Pump drive F600

Step By Step Guide

Frame sizes 3 to 11

www.controltechniques.com/support

EN

This guide provides a fast and simple start-up procedure for a basic drive and motor installation.

For help with more advanced installations: Comprehensive user guides, online videos and help tools can be accessed using the web address or QR code above.

*Please read the safety information booklet supplied with the drive before installation or set-up. It is essential to read Section 4.4 in the **F600 User Guide** using the web address or QR code above prior to using the Safe Torque Off function in safety systems.*

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Part Number: 0478-0621-03
Issue: 3

Contents

English

Introduction

The F600 is a simple and flexible range of drives from 1.1 kW to 280 kW in 9 frame sizes and four input voltage ranges (200 V, 400 V, 575 V and 690 V).

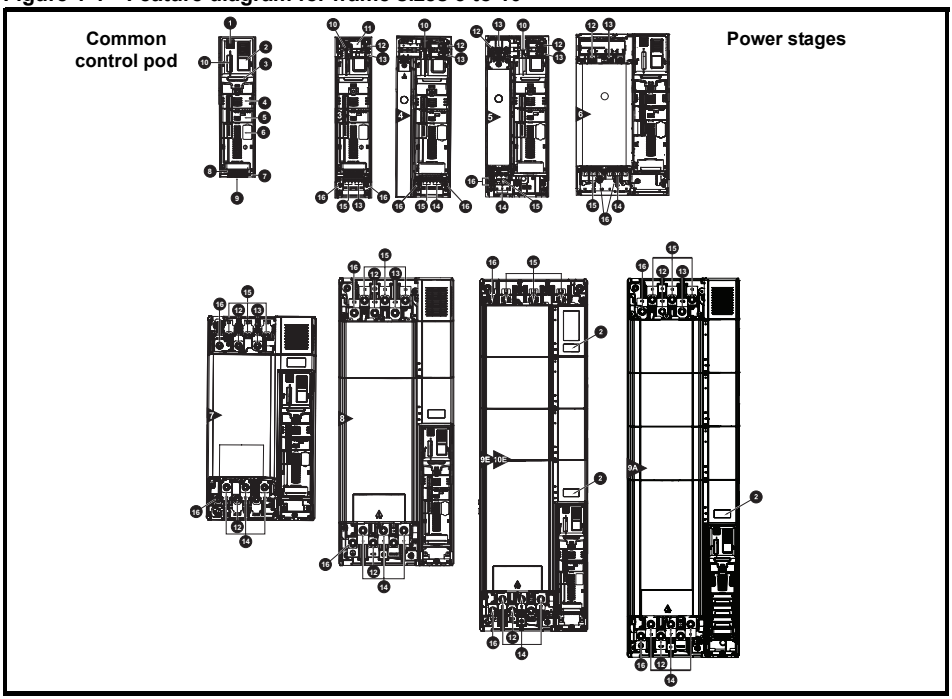
This Step-by Step guide provides simple instructions on how to mount the drive, fuse and cable selection, wiring the drive-up, programming the drive and running the motor keypad mode on frames 3 to 11.

The following information is available for download at 'www.controltechniques.com/support':

- F600 User Guide
  There is also a guided set-up contained in the software tool Connect available from:
  https://acim.nidec.com/drives/control-techniques/downloads
- F600 Parameter Reference Guide

Features of the drive

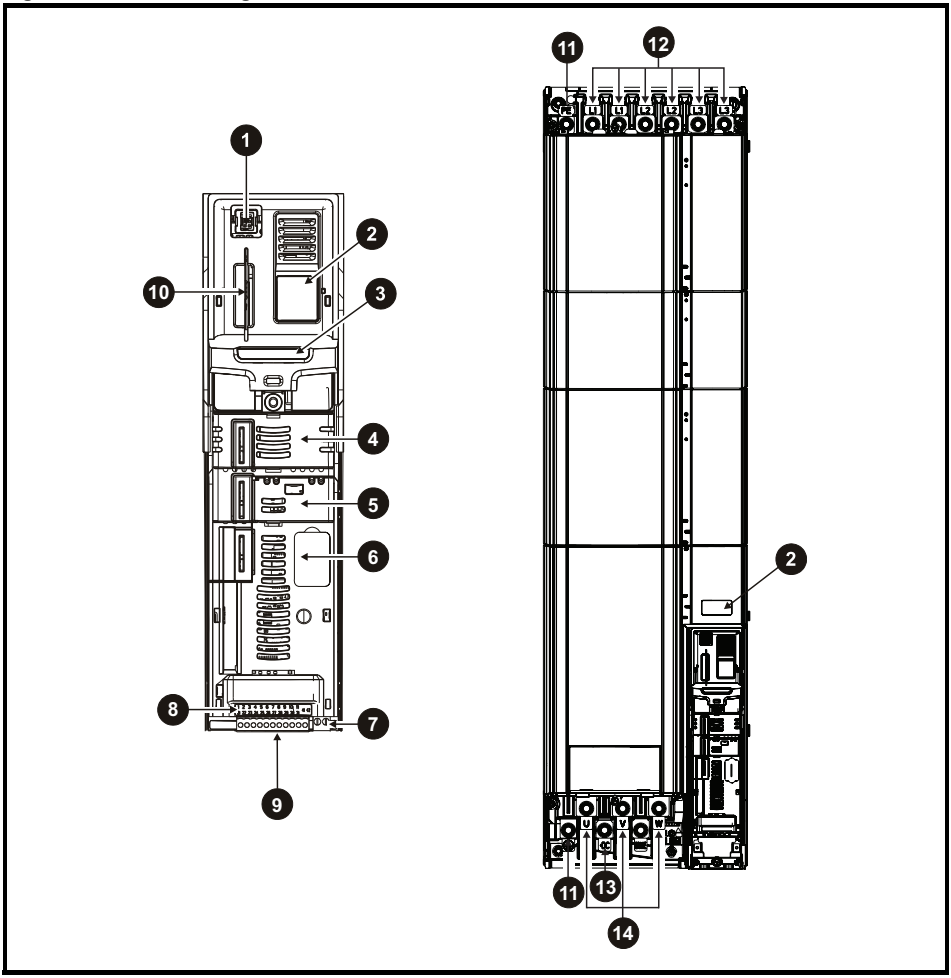
Figure 1-1 Feature diagram for frame sizes 3 to 10



Key

1. Keypad connection
2. Rating label
3. Identification label
4. Option module slot 1
5. Option module slot 2
6. Option module slot 3
7. Relay connections
8. Control connections
9. Communications port
10. NV media card slot
11. Internal EMC filter
12. DC bus +
13. DC bus -
14. Motor connections
15. AC supply connections
16. Ground connections

Figure 1-2 Feature diagram for frame size 11



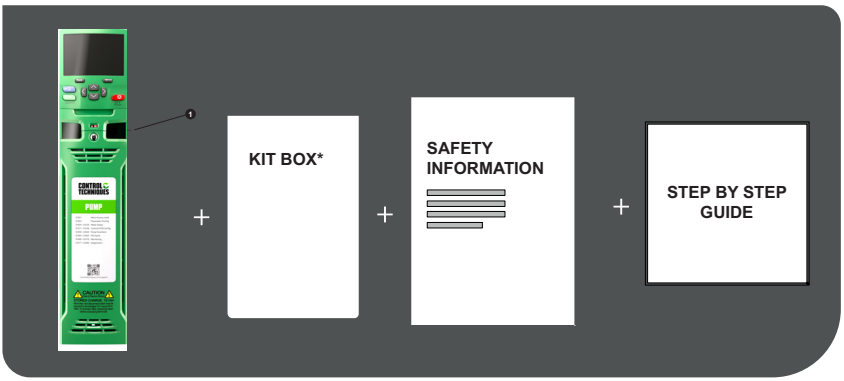
Key

1. Keypad connection
2. Rating label
3. Identification label
4. Option module slot 1
5. Option module slot 2
6. Option module slot 3
7. Relay connections
8. Control connections
9. Communications port
10. NV media card slot
11. Ground connections
12. AC supply connections*
13. DC bus +
14. Motor connections

*Common AC Supply connections are internally linked on the 11E 6 pulse drive

STEP 1: Check the contents of the box

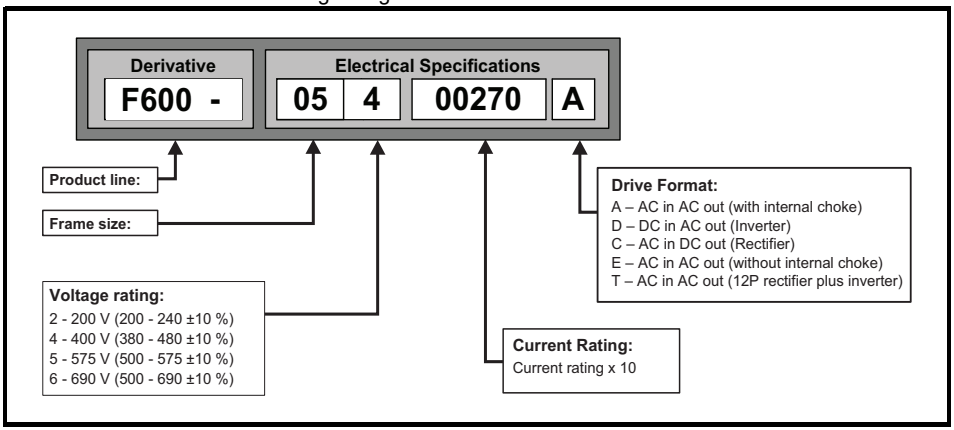
Check you have all the components and your drive has not been damaged during transportation.



* With frame size 7 to 11, surface mounting brackets are also supplied with the drive.

STEP 2: Check model and voltage

The model number can be found on the identification label ❶ on the top of the drive. Please check that the model and the drive voltage range is suitable for the installation.



STEP 3: Mount the drive

The drive should be mounted in an ambient temperature range of - 20 °C to 55 °C (- 4 °F to 131 °F).

Output current derating may be required at ambient temperatures > 40 °C (104 °F). Refer to the **F600 User Guide** (section 5). For UL installations, the maximum ambient temperature permitted is 50 °C (122 °F) with any specified derating applied.

The drive can be screwed on a wall or Through-panel mounted (Refer to the **F600 User Guide**). Table 3-1 highlights the clearances.

Table 3-1 Recommended spacing

Frame	Spacing Drive / Filter	Spacing Drive / Drive	Spacing above drive	Spacing below drive
3	0 mm (0.00 in)	0 mm (0.00 in)	100 mm (4.0 in)	100 mm (4.0 in)
4	30 mm (1.18 in)	30 mm (1.18 in)	100 mm (4.0 in)	100 mm (4.0 in)
5	30 mm (1.18 in)	30 mm (1.18 in)	100 mm (4.0 in)	100 mm (4.0 in)
6	30 mm (1.18 in)	30 mm (1.18 in)	100 mm (4.0 in)	100 mm (4.0 in)
7	30 mm (1.18 in)	30 mm (1.18 in)	100 mm (4.0 in)	100 mm (4.0 in)
8	30 mm (1.18 in)	30 mm (1.18 in)	100 mm (4.0 in)	100 mm (4.0 in)
9	60 mm (2.37 in)	60 mm (2.37 in)	60 mm (2.37 in)	100 mm (4.0 in)
10	60 mm (2.37 in)	60 mm (2.37 in)	60 mm (2.37 in)	100 mm (4.0 in)
11	60 mm (2.37 in)	60 mm (2.37 in)	60 mm (2.37 in)	100 mm (4.0 in)

Table 3-2 Drive dimensions and weights

Frame	Height		Width		Depth	Mounting holes (Ø)	Weight
	Mounting	Overall	Mounting	Overall			
3	365 mm (14.37 in)	382 mm (15.03 in)	73 mm (2.87 in)	83 mm (3.26 mm)	200 mm (7.87 in)	5.5 mm (0.21 in)	4.5 kg (9.92 lb)
4	365 mm (14.37 in)	391 mm (15.39 in)	106 mm (4.17 in)	124 mm (4.88 in)	200 mm (7.87 in)	6.5 mm (0.26 in)	6.5 kg (14.33 lb)
5	365 mm (14.37 in)	391 mm (15.39 in)	106 mm (4.17 in)	143 mm (5.63 in)	200 mm (7.87 in)	6.5 mm (0.26 in)	7.4 kg (16.3 lb)
6	365 mm (14.37 in)	391 mm (15.39 in)	196 mm (7.72 in)	210 mm (8.27 in)	287 mm (11.29 in)	7.0 mm (0.28 in)	14 kg (30.9 lb)
7	508 mm (20 in)	552 mm (21.73 in)	220 mm (8.66 in)	270 mm (10.63 in)	280 mm (11.02 in)	9.0 mm (0.35 in)	28 kg (61.70 lb)
8	753 mm (29.64 in)	804 mm (31.65 in)	259 mm (10.20 in)	310 mm (12.21 in)	290 mm (11.42 in)	9.0 mm (0.35 in)	52 kg (114.6 lb)
9	1049 mm (41.29 in)	1108 mm (43.62 in)	259 mm (10.20 in)	320 mm (12.59)	290 mm (11.42 in)	9.0 mm (0.35 in)	46 kg (101.4 lb)
10	1010 mm (39.76 in)	1069 mm (42.08 in)	259 mm (10.20 in)	310 mm (12.21 in)	290 mm (11.42 in)	9.0 mm (0.35 in)	46 kg (101.4 lb)
11	1189 mm (46.81 in)	1242 mm (48.89 in)	259 mm (10.20 in)	310 mm (12.21 in)	313 mm (12.32 in)	9.0 mm (0.35 in)	63 kg (138.8 lb)

STEP 4: Select supply / motor cables and fuses

Refer to Appendix B for the ratings for the 575V and 690V drives. The supply/motor cables and fuses or MCB's used should follow the ratings provided in the table below:

The voltage rating of fuses must be greater than or equal to the highest supply voltage of the system. **Fuses**: The AC supply to the drive must be installed with suitable protection against overload. Failure to observe this requirement will cause risk of fire.

NOTE The product is UL listed for use on a circuit up to 100 kA maximum supply symmetrical fault current, when protected by fuses.

NOTE IEC cable sizes assume Copper conductor, PVC insulation, Installation method B2 and ambient temperature of 40 °C (104 °F). UL cable sizes assume Copper conductor with insulation rated at 75 °C (167 °F).

Table 4-1 200 V drive ratings, cable sizes and fuse ratings (200 V to 240 V ±10 %)

Model	Max. cont. input current	Fuse				Nominal cable size				Normal Duty		
		IEC		UL		European		USA				
	3ph	Nom	Class	Nom	Class	Input	Output	Input	Output	Max. count. output current	Nom power @ 230 V	Motor power @ 230 V
	A	A		A		mm²	mm²	AWG	AWG	A	kW	hp
03200066	10.4	16	gG	20	CC, J or T*	1.5	1.5	14	14	6.6	1.1	1.5
03200080	12.6	20		20		1.5	1.5	14	14	8	1.5	2
03200110	17	20		25		4	4	12	12	11	2.2	3
03200127	20	25		25		4	4	12	12	12.7	3	3
04200180	20	25	gG	25	CC, J or T*	6	6	10	10	18	4	5
04200250	28	32		30		8	8	8	8	25	5.5	7.5
05200300	31	40	gG	40	CC, J or T*	10	10	8	8	30	7.5	10
06200500	48	63	gG	60	CC, J or T*	16	16	4	4	50	11	15
06200580	56	63		70		25	25	3	3	58	15	20
07200750	67	80	gG	80	CC, J or T*	35	35	2	2	75	18.5	25
07200940	84	100		100		35	35	1	1	94	22	30
07201170	105	125		125		70	70	1/0	1/0	117	30	40
08201490	137	200	gR	200	HSJ	6	95	3/0	3/0	149	37	50
08201800	166	200		225		2 x 70	2 x 70	2 x 1	2 x 1	180	45	60
09202160	205	250	gR	250	HSJ	2 x 70 (B1)	2 x 95 (B2)	2 x 2/0		216	55	75
09202660	260	315		300		2 x 95 (B1)	2 x 120 (B2)	2 x 4/0		266	75	100
10203250	305	400	gR	400	HSJ	2 x 120 (B1)	2 x 120 (B2)	2 x 250		325	90	125
10203600	361	450		450		2 x 150 (C)		2 x 300		360	110	150

Table 4-2 400 V drive ratings, cable sizes and fuse ratings (380 V to 480 V ±10 %)

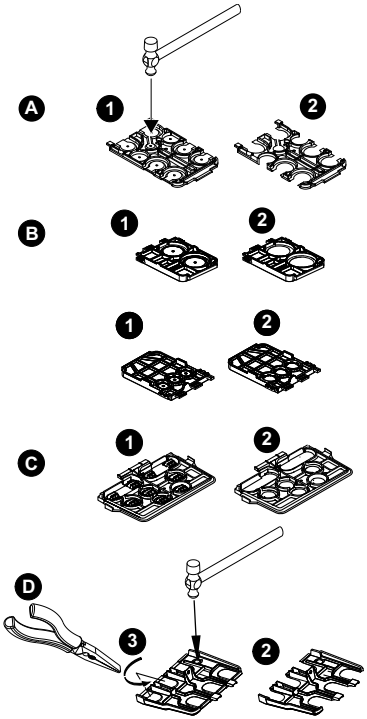
Model	Max. cont. input current	Fuse				Nominal cable size				Normal Duty		
		IEC		UL		European		USA				
	3ph	Nom	Class	Nom	Class	Input	Output	Input	Output	Max. count. output current	Nom power @ 400 V	Motor power @ 400 V
	A	A		A		mm²	mm²	AWG	AWG	A	kW	hp
03400034	5	10	gG	10	CC, J or T*	1.5	1.5	18	18	3.4	1.1	2
03400045	7	10		10		1.5	1.5	16	16	4.5	1.5	2
03400062	9	10		10		1.5	1.5	14	14	6.2	2.2	3
03400077	13	20		20		2.5	2.5	14	14	7.7	3	5
03400104	13	20		20		2.5	2.5	14	14	10.4	4	5
03400123	16	20		20		2.5	2.5	12	12	12.3	5.5	7.5
04400185	19	25	gG	25	CC, J or T*	4	4	10	10	18.5	7.5	10
04400240	24	32		30		6	6	8	8	24	11	15
05400300	29	40	gG	35	CC, J or T*	6	6	8	8	30	15	20
06400380	36	63	gR	40	CC, J or T*	10	10	6	6	38	18.5	25
06400480	46	63		50		16	16	4	4	48	22	30
06400630	60	63		60		25	25	3	3	63	30	40
07400790	74	100	gG	80	CC, J or T*	35	35	1	1	79	37	60
07400940	88	100		100		50	50	2	2	94	45	60
07401120	105	125		125		70	70	1/0	1/0	112	55	75
08401550	155	250	gR	225	HSJ	2 x 50	2 x 50	2 x 1	2 x 1	155	75	100
08401840	177	250		225		2 x 70	2 x 70	2 x 1/0	2 x 1/0	184	90	150
09402210	232	315	gR	300	HSJ	2 x 70 (B1)	2 x 95 (B2)	2 x 3/0	2 x 2/0	221	110	150
09402660	267			350		2 x 95 (B1)	2 x 120 (B2)	2 x 4/0	2 x 4/0	266**	132	200
10403200	332	400	gR	400	HSJ	2 x 120 (C)	2 x 120 (B2)	2 x 300	2 x 250	320	160	250
10403610	397	450		450		2 x 150 (C)	2 x 150 (B2)	2 x 350	2 x 300	361	200	300
11404370	449	500	gR	600	HSJ	4 x 95 (C)	2 x 185 (C)	4 x 3/0	2 x 400	437	225	350
11404870	492	500					2 x 240 (C)	4 x 4/0		487**	250	400
11405070	539	630								507**	280	450

* These fuses are fast acting.

** These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to the power and current ratings in the *F600 User Guide*.

STEP 5: Remove the finger guard breakouts

Removing the finger-guard break-outs



A: Size 3 to 11

B: Size 5 only

C: Size 6 only

D: Size 7 to 11

Place finger-guard on a flat solid surface and hit relevant break-outs with hammer as shown (1). For sizes 7 to 9 pliers can be used to remove the break-outs, grasp the relevant break-out with the pliers and twist it as shown (3). Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed.

Finger guard grommets are supplied in the kitbox for size 5 and 6.

STEP 6: Wire the drive up

This step covers connection of input power connection L1,L2, and L3 including the ground terminals, motor phases U V W and the control terminals.

The tools required for this are terminal screwdriver, flat screwdriver, M7, M8, M10 and M17 sockets T20 and T25 driver. When wiring the drive's power, ground and control connections, they should be tightened to the recommended torque settings shown in the table below:

Table 6-1 Drive control and relay terminal data

Model	Connection type	Torque settings
All	Plug-in terminal block	2.0 N m (1.4 lb ft)

Table 6-2 Drive power terminal data

Model size	AC and motor terminals		DC terminal		Ground terminal	
	Recommended	Maximum	Recommended	Maximum	Recommended	Maximum
3 and 4	Plug-in terminal block		T20 Torx (M4)		T20 Torx (M4) / M4 Nut (7 mm AF)	
	0.7 N m (0.5 lb ft)	0.8 N m (0.6 lb ft)	2.0 N m (1.4 lb ft)	2.5 N m (1.8 lb ft)	2.0 N m (1.4 lb ft)	2.5 N m (1.8 lb ft)
5	Plug-in terminal block		T20 Torx (M4) / M4 Nut (7 mm AF)		M5 Nut (8 mm AF)	
	1.5 N m (1.1 lb ft)	1.8 N m (1.3 lb ft)	1.5 N m (1.1 lb ft)	2.5 N m (1.8 lb ft)	2.0 N m (1.4 lb ft)	5.0 N m (3.7 lb ft)
6	M6 Nut (10 mm AF)		M6 Nut (10 mm AF)		M6 Nut (10 mm AF)	
	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)	6.0 N m (4.4 lb ft)	8.0 N m (6.0 lb ft)
7	M8 Nut (13 mm AF)		M8 Nut (13 mm AF)		M8 Nut (13 mm AF)	
	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)	12 N m (8.8 lb ft)	14 N m (10.0 lb ft)
8 to 11	M10 Nut (17 mm AF)		M10 Nut (17 mm AF)		M10 Nut (17 mm AF)	
	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)	15 N m (11.1 lb ft)	20 N m (14.8 lb ft)

Power and Ground connections

Connect the supply and motor connections using the cables and fuses quoted in the table shown in Step 4.

Figure 6-1 Size 3 power and ground connections

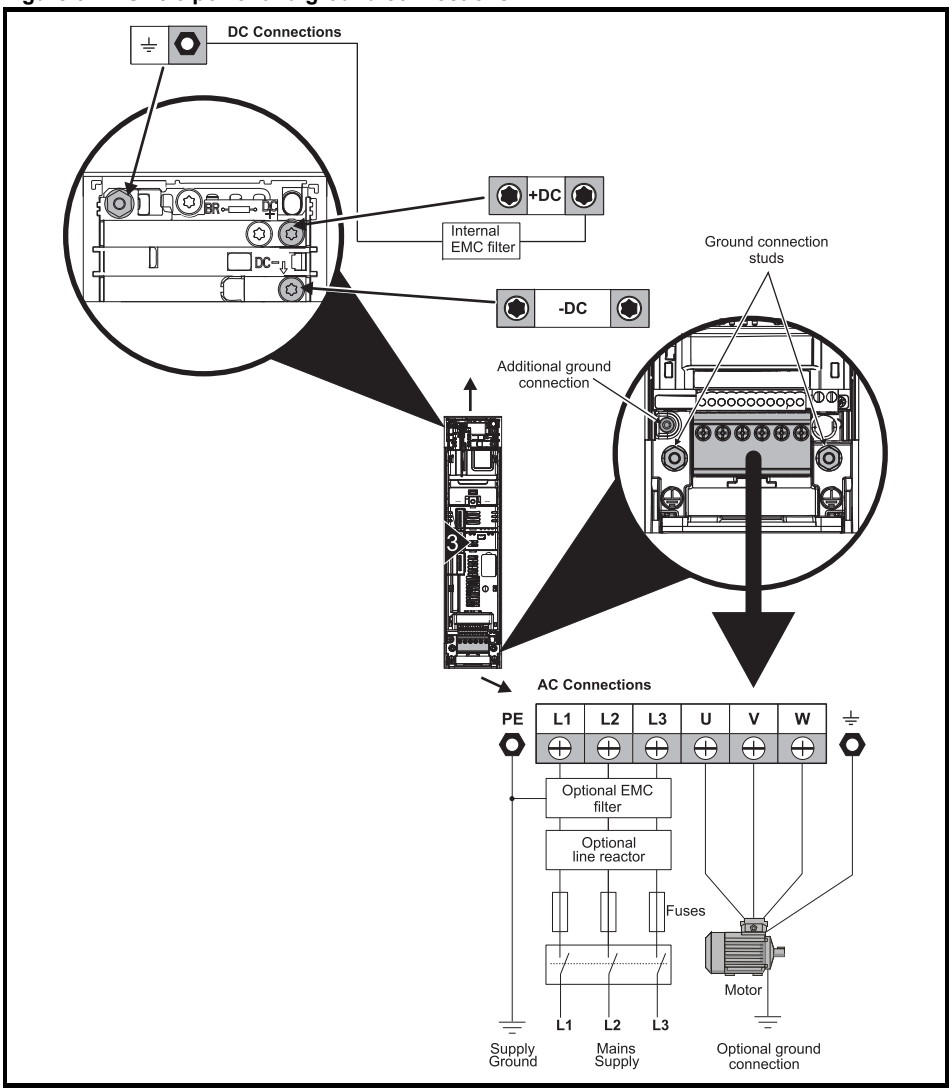


Figure 6-2 Size 4 power and ground connections

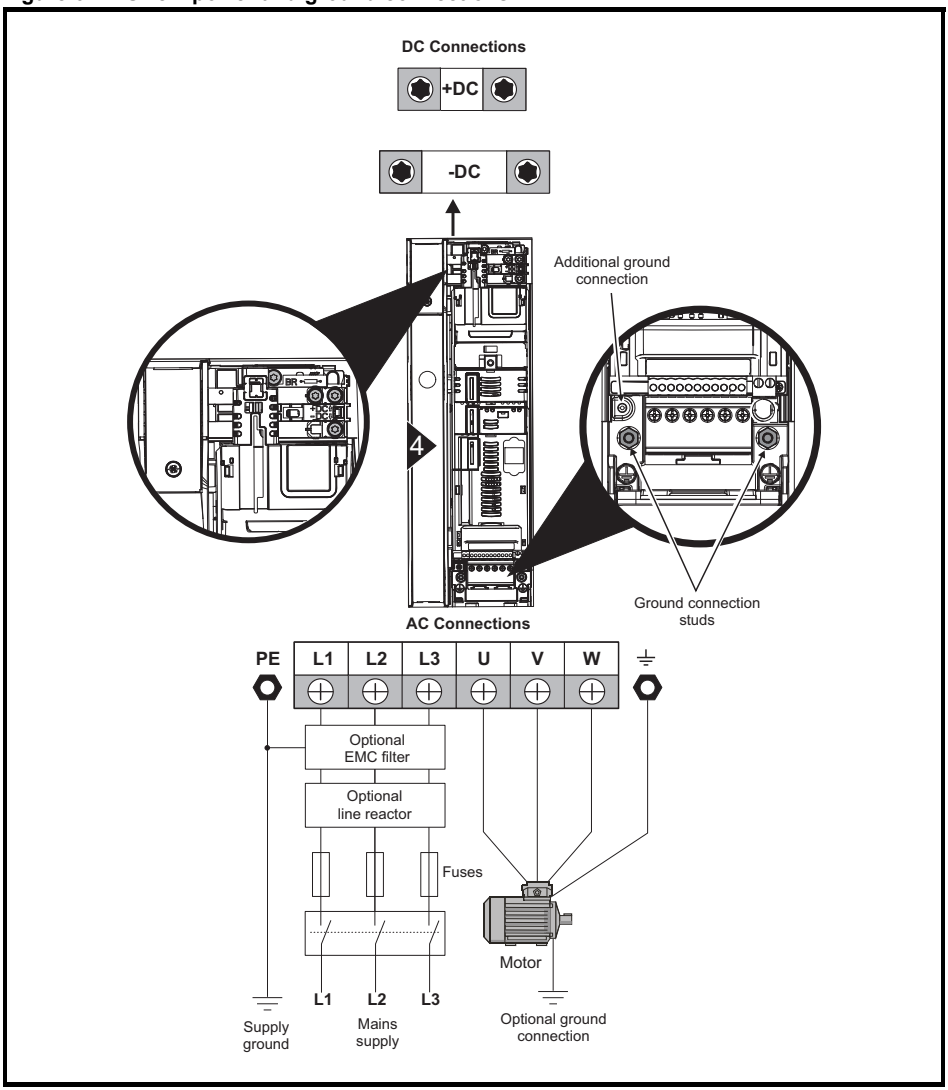


Figure 6-3 Size 5 power and ground connections

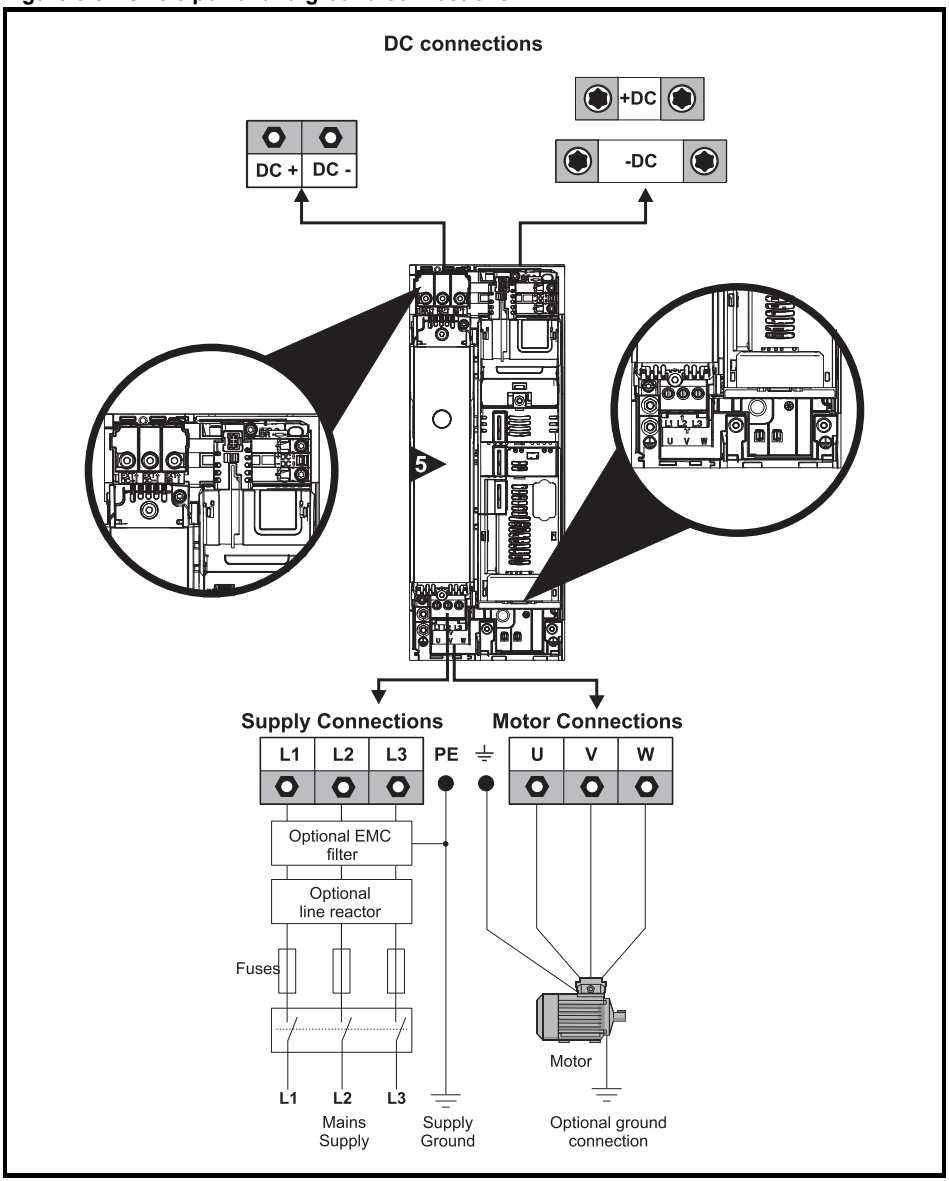


Figure 6-4 Size 6 power and ground connections

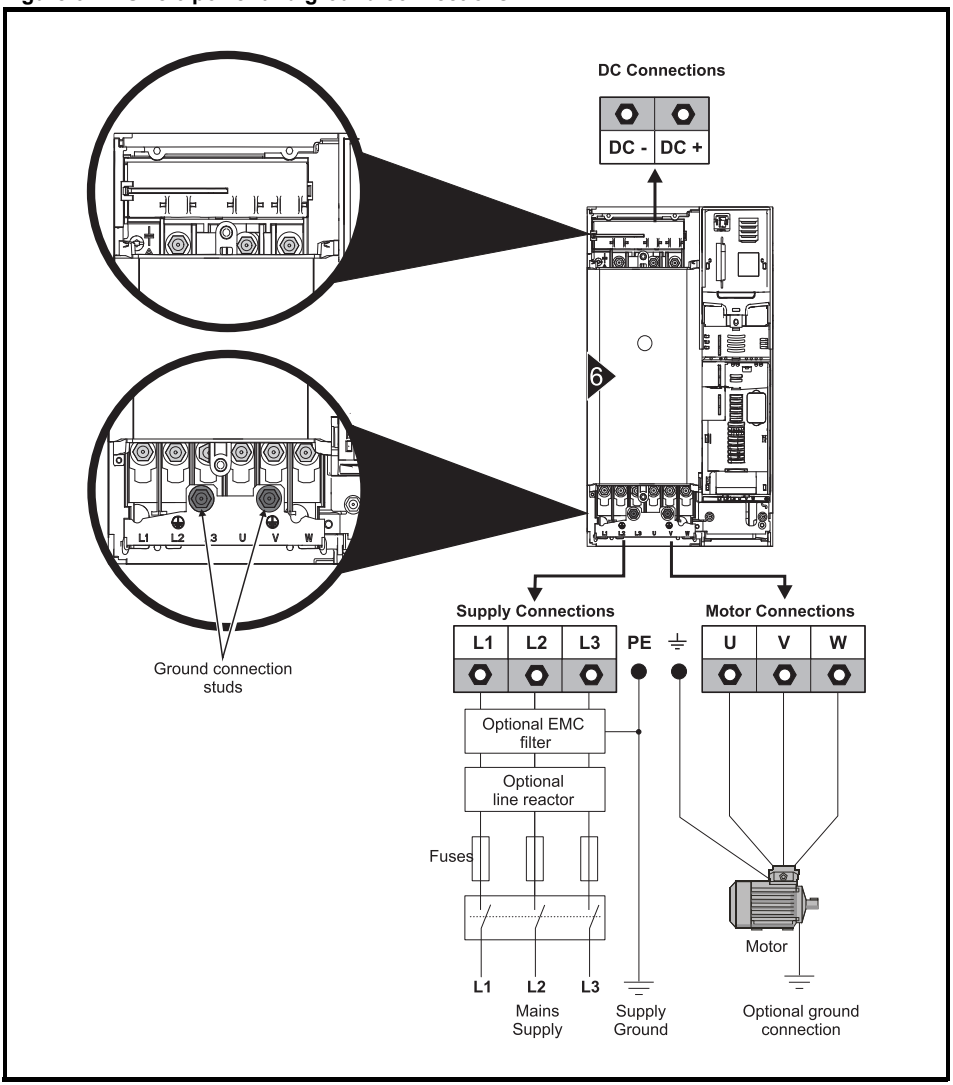


Figure 6-5 Size 7 and 8 power and ground connections (size 7 shown)

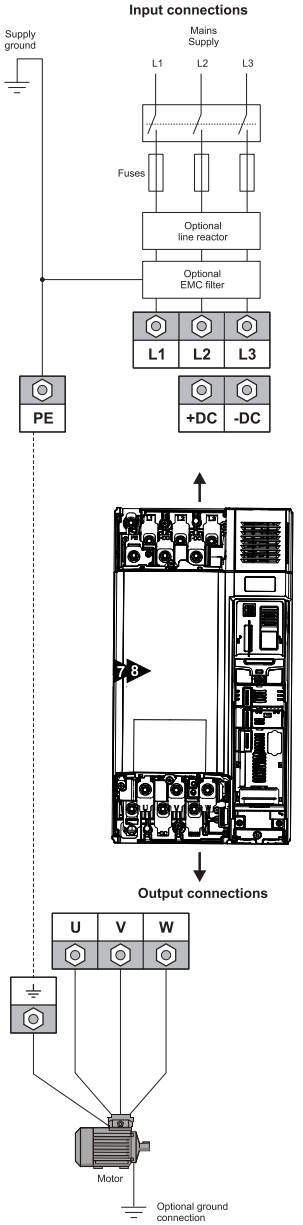


Figure 6-6 Size 9E, 10E power and ground connections

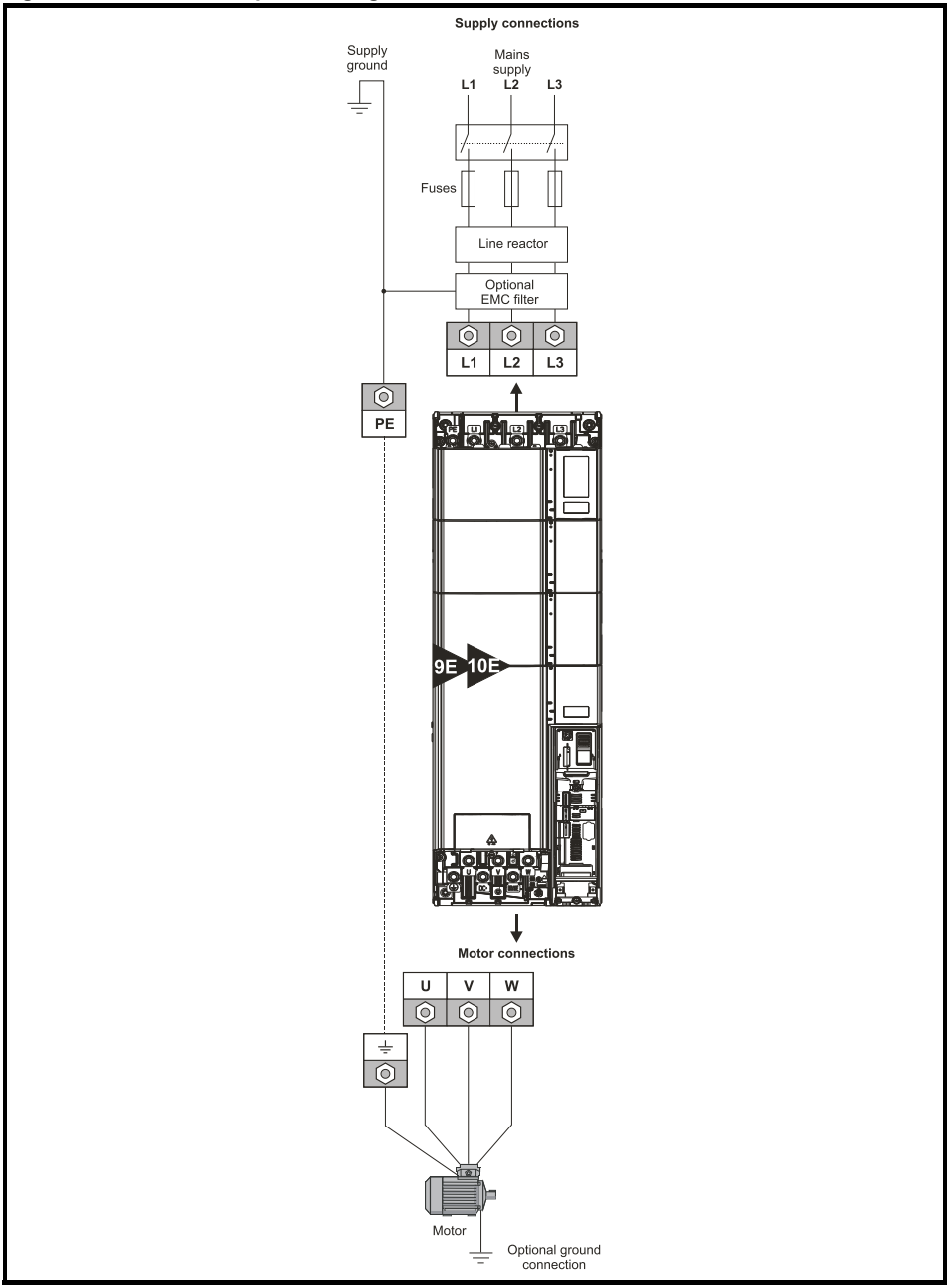


Figure 6-7 Size 9A power and ground connections

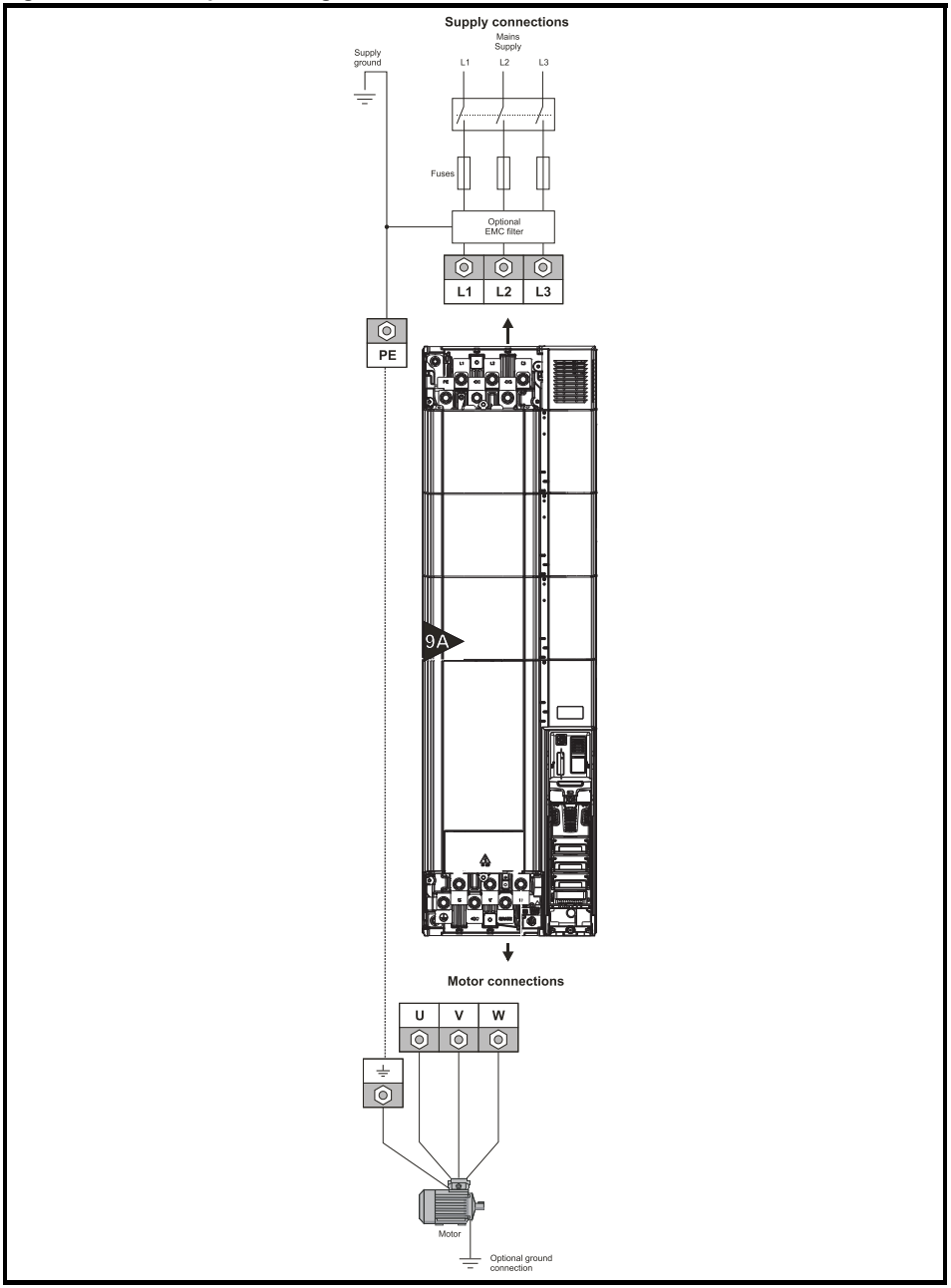
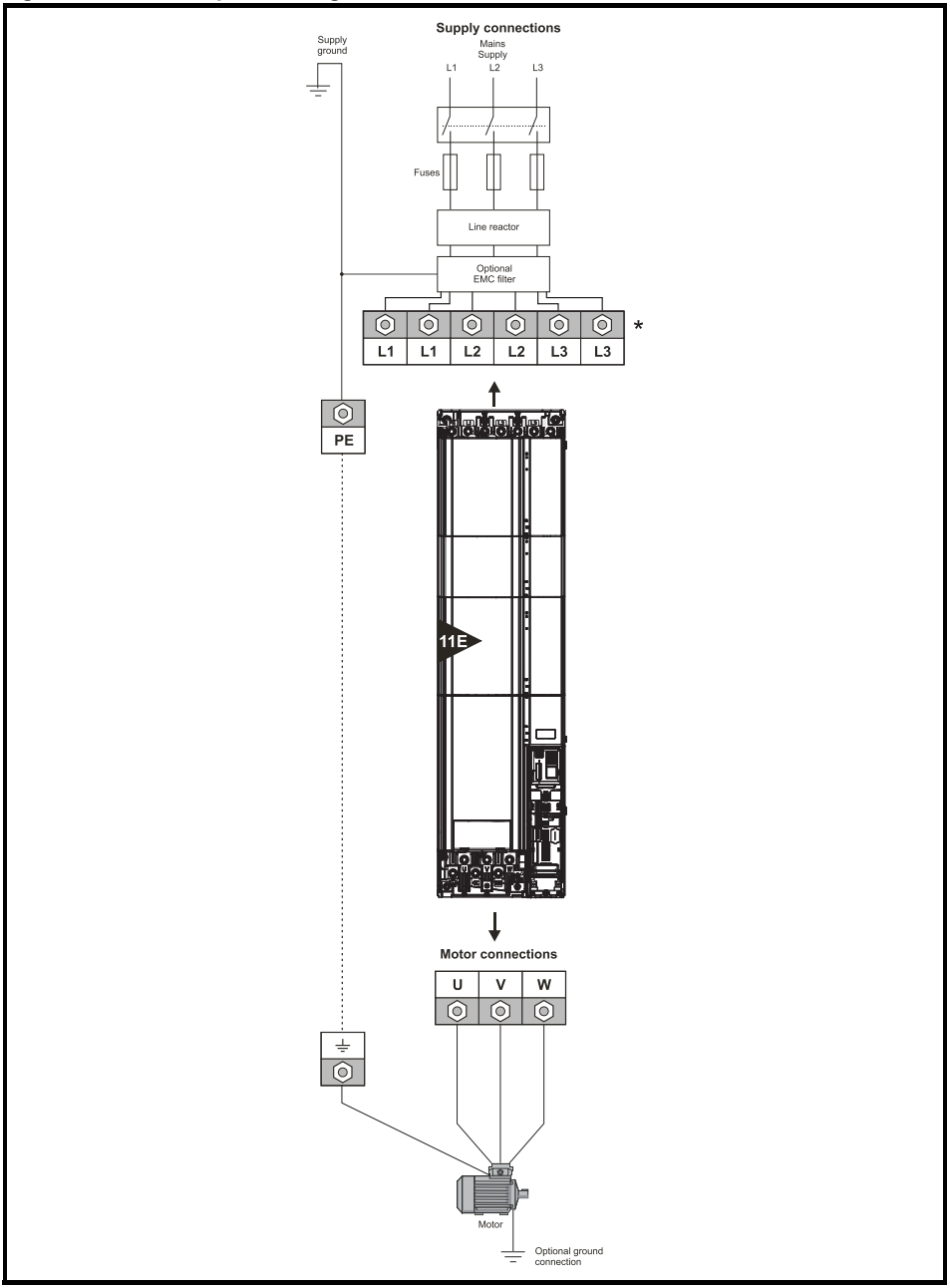


Figure 6-8 Size 11E power and ground connections



Electrochemical corrosion of grounding terminals
Ensure that grounding terminals are protected against corrosion i.e. as could be caused by condensation.

The drive must be connected to the system ground of the AC supply. The ground wiring must conform to local regulations and codes of practice.

The ground loop impedance must conform to the requirements of local safety regulations.
The drive must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply.
The ground connections must be inspected and tested at appropriate intervals.

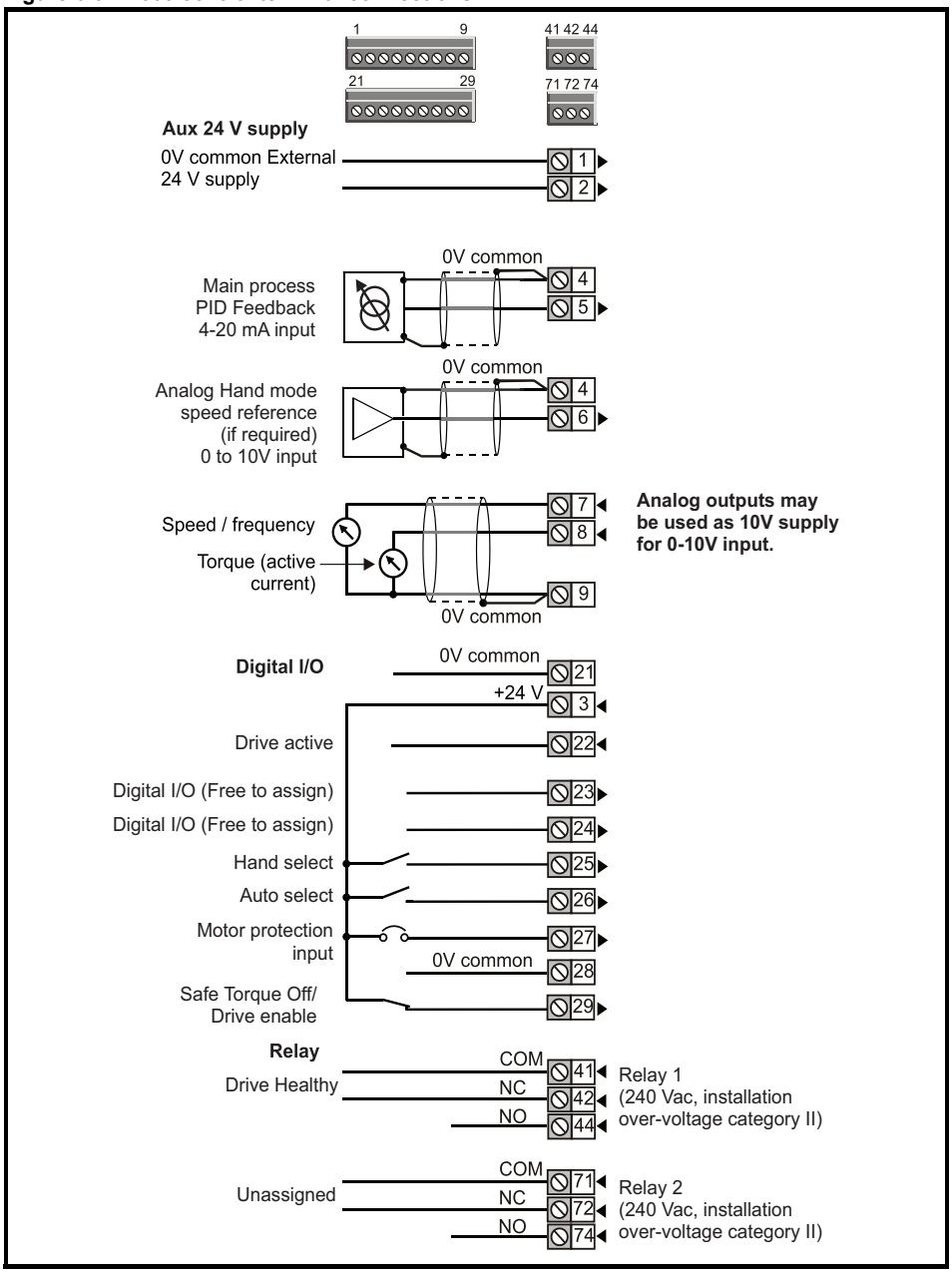
Table 6-3 Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
≤ 10 mm²	Either 10 mm² or two conductors of the same cross-sectional area as the input phase conductor
> 10 mm² and ≤ 16 mm²	The same cross-sectional area as the input phase conductor
> 16 mm² and ≤ 35 mm²	16 mm²
> 35 mm²	Half of the cross-sectional area of the input phase conductor

Control connections

The control terminals are configured by default for the arrangement shown below:

Figure 6-9 F600 control terminal connections



Communications connections

The drive offers a 2 wire EIA-485 serial interface located beneath the control terminals, see Figure 6-10 *Location of the comms connector* below. The drive supports the Modbus RTU protocol as standard. See Table 6-4 for the connection details.

Figure 6-10 Location of the comms connector

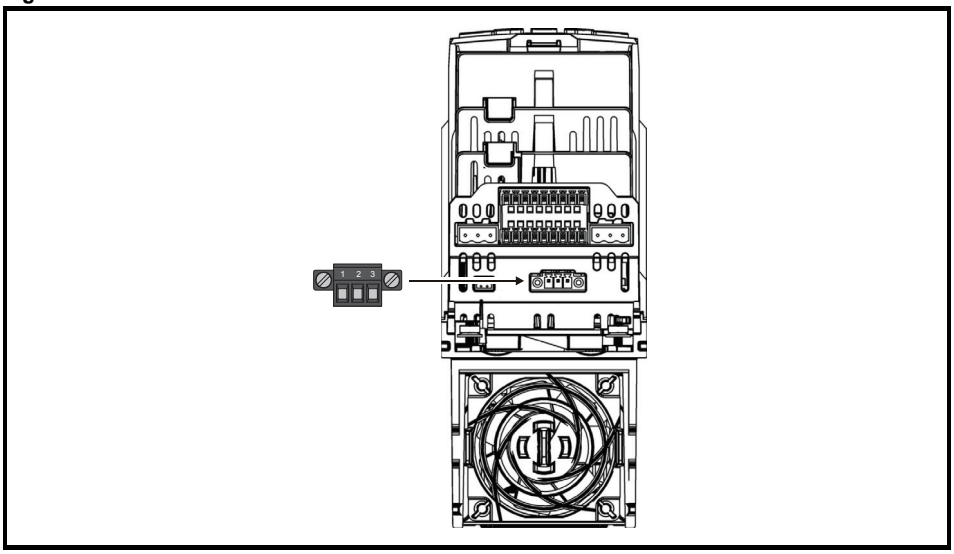


Table 6-4 Serial communication port pin-outs

Pin	Function
1	RX TX
2	Isolated 0V
3	RX\ TX\

EIA-485 Serial communications

The serial communications port is a 3 way screw type connector, which is isolated from the power stage and the other control terminals.The communications port applies a 2 unit load to the communications network.

USB/EIA-232 to EIA-485 Communications

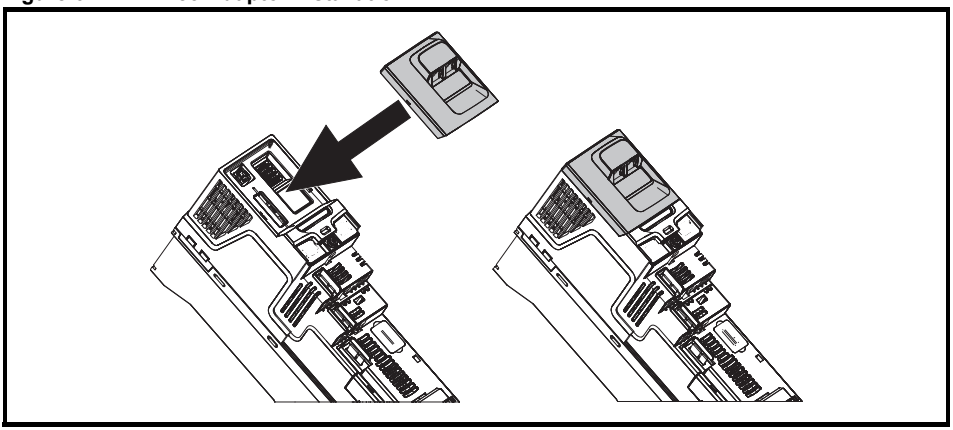
An external USB/EIA-232 hardware interface such as a PC cannot be used directly with the 2-wire EIA-485 interface of the drive.

To gain access to the drive parameters (including connection to Connect), a KI-485 Adaptor should be installed as shown in Figure 4-15 and used in conjunction with a suitable USB to EIA-485 isolated converter. A suitable isolated converter is available from Control Techniques:

- CT USB Comms Cable (CT part number: 4500-0096).

A KI-485 Adaptor is also required for remote LCD keypad operation. The communications cable between the KI-485 Adaptor and keypad is wired one to one. The maximum cable length is 100 m when conductors of 0.129 mm² (AWG 26) or larger are used and the cable shield should be connected to the grounded panel / cubicle at the keypad end of the cable.

Figure 6-11 KI-485 Adaptor Installation



To install, align the KI-485 Adaptor and press gently in the direction shown until it clicks into position.

To remove, reverse the installation instructions.

NOTE IEC cable sizes assume Copper conductor, PVC insulation, Installation method B2 and ambient temperature of 40 °C (104 °F). UL cable sizes assume Copper conductor with insulation rated at 75 °C (167 °F).

When using the Control Techniques converters or any other suitable converter with the drive, it is recommended that no terminating resistors be connected on the network. It may be necessary to disconnect the terminating resistor within the converter depending on which type is used.

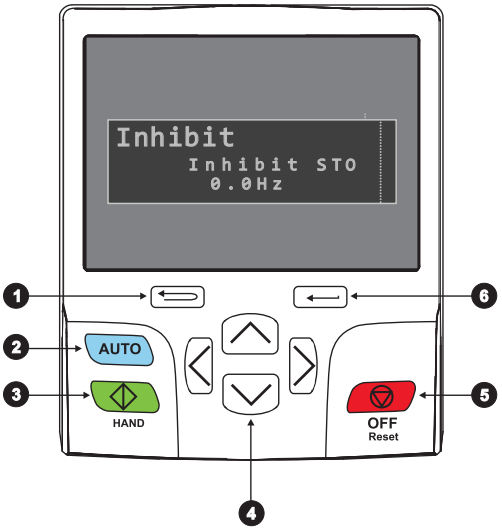
STEP 7: Use the keypad

The keypad display provides information to the user regarding the operating status of the drive, alarms and trip codes. The keypad buttons provide a means for changing parameters, stopping and starting the drive, and the ability to perform a drive reset.

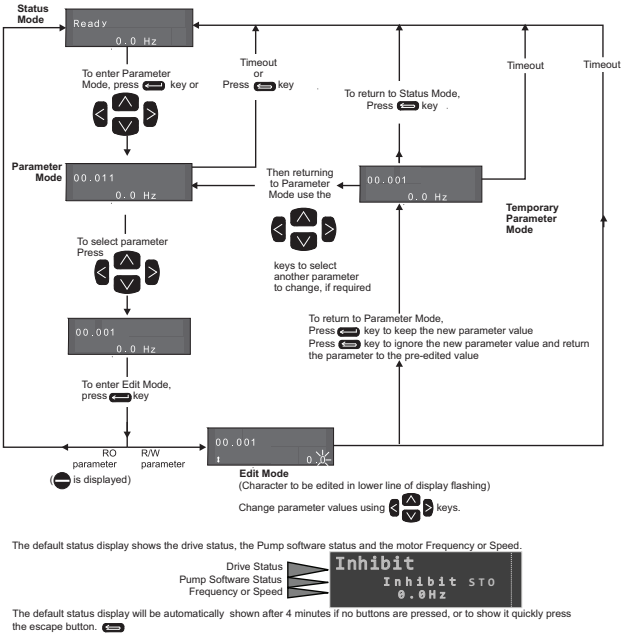
Keypad key identifier

1. Escape button
2. Auto
3. Hand
4. Navigation keys (x4)
5. OFF/ Reset
6. Enter button

Press and hold the Hand or Auto buttons for 2 s to select those functions. A short press will activate the Off function.



Instructions to edit parameters



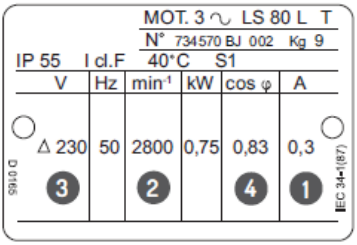
STEP 8: Run the drive for the first time in Hand mode

Step 8 and 9 cover basic fixed pressure pump setup. There is a comprehensive guided set-up wizard included in the Connect PC software package which covers pump system set-up.

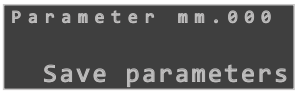
Hand mode is where the drive runs from a fixed frequency or speed reference where the process PID loop is disabled. The user can modify the hand mode frequency or speed as detailed in the following steps.

Before starting, it is important to identify the type of motor used in the application. If the type of motor isn't known, please contact the motor manufacturer to find out if it is an induction or permanent-magnet motor.

Run an Induction motor in open-loop (OL) control

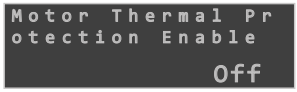
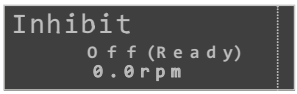
Action	Detail
Before power up.	Open the Enable or Safe Torque Off, Hand and Auto mode switches so the drive powers up in the *Inhibit* state. Make sure that no items are preventing the application motor from turning e.g. a seized pump.
Power up the drive.	After power up the display indicates as shown below. 
Select "Induction" motor.	Set Motor Type Pr **0.004** to *Induction* and press the red OFF / Reset button to change the mode. This selects open-loop (OL) control for an induction motor.   If "Induction" is already shown, then skip this step.
Configure the motor name plate details.	• Set *Rated Current* Pr **0.006** to the motor rated current in Amps. • Set *Rated Speed* Pr **0.007**, the motor rated speed in rpm. • Set *Rated Voltage* Pr **0.008**, the motor rated voltage in Volts. • Set *Rated Power Factor* Pr **0.009**, the motor rated power factor, (cos phi or cos φ). 
Configure motor thermal protection.	If a normally closed motor thermal protection switch has been connected, (contacts closed = temperature OK, contacts open = temperature fault), set *Motor Thermal Protection Enable* Pr **0.017** to On. Otherwise leave Pr **0.017** set to Off. 

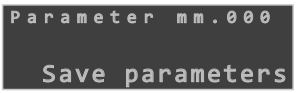
Set the Maximum Reference Clamp.	By default, *Maximum Reference Clamp* Pr **0.022** normally matches *Rated Frequency* Pr **0.005**  It may be required when running to reduce this value if pump cavitation is suspected during operation.
Set the Hand Mode Reference frequency.	Set *Hand Mode Reference* Pr **0.026** to configure the frequency reference used in Hand mode. By default, this is half of the motor rated frequency 
Enable the drive.	Close the Enable or Safe Torque Off input switch to the drive. The pump software status changes to *Off (Ready)*. 
Start the motor in Hand mode.	Make sure it is safe to run the motor. Press and hold the green Hand button for 2 s or close the Hand switch. The motor will turn at the Hand mode speed reference and the pump software status changes to *Hand Run*.   If the application requires more starting torque to get the motor turning, e.g. a waste water pump, increase *Low Frequency Voltage Boost* Pr **0.011**, in 1 % steps. If 5 % is reached and the motor still does not turn, stop the Motor by pressing the red OFF / Reset button or by opening the Hand switch. The pump software status changes to *Off (Ready)*.   When safe to do so, check the application for physical items that may be preventing the motor from rotating.

Check the motor is turning in the correct direction.	All pumps have a direction to turn in for their main operation. Use the manufacturer's data or labels on the apparatus and compare to the direction of rotation of the cooling fan or motor output shaft. *Hand Mode Reference* Pr **0.026** may need to be lowered to see the direction.  If the motor appears to be running in the wrong direction, reverse two motor phases electrically when safe to do so. Alternatively, set *Reverse Output Phase Sequence* Pr **0.018** to *On* to do this in software, and Set Pr **0.000** to *Save Parameters* and press the red OFF / Reset button.   
Stop the motor.	Stop the motor by pressing the red OFF / Reset button or by opening the Hand switch. The pump software status in changes to *Off (Ready)*.  

Run a Permanent-magnet motor in closed-loop sensorless (RFC-S)

Action	Detail
Before power up.	Open the Enable or Safe Torque Off, Hand and Auto mode switches so the drive powers up in the Inhibit state. Make sure that no items are preventing the application motor from turning e.g. a ceased or blocked pump.
Power up.	After power, up the display indicates as shown below. 
Select Permanent-magnet motor.	Set parameter Pr **0.004** to *Permanent-magnet* and press the red OFF / Reset button to change the mode. This selects closed-loop sensorless (RFC-S) control for a permanent-magnet motor.   If *Permanent-magnet* is already shown, then skip this step.

Configure the motor name plate details.	• Set *Back EMF / Ke* Pr **0.005**, the Back EMF / Ke in Volts per 1000 rpm (V/kmin^{-1}). • Set *Motor Rated Current* Pr **0.006**, the motor rated current in Amps. • Set *Motor Rated S.peed* Pr **0.007**, the motor rated speed in rpm. • Set *Motor Rated Voltage* Pr **0.008**, the motor rated voltage in Volts. • Set *Number of Motor Poles* Pr **0.010,** the number of motor poles. 
Configure Motor Thermal Protection.	If a normally closed motor thermal protection switch has been connected, (contacts closed = temperature OK, contacts open = temperature fault), set *Motor Thermal Protection* Enable Pr **0.017** to *On*. Otherwise leave Pr **0.017** set to *Off*. 
Set the Maximum Reference Clamp.	The Maximum Reference Clamp, Pr **0.022** normally matches the motor name plate speed as entered in Pr **0.007**.  It may be required when running to reduce this value if pump cavitation is suspected during operation.
Set the Hand Reference Speed.	Set the Hand mode digital frequency speed reference Pr **0.026**. By default, this is half of the motor rated speed. 
Select the auto-tune mode.	Set Pr **0.013** to *Stationary* to select a stationary auto-tune. The motor shaft will not rotate as a part of this test, however, as a precaution it should be treated as if will rotate. 
Enable the drive.	Close the Enable or Safe Torque Off input switch to the drive. The pump software status changes to *Off* (*Ready)*. 

Run the auto-tune.	Make sure it is safe to run the motor. Press and hold the green Hand button for 2 s or close the Hand switch.  HAND  The drive will run the auto-tune to measure the electrical properties of the motor. The autotune process takes approximately 30 s. When the Autotune is completed the pump software status changes to *Inhibit STO*. The drive sequencer prevents the drive running in an unexpected way after the auto-tune. To allow the motor to run after the auto-tune, do one of the following: • Open the Enable or Safe Torque Off switch. • Or press the red OFF / Reset button. • Or open the Hand switch. The pump software status changes to *Off (Ready)*.  OFF Reset 
Does the motor have a load?	If the motor has a pump attached or RFC Low Speed Mode Pr **0.014** = Injection, move to the next step to *Save the drive parameters*.  If the motor has no load attached e.g. for a basic bench test, and RFC Low Speed Mode Pr **0.014** = Current, reduce the Low Speed Sensorless Mode Current Pr **0.015** to 50.0 %.  When the load is attached, increase Pr **0.015** back to 100.0%.
Save the drive parameters.	Set Pr **0.000** to *Save Parameters* and press the red OFF / Reset button.  OFF Reset 

Start the motor in Hand mode.	Make sure it is safe to run the motor. Press and hold the green Hand button for 2 s or close the Hand switch. The motor will turn at the Hand mode speed reference and the pump software status changes to *Hand Run*.   If instability is noted at high speed and load, additional filtering of the estimated speed feedback may be required. Stop the motor by pressing the red OFF / Reset button or by opening the Hand switch. The pump software status changes to *Off (Ready)*.   Increase the Sensorless Mode Filter value Pr **0.019** in single steps until the required performance is reached. Stop and start the motor making sure it starts and runs at high speed properly. If the motor doesn't start properly and there is significant starting torque required to turn the load, check if the RFC Low Speed Mode Pr **0.014** = Injection. If it is set to "Injection" please try setting Pr **0.014** to "Current" instead and Increase the Low Speed Sensorless Current Pr **0.015** to 100 %.
Check the motor is turning in the correct direction.	All pumps have a direction to turn in for their main operation. Use the manufacturers data or labels on the apparatus and compare to the direction of rotation of the cooling fan or motor output shaft. The Hand Mode Reference Pr **0.026** may need to be lowered to see the direction.  If the motor appears to be running in the wrong direction, either reverse two motor phases electrically, when safe to do so. Alternatively, set Reverse Output Phase Sequence Pr **0.018** to "On".   
Stop the motor.	Stop the Motor by pressing the red OFF / Reset button or by opening the Hand switch. The pump software status changes to *Off (Ready)*.  

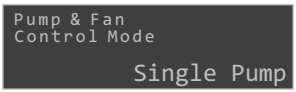
STEP 9: Running the drive in Auto mode

This section gives guidance on how to get running in Auto mode assuming the most common application, a single pump application running with closed process PID loop to control pressure. For alternative setups see the *F600 User Guide*.

It is assumed that the process feedback device is a 4-20 mA transducer which has been connected to terminal 4 and 5 during Step 7 – Wire the drive control connections up.

Action	Detail
Setup the process PID control feedback scaling.	Setup the *PID Minimum Scaling* Pr **0.030** and *PID Maximum Scaling* in Pr **0.031**. By default, the feedback is configured in percent where the range is 0.00 % to 100.00 %, where 100 % = the feedback device maximum value e.g. for a 1 bar pressure sensor 100 % = 1 bar.   Note that all setpoints and feedback related parameters will use this scaling. The units of the feedback and setpoint may be scaled into any unit type e.g. percent but on the display the unit type will be shown as *UU* or User Unit.
Test the feedback device.	Make sure it is safe to run the motor. Press and hold the green Hand button for 2 s or close the Hand switch. The motor will turn at the Hand mode speed reference and the pump software status changes to *Hand Run*.   Observe the *PID1 Feedback* Pr **0.067** and vary the Hand Mode Reference Pr **0.026**. The *PID1 Feedback* Pr **0.067** should increase with an increase in *Hand Mode Reference* Pr **0.026**.  If the feedback does not respond in proportion to the speed e.g. remains at 0. Please check the configuration of the feedback device and wiring.
Find the frequency or speed where flow starts.	Observe the output of the application. Increase the *Hand Mode Reference* Pr **0.026** and note the value when output flow is detected.  The resulting value should be entered as the *Positive Minimum Reference Clamp* Pr **0.023**. 
Stop the motor.	Stop the Motor by pressing the red OFF / Reset button or by opening the Hand switch. The pump software status changes to *Off (Ready)*.  

Set the process PID setpoint.	Set process *PID Setpoint 0* Pr **0.029** to the value required by the system design, e.g. A system is designed to run at a constant 0.5 bar pressure and the pressure transducer maximum is 1 bar so the process PID setpoint in percent units would be 50.00 %. 
Set the wake threshold.	The wake threshold determines the feedback value, below which, the drive will start operating and the minimum working feedback level, e.g. if the setpoint pressure is 50.00 % and the wake threshold is 40.00 % the drive try to maintain its output between these values. Set the *Wake Detection Feedback Threshold* Pr **0.040**. 
Set the sleep threshold.	The sleep threshold determines the frequency or speed below which the drive will stop during normal operation. Set the Sleep Detect Speed Threshold Pr **0.042** to a value in the order of 1 % to 5 % of motor rated frequency or speed above the *Positive Minimum Reference Clamp* Pr **0.023** value.  Setting the sleep threshold less than the *Positive Minimum Reference Clamp* Pr **0.023** value disables the sleep threshold.
Run in Auto mode.	When it is safe to do so, run the system in Auto mode. To do this, press and hold the blue Auto button for 2 s or close the Auto switch. The display will change to *Auto Run*.   The application motor should run at a speed that controls the system output at the process *PID Setpoint 0* Pr **0.029**. If the system remains in the sleeping state, the *process PID Final Feedback* Pr **0.075** has not fallen below the *Wake Detection Feedback Threshold* Pr **0.040**.    Move to the next step when the drive is running in Auto mode.
Verify the sleep threshold.	If the application has a discharge valve, slowly close it and make sure that the drive enters the *Sleeping* state. If the sleeping state is not entered with a fully closed discharge valve, note the frequency or speed while in this condition, and increase the *Sleep Detect Speed Threshold* Pr **0.042** to 1 % to 5 % above the noted value. 

Stop the motor when finished.	Stop the Motor by pressing the red OFF / Reset button for or by opening the Hand switch. The pump software status changes to *Off (Ready)*.  
Save the drive parameters.	Set Pr **0.000** to “Save Parameters” and press the red OFF / Reset button.  
Choose the operating mode and additional features.	Set *Pump Control* Mode Pr **0.021** to match the system. The options available are Single Pump, Cascade and Multi-leader.  Configure the Pump system features required. See the user guide functional description section or the Basic Features section for more details on the on the control modes and features available.

Drive Operating modes

Open-loop (OL) mode

The drive operating mode is set using Pr **0.004**, by selecting either “Induction” or “Permanent-magnet” and pressing the red OFF / Reset button.

Selecting “Induction” sets the drive into Open-loop (OL) mode and selecting “Permanent-magnet” sets the drive into RFC-S sensorless mode, which are the most common operating modes used.

The drive supports the following operating modes:

Open-loop (OL) mode for use with an induction motor

The drive applies power to the motor at frequencies varied by the user. The motor speed is a result of the output frequency of the drive and slip due to the mechanical load.

RFC-A mode for use with an induction motor with feedback device

The drive directly controls the speed of the motor using the feedback device. The motor flux is accurately controlled to provide full torque down to zero speed.

Synchronous permanent magnet brushless motor without feedback (RFC-S sensorless mode)

Flux control is not required because the motor is self-excited by the permanent magnets which form part of the rotor. Full torque is available down to zero speed, with salient motors. Position information from the sensorless algorithm is used to ensure the output voltage is matched to the back EMF of the motor.

Synchronous permanent magnet brushless motor with feedback device (RFC-S feedback mode)

The drive directly controls the speed of the motor using the feedback device. Flux control is not required because the motor is self-excited by the permanent magnets which form part of the rotor. Position information is required from the feedback device to ensure the output voltage is accurately matched to the back EMF of the motor. Full torque is available down to zero speed.

Pump software operation

Menu 0 is arranged so that:

Pr 00.001 – Menu Access Level

Pr 00.002 – Parameter Cloning

Pr 00.004 – Pr 00.020 - Motor set-up

Pr 00.021 – Pr 00.039 – Control & PID Config

Pr 00.040 – Pr 00.063 – Pump Functions

Pr 00.064 – Pr 00.065 – PID Gains

Pr 00.066 – Pr 00.076 – Monitoring

Pr 00.077 – Pr 00.080 – Diagnostics

Basic Features

This section details some of the basic features available in Menu 0 for the F600 to assist with a Pump application. For a complete feature list please see the *F600 User Guide*.

Auto Reset Attempts

In the event of a drive trip during operation e.g. Dry Well trip, the drive can automatically reset itself a user defined number of times after a delay period. The trip log parameters in Pr **0.078** to Pr **0.080** may be used to see which trip has occurred.

Parameter	Description
Pr 0.044	Number of Auto-reset Attempts.
Pr 0.045	Auto-reset Delay. This is the time in seconds after a trip to action an auto-reset.

Pipe Filling

In a pump application, when starting the drive in Auto mode but prior to automatic running, the drive may optionally run a fixed reference pipe filling routine. The routine has a time limit, (maximum time), to run which can be superseded by either reaching a PID feedback threshold or if flow is indicated from a hardware flow switch. When the routine completes, the system moves to Auto Run where the PID controls the motor speed.

Parameter	Description
Pr 0.046	Pipe Fill Mode. Disabled (0), pipe filling is disabled. Feedback Level (1), pipe filling is stopped when the main process PID level is reached. Flow Switch (2), pipe filling is stopped when Flow Switch Input Pr **29.066** = On(1) indicating flow.
Pr 0.047	Pipe Fill Reference. The frequency or speed used while pipe filling.
Pr 0.048	Pipe Fill Maximum Time. The maximum time in seconds that the pipe fill routine will run for. If the feedback level or flow switch indicates liquid in the pipe, the drive switches to auto run.
Pr 0.049	Pipe Fill Threshold. This is the PID feedback level that must be reached to terminate the pipe fill routine and not wait for Pipe Fill Maximum Time Pr **0.048** to elapse.

Dry Well / Low load detection

In a pump application, e.g. pumping from a well or tank, the level of liquid being pumped may drop below the level of the pump suction pipe. In this situation the pump should be slowed down or stopped to prevent pump wear. Dry Well Low Load detection automatically checks for this condition and can respond in a user selected way.

Parameter	Description
Pr 0.050	Dry Well Low Load Threshold. This is the load percentage below which a Dry Well condition is detected. This is typically set 10% above the percentage load value seen in Percentage Load Pr **0.070** when the pump runs dry. Dry well is detected when the load threshold is reached and the drive has reached the maximum reference, as indicated by At Maximum Drive Reference Pr **29.084**.

Pr 0.051	Dry Well Low Load Delay. The percentage load value in Pr **0.070** must be less than the Dry Well Low Load Threshold Pr **0.050** for the Dry Well Low Load Delay in seconds. This filters transient load values.
Pr 0.052	Dry Well Low Load Mode. Disabled (0), Dry Well Low Load detection is not operational. Alarm Only (1), Dry Well Low Load Alarm in Pr **29.062** = On(1) when a dry well is detected. Trip (2), The drive trips on Dry Well when a dry well low load condition is detected. Lower PID Output (3) the PID Output limit is reduced to the value set in Dry Well Low Load PID Reduction Pr **0.053**.
Pr 0.053	Dry Well Low Load PID Reduction. This is the PID output limit percentage used when a dry well low load condition is detected and Dry Well Low Load Mode Pr **0.052** = Lower PID Output (3).
Pr 0.054	Dry Well Low Load Restart Delay. When Dry Well Low Load Mode Pr **0.052** = Trip (2) and a dry well trip has been actioned, the drive will remain in the Dry Well Stop state for the duration of the Dry Well Low Load Restart Delay, allowing time for the well to fill.

No Flow

The no flow by software detection scheme is intended to detect when there is no liquid flow due to a closed pump discharge valve e.g. a closed tap. This is intended to be used in a pump system where the main process PID feedback is a pressure transducer and not a flow transducer.

Parameter	Description
Pr 0.055	No Flow Detect Threshold. This is a frequency or speed threshold below which No flow is detected. This must be set higher than the Positive Minimum Reference Clamp Pr **0.023** or the Sleep Detect Speed Threshold Pr **0.042**. When a pump discharge valve is closed, the PID output will reduce to maintain pressure. No Flow Detect Threshold must be greater than 0 to enable the feature.
Pr 0.056	No Flow Detection Band. This is a band above and below the No Flow Detect Threshold Pr **0.045**.
Pr 0.057	No Flow Detect Delay. When the process PID output is in the No flow detection band it must remain there for No Flow Detect Delay to filter intermittent no flow frequency or speed detection.
Pr 0.058	No Flow Setpoint Settling Delay. After the PID output is in the No flow detection band for No Flow Detect Delay seconds, the main process PID setpoint is lowered by a small value defined by No Flow Setpoint Reduction Pr **0.059**. If after the reduction is applied the PID output is still in the No Flow Detection Band, the system will be stopped due to no flow where the drive will enter the “Sleeping” state.
Pr 0.059	No Flow Setpoint Reduction. This is the amount that the main process PID setpoint will be reduced by in order to test to see if there is liquid flow.

Over-cycle protection

Over-cycle protection handles when the drive wakes and sleeps too many times in an hour.

Parameter	Description
Pr 0.059	Over-cycle Mode. Disabled (0), over-cycle detection is disabled. Alarm Only (1), Pr **29.131** indicates when the over-cycle threshold has been reached this hour. Trip (2), the drive trips Over-cycle when the Over-cycle Starts Per Hour Pr **0.061** is reached. Inc Setpoint (3) the main process PID setpoint is automatically increased to prevent the system from going to Sleep when the over-cycle limit is reached.
Pr 0.060	Over-cycle Starts Per Hour. The Over-cycle Mode Pr **0.060** is actioned when the number of starts per hour threshold is reached.

Diagnostics –

The last 3 trips are stored in Pr **00.077** to Pr **00.080**, with Pr **00.077** being the most recent trip.

Refer to the *F600 User guide* for a complete list of trips and their meaning.

Additional Information

Restoring drive defaults

The drive can be restored to the original factory settings by following the procedure below:

1. Ensure the drive is not enabled.
2. Select either 50Hz defs or 60Hz defs as appropriate in Pr **00.000**.
3. Press the red OFF Reset reset button.

Basic parameters range and default

For information on the full list of Menu 0 parameters please refer to the *F600 User Guide*.

Parameter			Range			Default		
	Description		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S
00.001	Menu access level	11.044	Menu 0 (0), All Menus (1), Read only Menu 0 (2), Read only (3), Status Only (4), No Access (5)					
00.002	Parameter cloning	11.042	None (0), Load File 1 (1), Save File 1 (2), Auto (3), Boot (4)			None (0)		
00.003		0.000						
00.004	Motor type	29.157	Induction (0), Permanent magnet (1)			Induction (0)		Permanent-magnet (1)
00.005	Volts per 1000 rpm	5.033	Rated Frequency		0 V to 1000 V	98 V		
00.006	Rated current	5.007	VM_RATED_CURRENT[MIN] to VM_RATED_CURRENT[MAX] A			VM_RATED_CURRENT[MAX]		
00.007	Rated speed	5.008	0 to 35940 rpm	0.00 to 33000.00 rpm		Std: 50 Hz: US:60 Hz:	Std: 1450 rpm US: 1750 rpm	Std: 1500 rpm US: 1800 rpm
00.008	Rated voltage	5.009	VM_AC_VOLTAGE_SET[MIN] to VM_AC_VOLTAGE_SET[MAX] V			200V drive: 230 V 400V drive 50Hz: 400 V 400V drive 60Hz: 460 V 575V drive: 575 V 690V drive: 690 V		
00.009 (Not RFC-S)	Rated power factor	5.010	0.000 to 1.000			0.85		
00.010	Number or motor poles	5.011	Automatic (0) to 480 (240) Poles			Automatic (0) Poles		
00.011 (Not RFC-S)	Low frequency voltage boost	5.015	0.0 to 25.0 %			1.0 %		
00.012 (OL only)	Low load power saving	5.013	OFF (0) or ON (1)			ON (1)	OFF (0)	
00.013 (RFC modes only)	Autotune	5.012		None (0), Basic (1), Improved (2)	None (0) Stationary(1) Full Stationary(5)	None (0)		
00.014 (RFC-S mode only)	RFC low speed mode	5.064	Injection (0), Current (1), Current (2), Current No Test (3), Current Step (4), Current Only (5)			Current (2)		
00.015 (RFC-S mode only)	Low speed sensor-less mode current	5.071	0.0 to 1000.0 %					100.0 %
00.016	Symmetrical current limit	4.007	VM_MOTOR1_CURRENT_LIMIT[MIN] to VM_MOTOR1_CURRENT_LIMIT[MAX] %			110.0 %		

Parameter			Range			Default		
	Description		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S
00.017	Motor thermal protection enable	29.087	OFF (0) or ON (1)			OFF (0)		
00.018	Reverse output phase sequence	5.042	OFF (0) or ON (1)			OFF (0)		
00.019 (RFC-S mode only)	Sensor-less mode filter	3.079			4 (0), 8 (1), 16 (2), 32 (3), 64 (4) ms			4 (0) ms
00.020		0.000						
00.021	Pump control mode	29.011	Single Pump (0), Cascade (1), Multi leader (2)			Single Pump (0)		
00.022	Maximum reference clamp	1.006	VM_NEGATIVE_REF_CLAMP1[MIN] to VM_NEGATIVE_REF_CLAMP1[MAX]			Std: 50 Hz US: 60 Hz	Std: 1500.0 rpm US: 1800.0 rpm	
00.023	Positive minimum reference clamp	1.004	VM_SPEED_FREQ_REF[MIN] to VM_SPEED_FREQ_REF[MAX]			0.0 Hz	0.0 rpm	
00.024	Control input mode	29.012	Input (0), Input & Keypad (1), Ctrl Wrd (2), Ctrl Wrd & Input (3)			Input & Keypad (1)		
00.025	Hand mode reference select	29.016	Digital Speed (0), Analog Speed (1)			Digital Speed (0)		
00.026	Hand mode frequency/ speed reference	1.022	VM_SPEED_FREQ_REF[MIN] to VM_SPEED_FREQ_REF[MAX]			Std:25 Hz US:30 Hz	Std: 750 rpm US: 900 rpm	
00.027	General acceleration rate 1	2.011	VM_ACCEL_RATE[MIN] to VM_ACCEL_RATE[MAX] s			1.0 s	1.000 s	
00.028	General deceleration rate 1	2.021	VM_ACCEL_RATE[MIN] to VM_ACCEL_RATE[MAX] s			1.0 s	1.000 s	
00.029	PID setpoint 0	29.022	0.00 to 327.67 UU			0.00 UU		
00.030	PID feedback min scaling	29.031	0.00 to 327.67 UU			0.00 UU		
00.031	PID feedback max scaling	29.032	0.00 to 327.67 UU			100.00 UU		
00.032	PID feedback filter time constant	29.033	0.00 to 327.67 s			1.00 s		
00.033	PID feedback loss action	29.048	Ignore (0), Trip (1), Fixed Speed (2)			Trip (1)		
00.034	PID feedback high trip threshold	29.041	0.00 to 327.67 UU			0.00 UU		
00.035	PID feedback low delay	29.042	0.0 to 6553.5 s			5.0 s		
00.036	PID feedback low mode	29.043	Disabled (0), Threshold (1), Bandwidth (2)			Disabled (0)		
00.037	PID feedback low threshold	29.044	0.00 to 327.67 UU			2.00 UU		

Parameter			Range			Default		
	Description		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S
00.037		0.000						
00.039		0.000						
00.040	Wake detect feedback threshold	29.049	0.00 to 327.37			1.00		
00.041	Wake detect delay	29.051	0.0 to 3000.0			875		
00.042	Sleep detect speed threshold	29.052	0.0 to 6553.5 s			5.0 s		
00.043	Sleep detect delay	29.052	0.0 to 6553.5 s			5.0 s		
00.044	Number of auto-reset attempts	10.034	None (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), Infinite (6)			5 (5)		
00.045	Auto-reset delay	10.035	1.0 to 600.0 s			10.0 s		
00.046	Pipe fill mode	29.075	Disabled (0), Feedback Level (1), Flow Switch (2)			Disabled (0)		
00.047	Pipe fill reference	1.024	VM_SPEED_FREQ_REF[MIN] to VM_SPEED_FREQ_REF[MAX]			Std: 25 Hz US: 30 Hz	Std: 750 rpm US: 900 rpm	
00.048	Pipe fill maximum time	29.077	0.0 to 6553.5 s			0.0 s		
00.049	Pipe fill threshold	29.076	0.00 to 327.67 UU			0.00 UU		
00.050	Dry well low load detection threshold percent	29.057	0.00% to 100%			1.00 %		
00.051	Dry well low load detection delay	29.058	0.0 to 6553.5 s			0.0 s		
00.052	Dry well low load mode	29.059	Disabled (0), Alarm Only (1), Trip (2), Lower PID Output (3)			Disabled (0)		
00.053	Dry well low load PID output reduction	29.060	0.00% to 100%			50.00%		
00.054	Dry well low load restart delay	29.061	0.0 to 6553.5 s			5.0 s		
00.055	No flow detection threshold	29.069	0.0 to 3000.0			0.0 Hz	0.0 rpm	
00.056	No flow detection band	29.070	0.0 to 3000.0			150.0		
00.057	No flow detection delay	29.071	0.0 to 6553.5 s			5.0 s		
00.058	No flow setpoint settling delay	29.072	0.0 to 6553.5 s			1.0 s		

Parameter			Range			Default		
	Description		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S
00.059	No flow setpoint reduction	29.073	0.00 to 2.55 UU			0.06 UU		
00.060	Over-cycle mode	29.127	Disabled (0), Alarm Only (1), Trip (2), Inc Setpoint (3)			Alarm Only (1)		
00.061	Over-cycle starts per hour	29.128	0 to 255			5		
00.062		0.000						
00.063		0.000						
00.064	PID 1 proportional gain	14.010	0.000 to 4.000			2.000		
00.065	PID 1 integral gain	14.011	0.000 to 4.000			1.000		
00.066	PID1 reference	14.020	±100.00 %					
00.067	PID feedback	14.021	±100.00 %					
00.068	PID 1 output	14.001	+/-100%					
00.069	Output frequency	5001	VM_SPEED_FREQ_REF[MIN] to VM_SPEED_FREQ_REF[MAX] Hz					
00.069	Speed feedback	3.002		VM_SPEED[MIN] to VM_SPEED[MAX]				
00.070	Percentage load	4.020	VM_USER_CURRENT[MIN] to VM_USER_CURRENT[MAX] %					
00.071	Output power	5.003	VM_POWER[MIN] to VM_POWER[MAX] kW					
00.072	Analog input 1 current loop loss	7.028	OFF (0) or ON (1)					
00.073	Operating status	29.003	Inhibit STO (0), Off (Ready) (1), Hand Run (2), Waking (3), Pipe Fill (4), Auto Run (5), Auto Run Leader (6), Auto Run Assist (7), Pre sleep (8), Sleeping (9),Cleaning (10), Level Stop (11),Timer Stop (12), Hand Timeout (13), Over cycle (14), Fbck Loss Run (15)Dry Well Run(16) Dry Well Stop(17) Auto Stop Assist(18)			Inhibit STO (0)		
00.074	NV Media Card Action Status	11.078	None (0), Active (1), Card Slot 1 (2), Card Slot 2 (3), Card Slot 3 (4), Card Slot 4 (5), Card Product (6), Card User Prog (7), Card Busy (8), Card Data Exists (9), Card Option (10), Card Read Only (11), Card Error (12), Card No Data (13), Card Full (14), Card File Error (15), Card Rating (16), Card File Data (17), Card Derivative (18)					
00.075	PID final feedback	29.036	-327.68 to 327.67 UU			0.00 UU		
00.076		0.000						

Parameter			Range			Default		
	Description		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S
00.077	Derivative software version	29.001	0 to 99999999					
00.078	Trip 0	10.020	0 to 255					
00.079	Trip 1	10.021	0 to 255					
00.080	Trip 2	10.022	0 to 255					

Appendix A UL information

A.1 UL file reference

These products are cUL Listed to Canadian and US requirements.

UL file reference is: NMMS/7 E171230.

Products that incorporate the Safe Torque Off (STO) function are Certified for Functional Safety.

UL file reference: FSPC E171230.

A.2 Operating environment

Pollution Degree

Products must be installed in a Pollution Degree 2 environment or better (dry, non-conductive pollution only).

Ambient temperature

The drives have been evaluated for use at ambient temperatures up to 40 °C. The drives have additionally been evaluated for 50 °C and 55 °C ambient air temperatures with a derated output.

The maximum surrounding air temperature is 55 °C.

A.3 Enclosure Ratings

Open Type

The products are Open Type as supplied.

Type 1

When fitted with a conduit box, the products meet the requirements for UL Enclosed Type 1. Suitable conduit boxes are available.

A.4 Through-panel (Type 12) mounting

Mounting hole access

When the drive is through-panel mounted, the main terminal cover(s) must be removed in order to provide access to the mounting holes. Once the drive has been mounted, the terminal cover(s) can be replaced.

A.5 Mounting bracket torque setting

Frame sizes 3 & 4

Through panel mounting brackets should be tightened to a maximum torque of 2 N m (16.8 lb in).

A.6 Installation in air handling spaces (plenum rating)

These products have been evaluated in accordance with the Standard for Fire Test for Heat and Visible Smoke Release for Discrete Products and their Accessories Installed in Air-Handling Spaces, UL 2043.

Products installed in air handling spaces must be Enclosed Type 1 as a minimum. A conduit box must be fitted. Alternatively, the product can be through-panel mounted in a Type 12 enclosure with the heatsink protruding through the wall of the enclosure into the air-handling space.

A.7 Mechanical Installation

Mounting

Products can be mounted on a vertical surface using the brackets provided. Several products may be mounted side by side without airspace between them.

In installations where space is limited, products with frame sizes 3, 4 and 5 may be 'Tile Mounted'.

In this configuration, the unit is mounted sideways with the side panel against the mounting surface. A Tile Mounting Kit is available but must be ordered separately.

A.8 Terminal Torque

Torque settings are specified in relevant sections of this guide.

A.9 Electrical Installation

Overvoltage category

Drives have been evaluated for OVC III

Branch circuit Protection

Branch circuit protection must be provided in accordance with the National Electrical Code (NEC), The Canadian Electrical Code, and any additional local codes.

The recommended fuses are specified within this guide.

Opening of branch circuit protective device

The opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, the equipment may be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced. Integral solid-state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local “codes”, or the equivalent.

Cables

Field wiring must use 75 °C rated copper wire only.

Ground connections

UL Listed closed-loop connectors sized according to the field wiring must be used for all ground connections.

Power connections

Frame sizes 3, 4 and 5: These frame sizes use plug-in terminal blocks for the power connections.

Frame sizes 6 to 11: UL Listed closed loop connectors sized according to the field wiring must be used for all power connections.

A.10 Motor overload protection

All models incorporate internal overload protection for the motor load that does not require the use of an external or remote overload protection device. The protection level is adjustable with the maximum current overload being dependent on the values entered into the current limit parameters (Pr **4.005** motoring current limit, Pr **4.006** regenerative current limit and Pr **4.007** symmetrical current limit entered as percentage) and Pr **5.007** motor rated current parameter (entered in Amperes). The duration of the overload is dependent on Pr **4.015** motor thermal time constant.

A.11 Thermal memory retention

All models are provided with thermal memory retention.

A.12 Motor protection using an external sensor

User terminals are provided that can be connected to a motor thermistor to protect the motor from high temperature, in the event of a motor cooling fan failure.

A.13 Transient Surge Suppression

Frames sizes 7 & 8 – 575 V ratings

Transient surge suppression shall be installed on the line side of this equipment and shall be rated to 575 Vac (phase to ground), 575 Vac (phase to phase), suitable for overvoltage category III, and shall provide protection for an impulse withstand voltage peak of 6 kV and a clamping voltage of maximum 2400 V.

A.14 Dynamic braking

The drives have not been evaluated for dynamic braking.

A.15 External Class 2 supply

Frame sizes 7 to 11

The external power supply shall be marked with the following: “Class 2” and the power supply shall not exceed 24 Vdc.

A.16 Modular Drive Systems

Products with DC+ and DC- supply connections have been investigated for use in Modular Drive Systems as inverters when supplied by the converter sections from the Unidrive-M or Mentor MP range. In these applications the inverters are required to be additionally protected by supplemental fuses.

A.17 AC supply, AC supply fuses and short circuit current rating (SCCR)

Frame sizes 3 & 4

Suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 480 Volts AC maximum when protected by the specified fuses.

UL Listed closed-loop connectors sized according to the field wiring shall be used for grounding connections. Frame size 6 only for closed loop connectors on all power connections (size 4 has a power connector like size 3 not studs)

Frame sizes 5 & 6

Suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 575 Volts AC maximum when protected by the specified fuses.

Frame size 7 & 8

Suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, (rated voltage in the ratings table or the product label) Volts AC Maximum when protected by the specified fuses.

Frame sizes 9 & 10

Suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, (voltage rating in ratings table or the product label) Volts AC Maximum when protected by the specified fuses.

Frame size 11

Suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, (voltage rating in ratings table or the product label) Volts AC Maximum when protected by the specified fuses.

A.18 Modular / group / parallel installation

Supply wiring

When used in modular drives/group / parallel installation applications the supply wires are not to be larger than 125 % of full load current of the device ratings

CSA (Canadian Standards Authority) approval

Frame sizes 9 to 11 are not certified for CSA approval when used in a modular / parallel setup.

Supply from converters

These devices are only intended to be supplied by converters manufactured by Control Techniques Ltd. when used as inverters.

Appendix B Drive ratings, cable sizes and fuse ratings

Table B-1 575 V drive ratings, cable sizes and fuse ratings (500 V to 575 V ±10 %)

Model	Max. cont. input current	Fuse				Nominal cable size				Normal Duty		
		IEC		UL		European		USA				
	3ph	Nom	Class	Nom	Class	Input	Output	Input	Output	Max. count. output current	Nom power @ 575 V	Motor power @ 575 V
	A	A		A		mm²	mm²	AWG	AWG	A	kW	hp
05500039	4	10	gG	10	CC, J or T*	0.75	0.75	16	16	3.9	2.2	3
05500061	7	10		10		1	1	14	14	6.1	4	5
05500100	11	20		20		1.5	1.5	14	14	10	5.5	7.5
06500120	13	20	gG	20	CC, J or T*	2.5	2.5	14	14	12	7.5	10
06500170	19	32		25		4	4	10	10	17	11	15
06500220	24	40		30		6	6	10	10	22	15	20
06500270	29	50		35		10	10	8	8	27	18.5	25
06500340	37	50		40		10	10	6	6	34	22	30
06500430	47	63		50		16	10	6	6	43	30	40
07500530	45	50	gG	50	CC, J or T*	16	16	4	4	53	45	50
07500730	62	80		80		25	25	3	3	73	55	60
08500860	83	125	gR	100	HSJ	35	35	1	1	86	75	75
08501080	104	160		150		50	50	1	1	108	90	100
09501250	166	150	gR	150	HSJ	2 x 70 (B2)	2 x 35 (B2)	2 x 1	2 x 3	125	110	125
09501500	166	200		175			2 x 50 (B2)		2 x 1	150	110	150
10502000	197	250	gR	250	HSJ	2 x 70 (B2)		2 x 2/0		200	150	200
11502480	265	400	gR	400	HSJ	2 x 70 (C)		2 x 3/0		248	185	250
11502880	310					2 x 95 (C)		2 x 4/0		288**	225	300
11503150	338					2 x 120 (C)		2 x 250		315**	250	350

* These fuses are fast acting.

** These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to the power and current ratings in the *F600 User Guide*.

Table B-2 690 V drive ratings, cable sizes and fuse ratings (500 V to 690 V ±10 %)

Model	Max. cont. input current	Fuse				Nominal cable size				Normal Duty		
		IEC		UL		European		USA				
	3ph	Nom	Class	Nom	Class	Input	Output	Input	Output	Max. count. output current	Nom power @ 690 V	Motor power @ 690 V
	A	A		A		mm²	mm²	AWG	AWG	A	kW	hp
07600230	20	25	gG	25	CC, J or T*	10	10	8	8	23	18.5	25
07600300	26	32		30		10	10	6	6	30	22	30
07600360	31	40		35		10	10	6	6	36	30	40
07600460	39	50		50		16	16	4	4	46	37	50
07600520	44	50		50		16	16	4	4	52	45	60
07600730	62	80		80		25	25	3	3	73	55	75
08600860	83	125	gR	100	HSJ	50	50	2	2	86	75	100
08601080	104	160		150		70	70	1/0	1/0	108	90	125
09601250	149	150	gR	150	HSJ	2 x 50 (B2)	2 x 35 (B2)	2 x 1	2 x 3	125	110	150
09601550	171	200		200		2 x 70 (B2)	2 x 50 (B2)	2 x 1/0	2 x 1	155	132	175
10601720	202	225	gR	250	HSJ	2 x 70 (B2)	2 x 70 (B2)	2 x 2/0	2 x 1/0	172	160	200
10601970	225	250		250		2 x 95 (B2)		2 x 3/0	2 x 2/0	197	185	250
11602250	256	400	gR	400	HSJ	2 x 70 (C)		2 x 3/0		225	200	250
11602750	302					2 x 95 (C)		2 x 4/0		275**	250	300
11603050	329					2 x 95 (C)		2 x 250		305**	280	400

* These fuses are fast acting.

** These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to the power and current ratings in the *F600 User Guide*.

Company information

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