowable rating (A)[1]	15	15	15	15	20	25	40	60	80	110	150

1. Maximum allowable rating by US National Electrical Code. Exact size must be chosen for each installation.

Table 16: VFD68Cxx Electrical Ratings

460 VAC	kW (HP)								
	0.4 (1/2)	0.75 (1)	1.5 (2)	2.2 (3)	3.7 (5)	5.5 (7.5)	7.5 (10)	11 (15)	15 (20)
Rated fuse voltage (V)	480 V or more								
Fuse maximum allowable rating (A) (without power factor improving reactor)[1]	6	10	15	20	30	40	70	80	90
Molded case circuit breaker (MCCB) Maximum allowable rating (A)[1]	15	15	15	15	20	30	40	50	70

1. Maximum allowable rating by US National Electrical Code. Exact size must be chosen for each installation.

Table 17: VFD68Dxx Drives Electrical Ratings

575 VAC	kW (HP)					
	0.75 (1)	1.5 (2)	2.2 (3)	3.7 (5)	5.5 (7.5)	7.5 (10)
Rated fuse voltage (V)	575 V or more					
Fuse maximum allowable rating (A) (without power factor improving reactor)[1]	6 A	10 A	15 A	20 A	30 A	40 A
Molded case circuit breaker (MCCB) maximum allowable rating (A)[1]	5 A	10 A	15 A	20 A	30 A	30 A

1. Maximum allowable rating by US National Electrical Code. Exact size must be chosen for each installation.

Short Circuit Ratings

The VFD68 drives meet the requirements for their respective rating categories (Table 18).

Table 18: VFD68 Drives Short Circuit Ratings

Rating Category	Suitable for use in a circuit capable of delivering not more than
VFD68Bxx Drives (230 VAC Class)	100 kA rms symmetrical amperes, 264 V maximum
VFD68Cxx Drives (460 VAC Class)	100 kA rms symmetrical amperes, 528 V maximum
VFD68Dxx Drives (575 VAC Class)	100 kA rms symmetrical amperes, 600 V maximum

High-Voltage Wire Size and Maximum Wire Length

IMPORTANT: Use copper conductors only. Make all wiring in accordance with local, national, and regional regulations.

Use UL Listed copper stranded wire with insulation rated at 75°C (167°F) for wiring the high-voltage supply to the drive (R/L1, S/L2, T/L3) and wiring the high-voltage drive output (U, V, W) to the motor.

Selecting the Correct VFD68 Drive for Your Fan Motor

1. Determine the maximum current consumption from the motor ratings label.
2. Select the appropriate table for your motor's current type.
   - For 230 VAC motors, see Table 19.
   - For 460 VAC motors, see Table 20.
   - For 575 VAC motors, see Table 21.

3. In the table that you just selected, find the maximum output current that just exceeds the motor's maximum current consumption and use the VFD68 Part Number associated with this maximum output current as the recommended Drive for the motor.
4. Use the same table to determine the recommended cable wiring size for the output current rating.

Table 19: 230 VAC, VFD68Bxx Drives, Maximum Output Amperes and Wiring Sizes

Part Number	Rated Capacity, kW (HP)	Maximum Output Current (Amperes)	Cable Wire Size				
			AWG[1]		PVC wires, (mm^2)[2]		
			R/L1, S/L2, T/L3	U, V, W	R/L1, S/L2, T/L3	U, V, W	Earthing (Ground) cable
VFD68BBB	0.1 (1/8)	0.8	14	14	2.5	2.5	2.5
VFD68BCB	0.2 (1/4)	1.4	14	14	2.5	2.5	2.5
VFD68BDC	0.4 (1/2)	2.5	14	14	2.5	2.5	2.5
VFD68BFD	0.75 (1)	4.2	14	14	2.5	2.5	2.5
VFD68BGG	1.5 (2)	7.0	14	14	2.5	2.5	2.5
VFD68BHG	2.2 (3)	10.0	14	14	2.5	2.5	2.5
VFD68BJK	3.7 (5)	16.5	12	12	4	4	4
VFD68BKL	5.5 (7-1/2)	23.8	10	10	6	6	6
VFD68BLL	7.5 (10)	31.8	6	8	16	10	6
VFD68BMP	11 (15)	45.0	6	6	16	16	16
VFD68BNP	15 (20)	58.0	4	4	25	25	16

1. The recommended cable wire size is that of the cable (THHW cable) with a continuous maximum permissible temperature of 75°C (167°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in the United States.)
2. The recommended cable wire size is that of the cable (PVC cable) with a continuous maximum permissible temperature of 70°C (158°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in Europe.)

Table 20: 460 VAC, VFD68Cxx Drives, Maximum Output Amperes and Wiring Sizes

Part Number	Rated Capacity, kW (HP)	Maximum Output Current (Amperes)	Cable Wire Size				
			AWG[1]		PVC wires, (mm^2)[2]		
			R/L1, S/L2, T/L3	U, V, W	R/L1, S/L2, T/L3	U, V, W	Earthing (Ground) cable
VFD68CDF	0.4 (1/2)	1.2	14	14	2.5	2.5	2.5
VFD68CFF	0.75 (1)	2.2	14	14	2.5	2.5	2.5
VFD68CGG	1.5 (2)	3.6	14	14	2.5	2.5	2.5
VFD68CHH	2.2 (3)	5.0	14	14	2.5	2.5	2.5
VFD68CJJ	3.7 (5)	8.0	14	14	2.5	2.5	2.5
VFD68CKL	5.5 (7.5)	12.0	12	14	4	2.5	4
VFD68CLL	7.5 (10)	16.0	12	12	4	4	4
VFD68CMP	11 (15)	23.0	10	10	6	6	10
VFD68CNP	15 (20)	29.5	8	8	10	10	10

1. The recommended cable wire size is that of the cable (THHW cable) with a continuous maximum permissible temperature of 75°C (167°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in the United States.)
2. The recommended cable wire size is that of the cable (PVC cable) with a continuous maximum permissible temperature of 70°C (158°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in Europe.)

Table 21: 575 VAC, VFD68Dxx Drives, Maximum Output Amperes and Wiring Sizes

Part Number	Rated Capacity, kW (HP)	Maximum Output Current (Amperes)	Cable Wire Size				
			AWG[1]		PVC wires, (mm^2)[2]		
			R/L1, S/L2, T/L3	U, V, W	R/L1, S/L2, T/L3	U, V, W	Earthing (Ground) Cable
VFD68DFM	**0.75 (1)**	**1.7**	14	14	2	2	3.5
VFD68DGM	**1.5 (2)**	**2.7**	14	14	2	2	3.5
VFD68DHM	**2.2 (3)**	**4.0**	14	14	2	2	3.5
VFD68DJN	**3.7 (5)**	**6.1**	14	14	2	2	3.5
VFD68DKN	**5.5 (7-1/2)**	**9.0**	14	14	2	2	5.5
VFD68DLN	**7.5 (10)**	**12.0**	12	14	3.5	2	5.5

1. **The recommended cable wire size is that of the cable (THHW cable) with a continuous maximum permissible temperature of 75°C (167°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in the United States.)**
2. **The recommended cable wire size is that of the cable (PVC cable) with a continuous maximum permissible temperature of 70°C (158°F). Assumes that the surrounding air temperature is 40°C (104°F) or less. (Selection example for use mainly in Europe.)**

Calculating the Maximum Wire Length

Use the following steps to determine the maximum wire length.

1. Use the recommended wire size in accordance with local, national, and regional regulations to determine the electrical resistance of the wire (R) according to Table 22.

Table 22: Electrical Resistance by Wire Size

Recommended Wire Size[1]	Electrical Resistance of Wire (milliohms/meter)	Recommended Wire Size[1]	Electrical Resistance of Wire (milliohms/meter)
25 mm^2	0.727	**5.3 mm^2 (10 AWG)**	3.28
21.2 mm^2 (4 AWG)	0.815	**4 mm^2**	4.61
16 mm	1.15	**3.3 mm^2 (12 AWG)**	5.21
13.3 mm^2 (6 AWG)	1.30	**2.5 mm^2**	7.41
10 mm^2	1.83	**2 mm^2 (14 AWG)**	8.28
8.3 mm^2 (8 AWG)	2.06	**1.5 mm^2**	12.1
6 mm^2	3.08		

1. The mm wire sizes that are given as equivalences to the AWG wire sizes are not commercially available.

2. Find the rated voltage (V) and maximum output current (I) from the rating plate on the selected VFD68 drive.

3. Use Figure 12 to determine the maximum recommended wiring length for the VFD68 drive.

$$\text{Maximum Wire Length} = \frac{(11.55 * V)}{(I * R)}$$

V = Voltage rating (230 or 460 VAC)
I = Maximum output current (Amps)
R = Electrical resistance of the wire (milliohms/meter)

Figure 12: Maximum Wire Length Calculation

Note: If the maximum wire length needs to be extended, select a larger wire size and recalculate the maximum wire length. **Do not exceed 100 m.**

Note: Maximum wiring length is also affected by the setting of P. 72. See *PWM Frequency, Audible Motor Noise, and EMI* on page 52.

Example:

Given a VFD66BGG-2C model, what is the maximum wiring length?

a. Table 1 on page 6 indicates that a VFD66BGG-2C model is a 230 VAC drive, rated for 1.49 kW (2 HP).

b. The rating information plate (Figure 1 on page 6) for that model indicates that the VFD66BGG drive has a voltage rating of 230 VAC and a maximum output rating of 7 amperes.

c. Table 19 on page 21 gives the recommended wire size as 14 AWG.

d. Table 22 on page 22 shows 14 AWG size wire as having an electrical resistance of 8.28 milliohms/meter.

e. Using the equation in Figure 12 on page 23 and using the values we found in the preceding steps:

(11.5 * 230) / (7 * 8.28) = 2656.6 / 57.96 = 45.8

The maximum wire length is 45.8 meters.

High-Voltage Wiring Connections

Making High-Voltage Wiring Connections on VFD68Bxx and VFD68Cxx Drives

1. Loosen the screws on the front cover and remove the cover to access the low-voltage wiring (Figure 13).

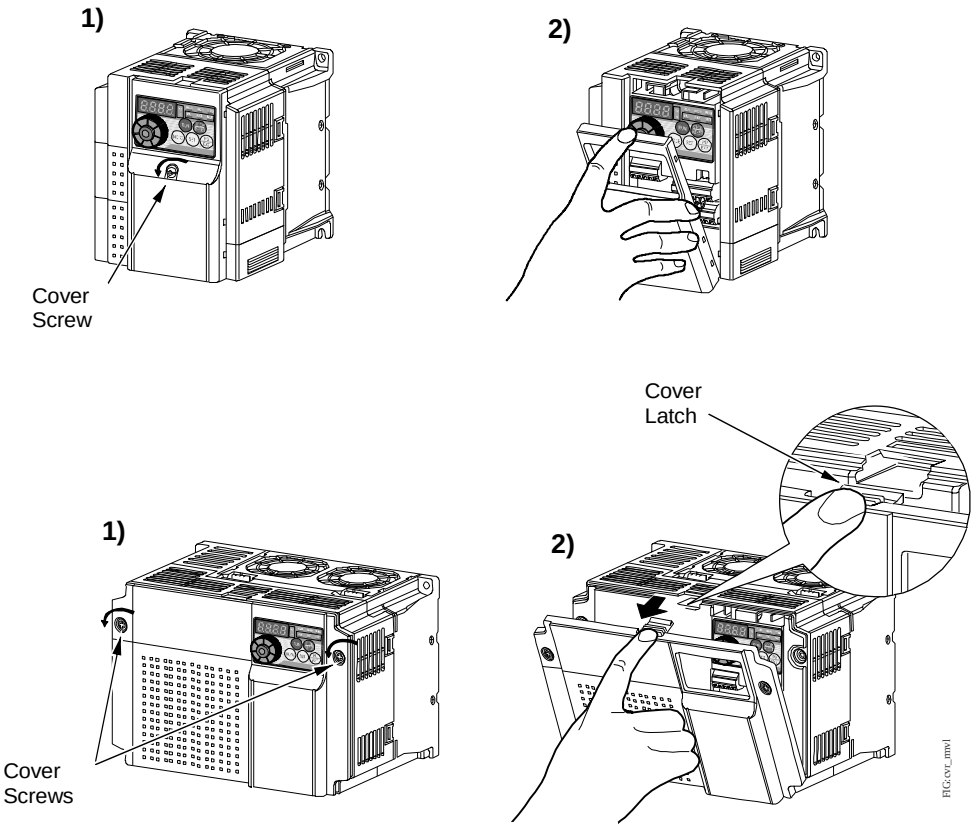


Figure 13: Loosen the Cover Screws and Remove the Front Cover

2. Remove the high-voltage wiring cover at the bottom of the VFD68 drive (Figure 14).

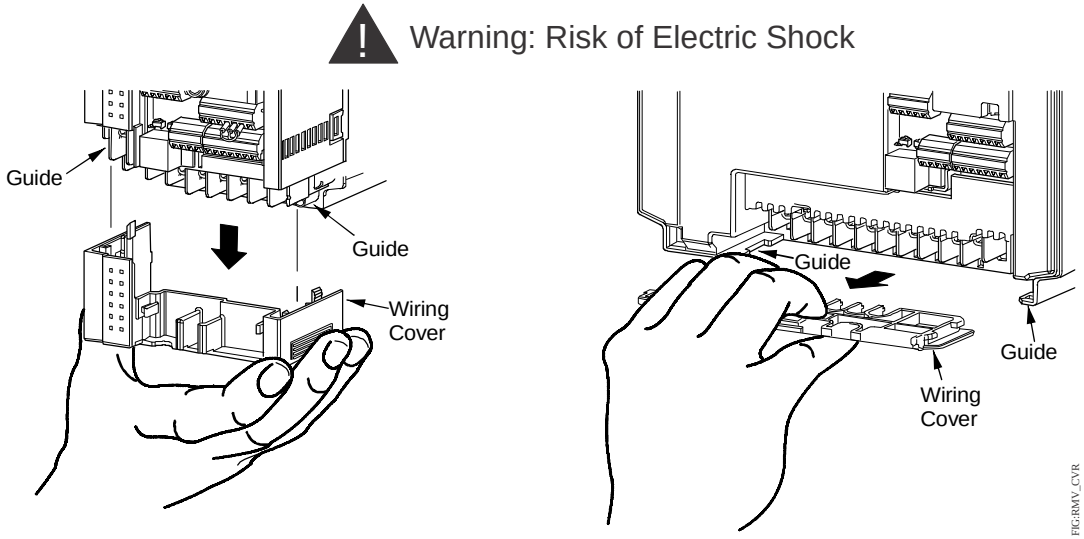


Figure 14: Remove the High-Voltage Wiring Cover

IMPORTANT: Use UL Listed copper, stranded wire with insulation rated at 75°C (167°F) for wiring in Step 3 and Step 4. See *High-Voltage Wire Size and Maximum Wire Length* on page 20.

3. For supplied three-phase power, connect the high-voltage power supply to terminals R/L1, S/L2, and T/L3 on the drive (Figure 15).

   For supplied single-phase power, connect the high-voltage power supply to terminals L1 and L3 (Figure 15).

4. Connect the motor wiring to high-voltage output terminals U, V, and W on the drive (Figure 15).

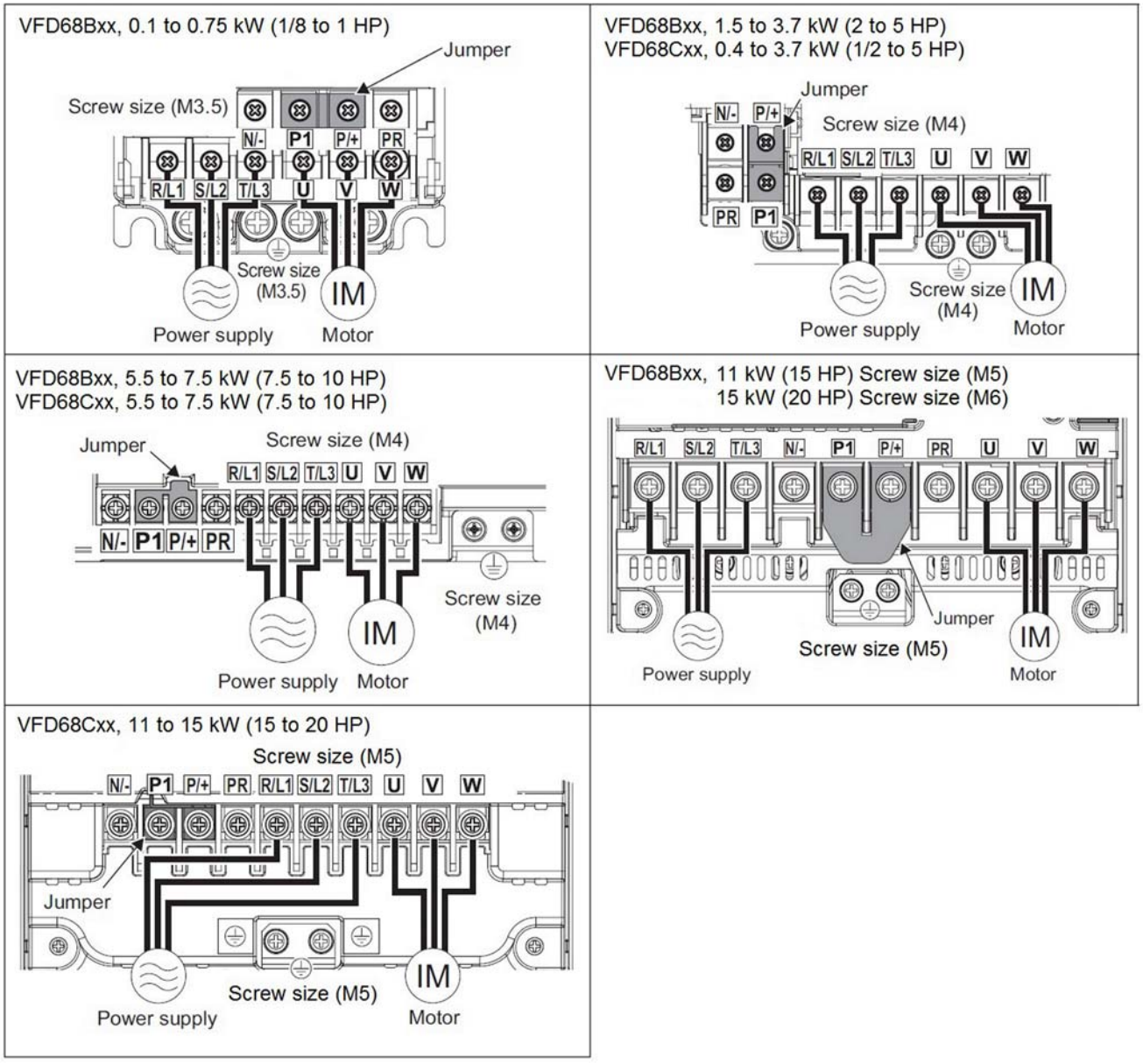


Figure 15: High-Voltage Terminal Block Wiring

5. Connect earth ground wiring to the earth ground terminals on the VFD68 drive and on the motor.
6. Replace the high-voltage wiring cover.

Note: When replacing the high-voltage cover, carefully space and position the leads through the vents or wire slots.

Making High-Voltage Wiring Connections on VFD68Dxx Drives

1. Push down on the hooks at Position A and Position B and pull it away from the VFD68 drive, using the hooks at Position C as supporting points (Figure 16).

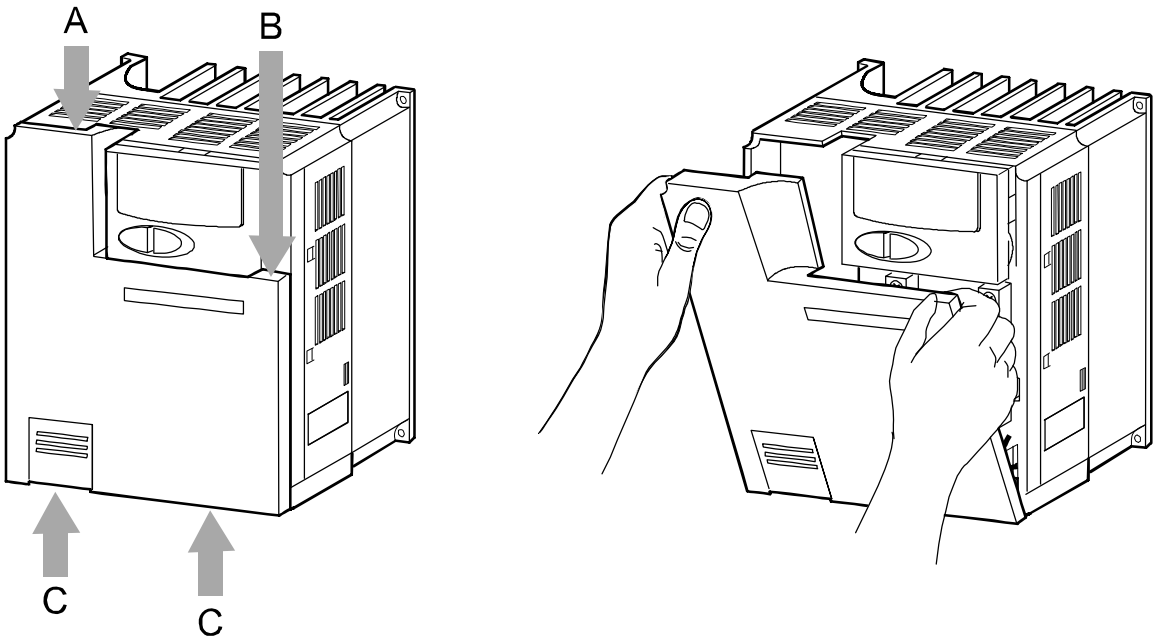


Figure 16: Release the Hooks and Remove the Front Cover

2. Remove the high-voltage wiring cover at the bottom of the VFD68 drive by pulling in the direction of Arrow A (Figure 14).

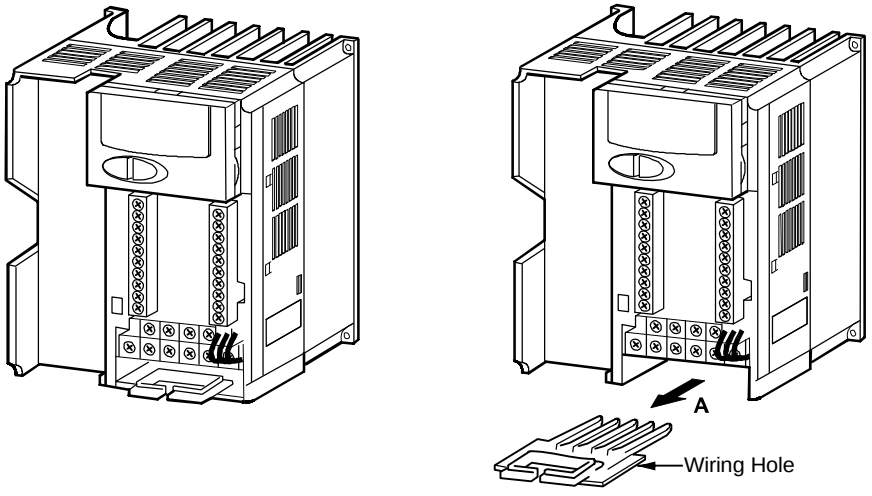


Figure 17: Remove the High-Voltage Wiring Cover

IMPORTANT: Use UL Listed copper, stranded wire with insulation rated at 75°C (167°F) for wiring in Step 3 and Step 4. See *High-Voltage Wire Size and Maximum Wire Length* on page 20.

3. Connect a 575 VAC three-phase power supply to Terminals R/L1, S/L2, and T/L3 (Figure 18).

   For supplied three-phase power, connect the high-voltage power supply to terminals R/L1, S/L2, and T/L3 on the drive (Figure 18).

   For supplied single-phase power, connect the high-voltage power supply to terminals L1 and L3 (Figure 18).

4. Connect the motor wiring to high-voltage output terminals U, V, and W on the drive (Figure 18).

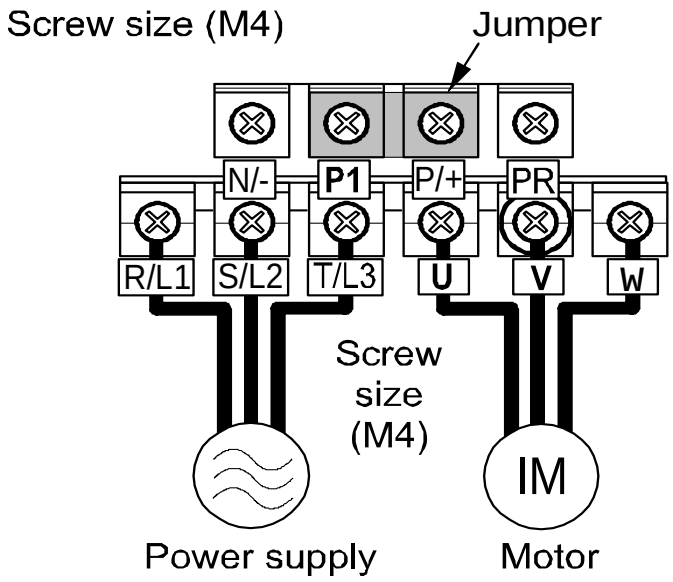


Figure 18: High-Voltage Terminal Block Wiring

5. Connect earth ground wiring to the earth ground terminals on the VFD68 drive and on the motor.
6. Replace the high-voltage wiring cover.

Note: When replacing the high-voltage cover, carefully space and position the leads through the vents or wire slots.

Low-Voltage Wiring Connections

Making Low-Voltage Wiring Connections on VFD68Bxx and VFD68Cxx Drives

IMPORTANT: If using two input devices, both devices must be identical. **Do not** use input devices with different ranges and operating characteristics.

Low-voltage wiring terminals are located underneath the front cover. See Figure 19 and Table 23.

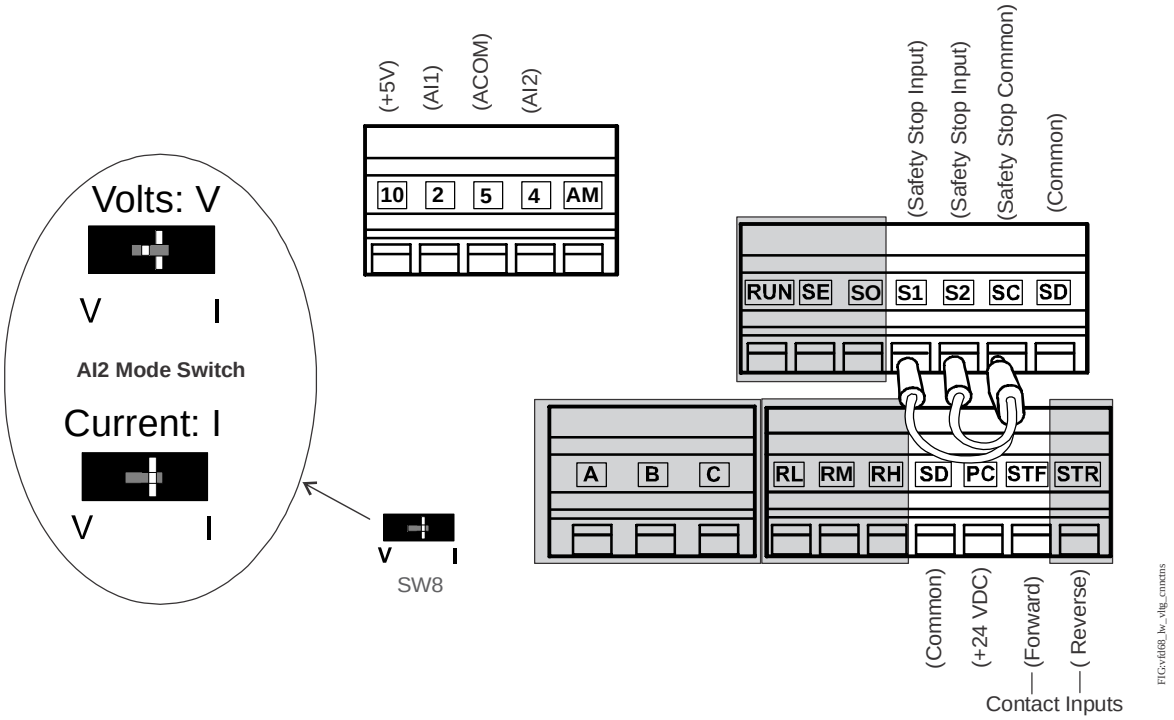


Figure 19: VFD68Bxx and VFD68Cxx Drives Low-Voltage Connections

Table 23: VFD68Bxx and VFD68Cxx Drives Low-Voltage Connections Information[1] (Part 1 of 2)

Terminal Label	Signal Type	Description
10	+5VDC	Provides + 5 VDC supply for P499R transducers (15 mA maximum)
2	Analog Input	Analog Input 1 (AI1) accepts 0–5 V or 0–10 V DC analog input signals
5	Analog Common	Common for analog inputs
4	Analog Input	Analog Input 2 (AI2) accepts 0–5 V, 0–10 V, or 4–20 mA analog input signals
AM	Analog Output	Provides a 0–10 VDC analog output signal corresponding to output frequency
RUN	Open Collector Transistor Output	VFD Running - Switched low (transistor conducts) when the VFD output frequency is higher than the start frequency (the motor is running). Switched high (transistor is off) when the motor is off.
SE	Open Collector Common	Common for RUN terminal
SO	Open Collector Transistor Output	Safety Stop Output
S1	Safety Stop Input	Terminals S1 and S2 must connect to terminal SC or the VFD shuts off.
S2	Safety Stop Input	Terminals S1 and S2 must connect to terminal SC or the VFD shuts off.

Table 23: VFD68Bxx and VFD68Cxx Drives Low-Voltage Connections Information[1] (Part 2 of 2)

Terminal Label	Signal Type	Description
SC	Safety Stop Common	Common for S0, S1, and S2 terminals
SD	Common	Common for + 24 VDC Supply and contact inputs (using Sink logic - default setting)
RL	Contact Input	Run Low Speed
RM	Contact Input	Run Medium Speed
RH	Contact Input	Run High Speed
SD	Common	Common for + 24 VDC Supply and contact inputs (when using Sink logic - default setting)
PC	+24 VDC	Provides + 24 VDC excitation voltage, 100 mA maximum, Use for P499A or P499V transducers.
STF	Contact Input	Forward rotation. Connect STF to SD terminal (common) to enable VFD to rotate forward.
STR	Contact Input	Reverse rotation (used to reverse motor rotation)
A	Relay Output (N.O.)	During normal operation, relay contacts A and C are open. (maximum alarm load: 230 VAC, 0.3 A or 30 VDC, 0.3 A)
B	Relay Output (N.C.)	During normal operation, relay contacts B and C are connected. (maximum alarm load: 230 VAC, 0.3 A or 30 VDC, 0.3 A)
C	Relay Output (C)	Relay output common

1. Gray cells indicate a terminal that is typically not used in condenser fan speed control applications.

   Terminal RL (Run Low Speed) corresponds to P. 6; Terminal RM (Run Medium Speed) corresponds to P. 5; Terminal RH (Run High Speed) corresponds to P. 4. When one of these terminals is connected to SD (common) the VFD runs at the speed shown in the corresponding parameter.

   Terminal STR (reverse rotation) is disabled by P. 78 setting = 1. This terminal is not useful for condenser fan speed control applications.

   Terminals A, B, and C are connected to relay contacts that activate when a fault has occurred and the VFD output has stopped.

To connect the input signal devices:

1. Loosen the screws on the front cover and remove the cover to access the low-voltage wiring (Figure 13 on page 24).
2. Locate the low-voltage wiring terminals (Figure 20).

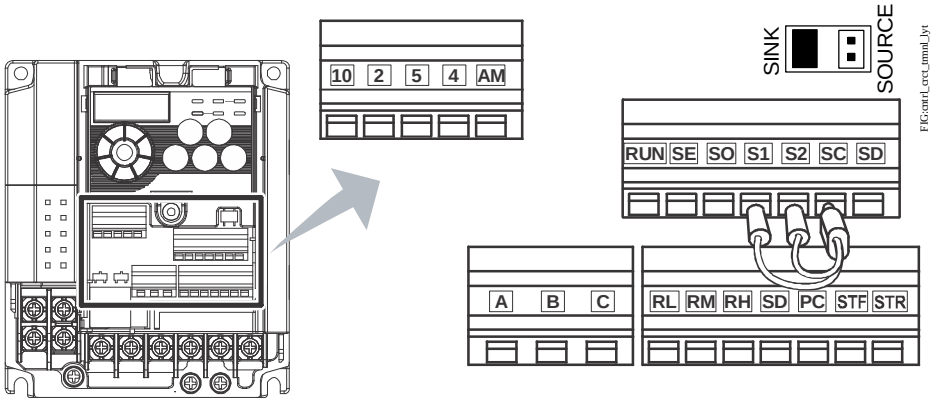


Figure 20: Locating the Low-Voltage Wiring Terminals

3. Push down on the orange tab to open the terminal (Figure 21).

IMPORTANT: Do not pull the wires out of the terminal block without pushing the orange tab all the way down. Pulling wires out of the low-voltage terminal block without opening the terminal may damage the terminal block or circuit board.

4. Insert the wire and release the orange tab to secure the wire.

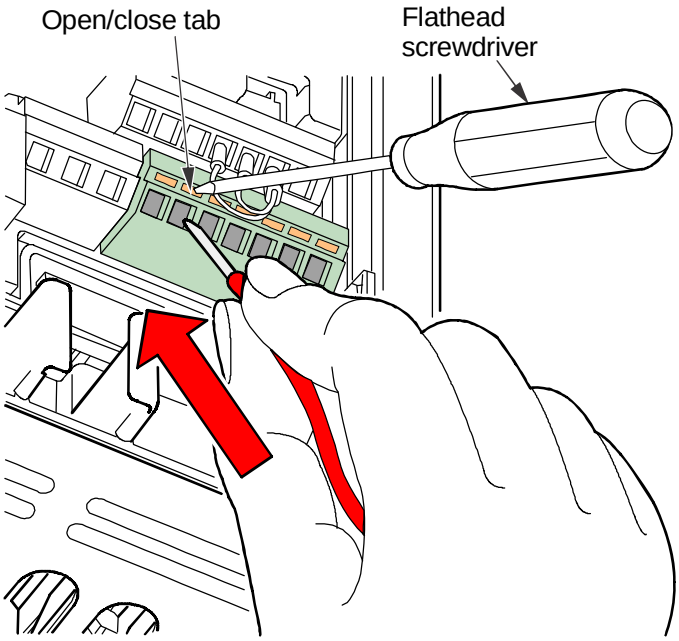


Figure 21: Wiring Analog Input Devices to the VFD68 Control

5. Wire the input devices to the analog input terminals (see *Low-Voltage Wiring Connections* on page 28) and make any necessary parameter adjustments.
6. Replace the front cover.

Making Low-Voltage Wiring Connections on VFD68Dxx Drives

Low-voltage wiring terminals are located underneath the front cover. See Figure 22, Table 24, and Table 25. After you finish making the low-voltage wiring connections, replace the front cover (Figure 16 on page 26).

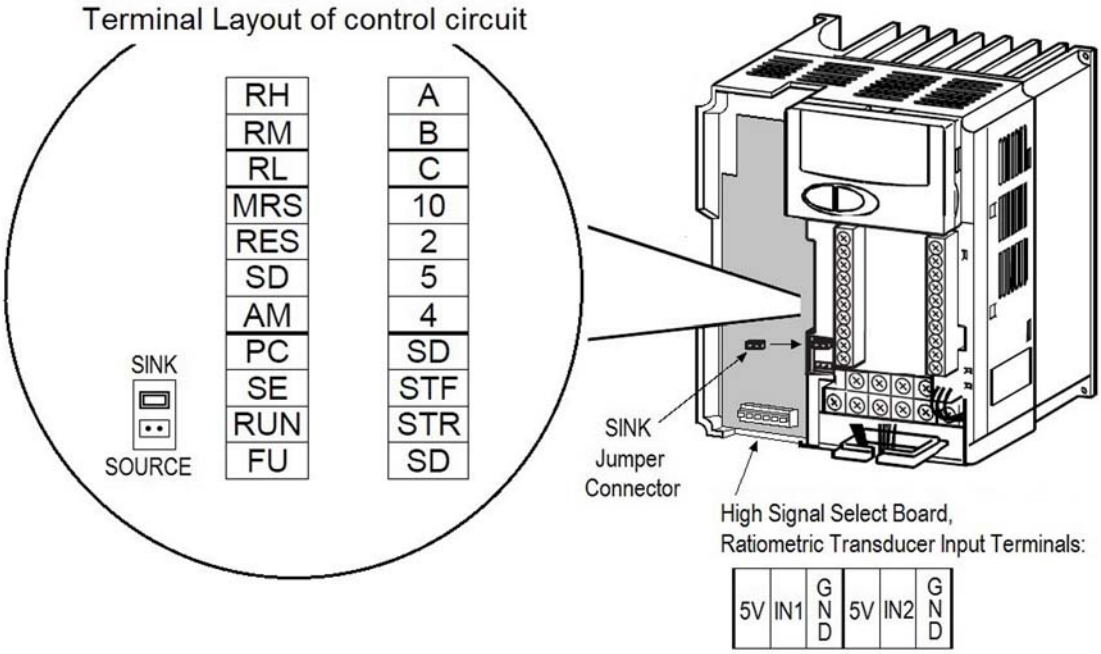


Figure 22: VFD68Dxx Drives Connection Information

Table 24: VFD68Dxx Drives Low-Voltage Connection Information for the Primary Board (Part 1 of 2)

Terminal Label[1]	Signal Type	Description
RH	Contact Input	Run High Speed
RM	Contact Input	Run Medium Speed
RL	Contact Input	Run Low Speed
MRS	Contact Input	Current Input Selection - Connect terminal MRS to terminal SD to enable the 4–20 mA input, Analog Input 2 (AI2).
RES	Contact Input	Reset - Turn on the RES signal (100 ms or longer) to turn off the VFD output and reset the thermal relay and regenerative brake circuits
SD	Common	Common for contact inputs (using Sink logic - default setting) and 24 VDC supply
AM	Analog Output	0–10 VDC analog output corresponding to output frequency
PC	+24V	+24 VDC Supply
SE	Open Collector Common	Common for RUN terminal
RUN	Open Collector Transistor Output	VFD Running - Switched low (transistor conducts) when the VFD output frequency is higher than the start frequency (the motor is running). Switched high (transistor is off) when the motor is off.
FU	Open Collector Transistor Output	Frequency detection output - switched low (transistor conducts) when VFD output frequency has reached or exceeded the detection frequency. Switched high (transistor is off) when VFD output frequency is below detection frequency.
A	Relay Output (N.O.)	During normal operation, relay contacts A and C are connected. (maximum alarm load: 230 VAC, 0.3 A or 30 VDC, 0.3 A).

Table 24: VFD68Dxx Drives Low-Voltage Connection Information for the Primary Board (Part 2 of 2)

Terminal Label[1]	Signal Type	Description
B	Relay Output (N.C.)	During normal operation, relay contacts B and C are connected (maximum alarm load: 230 VAC, 0.3 A or 30 VDC, 0.3 A).
C	Relay Output (C)	Relay output common
10	+5 V	+5 VDC Supply for P499R transducers (15 mA maximum)
2	Analog Input	Analog Input 1 (AI1) accepts 0–5 V or 0–10 V DC analog input signals
5	Analog Common	Common for analog inputs
4	Analog Input	Analog Input 2 (AI2) accepts 4–20 mA analog input signals
SD	Common	Common for contact inputs (when using Sink logic - default setting).
STF	Contact Input	Forward rotation. Must connect STF to SD terminal (common) using factory supplied jumper to allow VFD to rotate in a forward direction.
STR	Contact Input	Reverse rotation (not used)
SD	Common	Common for contact inputs (when using Sink logic - default setting).

1. Gray cells indicate a terminal that is typically not used in condenser fan speed control applications.

Table 25: VFD68Dxx Drives Low-Voltage Connection Information for the High Input Signal Select Board

Terminal Label	Signal Type	Description
5V	+5V	+5 VDC Supply for P499R transducers (15 mA maximum)
IN1	Analog Input	Analog Input 1 for 0.5 to 4.5 V Ratiometric High Signal Select
GND	Analog Common	Common for analog inputs
5V	+5V	+5 VDC Supply for P499R transducers (15 mA maximum)
IN2	Analog Input	Analog Input 2 for 0.5 to 4.5 V Ratiometric High Signal Select
GND	Analog Common	Common for analog inputs

Input Wiring Connections

Making Input Wiring Connections on VFD68Bxx and VFD68Cxx Drives

Wire the input device to the analog input terminals (Table 26) and make any necessary parameter adjustments. See *Setup and Adjustment* on page 38 and *Parameter Setting Calculations for Motor Speed vs. Pressure* on page 49 for more information.

Table 26: Wiring P499 Transducers as Input Devices

Signal	P499R Ratiometric Transducers	Analog Input Terminal
AI1	White wire of first transducer	Terminal 2
AI2	White wire of second transducer	Terminal 4
+5 V	Red wire	Terminal 10
ACOM	Black wire	Terminal 5

0.5–4.5 VDC Ratiometric P499 Transducer

The default parameter values (Table 34 on page 43) on the VFD68 drive are configured to operate a condenser fan motor on an R410 condensing unit, using a P499RCP-107 or P499RAP-107 ratiometric transducer (or transducers). Wire one transducer for single circuit condensing systems. Wire two transducers for dual circuit condensing systems (Figure 23).

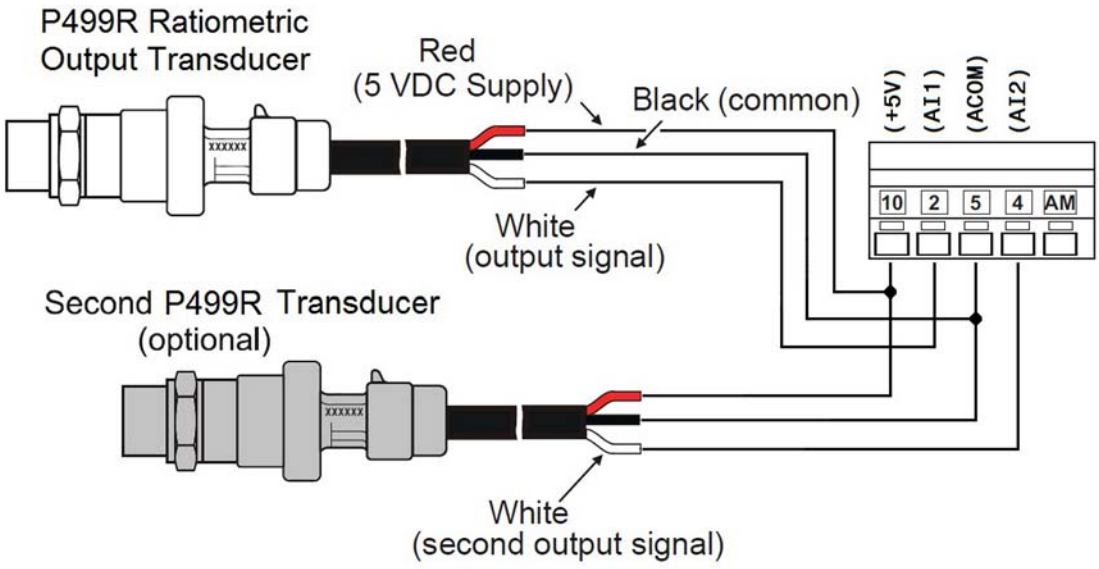


Figure 23: Wiring 0.5–4.5 VDC Ratiometric Input Signal Transducers

The VFD68 has the ability to control motor speed using the higher input signal value of two **voltage** inputs when you configure AI1 and AI2 as the same model transducer. For the **high-input signal select** application with two transducers (Figure 23 on page 33 or Figure 24 on page 34), use the parameter values in Table 28 and see *Adjusting the Default Parameters* on page 52.

Table 27: Settings for Single or Dual 0.5–4.5 VDC Ratiometric Transducers

Setting	Single Transducer	Dual Transducer, High-Signal Select
P. 73 [1]	1 (0–5 V)	1 (0–5 V)
P.266 [1]	1 (voltage input)	1 (voltage input)
P.267 [1]	1 (0–5 V)	1 (0–5 V)
Analog Input Terminal	AI1 or AI2	AI1 and AI2
AI2 Mode Switch[2]	V	V

1. For information on parameters, see Table 34 on page 43.
2. See Figure 19 on page 28.

IMPORTANT: If using two input devices, both devices must be identical. **Do not** use input devices with different ranges and operating characteristics.

For high-pressure refrigerants other than R410a, you must calculate and change the **C x** parameters. For medium and low pressure refrigerants, you must determine the proper P499R transducer and then calculate and change the **C x** parameters.

For more information, see *Setup and Adjustment* on page 38 and *Parameter Setting Calculations for Motor Speed vs. Pressure* on page 49.

0–10 VDC P499 Transducer

For applications using a 0–10 VDC P499V transducer, you must:

- adjust the parameter values that are listed in Table 28
- ensure that the AI2 mode switch (Figure 19 on page 28) is set correctly
- calculate and change **C x** parameters based on the desired operating pressure range for the condensing fans on your application

The VFD68 has the ability to control motor speed using the higher input signal value of two **voltage** inputs when you configure AI1 and AI2 as the same model transducer. For the **high-input signal select** application with two transducers (Figure 23 or Figure 24), use the parameter values in Table 28 and see Figure 29 on page 40, *VFD68Bxx and VFD68Cxx Drive Basic and Advanced Parameters* on page 43, and *Adjusting the Default Parameters* on page 52.

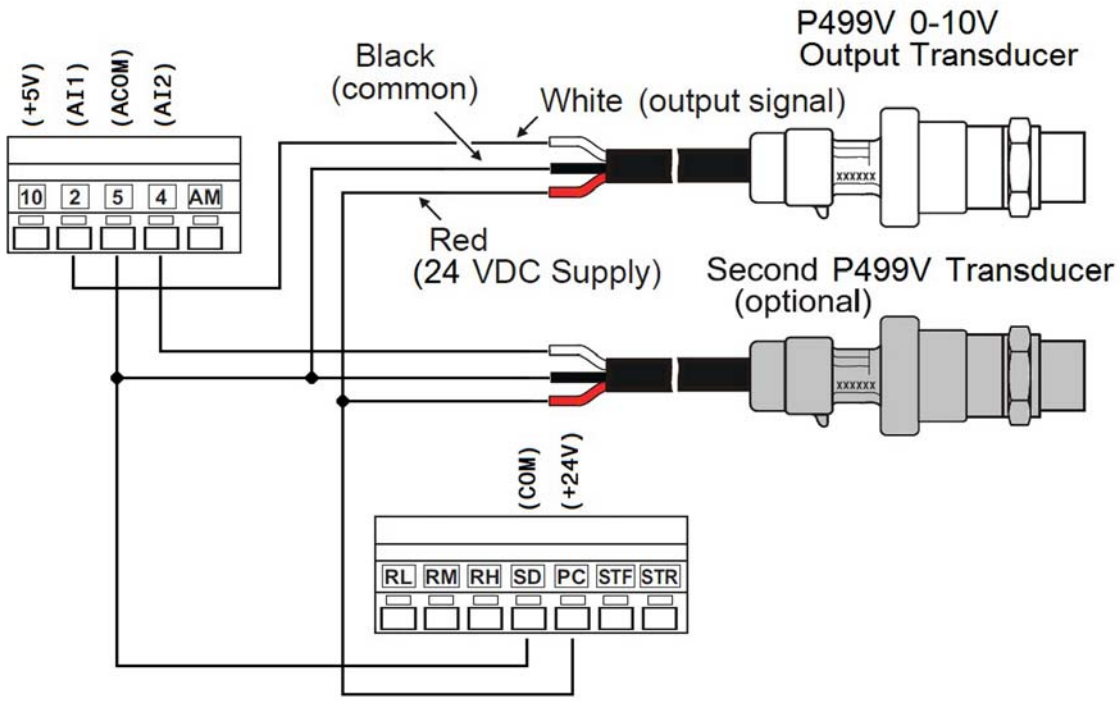


Figure 24: Wiring 0–10 VDC Input Signal Transducers

Table 28: Settings for Single or Dual 0–10 VDC Transducers

Setting	Single Transducer	Dual Transducer, High-Signal Select
P. 73 [1]	0 (0–10 V)	0 (0–10 V)
P.266 [1]	1 (voltage input)	1 (voltage input)
P.267 [1]	2 (0–10 V)	2 (0–10 V)
Analog Input Terminal	AI1 or AI2	AI1 and AI2
AI2 Mode Switch[2]	V	V

1. For information on parameters, see Table 34 on page 43.
2. See Figure 19 on page 28.

IMPORTANT: If using two input devices, both devices must be identical. **Do not** use input devices with different ranges and operating characteristics.

4–20 mA P499 Transducer

For applications using a 4–20 mA P499A transducer (Figure 25), you must:

- set P.266 and P.267 to 0
- set the AI2 mode switch position to I (see *VFD68Bxx and VFD68Cxx Drives* on page 56)
- calculate and change the C x parameters based on the desired operating pressure range for the condensing fans on your application

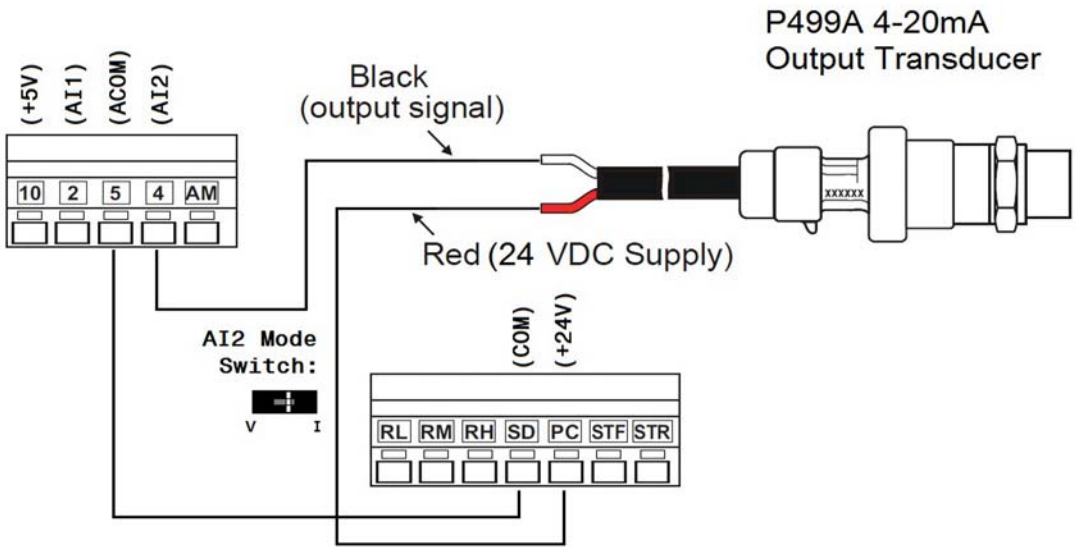


Figure 25: Wiring a 4–20 mA Input Signal Transducer

Table 29: Settings for Single 4–20 mA Transducer

Setting	Single Transducer, 4–20 mA
P. 73 [1]	N/A
P.266 [1]	0 (current input)
P.267 [1]	0 (4–20 mA)
Analog Input Terminal	AI2
AI2 Mode Switch[2]	I

1. For information on parameters, see Table 34 on page 43.
2. See Figure 19 on page 28.

Making Input Wiring Connections on VFD68Dxx Drives

Wire the input device to the analog input terminals (Table 26) and make any necessary parameter adjustments. See *Setup and Adjustment* on page 38 and *Parameter Setting Calculations for Motor Speed vs. Pressure* on page 49 for more information.

0.5–4.5 VDC Ratiometric P499 Transducer

The default parameter settings (Table 30) on the VFD68 drive are configured to operate a condenser fan motor on an R410 condensing unit, using a P499RCP-107 or P499RAP-107 ratiometric transducer (Figure 26).

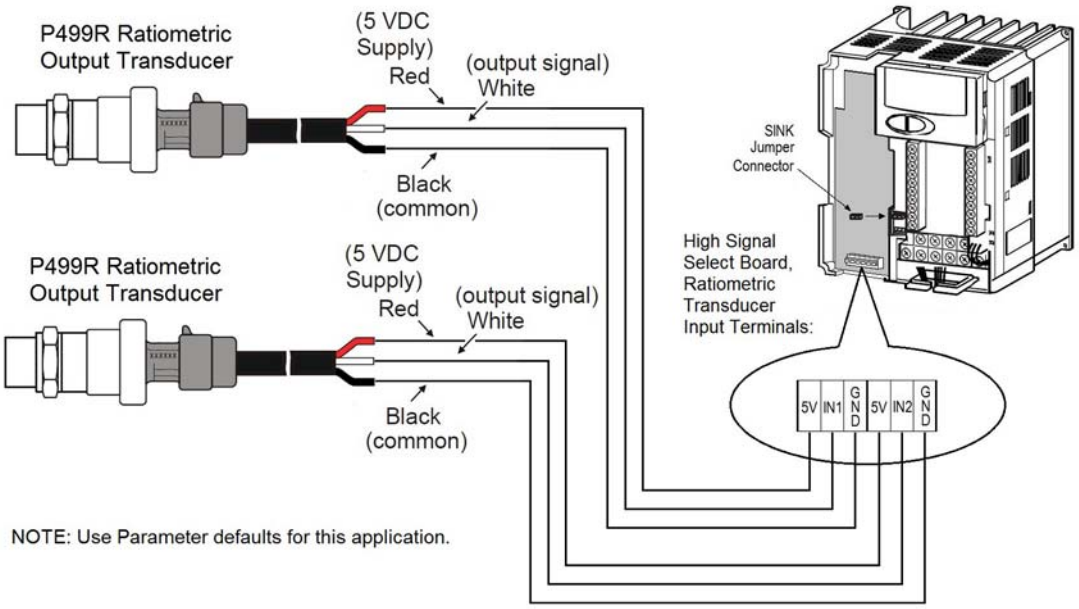


Figure 26: Wiring 0.5–4.5 VDC Ratiometric Input Signal Transducers

Table 30: Settings for a 0.5–4.5 VDC Transducer

Setting	0–5 V
Analog Input Terminals	IN1 and IN2

For high-pressure refrigerants other than R410a, you must calculate and change the P.90x parameters. For medium and low pressure refrigerants, you must determine the proper P499R transducer and then calculate and change the P.90x parameters.

For more information, see *Setup and Adjustment* on page 38, *VFD68Dxx Drive Parameters* on page 46, and Figure 55 on page 90.

0–10 VDC or 4–20 mA P499 Transducer

For applications using a 0–10 VDC or 4–20 mA P499 transducer, you must:

- change parameter values in Table 31
- calculate and change P.902 and P.903 (for 0–10 V operation) or P.904 and P.905 (for 4–20 mA operation), based on the desired operating pressure range and motor speed for the condensing fans on your application. See *VFD68Dxx Drives Operation Panel* on page 41 and *VFD68Dxx Drive Parameters* on page 46 for more information.

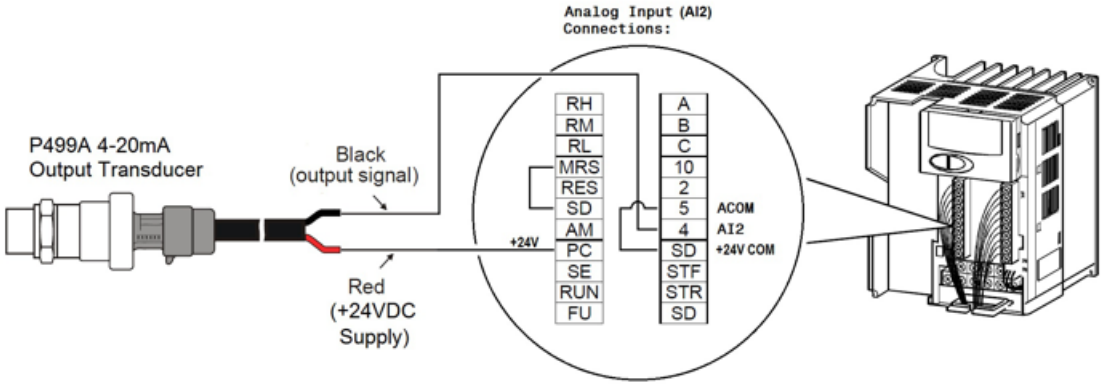


Figure 27: Wiring a 4–20 mA Input Signal Transducer

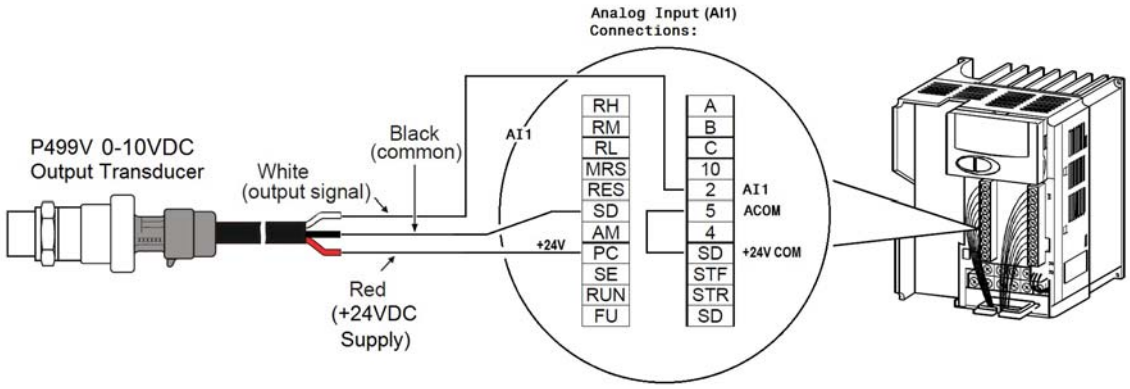


Figure 28: Wiring a 0–10 V Input Signal Transducer

Table 31: Settings for Single Input

Setting	4–20 mA	0–10 V
P. 73 [1]	N/A	1 (0–10 V)
Analog Input Terminal	AI2	AI1

1. For information on parameters, see Table 35 on page 46.

Note: To enable AI2 (4–20 mA) and disable AI1, connect terminal MRS to terminal SD.

Setup and Adjustment

IMPORTANT: If the LED display shows an error code, press STOP RESET and see *Troubleshooting* on page 58 for a list of fault or alarm indications, probable causes, and corrective actions.

Correspondences Between Digital and Actual Characters

The actual alphanumeric characters correspond to the following digital characters displayed on the operation panel:

Actual	Digital
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	

Actual	Digital
A	
B	
C	
D	
E	
F	
G	
H	
I	
J	
L	

Actual	Digital
M	
N	
O	
o	
P	
S	
T	
U	
V	
r	
-	

VFD68Bxx and VFD68Cxx Operation Panel

Operation Modes

The VFD68 drive's mode of operation is indicated by the mode of operation LEDs (labeled PU, EXT, and NET) on the drive's operation panel (Figure 29).

PU Mode: The Parameter Units (PU) mode is manual control mode. In PU mode, the drive and motor are completely controlled using the buttons and the setting dial on the drive's user interface. No external analog signals or network signals control the drive operation. The PU mode is typically used to set up, test, and troubleshoot the drive and motor operation using controlled input signal values.

EXT Mode: In the External (EXT) mode, the drive and motor respond to a signal or signals from one or two (external) analog input signal devices, such as pressure transducers or analog controllers. This is the typical mode of operation for the drive when it controls a condenser fan or other three-phase HVACR motor application.

PU/EXT Mode: In PU/EXT mode, the drive responds to the connected external signal devices and the drive setup values can be edited. The PU/EXT mode is typically used to set up your drive for initial operation, or to adjust setup parameters on an operating application.

NET Mode: In Network (NET) mode, the drive connects to and communicates over a network bus with other network devices and receives operating (Read/Write) commands from a master device on the network. The Network mode is not currently supported on VFD68 drives.

The VFD68 drives are RS485, RTU-compliant ModBus® slave devices. For more information, see *Appendix 4: VFD68Bxx and VFD68Cxx ModBus RTU RS485 Communications Bus Specifications* on page 90.

MON Mode: Shows motor speed represented as frequency (Hz) or RPM.

RUN, MON, PRM LEDs

The RUN, MON, and PRM LEDs provide drive status and indicate the type of information being displayed on the operation panel monitor.

RUN LED: The LED state (on steady, flashing, or flickering) provides information regarding the drive and motor run status. See Figure 29 for more information.

MON LED: Indicates that the monitor is displaying the drive's run status. Press (SET) to scroll through run frequency, output amperes, and output voltage.

PRM LED: Indicates that the monitor is set to display parameters and parameter values and allows you to view and edit parameter values.

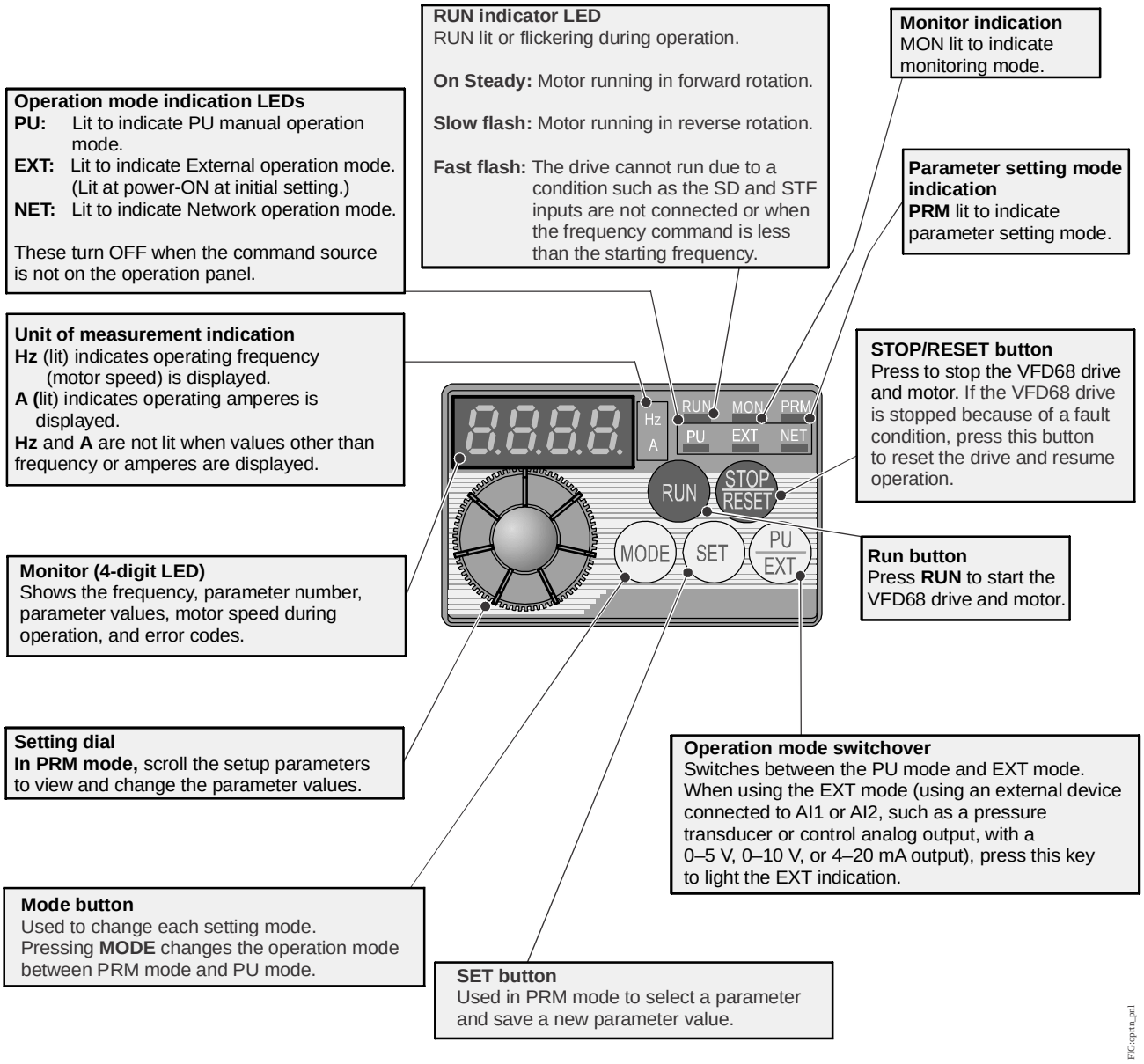


Figure 29: Operation Panel

VFD68Dxx Drives Operation Panel

Mode of Operation Icons

The VFD68 drive's mode of operation is indicated by the mode of operation icons (labeled PU and EXT) on the drive's operation panel (Figure 30).

PU Mode: The Parameter Units (PU) mode is manual control mode. In PU mode, the drive and motor are completely controlled using the buttons and the setting dial on the drive's user interface. No external analog signals or network signals control the drive operation. The PU mode is typically used to set up, test, and troubleshoot the drive and motor operation using controlled input signal values.

EXT Mode: In the External (EXT) mode, the drive and motor respond to a signal or signals from one or two (external) analog input signal devices, such as pressure transducers or analog controllers. This is the typical mode of operation for the drive when it controls a condenser fan or other three-phase HVACR motor application.

PU/EXT Mode: In PU/EXT mode, the drive responds to the connected external signal devices and the drive setup values can be edited. The PU/EXT mode is typically used to set up your drive for initial operation, or to adjust setup parameters on an operating application.

MON Mode: Shows motor speed represented as frequency (Hz) or RPM.

Display Code

Parameter Setting Mode: When the display shows **Pr..**, the VFD68 drive displays parameter codes and parameter setting values.

- Press ▲ or ▼ to scroll through the parameter codes and to edit parameter setting values.
- Press SET to enter the 3-digit parameter code for viewing and editing.

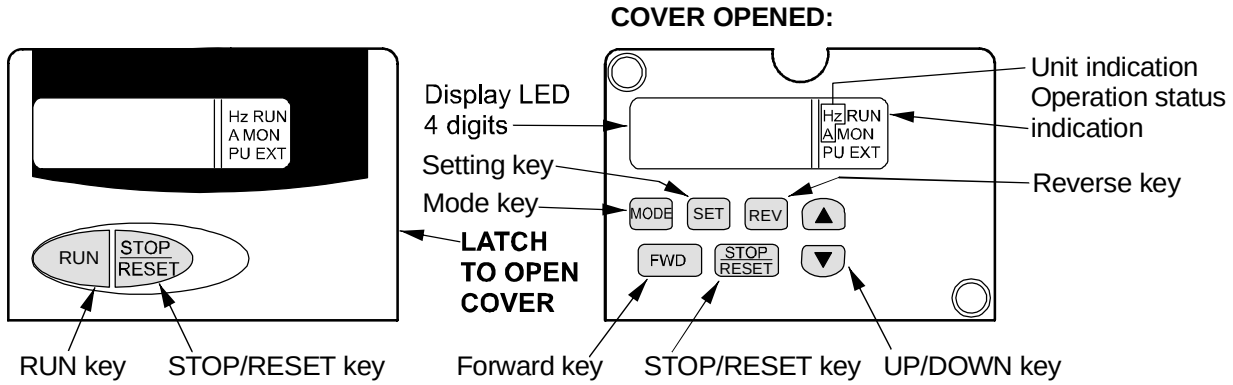


Figure 30: Operation Panel

Table 32: Operation Panel Keys (Part 1 of 2)

Key	Description
RUN	Used to give a start rotation command.
STOP RESET	• Used to stop operation. • Used to reset the VFD68 Drive when the output stops due to activation of the protection function.
MODE	Used to select the operation mode or setting mode.

Table 32: Operation Panel Keys (Part 2 of 2)

Key	Description
SET	Used to determine the frequency and parameter settings.
▲ ▼	• Used to increase or decrease the running frequency consecutively. Hold down the key to change the frequency. • Used to change the parameter setting consecutively, when in the setting mode. Press the key to change the parameter setting.
FWD	Used to give a forward rotation command.
REV	Used to give a reverse rotation command.
STOP RESET	• Used to stop operation. • Used to reset the VFD68 Drive when the output stops due to activation of the protection function.

Table 33: Unit Indications and Operating Status Indications

Indication	Description
Hz	Lit to indicate frequency
A	Lit to indicate the current (Amperes)
RUN	Lit to indicate drive operation Steady light = forward rotation Flickering light = reverse rotation
MON	Lit to indicate monitor display mode
PU	Lit to indicate the PU operation mode
EXT	Lit to indicate the external operation mode

VFD68Bxx and VFD68Cxx Drive Basic and Advanced Parameters

You can use the default parameter setting with the P499RxP-107C transducer and R410a refrigerant within a range of operation that depends on the specific model of P499 transducer selected. All other applications require some parameter changes and may require different transducers.

The parameters shown highlighted in gray in Table 34 are the advanced parameters. To view and change these parameters, change P.160 from 9999 to 0.

Table 34: Basic and Advanced Parameter Descriptions for VFD68Bxx and VFD68Cxx Drives (Part 1 of 4)

Parameter Indication on Monitor	Description	Range	VFD68xxx-2 Defaults
P. 0	**Torque Boost:** Defines the voltage (% total V) applied to the motor when the drive starts the motor at 0 Hz.	0–30%	6%/4%/3%
P. 1	**Maximum Frequency:** Defines the maximum speed of the motor in your application. See Figure 31.	0–120 Hz	60 Hz
P. 2	**Minimum Frequency:** Defines the minimum speed of the motor in your application. See Figure 31.	0–120 Hz	12.5 Hz
P. 3	**Base Frequency:** Set parameter to the rated frequency [Hz] on motor rating plate.	0–400 Hz	60 Hz
P. 4	**High Speed:** The speed, or frequency, that the VFD68 output drives the attached motor when terminal RH is connected to terminal SD (common).	0–400 Hz	40 Hz
P. 5	**Middle Speed:** The speed, or frequency, that the VFD68 output drives the attached motor when terminal RM is connected to terminal SD (common).	0–400 Hz	20 Hz
P. 6	**Low Speed:** The speed, or frequency, that the VFD68 output drives the attached motor when terminal RL is connected to terminal SD (common).	0–400 Hz	10 Hz
P. 7	**Acceleration Time:** Defines the time required to accelerate from stop (0 Hz) to full rated RPM (60 Hz).	0–3600 seconds	15 seconds
P. 8	**Deceleration Time:** Defines the time required to decelerate from full rated RPM (60 Hz) to stop (0 Hz).	0–3600 seconds	15 seconds
P. 9	**Motor Rated Current:** Set parameter to the rated FLA (full load amperes) on motor rating plate.	0–500 A	Rated VFD68 Output
P. 19	**Base Frequency Voltage:** Defines drive's maximum output voltage relative to the drive's supply voltage. (9999: drive's maximum output voltage is the same as the drive's power supply voltage.)	0–1000V, 9999	9999
P. 20	**Acceleration/Deceleration Reference Frequency:** Defines the high end frequency for P. 7 and P. 8.	0–400 Hz	60 Hz
P. 22	**Stall Prevention Output Current Level:** Defines the current level (as a percent of motor FLA) at which the drive begins to adjust the output frequency (Hz) to reduce the output current.	0–200%	150%
P. 31	**Frequency Jump 1A:** Frequency Jump parameters (P. 31 and P. 32) are used to set the low speed behavior of the drive. This parameter typically remains at 0 Hz.	0–400 Hz, 9999	0 Hz
P. 32	**Frequency Jump 1B:** maximum frequency to skip over to avoid very low fan airflow and unnecessary motor overheating (9999: frequency jump not enabled.) Ensure that P. 31 is set equal to C. 2 and C. 5	0–400 Hz, 9999	12.5 Hz
P. 33	**Frequency Jump 2A:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **below** noisy frequency 2.	0 to 400 Hz, 9999	9999

Table 34: Basic and Advanced Parameter Descriptions for VFD68Bxx and VFD68Cxx Drives (Part 2 of 4)

Parameter Indication on Monitor	Description	Range	VFD68xxx-2 Defaults
P. 34	**Frequency Jump 2B:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **above** noisy frequency 2.	0 to 400 Hz, 9999	9999
P. 35	**Frequency Jump 3A:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **below** noisy frequency 3.	0 to 400 Hz, 9999	9999
P. 36	**Frequency Jump 3B:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **above** noisy frequency 3.	0 to 400 Hz, 9999	9999
P. 37	**Speed Display:** Set the drive to display motor in RPMs (instead of Hz) by entering the maximum rated motor speed from the motor nameplate. When set to 0, the drive displays speed in Hz.	0, 0.01–9998	0
P. 40	**Run Key Rotation Direction:** Determines motor rotation direction when you press the RUN key. 0 = forward rotation; 1 = reverse rotation	0,1	0
P. 57	**Restart Coasting Time:** Determines the waiting time for a restart after a power failure.	0.1–5	5 seconds
P. 58	**Restart Cushion Time:** Determines the duration of linear voltage ramp-up during a restart after a power failure.	0–40	25 seconds
P. 60	**Energy Saving Control Selection:** Select 9 for energy-saving operation that is optimized for fan and pump applications.	9	9
P. 65	**Retry Selection:** Select 4 to allow the VFD to restart after most conditions causing a trip (but not after thermal overload) while the VFD operates/runs	4	4
P. 67	**Number of Retries at Fault Occurrence**: The number of consecutive retries that will occur after a fault occurs. If this number is exceeded and the drive fails to start, then a Fault Signal (ALM) will occur.	0–10	3
P. 68	**Retry Wait Time:** Defines the time delay (in seconds), after a fault shutdown, before the drive attempts to restart the motor.	0.1–600 seconds	10 seconds
P. 71	**Applied Motor:** 0: Standard motor; 13: Constant torque motor	0, 13	0
P. 72	**PWM Frequency Selection:** Allows you to reduce audible noise by changing the PWM frequency (Hz).	0 to 15[1]	1
P. 73	**Analog Input 1 Type:** Defines the input signal voltage range and motor rotation direction. (0: 0–10 VDC, 1: 0–5 VDC, 10: 0–10 VDC, and 11: 0–5 VDC).	0, 1, 10, 11	1
P. 77	**Parameter Write Select:** Enables or disables writing (changing) certain parameters and defines when parameters may be written (0: write when VFD stopped, 1: write disabled, 2: write enabled anytime).	0, 1, 2	2
P. 78	**Reverse Rotation Prevention Select:** 0= Both forward [STF] and reverse [STR] allowed; 1=Reverse rotation [STR] disabled; 2=Forward rotation [STF] disabled	0, 1, 2	1
P.160	**Extended Function Display Selection:** Defines whether to display only simple parameters or all parameters (9999: display only simple parameters; 0: display all parameters).	9999, 0	9999

Table 34: Basic and Advanced Parameter Descriptions for VFD68Bxx and VFD68Cxx Drives (Part 3 of 4)

Parameter Indication on Monitor	Description	Range	VFD68xxx-2 Defaults
P.161	**Frequency Setting/Key Lock Operation Select:** 10 = change speed on dial, then press SET to change VFD speed; 11 = change speed on dial to instantly change VFD speed	10, 11	11
P.162	**Auto Restart After Instantaneous Power Failure:** 1 = Enable without frequency search, 0 = Enable with frequency search	0, 1	1
P.167	Output Over Current Detection: 0 = no motor stoppage when over current occurs, 1= motor stops when over current occurs	0, 1	0
P.241	**Analog Input Display Unit Switchover:** 0 = display in 0.1% increments, 1 = display in 0.01V/0.01mA increments	0, 1	1
P.250	**Stop Selection:** 9999 = decelerate to stop, 1 = coast to stop	9999, 1	9999
P.255	**Life Alarm Status Display:** Displays remaining-life status of the control circuit capacitor, main circuit capacitor, cooling fan, and inrush current limit circuit (0: new; 15: end of life)		Read Only
P.256	**Inrush Current Limit Circuit Life Display:** Displays the deterioration level of inrush current limit circuit. (100[%]: new, 0[%]: end of life)		Read Only
P.257	**Control Circuit Capacitor Life Display:** Displays deterioration level of control circuit capacitor (100[%]: new, 0[%]: end of life).		Read Only
P.266	Set to 1 to enable voltage high signal select using both analog inputs (and set switch to **V**). Set to 0 to enable analog input 2 (Terminal 4) as a current input (and set AI2 mode switch to **I**).	0, 1	1
P.267	**Analog Input 2 (AI2) Mode:** Defines the input signal type to be connected to terminal 4. (Select 0 for 4–20 mA and position AI2 mode switch to I, or select 1 for 0–5 V or 2 for 0–10 V and position AI2 mode switch to V.)	0, 1, 2	1
P.295	**Magnitude of Frequency Change:** 0.1 = Frequency changes by 0.1 increments by rotation the selection dial.	0.1	0.1
P.296	**Password Lock Level:** Defines the read/write access level when password lock is enabled. (9999: No password lock; 1–6 or 101–106 = Set read/write restriction level when a password is implemented). Refer to *Appendix 3: Password Functions (P.296, P.297)* on page 88.	1–6, 101–106, 9999	9999
P.297	**Password Lock and Error Count:** If P.296 is 1–6 or 101–106, then password can be implemented from 1000 to 9998. After password is implemented, this parameter counts up to 5 password unlock failures. If P.296 is 9999, then P.297 is 9999, no password lock, read only.	1000–9998, (0–5, 9999)	9999
P.299	**Rotation Direction Detection:** 0 = disabled; 1 = enabled Example: If P. 78=1 and the controlled motor starts, but the VFD detects reverse rotation, the VFD decellerates the motor to a stop and then runs the motor in a forward direction.	0,1	1
P.549	**Communication Bus Protocol Selection:** 0= drive protocol, 1 = ModBus RTU	0,1	1
P.882	**Regenerative Avoidance Operation Selection:** 1 = Regenerative avoidance is always valid. If the VFD drive detects overvoltage, the VFD drive increases the frequency to avoid an overvoltage fault.	1	1
C 2	Analog Input 1 - Minimum speed defined as frequency.	0–400 Hz	12.5 Hz

Table 34: Basic and Advanced Parameter Descriptions for VFD68Bxx and VFD68Cxx Drives (Part 4 of 4)

Parameter Indication on Monitor	Description	Range	VFD68xxx-2 Defaults
C 3	Analog Input 1 - Input voltage to start minimum speed ramp	0–300%	1.90 V (38%)
C 4	Analog Input 1 - Input voltage for setpoint (where motor reaches maximum frequency or speed)	0–300%	2.74 V (54.8%)
C 5	Analog Input 2 - Minimum speed (frequency)	0–400 Hz	12.5 Hz
C 6	Analog Input 2 - Input voltage or current to start minimum speed ramp	0–300%	1.90 V or 7.6 mA (38%)
C 7	Analog Input 2 - Input voltage or current for setpoint (where motor reaches maximum frequency or speed)	0–300%	2.74 V or 11 mA (54.8%)

1. A setting value of 0 indicates 0.7 kHz. A setting value of 1 indicates 1 kHz. A setting value of 15 indicates 15 kHz.

VFD68Dxx Drive Parameters

You can use the default parameter setting with the P499RxP-107C transducer and R410a refrigerant within a range of operation that depends on the specific model of P499 transducer selected. All other applications require some parameter changes and may require different transducers.

Table 35: Parameter Descriptions for VFD68Dxx Drives (Part 1 of 3)

Parameter Indication on Monitor	Description	Settings	Default Setting
P. 0	**Torque Boost:** Defines the voltage (% total V) applied to the motor when the drive starts the motor at 0 Hz.	0–30%	4% or 3%
P. 1	**Maximum Frequency:** Defines the maximum speed of the motor in your application. See Figure 31.	0–120 Hz	60 Hz
P. 2	**Minimum Frequency:** Defines the minimum speed of the motor in your application.[1] See Figure 31.	0–120 Hz	12.5 Hz
P. 3	**Base Frequency:** Set parameter to the rated frequency [Hz] on motor rating plate.	0–400 Hz	60 Hz
P. 7	**Acceleration Time:** Defines the time required to accelerate from stop (0 Hz) to full rated RPM (60 Hz).	0–3600 seconds	15 seconds
P. 8	**Deceleration Time:** Defines the time required to decelerate from full rated RPM (60 Hz) to stop (0 Hz).	0–3600 seconds	15 seconds
P. 9	**Motor Rated Current:** Set parameter to the rated FLA on motor rating plate.	0–500 A	Rated VFD68 Output
P. 19	**VFD Output Voltage:** Defines the maximum output voltage relative to the drive's supply voltage.[2] • 9999: the maximum output voltage is the same as the drive's power supply voltage	0–1000V, 9999	9999
P. 22	**Stall Prevention Output Current Level:** Defines the current level (as a % of motor FLA) at which the drive begins to adjust the output frequency (Hz) to reduce the output current.	0–200%	150%
P. 31	**Frequency Jump 1A:** Frequency Jump parameters (P. 31 and P. 32) are used to set the low speed behavior of the drive. This parameter typically remains at 0 Hz	0–400 Hz, 9999	0 Hz

Table 35: Parameter Descriptions for VFD68Dxx Drives (Part 2 of 3)

Parameter Indication on Monitor	Description	Settings	Default Setting
P. 32	**Frequency Jump 1B:** Maximum frequency to skip over to avoid very low fan airflow and unnecessary motor overheating. (9999: frequency jump not enabled)[1] **Note:** Ensure that this is set equal to **P.902** (screen a) and **P.904** (screen a).	0–400 Hz, 9999	12.5 Hz
P. 33	**Frequency Jump 2A:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **below** noisy frequency 2.	0 to 400 Hz, 9999	9999
P. 34	**Frequency Jump 2B:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **above** noisy frequency 2.	0 to 400 Hz, 9999	9999
P. 35	**Frequency Jump 3A:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **below** noisy frequency 3.	0 to 400 Hz, 9999	9999
P. 36	**Frequency Jump 3B:** To avoid resonance noise caused by natural frequency of mechanical system, enter frequency just **above** noisy frequency 3.	0 to 400 Hz, 9999	9999
P. 37	**Speed Display:** Set the drive to display motor in RPMs (instead of Hz) by entering the maximum rated motor speed from the motor nameplate. When set to 0, the drive displays speed in Hz.	0, 0.01–9998	0
P. 68	**Retry Wait Time:** Defines the time delay (in seconds) before the drive attempts to restart the motor after a fault shutdown.	0.1–600 seconds	10 seconds
P. 72	**PWM Frequency Selection:** Allows you to reduce audible noise by changing the PWM frequency (Hz).	0–15[3]	1
P. 73	**Analog Input 1 Type:** Defines the input signal voltage range and motor rotation direction. • 0: 0–5 VDC • 1: 0–10 VDC	0, 1	0
P. 77	**Parameter Write Select:** Enables or disables writing (changing) certain parameters and defines when parameters may be written. • 0: write when VFD stopped • 1: write disabled • 2: write enabled anytime	0, 1, 2	2
P.183	Enable Analog Input 2 (AI2) when terminal MRS is connected to terminal SD	0–8, 16, 18	4
P.902 (screen a)	**Analog Input 1:** Minimum speed defined as frequency.	0–60 Hz	12.5 Hz
P.902b (screen b)	**Analog Input 1:** % of input voltage to start minimum speed ramp	0–100%	38% (1.90 V)
P.903 (screen a)	**Analog Input 1:** Maximum speed defined as frequency.	1–400 Hz	60 Hz
P.903 (screen b)	**Analog Input 1:** % of input voltage for setpoint (where motor reaches maximum frequency or speed).	1–100%	54.8% (2.74 V)
P.904 (screen a)	**Analog Input 2:** Minimum speed defined as frequency.	0–60 Hz	12.5 Hz
P.904 (screen b)	**Analog Input 2:** % of input current to start minimum speed ramp.	0–100%	38% (7.6 mA)

Table 35: Parameter Descriptions for VFD68Dxx Drives (Part 3 of 3)

Parameter Indication on Monitor	Description	Settings	Default Setting
P.905 (screen a)	**Analog Input 2:** Maximum speed defined as frequency.	1–400 Hz	60 Hz
P.905 (screen b)	**Analog Input 2:** % of input current for setpoint (where motor reaches maximum frequency or speed).	1–100%	54.8% (11 mA)

1. If P. 32 = 9999, then the speed of the motor controlled by the VFD68 will not drop below P. 2 (minimum motor speed), regardless of the mode selected.
2. If the VFD68 supply voltage is greater than the motor rating voltage (such as when using a 208 VAC motor with a 230 VAC supply), enter the motor rating voltage for P. 19. This allows the motor to run cooler.
3. A setting value of 0 indicates 0.7 kHz. A setting value of 1 indicates 1 kHz. A setting value of 15 indicates 15 kHz.

Frequency and Motor Speed

Frequency (Hz) is an expression of motor speed (RPM) on the VFD. Figure 31 and Figure 32 show how the drive's operating frequency is related to the speed (RPM) of the motor.

The VFD68Bxx and VFD68Cxx drive models can be configured to display operating frequency (Hz) or motor speed (RPM). To display motor speed (RPM) instead of operating frequency (Hz):

1. Set P.160 to 0.
2. Set P. 37 to the rated motor RPM value.
3. Set P.160 to 9999 (on the VFD68Bxx and VFD68Cxx models only).

See *Adjusting the Default Parameters* on page 52.

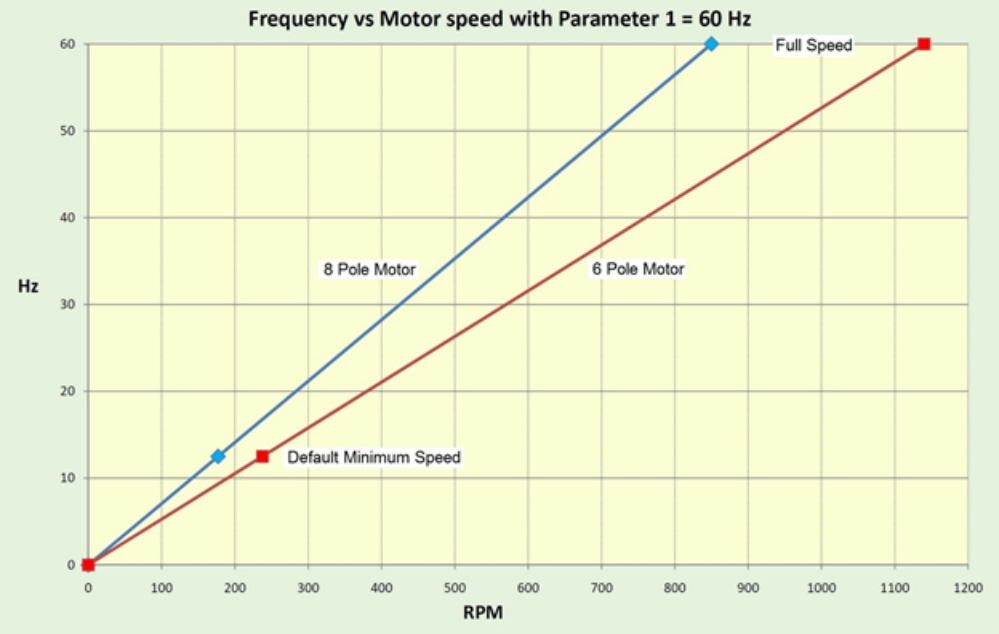


Figure 31: Frequency and Motor Speed (60 Hz)

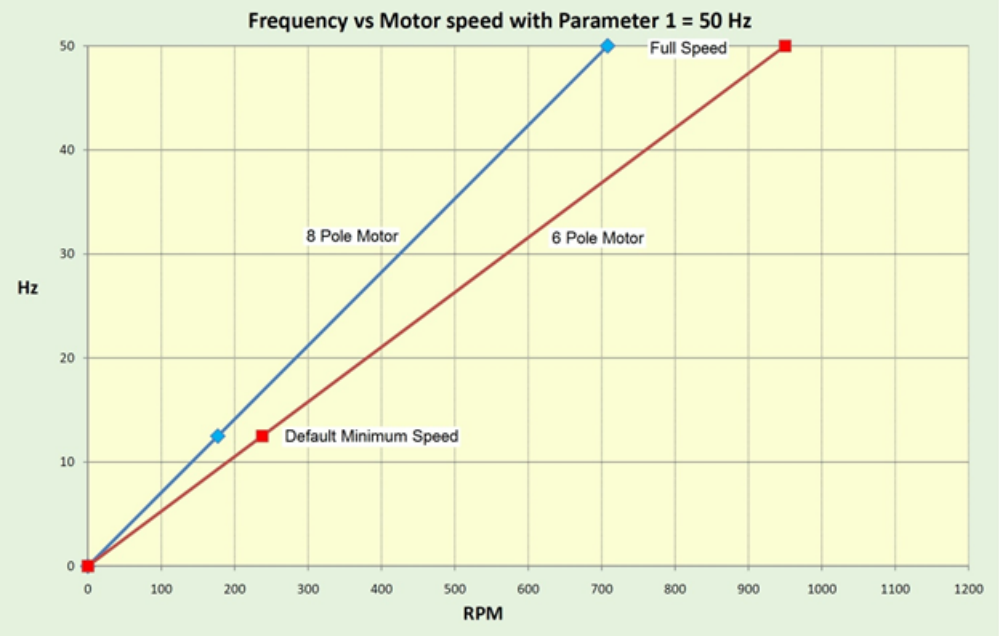


Figure 32: Frequency and Motor Speed (50 Hz)

Parameter Setting Calculations for Motor Speed vs. Pressure

Calculating C x Parameters for VFD68Bxx and VFD68Cxx Models

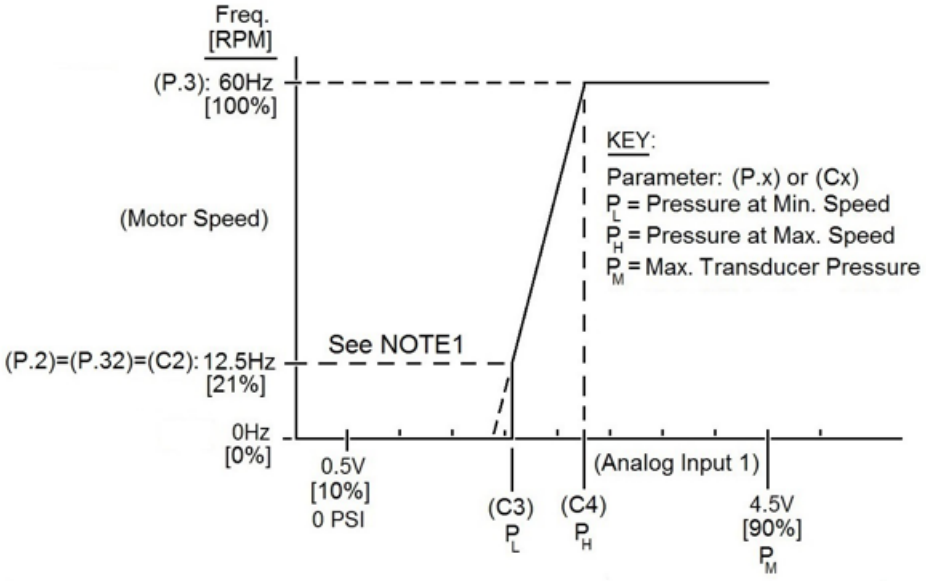
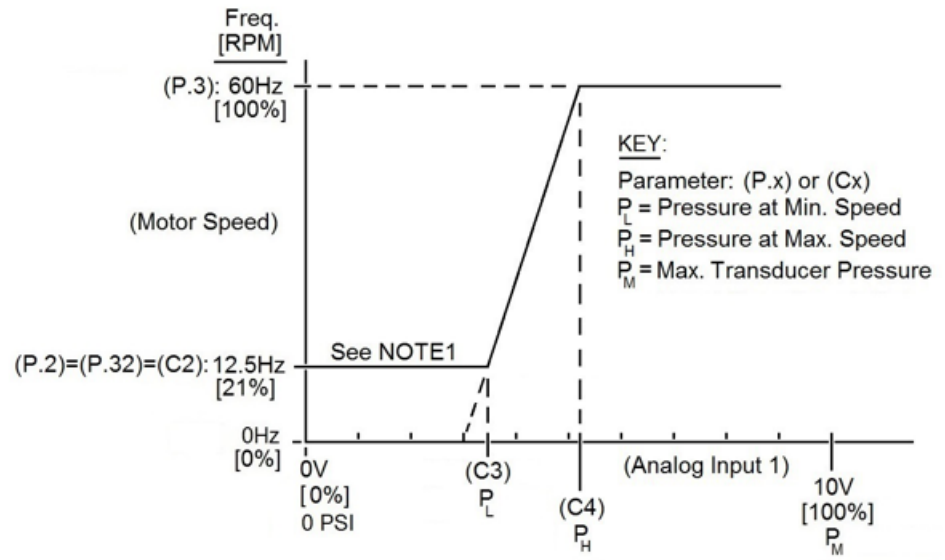
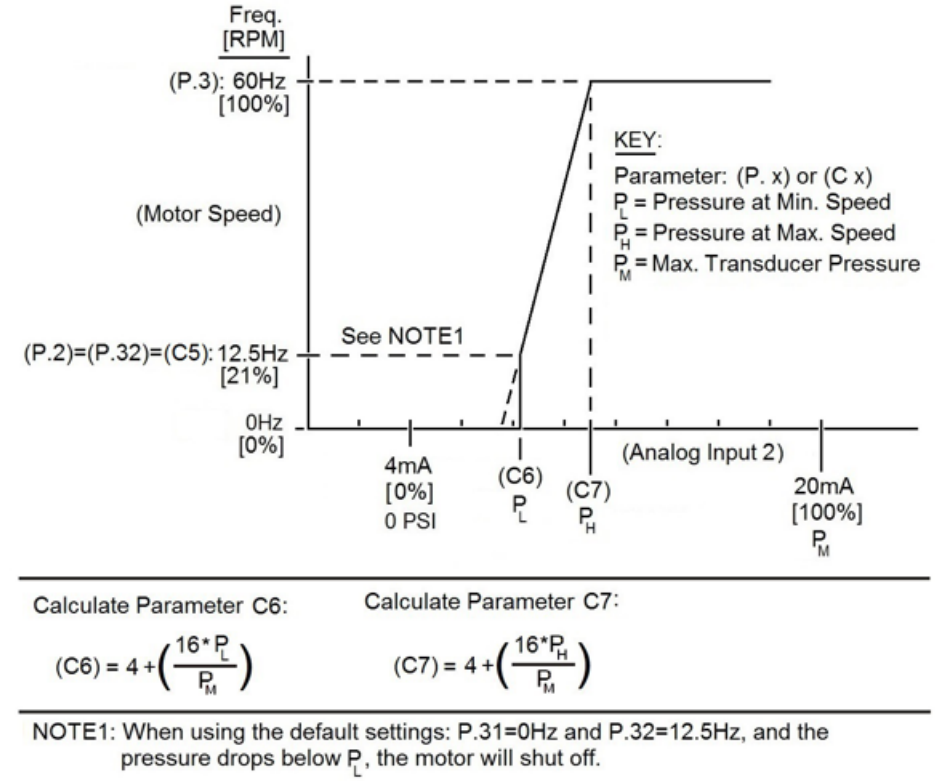


Figure 33: Applications Using 0.5–4.5 V Ratiometric Transducers



NOTE1: Set (P.32) to 9999 to cause the motor to run continuously at Min. Speed below P_L.

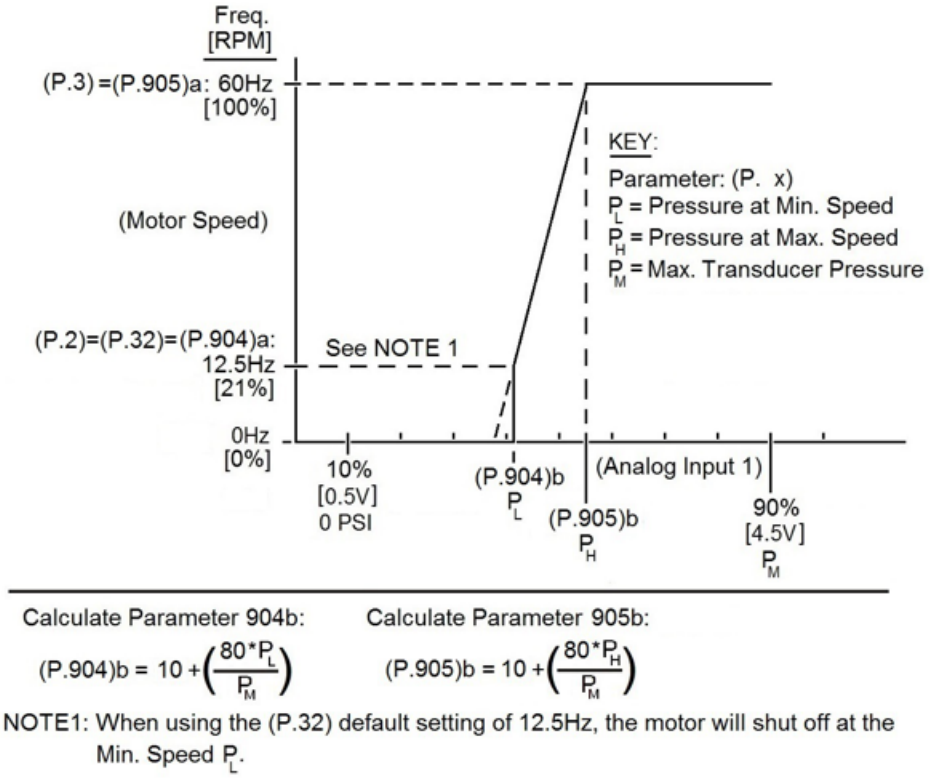
Figure 34: Applications Using 0–10 V Transducers



NOTE1: When using the default settings: P.31=0Hz and P.32=12.5Hz, and the pressure drops below P_L, the motor will shut off.

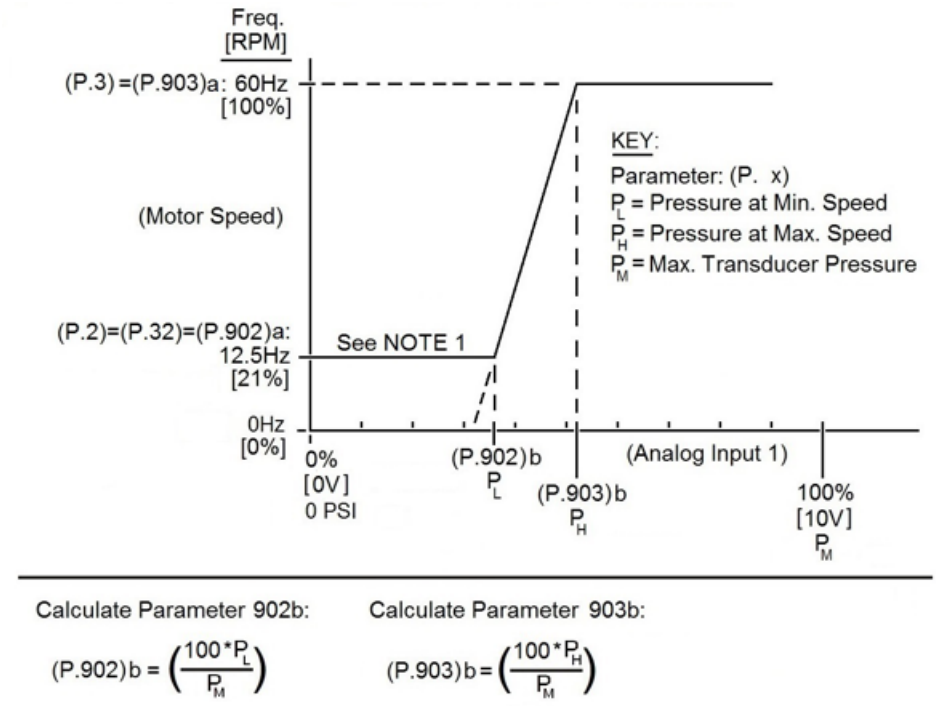
Figure 35: Applications Using 4–20 mA Transducers

Calculating Parameters 902 to 905 for VFD68Dxx Models



NOTE1: When using the (P.32) default setting of 12.5Hz, the motor will shut off at the Min. Speed P_L.

Figure 36: Applications Using 0.5–4.5 V Ratiometric Transducers



NOTE1: Set (P. 32) to 9999 to cause the motor to run continuously at Min. Speed below P_L.

Figure 37: Applications Using 0–10 V Transducers

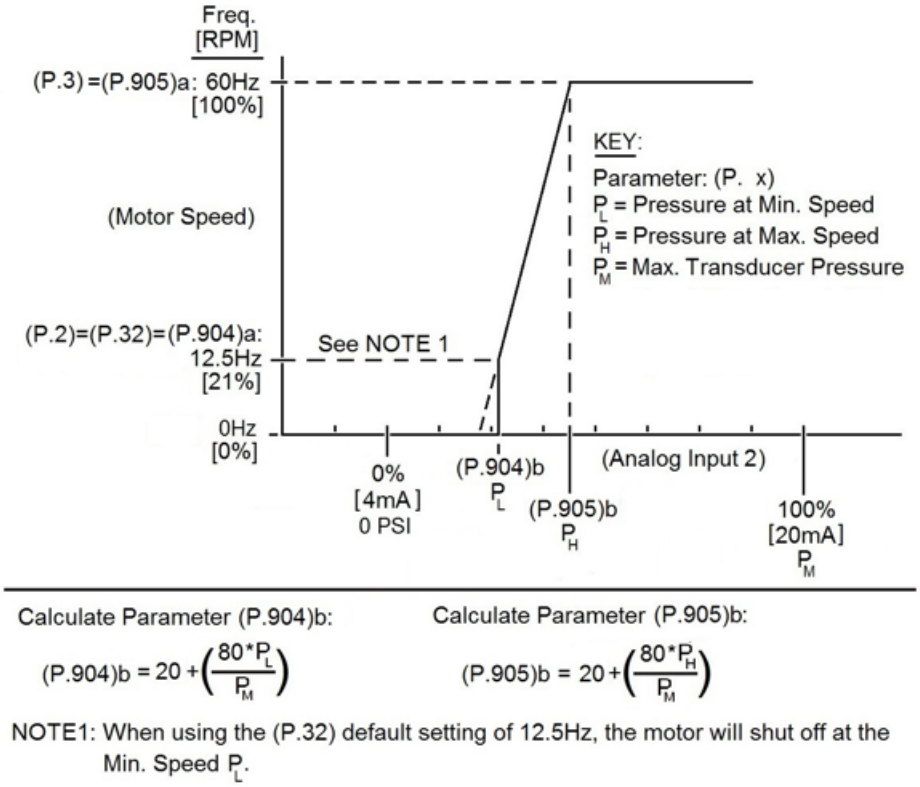


Figure 38: Applications Using 4–20 mA Transducers

PWM Frequency, Audible Motor Noise, and EMI

Using the default setting (P. 72 = 1, frequency = 1 kHz), electromagnetic interference (EMI) radiation and leakage current from the wiring between the VFD68 drive and the motor is low; however, there is a high level of audible motor noise. As the setting for P. 72 increases (up to P. 72 = 15, frequency = 15 kHz), audible motor noise decreases, while EMI radiation and leakage current increases.

If the audible noise from the VFD is too great with P.72 set to 1, increase the setting to 4 and listen to the audible noise. To minimize the EMI radiation, use the smallest number possible for P. 72.

Adjusting the Default Parameters

VFD68Bxx and VFD68Cxx Drives

CAUTION: Risk of Property Damage.
Do not apply power to the system before checking all wiring connections. Short circuited or improperly connected wires may result in permanent damage to the equipment.

MISE EN GARDE: Risque de dégâts matériels.
Ne pas mettre le système sous tension avant d'avoir vérifié tous les raccords de câblage. Des fils formant un court-circuit ou connectés de façon incorrecte risquent d'endommager irrémédiablement l'équipement.

Enter the Parameter Adjustment Mode

1. Remove the jumper that connects terminal SD to terminal STF.

IMPORTANT:	Remove the jumper to stop the motor before you change the parameter values.

2. Turn the power on. The monitor display appears. (The VFD68 drive is in EXT Mode.)
3. Press PU EXT to exit EXT mode and go to PU mode (manual override operation mode). The PU LED illuminates.
4. Press MODE to select PRM mode (parameter setting mode). The PRM LED illuminates.

Note: See Table 34 on page 43 for information on the parameters.

Select and Change Most Parameters

5. Turn to select a parameter number on the display. Example: **P. 32**
6. Press SET to show the parameter value. (The default value for **P. 32** is **12.5**.)
7. Turn to change the parameter value. (Set **P. 32** to **9999** if the motor is to run at minimum speed during low pressure events.)
8. Press SET twice to store the new value.
9. Press SET again to show the next parameter.

   To select and change the value of another parameter, repeat Step 5 through Step 9.

   To adjust the C-Prefix parameters, go to Step 10. If finished, go to Step 16.

Select and Change C-Prefix Parameters

10. Turn  until **C...** appears.
11. Press  . **C---** appears.
12. Turn  slightly until the C-prefix parameter that you want to change appears. See Table 34.
13. Press  , then turn  slightly to read the present set value.
14. Turn  again to change the parameter value.
15. Press  twice to store the new value. **C---** appears on the LED display.

    To select and change the value of another C-prefix parameter, repeat Step 12 through Step 15.

Exit the Parameter Adjustment Mode

16. Press  twice to exit parameter setting mode (PRM mode) and enter manual operation mode (PU mode). The PU LED illuminates.
17. Press  twice to exit PU mode and enter EXT RUN mode for normal operation. The EXT LED illuminates.
18. Use the jumper wire to connect terminal SD to terminal STF to run the motor using the analog input.

VFD68Dxx Drives

CAUTION: Risk of Property Damage.
Do not apply power to the system before checking all wiring connections. Short circuited or improperly connected wires may result in permanent damage to the equipment.

MISE EN GARDE: Risque de dégâts matériels.
Ne pas mettre le système sous tension avant d'avoir vérifié tous les raccords de câblage. Des fils formant un court-circuit ou connectés de façon incorrecte risquent d'endommager irrémédiablement l'équipement.

Enter the Parameter Adjustment Mode

1. Remove the jumper that connects terminal SD to terminal STF.

IMPORTANT: Remove the jumper to stop the motor before you change the parameter values.

2. Turn the power on. The monitor display appears.
3. Open the operation panel cover to reveal more keys.
4. Press  until **OP.nd EXT** appears on the display, then press until **PU PU** appears.

Select and Change Most Parameters

5. Press  until **Pr.. PU** appears.
6. To change Parameter 32, press multiple times until **P.032** appears.

7. Press SET to show **12.5** (default value of P. 32).
8. Press and hold ▼ until **9999** appears (9999 indicates that the motor is set to run at minimum speed and not turn off during a low pressure condition).
9. Press SET and hold for two seconds to set the new value.
10. Press SET again to advance to the next parameter.
11. To change additional parameters, press ▲ or ▼.

Select and Change P.90x Parameters

12. To change parameter 902 (screen a) or 902 (screen b), press MODE until **Pr.. PU** appears on the display.
13. Press SET . **P.000** appears. (The underline indicates a blinking character.)
14. Press ▼ once to show **P.900**.
15. Press SET twice until **P.900** appears.
16. Press ▲ twice to display **P.902**.
17. Press SET to show **P.90x**a. (The default value of **P.902**a is 12.5 Hz.) Press ▲ or ▼ to change the value.
18. Press and hold SET for two seconds to set the **P.90x**a value and show the actual input % for **P.90x**b.
19. Press ▲ once to view the default setting (38% for **P.902**b). Press ▲ or ▼ to change the value.
20. Press and hold SET for two seconds to set the new value.
21. Press SET again to advance to the next parameter.
22. Press ▲ or ▼ to display the next P.90x parameter that needs to be changed. Repeat Steps 17–21.

Exit the Parameter Adjustment Mode

23. When done, cycle power or press MODE until **PU PU** appears on the display, then press ▲ until **OP.nd EXT** appears on the display.
24. Press MODE until **0.00 MON EXT** appears on the display.
25. Use the jumper wire to connect terminal SD to terminal STF to run the motor using analog inputs.

Configuring Manual Motor Speed Control in PU Mode

VFD68Bxx and VFD68Cxx Drives

Verify that the VFD68 is in PU mode with no jumper between SD and STF (Figure 39 on page 56).

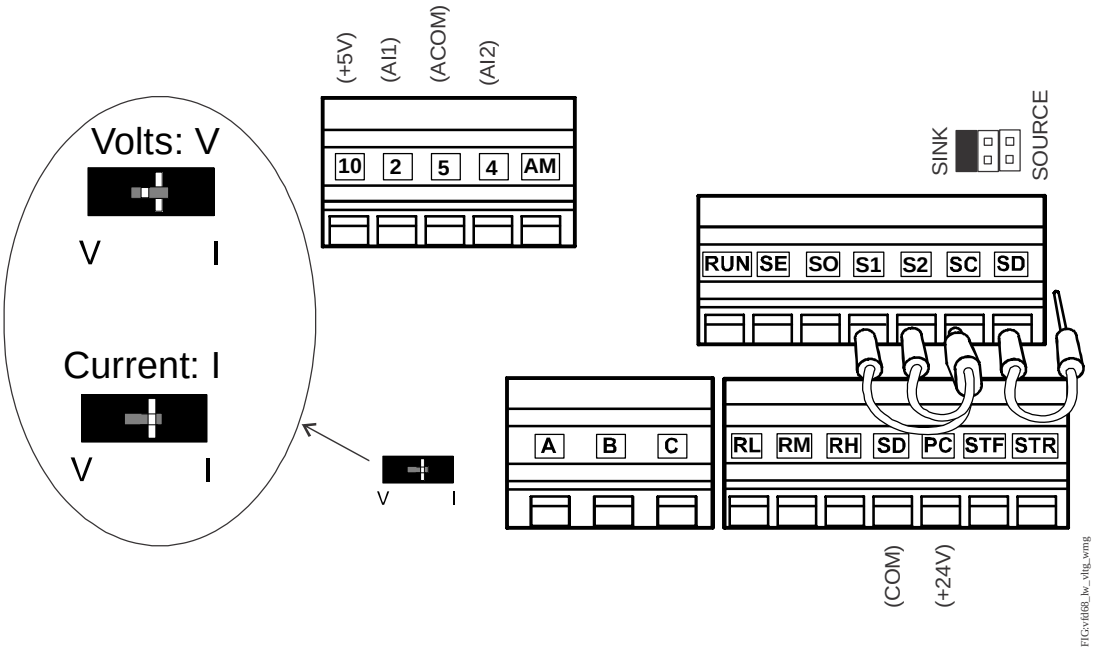


Figure 39: VFD68 Setup and Low-Voltage Connections

1. If the **PU** LED is not illuminated, press PU EXT until the **PU** LED comes on.
2. Press RUN to start the VFD68 output to the motor.
3. Turn to change motor speeds. Run the motor at high speed, maximum frequency.
4. Verify that the motor FLA is correct using one of the following methods:
   - Use a clamp-on amp meter
   - Press MODE repeatedly until **MON** LED is on; press SET until the LED display shows **A** for amperes instead of **Hz** for frequency.
5. Press STOP RESET to stop the output to the motor.

VFD68Dxx Drives

Verify that the VFD68 drive is in PU Manual Override Mode (with no jumper between SD and STF).

1. If the **PU** icon is not on, press MODE until **OP.nd** appears on the display, then press ▲ until **PU PU** appears on the display.
2. Press RUN or FWD to start the VFD68 output to the motor. The RUN icon appears on the display.
3. Press ▲ until the motor runs at maximum speed (50 or 60 Hz).
4. Verify that the motor FLA is correct using one of the following methods:
   - Use a clamp-on amp meter
   - Press SET until the **A** icon (Amperes) illuminates and replaces the **Hz** icon (frequency).
5. Press STOP RESET to stop the output to the motor.

Configuring EXT Mode Using Analog Inputs

VFD68Bxx and VFD68Cxx Drives

Verify that the VFD68 is in PU mode with no jumper between SD and STF (Figure 39 on page 56).

1. Verify that the jumper above terminal **SC** (Figure 39) is set to **SINK**.
2. Verify that the AI2 mode switch to the left of terminal **A** (Figure 39) is set to **V** for applications with 0–5 V or 0–10 V voltage input or set to **I** for applications with 4–20 mA current input.
3. Exit the PU (manual operation) mode by pressing PU EXT until the **EXT** LED is highlighted, then use a jumper to connect SD to STF.

The VFD68 is now commissioned, is in the external operation mode, and is ready to run the motor using the analog inputs.

VFD68Dxx Drives

After the motor FLA and speed have proven to be acceptable, follow the procedure in *Restarting the Motor After It Has Stopped* on page 70.

The VFD68 drive is now commissioned, is in the external operation mode, and is ready to run the motor using the analog input.

Troubleshooting

When an improper operating condition occurs in the VFD, the operation panel display changes to one of the status indications shown in Table 37. If the fault does not correspond to any of the faults in Table 37 on page 59 (or if you have any other problem), contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.

Table 36 defines the indication categories. Table 37 provides descriptions of the individual indicator messages.

Table 36: Indication Categories on the Operation Panel Display

Indication Category	Description
Error message	A message regarding operational or setting errors displays. The VFD continues operating.
Warning	The VFD continues operating. Failure to take appropriate measures will lead to a fault.
Alarm	The VFD continues operating. You can also output an alarm signal by adjusting a parameter setting.
Fault	When a fault occurs, the VFD output reduces to 0 Hz, the motor stops, and the VFD outputs a fault signal.

When a fault occurs, take the appropriate corrective action, then reset the VFD and resume operation. See *Resetting the VFD68 Drive* on page 69. Failure to take corrective action and reset the VFD may lead to a repeat of the fault condition and damage the VFD. For further information on troubleshooting, see *Advanced Troubleshooting* on page 71.

Table 37: Indicator Messages (Part 1 of 2)

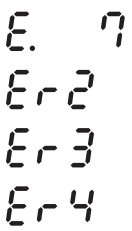
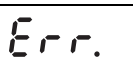
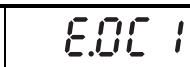
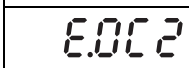
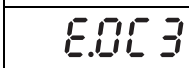
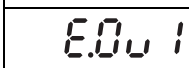
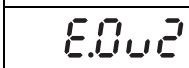
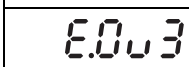
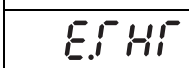
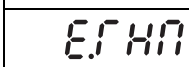
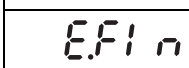
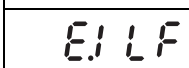
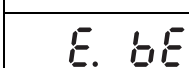
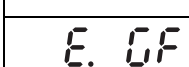
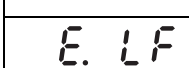
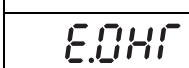
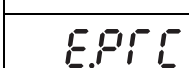
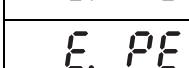
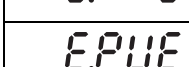
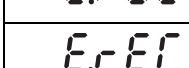
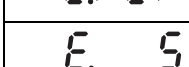
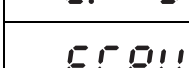
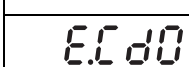
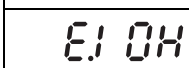
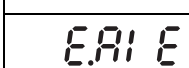
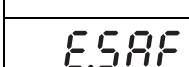
Operation Panel Indication			Name
Error message		E---	Faults history
		HOLD	Operation panel lock
		Er1 to 4	Parameter write error
		LOCD	Password locked
		Err.	VFD reset
Warning		OL	Stall protection (overcurrent)
		oL	Stall protection (overvoltage)
		RB	Regenerative brake pre-alarm (not used)
		TH	Electronic thermal relay function pre-alarm
		PS	PU stop
		MT	Maintenance signal output (not used)
		UV	Undervoltage
		SA	Safety stop
Alarm		FN	Fan alarm

Table 37: Indicator Messages (Part 2 of 2)

Operation Panel Indication			Name
Fault		E.OC1	Overcurrent trip during acceleration
		E.OC2	Overcurrent trip during constant speed
		E.OC3	Overcurrent trip during deceleration or stop
		E.OV1	Regenerative overvoltage during acceleration
		E.OV2	Regenerative overvoltage trip during constant speed
		E.OV3	Regenerative overvoltage trip during deceleration or stop
		E.THT	Inverter overload trip (electronic thermal O/L relay function)
		E.THM	Motor overload trip (electronic thermal O/L relay function)
		E.FIN	Heatsink overheat
		E.ILF	Input phase loss (not used)
		E.OLT	Stall prevention stop
		E. BE	Brake transistor alarm detection
		E.GF	Output side earth (ground) fault overcurrent at start (not used)
		E.LF	Output phase loss
		E.OHT	External thermal relay operation (not used)
		E.PTC	PTC thermistor operation (not used)
		E.PE	Parameter storage device fault (not used)
		E.PUE	PU disconnection (not used)
		E.RET	Retry count excess
		E.5	CPU fault
		E.CPU	
		E.CDO	Output current detection value exceeded (not used)
		E.IOH	Inrush current limit circuit fault
		E.AIE	Analog input fault
		E.SAF	Safety circuit fault

Causes and Corrective Actions For Each Error Message

When a message regarding operational troubles is displayed, output is not shut off.

Table 38: Operation Panel Lock

Operation Panel Indication	**HOLD**	HOLd
Description	Operation lock mode is set. Operation other than (STOP RESET) is invalid.	
Check Point	----------	
Corrective Action	Press (MODE) for 2s to release lock.	

Table 39: Password Locked

Operation Panel Indication	**LOCD**	LOCd
Description	Password function is active. Display and setting of parameter is restricted.	
Check point	----------	
Corrective action	Enter the password in P.297 to unlock the password function before operating.	

Table 40: Write Disable Error

Operation Panel Indication	**Er1**	Er 1
Description	• You attempted to make parameter setting when P. 77 has been set to disable parameter write. • Frequency jump setting range overlapped. • The PU and VFD cannot make normal communication.	
Check point	• Check the setting of P. 77. • Check the settings of P. 31 to P. 36. • Check the connection of the PU and VFD.	

Table 41: Write Error During Operation

Operation Panel Indication	**Er2**	Er2
Description	When parameter write was performed during operation with P. 77 set to other than 2 (writing is enabled independently of operation status in any operation mode) and the SD terminal is connected to either the STF or STR terminal.	
Check Point	• Check the P. 77 setting. • Check that the VFD is not operating.	
Corrective Action	• Set the value of P. 77 to 2. • After stopping operation, set the parameter.	

Table 42: Calibration Error

Operation Panel Indication	**Er3**	Er3
Description	Analog input bias and gain calibration settings are too close.	
Check Point	Check the settings of C 3, C 4, C 6, and C 7.	

Table 43: Mode Designation Error

Operation Panel Indication	**Er4**	Er4
Description	• Appears if a parameter setting is attempted in the External or NET operation mode with P. 77 set to other than 2. • Appears if a parameter setting is attempted when the command source is not at the operation panel.	
Check Point	• Check that operation mode is PU operation mode. • Check the P. 77 setting.	
Corrective Action	• After setting the operation mode to the PU operation mode, set the parameter. • After setting P. 77 to 2, set the parameter.	

Table 44: VFD Reset

Operation Panel Indication	**Err.**	Err.
Description	• Executing reset using RES signal, or reset command from communication or PU • Displays at powering OFF.	
Corrective Action	• Turn OFF the reset command.	

Warning

When a warning occurs, the output is not shut off.

Table 45: Stall Prevention (Overcurrent)

Operation Panel Indication	**OL**	OL
Description	During acceleration	When the output current of the VFD exceeds the stall prevention operation level (P. 22), this function stops the increase in frequency until the overload current decreases to prevent the VFD from resulting in overcurrent trip. When the overload current has reduced below stall prevention operation level, this function increases the frequency again.
	During constant-speed operation	When the output current of the VFD exceeds the stall prevention operation level (P. 22), this function reduces frequency until the overload current decreases to prevent the VFD from resulting in overcurrent trip. When the overload current has reduced below stall prevention operation level, this function increases the frequency up to the set value.
	During deceleration	When the output current of the VFD exceeds the stall prevention operation level (P. 22), this function stops the decrease in frequency until the overload current decreases to prevent the VFD from resulting in overcurrent trip. When the overload current has decreased below stall prevention operation level, this function decreases the frequency again.
Check Point	• Check that the Pr. 0 setting is not too large. • Check that the Pr. 7 and Pr. 8 settings are not too small. • Check that the load is not too heavy. • Check for any failures in peripheral devices. • Check that the value of P. 22 is appropriate.	
Corrective Action	• Increase or decrease the Pr. 0 setting by 1% and check the motor status. • Set a larger value in Pr. 7 and Pr. 8. • Reduce the load weight. • Set stall prevention operation current in P. 22 (The default value is 150%.) The acceleration/deceleration time may change. Increase the stall prevention operation level with P. 22.	

Table 46: Stall Prevention (Overvoltage)

Operation Panel Indication	**oL**	oL
Description	During deceleration, if the regenerative energy of the motor becomes excessive to exceed the regenerative energy consumption capability, this function stops the decrease in frequency to prevent overvoltage trip. As soon as the regenerative energy has reduced, deceleration resumes.	
Check Point	Check for sudden speed reduction.	
Corrective Action	The deceleration time may change. Increase the deceleration time using Pr. 8.	

Table 47: PU Stop

Operation Panel Indication	**PS**	PS
Description	Stop with STOP RESET of the PU is set in P. 75.	
Check Point	Check for a stop made by pressing STOP RESET of the operation panel.	
Corrective Action	Turn the start signal OFF and release with PU EXT.	

Table 48: Electronic Thermal Relay Function Pre-Alarm

Operation Panel Indication	**TH**	rH
Description	Appears if the cumulative value of the P. 9 reaches or exceeds 85% of the preset level. If it reaches 100% of the P. 9 setting, a motor overload trip (E. THM) occurs.	
Check Point	• Check for large load or sudden acceleration. • Is the P. 9 setting is appropriate?	
Corrective Action	• Reduce the load and frequency of operation. • Set an appropriate value in P. 9.	

Table 49: Undervoltage

Operation Panel Indication	**UV**	Uu
Description	If the power supply voltage of the VFD decreases, the control circuit will not perform normal functions. In addition, the motor torque will be insufficient and/or heat generation may increase. To prevent this, if the power supply voltage decreases below about 115 VAC (about 230 VAC for 400 V class, about 58 VAC for 100 V class), this function stops the VFD output and displays Uu. An alarm is reset when the voltage returns to normal.	
Check Point	Check that the power supply voltage is normal.	
Corrective Action	Check the power supply system equipment, such as a power supply.	

Table 50: Safety Stop

Operation Panel Indication	**SA**	SA
Description	Appears when the safety stop function is activated (during output shutoff).	
Check Point	Verify that the jumper wires connect terminals S1, S2, and SC together.	
Corrective Action	• When not using the safety stop function, short across terminals S1 and SC and across S2 and SC with shorting wire for the VFD to run. • If SA is indicated when the jumper wires between terminals S1, S2, and SC are connected, then an internal failure might be the cause. Contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.	

Alarm

When an alarm occurs, the output is not shut off. You can also output an alarm signal by making parameter setting..

Table 51: Fan Alarm

Operation Panel Indication	**FN**	Fn
Description	For the VFD that contains a cooling fan, Fn appears on the operation panel when the cooling fan stops due to an alarm.	
Check Point	Check the cooling fan for an alarm.	
Corrective Action	Check for fan alarm. Contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.	

Fault

When a fault occurs, the VFD trips and a fault signal is output.

Note: If faults other than these appear, contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.

Table 52: Overcurrent Trip During Acceleration

Operation Panel Indication	**E.OC1**	E.OC 1
Description	When the VFD output current reaches or exceeds approximately 200% of the rated current during acceleration, the protective circuit is activated and the VFD trips.	
Check Point	• Check for sudden acceleration. • Check for output short-circuit/ground fault. • Check that the P. 3 setting is not 60Hz when the motor rated frequency is 50Hz.	
Corrective Action	• Increase the acceleration time. • When E.OC1 is always lit at starting, disconnect the motor once and start the VFD. If E.OC1 is still lit, contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Set 50Hz in P. 3.	

Table 53: Overcurrent Trip During Constant Speed

Operation Panel Indication	**E.OC2**	
Description	When the VFD output current reaches or exceeds approximately 200% of the rated current during constant speed operation, the protective circuit is activated and the VFD trips.	
Check Point	• Check for sudden load change. • Check for output short-circuit/ground fault. • Check if the stall prevention operation level is set too high.	
Corrective Action	• Keep load stable. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Lower the setting of stall prevention operation level.	

Table 54: Overcurrent Trip During Deceleration or Stop

Operation Panel Indication	**E.OC3**	
Description	When the VFD output current reaches or exceeds approximately 200% of the rated VFD current during deceleration (other than acceleration or constant speed), the protective circuit is activated and the VFD trips.	
Check Point	• Check for sudden speed reduction. • Check for output short-circuit/ground fault. • Check for too fast operation of the motor's mechanical brake. • Check if the stall prevention operation level is set too high.	
Corrective Action	• Increase the deceleration time. • Check the wiring to make sure that output short circuit/ground fault does not occur. • Check the mechanical brake operation. • Lower the setting of stall prevention operation level.	

Table 55: Regenerative Overvoltage Trip During Acceleration

Operation Panel Indication	**E.OV1**	
Description	If regenerative energy causes the VFD's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated and the VFD trips. The circuit may also be activated by a surge voltage produced in the power supply system.	
Check Point	Check that the setting of P. 22 is not too small.	
Corrective Action	Set P. 22 correctly.	

Table 56: Regenerative Overvoltage Trip During Constant Speed

Operation Panel Indication	**E.OV2**	
Description	If regenerative energy causes the VFD's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the VFD output. The circuit may also be activated by a surge voltage produced in the power supply system.	
Check Point	Check that the setting of P. 22 is not too small.	
Corrective Action	Set P. 22 correctly.	

Table 57: Regenerative Overvoltage Trip During Deceleration or Stop

Operation Panel Indication	**E.OV3**	
Description	If regenerative energy causes the VFD's internal main circuit DC voltage to reach or exceed the specified value, the protective circuit is activated to stop the VFD output. The circuit may also be activated by a surge voltage produced in the power supply system.	
Check Point	Check for sudden speed reduction.	
Corrective Action	Increase the deceleration time.	

Table 58: Drive Overload Trip (Electronic Thermal O/L Relay Function)

Operation Panel Indication	**E.THT**	
Description	If the temperature of the output transistor element exceeds the protection level under the condition that a current not less than the rated VFD current flows and overcurrent trip does not occur (200% or less), the electronic thermal relay activates to stop the VFD output. (Overload capacity 150% 60s, 200% 0.5s)	
Check Point	• Check that acceleration/deceleration time is not too short. • Check that torque boost setting is not too large (small). • Check the motor for use under overload. • Check for too high surrounding air temperature.	
Corrective Action	• Increase acceleration/deceleration time. • Adjust the torque boost setting. • Reduce the load weight. • Set the surrounding air temperature to within the specifications.	

Table 59: Motor Overload Trip (Electronic Thermal O/L Relay Function)

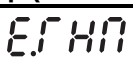
Operation Panel Indication	**E.THM**	
Description	The electronic thermal relay function in the VFD detects motor overheat due to overload or reduced cooling capability during constant-speed operation, and pre-alarm (TH display) is output when the integrated value reaches 85% of the P. 9 setting, and the protection circuit is activated to stop the VFD output when the integrated value reaches the specified value. When running a special motor such as a multi-pole motor or multiple motors, provide a thermal relay on the VFD output side since such motors cannot be protected by the electronic thermal relay function.	
Check Point	• Check the motor for use under overload. • Check that the stall prevention operation setting is correct.	
Corrective Action	• Reduce the load weight. • Check that the stall prevention operation setting is correct.	

Table 60: Heatsink Overheat

Operation Panel Indication	**E.FIN**	E.FIn
Description	If the heatsink overheats, the temperature sensor is actuated and the VFD trips. The FIN signal can be output when the temperature becomes approximately 85% of the heatsink overheat protection operation temperature.	
Check Point	• Check for too high surrounding air temperature. • Check for heatsink clogging. • Check that the cooling fan is not stopped (Check that Fn is not displayed on the operation panel).	
Corrective Action	• Set the surrounding air temperature to within the specifications. • Clean the heatsink. • Replace the cooling fan.	

Table 61: Stall Prevention Stop

Operation Panel Indication	**E.OLT**	E.OLT
Description	If the output frequency has fallen to 1Hz by stall prevention operation and remains for 3 seconds, a fault (E.OLT) appears and the VFD trips. OL appears while stall prevention is being activated. E.OLT may not occur if stall prevention (OL) is activated during output phase loss.	
Check Point	Check the motor for use under overload.	
Corrective Action	Reduce the load weight. (Check the P. 22 setting.)	

Table 62: Brake Transistor Alarm Detection

Operation Panel Indication	**E.BE**	E. bE
Description	When a brake transistor alarm has occurred due to the large regenerative energy from the motor, the brake transistor alarm is detected and the VFD trips. **In this case, the VFD must be powered OFF immediately.**	
Check Point	Reduce the load inertia.	
Corrective Action	Replace the VFD.	

Table 63: Output Phase Loss

Operation Panel Indication	**E.LF**	E. LF.
Description	If one of the three phases (U, V, W) on the VFD's output side (load side) is lost during VFD operation (except during DC injection brake operation and when output frequency is under 1Hz), VFD stops the output. Whether the protective function is used or not is set with P.251.	
Check Point	Check the wiring. (Check that the motor is normal.) Check that the capacity of the motor used is not smaller than that of the VFD.	
Corrective Action	Wire the cables properly. Check the P.251 setting.	

Table 64: Retry Count Excess

Operation Panel Indication	**E.RET**	E.rEt.
Description	If operation cannot be resumed properly within the number of retries set, this function trips the VFD. This function is available only when P. 67 is set to a value other than 0. When P. 67 is set to 0, this protective function does not function. P. 67 is factory-set to 3.	
Check Point	Find the cause of fault occurrence.	
Corrective Action	Eliminate the cause of the error preceding this error indication.	

Table 65: CPU Fault

Operation Panel Indication	**E.5**	E. 5
	E.CPU	E.CPU
Description	Stops the VFD output if the communication fault of the built-in CPU occurs.	
Check Point	Check for devices producing excess electrical noises around the VFD.	
Corrective Action	Take measures against noises if there are devices producing excess electrical noises around the VFD. Contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.	

Table 66: Inrush Current Limit Circuit Fault

Operation Panel Indication	**E.IOH**	E.IOH
Description	This function is activated when the resistor of the inrush current limit circuit overheats.	
Check Point	Check that frequent power ON/OFF is not repeated.	
Corrective Action	Configure a circuit where frequent power ON/OFF is not repeated. If the problem still persists after taking the above measure, please contact your sales representative.	

Table 67: Analog Input Fault

Operation Panel Indication	**E.AIE**	E.AIE
Description	Appears if voltage (current) is input to terminal 4 when the setting in P.267 and the setting of the voltage/current input switch are different.	
Check Point	Check the setting of P.267 and the voltage/current input switch.	
Corrective Action	Either give a frequency command by current input or set P.267, and voltage/current input switch to voltage input.	

Table 68: Safety Circuit Fault

Operation Panel Indication	**E.SAF**	E.SAF
Description	Appears when safety circuit is malfunctioning. Appears when one of the lines between S1 and SC, or between S2 and SC is opened.	
Check Point	Verify that the jumper wire connects together terminals S1, S2, and SC.	
Corrective Action	Connect terminals S1, S2, and SC.	

Resetting the VFD68 Drive

WARNING: Risk of Personal Injury.
Before you reset the VFD68 drive, verify that all persons are clear of the controlled equipment. Resetting the VFD68 drive may immediately start the controlled equipment, and failure to verify that all persons are clear of the controlled equipment before resetting the VFD68 drive may result in severe personal injury or death.

AVERTISSEMENT: Risque de blessure.
Avant de réinitialiser le VFD68 drive, assurez-vous qu'aucune personne n'est à proximité de l'équipement. La réinitialisation du VFD68 drive peut faire redémarrer l'équipement contrôlé immédiatement et le non-respect de cette précaution pourrait entraîner des blessures graves, voire mortelles.

IMPORTANT: To prevent the motor from starting immediately after a fault reset, remove the jumper that connects terminal SD to terminal STF before clearing the reset.

If the motor stops due to a fault, you can reset the VFD by using either of the following two methods.

Reset Option 1

1. Remove the jumper that connects terminal SD to terminal STF before clearing the reset.
2. Using the operation panel, press STOP RESET to reset the VFD.
3. Go to *Restarting the Motor After It Has Stopped*.

Reset Option 2

1. Remove the jumper that connects terminal SD to terminal STF before clearing the reset.
2. Disconnect power from the drive. After the indicator of the operation panel turns OFF, reinstall the jumper that connects terminal SD to terminal STF.
3. Reconnect power to the drive.

Manually Stopping the Motor

You can stop the motor while the VFD68 drive is in any mode (PU, EXT, or NET) by pressing STOP RESET. When you press STOP RESET, the drive monitor displays **PS** (PU Stop Warning) and then performs a controlled shutdown of the motor.

Restarting the Motor After It Has Stopped

VFD68Bxx and VFD68Cxx Drives

To restart the motor after a controlled stop, disconnect the supply power from the drive for at least 30 seconds and then reconnect the supply power to the drive.

If it is not easy to disconnect the supply power from the drive, follow these steps:

1. Disconnect the jumper between the SD and STF terminals on the low-voltage terminal blocks.
2. Press PU/EXT. The PU LED lights.
3. Press PU/EXT two more times. The EXT LED lights.
4. Reconnect the jumper between the SD and STF terminals.

VFD68Dxx Drives

To restart the motor after a controlled stop, disconnect the supply power from the drive for at least 30 seconds and then reconnect the supply power to the drive.

If it is not easy to disconnect the supply power from the drive, follow these steps:

1. Disconnect the jumper between the SD and STF terminals on the low-voltage terminal blocks.
2. Verify that the SINK/SOURCE jumper to the left of the low-voltage terminal blocks (Figure 22) is set to **SINK**.
3. Press MODE until **PU PU** appears on the display.
4. Press ▲ until **OP.nd EXT** appears on the display.
5. Press MODE until **0.00 MON EXT** appears on the display.
6. Reconnect the jumper between the SD and STF terminals.

The VFD68 is now commissioned, is in the external operation mode, and is ready to run the motor using the analog inputs.

7. Press MODE to return to monitor mode. **0.00 MON PU** appears on the screen.

Advanced Troubleshooting

Use the following tables to resolve problems with the VFD68 drive.

Table 69: Symptoms and Resolutions

Symptom	Resolution Table
Motor Does Not Start	Table 70 on page 72
Motor or Machine Makes Generates Acoustic Noise	Table 71 on page 73
VFD Generates Abnormal Acoustic Noise	Table 72 on page 73
Motor Generates Heat Abnormally	Table 73 on page 73
Motor Rotates in the Opposite Direction	Table 74 on page 73
Speed Greatly Differs from the Setting	Table 75 on page 74
Acceleration/Deceleration Is Not Smooth	Table 76 on page 74
Speed Varies During Operation	Table 77 on page 74
Operation Mode Cannot Be Changed	Table 78 on page 74
Operation Panel Display Does Not Operate	Table 79 on page 74
Motor Current is Too Large	Table 80 on page 75
Unable to Write Parameter Setting	Table 81 on page 75

Table 70: Motor Does Not Start

Check Points	Possible Cause	Action
Main Circuit	Appropriate power supply voltage is not applied. (Operation panel display is not provided.)	Power ON moulded case circuit breaker (MCCB), an earth leakage circuit breaker (ELB), or a magnetic contactor (MC).
		Check for the proper input voltage, input phase loss, and wiring.
	Motor is not connected properly.	Check the wiring between the VFD and the motor.
	The jumper from terminal P/+ to terminal P1 (on VFD68Bxx and VFD68Cxx models) or from terminal P to terminal P1 (on VFD68Dxx models) has been removed.	Connect a jumper from terminal P/+ or terminal P to terminal P1.
Input Signal	Analog input signal is not enough to start the motor.	Check for proper voltage on analog inputs. Verify that the PU and EXT LEDs are illuminated.
	Terminal STR is connected to terminal SD.	Disable the STR feature by setting P. 78 = 1. Connect terminal SD to terminal STF to run the motor in the forward direction.
	Frequency command is zero. (RUN LED on the operation panel is flickering.)	Check the frequency command source and enter a frequency command.
	SINK-SOURCE jumper is set incorrectly. (RUN LED on the operation panel is flickering.)	Check that the control logic switchover jumper connector is installed in the SINK position: • VFD68Bxx and VFD68Cxx: Figure 20 on page 29 • VFD68Dxx: Figure 22 on page 31 If it is not installed correctly, input signal is not recognized.
	Jumper wires between S1 and SC, S2 and SC are disconnected (VFD68Bxx and VFD68Cxx models only).	Verify that jumper wires connect together terminals S1, S2, and SC.
	Voltage/current input switch is not correctly set for analog input signal (0 to 5 V or 0 to 10 V, 4 to 20 mA) (VFD68Bxx and VFD68Cxx models only). (RUN LED on the operation panel is flickering.)	Set P. 73, P.266, P.267, and a voltage/current input switch correctly, then input an analog signal in accordance with the setting.
Param. Setting	Motor Speed vs. Pressure (C 2 to C 7) settings are improper.	Check the Motor Speed vs. Pressure (C 2 to C 7) calculations and settings.
Load	Load is too heavy.	Reduce the load.
	Shaft is locked.	Inspect the machine (motor).
Others	Operation panel display shows an error (E.OC1).	When any fault occurs, take an appropriate corrective action, then reset the VFD, and resume the operation.

Table 71: Motor or Machine Generates Abnormal Acoustic Noise

Check Points	Possible Cause	Action
Param. Setting	Resonance occurs (mechanical system resonance frequency)	• For Frequency Jump 2, set P. 33 and P. 34. • For Frequency Jump 3, set P. 35 and P. 36 When it is desired to avoid resonance attributable to the natural frequency of a mechanical system, these parameters allow resonant frequencies to be jumped.
	Resonance occurs (carrier frequency)	Change P. 72 setting. Changing the PWM carrier frequency can reduce the audible noise created when the motor is running at speeds slower than the maximum rated speed (see *PWM Frequency, Audible Motor Noise, and EMI* on page 52).
Others	Mechanical looseness	Adjust machine/equipment so that there is no mechanical looseness.
Motor	Operating with output phase loss	Check the motor wiring. Contact the motor manufacturer.

Table 72: VFD Generates Abnormal Acoustic Noise

Check Points	Possible Cause	Action
Fan	The fan cover was not correctly installed when a cooling fan was replaced.	Install the fan cover correctly.

Table 73: Motor Generates Heat Abnormally

Check Points	Possible Cause	Action
Param. Setting	The fan motor is running too slowly to create airflow.	Verify that P. 31 is set to 0 and P. 32 is set to 12.5 Hz. If 12.5 Hz is too slow, increase frequency for • P.32, C 2, C 5 (VFD68Bxx and VFD68Cxx models) • P.32, P.902a, P.904a (VFD68Dxx models).
Motor	The fan motor is not working (dust is accumulating.)	Clean the motor fan. Improve the environment.
	Phase to phase insulation of the motor is insufficient.	Check the insulation of the motor.
Main Circuit	The VFD output voltage (U, V, W) are unbalanced.	Check the output voltage of the VFD. Check the insulation of the motor.

Table 74: Motor Rotates in the Opposite Direction

Check Points	Possible Cause	Action
Main Circuit	Phase sequence of output terminals U, V and W is incorrect.	Connect phase sequence of the output cables (terminals U, V, W) to the motor correctly

Table 75: Speed Greatly Differs From the Setting

Check Points	Possible Cause	Action
Input Signal	Analog input device is not creating the proper analog signal.	Measure the input signal level.
	The analog input signal lines are affected by external EMI.	Use shielded wire for the low-voltage analog inputs and route the wiring away from high-voltage wiring. Connect shields to VFD terminal 5. If EMI still affects the control or the VFD, then install a ferrite core (such as TDK P/N: ZCAT3035-1330) on the analog input wiring.
Param. Setting	Torque Boost or Maximum Speed settings are improper.	Check the settings of P. 1 and P. 2.
	Motor Speed versus Pressure Ramp settings are improper.	**VFD68Bxx and VFD68 Cxx:** Check the C 2 to C 7 settings. **VFD68Dxx:** Check the P.905 to P.905 settings.
	P. 32 setting is incorrect.	Determine the best minimum motor speed needed before the motor shuts off and use that value for P. 32.

Table 76: Acceleration/Deceleration is not Smooth

Check Points	Possible Cause	Action
Param. Setting	Acceleration/deceleration time is too short or too long.	Change P. 7 and P. 8 values.

Table 77: Speed Varies During Operation

Check points	Possible Cause	Action
Input signal	The analog input signal lines are affected by EMI.	Use shielded wires for the low-voltage analog input signal lines. Route the wiring away from high-voltage wiring. Connect shields to VFD terminal 5. If EMI still affects the control or the VFD, then install a ferrite core (such as TDK P/N: ZCAT3035-1330) on the analog input wiring.
Param. Setting	The power supply voltage fluctuates too much.	Change the P. 19 setting to the voltage rating on the controlled motor.

Table 78: Operation Mode Cannot Be Changed

Check Points	Possible Cause	Action
Input Signal	Start signal is enabled (terminal STF is connected to terminal SD).	Check that a jumper is not connecting the STF and SD terminals. If the jumper is connected, the operation mode cannot be changed.

Table 79: Operation Panel Display Malfunctions

Check Points	Possible Cause	Action
Display	The operation panel display malfunctions.	Contact PENN by Johnson Controls Application Engineering at 1-414-524-5535 or 1-800-275-5676.

Table 80: Motor Current is Too Large

Check Points	Possible Cause	Action
Load	The fan motor stalls and error code OL appears on the display.	Ensure that combination of motors connected in parallel does not exceed the VFD68 drive's output current rating.

Table 81: Unable to Write Parameter Setting

Check Points	Possible Cause	Action
Input Signal	P. 77 should be set to 2.	Verify that P.77 is set to 2.
Param. Setting	P.296 and P.297 may be set for Password Lock.	Check with your local equipment supervisor to verify the Password Lock restriction level.

Technical Specifications

VFD68Bxx or VFD68Cxx Variable Frequency Drive (230 or 460 VAC)

Input Power Voltage/ Frequency	230 VAC, 50 HZ (208/230 VAC, 60 Hz); 400 VAC, 50 Hz (460 VAC, 60 Hz); Continuous Duty
Output Voltage/Frequency	230 VAC, 50 HZ (208/230 VAC, 60 Hz); 400 VAC, 50 Hz (460 VAC, 60 Hz); Continuous Duty
Input Devices	Johnson Controls/PENN® P499 Electronic Pressure Transducers
PWM Carrier Frequency	Adjustable 0.7 to 15 kHz
Motor Requirements	Three-phase NEMA Design B motors required; Inverter-rated motors recommended
Overload Capacity	150% of ampere rating for 1 minute
Start/Stop	Use STF input to start or stop the motor
Ambient Conditions	**Storage:** -40 to 65ºC (-40 to 149ºF), 0 to 95% RH noncondensing
	Operating: -40 to 50ºC (-40 to 122ºF), 0 to 95% RH noncondensing
	Altitude: 1,000 m (3,300 ft) Maximum without derating
Enclosures	UL Type 1 (NEMA) Fan Cooled (230 VAC 1 hp and lower models do not have a fan)
Maximum High Voltage Wire Length	Up to 100 m (328 ft) between the VFD68 drive and the motor (using the appropriate wire gauge)
Compliance CE	**North America:** cULus Listed, UL 508C, CSA-C22.2 No. 14, File E244421; Industry Canada (IC) Compliant to Canadian ICES-003, Class B limits **Europe:** CE Mark - Johnson Controls, Inc. declares that this product is in compliance with the essential requirements and other relevant provisions of the Low Voltage Directive and the EMC Directive when an EMC-compliant line filter is attached to the power supply.[1] **Australia:** Regulatory Compliance Mark (RCM)
Dimensions (H x W x D)	**Minimum:** 128 x 68 x 81 mm (5 x 2-11/16 x 3-3/16 in.) **Maximum:** 150 x 140 x 136 mm (5-15/16 x 5-1/2 x 5-5/16 in.)
Shipping Weight	**230 VAC ±10% Production Models:** **VFD68BBB, VFD68BCB**: 0.5 kg (1.1 lb) **VFD68BDC**: 0.8 kg (1.8 lb) **VFD68BFD**: 1.0 kg (2.2 lb) **VFD68BGG, VFD68BHG**: 1.4 kg (3.1 lb) **VFD68BJK**: 1.8 kg (4.0 lb) **VFD68BKL, VFD68BLL**: 3.6 kg (8.0 lb) **VFD68BMP**, **VFD68BNP**: 6.5 kg (14.3 lb) **460 VAC ±10% Production Models:** **VFD68CDF, VFD68CFF**: 1.3 kg (2.9 lb) **VFD68CGG**: 1.4 kg (3.1 lb) **VFD68CHH, VFD68CJJ**: 1.5 kg (3.3 lb) **VFD68CKL, VFD68CLL**: 3.3 kg (7.3 lb) **VFD68CMP, VFD68CNP:** 6.5 kg (14.3 lb)

1. For more information, see *Appendix 5: EMC Line Filter Selection Chart* on page 107.

VFD68Dxx Variable Frequency Drive (575 VAC) (Part 1 of 2)

Input Power Voltage/ Frequency	575 VAC, 50 Hz; Continuous Duty
Output Voltage/Frequency	575 VAC, 50 Hz; Continuous Duty
Input Devices	Johnson Controls/PENN® P499 Electronic Pressure Transducers

VFD68Dxx Variable Frequency Drive (575 VAC) (Part 2 of 2)

PWM Carrier Frequency	Adjustable 0.7 to 15 kHz
Motor Requirements	Three-phase NEMA Design B motors required; Inverter-rated motors recommended
Overload Capacity	150% of ampere rating for 1 minute
Start/Stop	Use STF input to start or stop the motor
Ambient Conditions	**Storage:** -40 to 65ºC (-40 to 149ºF), 0 to 95% RH Non-condensing
	Operating: -40 to 50ºC (-40 to 122ºF), 0 to 95% RH Non-condensing
	Altitude: 1,000 m (3,300 ft) Maximum without derating
Enclosures	UL Type 1 (NEMA) Fan Cooled
Maximum High-Voltage Wire Length	Up to 100 m (328 ft) between the VFD68 drive and the motor (using the appropriate wire gauge)
Compliance	**North America:** cULus Listed, UL 508C, CSA-C22.2 No. 14, File E244421;
Dimensions (H x W x D)	**Minimum:** 150 x 140 x 136 mm (5-15/16 x 5-1/2 x 5-5/16 in.) **Maximum:** 150 x 220 x 148 mm (5-15/16 x 8-11/16 x 5-13/16 in.)
Shipping Weight	**575 VAC +5/-10% Production Models:** **VFD68DFM**: 1.8 kg (3.96 lb) **VFD68DGM, VFD68DHM**: 2.0 kg (4.41 lb) **VFD68DJN, VFD68DKN, VFD68DLN**: 3.8 kg (8.38 lb)

Appendix 1: Check Fault History

The last eight Fault, Error, or Warning indicator messages are stored in the VFD. To view these messages, use the following procedure and see Figure 40 on page 79:

1. Power the VFD and set it to the MON mode (**MON** LED is on).
2. Press the MODE button twice to enter Fault History mode (**E---**).
3. Rotate the setting dial slightly.
   - If an Indicator Fault, Error, or Warning has occurred, the display blinks while showing an indicator message.
   - If no Fault, Error, or Warning has occurred, the display shows **E 0**.
4. Press the setting dial to view the actual indicator message number (message number 1 is the most recent).
5. Rotate the setting dial to view all eight indicator messages.

To exit the Fault History Mode, press the MODE button until the MON LED is on.

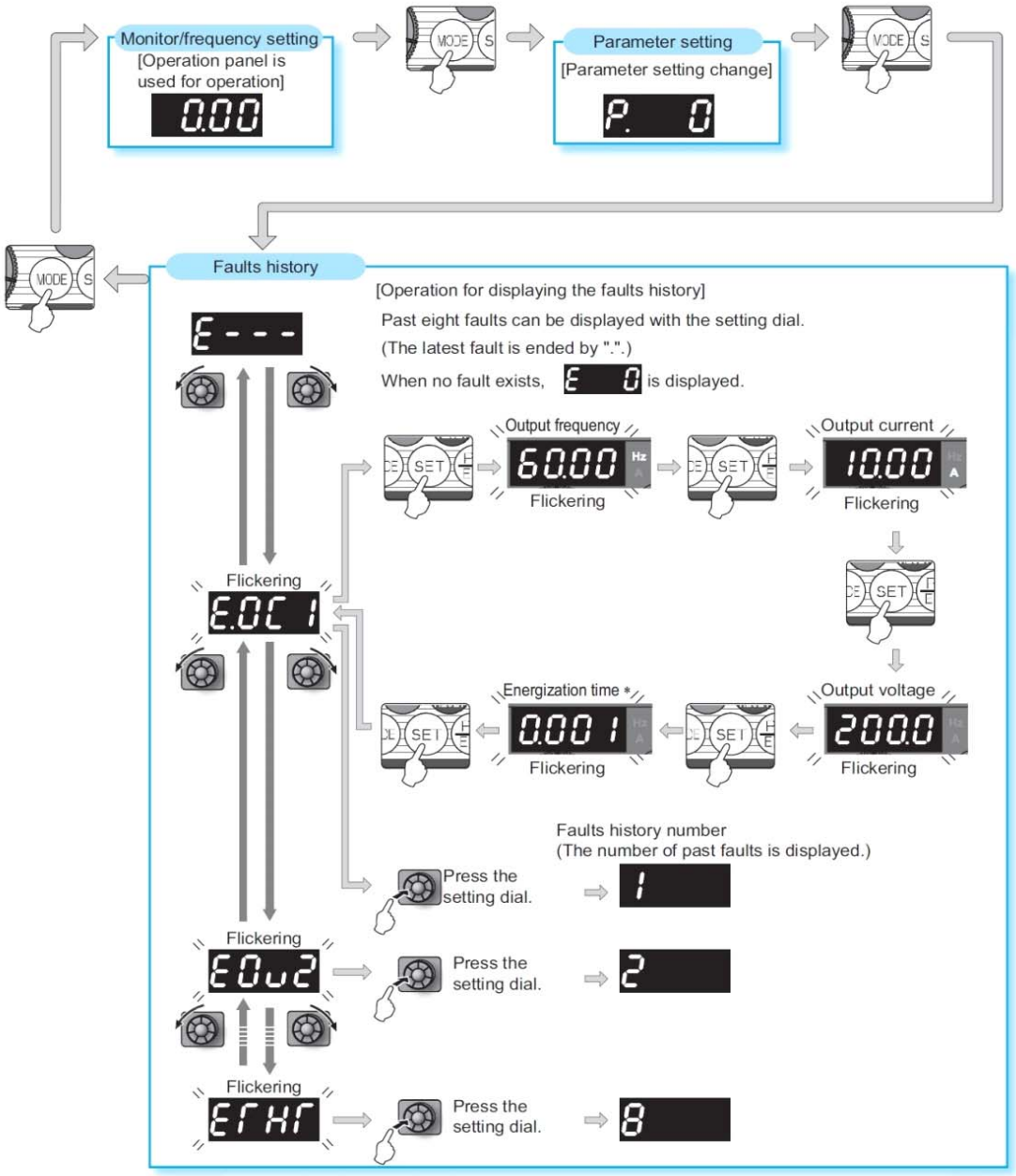


Figure 40: Check Fault History

Appendix 2: Additional VFD68 Drive Application Examples

VFD68Bxx and VFD68Cxx Drives

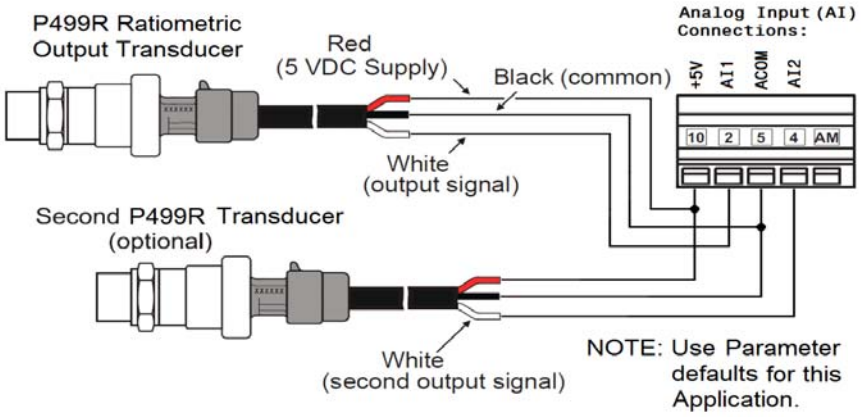


Figure 41: Connecting Two Ratiometric Transducers

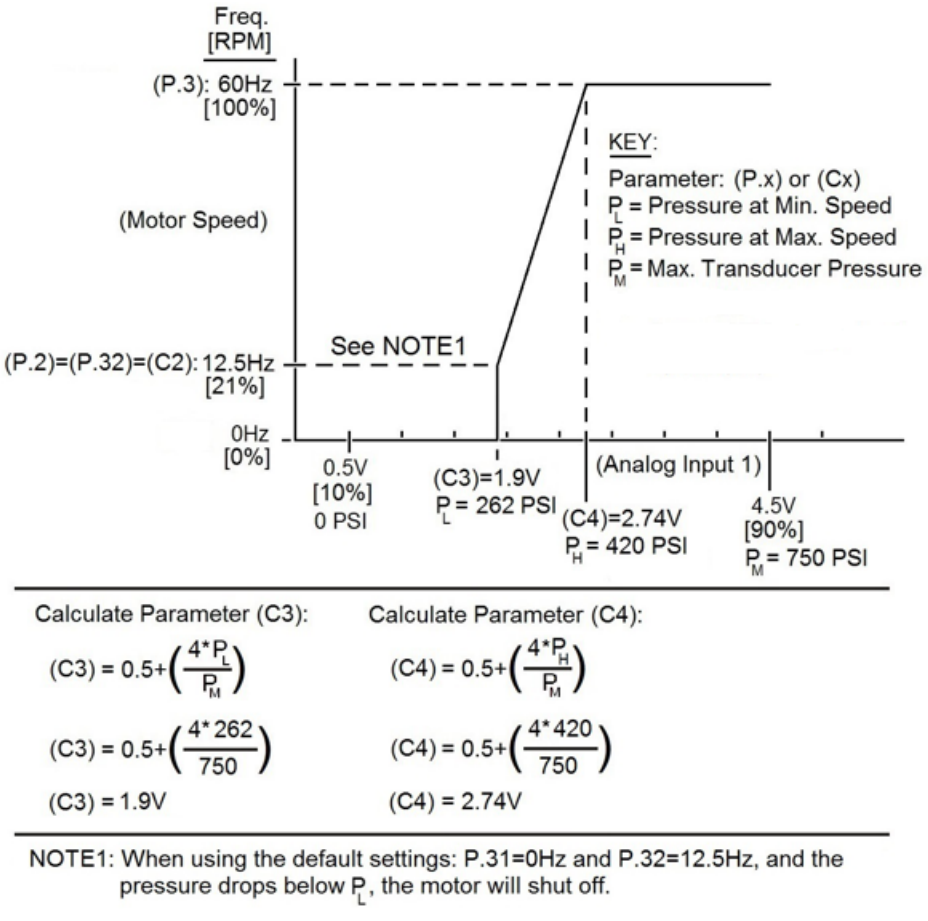
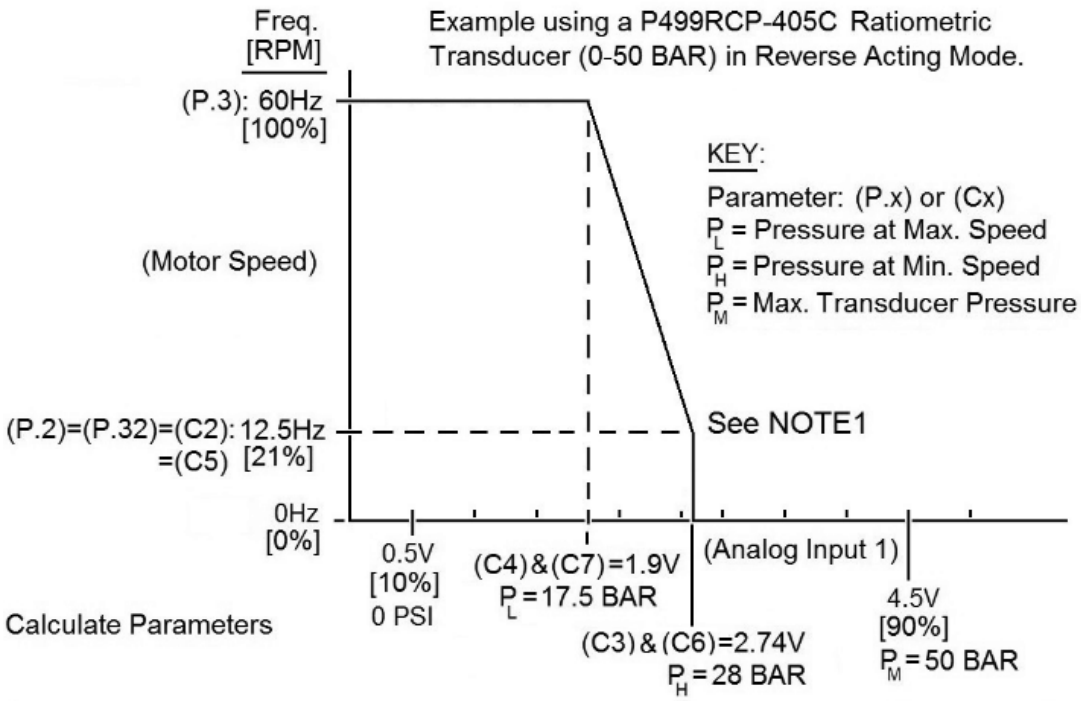


Figure 42: Motor Speed versus Pressure Ramp for 0–750 PSI Transducer

P_L = 262 PSI; P_H = 420 PSI; C 3, C 4, C 6, and C 7 use default settings.



Calculate Parameters (C4) & (C7):

$$(C4)\ \&\ (C7) = 0.5+\left(\frac{4*P_L}{P_M}\right)$$

$$(C4)\ \&\ (C7) = 0.5+\left(\frac{4*17.5}{50}\right)$$

$$(C4)\ \&\ (C7) = 1.9V$$

Calculate Parameters (C3) & (C6):

$$(C3)\ \&\ (C6) = 0.5+\left(\frac{4*P_H}{P_M}\right)$$

$$(C3)\ \&\ (C6) = 0.5+\left(\frac{4*28}{50}\right)$$

$$(C3)\ \&\ (C6) = 2.74V$$

NOTE1: To create the Reverse Acting mode functionality (where the fan runs at full speed when pressure is low and runs at minimum speed or shuts off at high pressure), assign the low pressure at Max. Speed point to Parameters C4 and C7, and assign the high pressure at Min. Speed point to Parameters C3 and C6.

When using the default settings: P.31=0Hz and P.32=12.5Hz, and the pressure rises above P_H, the motor will shut off.

Figure 43: Motor Speed versus Pressure Ramp for 0–50 PSI Transducer Used in a Reverse Acting Mode (RA Mode)

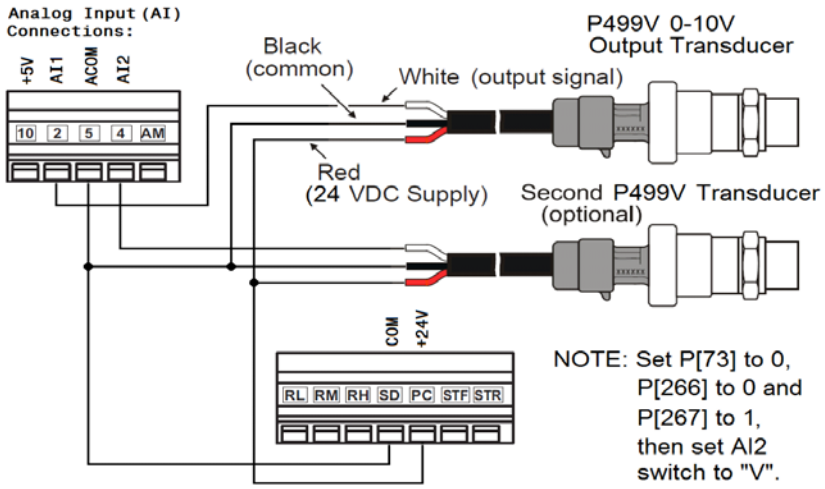


Figure 44: Connecting Two 0–10V Output Transducers

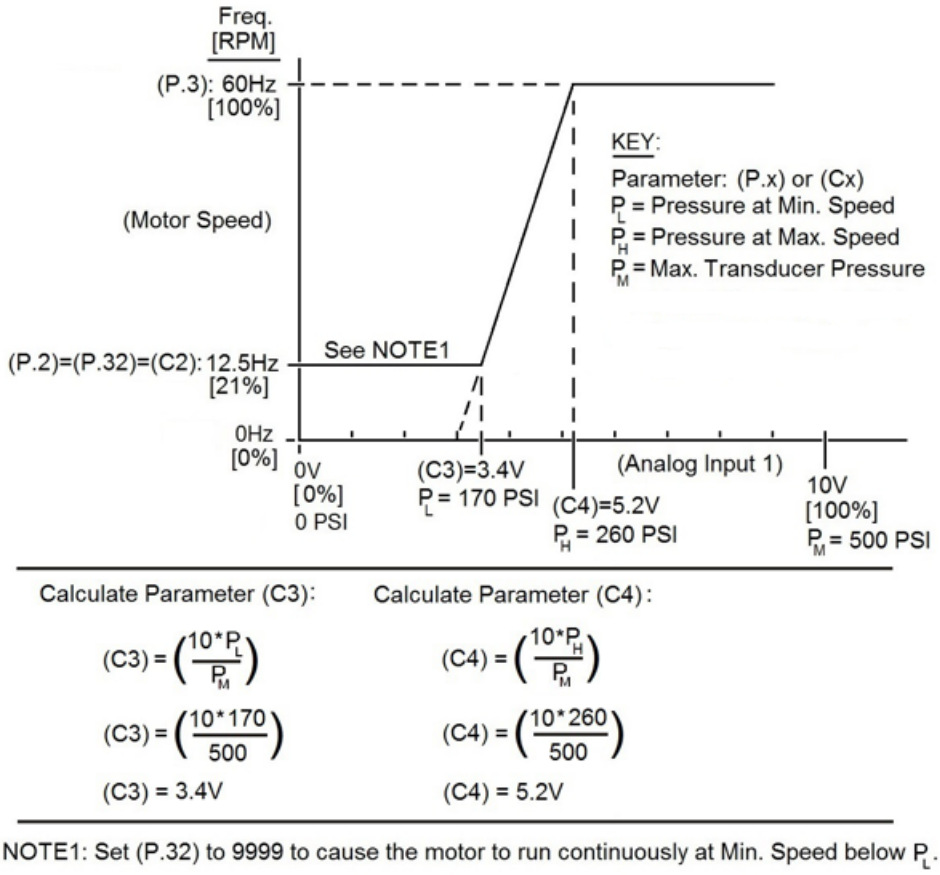


Figure 45: Motor Speed versus Pressure Ramp for 0–500 PSI Transducer

P_L = 170 PSI; P_H = 260 PSI; Calculate new values for C 3 and C 4. When connecting a second P499V transducer, then also change Parameter C 6 to 3.4V and change C 7 to 5.2V.

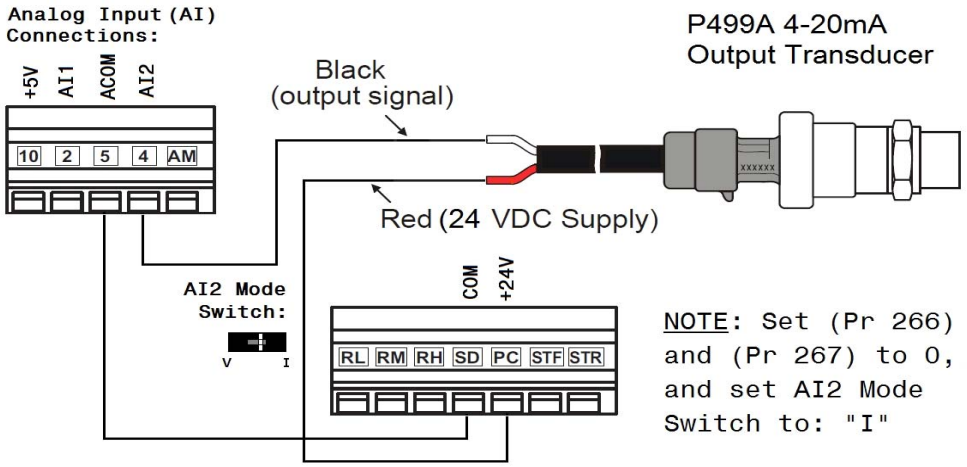


Figure 46: Connecting One 4–20 mA Output Transducer

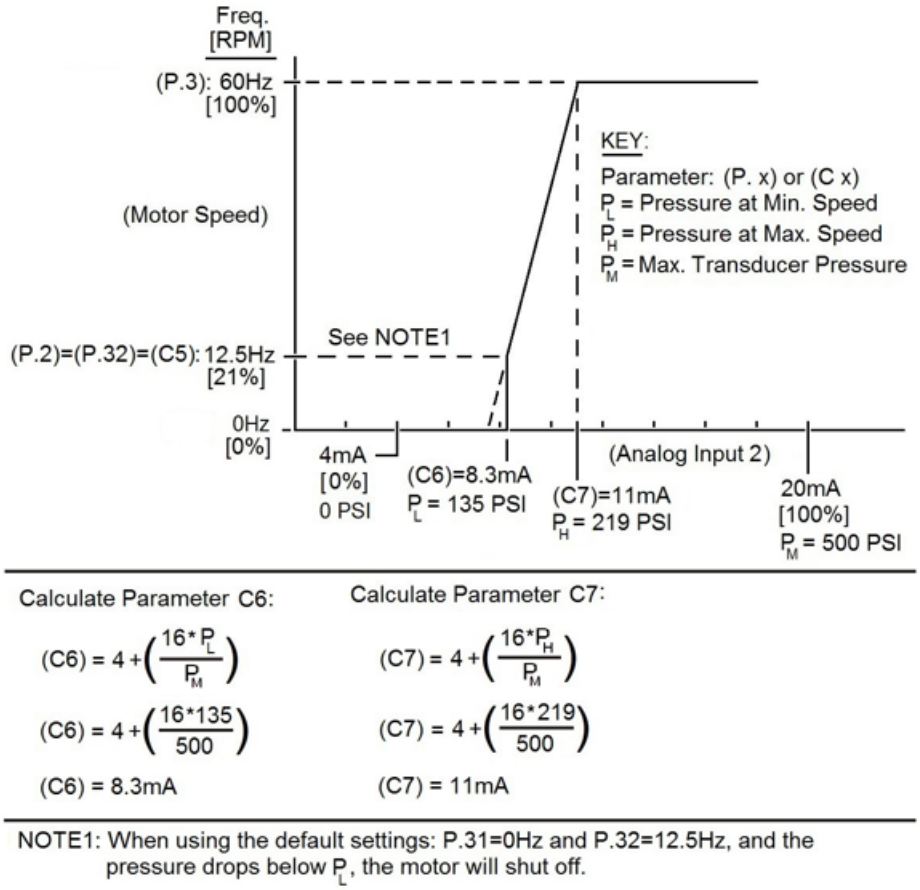


Figure 47: Motor Speed versus Pressure Ramp for 0–500 PSI 4–20 mA Transducer

P_L = 135 PSI; P_H = 219 PSI; Calculate new values for C 6 and C 7.

The C450CQN can use temperature, pressure, or humidity to control the VFD68 output to a motor. Set the AI2 mode switch to **V**.

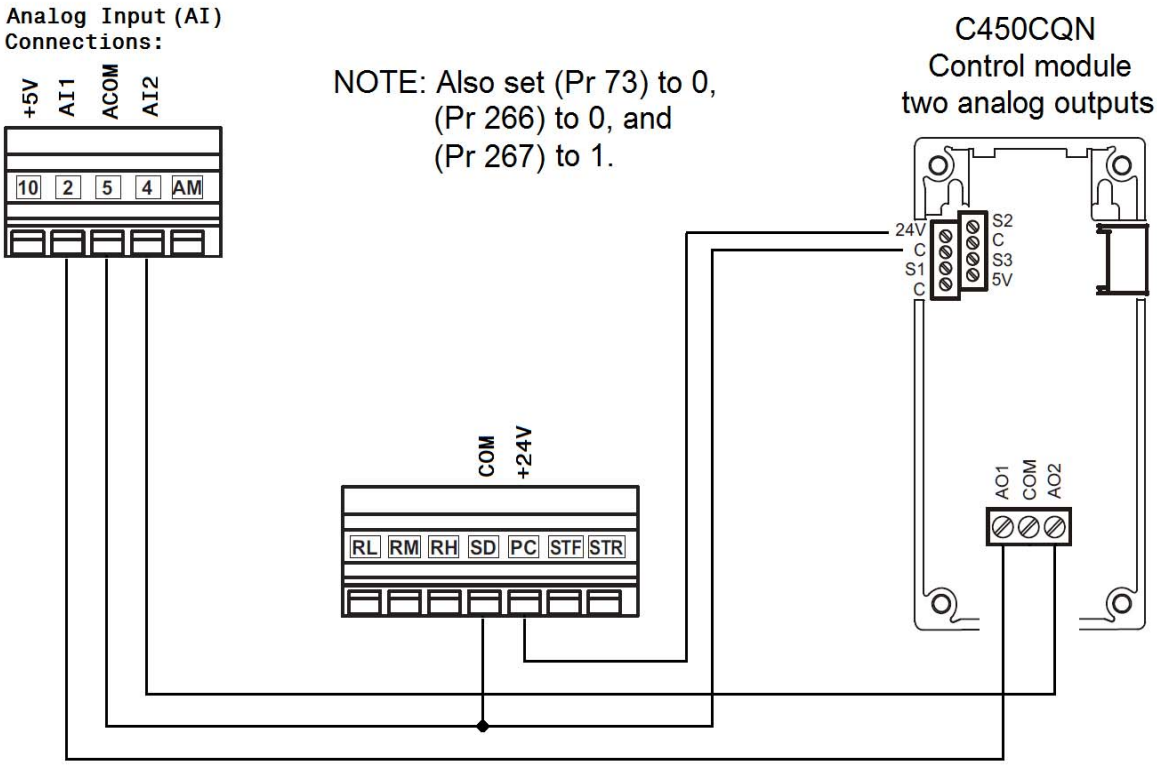


Figure 48: Connecting a C450CQN Control with a 0–10 V Output to a VFD68Bxx or VFD68Cxx Drive

VFD68Dxx Drives

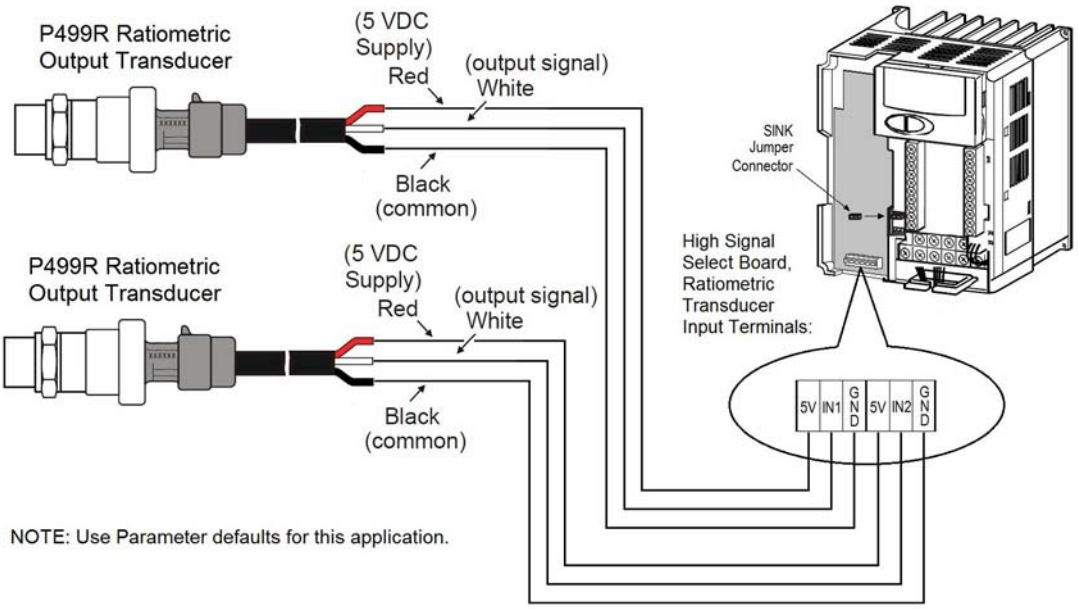


Figure 49: Wiring 0.5–4.5 VDC Ratiometric Input Signal Transducers

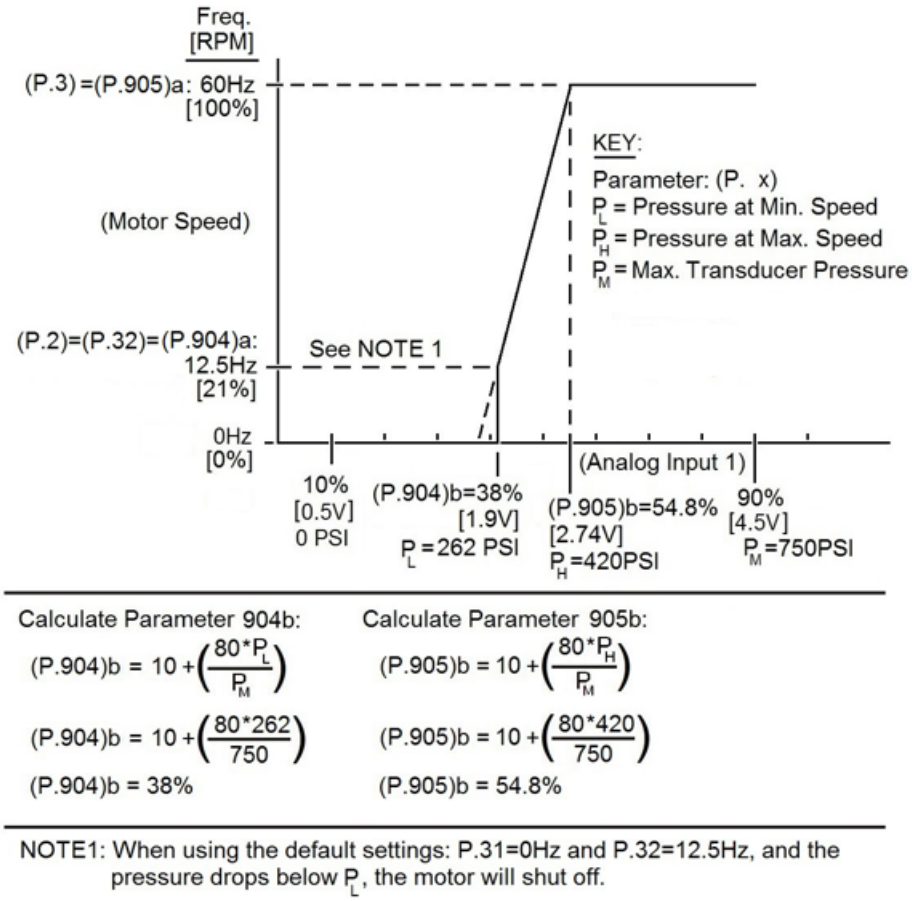


Figure 50: Motor Speed vs Pressure Ramp for Two 0.5–4.5 VDC 750 PSI Ratiometric Transducers

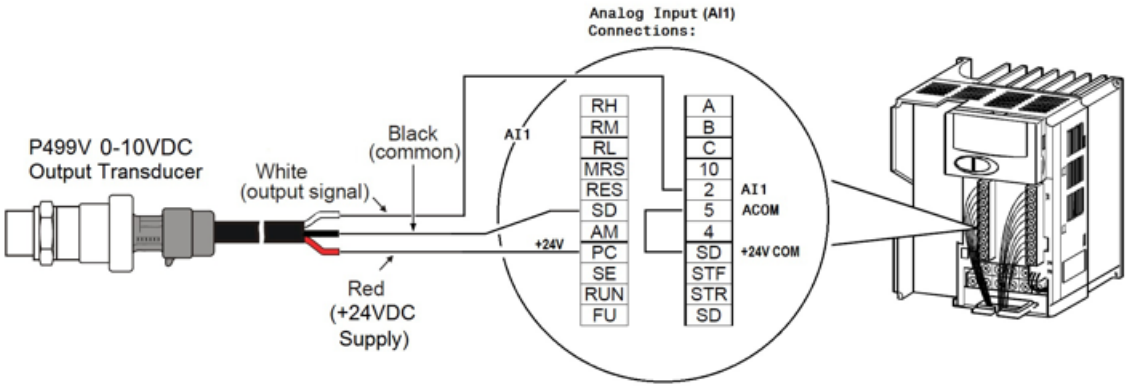
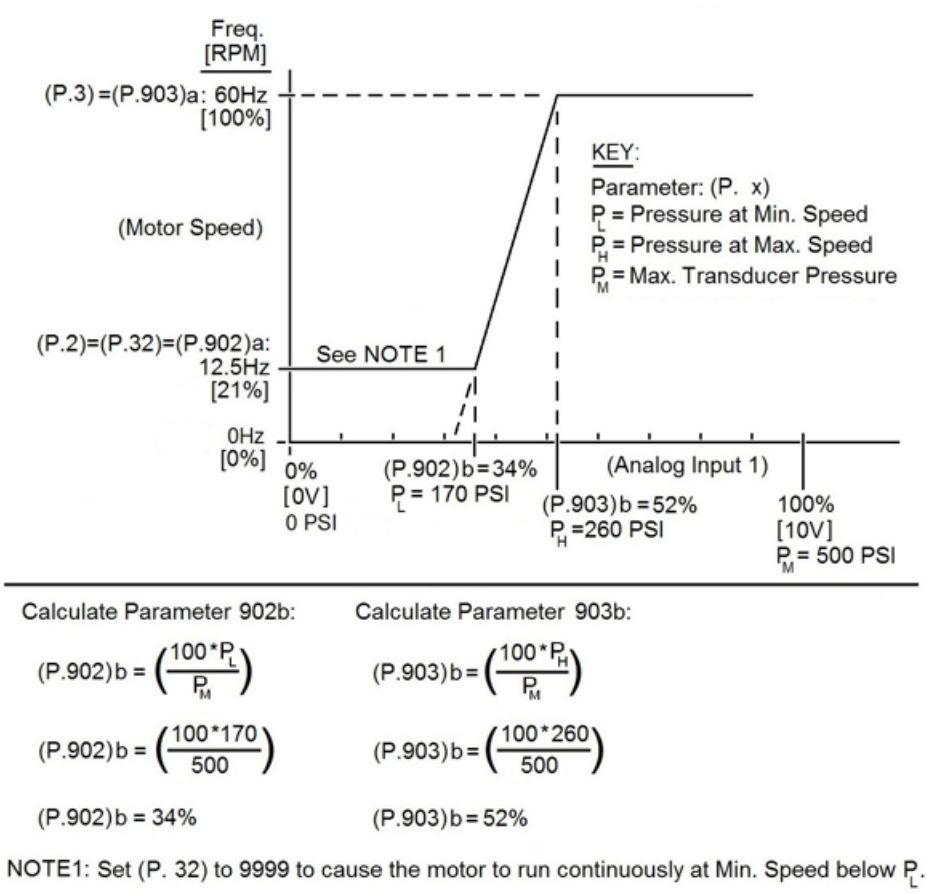


Figure 51: Wiring 0–10 V Input Signal Transducer



Calculate Parameter 902b:

$$(P.902)b = \left(\frac{100 * P_L}{P_M}\right)$$

$$(P.902)b = \left(\frac{100 * 170}{500}\right)$$

$$(P.902)b = 34\%$$

Calculate Parameter 903b:

$$(P.903)b = \left(\frac{100 * P_H}{P_M}\right)$$

$$(P.903)b = \left(\frac{100 * 260}{500}\right)$$

$$(P.903)b = 52\%$$

NOTE1: Set (P. 32) to 9999 to cause the motor to run continuously at Min. Speed below P_L.

Figure 52: Motor Speed vs Pressure Ramp for 0–10 VDC 500 PSI Transducer

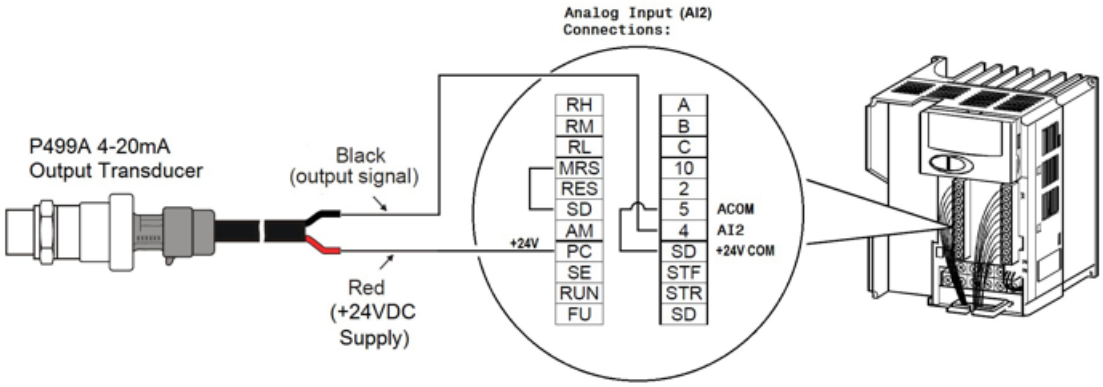
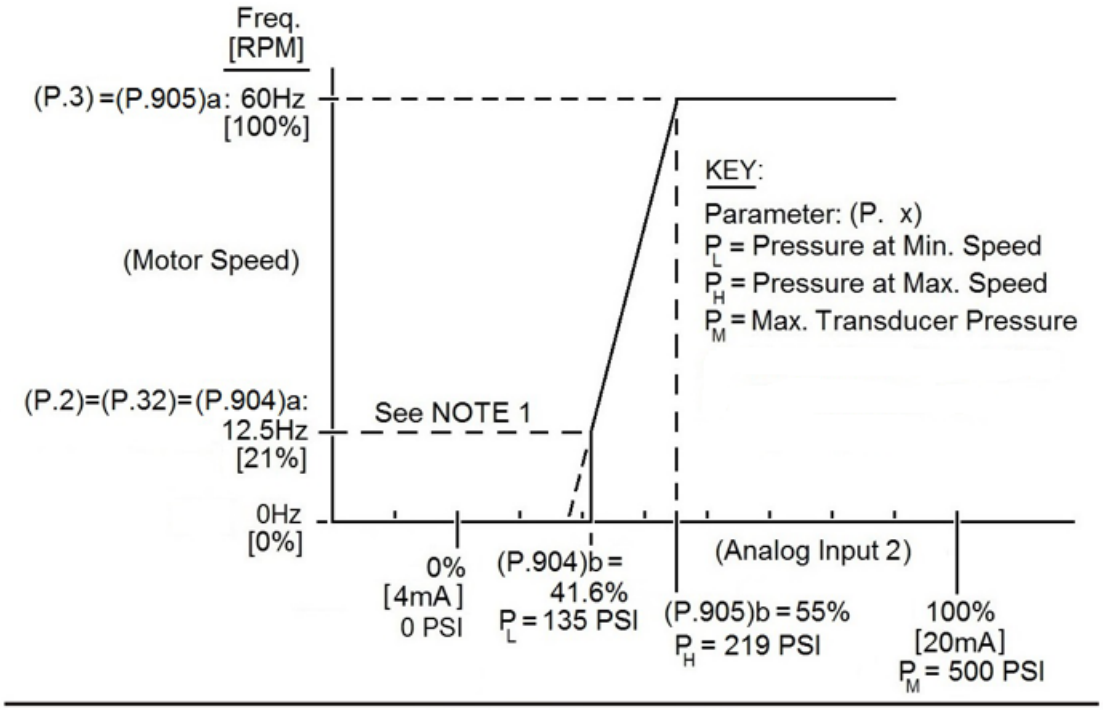


Figure 53: Wiring 4–20 mA Input Signal Transducer



Calculate Parameter (P.904)b:

$$(P.904)b = 20 + \left(\frac{80 * P_L}{P_M}\right)$$

$$(P.904)b = 20 + \left(\frac{80 * 135}{500}\right)$$

$$(P.904)b = 41.6\%$$

Calculate Parameter (P.905)b:

$$(P.905)b = 20 + \left(\frac{80 * P_H}{P_M}\right)$$

$$(P.905)b = 20 + \left(\frac{80 * 219}{500}\right)$$

$$(P.905)b = 55\%$$

NOTE1: When using the (P.32) default setting of 12.5Hz, the motor will shut off at the Min. Speed P_L.

Figure 54: Motor Speed vs Pressure Ramp for 4–20 mA 500 PSI Transducer

Appendix 3: Password Functions (P.296, P.297)

Registering a four-digit password can restrict parameter reading and writing. You can set these parameters when P.160 = 0.

Note: When P.296 is set to something other than 9999, then P.297 is always available to enter a password, regardless of the setting for P.160.

Table 82: Implement Password Protection

Parameter	Name	Default	Range	Description
P.296	Password Lock Level	9999	1 to 6, 101 to 106	Select the restriction level of parameter reading and writing when a password is required.
			9999	No password lock
P.297	Password Unlock/Lock	9999	1000 to 9998	Register a four-digit password
			(0)	(reading only) Valid when P.296 = 1 to 6
			(0 to 5)	Displays password unlock error count (reading only) Valid when P.296 = 101 to 106
			(9999)	No password lock (reading only)

Parameter Reading and Writing Restriction Level

P.296 controls the level of reading and writing restriction.

Table 83: Parameter Reading and Writing Restriction (P.296)

P.296 Setting	PU Operation Mode Command[1]		NET Mode Operation Command[2]	
	Read[3]	**Write[4]**	**Read[3]**	**Write[4]**
9999	Enabled	Enabled	Enabled	Enabled
1, 101	Enabled	Restricted	Enabled	Restricted
2, 102	Enabled	Restricted	Enabled	Enabled
3, 103	Enabled	Enabled	Enabled	Restricted
4, 104	Restricted	Restricted	Restricted	Restricted
5, 105	Restricted	Restricted	Enabled	Enabled
6, 106	Enabled	Enabled	Restricted	Restricted

1. Parameter access from a unit where the parameter is written in the PU Manual Operation mode is restricted.
2. Parameter access in NET Operation mode with RS-485 communication is restricted.
3. If the parameter reading is restricted by P.160, P.296 is unavailable for reading, even when enabled.
4. If the parameter writing is restricted by P.77, P.296 is unavailable for writing, even when enabled.

Password Lock and Unlock

Lock

1. Set the parameter restriction level as shown in Table 84.

Table 84: Set Password Restriction Level (P.296)

P.296 Setting	Restriction of Password Unlock Error	P.297 Display
1 to 6	No restriction	Always 0
101 to 106	Restricted at fifth error[1]	Displays error count (0 to 5)

1. If the password unlock error has occurred five times, see *Perform a Parameter All Clear* to unlock the restriction. Entering the correct password after the fifth incorrect entry has no effect.

2. Enter a four-digit number (1000 to 9998) as a password.
   - When a password is registered, parameter reading and writing is restricted with the restriction level set in P.297 until unlocking.
   - After registering a password, a read value of P.297 is always 0 to 5.
   - When a password-restricted parameter is read or written, LOCd appears on the display.
   - Even if a password is registered, parameters that the VFD itself writes, such as VFD Parts Life, are overwritten occasionally.

Unlock

You can unlock the password one of two ways:

- enter a password in P.297
- perform a parameter all clear (see *Perform a Parameter All Clear* on page 89.)

Enter a Password in P.297

Entering a correct password in P.297 unlocks the VFD and sets P. 297 back to 9999 (no password lock). You must enter a setting from 1000 to 9998 again for this parameter to register a new 4-digit password. Entering an incorrect password:

- (when P.296 = 1 to 6) creates a password unlock error, but does not lock the VFD. If the correct password is eventually entered, the VFD68 will unlock.
- (when P.296 = 101 to 106) creates a password unlock error.

  Note: If the password unlock error has occurred five times, the VFD password function locks, and you must perform a Parameter All Clear to unlock the restriction (see *Perform a Parameter All Clear* on page 89). Entering the correct password after the fifth incorrect entry has no effect.

Perform a Parameter All Clear

- If you forgot the password, perform a parameter all clear to unlock the parameter restriction.

  Note: When you perform a parameter all clear, all parameters are restored to the default values.
- Parameter all clear cannot be performed while the VFD has an active voltage output.

Appendix 4: VFD68Bxx and VFD68Cxx ModBus RTU RS485 Communications Bus Specifications

You must create a custom RS485 communication cable to connect the VFD68Bxx or VFD68Cxx to the head end of a ModBus RTU network.

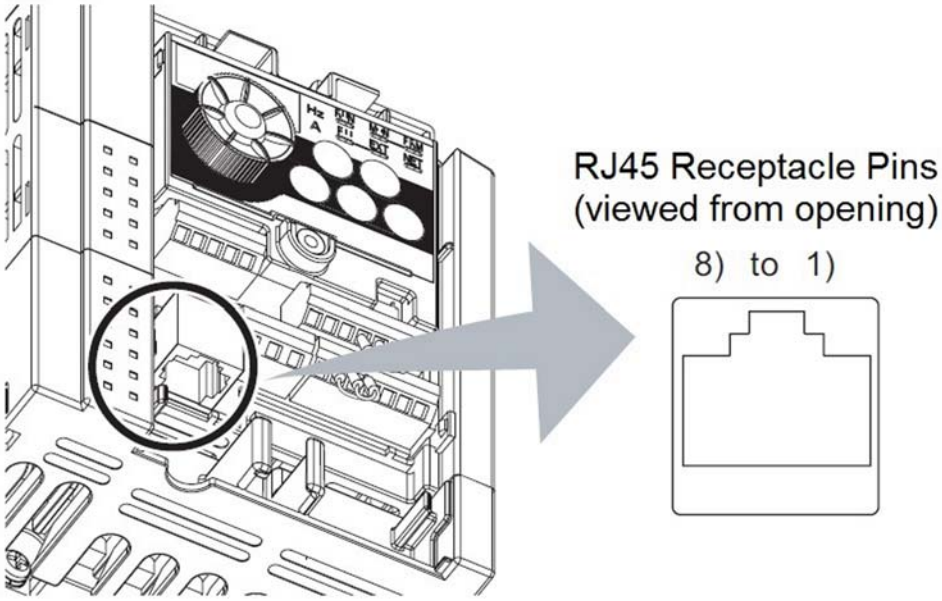


Figure 55: VFD68Bxx and VFD68Cxx Identification of RJ45 Receptacle

IMPORTANT: **Do not** connect pin 2 or pin 8 to a communication cable. Pin 2 and pin 8 of the RJ45 receptacle are connected to a power supply in the VFD68 drive. Connecting one or both of these pins to a communication cable may damage the VFD68 drive.

Table 85: VFD68Bxx and VFD68Cxx RJ45 Pin Identifications for Communications Bus

Pin Number	Name	Description
1	SG	Earth (ground) (connected to terminal 5)
2	—	Power supply
3	RDA	VFD receive (+)
4	SDB	VFD send (-)
5	SDA	VFD receive (+)
6	RDB	VFD send (-)
7	SG	Earth (ground) (connected to terminal 5)
8	—	Power supply

Using the Modbus RTU communication protocol, you can set the communication operation or parameter using the operation panel on the VFD68 drive. These parameters can be set when P.160 = 0.

Table 86: Parameters for ModBus RTU RS485 Communications

Parameter Number	Name	Default	Range				
P.117	PU communication station number	0	0	No reply to the master[1]			
			1 to 247	VFD station number specification Set the VFD station numbers when two or more VFDs are connected to one computer.			
P.118	PU communication speed	96	48, 96, 192, 384	Communication speed The setting value x 100 equals the communication speed. For example, if the communication setting is 96, the communication speed is 9600 bps.			
P.120	PU communication parity check	2	0	Without parity check; Stop bit length: 2 bits			
			1	With odd parity check; Stop bit length: 1 bit			
			2	With even parity check; Stop bit length: 1 bit			
P.122[2]	PU communication check time interval	9999	0				
			0.1 to 999.8				
			9999				
P.343	Communication error count	0	___	Displays the number of communication errors during Modbus RTU communication (reading only)			
P.502	Stop mode selection at communication error	0		**At Fault Occurrence**	**Indication**	**Fault Output**	**At Fault Removal**
			0	Coasts to stop	E.PUE	Output	Stop (E.PUE)
			1	Decelerates to stop	After stop, E.PUE	Output after stop	Stop (E.PUE)
			2	Decelerates to stop	After stop, E.PUE	Without output	Automatic restart functions
P.549	Protocol selection	0	0	VFD (computer link operation) protocol			
			1	Modbus RTU protocol			

1. When Modbus RTU communication is performed from the master with address 0 (station number 0) set, broadcast communication is selected and the VFD does not send a response message. When a response from the VFD is necessary, set a value other than 0 in P.117. Some functions are invalid for broadcast communication.
2. Specifications differ according to the date assembled.

Communication Specification

Table 87: Communication Specification

Item		Description	Related Parameter
Communication Protocol		Modbus RTU protocol	P.549
Conforming Standard		EIA-485 (RS-485)	—
Number of Connectable Devices		1:N (maximum 32 units), setting is 0 to 247 stations	P.117
Communication Speed		Select 4800, 9600, 19200, or 38400 bps	P.118
Control Procedure		Asynchronous	—
Communication Method		Half-duplex	—
Communication	Character System	Binary (always 8 bits)	—
	Start Bit	1 bit	—
	Stop Bit Length Parity Check	• No parity, stop bit length: 2 bits • Odd Parity; stop bit length: 1 bit • Even parity; stop bit length: 1 bit	P.120
	Error Check	CRC code check	—
	Terminator	Not used	—
Waiting Time Setting		Not used	—

Outline

The Modbus protocol performs serial communication between the master and slave (VFD) using the dedicated message frame. The dedicated message frame has functions that can read and write data. Using these functions, you can:

- read and write the parameter values from the VFD
- write the input commend of the VFD
- check the operating status

The master communicates with the slave (VFD) by accessing the assigned holding register address.

Note: There are two different serial transmission modes: ASCII (American Standard Code for Information Interchange) and RTU (Remote Terminal Unit) mode. This product supports only the RTU mode, in which 1-byte (8-bit) data is transmitted as it is. Only the communication protocol is defined by the Modbus protocol - the physical layer is not stipulated.

Message Format

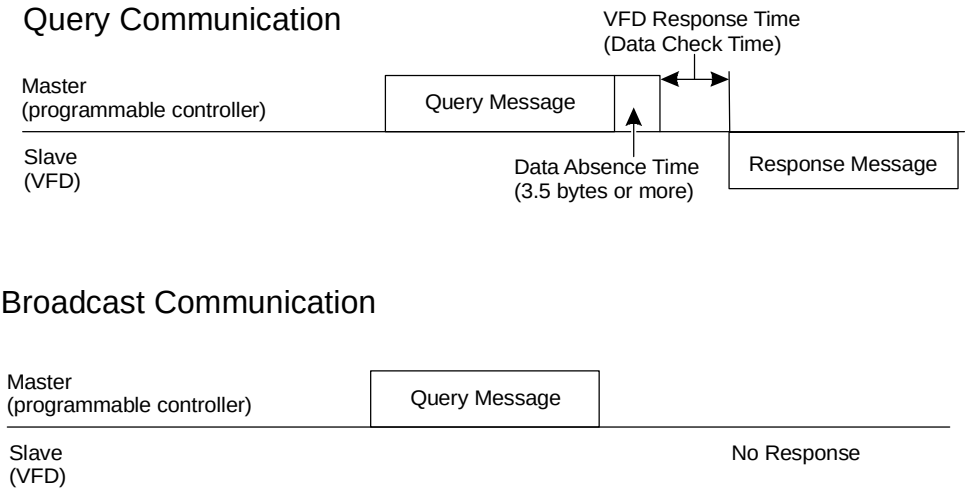


Figure 56: Message Format

Table 88: Data Check Time

Item	Check Time
Various Monitors, Operation Command, Frequency Setting (RAM)	< 20 ms
Parameter Read and Write, Frequency Setting (EEPROM)	< 50 ms
Parameter Clear or All Clear	< 5 s
Reset Command	No answer

Query

The master sends a message to the slave (VFD) at the specified address.

Normal Response

After receiving the query from the master, the slave executes the requested function and returns the corresponding normal response to the master.

Error Response

If an invalid function code, address, or data is received, the slave returns it to the master. When a response description is returned, the error code indicating that the request from the master cannot be executed is added. No response is returned for the hardware-detected error, frame error, and CRC check error.

Broadcast

By specifying address 0, the master can send a message to all slaves. All slaves that received the message from the master execute the requested function. In this communication, the slaves do not return a response to the master.

Note: The VFD performs the function independently of the VFD station number setting (P.117) during broadcast communication.

Message Frame (Protocol)

Communication Method

The master sends a query message (question), and the slave returns a response message (response). When communication is normal, Device Address and Function Code are copied. When communication is abnormal (function code or data code is illegal), bit 7 (=80H) of Function Code is turned on, and the error code is set to Data Bytes.

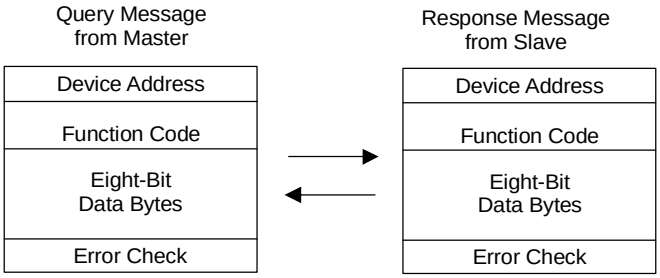


Figure 57: Communication Message Structure

The message frame consists of the four message fields as shown in Figure 57. By adding the no-data time (T1: Start, End) of 3.5 characters to the beginning and end of the message data, the slave recognizes it as one message.

Protocol Details

Table 89: Summary of Message Fields

Start	1	2	3	4		End
	Address	Function	Data	CRC Check		
T1	8 bit	8 bit	n x 8 bit	L 8 bit	H 8 bit	T1

Table 90: Description of Message Fields (Part 1 of 2)

Message Field	Description
Address	The address code is 1 byte long (8 bits) and any address from 0 to 247 can be set. Set 0 to send a broadcast message (all-address instruction) or any of 1 to 247 to send a message to each slave. When the slave responds, it returns the address set from the master. The value of P.117 is the slave address.

Table 90: Description of Message Fields (Part 2 of 2)

<table>
<tr><th>Message Field</th><th>Description</th></tr>
<tr><td>Function</td><td>The function code is 1 byte (8 bits) and any address from 0 to 247 can be set. The master sets the function that it wants to request to the slave, and the slave performs the requested operation.
See the sub-table for the supported function codes.
<table>
<tr><th>Code</th><th>Function Name</th><th>Outline</th><th>Broadcast Communication</th></tr>
<tr><td>H03</td><td>Read Holding Register</td><td>Reads the holding register data</td><td>Not Allowed</td></tr>
<tr><td>H06</td><td>Present Single Register</td><td>Writes data to the holding register</td><td>Allowed</td></tr>
<tr><td>H08</td><td>Diagnostics</td><td>Function diagnosis (communication check only)</td><td>Not Allowed</td></tr>
<tr><td>H10</td><td>Present Multiple Register</td><td>Writes data to multiple consecutive holding registers</td><td>Allowed</td></tr>
<tr><td>H46</td><td>Read Holding Register Access Log</td><td>Reads the number of registers that succeeded in communication last time</td><td>Not Allowed</td></tr>
</table>
• If the set function code is other than the ones listed in this sub-table, the slave returns an error response.
• When the slave returns a normal response, it returns the function code set by the master.
• When the slave returns an error response, it returns H80 + function code.</td></tr>
<tr><td>Data</td><td>The format changes depending on the function code. Data includes the byte count, number of bytes, description of the access to the holding register, and similar information.</td></tr>
<tr><td>CRC Check</td><td>The message frame is checked for error by creating a CRC number. This two-byte long CRC data is added to the end of the message. When CRC is added to the message, the low-order byte is added first and is followed by the high-order byte.
The CRC value is calculated by the master and is added to the master message. The slave recalculates the CRC after the message is received and compares it with the value received in the message. If these values do not match, then the slave flags this message as containing an error and discards the message.</td></tr>
</table>

Message Format Types

Read Holding Register Data (H03 or 03)

Can read the description of the following items:

1. system environment variables
2. real-time monitor
3. fault history
4. VFD parameters assigned to the holding register area

Table 91: Query Message

Slave Address	Function	Starting Address		Number of Points		CRC Check	
(8 bit)	H03 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 92: Normal Response Message

Slave Address	Function	Byte Count	Data			CRC Check	
(8 bit)	H03 (8 bit)	(8 bit)	H (8 bit)	L (8 bit)	... (n x 16 bit)	L (8 bit)	H (8 bit)

Table 93: Query Message Description

Message	Description
Slave Address	Address to which the message is sent. Broadcast communication cannot be made (0 is invalid).
Function	Set H03
Starting Address	Set the address at which holding register data read is started Starting address = starting register address (decimal)-40001 For example, setting the starting address 0001 reads the data of the holding register 40002.
Number of Points	Number of holding registers from which the data is read (125 maximum).

Table 94: Normal Response Message Description

Message	Description
Byte Count	The setting range is H02 to H14 (2 to 20). The byte count is set at twice the number of points.
Data: Read Data	The number of data to be read equals the number of points. Data are read in order of high byte and low byte, and set in order of starting address data, starting address+1 data, starting address +2 data, and so forth.

Example

The following tables contain a query message directed to the VFD68 slave address 17 (H11). This message requests a read of register addresses (parameter values) 41004 (P.4) to 41006 (P.6). These tables also show the VFD68 slave response message containing the 2 byte Parameter Values P. 4, P. 5, and P. 6 (Table 95 and Table 96).

Table 95: Query Message

Slave Address	Function	Starting Address		Number of Points		CRC Check	
H11 (8 bit)	H03 (8 bit)	H03 (8 bit)	HEB (8 bit)	H00 (8 bit)	H03 (8 bit)	H77 (8 bit)	H2B (8 bit)

Table 96: Normal Response (Response Message)

Slave Address	Function	Byte Count	Data						CRC Check	
H11 (8 bit)	H03 (8 bit)	H06 (8 bit)	H17 (8 bit)	H70 (8 bit)	H0B (8 bit)	HB8 (8 bit)	H03 (8 bit)	HE8 (8 bit)	H2C (8 bit)	HE6 (8 bit)

Register Starting Address: H03 HEB = 1003 decimal. A base number of 40001 decimal must be added to this Register Starting Address to achieve the Register number of: 41004 decimal for Parameter 4 (see Table 120).

Read value

Register 41004 (P.004); H1770 (60.00 Hz)

Register 41005 (P.005); H0BB8 (30.00 Hz)

Register 41006 (P.006); H03E8 (10.00 Hz)

Write Holding Register Data (H06 or 06)

The following tables contain a query message directed to the VFD68 slave instructing a write to a register address (parameter value) using the 2 byte preset data, followed by the VFD68 response message (Table 97 through Table 100).

Table 97: Query Message

Slave Address	Function	Register Address		Preset Data		CRC Check	
(8 bit)	H06 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 98: Normal Response (Response Message)

Slave Address	Function	Register Address		Preset Data		CRC Check	
(8 bit)	H06 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 99: Query Message Setting

Message	Setting Description
Slave Address	Address to which the message will be sent. Setting address to 0 enables broadcast communication.
Function	Set H06
Register Address	Address of holding register to which data will be written Register address = holding register address (decimal)-40001 For example, setting the register address 0001 reads the data of the holding register 40002.
Preset Data	Data that will be written to the holding register. The written data is always 2 bytes.

Table 100: Description of Normal Response[1]

Message	Setting Description
Slave Address	Address to which the message is sent. Setting address to 0 enables broadcast communication.
Function	Set H06
Register Address	Address of holding register to which data is written Register address = holding register address (decimal)-40001 For example, setting the register address 0001 reads the data of the holding register 40002.
Preset Data	Data that is written to the holding register. The written data is always 2 bytes.

1. Slave address, function, register address, preset data, and CRC check of the normal response are identical to those of the query message. No response is made for broadcast communication.

Example

The following tables contain a query message directed to the VFD68 slave address 5 (H05) instructing a 2 byte preset data write a value of 60HZ (H1770) to the running frequency RAM register address (system environment variable) of 40014, followed by the VFD68 response message (Table 101, Table 102).

Table 101: Query Message

Slave Address	Function	Register Address		Preset Data		CRC Check	
H05 (8 bit)	H06 (8 bit)	H00 (8 bit)	H0D (8 bit)	H17 (8 bit)	H70 (8 bit)	H17 (8 bit)	H99 (8 bit)

Table 102: Normal Response (Response Message)[1]

Slave Address	Function	Register Address		Preset Data		CRC Check	
H05 (8 bit)	H06 (8 bit)	H00 (8 bit)	H0D (8 bit)	H17 (8 bit)	H70 (8 bit)	H17 (8 bit)	H99 (8 bit)

1. Slave address, function, register address, preset data, and CRC check of the normal response are identical to those of the query message. No response is made for broadcast communication.

Note: For broadcast communication, no response is returned in reply to a query; therefore, the next query must be made when the VFD processing time has elapsed after the previous query.

Function Diagnosis (H08 or 08)

A communication check can be made because the query message that was sent is returned unchanged as a response message (function of subfunction code H00).

Table 103: Query Message

Slave Address	Function	Subfunction		Date		CRC Check	
(8 bit)	H08 (8 bit)	H00 (8 bit)	H00 (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 104: Normal Response (Response Message)

Slave Address	Function	Subfunction		Date		CRC Check	
(8 bit)	H08 (8 bit)	H00 (8 bit)	H00 (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 105: Query Message Setting

Message	Setting Description
Slave Address	Address to which the message is sent. Broadcast communication cannot be made: 0 is an invalid setting.
Function	Set H08
Subfunction	Set H000
Data	Any data can be set if it is 2 bytes long. The setting range is H0000 to HFFFF.

Table 106: Normal Response Message to Query[1]

Message	Setting Description
Slave Address	Address to which the message is sent. Broadcast communication cannot be made: 0 is an invalid setting.
Function	Set H08
Subfunction	Set H000
Data	Any data can be set if it is 2 bytes long. The setting range is H0000 to HFFFF.

1. Slave address, function, subfunction, and CRC check of the normal response are identical to those of the query message.

For broadcast communication, no response is returned in reply to a query; therefore, the next query must be made when the VFD processing time has elapsed after the previous query.

Write Multiple Holding Register Data (H10 or 16)

You can write data to multiple holding registers.

Table 107: Query Message

Slave Address	Function	Starting Address		Number of registers		Byte Count	Data			CRC Check	
(8 bit)	H10 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	(8 bit)	H (8 bit)	L (8 bit)	... (nx2x8 bit)	L (8 bit)	H (8 bit)

Table 108: Normal Response (Response Message)

Slave Address	Function	Starting Address		Number of registers		CRC Check	
(8 bit)	H10 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 109: Query Message Setting[1]

Message	Setting Description
Slave Address	Address to which the message is sent. 0 enables broadcast communication
Function	Set H10
Starting Address	Address where holding register data write is started. Starting address = starting register address (decimal)-40001 For example, setting the starting address 0001 reads the data of the holding address 40002.
Number of Points	Number of holding registers where data is written. The number of registers where data can be written is a maximum of 125.
Byte Count	Setting range is H02 to HFA (0 to 250). Set a value twice greater than the value for the number of points.
Data	Set the data specified by the number of points. The written data are set in order of high byte and low byte, and arranged in order of the starting address data, starting address +1 data, starting address +2 data, and so forth.

1. Slave Address, Function, Starting Address, Number of Points, and CRC Check are the same for a normal response as for a query message.

Example

Use the following query message to write 0.5 seconds (H05) to 41007 (P.007) at the slave address 25 (H19) and 1 second (H0A) at 41008 (P.008)

Table 110: Query Message

Slave Address	Function	Starting Address		Number of Points		Byte Count	Data			CRC Check	
H19 (8 bit)	H10 (8 bit)	H03 (8 bit)	HEE (8 bit)	H00 (8 bit)	H02 (8 bit)	H04 (8 bit)	H00 (8 bit)	H05 (8 bit)	H00 (8 bit)	H86 (8 bit)	H3D (8 bit)

Table 111: Normal Response (Response Message)

Slave Address	Function	Starting Address		Number of Points		CRC Check	
H19(8 bit)	H10 (8 bit)	H03 (8 bit)	HEE (8 bit)	H00 (8 bit)	H02 (8 bit)	H22 (8 bit)	H61 (8 bit)

Read Holding Register Access Log (H46 or 70)

A response can be made to a query made by the function code H03 or H10. The starting address of the holding registers that succeed in access during previous communication are returned. Also, the number of successful registers are returned. In response to the query for other than the above function code, 0 is returned for the address and number of registers.

Table 112: Query Message

Slave Address	Function	CRC Check	
(8 bit)	H46 (8 bit)	L (8 bit)	H (8 bit)

Table 113: Normal Response (Response Message)

Slave Address	Function	Starting Address		Number of Points		CRC Check	
(8 bit)	H46 (8 bit)	H (8 bit)	L (8 bit)	H (8 bit)	L (8 bit)	L (8 bit)	H (8 bit)

Table 114: Query Message Setting

Message	Setting Description
Slave Address	Address to which the message is sent. Broadcast communication cannot be made: 0 is an invalid setting.
Function	Set H46

Table 115: Normal Response Message to Query

Message	Setting Description
Starting Address	The starting address of the holding registers that succeeded is returned. Starting address = starting register address (decimal) - 40001 For example, when the starting address 0001 is returned, the address of the holding register that succeeded in access if 40002.
Number of Points	The number of holding registers that succeeded in access is returned

Example

Use the following query message to read the successful register starting address and successful count from the slave address 25 (H19).

Table 116: Query Message

Slave Address	Function	CRC Check	
H19 (8 bit)	H46 (8 bit)	L (8 bit)	H (8 bit)

Table 117: Normal Response (Response Message)

Slave Address	Function	Starting Address		Number of Points		CRC Check	
H19 (8 bit)	**H10** (8 bit)	H03 (8 bit)	HEE (8 bit)	H00 (8 bit)	H02 (8 bit)	H22 (8 bit)	H61 (8 bit)

Success of two registers at starting address 41007 (P.007) is returned.

Error Response

An error response is returned if the query message received from the master has an illegal function, address, or data. No response is returned for a parity, CRC, overrun, framing, or busy error.

Note: No response message is sent in the case of broadcast communication.

Table 118: Error Response (Response Message)

Slave Address	Function	Exception Code	CRC Check	
(8 bit)	H80 + function (8 bit)	(8 bit)	L (8 bit)	H (8 bit)

Table 119: Error Response (Response Message)

Message	Setting Description
Slave Address	Address received from the master.
Function	Master-requested function code + H80
Exception Code	See Table 120.

Table 120: Error Code List

Code	Error Item	Error Description
01	Illegal Function	The set function code in the query message from the master cannot be processed by the slave.
02	Illegal Data Address[1]	The set register address in the query message from the master cannot be processed by the slave.
03	Illegal Data Value	The set data in the query message from the master cannot be processed by the slave.

1. An error does not occur in the following cases:
   a. Function code H03 (Read holding register data) - when the number of points is 1 or more and there is one or more holding registers from which the data may be read.
   b. Function code H10 (write multiple holding register data) - when the number of points is 1 or more and there is one or more holding registers to which the data may be written.

   When the function code H03 or H10 is used to access multiple holding registers, an error does not occur if a nonexistent holding register, read-disabled register, or write-disabled register is accessed.

Note: An error occurs if all accessed holding registers do not exist.

Note: Data read from a nonexistent holding register is 0, and data written there is invalid.

Message Data Mistake Detection

To detect the mistakes of message data from the master, error items are checked for the errors in Table 121. If an error is detected, a trip does not occur.

Table 121: Message Data Mistake Detection

Error Item	Error Description	VFD Operation
Parity Error	The data received by the VFD differs from the specified parity (P.120 setting).	1. P.343 increases by 1 at the error occurrence. 2. The terminal LF is output at an error occurrence.
Framing Error	The data received by the VFD differs from the specified slop bit length (P.120).	
Overrun Error	The following data was sent from the master before the VFD completes receiving data.	
Message Frame Error	The message frame data length is checked, and the received data length of less than 4 bytes is regarded as an error.	
CRC Check Error	A mismatch found by CRC Check between the message frame data and calculation result is regarded as an error.	

Modbus Registers

Table 122: System Environment Variable

Register	Definition	Read/Write	Remarks
40002	VFD Reset	Write	Any value can be written.
40003	Parameter Clear	Write	Set H965A as a written value.
40004	All Parameters Clear	Write	Set H965A as a written value.
40006	Parameter Clear[1]	Write	Set H965A as a written value.
40007	All Parameters Clear[1]	Write	Set H965A as a written value.
40009	VFD Status/Control Input Instruction[2]	Read/Write	See below.[2]
40010	Operation Mode/VFD Setting[3]	Read/Write	See below.[3]
40014	Running Frequency (RAM Value)	Read/Write	According to the P. 37 settings, the frequency and selectable speed are in 1 rotation/minute increments.
40015	Running Frequency (EEPROM Value)	Write	

1. The communication parameter values are not cleared.
2. For write, set data as the control input instruction. For read, data is read as a VFD operating status.
3. For write, set data as the operation mode setting. For read, data is read as the operation mode status.

Table 123: VFD Status

Bit	Definition	
	Control Input Instruction	**VFD Status**
0	Stop command	RUN (VFD operational)[1]
1	forward rotation command	Forward rotation
2	reverse rotation command	During reverse rotation
3	RH (high-speed operation command)[2]	SU (up-to-frequency)
4	RM (middle-speed operation command)[2]	OL (overload)
5	RL (low-speed operation command)[2]	0
6	0	FU (frequency detection)
7	RT (second function selection)	ABC (fault)[1]
8	AU (terminal 4 input selection)	0
9	0	0
10	MRS (output stop)	0
11	0	0
12	0	0
13	0	0
14	0	0
15	0	Fault occurrence

1. The signal within parenthesis is the initial setting. Definitions change according to the settings for P.180 to P182.
2. The signal within the parenthesis is the initial setting. Definitions change according to the settings for P.190 and P.192.

Table 124: Real-Time Monitor

Register	Description	Unit
40201	Output Frequency/Speed	0.01 Hz[1]
40202	Output Current	0.01 A
40203	Output Voltage	0.1 V
40205	Output Frequency/Speed Setting	0.01 Hz/1[1]
40208	Converter Output Voltage	0.1 V
40209	Regenerative Brake Duty	0.1%
40210	Electronic Thermal Relay Function Load Factor	0.1%
40211	Output Current Peak Value	0.01 A
40212	Converter Output Voltage Peak Value	0.1 V
40214	Output Power	0.01 kW
40215	Input Terminal Status[2]	–
40216	Output Terminal Status[2]	–
40220	Cumulative Energization Time	1 h
40223	Actual Operation Time	1 h
40224	Motor Load Factor	0.1%
40225	Cumulative Power	1 kWh
40252	PID Setpoint	0.1%
40253	PID Measured Value	0.1%
40254	PID Deviation	0.1%
40261	Motor Thermal Load Factor	0.1%
40262	VFD Thermal Load Factor	0.1%
40263	Cumulative Power 2	0.01 kWh
40264	PTC Thermistor Resistance	0.01 k

1. When P. 37 = 0.01 to 9998, this displays as an integer number.
2. See Table 125.

Table 125: Input and Output Terminal Status Monitor

	b15 to b7	b6	b5	b4	b3	b2	b1	b0
Input Terminal Monitor Details	–	RH	RM	RL	–	–	STR	STF
Output Terminal Monitor Details	–	–	ABC	–	–	–	–	RUN

Table 126: Parameter (Part 1 of 2)

Parameter	Register	Parameter Name	Read/Write	Remarks
P. 0 to P.999	41000 to 41999	See the *VFD68Bxx and VFD68Cxx Drive Basic and Advanced Parameters* on page 43 and *VFD68Dxx Drive Parameters* on page 46 for the parameter names.	Read/Write	The parameter number +41000 is the register number.
C 2 (P.902)	41902	Terminal 2 Frequency Setting Bias Frequency	Read/Write	

Table 126: Parameter (Part 2 of 2)

Parameter	Register	Parameter Name	Read/Write	Remarks
C 3 (P.902)	42092	Terminal 2 Frequency Setting Bias (Analog Value)	Read/Write	The analog value (%) set to C 3 (P.902) is read.
	43092	Terminal 2 Frequency Setting Bias (Terminal Analog Value)	Read	The analog value (%) of the voltage (current) applied to terminal 2 is read.
P.125 (P.903)	41903	Terminal 2 Frequency Setting Gain Frequency	Read/Write	
C 4 (P.903)	42903	Terminal 2 Frequency Setting Gain (Analog Value)	Read/Write	The analog value (%) set to C 4 (P.903) is read.
	43903	Terminal 2 Frequency Setting Gain (Terminal Analog Value)	Read	The analog value (%) of the voltage (current) applied to terminal 2 is read.
C 5 (P.904)	41904	Terminal 4 Frequency Setting Bias Frequency	Read/Write	
C 6 (P.904)	42904	Terminal 4 Frequency Setting Bias (Analog Value)	Read/Write	The analog value (%) set to C 6 (P.904) is read.
	43904	Terminal 4 Frequency Setting Bias (Terminal Analog Value)	Read	The analog value (%) of the voltage (current) applied to terminal 4 is read.
P.126 (P.905)	41905	Terminal 4 Frequency Setting Gain Frequency	Read/Write	
C 7 (P.905)	42905	Terminal 4 Frequency Setting Gain (Analog Value)	Read/Write	The analog value (%) set to C 7 (P.905) is read.
	43905	Terminal 4 Frequency Setting Gain (Terminal Analog Value)	Read	The analog value (%) of the voltage (current) applied to terminal 4 is read.

Table 127: Faults History

Register	Definition	Read/Write	Remarks
40501	Fault History 1	Read/Write	Data is 2-bytes long, so is stored as H00OO. Refer to the lowest 1-byte for the error code. Perform write using the register 40501 batch-clears the faults history. Set any value as data.
40502	Fault History 2	Read	
40503	Fault History 3	Read	
40504	Fault History 4	Read	
40505	Fault History 5	Read	
40506	Fault History 6	Read	
40507	Fault History 7	Read	
40508	Fault History 8	Read	

Table 128: Faults Code List

Data	Definition	Data	Definition	Data	Definition
H00	No fault present	H31	E.THM	HB0	E.PE
		H40	E.FIN	HB1	E.PUE
H10	E.OC1	H52	E.ILF	HB2	E.RET
H11	E.OC2	H60	E.OLT	HC0	E.CPU
H12	E.OC3	H70	E.BE	HC4	E.CDO
H20	E.OV1	H80	E.GF	HC5	E.IOH
H21	E.OV2	H81	E.LF	HC7	E.AIE

Table 128: Faults Code List

Data	Definition	Data	Definition	Data	Definition
H22	E.OV3	H90	E.OHT	HC9	E.SAF
H30	E.THT	H91	E.PTC	HF5	E.5

P.343 Communication Error Count

You can check the cumulative number of communication errors.

Table 129: P.343 Communication Error Count

Parameter	Setting Range	Minimum Setting Range	Initial Value
P.343	(Reading Only)	1	0

Note: The number of communication errors is temporarily stored in RAM. It is not stored in EEPROM, so performing a power supply reset or a VFD reset clears the value to 0.

Output Terminal LF: Alarm Output (Communication Error Warnings)

During a communication error, the alarm signal (LF signal) is output by the open collector output. Assign the used terminal using P.190, P.192, or P.197 (output terminal function selection).

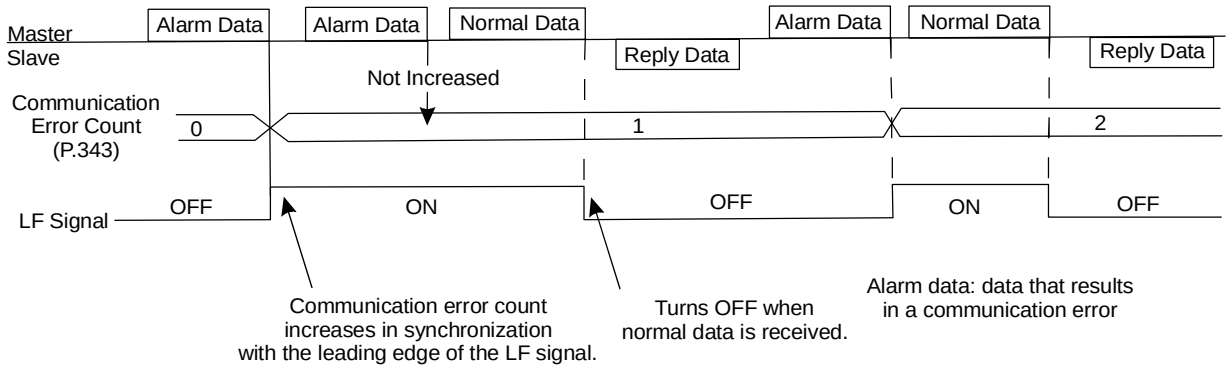


Figure 58: Alarm Output (Communication Error Warnings)

Note: The LF signal can be assigned to the output terminal using P.190, P.192, or P.197. Changing the terminal assignment may affect the other functions. Make the setting after confirming the function of each terminal.

Appendix 5: EMC Line Filter Selection Chart

Table 130: VFD68Bxx Models, 200–240 V

VFD68 Model	Rasmi EMC Filter Number	kW (H.P.)	Typical Full Load Input Current, Amperes	Continuous Output Current, Amperes	Dimensions, H x W x D, mm (in.)
VFD68BDC-2C	FE7200.7	0.4 (1/2)	3.8	2.5	128 x 68 x 113 (5 x 2-11/16 x 4-7/16)
VFD68BFD-2C	FE7200.7	1 (0.75)	6.6	4.2	128 x 68 x 133 (5x 2-11/16 x 5-1/4)
VFD68BGG-2C	FE7200.7	1.5 (2)	10.5	7.0	128 x 108 x 136 (5 x 4-1/4 x 5-5/16)
VFD68BHG-2C	FE7203.7	2.2 (3)	12.1	10.0	128 x 108 x 156 (5 x 4-1/4 x 6-1/8)
VFD68BJK-2C	FE7203.7	3.7 (5)	22.2	16.5	128 x 170 x 142 (5 x 6-11/16 x 5-5/8)
VFD68BKL-2C	FE7207.5	5.5 (7-1/2)	29.8	23.8	150 x 220 x 155 (5-15/16 x 8-11/16 x 6-1/8)
VFD68BLL-2C	FE7207.5	7.5 (10)	37.5	31.8	150 x 220 x 155 (5-15/16 x 8-11/16 x 6-1/8)
VFD68BMP-2C	FE72015	11 (15)	53.3	45.0	260 x 220 x 190 (10-1/4 x 8-11/16 x 7-1/2)
VFD68BNP-2C	FE72015	15 (20)	75.0	58.0	260 x 220 x 190 (10-1/4 x 8-11/16 x 7-1/2)

Table 131: VFD68Cxx Models, 380–480 V

VFD68 Model	Rasmi EMC Filter Number	kW (H.P.)	Typical Full Load Input Current, Amperes	Continuous Output Current, Amperes	Dimensions, H x W x D, mm (in.)
VFD68CDF-2C	FFR-CSH-036-8A-RF1	0.4 (1/2)	1.8	1.2	128 x 108 x 130 (5 x 4-1/4 x 5-1/8)
VFD68CFF-2C	FFR-CSH-036-8A-RF1	0.75 (1)	3.5	2.2	128 x 108 x 130 (5 x 4-1/4 x 5-1/8)
VFD68CGG-2C	FFR-CSH-036-8A-RF1	1.5 (2)	5.9	3.6	128 x 108 x 136 (5 x 4-1/4 x 5-5/16)
VFD68CHH-2C	FRR-MSH-80-16A-RF1	2.2 (3)	8.4	5.0	128 x 108 x 156 (5 x 4-1/4 x 6-1/8)
VFD68CJJ-2C	FRR-MSH-80-16A-RF1	3.7 (5)	13.9	8.0	128 x 108 x 166 (5 x 4-1/4 x 6-1/2)
VFD68CKL-2C	FRR-MSH-170-30A-RF1	5.5 (7-1/2)	16.7	12.0	150 x 220 x 155 (5-15/16 x 8-11/16 x 6-1/8)
VFD68CLL-2C	FRR-MSH-170-30A-RF1	7.5 (10)	23.8	16.0	150 x 220 x 155 (5-15/16 x 8-11/16 x 6-1/8)
VFD68CMP-2C	FRR-MSH-300-50A-RF1	11 (15)	29.9	23.0	260 x 220 x 190 (10-1/4 x 8-11/16 x 7-1/2)
VFD68CNP-2C	FRR-MSH-300-50A-RF1	15 (20)	40.0	29.5	260 x 220 x 190 (10-1/4 x 8-11/16 x 7-1/2)

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