

User Guide

VFD66 Drive

AC variable speed drive for
3 phase induction motors
from 0.75kW to 2.2kW,
1hp to 3hp

Part Number: 24-10511-90
Issue: 2

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional parameters of the equipment or from mismatching the variable speed drive with the motor.

The contents of this guide are believed to be correct at the time of printing. In the interests of commitment to a policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the content of the guide without notice.

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Drive software version

This product is supplied with the latest version of user-interface and machine control software. If this product is to be used in a new or existing system with other drives, there may be some differences between their software and the software in this product. These differences may cause the product to function differently. If there is any doubt, please contact Johnson Controls.

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Software: 01.01.00

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EC Declaration of Conformity



PDM Name:	EU-DOC-VFD66-Variable Frequency Drive.doc
Manufacturer:	Johnson Controls Inc.
Address:	4620 Olympic Blvd Erlanger KY 41018-0000
Country:	USA
Phone number:	859-283-1384

Certify and declare under our sole responsibility that the following:

Description:	Variable Frequency Drive for 3 phase induction motors
Product name:	VFD66
Brand:	Johnson Controls / Penn
Identification	VFD66 followed by A,B,C,D,E,F,J or K followed by two letters. All can be followed by up to three additional numbers followed by up to two additional letters.

conforms with the essential requirements of the following directives:

EMC Directive 2004/108/EC Low Voltage Directive 2006/95/EC

The following harmonised standards have been applied:

EN 61800-5-1:2007
EN 61800-3:2004
EN 61000-6-2:2005
EN 61000-6-4:2007
EN 61000-3-2:2006
EN 61000-3-3:2008

EN 61000-3-2:2006: Applicable where input current <16A.

No limits apply for professional equipment where input power >1kW.

Therefore this product complies with the essential requirements and provisions of the Directives.

The Technical documentation can be requested by the surveillance Authorities at the following address:

Company:	Johnson Controls Inc. Att: Environment & Legislation
Address, City:	Christian X's Vej 201, 8270 Hoejbjerg
Country:	Denmark
Phone number:	+ 45 8736 7000

Name and position of person authorised by the manufacturer:

Date: 1/21/2011	
	George Rudich
	Engineering Manager
	Johnson Controls Inc

1 Safety information

1.1 Warnings, cautions and notes



A **Warning** contains information, which is essential for avoiding a safety hazard.



A **Caution** contains information, which is necessary for avoiding a risk of damage to the product or other equipment.



A **Note** contains information, which helps to ensure correct operation of the product.

1.2 Electrical safety - general warning

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive.

Specific warnings are given at the relevant places in this guide.

1.3 System design and safety of personnel

The drive is intended as a component for professional incorporation into complete equipment or system. If installed incorrectly, the drive may present a safety hazard.

The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury.

System design, installation, commissioning / start up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this guide carefully.

The STOP and START controls or electrical inputs of the drive must not be relied upon to ensure safety of personnel. They do not isolate dangerous voltages from the output of the drive. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

The drive is not intended to be used for safety-related functions.

Careful consideration must be given to the function of the drive which might result in a hazard, either through its intended behavior or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk.

1.4 Environmental limits

Instructions within the supplied data regarding transport, storage, installation and the use of the drive must be complied with, including the specified environmental limits.

1.5 Access

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with. The IP (Ingress Protection) rating of the drive is installation dependant.

1.6 Motor

Ensure the motor is installed in accordance with the manufacturer's recommendations. Ensure the motor shaft is not exposed.

Standard squirrel cage induction motors are designed for single speed operation. If it is intended to use the capability of a drive to run a motor at speeds above its designed maximum, it is strongly recommended that the manufacturer is consulted first.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. If necessary, an electric force vent fan should be used.

1.7 Adjusting parameters

Some parameters have a profound effect on the operation of the drive. They must not be altered without careful consideration of the impact on the controlled system. Measures must be taken to prevent unwanted changes due to error or tampering.

1.8 Electrical installation

1.8.1 Electric shock risk

The voltages present in the following locations can cause severe electric shock and may be lethal:

- AC supply cables and connections
- Output cables and connections
- Many internal parts of the drive

Unless otherwise indicated, control terminals are single insulated and must not be touched.

1.8.2 Isolation device

The AC supply must be disconnected from the drive using an approved isolation device before any cover is removed from the drive or before any servicing work is performed.

1.8.3 STOP function

The STOP function does not remove dangerous voltages from the drive or the motor.

1.8.4 Ground leakage current

The drive is supplied with an internal EMC filter capacitor installed. If the input voltage to the drive is supplied through an ELCB or RCD, these may trip due to the ground leakage current. See section 4.3.1 *Internal EMC filter* on page 14 for further information and how to disconnect the internal EMC capacitor.



The VFD66 series variable speed drives are intended to control equipment under normal operating conditions. Where failure or malfunction of a VFD66 drive could lead to an abnormal operating condition that could cause personal injury or damage to the equipment or other property, other devices, (limit or safety controls) or systems (alarm or supervisory) intended to warn of, or protect against, failure or malfunction of the VFD66 drive must be incorporated into and maintained as part of the control system.

**Risk of thermal damage**

The VFD66 control can generate and dissipate significant heat. Mount the control on a metal, concrete, or cinderblock mounting surface. Mounting the VFD66 control on surfaces made of wood or other heat-sensitive material may result in damage to the mounting surface.

**Risk of equipment damage**

Motors used with the VFD66 controls must meet certain specifications for proper performance and operation. Motors that do not meet these specifications may be damaged.

**Risk of electrical shock**

The printed wiring board and its components are at AC line voltage. **Direct or indirect contact with line voltage can result in personal injury or death.**

**Risk of electrical shock**

The VFD66 drive remains electrically charged for a period of time after the power is removed. To avoid possible electrical shock, wait at least 10 minutes after AC supply power has been disconnected from the VFD66 drive before servicing the control. Failure to wait until the VFD66 drive fully discharges could cause electrical shock, personal injury, or death.

**Risk of equipment damage**

Connect each of these items to the VFD66 drive using a separate conduit for each set of wires:

- Line voltage supply power
- Line voltage output power to motor
- Low voltage signals from input devices

Running different voltage and frequency wires in the same conduit can create electronic noise or harmonics, which may damage the condenser fan motors.

2 Rating data

The following information describes the electrical and mechanical ratings for the range of Johnson Controls drives.

Table 2-1 VFD66 model numbers and ratings

Model Number	Motor power		Supply voltage and frequency	Output voltage and frequency	Input fuse rating	Typical RMS input current	Rated RMS output current (A)	
	kW	hp					50°C	60°C
VFD66AAA-2	0.75	1.0	3 phase 200 to 240Vac ±10% 48 to 65Hz	Three phase 0 to 240Vac 0 to 1500Hz	10	6.3	4.0	4.0
VFD66CAA-2	1.5	2.0			13	9.9	7.5	6.2
VFD66EBA-2*	2.2	3.0			16	13.1	10.6	9.0
VFD66BAA-2	0.75	1.0	3 phase 380 to 480Vac ±10% 48 to 65Hz	Three phase 0 to 480Vac 0 to 1500Hz	6	3.5	1.8	1.8
VFD66DAA-2	1.5	2.0			8	5.7	3.6	3.6
VFD66FAA-2	2.2	3.0			10	7.5	5.5	5.5

*With fan

Overload capacity

110% of output current for 1 minute.

Output frequency

0 to 1500Hz

Output voltage

3 phase, 0 to drive rating (240 or 480Vac maximum set by Pr 08).

NOTE The output frequency can be increased by 20% during deceleration.

2.1 Supply types

The drive is suitable for use on:

Star and Delta connected supplies

Three phase supplies with a grounded star point neutral configuration.

Three phase supplies with a line grounded delta configuration.

Ground supplies

Supplies with ground configurations TN, TN-C, and TN-S.

Floating supplies

IT supply configurations

2.2 Supply imbalance

The maximum supply imbalance: 2% negative phase sequence as per IEC 60146-1-1.

2.3 Maximum motor cable length

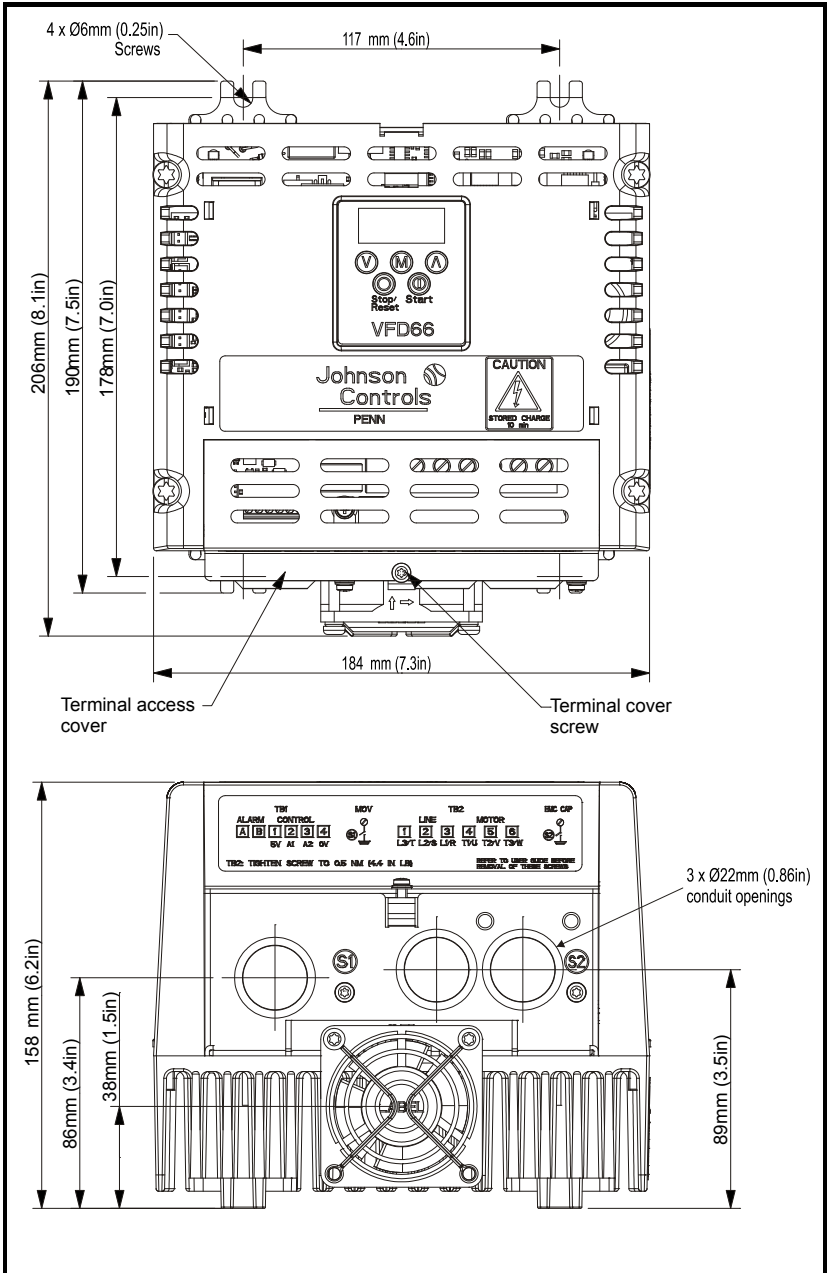
50m (165 ft) maximum from the motor.

2.4 Multi-motor capability

The VFD66 drive is capable of operating multiple motors at a common frequency as long as the total current is less than or equal to the drive rating. Individual motor protection must be provided and the output of the drive should be chain connected to the motors. The fixed V/F mode (Pr 41 = Fd) should be used.

3 Mechanical installation

Figure 3-1 VFD66 drive basic dimensions





Enclosure

The drive is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which 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.



The VFD66 drive can generate and dissipate significant heat. Mount the drive on a metal, concrete or cinder block mounting surface. Mounting the VFD66 drive on surfaces made of wood or other heat-sensitive material may result in damage to the mounting surface.

Observe the following the guidelines when mounting a VFD66 drive:

- Mount the VFD66 drive on a vertical surface with the heatsink fins oriented vertically and the conduit holes facing down.
- Provide a minimum of 4 in. (102 mm) clearance around the heatsink.
- Ensure that output power wiring between the VFD66 drive and the motor does not exceed 50m (165 ft).

Mount the VFD66 drive in a location protected from condensation, explosive vapours, corrosive gas, water, and dust.

3.1 Accessing the interior

Remove the terminal access cover by removing the terminal cover screw (see Figure 3-1) to access terminal blocks, ground connections, EMC filter link and MOV link (see Figure 4-1, Figure 4-2, Figure 4-3 and Figure 4-4).

NEMA 1 enclosure

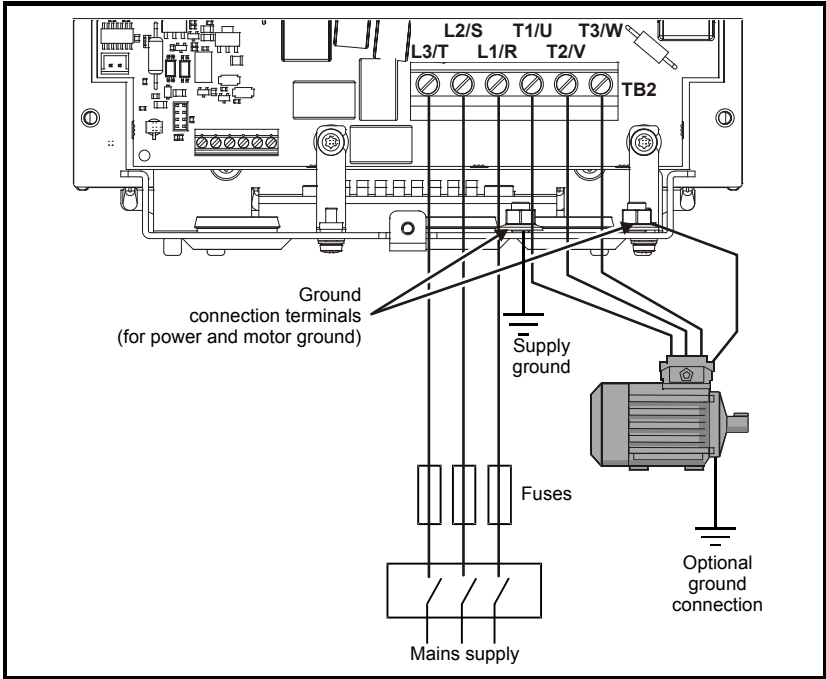
Follow the following steps to remove the terminal cover:

1. Remove the terminal cover screw and push upwards on the front of the cover.
2. Pull outward on the top of the terminal access cover.

4 Electrical installation

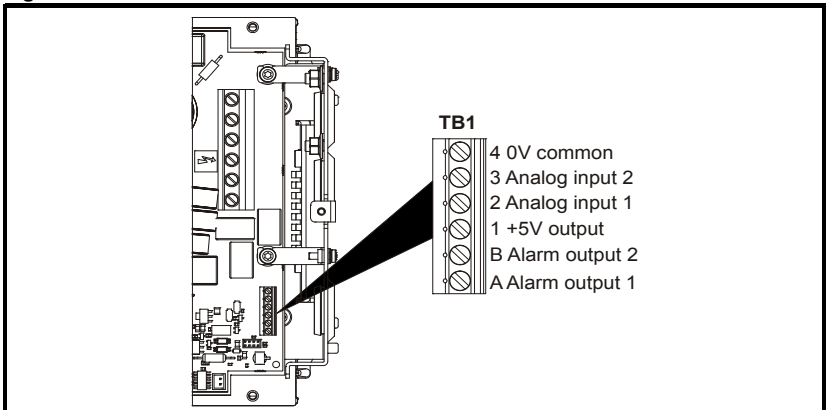
4.1 VFD66 drive

Figure 4-1 VFD66 drive power terminal connections



NOTE Two M5 locknuts are installed on the ground connection terminals

Figure 4-2 VFD66 drive control connections





Fuses/MCB

The AC supply to the drive must be installed with suitable protection against overload and short circuits. Failure to observe this requirement will cause risk of fire.



The drive must be grounded by a conductor sufficient to carry the prospective fault current in the event of a fault. See also the warning in section 4.2 *Ground leakage* relating to ground leakage current.

Model	Maximum power terminal screw torque
VFD66	0.5 Nm / 4.4 lb in

4.2 Ground leakage

The ground leakage current depends upon the internal EMC filter being installed. The drive is supplied with the filter installed. Instructions for removal of the internal EMC filter are given in section 4.3.2 *Removing the internal EMC filter*.

With internal EMC filter installed

3 Phase 200V drives

7.8mA AC maximum at 220V, 50Hz (proportional to supply voltage and frequency).

3 Phase 200V drives

10.4mA AC maximum at 400V, 50Hz (proportional to supply voltage and frequency).

NOTE

The above leakage currents are the leakage currents of the drive with the Internal EMC filter connected. No account is taken for leakage currents of the motor or motor cable.

With internal EMC filter removed <1mA

NOTE

There is an internal voltage surge suppression device connected to ground. Under normal circumstances, this carries negligible current.



When the internal EMC filter is installed, the leakage current is high. In this case, a permanent fixed ground connection must be provided.

4.2.1 Use of ground fault circuit interrupter (GFCI)

There are three common types of GFCI:

Type AC - detects AC fault currents

Type A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)

Type B - detects AC, pulsating DC and smooth DC fault currents

- Type AC should never be used with drives
- Type A can only be used with single phase drives
- Type B must be used with three phase drives

4.3 EMC

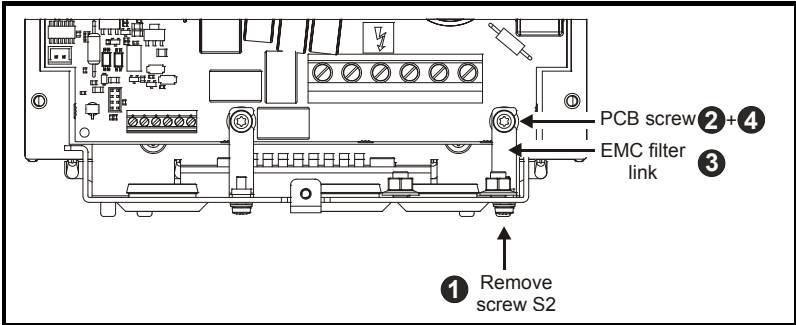
4.3.1 Internal EMC filter

It is recommended that the internal EMC filter is kept in place unless there is a specific reason for removing it.

It is recommended that the filter be used in all applications unless the ground leakage current is unacceptable.

4.3.2 Removing the internal EMC filter

Figure 4-3 Removal of the VFD66 internal EMC filter



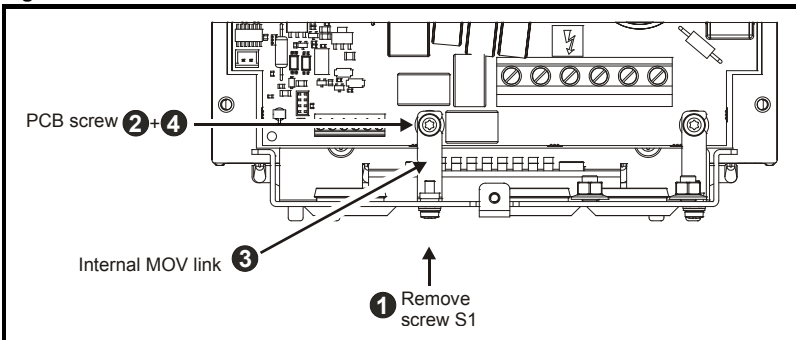
To disconnect the VFD66 internal EMC filter:

1. Remove the front panel Torx T10 screw (S2).
2. Loosen the PCB Torx T10 screw.
3. Remove the EMC filter link.
4. Re-tighten the Torx T10 PCB screw to 1 Nm (8.9 lb in).

Removal of the MOV varistor

A MOV (varistor) is installed between the power circuit and ground in order to protect the drive from high voltage impulses caused by lightning etc. In some applications it may be necessary to disconnect this device, depending upon the applicable regulations - for example if there is no fixed ground connection.

Figure 4-4 Removal of the VFD66 internal MOV



To disconnect the VFD66 internal MOV:

1. Remove the front panel Torx T10 screw (S1).
2. Loosen the PCB Torx T10 screw.
3. Remove the internal MOV link.
4. Re-tighten the Torx T10 PCB screw to 1 Nm (8.9 lb in).

4.3.3 Emissions Compliance

An internal factory installed EMC filter is provided with all ratings, it is recommended that it is kept in place unless there is a specific reason for removing it. This internal filter reduces radio-frequency emissions into the line power supply. When the motor cable is short, it permits the requirements of EN61800-3:2004 to be met for the second environment with restricted distribution. For longer motor cables, the filter continues to provide a useful reduction in emission level. When used with any length shielded motor cable (up to the limit for the drive), it is unlikely that nearby industrial equipment will be disturbed.

Installation of an additional external EMC filter as shown in Table 4-1, provides higher levels of emissions compliance. If the application requires these levels of compliance then the external filter must be installed in order to ensure compliance with EMC regulations such as the EC EMC Directive, and to ensure the validity of the CE mark.

Table 4-1 Emissions compliance for VFD66 based on EMC filter configuration

Motor Cable Length m (ft)	Filter and Switching Frequency								
	Internal Filter Only			Standard Filter			Low Leakage Filter		
				Schaffner P/N: FS6514-14-07			Schaffner P/N: FS6514-14-07-LL*		
	3kHz	6kHz	12kHz	3kHz	6kHz	12kHz	3kHz	6kHz	12kHz
1 (3)	C4	C4	C4	C2	C2	C3	C2	C2	C3
5 (16)	C4	C4	C4	C2	C2	C3	C2	C2	C3
10 (33)	C4	C4	C4	C2	C3	C3	C3	C3	C3
15 (50)	C4	C4	C4	C2	C3	C3	C3	C3	C3
25 (82)	C4	C4	C4	C2	C3	C3	C3	C3	C3
50 (164)	C4	C4	C4	C2	C3	C3	C3	C3	C3

*The typical leakage current of the low leakage filter is 3mA compared to the standard filter which has a typical leakage current of 40mA.

Table 4-2 Key to conformity

Compliance Level	Standard	Description	Frequency Range	Limits	Application
C2	EN 61000-6-4:2007	Generic emission standard for the Industrial Environment	0.15 – 0.50 MHz	79dB μ V quasi peak 66dB μ V average	AC Supply Lines
			0.50 – 30 MHz	73dB μ V quasi peak 60dB μ V average	
	EN 61800-3:2004 IEC 61800-3	Product standard for adjustable power drive systems.	Requirements for the first environment (1) with restricted distribution (2).		
C3	EN 61800-3:2004 IEC 61800-3	Product standard for adjustable power drive systems.	Requirements for the second environment with unrestricted distribution.		
C4			Requirements for the second environment with restricted distribution (2).		

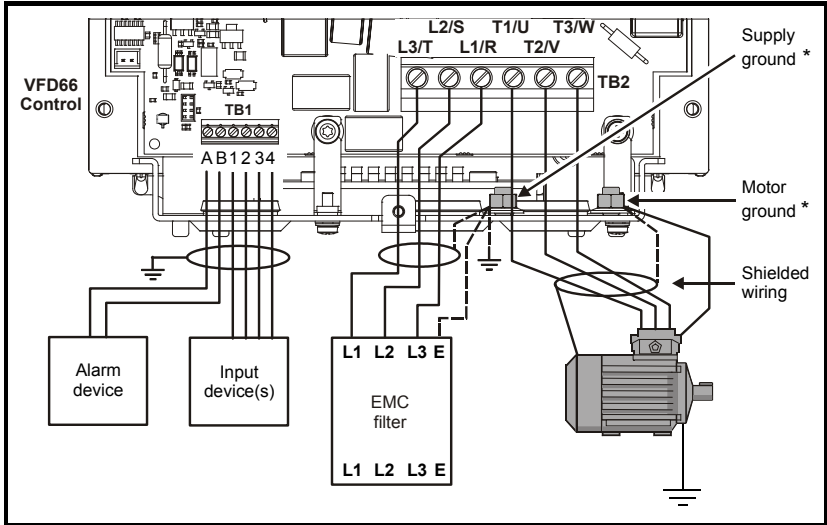
Notes:

- (1) The first environment is one where the low voltage supply network also supplies residential premises
- (2) When distribution is restricted, drives are available only to installer with EMC competence.

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(3) Operation without an external filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. This is in accordance with EN 61800-3:2004 in the second environment, with restricted distribution. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Figure 4-5 CE Compliance Wiring



NOTE

* The M5 nuts are provided to connect the shield to ground (earth).

- Physically separate the input and output cables.
- All input and output cables should be fully shielded, with the shield securely grounded. The motor cable shield should be connected to the ground connection.
- Do not run input cables alongside output cables. Do not bundle input and output cables together.
- The input ground wire should be connected to the ground connection.
- Ideally, the motor cable shield should be clamped directly to the back plate.
- The EMC filter body needs to be fixed to the same grounded metal part (e.g. the back plate) as the motor cable shield.

4.3.4 Immunity Compliance

The level of the drives immunity from conducted and radiated emissions from external sources is summarised below in Table 4-3.

Table 4-3 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC 61000-4-2 EN 61000-4-2	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
IEC 61000-4-3 EN 61000-4-3	Radio frequency radiated field	10V/m prior to modulation 80 – 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3 (industrial)
IEC 61000-4-4 EN 61000-4-4	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC 61000-4-5 EN 61000-4-5	Surges	Common mode 4kV 1.2/50µs waveshape	AC supply lines: Line to ground	Level 4
		Differential mode 2kV 1.2/50µs waveshape	AC supply lines: Line to line	Level 3
		Lines to ground	Signal ports to ground	Level 2
IEC 61000-4-6 EN 61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 – 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
IEC 61000-4-11 EN 61000-4-11	Voltage dips and interruptions	-30% 10ms +60% 100ms -60% 1s <-95% 5s	AC power ports	
IEC 61000-6-1 EN 61000-6-1:2007	Generic immunity standard for the residential, commercial and light – industrial environment			Complies
IEC 61000-6-2 EN 61000-6-2:2005	Generic immunity standard for the industrial environment			Complies
IEC 61800-3 EN 61800-3:2004	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

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4.4 Control terminals I/O specification



The control circuits are isolated from the power circuits in the drive by basic insulation (single insulation) only. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation (supplementary insulation) rated for use at the AC supply voltage.



If the control circuits are to be connected to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to personal computer), an additional isolating barrier must be included in order to maintain the SELV classification.

4.4.1 VFD66 control connections

A	Alarm output 1 - drive OK (normally open)*
Voltage rating	5-24Vac or 5-30Vdc
Current rating	100 μ A at 24V minimum / 200mA maximum

B	Alarm output 2
----------	----------------

1	+5V output
Max current rating	20mA (short circuit proof)

2	Analog reference input 1
Voltage	0 to +5V / 0 to +10V
Input impedance	100k Ω
Resolution	0.1%
Accuracy	\pm 5%
Sample time	6ms

3	Analog reference input 2
Voltage	0 to +5V / 0 to +10V
Input impedance	100k Ω
Resolution	0.1%
Accuracy	\pm 5%
Sample time	6ms

4	0V Common
----------	-----------

* Used with class 2 circuits.

4.4.2 Wiring input devices to a VFD66

Connect the appropriate low-voltage input signal device to Terminal Block TB1 (Figure 4-2 on page 12). See Table 4-4 below, Figure 4-6 on page 19, Figure 4-7 on page 19, and Figure 4-8 on page 20 for additional information on wiring specific Johnson Controls/PENN™ input devices to the VFD66 controls.

Table 4-4 Wiring Johnson Controls/PENN input devices

Input Device	Input Device Terminal	VFD66 Control TB1 Terminal
P35AG-9200R Transducer	1	1
	2	2 (or 3) ¹
	3	4
C450CPN control module	AO1	2
	COM	4
C450CQN control module	AO1	2
	AO2	3
	COM	4
P499 Series Transducers	Red	1
	White	2 (or 3) ¹
	Black	4

Input Devices

¹ Use terminal 3 to connect an optional second input device to the VFD66 as shown in Figure 4-6 and Figure 4-7 below.

Figure 4-6 Wiring P35 transducers to VFD66 terminal block TB1

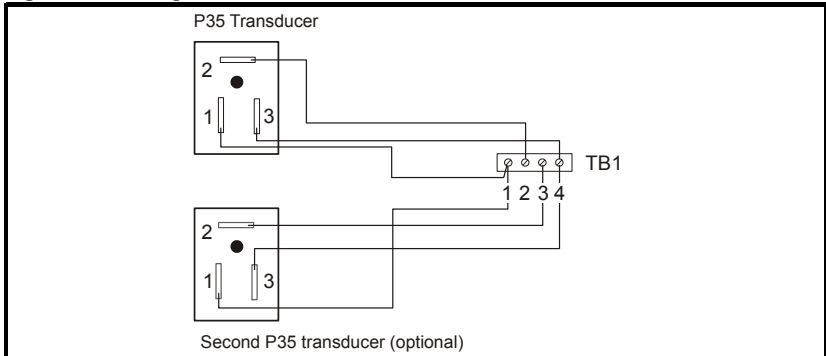


Figure 4-7 Wiring P499 transducers to VFD66 terminal block TB1

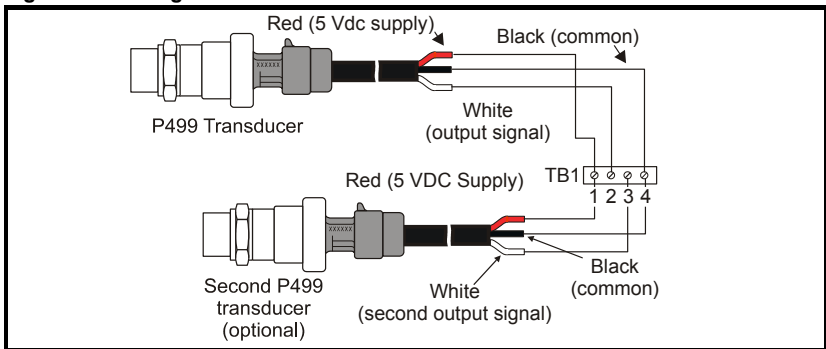
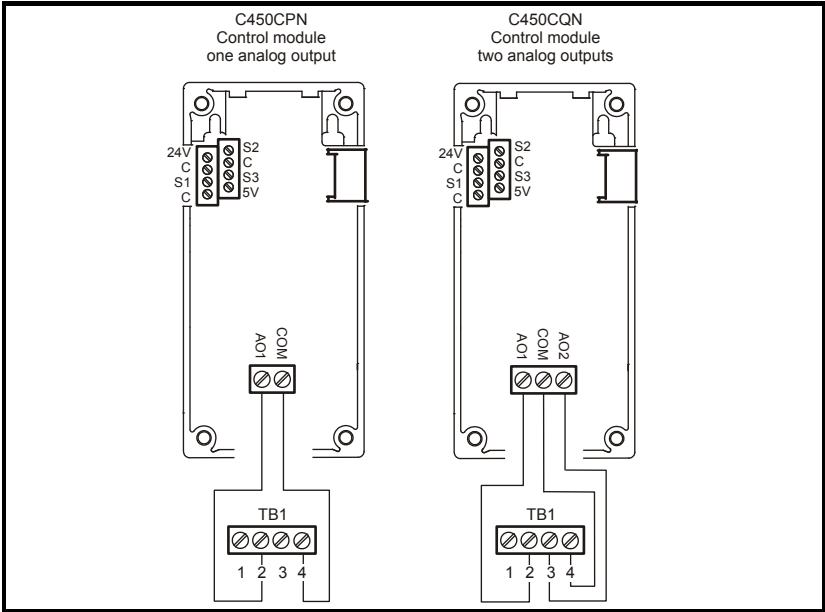


Figure 4-8 Wiring C450CPN control module or C450CQN control module to VFD66 Terminal Block TB1



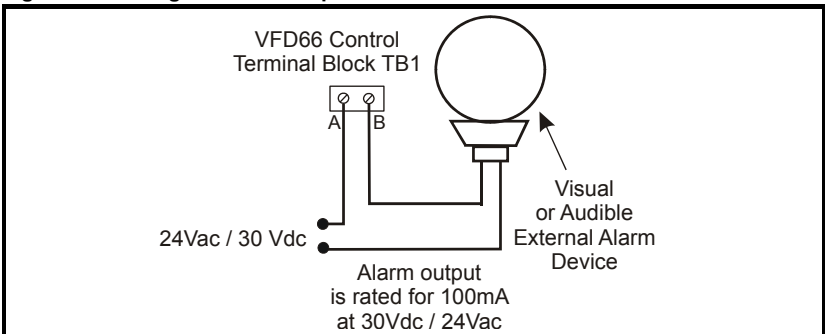
The VFD66 controls work with most 0 to 5Vdc or 0 to 10Vdc electronic pressure transducers. For best results, use 0 to 5Vdc, ratiometric P499 Electronic Pressure Transducers. Ratiometric transducers vary the signal voltage from 10 to 90% of the 5Vdc supply power as the pressure goes from minimum to maximum of the transducer rating.

NOTE Applications using a 0 to 10 Vdc transducer must be powered separately.

4.4.3 Wiring an external alarm to a VFD66 control

The Metal Oxide Silicon Field Effect Transistor (MOSFET) alarm output activates when a permanent fault condition occurs. See Figure 4-9 below.

Figure 4-9 Wiring the alarm output



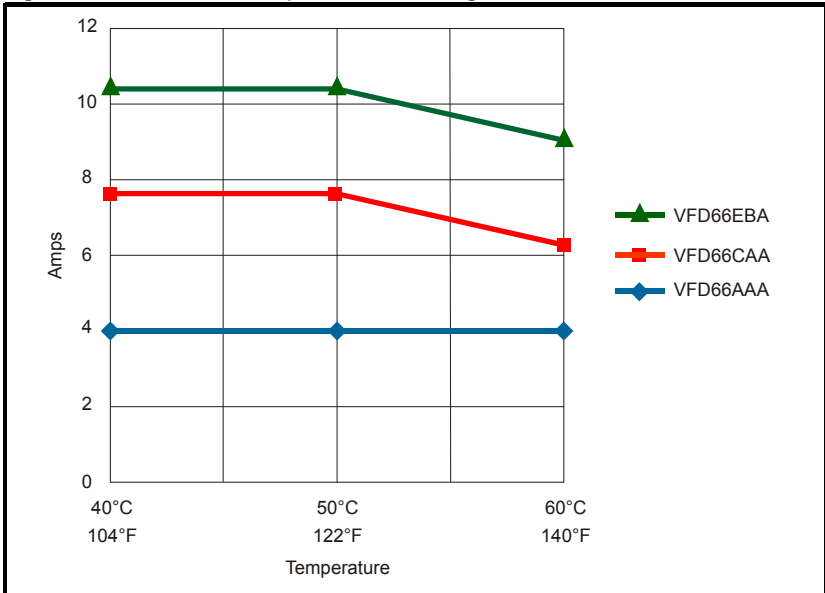
Wiring the VFD66 input and output power

Select a wire size for field wiring based on a wire insulation temperature resistance rating of 75°C (167°F), with a maximum wire size of 12 AWG. Use only stranded copper wire, rated for at least 600 volts.

5 De-rating

5.1 De-rating information

Figure 5-1 200/230 Vac Temperature De-Rating



No de-rating for 400/460 Vac drives up to 60°C (140°F). Contact JCI application engineering for 6KHz and 12KHz versions

NOTE This is the de-rating with the switching frequency at 3kHz.

De-Rating examples

For these examples, the drive used is a VFD66EBA type. See Figure 5-1 and Table 5-1.

- If the VFD66EBA drive is used in Denver, Colorado (altitude 5200 ft), the output rating is reduced (see Table 5-1). When the temperature is less than 122°F (50°C), the VFD66EBA drive is rated for 9.96 amperes, as shown by the equation:
De-Rated maximum output amperes = 10.6 A x 0.94 = 9.96 amperes
- If the VFD66EBA drive is used in Denver, Colorado (altitude 5200 ft) and the ambient temperature reaches 140°F (60°C), then the VFD66EBA drive is de-rated to maximum current of 9.0 amperes due to the high ambient temperature and is further de-rated to 8.46 amperes because of the high altitude.
De-Rated maximum output amperes = 9.0 amperes x 0.94 = 8.46 amperes.

5.2 Altitude de-rating

See Table 5-1 for altitude multipliers. Use the following formula to determine the adjusted rating:

$$\text{Temperature De-Rated Maximum Output Amperes} \times \text{Altitude Multiplier} = \text{De-Rated Maximum Output Amperes}$$

Table 5-1 Altitude multipliers

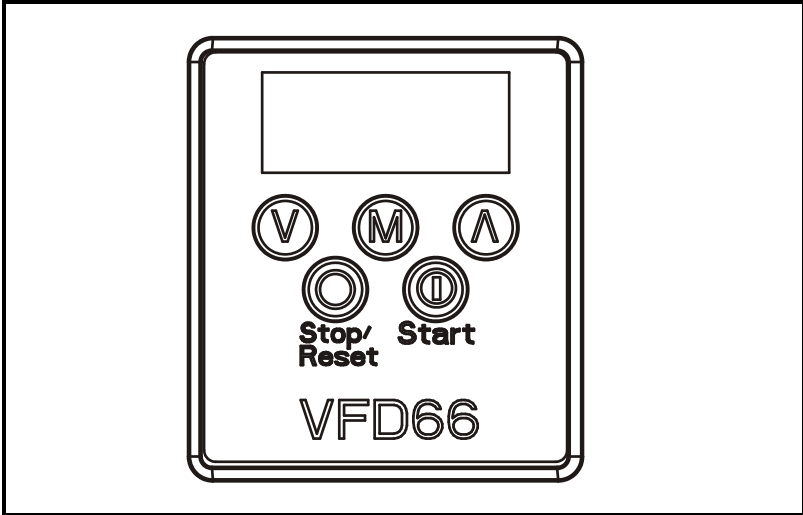
Altitude Range	Altitude Multiplier
0-3300 ft (0-1000 m)	1.0
3300-4300 ft (1000-1305 m)	0.97
4300-5300 ft (1305-1610 m)	0.94
5300-6300 ft (1610-1915 m)	0.91
6300-7300 ft (1915-2220 m)	0.88
7300-8300 ft (2220-2525 m)	0.86
8300-9300 ft (2525-2830 m)	0.83
9300-9842 ft (2830-3000 m)	0.80

6 Keypad and display

The keypad and display are used for the following:

- Displaying the operating status of the drive
- Displaying a fault or trip code
- Reading and changing parameter values
- Stopping, starting and resetting the drive

Figure 6-1 Keypad and display



6.1 Programming keys

The **M** **MODE** key is used to change the mode of operation of the drive.

The **^** **UP** and **v** **DOWN** keys are used to select parameters and edit their values. In manual input mode, they are used to increase and decrease the speed of the motor.

6.2 Control keys

The **Start** key is used to start the drive in manual input mode.

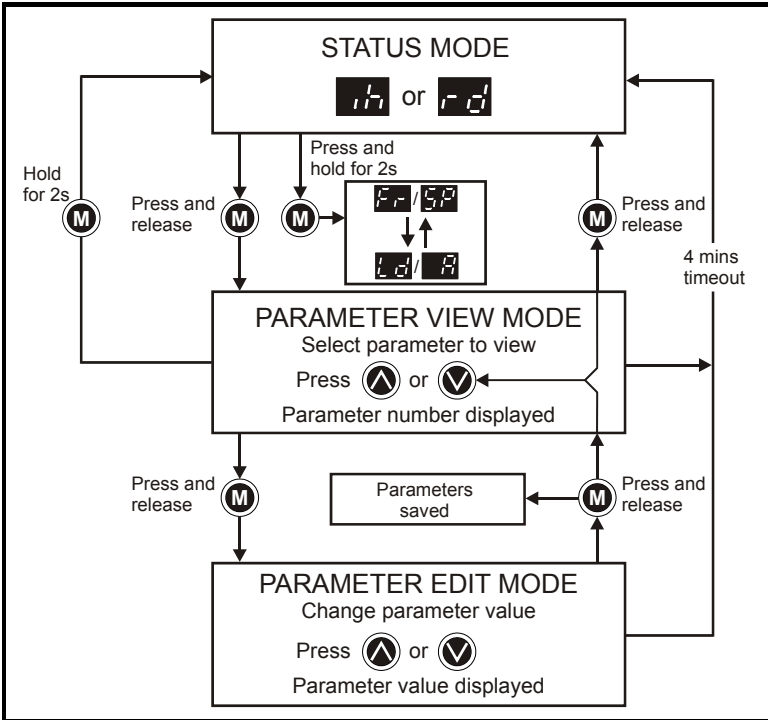
The **STOP/RESET** key is used to stop and reset the drive.

6.3 Selecting and changing parameters

NOTE

This procedure is written from the first power up of the drive and assumes no terminals have been connected, no parameters have been changed and no security has been set.

Figure 6-2



When in Status mode, pressing and holding the **M** MODE key for 2 seconds will change the display from displaying a speed indication to displaying load indication (or output current) and vice versa.

Pressing and releasing the **M** MODE key will change the display from status mode to parameter view mode. In parameter view mode, the display flashes between the parameter number and the value of that parameter.

Pressing and releasing the **M** MODE key again will change the display from parameter view mode to parameter edit mode. In parameter edit mode, the display shows the value in the parameter.

Pressing the **M** MODE key in parameter edit mode will return the drive to the parameter view mode. If the **M** MODE key is pressed again then the drive will return to status mode, but if either of the **▲** up or **▼** down keys are pressed to change the parameter being viewed before the **M** MODE key is pressed, pressing the **M** MODE key will change the display to the parameter edit mode again. This allows the user to very easily change between parameter view and edit modes during commissioning / start up of the drive.

Status Modes

Display	Status	Explanation
	Drive ready	The drive is enabled and ready for a start command. The output bridge is inactive.
	Drive inhibited	The drive is inhibited because there is no enable command, or the drive is inhibited during a trip reset.
	Mains loss	The drive is in mains loss ride through mode.

6.4 Saving parameters

Parameters are automatically saved when the **M** MODE key is pressed when going from parameter edit mode to parameter view mode.

6.5 Parameter access

There are 3 levels of parameter access controlled by Pr **10**. This determines which parameters are accessible. See Table 6-1.

The setting of the user security Pr **25** determines whether the parameter access is read only (RO) or read write (RW).

Table 6-1

Parameter access (Pr 10)	Parameters accessible
L1	Pr 01 to Pr 10
L2	Pr 01 to Pr 67
L3	Pr 01 to Pr 95

6.6 Security codes

Setting a security code allows view only access to all parameters.

A security code is locked into the drive when Pr **25** is set to any other value than 0 and then **LoC** is selected in Pr **10**. On pressing the **M** MODE key, Pr **10** is automatically changed from **LoC** to **L1** and Pr **25** will be automatically set to 0 so as not to reveal the security code.

Pr **10** may be changed to L2 or L3 to allow view only access to parameters.

6.6.1 Setting a security code

- Set Pr **10** to L2.
- Set Pr **25** to the desired security code e.g. 5
- Set Pr **10** to LoC.
- Press the **M** MODE key
- Pr **10** will now be reset to L1 and Pr **25** will be reset to 0.
- The security code will now be locked into the drive.
- Security will also be set if the drive is powered down after a security code has been set into Pr **25**.

6.6.2 Unlocking a security code

- Select parameter to be edited
- Press the **M** MODE key, the display will flash 'CodE'
- Press the **▲** UP key to start entering the set security code.
- Enter the correct security code
- Press the **M** MODE key
- If the correct security code has been entered, the display will flash and can now be adjusted.
- If the security code has been entered incorrectly, the above procedure should be followed again.

6.6.3 Re-locking security

When a security code has been unlocked and the required parameter changes made, to re-lock the same security code:

- Set Pr **10** to LoC
- Press the **●** STOP/RESET key

6.6.4 Setting security back to 0 (zero) - no security

- Set Pr **10** to L2
- Go to Pr **25**
- Unlock security as described above.
- Set Pr **25** to 0
- Press the **M** MODE key.

6.7 Setting drive back to default values

- Set Pr **10** to L2
- Set Pr **29** to Eur and press the **M** MODE key. This loads 50Hz default parameters.
or
- Set Pr **29** to USA and press the **M** MODE key. This loads 60Hz default parameters.

7 Parameters

Parameters are grouped together into appropriate subsets as follows:

Level 1

Pr 01 to Pr 10: Basic drive set-up parameters

Level 2

Pr 22 to Pr 29: Display / keypad configuration

Pr 33: System configuration

Pr 37 to Pr 42: Motor configuration (non-standard set-up)

Pr 45: Drive software version

Pr 55 to Pr 58: Drive trip log

Pr 61 to Pr 70: Control mode setup

Level 3

Pr 81 to Pr 95: Drive diagnostics parameters

These parameters can be used to optimise the set-up of the drive for the application.

7.1 Parameter descriptions - level 1

No	Function	Range	Defaults	Type
01	Minimum set speed	0 to Pr 02 Hz	0.0	RW

Used to set the minimum speed at which the motor will run in both directions.

No	Function	Range	Defaults	Type
02	Maximum set speed	0 to 1500 Hz	Eur: 50.0, USA: 60.0	RW

Used to set the maximum speed at which the motor will run in both directions.

If Pr 02 is set below Pr 01, Pr 01 will be automatically set to the value of Pr 02.



No	Function	Range	Defaults	Type
03	Acceleration rate	0 to 3200.0 s/100Hz	Eur: 5.0, USA: 5	RW
04	Deceleration rate		Eur: 5.0, USA: 5	

Sets the acceleration and deceleration rate of the motor in both directions in seconds/100Hz.

NOTE With the standard ramp mode, the deceleration rate could be extended automatically by the drive to prevent over voltage (OV) trips if the load inertia is too high for the programmed deceleration rate.

No	Function	Range	Defaults	Type
05	Drive configuration	PAd, Std, EPt, rES	Eur: Std, US: Std	RW

The setting of Pr 05 automatically sets up the drives configuration.

NOTE A change to Pr 05 is set by pressing the  MODE key on exit from parameter edit mode. The drive must be disabled, stopped or tripped for a change to take place. If Pr 05 is changed while the drive is running, when the  MODE key is pressed on exit from parameter edit mode, Pr 05 will change back to its previous value.

NOTE When the setting of Pr 05 is changed, the appropriate drive configuration parameters are set back to their default values.



When the mode is changed in Pr **05** to Std or EPt, if there is an analog reference present of more than 0.5V (5V reference), then the motor may start turning.
The reserved (rES) setting should not be used.

Configuration of VFD66

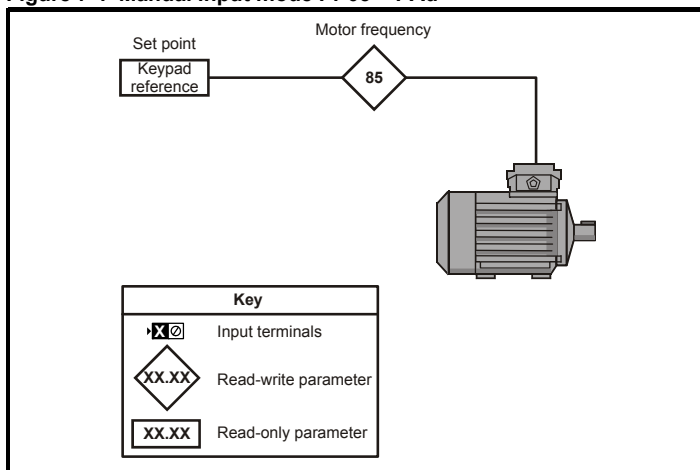
Configuration	Description
PAd	Manual input mode
Std	Standard input mode
EPt	Electronic pressure transducer input mode
rES	Reserved

Manual input mode

Manual mode uses the keypad buttons to start and stop the motor, as well as increasing and decreasing the motor speed. It also allows the user to set a constant motor speed. This mode will be useful, during installation and repair.

The *Set point* is the keypad reference and is used as an input, with the speed being adjustable between 0 to 100%. Transducer input will not have any effect on the speed of the motor.

Figure 7-1 Manual input mode Pr 05 = PAd



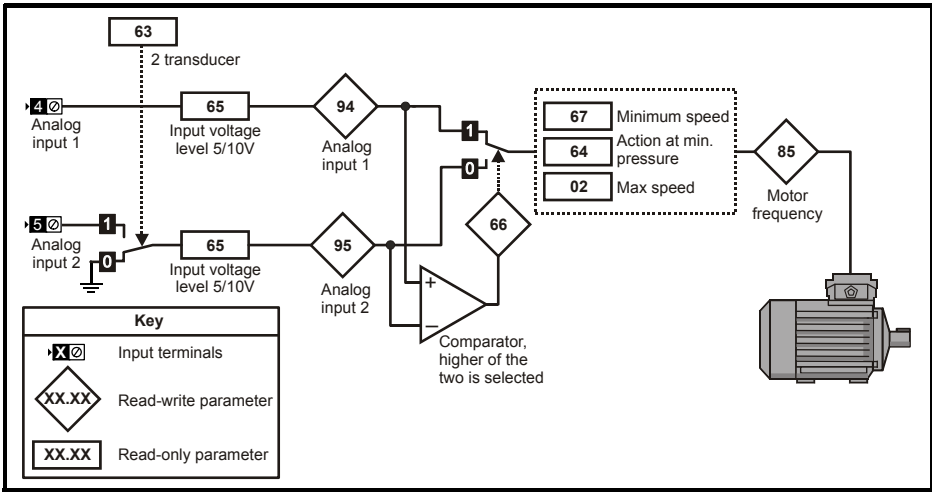
Standard input mode

The VFD66 extensively uses this mode. The majority of input devices compatible with the drive are used with this mode. The input device determines the set point and proportional band. The parameters which are used in these modes are *Minimum speed* (Pr **67**) as a percentage of *Maximum speed* (Pr **02**), range from 0 to 50%.

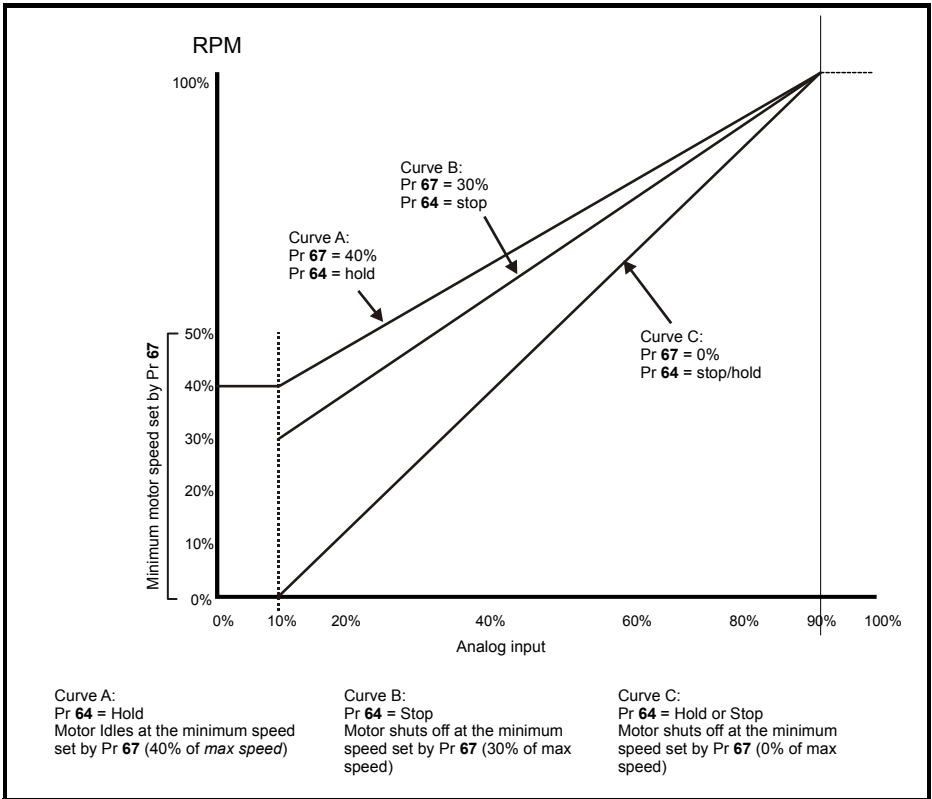
Action at minimum speed (Pr **64**), range Hold or Stop.

Maximum speed (Pr **02**), range 0 to 1500Hz.

Figure 7-2 Standard input mode Pr 05 = Std



The Proportional band of the drive will be between the values selected in Pr 67 (0 to 50%) and *Maximum speed* Pr 02.



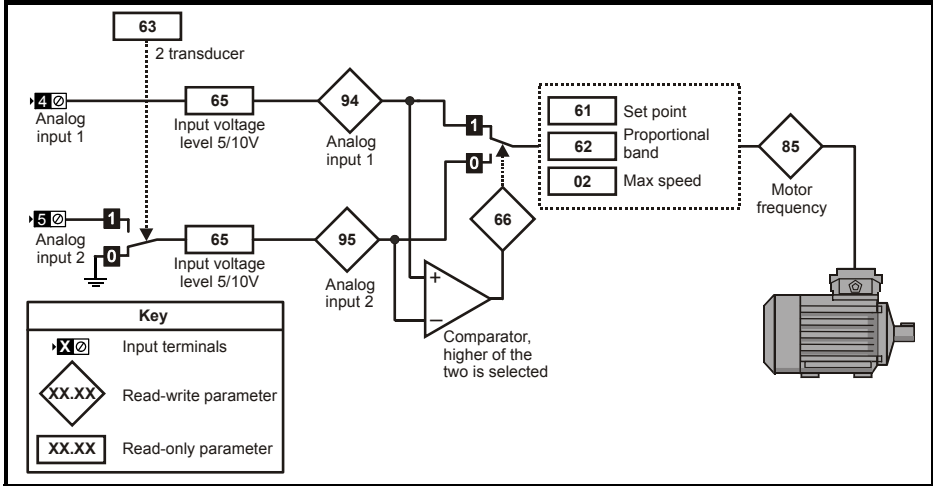
Safety information
Rating data
Mechanical installation
Electrical installation
Derating
Keypad and display
Parameters
Diagnostics
Technical specifications
UL Listing

Electronic pressure transducer input mode

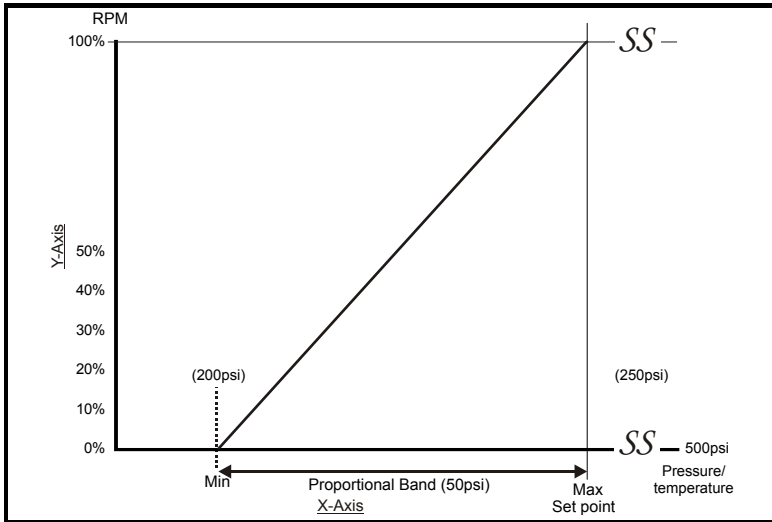
The VFD66 controls work with any electronic pressure transducer that generated a 0-5 Vdc or 0-10Vdc output signal.

The user can configure the drive using *Set point* (Pr 61) & *Proportional Band* (Pr 62) and *Max Speed* (Pr 02). Note that *Minimum Speed* (Pr 67) and *Action at Min Speed* (Pr 64) cannot be configured in this mode.

Figure 7-3 Electronic pressure transducer input mode Pr 05 = EPT



The setpoint (0 to 95%) minus Proportional band (0 to 95%) value cannot be a negative value.



Example:

Selected transducer type P399BAA-1C. Pressure range: 0-500psi

P1: Set point range =250psi

P2: Proportional bands = 50psi

Then the fan motor starting point (min speed) =Set point (P1) - Proportional band (P2) = 250-50=200psi

Fan motor max speed at P1=Set point=250psi

Thus as soon as the pressure transducer input reaches 200psi, the motor starts at minimum speed, and after reaching 250 psi, the motor reaches *Max speed*.

Therefore if the *Set point* (Pr **61**) was set to 50% and the *Proportional Band* (Pr **62**) was set to 10%. This would mean that the drive would run at 60Hz when the input is 2.5V and at 0Hz when the input is 2V (using the 0 to 5V input range).

NOTE Minimum motor speed and motor action as minimum speed cannot be set in this mode.

NOTE The VFD66 has line start with a single auto restart after 25s.

The drive can be stopped by pressing the stop/reset button. However, before the drive can be restarted in either Std or EPt mode, the mode will need to be changed.

No	Function	Range	Defaults	Type
06	Motor rated current	0 to Drive rated current A	Drive rating	RW

Enter the motor current rating (taken from the motor name plate).

The drive rated current is the 100% RMS output current value of the drive. This value can be set to a lower value but not to a higher value than the drive rated current.



Pr **06** *Motor rated current* must be set correctly to avoid a risk of fire in the event of a motor overload.

No	Function	Range	Defaults	Type
07	Motor rated speed	0 to 9999 rpm	Eur: 1500, USA: 1800	RW

Enter the rated full load speed of the motor (taken from the motor name plate).

The motor rated speed is used to calculate the correct slip speed for the motor.

No	Function	Range	Defaults	Type
08	Motor rated voltage	0 to 240, 0 to 480 V	Eur: 230 / 400 USA: 230 / 460	RW

Enter the motor rated voltage (taken from the motor name plate).

This is the voltage applied to the motor at base frequency.

NOTE If the motor is not a standard 50 or 60Hz motor, see Pr **39** on page 33 and adjust accordingly.

No	Function	Range	Defaults	Type
09	Motor power factor	0 to 1	0.85	RW

Enter the motor rated power factor $\cos \varphi$ (taken from the motor name plate).

No	Function	Range	Defaults	Type
10	Parameter access	L1, L2, L3, LoC	L2	RW

L1: Level 1 access - only the first 10 parameters can be accessed
L2: Level 2 access - All parameters from 01 to 67 can be accessed
L3: Level 3 access - All parameters from 01 to 95 can be accessed
LoC: Used to lock a security code in the drive. See section 6.6 *Security codes* on page 25 for further details.

7.2 Parameter descriptions - level 2

No	Function	Range	Defaults	Type
22	Load display units	Ld, A	Ld	RW

Ld: Active current as a % of motor rated active current
A: Drive output current per phase in Amps

No	Function	Range	Defaults	Type
23	Speed display units	Fr, SP	Fr	RW

Fr: Drive output frequency in Hz
SP: Motor speed in rpm

No	Function	Range	Defaults	Type
25	User security code	0 to 999	0	RW

Used to set-up a user security code. See section 6.6 *Security codes* on page 25.

No	Function	Range	Defaults	Type
26	Not used			

No	Function	Range	Defaults	Type
29	Load defaults	no, Eur, USA	no	RW

no: defaults are not loaded
Eur: 50Hz default parameters are loaded
USA: 60Hz default parameters are loaded

Default parameters are set by pressing the  MODE key on exit from parameter edit mode after Pr **29** has been set to Eur or USA.

When default parameters have been set, Pr **10** will be reset to L2.

NOTE The drive must be in a disabled, stopped or tripped condition to allow default parameters to be set. If default parameters are set while the drive is running, the display will flash FAIL once before changing back to no.
 With the 28C/29C variants, if defaults are loaded, these variants will have standard parameter settings, not 28C/29C settings.

No	Function	Range	Defaults	Type
33	Catch a spinning motor select	0 to 3	1	RW

- 0: Disabled
- 1: Detect positive and negative frequencies
- 2: Detect positive frequencies only
- 3: Detect negative frequencies only

NOTE This function is only active when the drive is in fixed boost mode.

No	Function	Range	Defaults	Type
37	Maximum switching frequency	3, 6, 12 kHz	3	RW

- 3: 3kHz
- 6: 6kHz
- 12: 12kHz

No	Function	Range	Defaults	Type
38	Autotune	0 to 2	0	RW

- 0: No autotune
- 1: Non-rotating static autotune
- 2: Rotating autotune



WARNING

When a rotating autotune is selected, the drive will accelerate the motor up to $2/3$ maximum speed in Pr **02**.

NOTE The motor must be at a standstill before a non-rotating autotune is initiated.

NOTE The motor must be at a standstill and unloaded before a rotating autotune is initiated.

NOTE If an autotune is to be performed, then the drive should be in a vector mode.

NOTE Once a rotating autotune has been initiated (Pr **38** = 2), it must be completed before the drive will operate normally. If the rotating autotune is not completed (through the drive being disabled or a trip occurring), the drive will only run at the autotune speed ($2/3$ rated speed reference).

No	Function	Range	Defaults	Type
39	Motor rated frequency	0.0 to 1500.0 Hz	Eur: 50.0, USA: 60.0	RW

Enter the motor rated frequency (taken from the motor name plate).
Defines the voltage to frequency ratio applied to the motor.

No	Function	Range	Defaults	Type
40	Number of motor poles	Auto, 2P, 4P, 6P, 8P	Auto	RW

Auto: Automatically calculates the number of motor poles from the settings of Pr 07 and Pr 39

2P: Set for a 2 pole motor

4P: Set for a 4 pole motor

6P: Set for a 6 pole motor

8P: Set for an 8 pole motor

No	Function	Range	Defaults	Type
41	Voltage mode select	Ur S, Ur, Fd, Ur A, Ur I, SrE	Ur A	RW

Ur S: Stator resistance is measured each time the drive is enabled and run

Ur: No measurement is taken

Fd: Fixed boost (V/Hz)

Ur A: Stator resistance is measured the first time the drive is enabled and run

Ur I: Stator resistance measured at each power up when the drive is enabled and run

SrE: Square law characteristic

In all Ur modes, the drive operates in open loop vector mode.

NOTE The drive default setting is **Ur A** mode, which means that the drive will carry out an autotune the first time the drive is powered up and enabled. If the load is not going to be stationary when the drive is powered up and enabled the first time, then one of the other modes should be selected. Not selecting another mode could result in poor motor performance or OI.AC, It.AC or OV trips.

Once the autotune has been performed successfully in **Ur A** mode, Fixed boost mode will then be used.

The Fixed boost mode should be used for multiple motor applications.

NOTE If the autotune fails i.e. trips on rS, due to no motor being connected, the voltage mode will then be Ur mode.

No	Function	Range	Defaults	Type
42	Low frequency voltage boost	0.0 to 50%	3.0	RW

Determines the boost level when Pr 41 is set to Fd or SrE.

The range is 0.0 to 50% of motor rated voltage.

No	Function	Range	Defaults	Type
45	Software version	1.00 to 99.99		RO

No	Function	Range	Defaults	Type
55	Last trip		0	RO
56	Trip before Pr 55			
57	Trip before Pr 56			
58	Trip before Pr 57			

Indicates the last 4 trips of the drive.

No	Function	Range	Defaults	Type
61	Set point	0 to 95.0%	90.0%	RW
62	Proportional band	0 to 95.0%	80.0%	RW
63	Dual transducer mode	IInP(0) or 2InP(1)	IInP(0)	RW
64	Action at min pressure	StOP(0) or HOLd(1)	StOP(0)	RW
65	Transducer voltage rating	5V (OFF) or 10V(On)	5V(OFF)	RW
66	Input comparator	OFF (ANIP2) or On (ANIP1)	OFF (ANIP2)	RO
67	Minimum speed	0.0 to 1500Hz	0.0	RW

7.3 Parameter descriptions - level 3

No	Function	Range	Defaults	Type
71 to 80	Pr 61 to Pr 70 set up	0 to Pr 21.51		RW

7.4 Diagnostic parameters

The following read only (RO) parameters can be used as an aid to fault diagnosis on the drive.

No	Function	Range	Type
81	Frequency reference selected	± Pr 02 Hz	RO
82	Pre-ramp reference	± Pr 02 Hz	RO
83	Post ramp reference	± Pr 02 Hz	RO
84	DC Bus voltage	0 to Drive maximum Vdc	RO
85	Motor frequency	± Pr 02 Hz	RO
86	Motor voltage	0 to Drive rating V	RO
87	Motor speed	± 9999 rpm	RO
88	Motor current	0 to Drive maximum A	RO
89	Motor active current	± Drive maximum A	RO
91	Reference enabled indicator	OFF or On	RO
93	Analog input 3 level	0 to 100.0%	RO
94	Analog input 1 level	0 to 100.0%	RO
95	Analog input 2 level	0 to 100.0%	RO

8 Diagnostics



Do not attempt to carry out internal repairs. Return a faulty drive to the supplier for repair.

Trip code	Condition	Possible cause
UV	DC bus under voltage	Low AC supply voltage
OV	DC bus over voltage	Deceleration rate set too fast for the inertia of the machine
OI.AC**	Drive output instantaneous over current	Line to line output fault detected Line to ground output fault detected
O.SPd	Over speed	Excessive motor speed
It.AC	I^2t on drive output current	Excessive mechanical load High impedance phase to phase or phase to ground short circuit at drive output
O.ht1	IGBT over heat based on drives thermal model	Overheat software thermal model
O.ht2	Over heat based on drives heatsink	Heatsink temperature exceeds allowable maximum
O.Ld1	User +5V output overload	Excessive load or short circuit on +5V output
O.ht3	Drive over-heat based on thermal model	Overheat software thermal model
EEF	Internal drive EEPROM trip	Possible loss of parameter values (set default parameters (see Pr 29 on page 32))
PH	Input phase imbalance or input phase loss	One of the input phases has become disconnected from the drive
rS	Failure to measure motors stator resistance	Motor too small for drive Motor cable disconnected during measurement
HFxx trip	Hardware faults	Internal drive hardware fault

** These trips cannot be reset for 10 seconds after they occur.

Table 8-1 DC bus voltages

Drive voltage rating	UV Trip	UV Reset	OV trip
200V	175	215 *	415
400V	330	425 *	830

NOTE * These are the absolute minimum DC voltages the drives can be supplied by.

Table 8-2 Alarm warnings/Display indications

Display	Condition	Solution
OVLd	$I \times t$ overload (I = current, t = time)	Reduce motor current (Load)
hot	Heatsink/IGBT temperature high	Reduce ambient temperature or reduce motor current
ACLt	Drive is in current limit	Increase ramp time
FAIL	Failed attempt to default drive	An attempt has been made to default the drive when the drive was not disabled or tripped.

NOTE If no action is taken when an alarm warning appears, the drive will trip on the appropriate fault code.

8.1 Fault clearing

Drive faults may be cleared by one of the following methods:

- Removing and re-applying power to the drive.
- Pressing the stop/reset button on the keypad.

8.2 Repairs and replacements

Field repairs of the VFD66 Control should not be made. In case of a defective or improperly functioning control, contact your nearest Authorized Johnson Controls/PENN® Distributor or Sales Representative. When contacting your Johnson Controls/PENN distributor, have the model number of the control available. This number can be found on the label on the side of the control.

Safety information
Rating data
Mechanical installation
Electrical installation
De-rating
Keypad and display
Parameters
Diagnostics
Technical specifications
UL Listing

9 Technical specifications

Model	VFD66
Drive voltage rating	230Vac, 460Vac @ 60Hz (230Vac, 400Vac @ 50Hz)
Output Voltage/Output frequency	230Vac, 460Vac @ 60Hz (230Vac, 400Vac @ 50Hz)
Switching frequency	3kHz, 6kHz, 12kHz
Duty	Normal
Overload limit	110% overload current for 60s
Acceleration/Deceleration	0 to 3200.0 s/100Hz
Start/Stop	Terminal control / keypad control
Motor cable lengths	≤50m
Ambient temperature	-40°C (-40°F) to 50°C (122°F) [60°C (140°F) with derating]
Storage temperature	-40°C to 50°C (-40°F to 122°F)
Altitude	Rated altitude: 1000m (3300 ft) Refer to <i>section 5.2 Altitude de-rating on page 22</i>
Humidity	Maximum relative humidity 90% non-condensing at 40°C (104°F)
Storage humidity	Maximum relative humidity 93%, 40°C, 4 days
Vibration	Meets EN61800-5-1 and ETS 300019-2-2
Enclosure	IP20 (UL Type 1)
Approvals	RoHS compliant, CE approval, UL / cUL approval (JCI file number E244421) C tick approval
Input devices	Johnson Controls / Penn (C450CPN, C450CQN, P35, P499). Also works with rack controllers, electronic pressure transducers and other 0-5 Vdc or 0-10Vdc input signal devices made by various manufacturers.
Dimensions	See Figure 3-1 on page 10
Weight	5.5 lb (2.5kg)

NOTE The performance specifications are nominal and conform to acceptable industry standards. For application at conditions beyond these specifications, consult Johnson Controls/PENN Refrigeration Application Engineering at 1-800-275-5676. Johnson Controls, Inc. shall not be liable for damages resulting from misapplication or misuse of its products.


Johnson Controls
Building Efficiency
 507 East Michigan Street
 Milwaukee
 WI 53202

10 UL listing information

Table 10-1 Approvals

	CE approval	Europe
	C tick approval	Australia
	UL/cUL approval	USA & Canada

10.1 UL information

(For VFD66AAA, VFD66BAA, VFD66CAA, VFD66DAA, VFD66EBA, VFD66FAA)

The Johnson Control UL file number is E244421. Confirmation of UL listing can be found on the UL website: www.ul.com.

10.1.1 Conformity

The drive conforms to UL listing requirements only when the following are observed:

- Class 1 60/75°C (140/167°C) copper wire only is used in the installation.
- The ambient temperature does not exceed 50°C (122°F) when the drive is operating.
- The terminal tightening torques specified in section 4.1 *VFD66 drive* on page 12 are used.
- UL listed class CC acting fuses e.g. Bussman Limitron KTK series, Gould AmpTrap ATM series or equivalent are used in the AC supply.

10.1.2 AC supply specification

The drive is suitable for use on available circuits of 5,000A RMS maximum, 480V/240V maximum, when protected by fuses only, sized 250% FLA maximum.

10.1.3 Motor overload protection

The drive provides motor overload protection. The overload protection level is 110% of the full load current. For individual motor drive current rating, please refer to the relevant section of the *User Guide*.

10.1.4 Over-speed protection

The drive provides over-speed protection. However, it does not provide the level of protection afforded by an independent high integrity over-speed protection device.



24-10511-90