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Installation and Commissioning Guide

HVAC Drive H300

Model sizes 3 to 11

Building Automation HVAC drive

Part Number: 0479-0000-05
Issue: 5

Original Instructions

For the purposes of compliance with the EU Machinery Directive 2006/42/EC, the English version of this manual is the Original Instructions. Manuals in other languages are Translations of the Original Instructions.

Documentation

Manuals are available to download from the following locations: **http://www.drive-setup.com/ctdownloads**

The information contained in this manual is believed to be correct at the time of printing and does not form part of any contract. The manufacturer reserves the right to change the specification of the product and its performance, and the contents of the manual, without notice.

Warranty and Liability

In no event and under no circumstances shall the manufacturer be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings. The manufacturer is not liable for consequential and incidental damages. Contact the supplier of the dive for full details of the warranty terms.

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Control Techniques Ltd operates an Environmental Management System (EMS) that conforms to the International Standard ISO 14001.

Further information on our Environmental Policy can be found at: **http://www.drive-setup.com/environment**

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The products covered by this manual comply with European and International regulations on the Restriction of Hazardous Substances including EU directive 2011/65/EU and the Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products.

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When electronic products reach the end of their useful life, they must not be disposed of along with domestic waste but should be recycled by a specialist recycler of electronic equipment. Control Techniques products are designed to be easily dismantled into their major component parts for efficient recycling. The majority of materials used in the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates. Smaller products are packaged in strong cardboard cartons which have a high recycled fibre content. Cartons can be re-used and recycled. Polythene, used in protective film and bags for wrapping the product, can be recycled. When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

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Further information on our compliance with REACH can be found at: **http://www.drive-setup.com/reach**

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Contents

1 Safety information

1.1 Warnings, Cautions and Notes

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

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

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

1.2 Important safety information. Hazards. Competence of designers and installers

This guide applies to products which control electric motors either directly (drives) or indirectly (controllers, option modules and other auxiliary equipment and accessories). In all cases the hazards associated with powerful electrical drives are present, and all safety information relating to drives and associated equipment must be observed.

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

Drives and controllers are intended as components for professional incorporation into complete systems. If installed incorrectly they 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. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning/start-up and maintenance must be carried out by personnel who have the necessary training and competence. They must read this safety information and this guide carefully.

1.3 Responsibility

It is the responsibility of the installer to ensure that the equipment is installed correctly with regard to all instructions given in this guide. They must give due consideration to the safety of the complete system, so as to avoid the risk of injury both in normal operation and in the event of a fault or of reasonably foreseeable misuse.

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation of the equipment.

1.4 Compliance with regulations

The installer is responsible for complying with all relevant regulations, such as national wiring regulations, accident prevention regulations and electromagnetic compatibility (EMC) regulations. Particular attention must be given to the cross-sectional areas of conductors, the selection of fuses or other protection, and protective ground (earth) connections.

This guide contains instructions for achieving compliance with specific EMC standards.

All machinery to be supplied within the European Union in which this product is used must comply with the following directives:

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

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. Hazardous voltage may be present in any of the following locations:

- AC and DC supply cables and connections
- Output cables and connections
- Many internal parts of the drive, and external option units

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

The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

The STOP and Safe Torque Off functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit.

The drive must be installed in accordance with the instructions given in this guide. Failure to observe the instructions could result in a fire hazard.

1.6 Stored electrical charge

The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

1.7 Mechanical hazards

Careful consideration must be given to the functions of the drive or controller which might result in a hazard, either through their intended behaviour 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 - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

With the sole exception of the Safe Torque Off function, none of the drive functions must be used to ensure safety of personnel, i.e. they must not be used for safety-related functions.

The Safe Torque Off function may be used in a safety-related application. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards.

The design of safety-related control systems must only be done by personnel with the required training and experience. The Safe Torque Off function will only ensure the safety of a machine if it is correctly incorporated into a complete safety system. The system must be subject to a risk assessment to confirm that the residual risk of an unsafe event is at an acceptable level for the application.

1.8 Access to equipment

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

1.9 Environmental limits

Instructions in this guide regarding transport, storage, installation and use of the equipment must be complied with, including the specified environmental limits. This includes temperature, humidity, contamination, shock and vibration. Drives must not be subjected to excessive physical force.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

1.10 Hazardous environments

The equipment must not be installed in a hazardous environment (i.e. a potentially explosive environment).

1.11 Motor

The safety of the motor under variable speed conditions must be ensured.

To avoid the risk of physical injury, do not exceed the maximum specified speed of the motor.

Low speeds may cause the motor to overheat because the cooling fan becomes less effective, causing a fire hazard. The motor should be installed with a protection thermistor. If necessary, an electric forced vent fan should be used.

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive must not be relied upon. It is essential that the correct value is entered in the Motor Rated Current parameter.

1.12 Mechanical brake control

Any brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in a risk of injury. In any application where the incorrect operation of the brake release mechanism could result in injury, independent protection devices of proven integrity must also be incorporated.

1.13 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.

1.14 Electromagnetic compatibility (EMC)

Installation instructions for a range of EMC environments are provided in the relevant Power Installation Guide. If the installation is poorly designed or other equipment does not comply with suitable standards for EMC, the product might cause or suffer from disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation in the place of use.

2 Product information

2.1 Introduction

The H300 is a high performance open loop AC drive specifically designed for use in building automation / Commercial HVAC/R applications. Figure 2-1 below indicates the key product features including built in connectivity to building automation systems. Each drive is equipped with three identical option slots for I/O and communications expansion.

Figure 2-1 Features
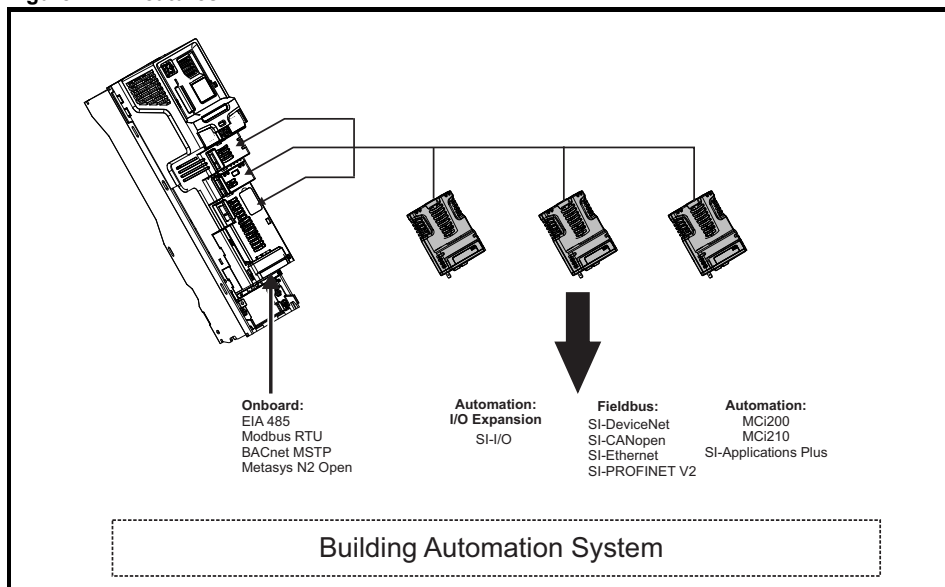
The H300 drive can be used as a stand alone motor controller or integrated into a building automation system using analog and digital I/O or serial communications. The base drive incorporates a EIA 485 serial communications port that is selectable between Modbus RTU, BACnet MSTP or Metasys N2 Open.

DeviceNet, CANopen, Ethernet and PROFIBUS connectivity is achieved with the addition of plug-in option modules.

Key features:
- Universal high performance drive for induction and sensorless permanent magnet motors.
- Onboard IEC 61131-3 programmable automation
- NV Media Card for parameter copying and data storage
- Communications interface
- Single channel Safe Torque Off (STO) input

Fire mode

Fire Mode is a configurable override function that is used to alter the operation of the drive based upon external inputs, typically a discrete digital input from a Building Management Fire Protection system.

⚠️ **WARNING**	**Fire Mode - Important Warning** When Fire Mode is active the motor overload and thermal protection are disabled, as well as a number of drive protection functions. Fire Mode is provided for use only in emergency situations where the safety risk from disabling protection is less than the risk from the drive tripping - typically in smoke extraction operation to permit evacuation of a building. The use of Fire Mode itself causes a risk of fire from overloading of the motor or drive, so it must only be used after careful consideration of the balance of risks. Care must be taken to prevent inadvertent activation or de-activation of Fire Mode. Fire Mode is indicated by a flashing display text warning "Fire mode active". Care must be taken to ensure that parameters Pr **01.053** or Pr **01.054** are not inadvertently re-allocated to different inputs or variables. It should be noted that, by default, Pr **01.054** is controlled from digital input 4 and changing Pr **06.004** or Pr **08.024** can re-allocate this digital input to another parameter. These parameters are at access level 2 in order to minimize the risk of inadvertent or unauthorized changes. It is recommended that User Security be applied to further reduce the risk (see section 5.11 *Parameter access level and security* on page 70). These parameters may also be changed via serial communications so adequate precautions should be taken if this functionality is utilized.

Real time clock
• An internal real time clock is available which is used for the timer functions and trip log.

Timer functions
• Two timers are available to switch an output on a routine basis.

Sleep / Wake mode
• Sleep / wake mode stops and starts the motor during periods of low demand to improve system efficiency.

Advanced Process PID
• Two PIDs are available which can operate independently or combine to provide more complex functionality.

RTD's
• A PT1000 RTD temperature sensor input is available which can directly provide an analog input without a transducer for control of fans and pumps.

Optional features
• Select up to three option modules
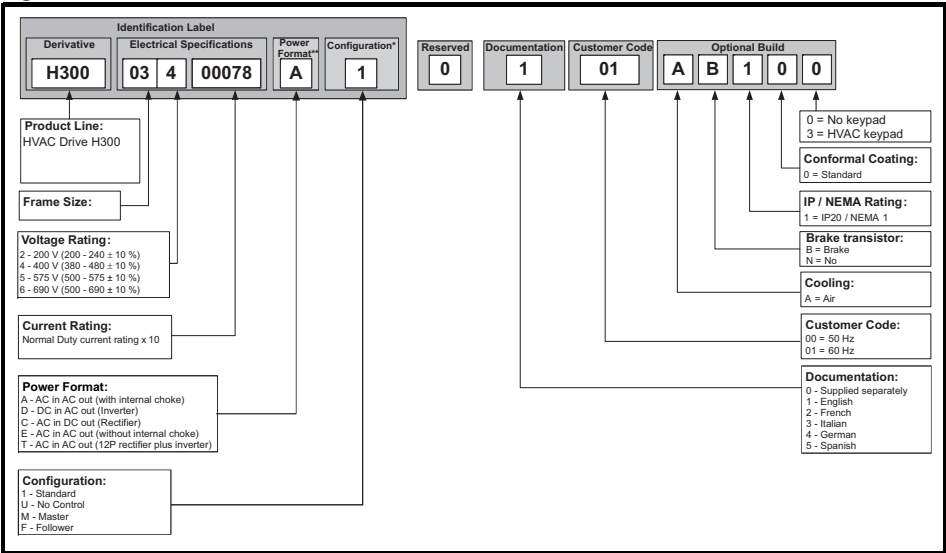
This guide covers the *HVAC H300* product.

Table 2-1   Supported operating modes

Product	Supported operating modes		
	Open-Loop	**RFC-A Sensorless**	**RFC-S Sensorless**
HVAC Drive H300	✓	✓	✓

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

2.2   Model number

The way in which the model numbers for the HVAC Drive H300 range are formed is illustrated below:

Figure 2-2   Model number

Identification Label

Derivative	Electrical Specifications	Power Format**	Configuration*	Reserved	Documentation	Customer Code	Optional Build
H300	03 4 00078	A	1	0	1	01	A B 1 0 0

Product Line:
HVAC Drive H300

Frame Size:

Voltage Rating:
2 - 200 V (200 - 240 ± 10 %)
4 - 400 V (380 - 480 ± 10 %)
5 - 575 V (500 - 575 ± 10 %)
6 - 690 V (500 - 690 ± 10 %)

Current Rating:
Normal Duty current rating x 10

Power Format:
A - AC in AC out (with internal choke)
D - DC in AC out (Inverter)
C - AC in DC out (Rectifier)
E - AC in AC out (without internal choke)
T - AC in AC out (12P rectifier plus inverter)

Configuration:
1 - Standard
U - No Control
M - Master
F - Follower

0 = No keypad
3 = HVAC keypad

Conformal Coating:
0 = Standard

IP / NEMA Rating:
1 = IP20 / NEMA 1

Brake transistor:
B = Brake
N = No

Cooling:
A = Air

Customer Code:
00 = 50 Hz
01 = 60 Hz

Documentation:
0 - Supplied separately
1 - English
2 - French
3 - Italian
4 - German
5 - Spanish

* Only shown on Frame 9 and above identification label.

** For further information on the D, C or T power format models, please refer to the *Modular Installation Guide*

NOTE

For simplicity, a Frame 9 drive with no internal choke (i.e. model 09xxxxxxE) is referred to as a Frame 9E and a Frame 9 drive with an internal choke (i.e. model 09xxxxxxA) is referred to as a Frame 9A. Any reference to Frame 9 is applicable to both sizes 9E and 9A. All Frame 10 and 11 drives are supplied with no internal choke.

2.3   Nameplate description

Figure 2-3   Typical drive rating labels
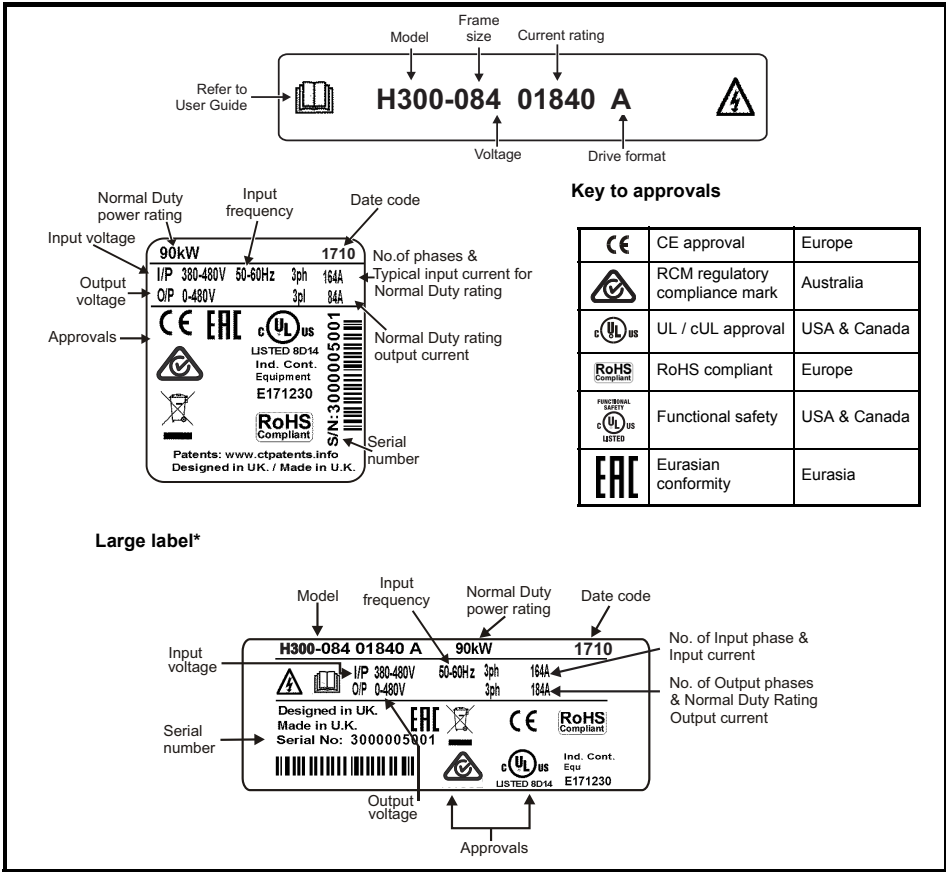
* This label is only applicable to size 7 and above.

Refer to Figure 2-2 *Model number* on page 11 for further information relating to the labels.

NOTE   **Date code format**

The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built.

Example:

A date code of **1710** would correspond to week 10 of year 2017.

Safety information
Product information
Mechanical installation
Electrical installation
Getting started
Basic parameters (Menu 0)
Running the motor
Optimization
NV Media Card Operation
Diagnostics and maintenance
UL listing information

2.4 Ratings

⚠ WARNING

Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. The following section shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

NOTE Nominal cables sizes below are based on the cable installation method B2 (ref: IEC60364-5-52:2001) unless otherwise specified, and are provided as a guide only. Ensure cables used suit local wiring regulations.

Table 2-2   200 V drive ratings, cable sizes and fuse ratings (200 V to 240 V ±10 %)

Model	Max. cont. input current 3ph	Fuse IEC Nom	Fuse IEC Class	Fuse UL Nom	Fuse UL Class	European Input	European Output	USA Input	USA Output	Normal Duty Max. cont. output current	Normal Duty Nom power @ 230 V	Normal Duty 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	gG	20	CC, J or T*	1.5	1.5	14	14	8	1.5	2
03200110	17	20	gG	25	CC, J or T*	4	4	12	12	11	2.2	3
03200127	20	25	gG	25	CC, J or T*	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	gG	30	CC, J or T*	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	gG	70	CC, J or T*	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	gG	100	CC, J or T*	35	35	1	1	94	22	30
07201170	105	125	gG	125	CC, J or T*	70	70	1/0	1/0	117	30	40
08201490	137	200	gR	200	HSJ	95	95	3/0	3/0	149	37	50
08201800	166	200	gR	225	HSJ	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	gR	300	HSJ	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	gR	450	HSJ	2 x 150 (C)	2 x 120 (B2)	2 x 300		360	110	150

* These fuses are fast acting.

Table 2-3 400 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		Max. cont. output current	Nom power @ 400 V	Motor power @ 460 V
	3ph	Nom	Class	Nom	Class	Input	Output	Input	Output			
	A	A		A		mm²	mm²	AWG / kcmil		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 *Drive User Guide*.

Table 2-4   575 V drive ratings, cable sizes and fuse ratings (500 V to 575 V ±10 %)

Model	Max. cont. input current 3ph (A)	Fuse IEC Nom (A)	Fuse IEC Class	Fuse UL Nom (A)	Fuse UL Class	European Input (mm²)	European Output (mm²)	USA Input (AWG)	USA Output (AWG)	Normal Duty Max. cont. output current (A)	Normal Duty Nom power @ 575 V (kW)	Normal Duty Motor power @ 575 V (hp)
05500039	4	10	gG	10	CC, J or T*	0.75	0.75	16	16	3.9	2.2	3
05500061	7	10	gG	10	CC, J or T*	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		20		2.5	2.5	14	14	12	7.5	10
06500170	19	32		25		4	4	10	10	17	11	15
06500220	24	40	gG	30	CC, J or T*	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 70 (B2)	2 x 50 (B2)	2 x 1	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		gR		HSJ	2 x 70 (C)		2 x 3/0		248	185	250
11502880	310	400	gR	400	HSJ	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 *Drive User Guide*.

Table 2-5   690 V drive ratings, cable sizes and fuse ratings (500 V to 690 V ±10 %)

Model	Max. cont. input current 3ph (A)	Fuse IEC Nom (A)	Fuse IEC Class	Fuse UL Nom (A)	Fuse UL Class	European Input (mm²)	European Output (mm²)	USA Input (AWG)	USA Output (AWG)	Normal Duty Max. cont. output current (A)	Normal Duty Nom power @ 690 V (kW)	Normal Duty Motor power @ 690 V (hp)
07600230	20	25		25		10	10	8	8	23	18.5	25
07600300	26	32		30		10	10	6	6	30	22	30
07600360	31	40	gG	35	CC, J or T*	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 70 (B2)	2 x 3/0	2 x 2/0	197	185	250
11602250	256				HSJ	2 x 70 (C)		2 x 3/0		225	200	250
11602750	302	400	gR	400	HSJ	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.

Table 2-6   Protective ground cable ratings

Input phase conductor size	Minimum ground conductor size
≤ 10 mm^2	Either 10 mm^2 or two conductors of the same cross-sectional area as the input phase conductor.
> 10 mm^2 and ≤ 16 mm^2	The same cross-sectional area as the input phase conductor
> 16 mm^2 and ≤ 35 mm^2	16 mm^2
> 35 mm^2	Half of the cross-sectional area of the input phase conductor

Typical short term overload limits

The maximum percentage overload limit changes depending on the selected motor. Variations in motor rated current, motor power factor and motor leakage inductance all result in changes in the maximum possible overload. Typical values are shown in the table below:

Table 2-7   Typical overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 165 s	110 % for 9 s	110 % for 165 s	110 % for 9 s

Generally the drive rated current is higher than the matching motor rated current allowing a higher level of overload than the default setting.

The time allowed in the overload region is proportionally reduced at very low output frequency on some drive ratings.

NOTE   The maximum overload level which can be attained is independent of the speed.

Output current

The continuous output current ratings given on the rating label are for maximum 40 °C (104 °F), 1000 m altitude and 3 kHz switching frequency (except where shown). Derating is required for higher switching frequencies, ambient temperatures >40 °C (104 °F) and higher altitude. For derating information, refer to the *Drive User Guide.*

Input current

The input current is affected by the supply voltage and impedance. The input current given on the rating label is the typical input current and is stated for a balanced supply.

Input line reactor (Frame 9E, 10E and 11E)

A line reactor must be used with Frame 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive. Refer to Table 2-8.

Table 2-8   Size 9E, 10E and 11E model and line reactor part numbers

Size	Drive model	Inductor model	Line reactor part number
9E	09202160, 09202660, 09402210, 09402660	INL 401	4401-0181
	09501250, 09501500, 09601720, 09601970	INL 601	4401-0183
10E	10203250, 10203600, 10403200, 10403610	INL 402	4401-0182
	10502000, 10601720, 10601970	INL 602	4401-0184
11E	11404370	INL 403L**	4401-0274
	11404370, 11404870, 11405070	INL 403*	4401-0259
	11502480, 11502880, 11503150, 11602250, 11602750, 11603050	INL 603*	4401-0261

* Natural cooling.

** May represent a more economic solution when operating below 420 A.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

2.5   Operating modes

The drive is designed to operate in any of the following modes:

1. Open loop mode
      Open loop vector mode
      Fixed V/F mode (V/Hz)

      Quadratic V/F mode (V/Hz)

NOTE   Open loop operating mode is the mode to be used on HVAC fan and pump induction
            motors.

2. RFC - A Sensorless

3. RFC - S Sensorless

2.5.1   Open loop mode

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. The drive can improve the
speed control of the motor by applying slip compensation. The performance at low speed depends
on whether V/F mode or open loop vector mode is selected.

Open loop vector mode

The voltage applied to the motor is directly proportional to the frequency except at low speed where
the drive uses motor parameters to apply the correct voltage to keep the flux constant under varying
load conditions. Typically 100 % torque is available down to 1 Hz.

Fixed V/F mode

The voltage applied to the motor is directly proportional to the frequency except at low speed where a
voltage boost is provided which is set by the user. This mode can be used for multi-motor
applications.

Typically 100 % torque is available down to 4 Hz.

Quadratic V/F mode

The voltage applied to the motor is directly proportional to the square of the frequency except at low
speed where a voltage boost is provided which is set by the user. This mode can be used for running
fan or pump applications with quadratic load characteristics or for multi-motor applications. This
mode is not suitable for applications requiring a high starting torque.

2.5.2   RFC-A Sensorless

Rotor **F**lux **C**ontrol for Asynchronous (induction) motors (**RFC-A**) encompasses closed loop vector
control without a position feedback device by using current, voltages and key operating motor
parameters to estimate the motor speed. It can eliminate instability traditionally associated with open
loop control such as operating large motors with light loads at low frequencies.

2.5.3   RFC- S Sensorless

Rotor **F**lux **C**ontrol for Synchronous (permanent magnet brushless) motors (**RFC-S**) provides closed
loop control without a position feedback device.

For use with permanent magnet brushless motors without a feedback device installed.

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 all the way down to zero speed, with salient motors.

2.6 Drive features

Figure 2-4 Features of the drive (size 3 to 10)

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Key

1. Keypad connection
2. Rating label
3. Identification label
4. Status LED
5. Option module slot 1

6. Option module slot 2
7. Option module slot 3
8. Relay connections
9. Position feedback connections
10. Control connections

11. NV media card slot
12. Internal EMC filter
13. DC bus +
14. DC bus -
15. Motor connections

16. AC supply connections
17. Ground connections

Figure 2-5   Features of the drive (size 11)

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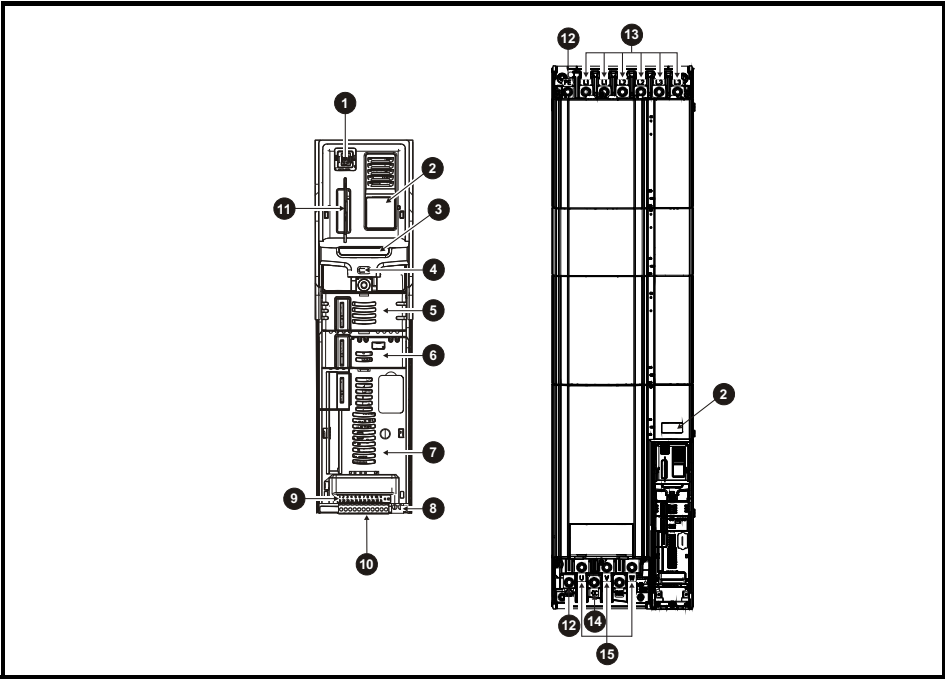
1. Keypad connection	5. Option module slot 1	9. Control connections	13. AC supply connections*
2. Rating label	6. Option module slot 2	10. Communications port	14. DC bus +
3. Identification label	7. Option module slot 3	11. NV media card slot	15. Motor connections
4. Status LED	8. Relay connections	12.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

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

2.7 Options / Accessories

Figure 2-6   Drive features and options
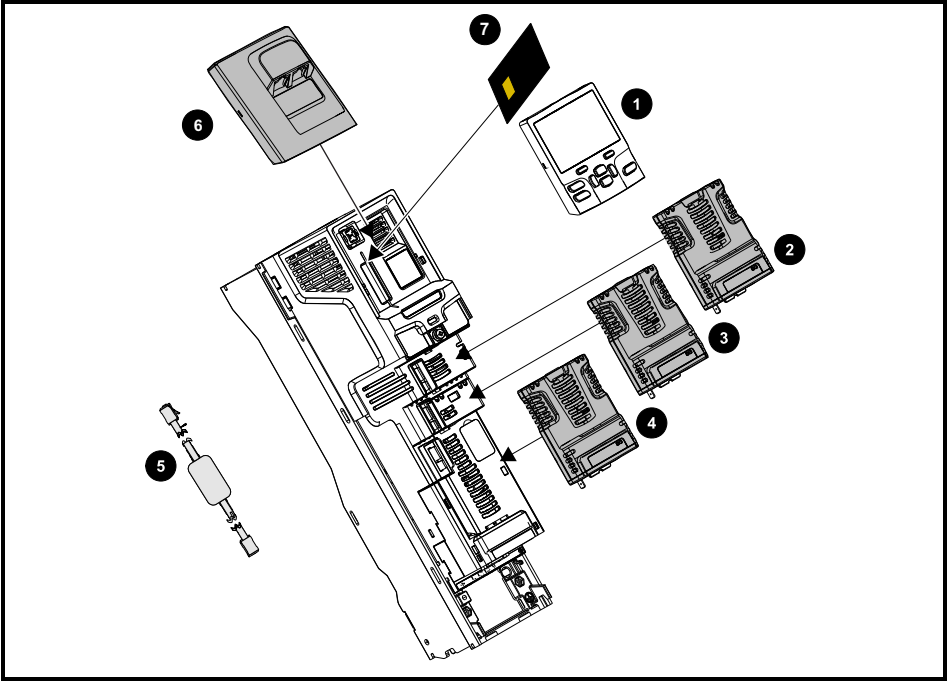
1. Keypad / Remote keypad	2. Option module slot 1	3. Option module slot 2
4. Option module slot 3	5. CT USB Comms cable	6. KI-485 comms adaptor*
7. NV media card		

* A KI-485 Adaptor is required for remote LCD keypad operation and connection to HVAC Drive Connect.

⚠ **WARNING**   Be aware of possible live terminals when inserting or removing the NV media card.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

All standard option modules are color-coded in order to make identification easy. All modules have an identification label on top of the module. Standard option modules can be installed to any of the available option slots on the drive. The following tables shows the color-code key and gives further details on their function.
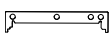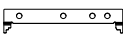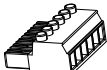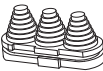
Table 2-9   Option modules, Keypad and additional options available

Type	Name	Further details
Fieldbus	KI-485 Adaptor	**EIA 485 Comms Adaptor** EIA 485 Comms adaptor provides an EIA 485 communication interface. This adaptor supports 115 k Baud, node addresses between 1 to 16 and 8 1 NP M serial mode.
	SI-PROFIBUS	**Profibus option** PROFIBUS adapter for communications with the drive.
	SI-DeviceNet	**DeviceNet option** DeviceNet adapter for communications with the drive.
	SI-CANopen	**CANopen option** CANopen adapter for communications with the drive.
	SI-Ethernet	**Ethernet option** External Ethernet module that supports EtherNet/IP and Modbus TCP/IP
	SI-PROFINET V2	**PROFINET option** PROFINET adapter for communications with the drive.
Automation (I/O expansion)	SI-I/O	**Extended I/O** Increases the I/O capability by adding the following combinations: Digital I/O, Digital Inputs, Analog Inputs (differential or single ended), Analog Output, Relays.
Automation (applications)	MCi200	**Machine Control Studio Compatible Applications Processor** 2nd processor for running pre-defined and/or customer created application software.
	MCi210	**Machine Control Studio Compatible Applications Processor (with Ethernet communications)** 2nd processor for running pre-defined and/or customer created application software with Ethernet communications.
	SI-Applications Plus	**SyPTPro Compatible Applications Processor (with CTNet)** 2nd processor for running pre-defined and/or customer created application software with CTNet support (can only be used on Slot 3).
Keypad	KI-HOA Keypad RTC	**LCD keypad option** Keypad with a LCD display and real time clock.
Back-up	SD Card Adaptor	**SD Card Adaptor** Allows the drive to use an SD card for drive back-up.
	SMARTCARD	**SMARTCARD** Used for parameter back-up with the drive.

For more information refer to the *Drive User Guide* and the relevant *Option Module User Guide*.
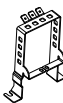
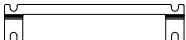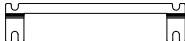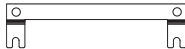## 2.8 Items supplied with the drive

Table 2-10 Parts supplied with the drive (size 3 to 8)

Description	Size 3	Size 4	Size 5	Size 6	Size 7	Size 8
Control connectors 1 to 9 and 21 to 29			x 1 x 1			
Communication connector			x 1			
Relay connector			x 1 x 1			
24 V power supply connector					x 1	
Grounding bracket			x 1			
Surface mounting brackets	x 2	x 2	x 2	x 2	x 2	x 2
Grounding clamp	x 1		x 1	x 1		
DC terminal cover grommets	x 2					
Terminal nuts				M6 x 11		
Supply and motor connector	x 1		x 1 x 1			
Finger guard grommets			x 3	x 2		

Table 2-11   Parts supplied with the drive (size 9A, 9E, 10E and 11E)

Description	Size 9A/9E	Size 10E	Size 11E
Control connectors 1 to 9 and 21 to 29		x 1 x 1	
Communication connector		x 1	
Relay connector		x 1 x 1	
24 V power supply connectors		x 1 x 1	
Grounding bracket		x 1	
Fan power supply connector		x 1	
Surface mounting brackets	x 2		x 2 x 1

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

3 Mechanical installation

This chapter describes how to use all mechanical details to install the drive. The drive is intended to be installed in an enclosure. Key features of this chapter include:

• Option module installing
• Terminal location and torque setting

3.1 Safety information

⚠ **WARNING**

Follow the instructions
The mechanical and electrical installation instructions must be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the drive and any external option unit, and the way in which they are operated and maintained, comply with the requirements of the Health and Safety at Work Act in the United Kingdom or applicable legislation and regulations and codes of practice in the country in which the equipment is used.

⚠ **WARNING**

Stored charge
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge, or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Nidec Industrial Automation or their authorized distributor.

⚠ **WARNING**

Competence of the installer
The drive must be installed by professional assemblers who are familiar with the requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

⚠ **WARNING**

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.

3.2 Planning the installation

The following considerations must be made when planning the installation:

3.2.1 Access

Access must be restricted to authorized personnel only. Safety regulations which apply at the place of use must be complied with.

The IP/NEMA (Ingress Protection/National Electrical Manufacturers Association) rating of the drive is installation dependent.

3.2.2 Environmental protection

The drive must be protected from:

• Moisture, including dripping water or spraying water and condensation. An anti-condensation heater may be required, which must be switched off when the drive is running.
• Contamination with electrically conductive material
• Contamination with any form of dust which may restrict the fan, or impair airflow over various components
• Temperature beyond the specified operating and storage ranges
• Corrosive gasses

| NOTE | During installation it is recommended that the vents on the drive are covered to prevent debris (e.g. wire off-cuts) from entering the drive. |

3.2.3 Cooling

The heat produced by the drive must be removed without its specified operating temperature being exceeded. Note that a sealed enclosure gives much reduced cooling compared with a ventilated one, and may need to be larger and/or use internal air circulating fans.

3.2.4 Electrical safety

The installation must be safe under normal and fault conditions. Electrical installation instructions are given in Chapter 4 *Electrical installation on page 42*.

3.2.5 Electromagnetic compatibility

Variable speed drives are powerful electronic circuits which can cause electromagnetic interference if not installed correctly with careful attention to the layout of the wiring.

Some simple routine precautions can prevent disturbance to typical control equipment.

If it is necessary to meet strict emission limits, or if it is known that electromagnetically sensitive equipment is located nearby, then full precautions must be observed. In-built into the drive, is an internal EMC filter, which reduces emissions under certain conditions. If these conditions are exceeded, then the use of an external EMC filter may be required at the drive inputs.
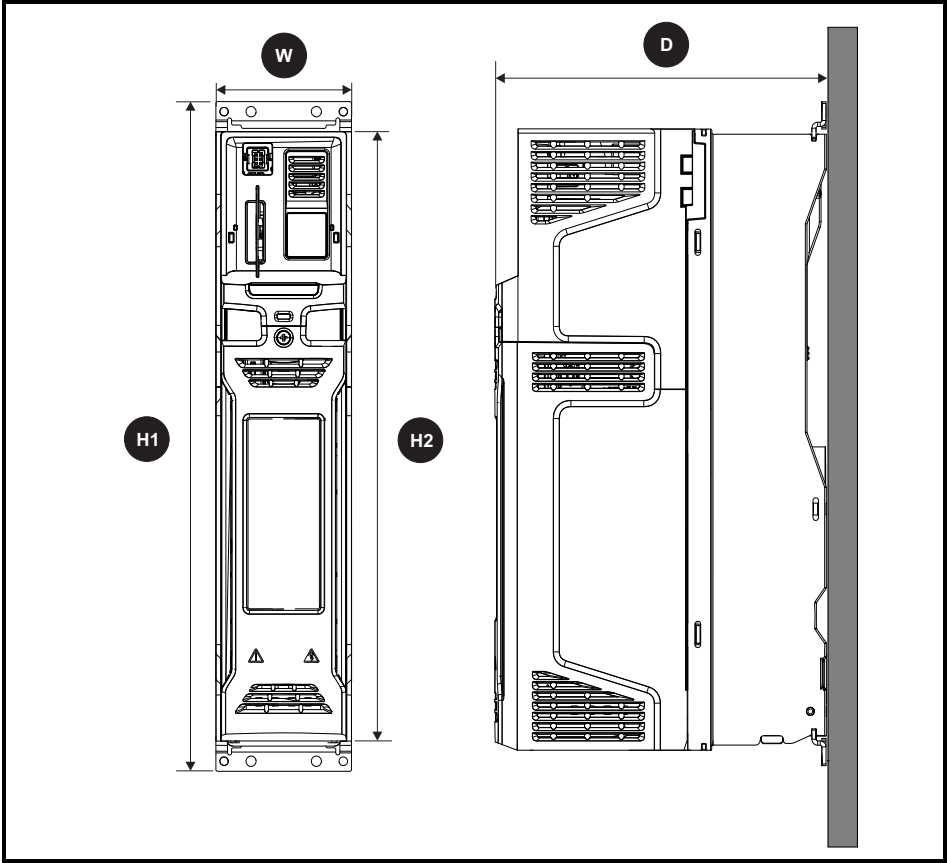
Refer to the *Drive User Guide* for additional information on external EMC filters.

3.2.6 Hazardous areas

The drive must not be located in a classified hazardous area unless it is installed in an approved enclosure and the installation is certified.
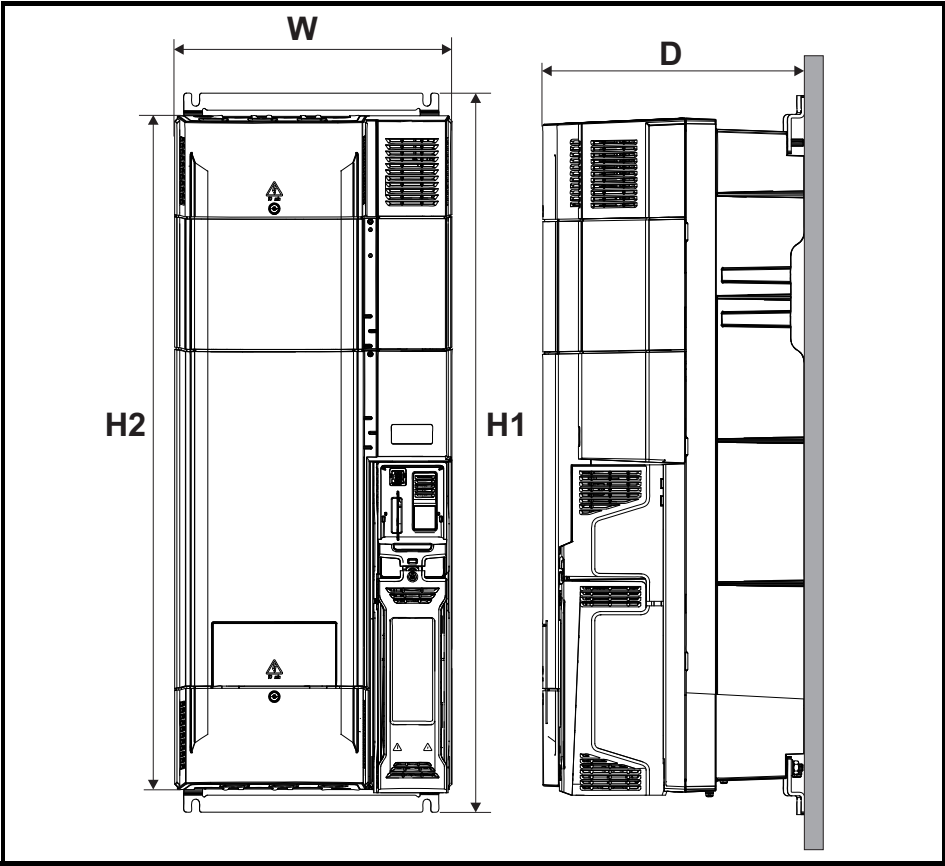
3.3 Drive dimensions

Figure 3-1   Drive dimensions (size 3 to 8)

Size	H1		H2		W		D	
	mm	in	mm	in	mm	in	mm	in
3	382	15.04	365	14.37	83	3.27	200	7.87
4	391	15.39			124	4.88		
5	391	15.39			143	5.63	200	7.87
6	391	15.39			210	8.27	227	8.94
7	557	21.93	508	20	270	10.63	280	11.02
8	804	31.65	753	29.65	310	12.21	290	11.42

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 3-2   Drive dimensions (size 9 to 11)

Size	H1		H2		W		D	
	mm	in	mm	in	mm	in	mm	in
9A	1108	43.6	1049	41.3	310	12.2	290	11.4
9E and 10E	1069	42.1	1010	39.7	310	12.2	290	11.4
11E	1242	48.9	1189	46.8	310	12.2	313	12.3

3.4 Surface mounting

Figure 3-3 Surface mounting dimensions (size 3 to 7)
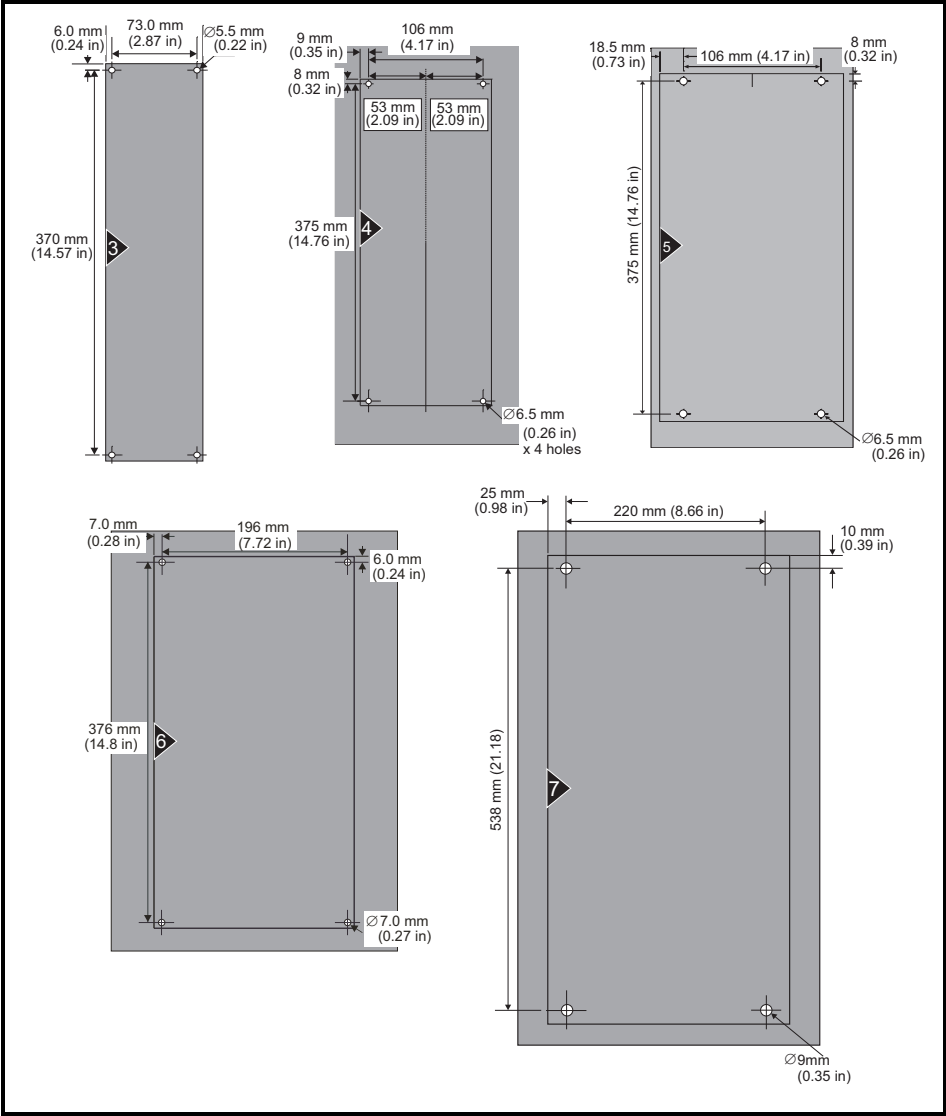
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

HVAC Drive H300 Installation and Commissioning Guide
Issue Number: 5

29

Figure 3-4   Surface mounting dimensions (size 8 to 10)

26 mm
(1.02 in)

259 mm (10.20 in)

9 mm
(0.35 in)

∅ 9 mm
(0.35 in)
x 4 holes

26 mm
(1.02 in)

259 mm (10.20 in)

9.5 mm
(0.37 in)

784 mm (30.87 in)
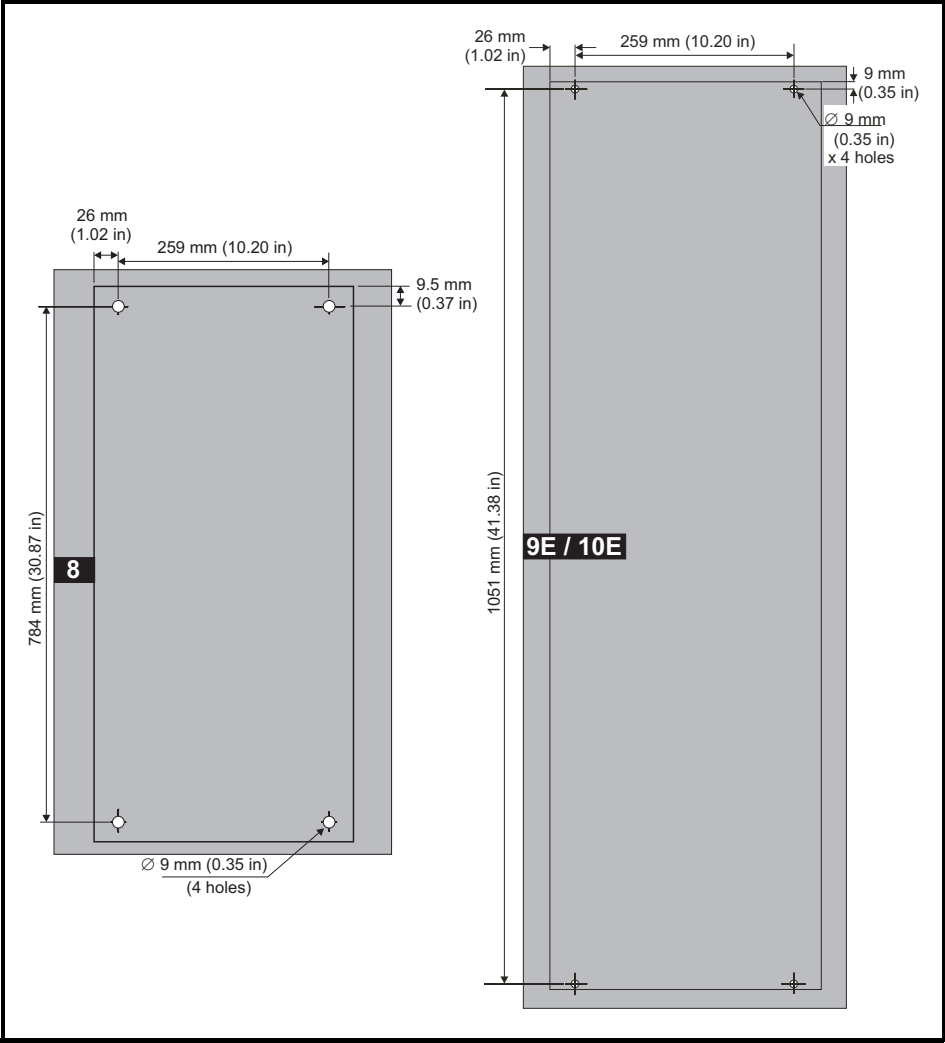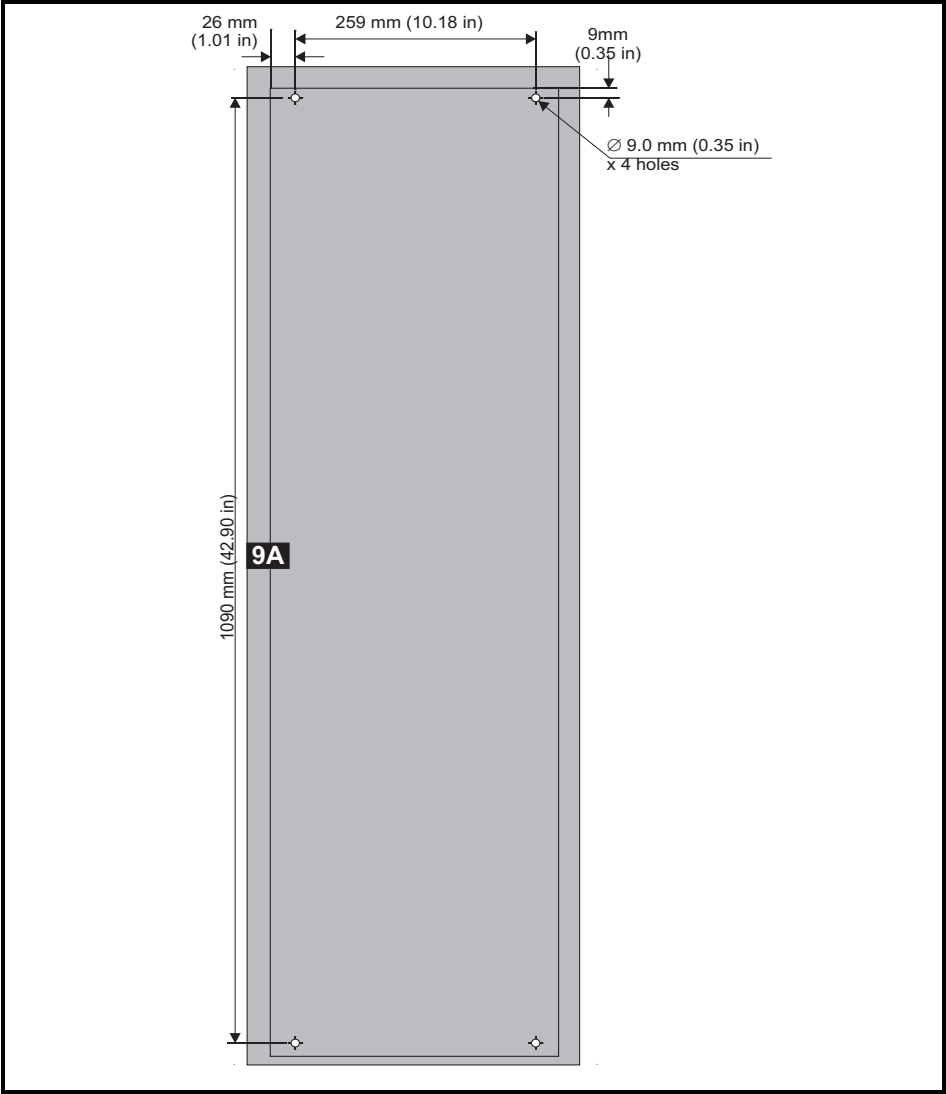
8

1051 mm (41.38 in)

9E / 10E

∅ 9 mm (0.35 in)
(4 holes)

Figure 3-5   Surface mounting dimensions (size 9A)
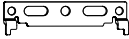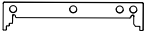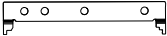
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 3-6   Surface mounting dimensions (size 11E)
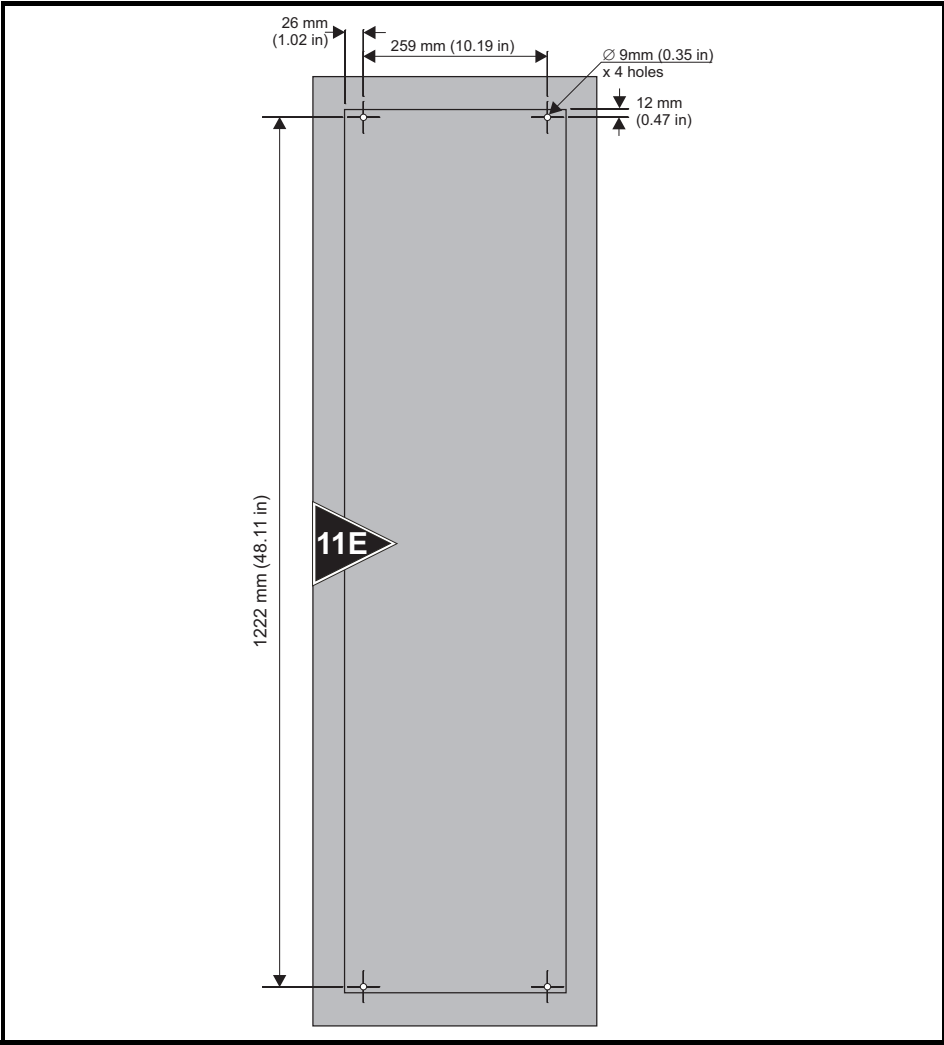
3.4.1 Mounting brackets

Table 3.7 Mounting brackets (size 3 to 10)

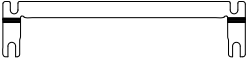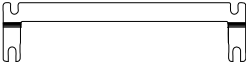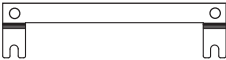| Frame size	Surface mounting brackets	Qty
3	Outer hole size: 5.2 mm (0.20 in) Centre hole / slot size: 6.2 mm (0.24 in)	**x 2**
4	Hole size: 6.5 mm (0.26 in)	**x 2**
5	Hole size: 6.5 mm (0.26 in)	**x 2**
6	Hole size: 6.5 mm (0.26 in)	**x 2**
7	Hole size: 9 mm (0.35 in)	**x 2**
8	Hole size: 9 mm (0.35 in)	**x 2**
9A, 9E and 10E	Hole size: 9 mm (0.35 in)	**x 2**
11E	Hole size: 9 mm (0.35 in)	**x 2**
	Hole size: 9 mm (0.35 in)	**x 1**

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

3.4.2 Terminal sizes and torque settings

> ⚠️ **WARNING**
>
> To avoid a fire hazard and maintain validity of the UL listing, adhere to the specified tightening torques for the power and ground terminals. Refer to the following tables.

Table 3-1   Drive control and relay terminal data

Model	Connection type	Torque setting
All	Plug-in terminal block	0.5 N m (0.4 lb ft)

Table 3-2   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)

3.5 Spacing and layout for standard drives

Please observe the clearances in the diagram below taking into account any appropriate notes for other devices / auxiliary equipment when planning the installation.

Figure 3-8 Enclosure layout (size 3 to 8)
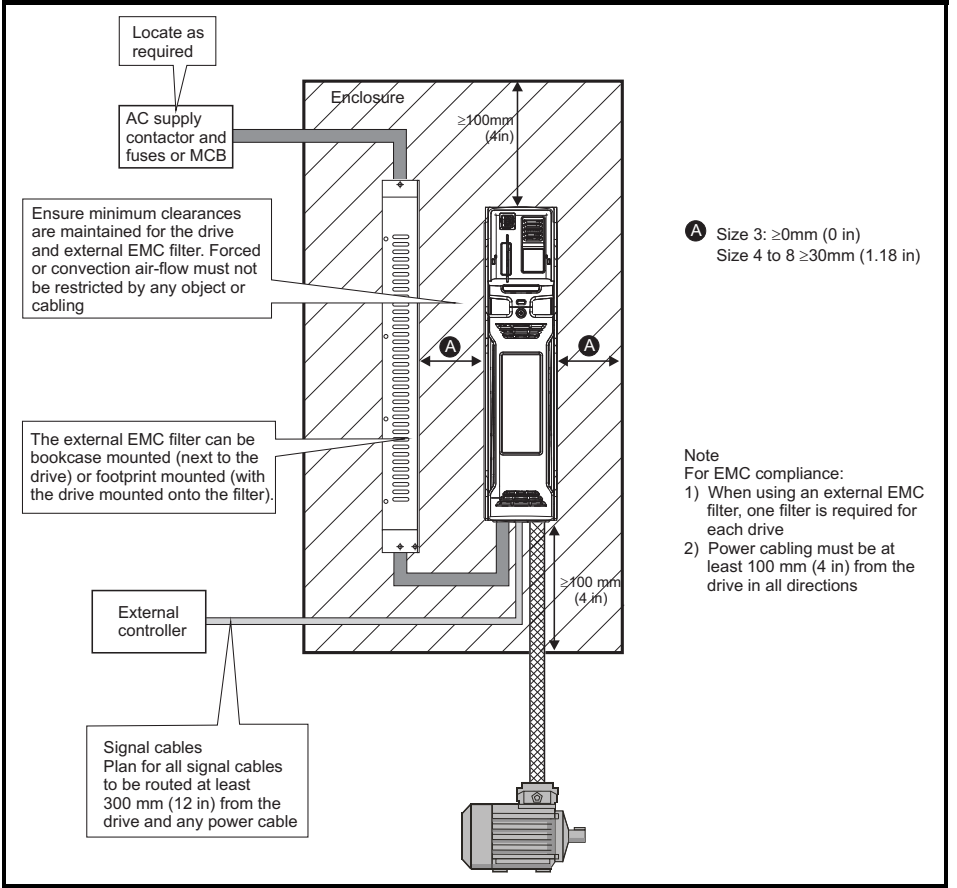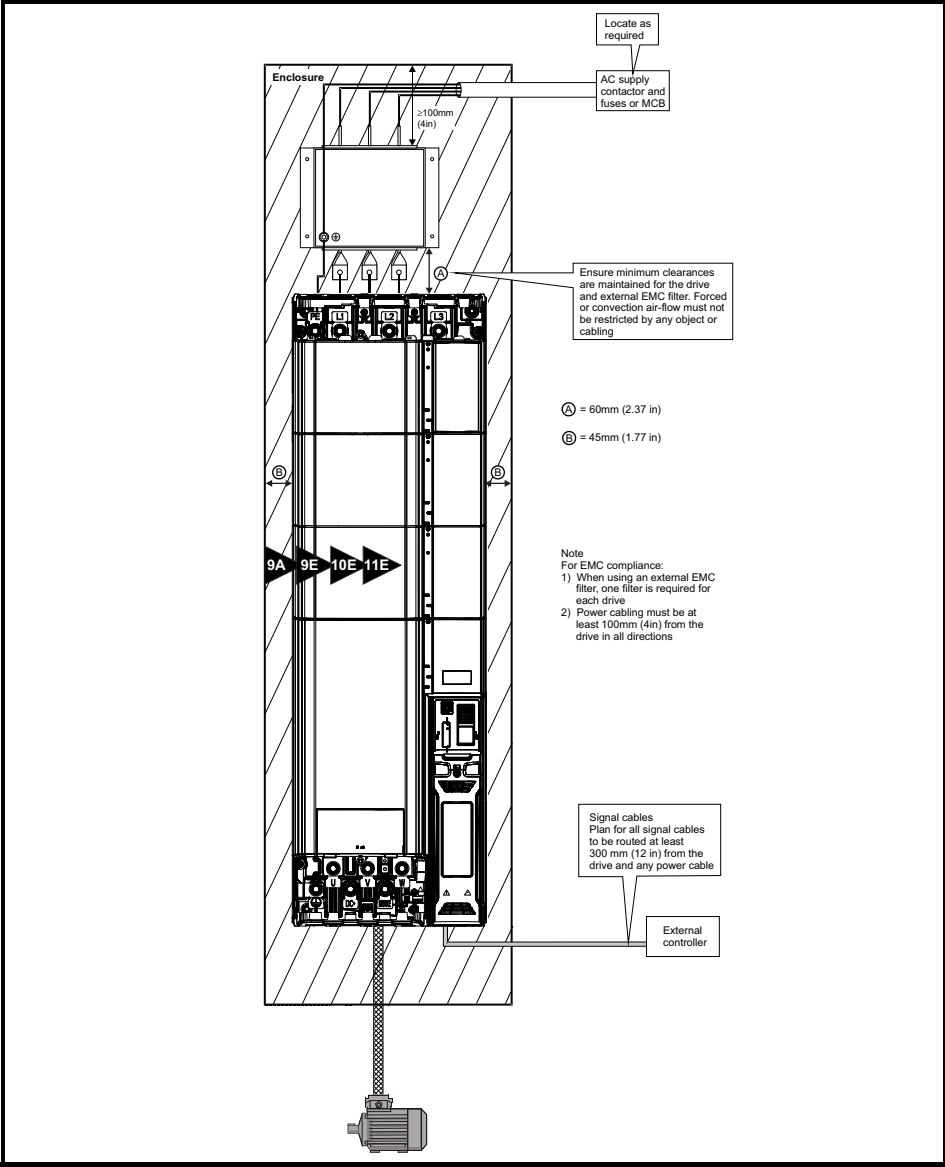
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 3-9   Enclosure layout (size 9 to 11)

Locate as required

AC supply contactor and fuses or MCB

Enclosure

≥100mm (4in)

Ⓐ

Ensure minimum clearances are maintained for the drive and external EMC filter. Forced or convection air-flow must not be restricted by any object or cabling

Ⓐ = 60mm (2.37 in)

Ⓑ = 45mm (1.77 in)

Ⓑ   Ⓑ

9A 9E 10E 11E

Note
For EMC compliance:
1) When using an external EMC filter, one filter is required for each drive
2) Power cabling must be at least 100mm (4in) from the drive in all directions

Signal cables
Plan for all signal cables to be routed at least 300 mm (12 in) from the drive and any power cable

External controller

3.6 EMC filters

3.6.1 Internal filter

It is recommended that the internal EMC filter be kept in place unless there is a specific reason for removing it. If the drive is part of a regen system or it is connected to an IT supply then the internal EMC filter must be removed. The internal EMC filter reduces radio-frequency emission into the line power supply. Where the motor cable is short, it permits the requirements of EN 61800-3:2004 to be met for the second environment - for further information see the *Drive User Guide*. For longer motor cables the filter continues to provide a useful reduction in emission level, and when used with any length of shielded motor cable up to the limit for the drive, it is unlikely that nearby industrial equipment will be disturbed. It is recommended that the filter be used in all applications unless the instructions given above require it to be removed or the ground leakage current of the drive is unacceptable.
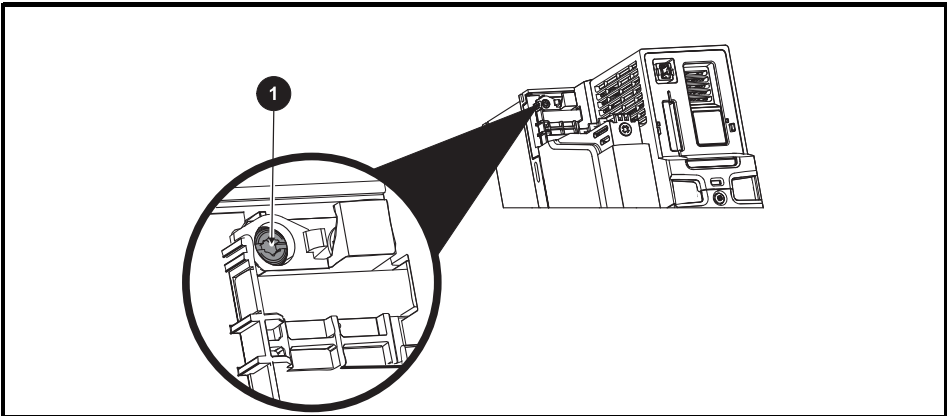
Figure 3-10   Removal of Size 3 internal EMC filter
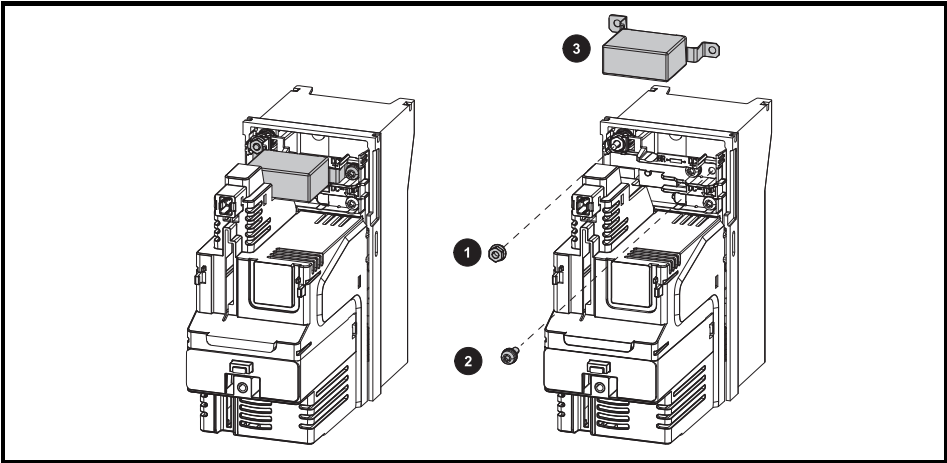
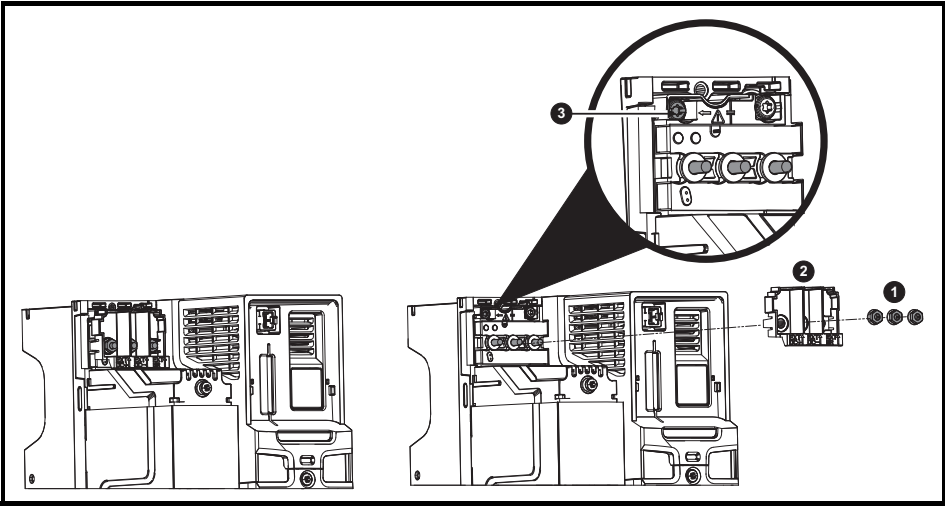Loosen / remove the screw and nut as shown (1) and (2).

Lift away from securing points and then rotate away from the drive. Ensure the screw and nut are replaced and re-tightened with a maximum torque of 2 N m (1.47 lb ft).

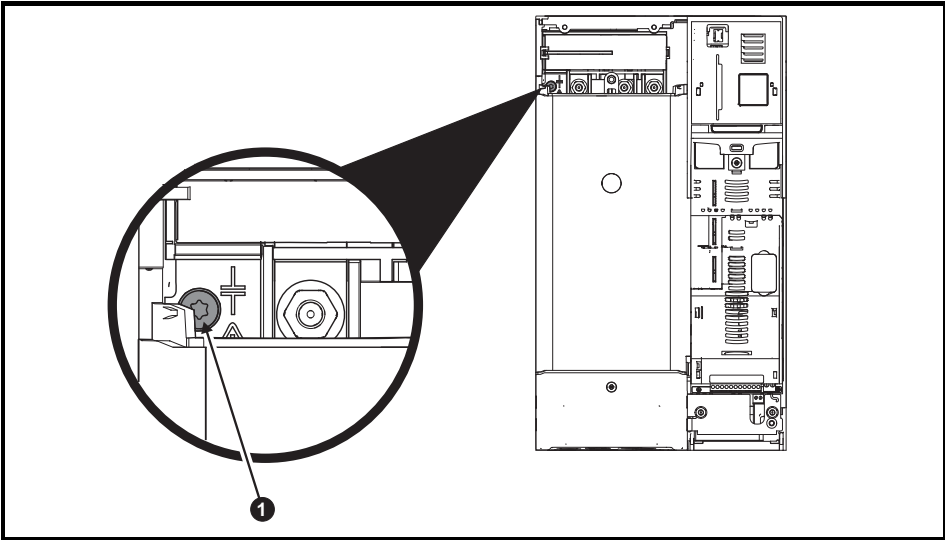**Figure 3-11   Removal of the size 4 internal EMC filter**

To electrically disconnect the Internal EMC filter, remove the screw (1) as highlighted above.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 3-12   Removal of the size 5 internal EMC filter

Remove the three M5 terminal nuts (1). Lift away the cover (2) to expose the M4 Torx internal EMC filter removal screw. Finally remove the M4 Torx internal EMC filter removal screw (3) to electrically disconnect the internal EMC filter.

Figure 3-13   Removal of the size 6 internal EMC filter

To electrically disconnect the Internal EMC filter, remove the screw (1) as highlighted above.

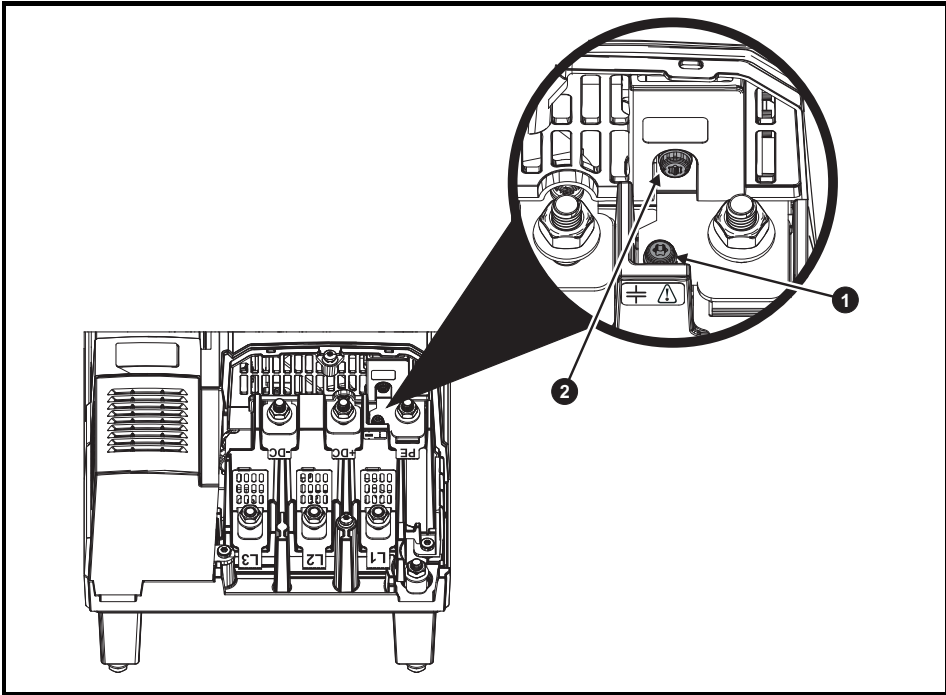**Figure 3-14   Removal of the size 7, 8 and 9A internal EMC filter and line to ground varistors (size 7 shown)**

To electrically disconnect the Internal EMC filter, remove the screw as highlighted above (1).

To electrically disconnect the line to ground varistors, remove the screw as highlighted above (2).

NOTE   The Internal EMC filter on size 9E, 10E and 11E cannot be removed.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

3.6.2   Line to ground varistors

⚠️ **WARNING** The line to ground varistors should only be removed in special circumstances such as ungrounded supplies with more than one source, for example on ships. Where the line to ground varistors are removed, ensure that line to ground transients are limited to values of category II. This is to ensure that line to ground transients do not exceed 4 kV as the drive insulation system from power to ground is designed to category II.Contact the supplier of the drive for more information.

Figure 3-15   Removal of size 9E and 10E line to ground varistors
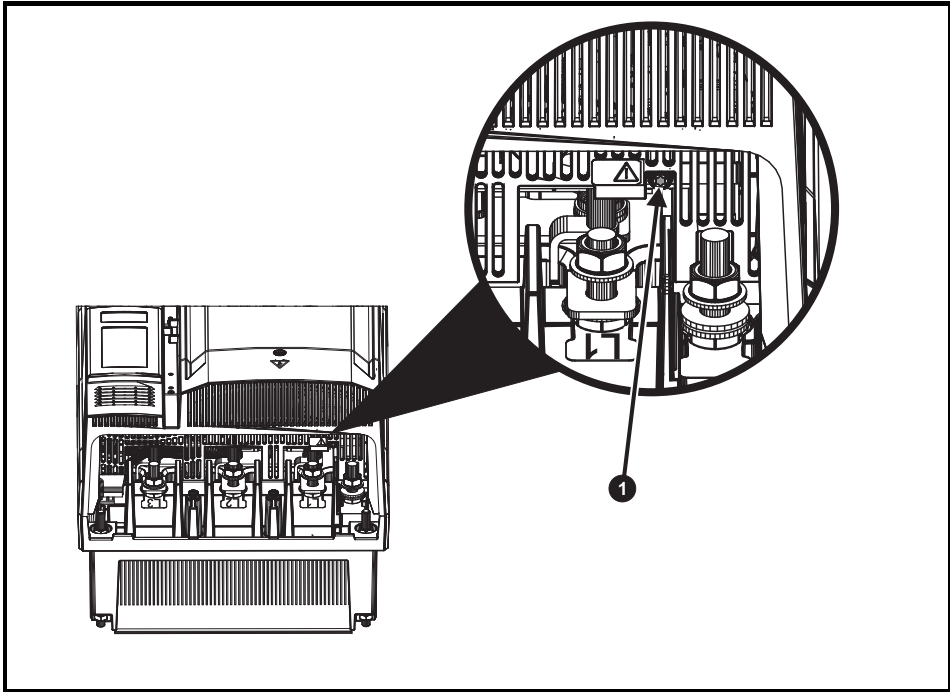
To electrically disconnect the line to ground varistors, remove the screw as highlighted above (1).

Figure 3-16   Removal of line to ground varistors (size 11E)
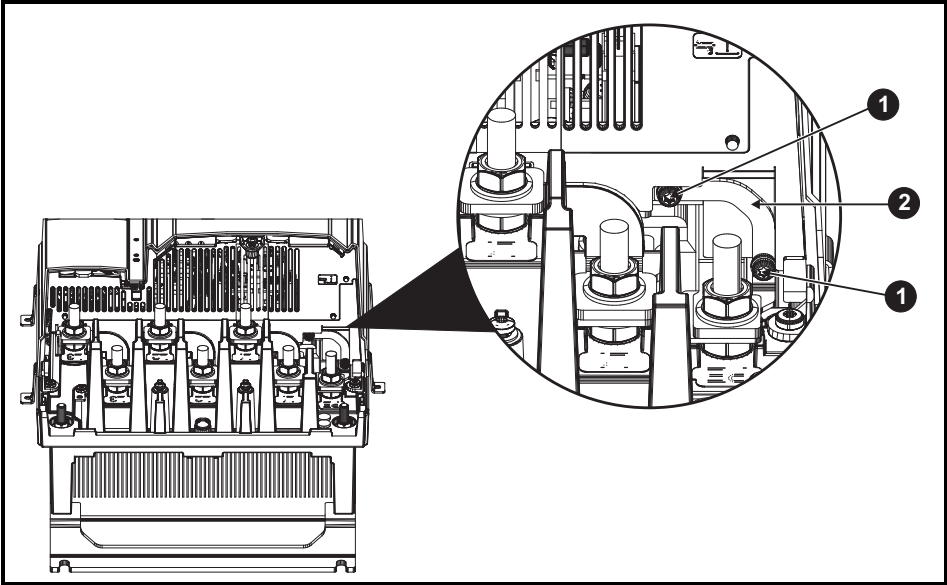
To electrically disconnect the line to ground varistors, remove the two screws highlighted (1) above and remove the bracket (2).

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

4 Electrical installation

Many cable management features have been incorporated into the product and accessories, this chapter shows how to optimize them. Key features include:

- Safe Torque Off function
- Internal EMC filter
- EMC compliance with shielding / grounding accessories
- Product rating, fusing and cabling information

⚠ WARNING	**Electric shock risk** The voltages present in the following locations can cause severe electric shock and may be lethal: AC supply cables and connections DC and brake cables, and connections Output cables and connections Many internal parts of the drive, and external option units Unless otherwise indicated, control terminals are single insulated and must not be touched.

⚠ WARNING	**Isolation device** The AC and / or DC power 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.

⚠ WARNING	**STOP function** The STOP function does not remove dangerous voltages from the drive, the motor or any external option units.

⚠ WARNING	**Safe Torque Off function** The Safe Torque Off function does not remove dangerous voltages from the drive, the motor or any external option units.

⚠ WARNING	**Stored charge** The drive contains capacitors that remain charged to a potentially lethal voltage after the AC and / or DC power supply has been disconnected. If the drive has been energized, the AC and / or DC power supply must be isolated at least ten minutes before work may continue. Normally, the capacitors are discharged by an internal resistor. Under certain, unusual fault conditions, it is possible that the capacitors may fail to discharge, or be prevented from being discharged by a voltage applied to the output terminals. If the drive has failed in a manner that causes the display to go blank immediately, it is possible the capacitors will not be discharged. In this case, consult Control Techniques or their authorized distributor.

⚠ WARNING	**Equipment supplied by plug and socket** Special attention must be given if the drive is installed in equipment which is connected to the AC supply by a plug and socket. The AC supply terminals of the drive are connected to the internal capacitors through rectifier diodes which are not intended to give safety isolation. If the plug terminals can be touched when the plug is disconnected from the socket, a means of automatically isolating the plug from the drive must be used (e.g. a latching relay).

Safety
information

Product
information

Mechanical
installation

**Electrical
installation**

Getting started

Basic parameters
(Menu 0)

Running the
motor

Optimization

NV Media Card
Operation

Diagnostics and
maintenance

UL listing
information

⚠ **WARNING**

Permanent magnet motors
Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals. If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

4.1 AC supply requirements

Voltage:

200 V drive:	200 V to 240 V ±10 %
400 V drive:	380 V to 480 V ±10 %
575 V drive:	500 V to 575 V ±10 %
690 V drive:	500 V to 690 V ±10 %

Number of phases: 3

Maximum supply imbalance: 2 % negative phase sequence (equivalent to 3 % voltage imbalance between phases).

Frequency range: 45 to 66 Hz

For UL compliance only, the maximum supply symmetrical fault current must be limited to 100 kA

4.1.1 Supply types

All drives are suitable for use on any supply type i.e TN-S, TN-C-S, TT and IT.

Supplies with voltage up to 600 V may have grounding at any potential, i.e. neutral, centre or corner ("grounded delta")

Supplies with voltage above 600 V may not have corner grounding

Drives are suitable for use on supplies of installation category III and lower, according to IEC 60664-1. This means they may be connected permanently to the supply at its origin in a building, but for outdoor installation additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce category IV to category III.

NOTE If the drive is to be used on an IT (ungrounded) supply, refer to the *Drive User Guide* for more information.

4.2 Ratings

See section 2.4 *Ratings* on page 13.
Maximum continuous input current
The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for the worst case condition with the unusual combination of stiff supply with high imbalance. The value stated for the maximum continuous input current would only be seen in one of the input phases. The current in the other two phases would be significantly lower.
The values of maximum input current are stated for a supply with a 2 % negative phase-sequence imbalance and rated at the maximum supply fault current given in section 2.4 *Ratings* on page 13.
The nominal cable sizes given in section 2.4 *Ratings* on page 13 are only a guide. Refer to local wiring regulations for the correct size of cables. In some cases a larger cable is required to avoid excessive voltage drop.

NOTE The nominal output cable sizes in section 2.4 *Ratings* on page 13 assume that the motor maximum current matches that of the drive. Where a motor of reduced rating is used the cable rating may be chosen to match that of the motor. To ensure that the motor and cable are protected against over-load, the drive must be programmed with the correct motor rated current.

⚠️ **WARNING**	**Fuses** The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Nominal fuse ratings are shown in section 2.4 *Ratings* on page 13. Failure to observe this requirement will cause risk of fire.

A fuse or other protection must be included in all live connections to the AC supply. An MCB (miniature circuit breaker) or MCCB (moulded-case circuit-breaker) with type C may be used in place of fuses for size 3 under the following conditions:

• The fault-clearing capacity must be sufficient for the installation.

Fuse types

The fuse voltage rating must be suitable for the drive supply voltage.

4.3 Power connections

4.3.1 AC and DC connections
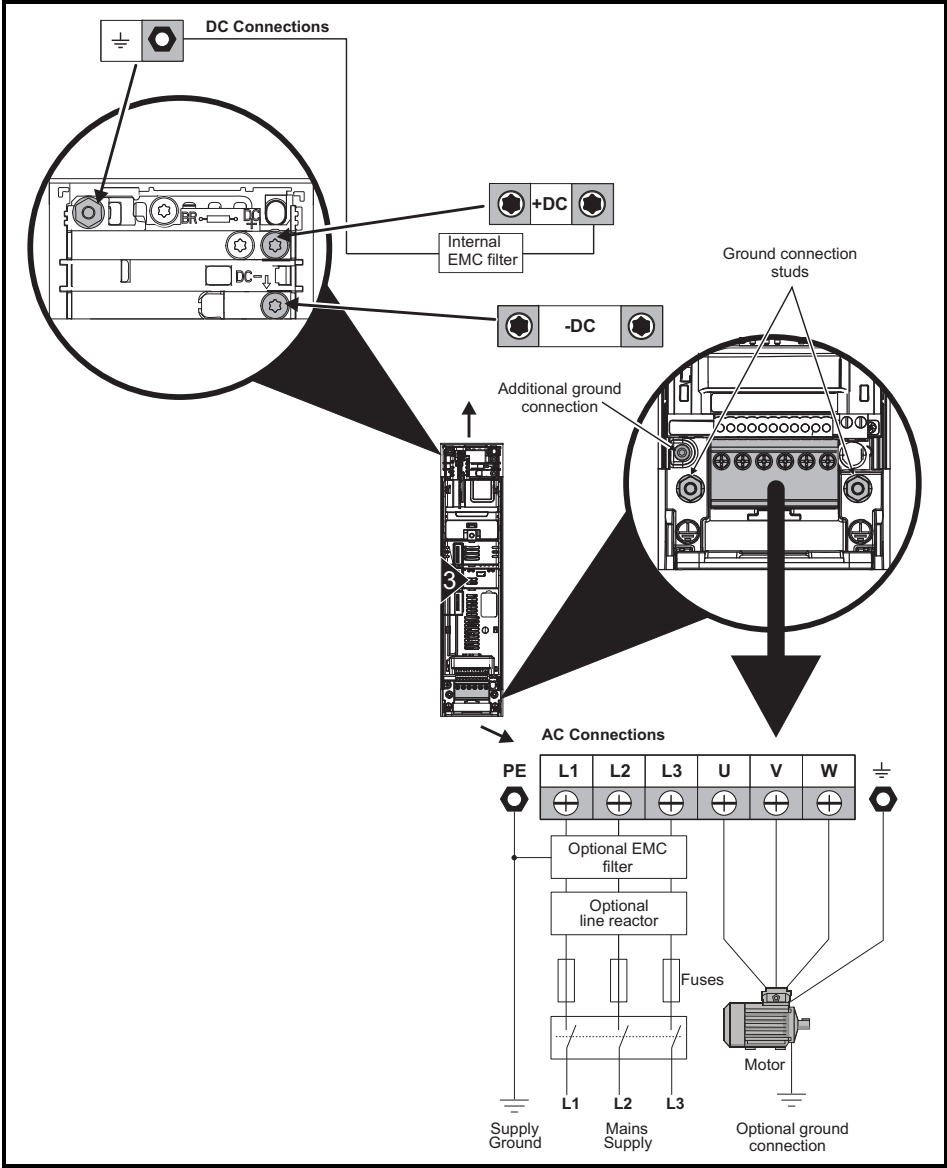
Figure 4-1 Size 3 power and ground connections

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 4-2   Size 4 power and ground connections

DC connections

+DC

-DC

Additional ground connection

Ground connection studs

AC Connections

PE	L1	L2	L3	U	V	W	⏚

Optional EMC filter

Optional line reactor

Fuses

Motor

L1   L2   L3

Supply ground

Mains supply

Optional ground connection
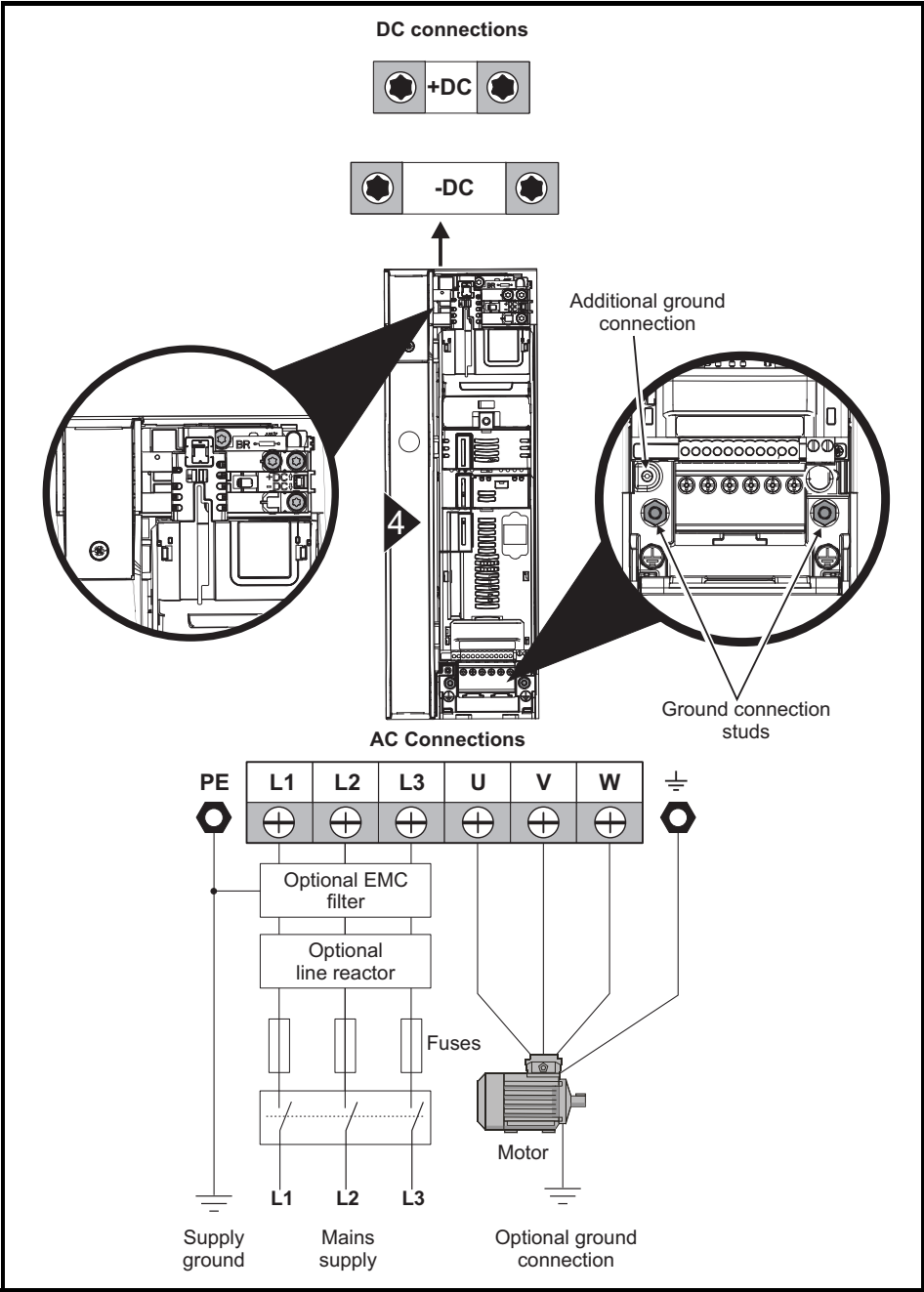
Figure 4-3   Size 5 power and ground connections
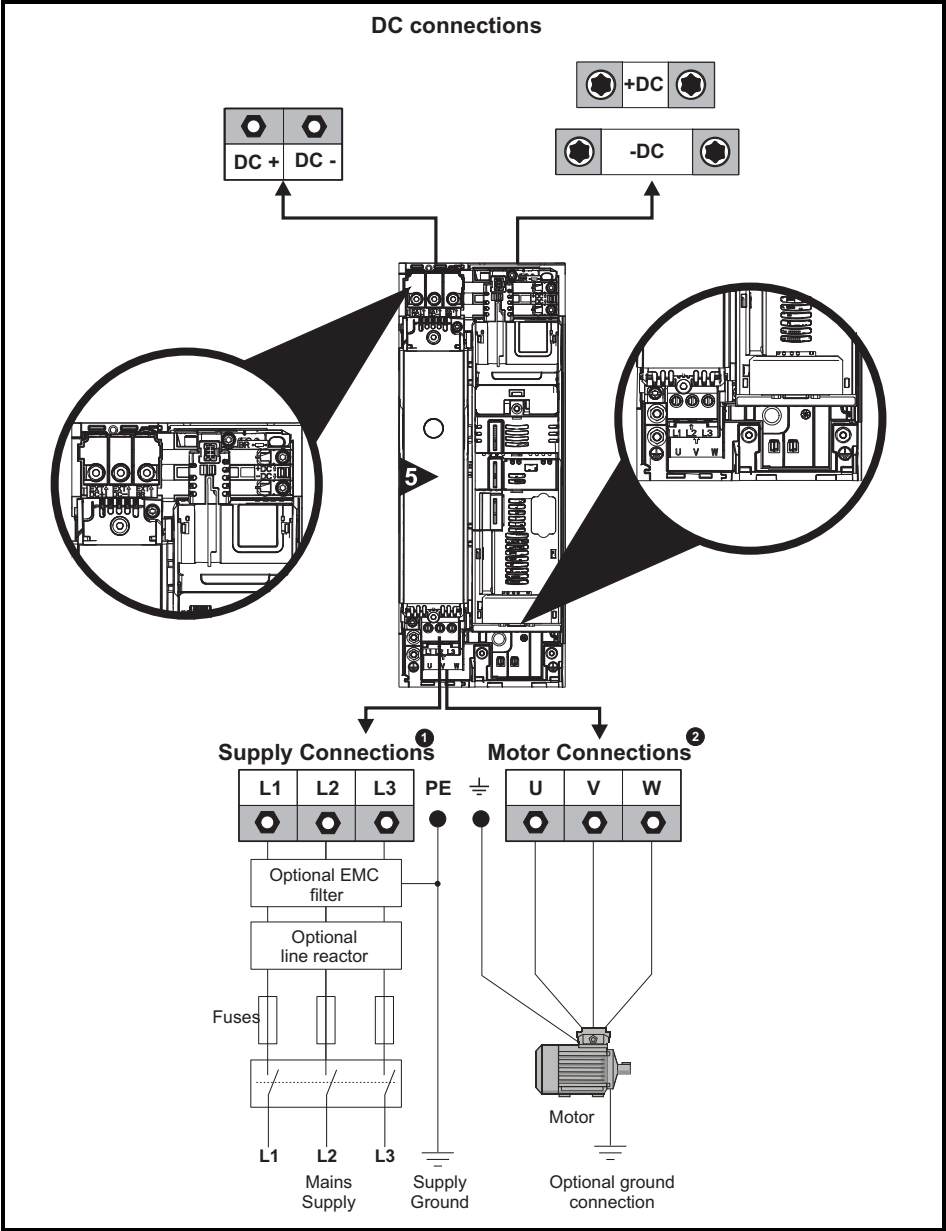
The upper terminal block (1) is used for AC supply connection.

The lower terminal block (2) is used for Motor connection.
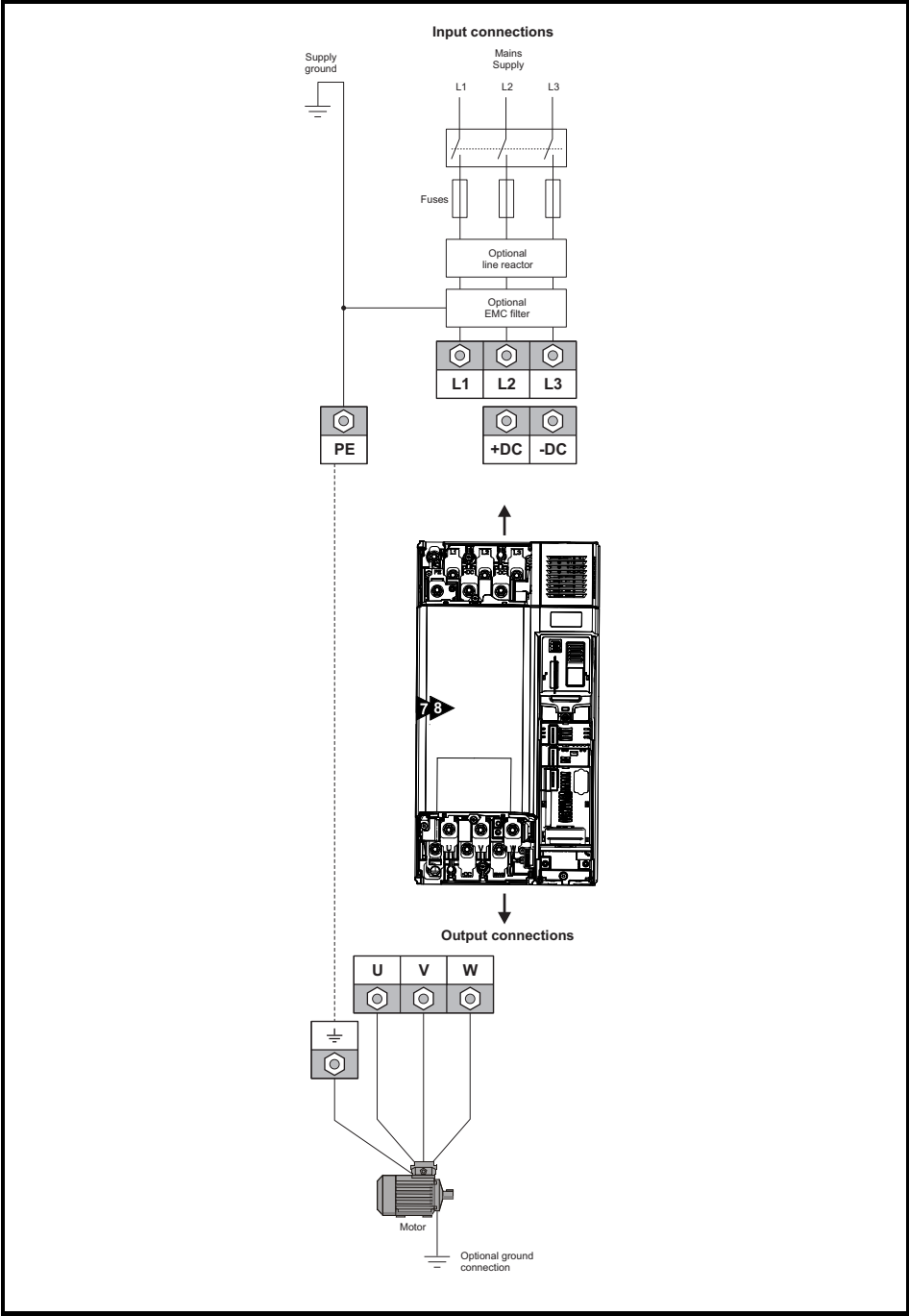
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 4-4   Size 6 power and ground connections

DC Connections

DC -   DC +

Ground connection studs

Supply Connections

L1   L2   L3   PE

Optional EMC filter

Optional line reactor

Fuses

L1   L2   L3

Mains Supply

Supply Ground

Motor Connections
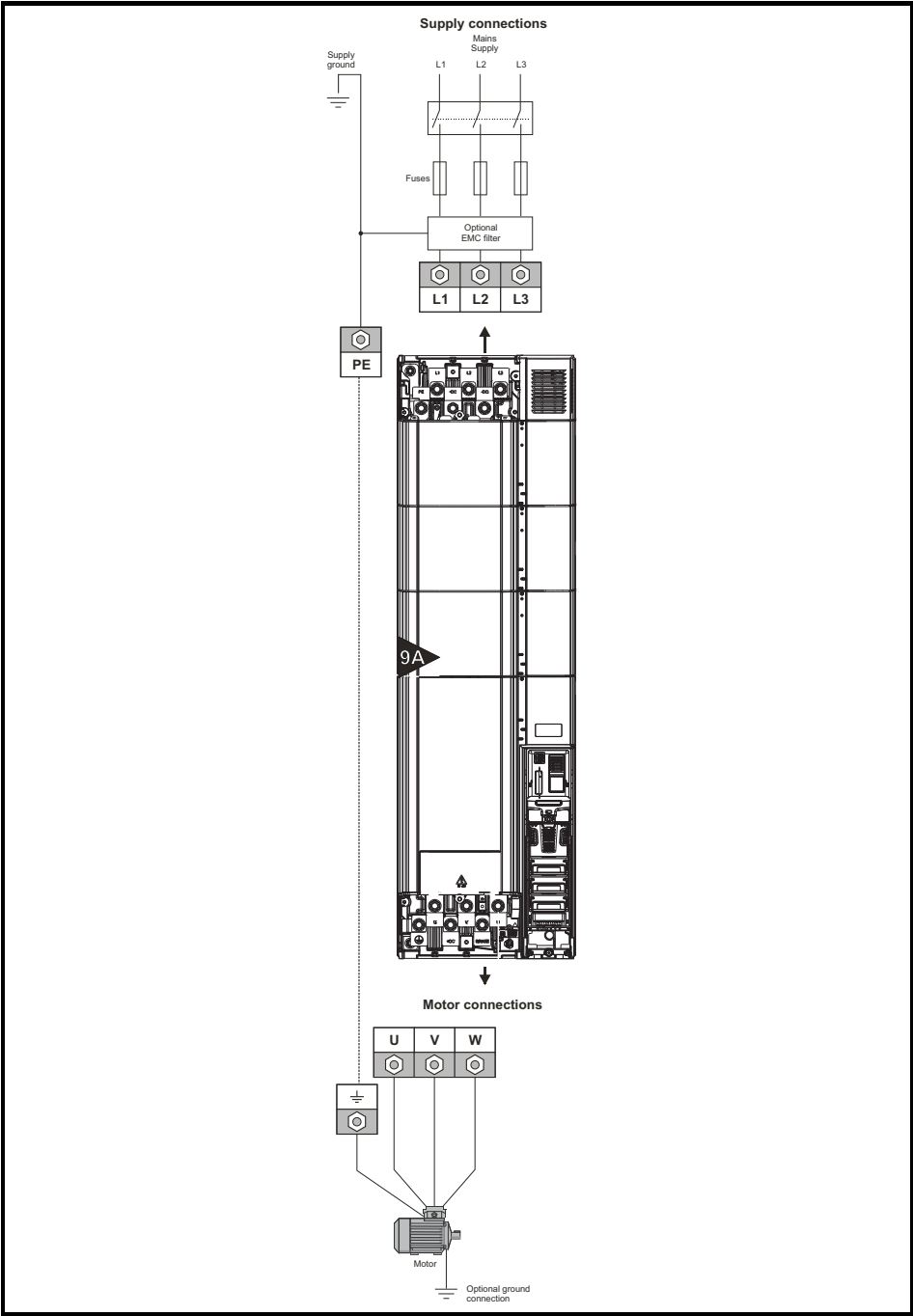
U   V   W

Motor

Optional ground connection
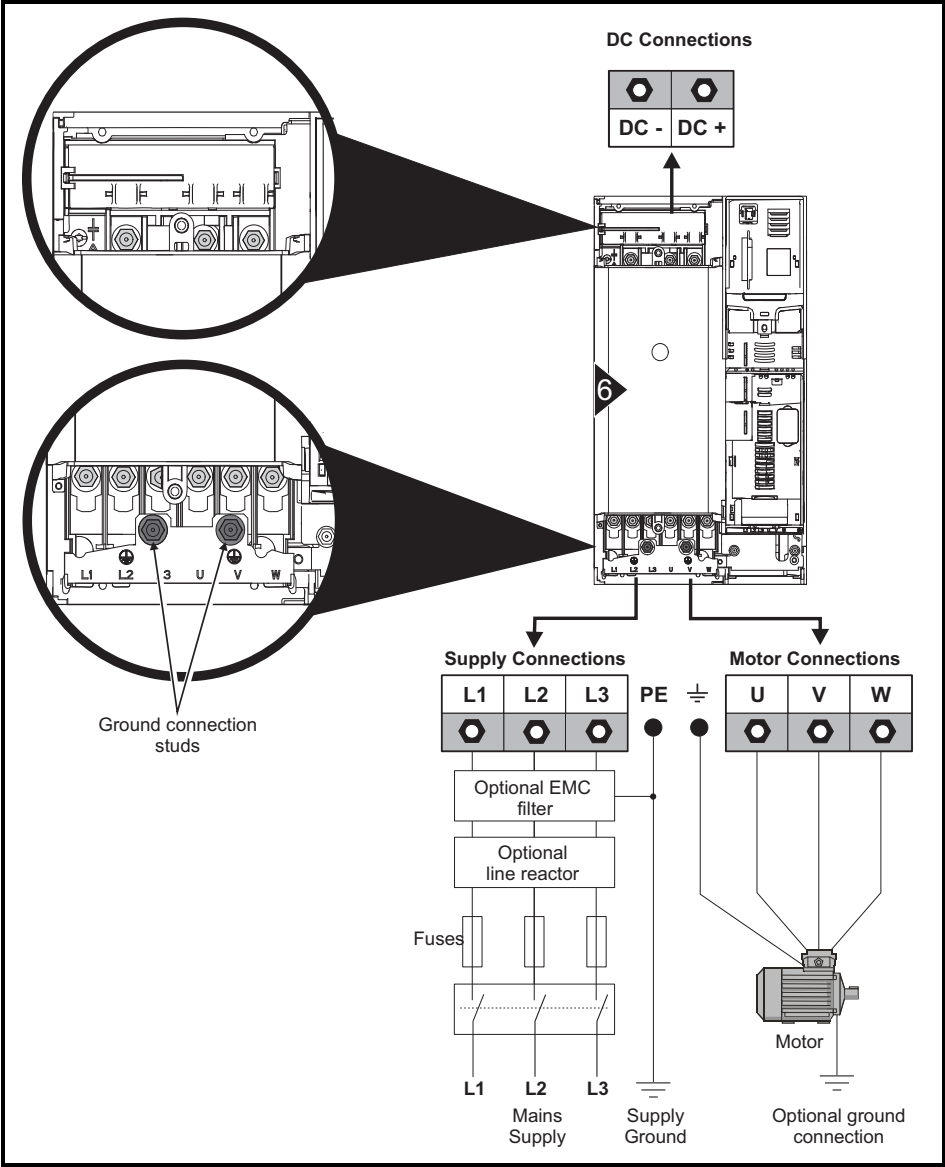
Figure 4-5 Size 7 and 8 power and ground connections (size 7 shown)

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

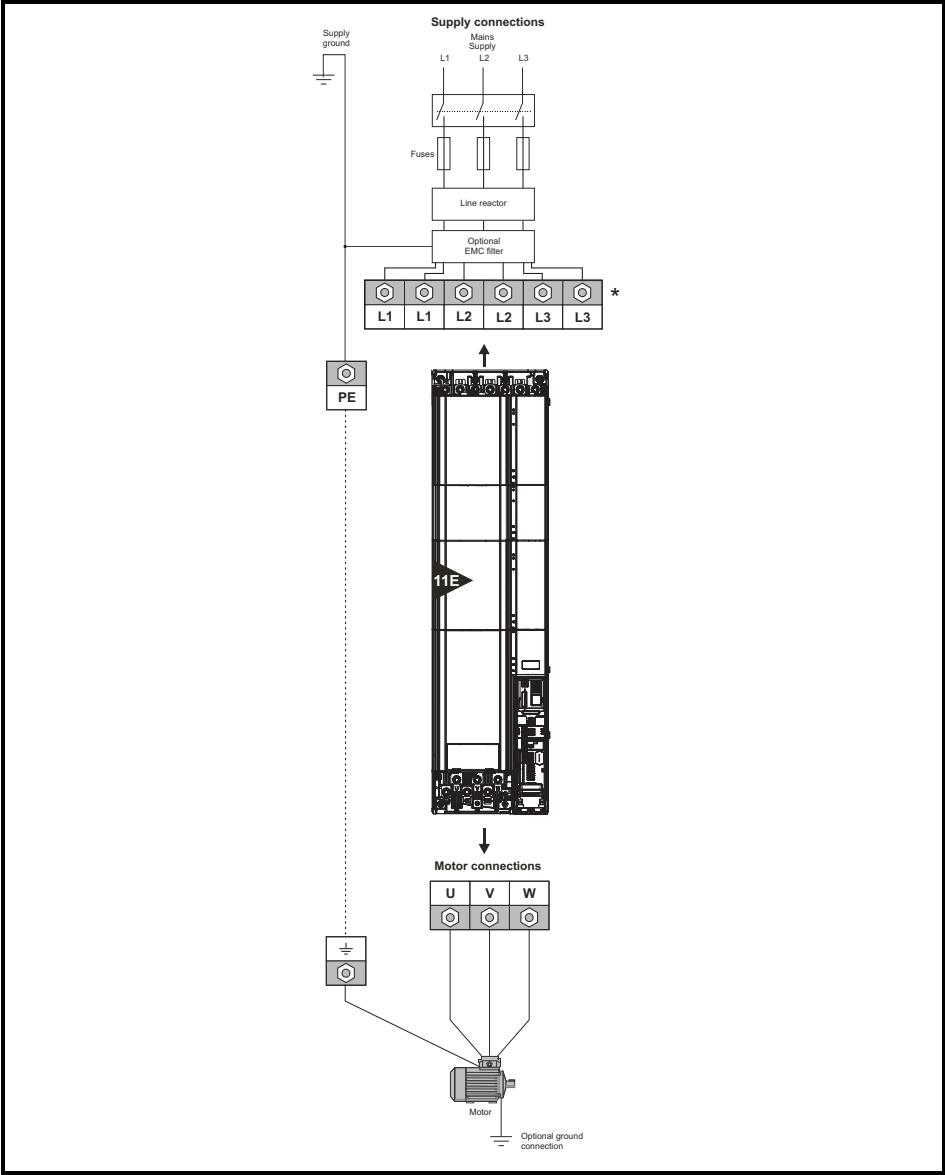**Figure 4-6 Size 9E and 10E power and ground connections**
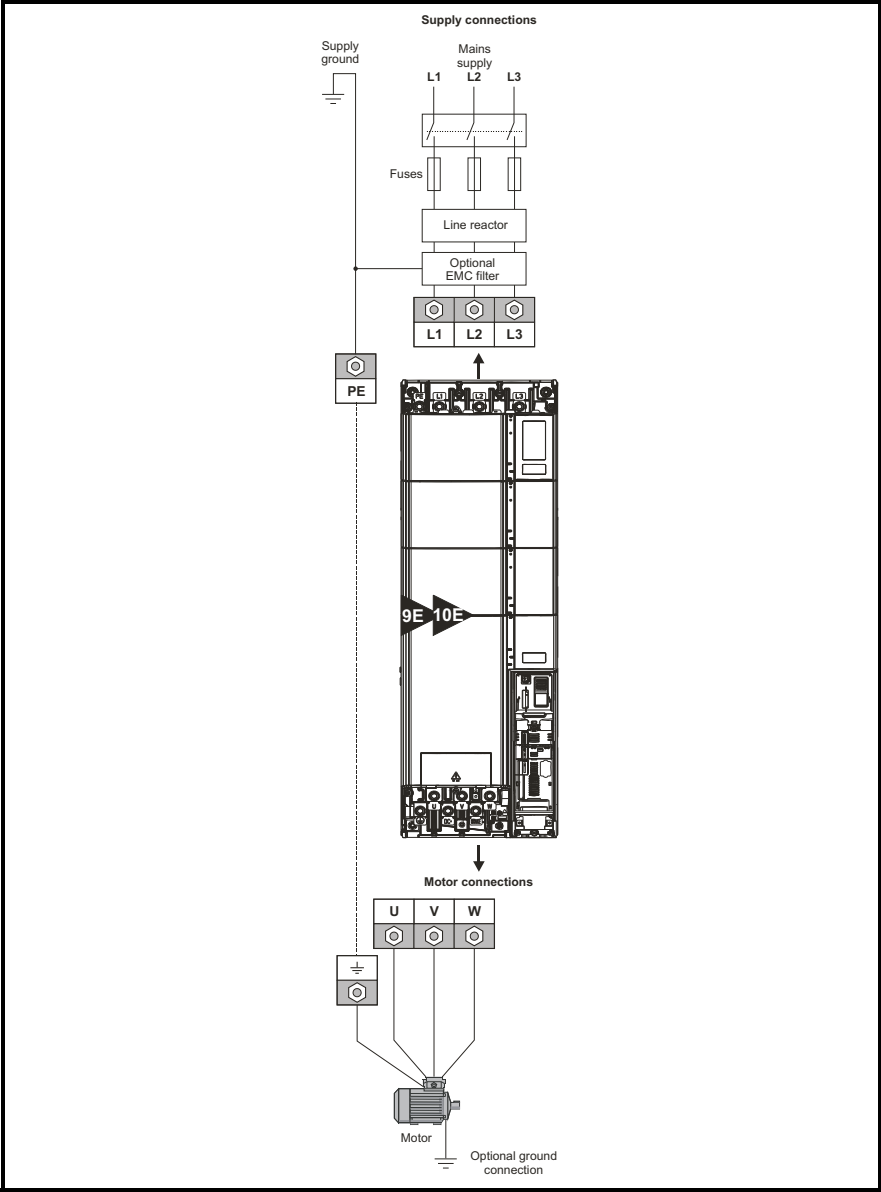
A separate line reactor (INLXXX) must be used for size 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive. Refer to Table 2-8 *Size 9E, 10E and 11E model and line reactor part numbers* on page 17.

CAUTION

Figure 4-7   Size 9A power and ground connections

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 4-8   Size 11E power and ground connections

* Connect to either terminal.

⚠ CAUTION	A separate line reactor (INLXXX) must be used for size 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive. Refer to Table 2-8 *Size 9E, 10E and 11E model and line reactor part numbers* on page 17.

4.4 Ground connections

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.

On size 3 and 4, the supply and motor ground connections are made using the M4 studs located either side of the drive near the plug-in power connectors. See Figure 4-1 and Figure 4-2 for details.
On size 5, the supply and motor ground connections are made using the M5 studs located near the plug-in power connector. Refer to Figure 4-3.
On a size 6, the supply and motor ground connections are made using the M6 studs located above the supply and motor terminals. Refer to Figure 4-4.
On size 7, the supply and motor ground connections are made using the M8 studs located by the supply and motor connection terminals. Refer to Figure 4-5.
On size 8, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals. Refer to Figure 4-5.
On size 9E and 10E, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals. Refer to Figure 4-6.
On size 9A, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals. Refer to Figure 4-7
On size 11E, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals. Refer to Figure 4-8.

⚠ WARNING

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.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

4.5 Shield connections

The following guidelines should be followed to ensure suppression of radio-frequency emission and good noise immunity. Use the grounding bracket and grounding clamp supplied with the drive to terminate the shields at the drive.

Figure 4-9   Grounding of signal cable shields using the grounding bracket
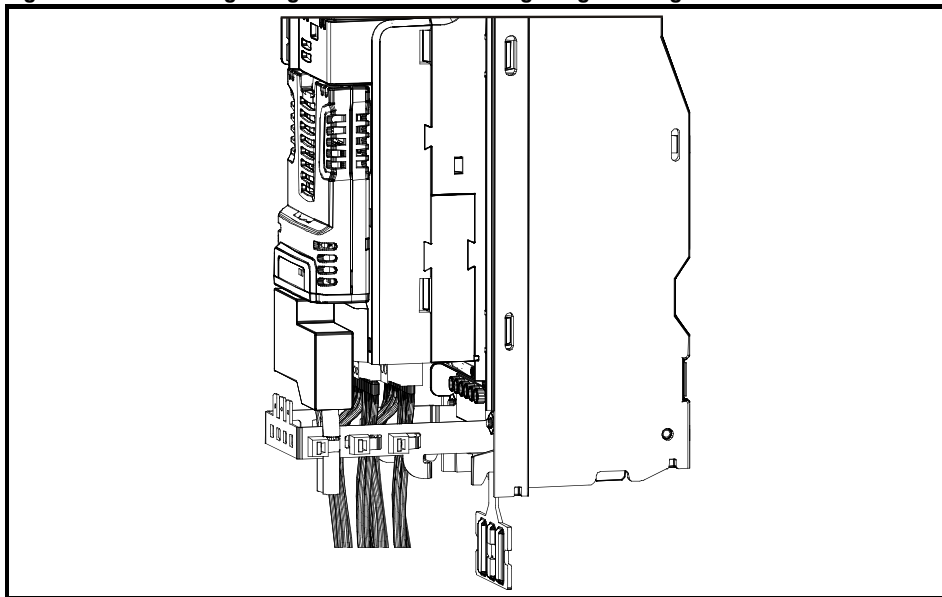
Motor cable: Use a motor cable with an overall shield. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long. A full 360 ° termination of the shield to the terminal housing of the motor is beneficial.

Control cables: If the control wiring is to leave the enclosure, it must be shielded and the shield(s) clamped to the drive using the grounding bracket. Remove the outer insulating cover of the cable to ensure the shield(s) make contact with the bracket, but keep the shield(s) intact until as close as possible to the terminals.

Figure 4-10   Installation of grounding clamp (size 3 and 4)
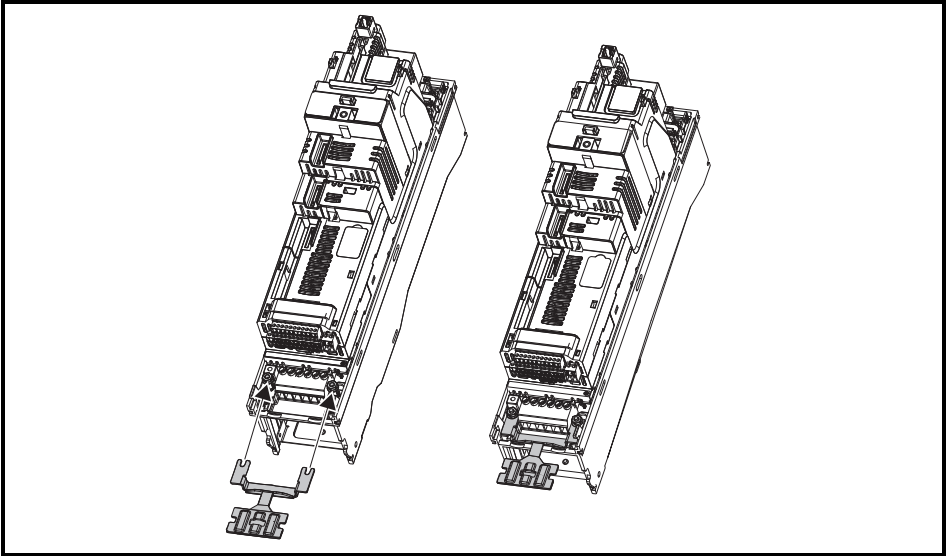
Loosen the ground connection nuts and slide the grounding clamp in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-11   Installation of grounding clamp (size 5)
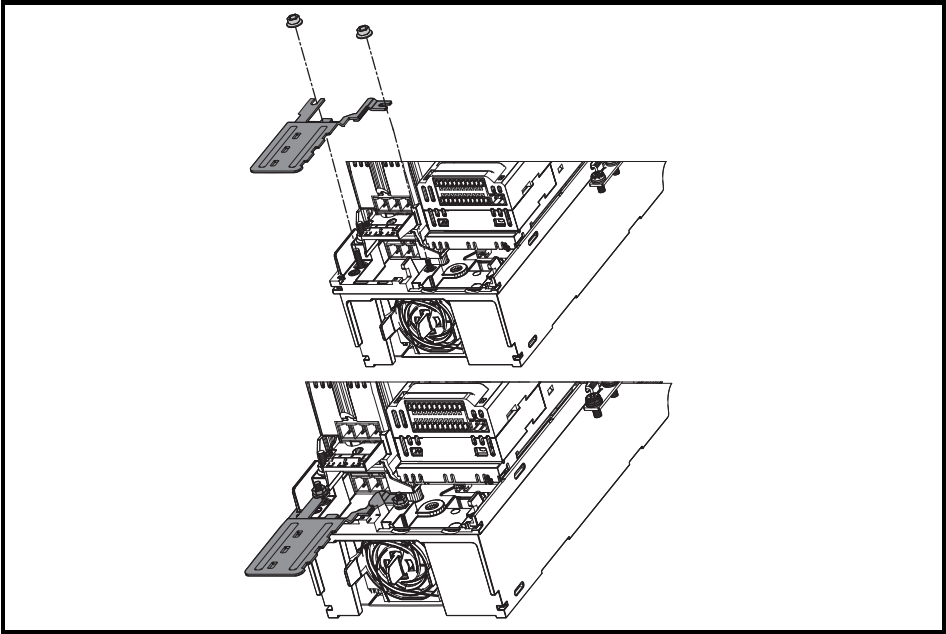
Loosen the ground connection nuts and slide the grounding clamp down onto the pillars in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 4-12   Installation of grounding clamp (size 6)
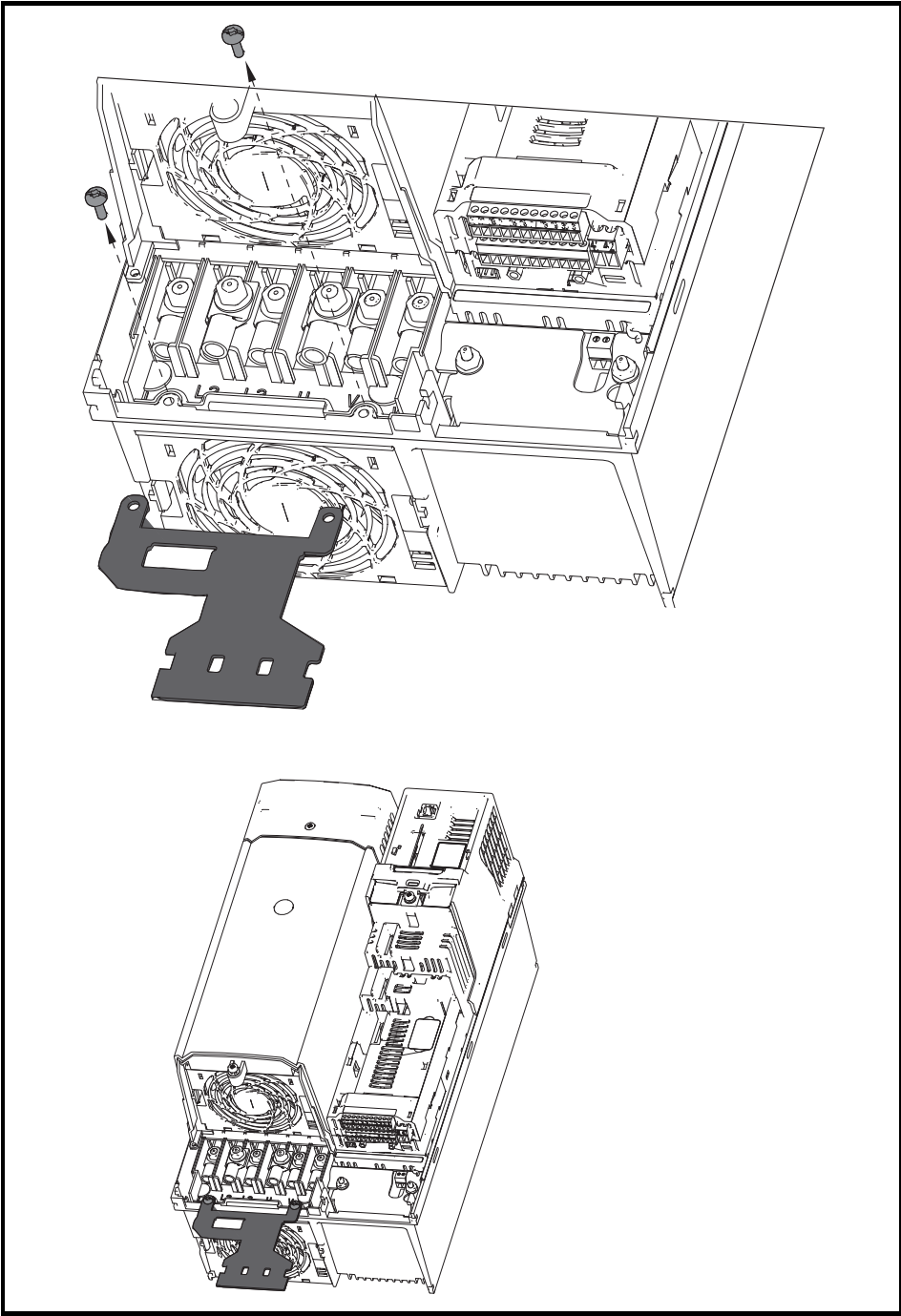
Figure 4-13 Installation of grounding bracket (all sizes -size 3 shown)

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information
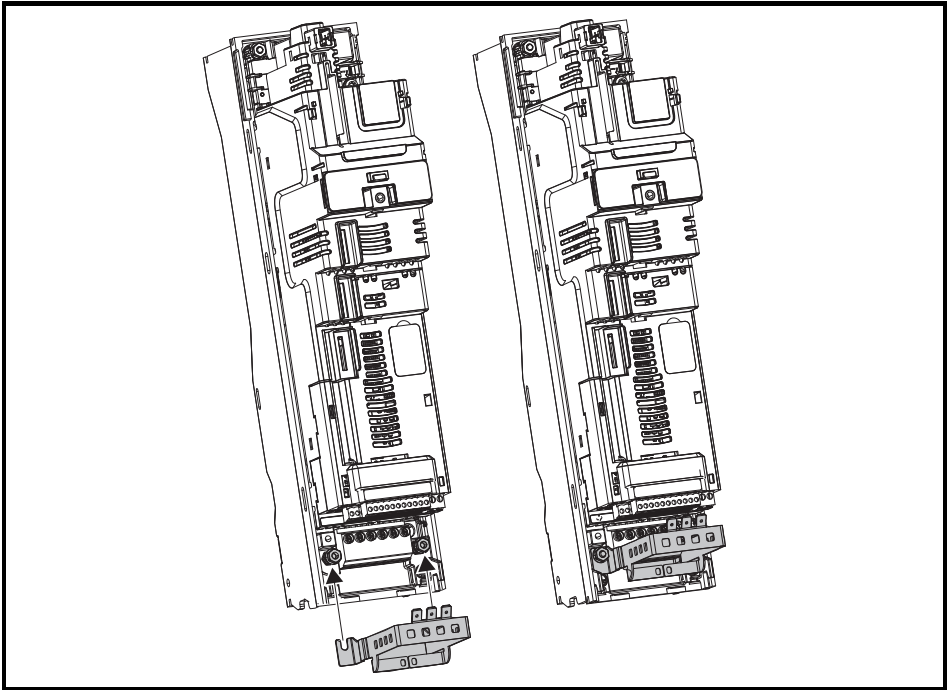
Loosen the ground connection nuts and slide the grounding bracket in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

⚠ WARNING

On size 3 the grounding bracket is secured using the power ground terminal of the drive. Ensure that the supply ground connection is secure after installing / removing the grounding bracket. Failure to do so will result in the drive not being grounded.

A faston tab is located on the grounding bracket for the purpose of connecting the drive 0V to ground should the user require to do so.
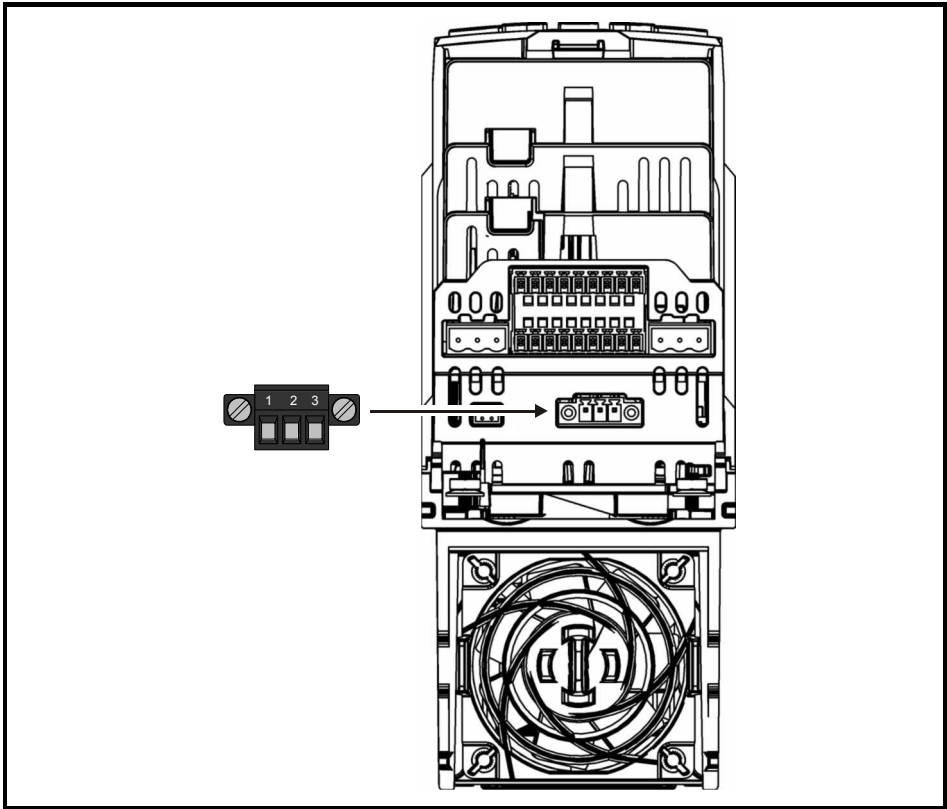
4.6 Control connections
For information on control connections, refer to the back cover of this guide.

4.7   Communications connections

The drive offers a 2 wire EIA-485 serial interface located beneath the control terminals, see Figure 4-14 *Location of the comms connector* below. The drive supports the Modbus RTU, BACnet MSTP and Metasys N2 Open protocols. See Table 4-1 for the connection details.

Figure 4-14   Location of the comms connector

Table 4-1   Serial communication port pin-outs

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

4.7.1   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.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

To gain access to the drive parameters (including connection to HVAC 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 mm^2 (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 4-15   KI-485 Adaptor Installation
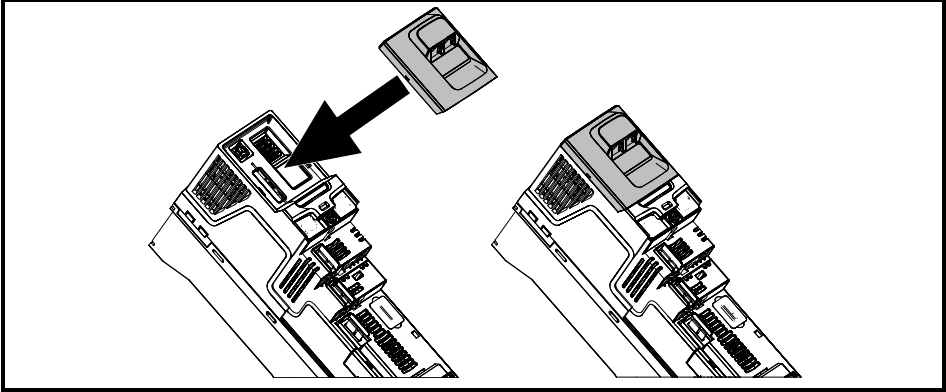
To install, align the KI-485 Adaptor and press gently in the direction shown until it clicks into position. To remove, reverse the installation instructions.

NOTE

The KI-485 Adaptor can be installed / removed while the drive is powered up and running a motor, providing a remote keypad is not connected to a port on the KI-485 Adaptor and operating in keypad mode

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.

4.8 24 Vdc supply

The 24 Vdc supply connected to control terminals 1 & 2 provides the following functions:

- It can be used to supplement the drive's own internal 24 V supply when multiple option modules are being used and the current drawn by these module is greater than the drive can supply.

- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules, application modules, encoders or serial communications to continue to operate.

- It can be used to commission the drive when the line power supply is not available, as the display operates correctly. However, the drive will be in the Under voltage trip state unless either line power supply or low voltage DC operation is enabled, therefore diagnostics may not be possible. (Power down save parameters are not saved when using the 24 V back-up power supply input).

- If the DC bus voltage is too low to run the main SMPS in the drive, then the 24 V supply can be used to supply all the low voltage power requirements of the drive. *Low Under Voltage Threshold Select* (06.067) must also be enabled for this to happen.

| NOTE | On size 6 and larger, the power 24 Vdc supply (terminals 51, 52) must be connected to enable the 24 V dc supply to be used as a backup supply, when the line power supply is removed. If the power 24 Vdc supply is not connected none of the above mentioned functions can be used, "Waiting For Power System" will be displayed on the keypad and no drive operations are possible. The location of the power 24 Vdc can be identified from Figure 4-16 *Location of the 24 Vdc power supply connection on size 6* on page 61 |

Table 4-2   24 Vdc Supply connections

Function	Sizes 3-5	Sizes 6-7
Supplement the drive's internal supply	Terminal 1, 2	Terminal 1, 2
Back-up supply for the control circuit	Terminal 1, 2	Terminal 1, 2 51, 52

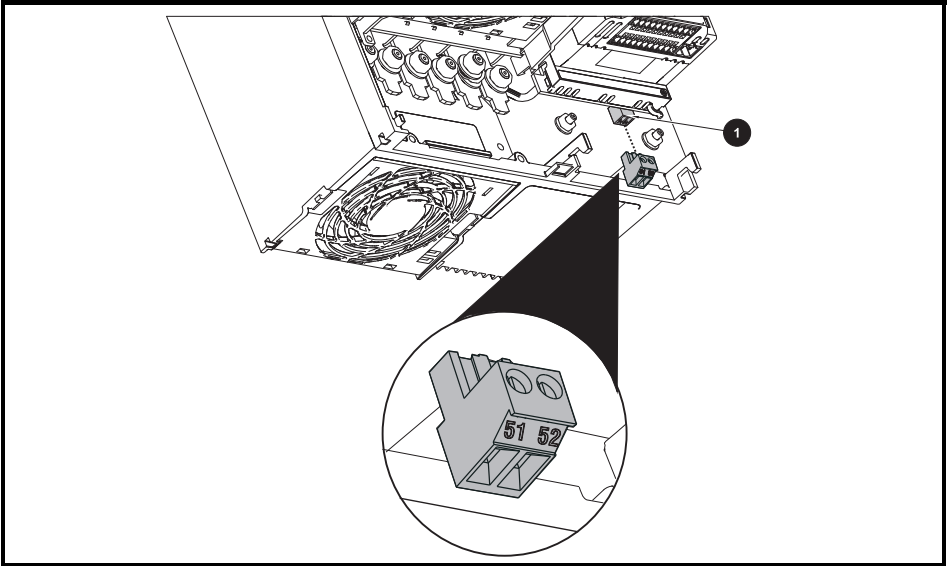The working voltage range of the control 24 V power supply is as follows:

1	0V common
2	+24 Vdc

Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	19.2 V
Maximum continuous operating voltage	28.0 V
Minimum start up voltage	21.6 V
Maximum power supply requirement at 24 V	40 W
Recommended fuse	3 A, 50 Vdc

Minimum and maximum voltage values include ripple and noise. Ripple and noise values must not exceed 5 %.

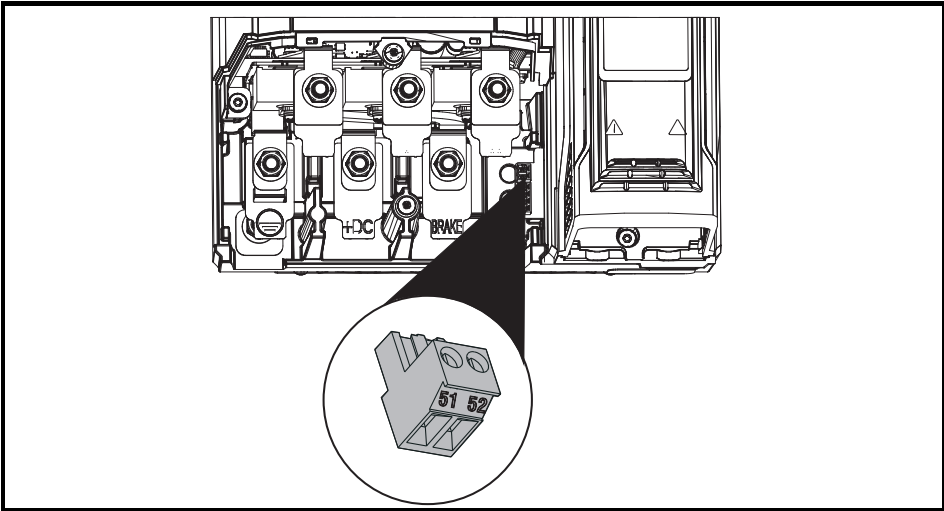The working range of the 24 V power supply is as follows:

51	0V common	
52	+24 Vdc	
Size 6		
Nominal operating voltage		24.0 Vdc
Minimum continuous operating voltage		18.6 Vdc
Maximum continuous operating voltage		28.0 Vdc
Minimum startup voltage		18.4 Vdc
Maximum power supply requirement		40 W
Recommended fuse		4 A @ 50 Vdc
Size 7 to 11		
Nominal operating voltage		24.0 Vdc
Minimum continuous operating voltage		19.2 Vdc
Maximum continuous operating voltage		30 Vdc (IEC), 26 Vdc (UL)
Minimum startup voltage		21.6 Vdc
Maximum power supply requirement		60 W
Recommended fuse		4 A @ 50 Vdc

**Figure 4-16   Location of the 24 Vdc power supply connection on size 6**

1.   24 Vdc power supply connection

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 4-17   Location of the 24 Vdc power supply connection on size 7

Figure 4-18   Location of the 24 Vdc power supply connection on size 8 to 11
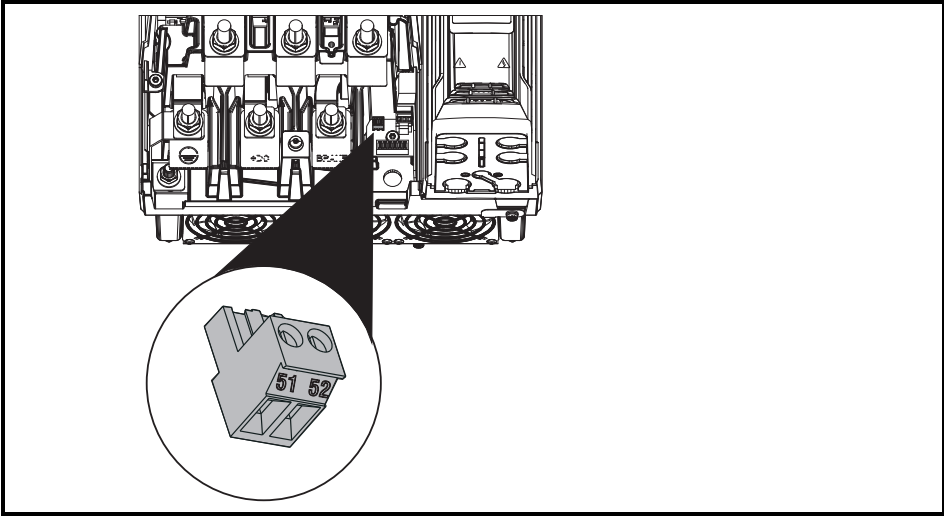
5 Getting started

This chapter introduces the user interfaces, menu structure and security level of the drive.
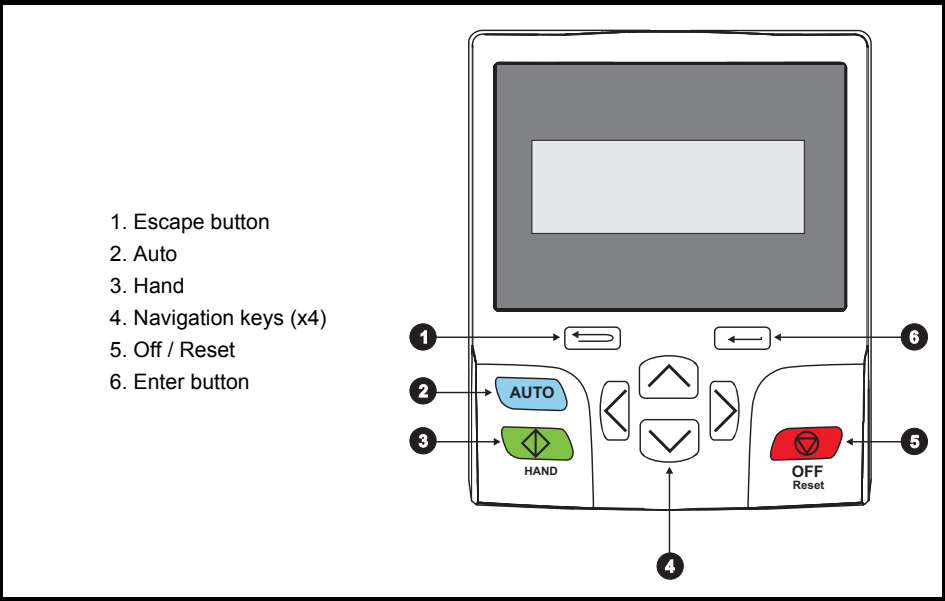
5.1 Understanding the display

The KI-HOA keypad RTC can only be mounted on the drive. The HOA keypad RTC can be mounted on the drive or remotely mounted.

5.1.1 Keypad details

The display of both keypads consists of two rows of text. The upper row shows the drive status or the menu and parameter number currently being viewed. The lower row of the display line shows the parameter value or the specific trip type. The last two characters on the first row may display special indications. If more than one of these indications is active then the indications are prioritized as shown in Table 5-1

When the drive is powered up the lower row will show the power up parameter defined by *Parameter Displayed At Power-up* (11.022). Refer to the *Drive User Guide* for further information.

Figure 5-1   KI-HOA Keypad RTC / HOA Keypad RTC

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

| NOTE | The red Off/ Reset ⬡ button is also used to reset the drive.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Table 5-1   Active action icon

| Active action icon	Description	Row (1=top)	Priority in row
	Accessing non-volatile media card	1	1
	Alarm active	1	2
	Keypad real-time clock battery low (Refer to section 10.11.1 *Real time clock battery replacement* on page 158)	1	3
or	Drive security active and locked or unlocked	1	4
	User program running	3	1
	Keypad reference active	4	1

5.2   Keypad operation

5.2.1   Control buttons

The keypad consists of:

- Navigation Keys - Used to navigate the parameter structure and change parameter values.
- Enter / Mode button - Used to toggle between parameter edit and view mode.
- Escape / Exit button - Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the exit button pressed the parameter value will be restored to the value it had on entry to edit mode.
- Three control buttons - used to select Hand / Off / Auto modes (see *Drive User Guide*).

Figure 5-2   Display modes
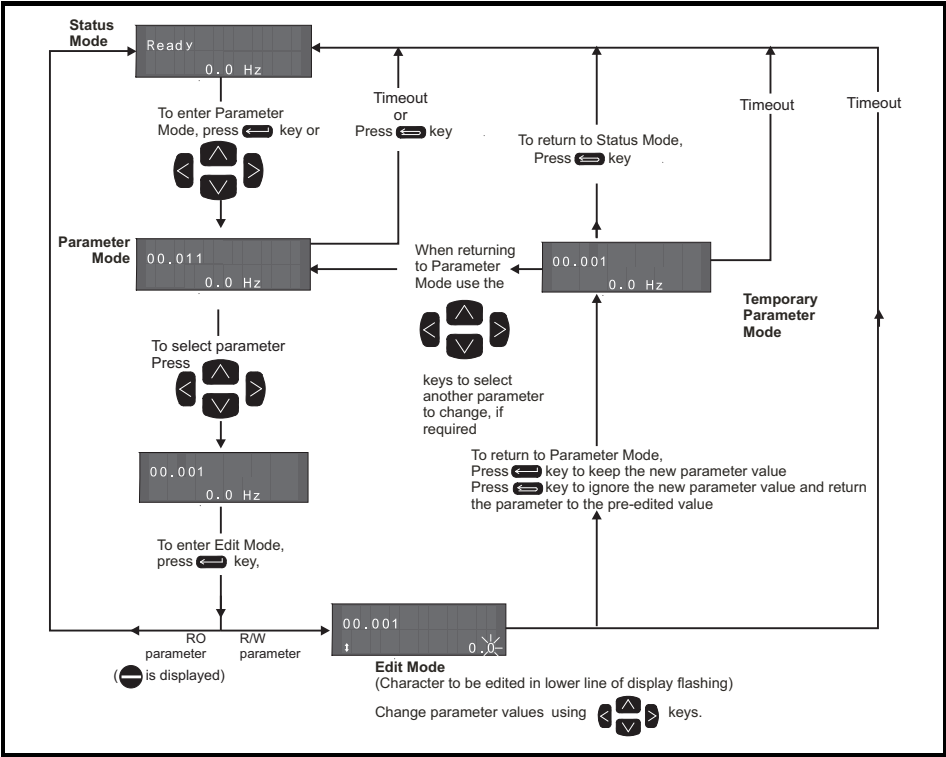
NOTE

The navigation keys can only be used to move between menus if Pr **00.031** has been set to show 'All Menus'.

5.2.2   Quick access mode

The quick access mode allows direct access to any parameter without scrolling through menus and parameters.

To enter the quick access mode, press and hold the ⬅ Enter button on the keypad while in 'parameter mode'.

Figure 5-3   Quick access mode

HVAC Drive H300 Installation and Commissioning Guide
Issue Number: 5

65
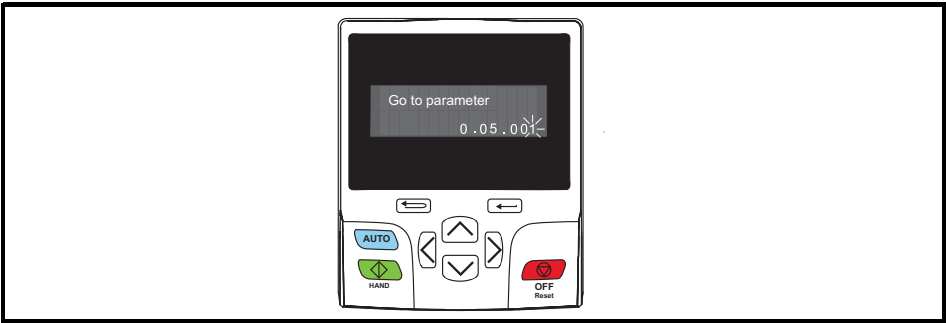
5.2.3   Keypad shortcuts

In 'parameter mode':

• If the ⟨∧⟩ up and down ⟨∨⟩ keypad buttons are pressed together, then the keypad display will jump to the start of the parameter menu being viewed, i.e. Pr **05.005** being viewed, when the above buttons pressed together will jump to Pr **05.000**.

• If the ⟨<⟩ left and right ⟨>⟩ keypad buttons are pressed together, then the keypad display will jump to the last viewed parameter in Menu 0.

In 'parameter edit mode':
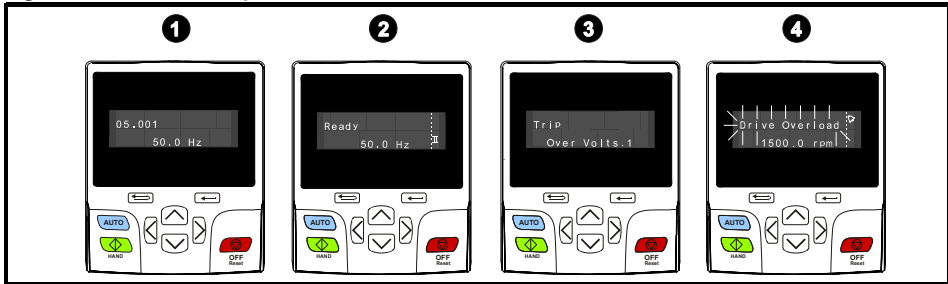
• If the ⟨∧⟩ up and down ⟨∨⟩ keypad buttons are pressed together, then the parameter value of the parameter being edited will be set to 0.

• If the ⟨<⟩ left and right ⟨>⟩ keypad buttons are pressed together, the least significant digit (furthest right) will be selected on the keypad display for editing.

Figure 5-4   Mode examples

1. **Parameter view mode: Read write or Read only**
2. **Status mode: Drive OK status**
If the drive is ok and the parameters are not being edited or viewed, the upper row of the display will show one of the following:

• 'Inhibit', 'Ready' or 'Run'.

3. **Status mode: Trip status**
When the drive is in trip condition, the upper row of the display will indicate that the drive has tripped and the lower row of the display will show the trip code. For further information regarding trip codes. refer to the *Drive User Guide*.

4. **Status mode: Alarm status**
During an 'alarm' condition the upper row of the display flashes between the drive status (Inhibit, Ready or Run, depending on what is displayed) and the alarm.

⚠ **WARNING**   Do not change parameter values without careful consideration; incorrect values may cause damage or a safety hazard.

NOTE   When changing the values of parameters, make a note of the new values in case they need to be entered again.

NOTE   For new parameter values to apply after the AC supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *Saving parameters* on page 69.
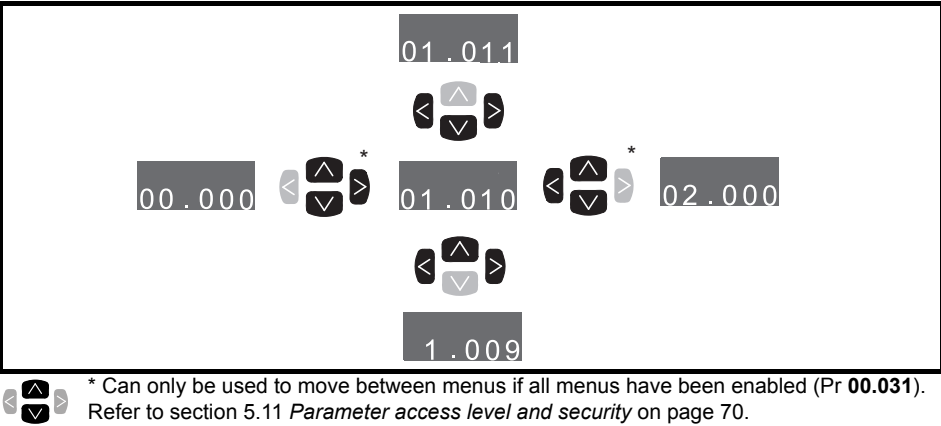
5.3 Menu 0

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. Appropriate parameters are copied from the advanced menus into menu 0 and thus exist in both locations. For further information, refer to Chapter 6 *Basic parameters (Menu 0)* on page 74.

5.4 Menu structure

The drive parameter structure consists of menus and parameters. The drive initially powers up so that only Menu 0 can be viewed. The up and down arrow buttons are used to navigate between parameters and once Pr **00.031** has been set to 'All Menus' the left and right buttons are used to navigate between menus. For further information, refer to section 5.11 *Parameter access level and security* on page 70.

Figure 5-5   Parameter navigation

* Can only be used to move between menus if all menus have been enabled (Pr **00.031**). Refer to section 5.11 *Parameter access level and security* on page 70.

The menus and parameters roll over in both directions.

i.e. if the last parameter is displayed, a further press will cause the display to rollover and show the first parameter.

When changing between menus the drive remembers which parameter was last viewed in a particular menu and thus displays that parameter.

Figure 5-6   Menu structure
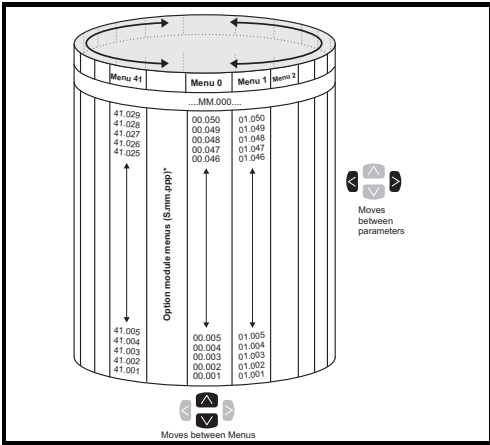
The menus and parameters roll over in both directions. i.e. if the last parameter is displayed, a further press will cause the display to rollover and show the first parameter.

When changing between menus the drive remembers which parameter was last viewed in a particular menu and thus displays that parameter.

* The option module menus (S.mm.ppp) are only displayed if option modules are installed. Where S signifies the option module slot number and the mm.ppp signifies the menu and the parameter number of the option module's internal menus and parameter.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

NV Media Card Operation

Diagnostics and maintenance

UL listing information

5.5 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. Menus 0 to 41 can be viewed on the KI-HOA Keypad RTC or HOA Keypad RTC.

Table 5-2 Advanced menu descriptions

Menu	Description
0	Commonly used basic set-up parameters for quick / easy programming
1	Frequency / speed reference
2	Ramps
3	Speed feedback and speed control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	Analog I/O, Temperature monitoring
8	Digital I/O
9	Programmable logic, motorized pot, binary sum, timers and scope
10	Status and trips
11	Drive set-up and identification, serial communications
12	Threshold detectors and variable selectors
14	User PID controller
15	Option module slot 1 set-up menu
16	Option module slot 2 set-up menu
17	Option module slot 3 set-up menu
18	General option module application menu 1
19	General option module application menu 2
20	General option module application menu 3
22	Menu 0 set-up
23	Not allocated
28	Not allocated
29	Building Automation communications configuration
30	Onboard user programming application menu
Slot 1	Slot 1 option menus*
Slot 2	Slot 2 option menus*
Slot 3	Slot 3 option menus*

* Only displayed when the option modules are installed.

Table 5-3 Key to parameter table coding

Coding	Attribute
RW	Read/Write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'Off' on the display
NC	Not copied: not transferred to or from non-volatile media during copying
PT	Protected: cannot be used as a destination
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save

5.6 Changing the operating mode

Changing the operating mode returns all parameters to their default value, including the motor parameters. *User security status* (00.031) and *User security code* (00.030) are not affected by this procedure).

Procedure

Use the following procedure only if a different operating mode is required:

1. Ensure the drive is not enabled, i.e. terminal 29 is open or Pr **006.015** is OFF (0)
2. Enter either of the following values in Pr **mm.000**, as appropriate:
   1253 (50 Hz AC supply frequency)
   1254 (60 Hz AC supply frequency)
3. Change the setting of Pr **00.030** to L2 to allow access to Pr **11.031**
4. Change the setting of Pr **11.031** as follows:

Pr 11.031 setting		Operating mode
11.031 ↑ Open-loop	1	Open-loop (Induction motor)
11.031 ↕ RFC-A	2	RFC-A (Induction motor without position feedback)
11.031 ↕ RFC-S	3	RFC-S (Permanent magnet motor without position feedback)

The figures in the second column apply when serial communications are used.

5. Either:
- Press the red ⊘ Off/Reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100.

> **NOTE** Entering 1253 or 1254 in Pr **mm.000** will only load defaults if the setting of Pr **11.031** has been changed.

5.7 Saving parameters

When changing a parameter in Menu 0, the new value is saved when pressing the ⬅ Enter button to return to parameter view mode from parameter edit mode.

If parameters have been changed in the advanced menus, then the change will not be saved automatically. A save function must be carried out.

Procedure

1. Select 'Save Parameters'* in Pr **mm.000** (alternatively enter a value of 1000* in Pr **mm.000**)
2. Either:
- Press the red ⊘ Off/Reset button
- Toggle the reset digital input, or
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

* If the drive is in the under voltage state (i.e. when the control terminal 1 & 2 are being supplied from

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

NV Media Card Operation

Diagnostics and maintenance

UL listing information

a low voltage DC supply) a value of 1000 must be entered into Pr **mm.000** to perform a save function.

5.8   Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drives memory. *User security status* (00.031) and *User security code* (00.030) are not affected by this procedure).

Procedure
1. Ensure the drive is not enabled, i.e. terminal 29 is open or Pr **06.015** is OFF (0)
2. Select 'Reset 50 Hz Defs' or 'Reset 60 Hz Defs' in Pr **mm.000**. (alternatively, enter 1233 (50 Hz settings) or 1244 (60 Hz settings) in Pr **mm.000**).
3. Either:

•   Press the red ⬤ Off/Reset button
•   Toggle the reset digital input
•   Carry out a drive reset through serial communications by setting Pr **10.038** to 100

5.9   Displaying parameters with non-default values only

By selecting 'Show non-default' in Pr **mm.000** (Alternatively, enter 12000 in Pr **mm.000**), the only parameters that will be visible to the user will be those containing a non-default value. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **mm.000** and select 'No action' (alternatively enter a value of 0). Please note that this function can be affected by the access level enabled, refer to section 5.11 *Parameter access level and security* on page 70 for further information regarding access level.

5.10   Displaying destination parameters only

By selecting 'Destinations' in Pr **mm.000** (Alternatively enter 12001 in Pr **mm.000**), the only parameters that will be visible to the user will be destination parameters. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **mm.000** and select 'No action' (alternatively enter a value of 0).

Please note that this function can be affected by the access level enabled, refer to section 5.11 *Parameter access level and security* on page 70 for further information regarding access level.

5.11   Parameter access level and security

The parameter access level determines whether the user has access to Menu 0 only or to all the advanced menus (Menus 1 to 41) in addition to Menu 0. The User Security determines whether the access to the user is read only or read write. Both the User Security and Parameter Access Level can operate independently of each other as shown in Table 5-4.

Table 5-4 Parameter access level and security

User security status (11.044)	Access level	User security	Menu 0 status	Advanced menu status
0	Menu 0	Open	RW	Not visible
		Closed	RO	Not visible
1	All Menus	Open	RW	RW
		Closed	RO	RO
2	Read-only Menu 0	Open	RO	Not visible
		Closed	RO	Not visible
3	Read-only	Open	RO	RO
		Closed	RO	RO
4	Status only	Open	Not visible	Not visible
		Closed	Not visible	Not visible
5	No access	Open	Not visible	Not visible
		Closed	Not visible	Not visible

The default settings of the drive are Parameter Access Level Menu 0 and User Security Open i.e. read / write access to Menu 0 with the advanced menus not visible.

5.11.1 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **00.031** or Pr **11.044**. The Security Level can be changed through the keypad even if the User Security Code has been set.

5.11.2 User Security Code

The User Security Code, when set, prevents write access to any of the parameters in any menu.

Setting User Security Code

Enter a value between 1 and 2147483647 in Pr **00.030** and press the ⟵ button; the security code has now been set to this value. In order to activate the security, the Security level must be set to desired level in Pr **00.031**. When the drive is reset, the security code will have been activated and the drive returns to Menu 0 and the 🔒 symbol is displayed in the right hand corner of the keypad display. The value of Pr **00.030** will return to 0 in order to hide the security code.

Unlocking User Security Code

Select a parameter that need to be edited and press the ⟵ button, the upper display will now show 'Security Code'. Use the arrow buttons to set the security code and press the ⟵ button. With the correct security code entered, the display will revert to the parameter selected in edit mode.

If an incorrect security code is entered, the following message 'Incorrect security code' is displayed, then the display will revert to parameter view mode.

Disabling User Security

Unlock the previously set security code as detailed above. Set Pr **00.030** to 0 and press the ⟵ button. The User Security has now been disabled, and will not have to be unlocked each time the drive is powered up to allow read / write access to the parameters.

5.11.3 KI-HOA Keypad RTC set-up menu

To enter the keypad set-up menu press and hold the escape ⟵ button on the keypad from status mode. All the keypad parameters are saved to the keypad non-volatile memory when exiting from the keypad set-up menu. To exit from the keypad set-up menu press the escape ⟵ or ⟨ or ⟩ button. Table 5-5 shows the keypad set-up parameters.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Table 5-5   KI-HOA Keypad RTC set-up parameters

Parameters		Range	Type
Keypad.00	Language*	Classic English (0), English (1), German (2) French (3), Italian (4) Spanish (5), Chinese (6)	RW
Keypad.01	Show Units	Off (0), On (1)	RW
Keypad.02	Backlight Level	0 to 100 %	RW
Keypad.03	Keypad Date	01.01.10 to 31.12.99	RO
Keypad.04	Keypad Time	00:00:00 to 23:59:59	RO
Keypad.05	Show Raw Text Parameter Values	Off (0), On (1)	RW
Keypad.06	Software Version	00.00.00.00 to 99.99.99.99	RO
Keypad.07	Language version	00.00.00.00 to 99.99.99.99	RO
Keypad.08	Font version	0 to 1000	RO
Keypad.09	Show menu names	Off (0), On (1)	RW

NOTE

It is not possible to access the keypad parameters via any communications channel.

* The languages available will depend on the keypad software version.

5.11.4   Display messages
The following tables indicate the various possible mnemonics which can be displayed by the drive and their meaning.

Table 5-6   Status indications

Upper row string	Description	Drive output stage
Inhibit	The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr **06.015** is set to 0. The other conditions that can prevent the drive from enabling are shown as bits in *Enable Conditions* (06.010)	Disabled
Ready	The drive is ready to run. The drive enable is active, but the drive inverter is not active because the final drive run is not active	Disabled
Stop	The drive is stopped / holding zero speed	Enabled
Run	The drive is active and running	Enabled
Scan	The drive is enabled in Regen mode and is trying to synchronize to the supply	Enabled
Supply Loss	Supply loss condition has been detected	Enabled
Deceleration	The motor is being decelerated to zero speed / frequency because the final drive run has been deactivated	Enabled
dc injection	The drive is applying dc injection braking	Enabled
Position	Positioning / position control is active during an orientation stop	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display	Disabled
Active	The Regen unit is enabled and synchronized to the supply	Enabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode	Disabled
Heat	The motor pre-heat function is active	Enabled
Phasing	The drive is performing a 'phasing test on enable'	Enabled

5.11.5 Alarm indications

An alarm is an indication given on the display by alternating the alarm string with the drive status string on the upper row and showing the alarm symbol in the last character in the upper row. Alarms strings are not displayed when a parameter is being edited, but the user will still see the alarm character on the upper row.

Table 5-7 Alarm indications

Alarm string	Description
Motor Overload	*Motor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Ind Overload	Regen inductor overload. *Inductor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Drive Overload	Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.
Limit Switch	Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped.

Table 5-8 Option module and NV media card and other status indications at power-up

First row string	Second row string	Status
Booting	Parameters	Parameters are being loaded
Drive parameters are being loaded from a NV Media Card		
Booting	User Program	User program being loaded
User program is being loaded from a NV Media Card to the drive		
Booting	Option Program	User program being loaded
User program is being loaded from a NV Media Card to the option module in slot X		
Writing To	NV Card	Data being written to NV Media Card
Data is being written to a NV Media Card to ensure that its copy of the drive parameters is correct because the drive is in Auto or Boot mode		
Waiting For	Power System	Waiting for power stage
The drive is waiting for the processor in the power stage to respond after power-up		
Waiting For	Options	Waiting for an option module
The drive is waiting for the options modules to respond after power-up		
Uploading From	Options	Loading parameter database
At power-up it may be necessary to update the parameter database held by the drive because an option module has changed or because an applications module has requested changes to the parameter structure. This may involve data transfer between the drive an option modules. During this period 'Uploading From Options' is displayed		

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

NV Media Card Operation

Diagnostics and maintenance

UL listing information

6 Basic parameters (Menu 0)

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. All the parameters in Menu 0 appear in other menus in the drive (denoted by {…}). Menu 22 can be used to configure the parameters in Menu 0.

Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.001	Motor Rpm	{05.004}	±180000 rpm						RO	Num	ND	NC	PT	FI
	Speed Feedback	{03.002}		VM_SPEED rpm					RO	Num	ND	NC	PT	FI
00.002	Output Frequency	{05.001}	VM_SPEED _FREQ_ REF Hz	±2000.0 Hz					RO	Num	ND	NC	PT	FI
00.003	Current Magnitude	{04.001}	0.000 to VM_DRIVE_CURRENT_ UNIPOLAR A						RO	Bit	ND	NC	PT	FI
00.004	Output Power	(05.003)	VM_POWER kW						RO	Num	ND	NC	PT	FI
00.005	Software Version	{11.029}	00.00.00.00 to 99.99.99.99						RO	Num	ND	NC	PT	
00.010	Minimum Reference Clamp	{01.007}	VM_NEGATIVE_REF_CLAMP1 Hz / rpm			0.0 Hz / rpm			RW	Num				US
00.011	Maximum Reference Clamp	{01.006}	VM_POSITIVE_REF_CLAMP1 Hz / rpm			50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz	50 Hz default: 1500.0 rpm 60 Hz default: 1800.0 rpm	3000.0 rpm	RW	Num				US
00.012	Acceleration Rate 1	{02.011}	0.0 to VM_ACCEL _RATE s to Pr **01.006**	0.000 to VM_ACCEL_RATE s to Pr **01.006**		20.0 s to Pr **01.006**	20.000 s to Pr **01.006**		RW	Num				US
00.013	Deceleration Rate 1	{02.021}	0.0 to VM_ACCEL _RATE s to Pr **01.006**	0.000 to VM_ACCEL_RATE s from Pr **01.006**		20.0 s from Pr **01.006**	20.000 s from Pr **01.006**		RW	Num				US
00.014	Open-loop Control Mode	{05.014}	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Current 1P (6)			Ur I (4)			RW	Txt				US
	Speed Controller Proportional Gain Kp1	{03.010}		0.0000 to 200.0000 s/rad			0.0300 s/rad		RW	Num				US
00.015	Dynamic V to F Select	{05.013}	Off (0) or On (1)			On (1)			RW	Bit				US
	Speed Controller Integral Feedback Gain Ki 1	{03.011}		0.00 to 655.35 s^2/rad			0.10 s^2/rad		RW	Num				US

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor
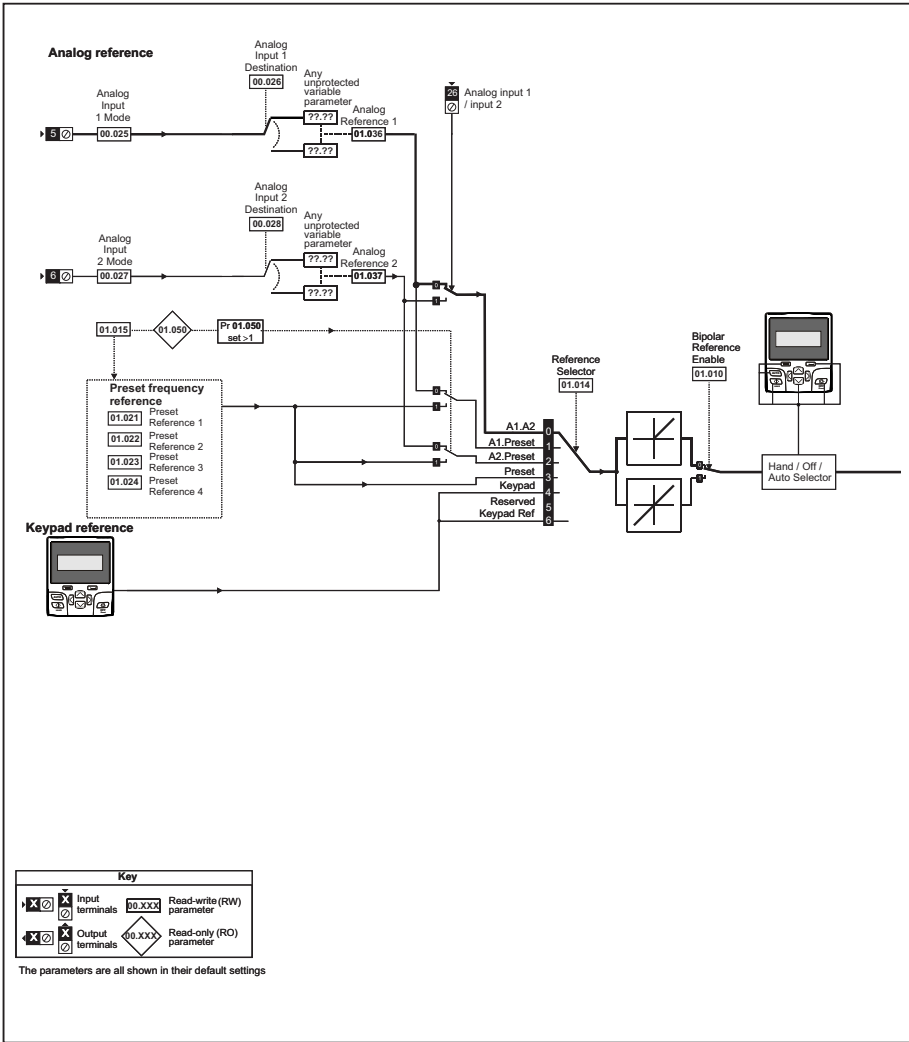
Optimization

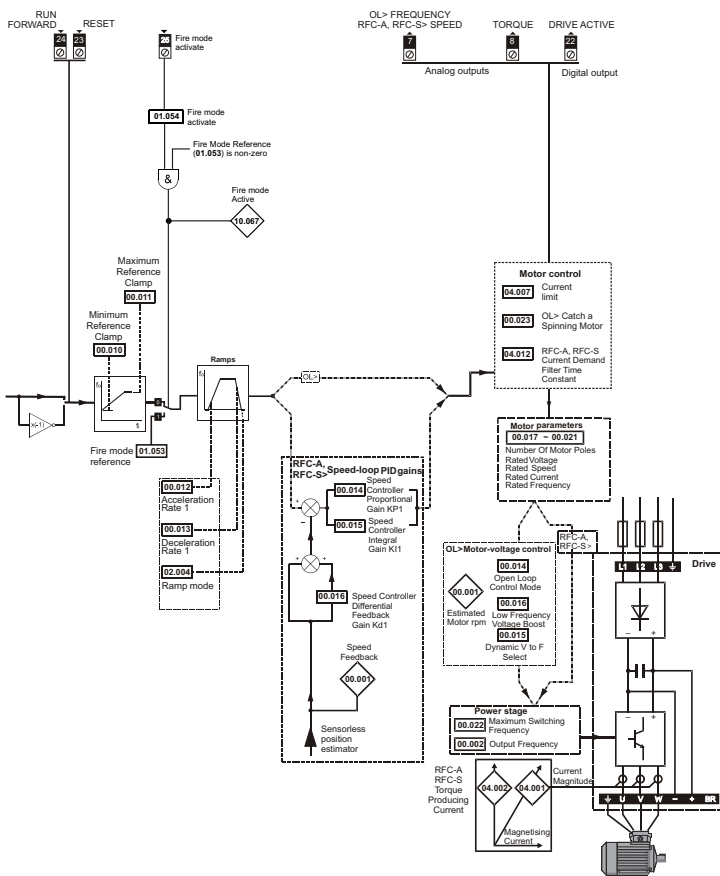NV Media Card Operation

Diagnostics and maintenance

UL listing information

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.016	Low Frequency Voltage Boost {05.015}	0.0 to 25.0 %			1.0 %			RW	Num				US
	Speed Controller Differential Feedback Gain Kd1 {03.012}		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
00.017	Number Of Motor Poles {05.011}	Automatic (0) to 480 Poles (240)			Automatic (0)		8 Poles (4)	RW	Num				US
00.018	Rated Voltage {05.009}	0 to VM_AC_VOLTAGE_SET V			200V drive: 230V 50Hz default 400V drive: 400V 60Hz default 400V drive: 460V 575V drive: 575V			RW	Num			RA	US
00.019	Rated Speed {05.008}	0 to 33000 rpm	0.00 to 33000.00 rpm		50 Hz default - 1500 rpm 60 Hz default- 1800 rpm	50 Hz default - 1450.00 rpm 60 Hz default- 1750.00 rpm	3000. 00 rpm	RW	Num				US
00.020	Rated Current {05.007}	0.000 to VM_RATED_CURRENT A			Maximum rated current (Pr 11.060) A			RW	Num			RA	US
00.021	Rated Frequency {05.006}	0.0 to 550.0 Hz			50Hz default: 50.0 60Hz default: 60.0			RW	Num				US
	Volts per 1000 rpm {05.033}			0 to 10000 V / 1000 rpm			98 V / 1000 rpm	RW	Num				US
00.022	Maximum Switching Frequency {05.018}	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)			3 kHz (1)			RW	Txt			RA	US
00.023	Catch A Spinning Motor {06.009}	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)			Disable (0)			RW	Txt				US
00.024	Auto-tune {05.012}	0 to 2	0 to 2	0, 1, 2, 6	0			RW	Num		NC		
00.025	Analog Input 1 Mode {07.007}	4-20 mA Low (-4), 20-4 mA Low (-3), 4-20 mA Hold (-2), 20-4 mA Hold (-1), 0-20 mA (0), 20-0 mA (1),4-20 mA Trip (2), 20-4 mA Trip (3), 4-20 mA (4), 20-4 mA (5), Volt (6), Therm Short Cct (7), Thermistor (8), Therm No Trip (9)			4-20 mA (4)			RW	Txt				US
00.026	Analog Input 1 Destination {07.010}	0.000 to 59.999			01.036			RW	Num	DE		PT	US
00.027	Analog Input 2 Mode {07.011}	4-20 mA Low (-4), 20-4 mA Low (-3), 4-20 mA Hold (-2), 20-4 mA Hold (-1), 0-20 mA (0), 20-0 mA (1), 4-20 mA Trip (2), 20-4 mA Trip (3), 4-29 mA (4), 20-4 mA (5), Volt (6), Therm Short Cct (7), Thermistor (8), Therm No Trip (9)			Volt (6)			RW	Txt				US
00.028	Analog Input 2 Destination {07.014}	00.000 to 59.999			01.037			RW	Num	DE		PT	US

Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.029	Analog Input 2 Thermistor Type	{07.058}	DIN44082 (0), KTY84 (1), PT100 (2), PT1000 (3), PT2000 (4), NI1000 (5)			DIN44082 (0)			RW	Txt				US
00.030	User Security Code	{11.030}	0 to 2147483647			0			RW	Num	ND	NC	PT	US
00.031	User Security Status	{11.044}	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)			Menu 0 (0)			RW	Txt	ND		PT	
00.032	NV Media Card Data Previously Loaded	{11.036}	0 to 999			0			RO	Num		NC	PT	
00.033	Parameter Cloning	{11.042}	None (0), Read (1), Program (2), Auto (3), Boot (4)			None (0)			RW	Txt		NC		US
00.034	Date	{06.016}	00-00-00 to 31-12-99						RW	Date	ND	NC	PT	
00.035	Time	{06.017}	00:00:00 to 23:59:59						RW	Time	ND	NC	PT	
00.036	Day Of Week	{06.018}	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)						RO	Txt	ND	NC	PT	
00.037	Date/Time Selector	{06.019}	Set (0), Powered (1), Running (2), Acc Powered (3), Local Keypad (4), Remote Keypad (5), Slot 1 (6), Slot 2 (7), Slot 3 (8), Slot 4 (9)			Local Keypad (4)			RW	Txt				US
00.038	Date Format	{06.020}	Std (0) or US (1)			US (1)			RW	Txt				US
00.040	RFC Low Speed Mode	{05.064}			Injection (0), Non-salient (1), Current (2), Current No Test (3)			Non-salient (1)	RW	Txt				US
00.041	Low Speed Sensorless Mode Current	{05.071}			0.0 to 1000.0 %			20.0 %	RW	Num		RA		US
00.042	No-load Lq	{05.072}			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
00.043	Iq Test Current for Inductance Measurement	{05.075}			0 to 200 %			100 %	RW	Num				US
00.044	Phase Offset At Iq Test Current	{05.077}			±90.0 °			0.0 °	RW	Num		RA		US
00.045	Lq At The Defined Iq Test Current	{05.078}			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
00.046	Id Test Current for Inductance Measurement	{05.082}			-100 to 0 %			-50 %	RW	Num				US
00.047	Lq At The Defined Id Test Current	{05.084}			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
00.048	Number Of Auto-reset Attempts	{10.034}	None (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), Infinite (6)			5 (5)			RW	Txt				US
00.049	Auto-reset Delay	{10.035}	0.0 to 600.0 s			5.0 s			RW	Num				US

Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.050	Trip 0	{10.020}	0 to 255						RO	Txt	ND	NC	PT	PS
00.051	Trip 1	{10.021}	0 to 255						RO	Txt	ND	NC	PT	PS
00.052	Trip 2	{10.022}	0 to 255						RO	Txt	ND	NC	PT	PS
00.053	Trip 3	{10.023}	0 to 255						RO	Txt	ND	NC	PT	PS
00.054	Trip 4	{10.024}	0 to 255						RO	Txt	ND	NC	PT	PS
00.055	Trip 5	{10.025}	0 to 255						RO	Txt	ND	NC	PT	PS
00.056	Trip 6	{10.026}	0 to 255						RO	Txt	ND	NC	PT	PS
00.057	Trip 7	{10.027}	0 to 255						RO	Txt	ND	NC	PT	PS
00.058	Trip 8	{10.028}	0 to 255						RO	Txt	ND	NC	PT	PS
00.059	Trip 9	{10.029}	0 to 255						RO	Txt	ND	NC	PT	PS
00.060	Trip 0 Date	{10.041}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.061	Trip 0 Time	{10.042}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.062	Trip 1 Date	{10.043}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.063	Trip 1 Time	{10.044}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.064	Trip 2 Date	{10.045}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.065	Trip 2 Time	{10.046}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.066	Trip 3 Date	{10.047}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.067	Trip 3 Time	{10.048}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.068	Trip 4 Date	{10.049}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.069	Trip 4 Time	{10.050}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.070	Trip 5 Date	{10.051}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.071	Trip 5 Time	{10.052}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.072	Trip 6 Date	{10.053}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.073	Trip 6 Time	{10.054}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.074	Trip 7 Date	{10.055}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.075	Trip 7 Time	{10.056}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.076	Trip 8 Date	{10.057}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.077	Trip 8 Time	{10.058}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.078	Trip 9 Date	{10.059}	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.079	Trip 9 Time	{10.060}	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 6-1 Menu 0 logic diagram

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

6.1 Parameter descriptions

6.1.1 Pr mm.000

Pr **mm.000** is available in all menus, commonly used functions are provided as text strings in Pr **mm.000** shown in Table 6-1. The functions in Table 6-1 can also be selected by entering the appropriate numeric values (as shown in Table 6-2) in Pr **mm.000**. For example, enter 7001 in Pr **mm.000** to erase the file in NV media card location 001.

Table 6-1 Commonly used functions in Pr mm.000

String	Action
Save parameters	Save parameters when under voltage is not active and low voltage threshold is not active
Load file 1	Load the drive parameters or user program file from NV media card file 001
Save to file 1	Transfer the drive parameters to parameter file 001
Load file 2	Load the drive parameters or user program file from NV media card file 002
Save to file 2	Transfer the drive parameters to parameter file 002
Load file 3	Load the drive parameters or user program file from NV media card file 003
Save to file 3	Transfer the drive parameters to parameter file 003
Show non-default	Displays parameters that are different from defaults
Destinations	Displays parameters that are set
Reset 50Hz Defs	Load parameters with standard (50 Hz) defaults
Reset 60Hz Defs	Load parameters with US (60 Hz) defaults
Reset modules	Reset all option modules
Read Enc.NP P1	No function on H300
Read Enc.NP P2	No function on H300

Table 6-2 Functions in Pr mm.000

Value	Action
1000	Save parameters when *Under Voltage Active* (Pr **10.016**) is not active and *Low Under Voltage Threshold Select* mode (Pr **06.067** = Off) is not active.
1001	Save parameter under all conditions
1070	Reset all option modules
1233	Load standard (50 Hz) defaults
1234	Load standard (50 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1244	Load US (60 Hz) defaults
1245	Load US (60 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1253	Change drive mode and load standard (50 Hz) defaults
1254	Change drive mode and load US (60 Hz) defaults
1255	Change drive mode and load standard (50 Hz) defaults except for menus 15 to 20 and 24 to 28
1256	Change drive mode and load US (60 Hz) defaults except for menus 15 to 20 and 24 to 28
1299	Reset {Stored HF} trip.
2001*	Create a boot file on a non-volatile media card based on the present drive parameters including all Menu 20 parameters
4yyy*	NV media card: Transfer the drive parameters to parameter file xxx
5yyy*	NV media card: Transfer the onboard user program to onboard user program file xxx
6yyy*	NV media card: Load the drive parameters from parameter file xxx or the onboard user program from onboard user program file xxx
7yyy*	NV media card: Erase file xxx
8yyy*	NV Media card: Compare the data in the drive with file xxx
9555*	NV media card: Clear the warning suppression flag
9666*	NV media card: Set the warning suppression flag
9777*	NV media card: Clear the read-only flag
9888*	NV media card: Set the read-only flag
9999*	NV media card: Erase and format the NV media card
59999	Delete onboard user program
12000**	Only display parameters that are different from their default value. This action does not require a drive reset.
12001**	Only display parameters that are used to set-up destinations (i.e. DE format bit is 1). This action does not require a drive reset.

* See Chapter 9 *NV Media Card Operation* on page 113 for more information on these functions.

** These functions do not require a drive reset to become active. All other functions require a drive reset to initiate the function.
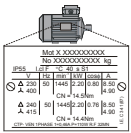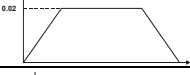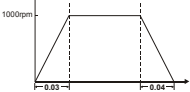
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

7 Running the motor

This chapter takes the new user through all the essential steps to running a motor for the first time, in each of the possible operating modes.

⚠ **WARNING**	Ensure that no damage or safety hazard could arise from the motor starting unexpectedly.

⚠ **CAUTION**	The values of the motor parameters affect the protection of the motor. The default values in the drive should not be relied upon. It is essential that the correct value is entered in Pr **00.020** *Rated Current*. This affects the thermal protection of the motor.

⚠ **CAUTION**	If the drive is started using the keypad it will run to the speed defined by the keypad reference (Pr **01.017**). This may not be acceptable depending on the application. The user must check in Pr **01.017** and ensure that the keypad reference has been set to 0.

⚠ **WARNING**	If the intended maximum speed affects the safety of the machinery, additional independent over-speed protection must be used.

7.1 Quick start connections

7.1.1 Basic requirements

This section shows the basic connections which must be made for the drive to run in the required mode. For minimal parameter settings to run in each mode please see the relevant part of section 7.2 *Quick Start commissioning / start-up* on page 87.

Table 7-1 Minimum control connection requirements for each control mode

Drive control method	Requirements
Terminal mode	Drive enable Speed / Torque reference Run forward / Run reverse
Hand mode	Drive enable
Serial communications	Drive enable Serial communications link

Table 7-2 Minimum control connection requirements for each mode of operation

Operating mode	Requirements
Open loop mode	Induction motor
RFC - A sensorless (without feedback position)	Induction motor with speed feedback
RFC - S sensorless (without position feedback)	Permanent magnet motor with speed and position feedback

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 7-1   Minimum connections to get the motor running in any operating mode (size 3 and 4)
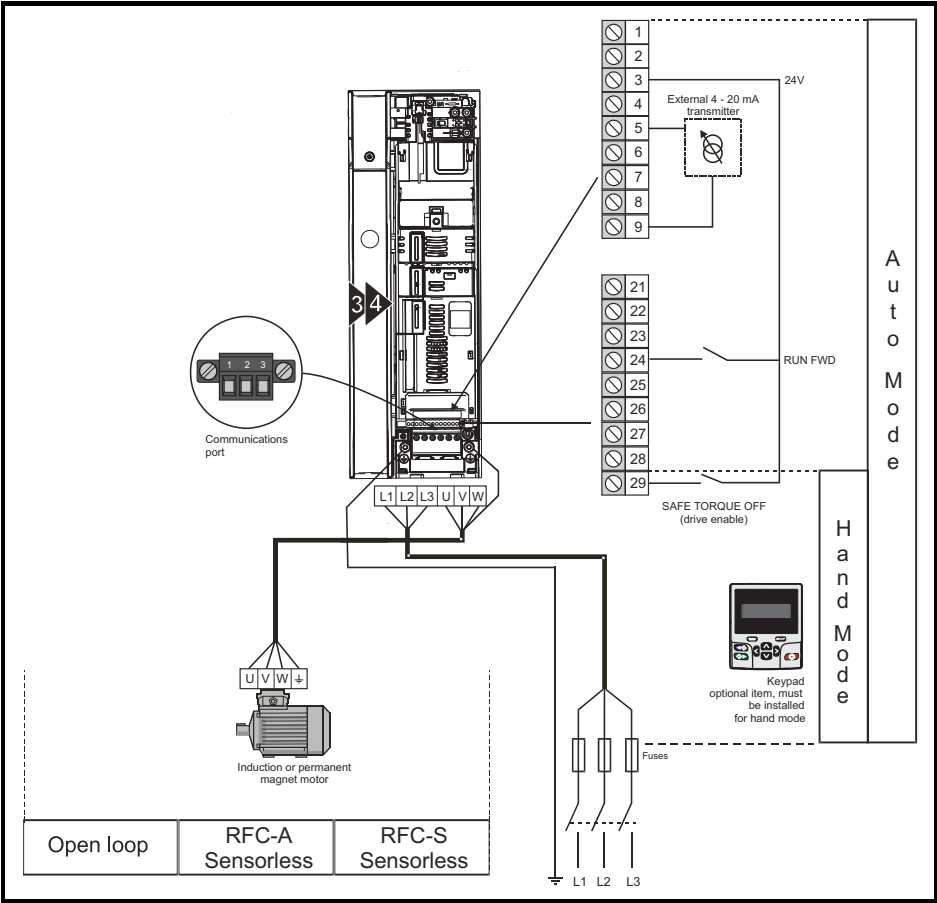
Figure 7-2   Minimum connections to get the motor running in any operating mode (size 5)
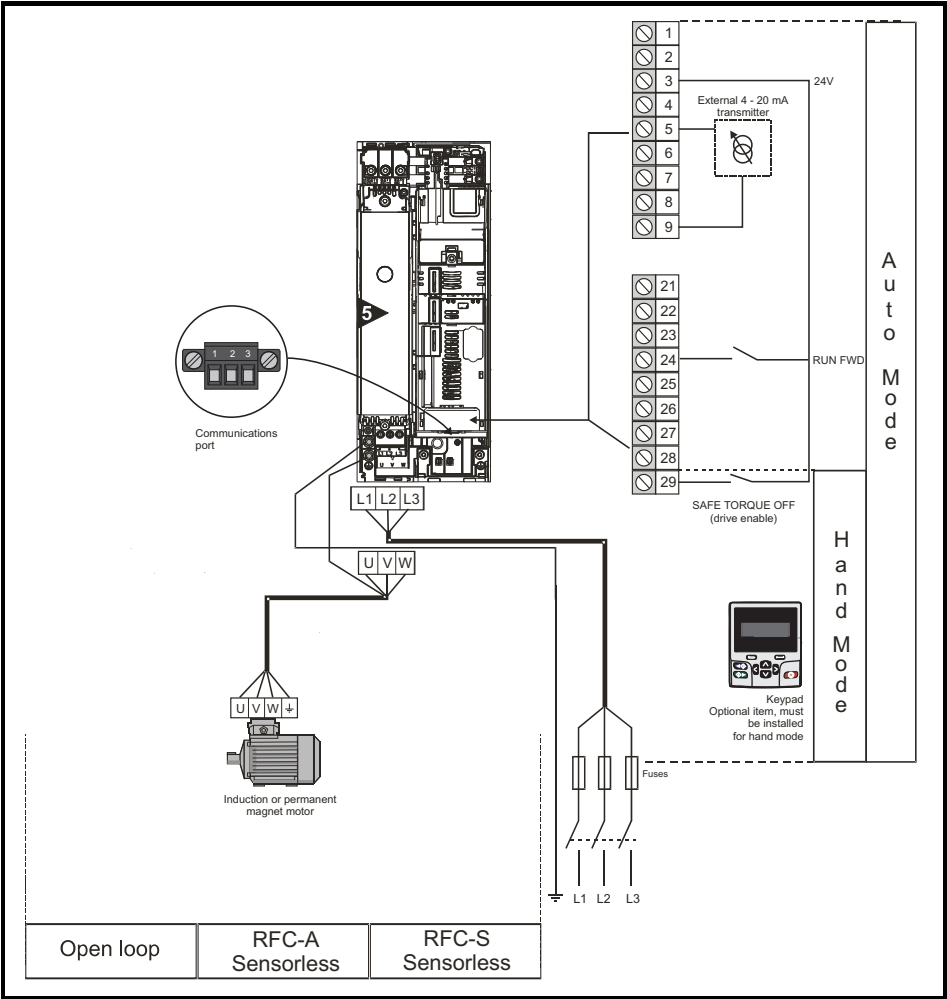
Figure 7-3   Minimum connections to get the motor running in any operating mode (size 6)
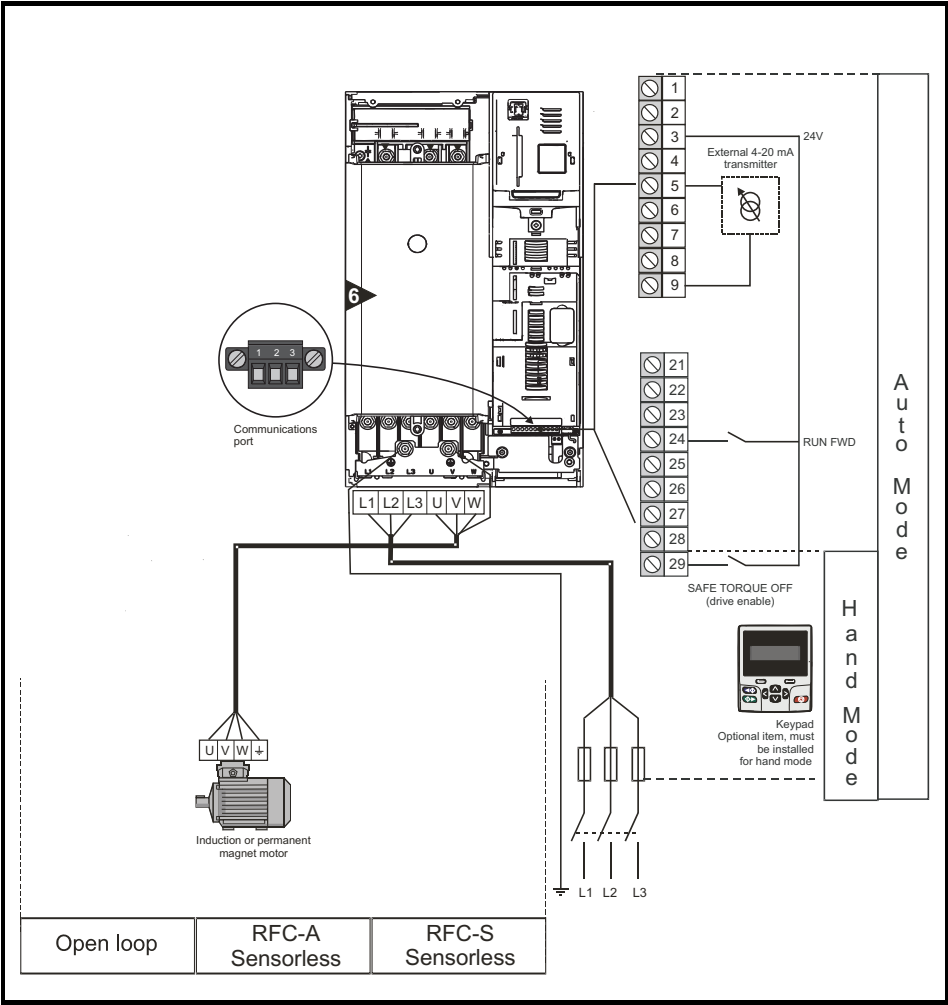
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Figure 7-4   Minimum connections to get the motor running in any operating mode (size 7 onwards)

*Required for size 9E, 10E and 11E.
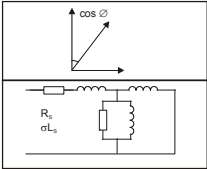
7.2 Quick Start commissioning / start-up

7.2.1 Open loop

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 29) • Run signal is not given • Motor is connected	
Power-up the drive	Verify that Open Loop mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 69. Ensure that the drive displays 'Inhibit' If the drive trips, see Chapter 10 *Diagnostics and maintenance* on page 116	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.021** (Hz) • Motor rated current in Pr **00.020** (A) • Motor rated speed in Pr **00.019** (rpm) • Motor rated voltage in Pr **00.018** (V) - check if $\curlywedge$ or $\triangle$ connection	
Set maximum frequency	Enter: • Maximum frequency in Pr **00.011** (Hz)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.012** (s to Pr **01.006**) • Deceleration rate in Pr **00.013** (s from Pr **01.006**)	
Motor thermistor set-up	The motor thermistor can be selected in Pr **00.029**.	

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Action	Detail	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive. **⚠ WARNING** — A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. A stationary autotune measures stator resistance and transient inductance of the motor and values relating to deadtime compensation from the drive. These are required for good performance in vector control modes. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **05.010**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^2/_3$ base speed in the direction selected. The rotating autotune measures the power factor of the motor. To perform an autotune: • Set Pr **00.024** = 1 for a stationary autotune or set Pr **00.024** = 2 for a rotating autotune • Close the Drive Enable signal (terminal 29). The drive will display 'Ready'. • Close the run signal (terminal 24). The upper row of the display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Inhibit' and for the motor to come to a standstill. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press the red 🔴 reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.2.2 RFC-A Sensorless

Induction motor without position feedback

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 29) • Run signal is not given • Motor is connected	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 69, otherwise restore parameter defaults (see section 5.8 *Restoring parameter defaults* on page 70. Ensure that the drive displays 'Inhibit'	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.021** (Hz) • Motor rated current in Pr **00.020** (A) • Motor rated speed in Pr **00.019** (rpm) • Motor rated voltage in Pr **00.018** (V) - check if 人 or △ connection	
Set maximum speed	Enter: • Maximum speed in Pr **00.011** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.012** (s to Pr **01.006**) • Deceleration rate in Pr **00.013** (s from Pr **01.006**)	

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Action	Detail	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. **NOTE** It is highly recommended that a rotating autotune is performed (Pr **00.024** set to 2). ⚠ **WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference.The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. The stationary autotune measures the stator resistance and transient inductance of the motor and values relating to deadtime compensation from the drive. Measured values are used to calculate the current loop gains, and at the end of the test the values in Pr **04.013** and Pr **04.014** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **05.010**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at 2/3 base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor. To perform an autotune: • Set Pr **00.024** = 1 for a stationary autotune or set Pr **00.024** = 2 for a rotating autotune • Close the drive enable signal (terminal 29). The drive will display 'Ready' or 'Inhibit'. • Close the run signal (terminal 24). The lower displaywill flash 'Autotune' while the drive is performing the autotune. • Wait for the drive to display 'Inhibit' and for the motor to come to a standstill. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press red ⊘ reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.2.3 RFC-S Sensorless (permanent magnet motor without position feedback)

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 29). • Run signal is not given • Motor is connected	
Power-up the drive	Verify that RFC-S mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 69, otherwise restore parameter defaults (see section 5.8 *Restoring parameter defaults* on page 70). Ensure that the drive displays 'inhibit'	
Enter motor nameplate details	Enter: • Motor rated current in Pr **00.020** (A) • Number of poles in Pr **00.017** • Motor rated voltage in Pr **00.018** (V)	
Set maximum speed	Enter: • Maximum speed in Pr **00.011** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.012** (s to Pr **01.006**) • Deceleration rate in Pr **00.013** (s from Pr **01.006**)	
Autotune	The drive is able to perform a stationary autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance. • A stationary autotune is performed to locate the flux axis of the motor. The stationary autotune measures the stator resistance, inductance in flux axis, inductance in torque axis with no load on the motor and values relating to deadtime compensation from the drive. Measured values are used to calculate the current loop gains, and at the end of the test the values in Pr **04.013** and Pr **04.014** are updated. To perform an autotune: • Set Pr **00.024** = 1 or 2 for a stationary autotune. (Both perform the same tests). • Close the drive enable signal (terminal 29). • Close the run signal (terminal 24) • The upper row of the display will flash 'Auto Tune' during the test. • Wait for the drive to display 'Inhibit'. If the drive trips it cannot be reset until the drive enable signal (terminal 29) has been removed. See Chapter 10 *Diagnostics and maintenance* on page 116. • Remove the drive enable and run signal from the drive.	R_s L_d No-load L_q Ef
Check Saliency	In sensorless mode, when the motor speed is below Pr **00.019** / 10, a special low speed algorithm must be used to control the motor. The ratio No-load Lq (Pr **00.042**) / Ld (Pr **05.024**) provides a measure of the saliency. If this value is > 1.1, then Injection (0) mode may be used. Current (2) mode may be used (but with limitations). If this value is < 1.1, then Current (2) mode must be used. Set Pr **00.040** for the required mode: Injection (0), Non-salient (1), Current (2) or Current No Test (3).	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press red 🛑 reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.3 Quick start commissioning / start-up using HVAC Drive Connect (V02.00.04 onwards)

HVAC Drive Connect is a Windows™ based software commissioning / start-up tool for HVAC Drive Connect can be used for commissioning / start-up and monitoring, drive parameters can be uploaded, downloaded and compared and simple or custom menu listings can be created. Drive menus can be displayed in standard list format or as live block diagrams. HVAC Drive Connect is able to communicate with a single drive or a network. HVAC Drive Connect can be downloaded from www.controltechniques.com (file size approximately 100 MB). A KI-485 Adaptor and suitable USB to EIA-485 isolated converter is required for connection to HVAC Drive Connect. A suitable isolated converter is available from Control Techniques:

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

HVAC Drive Connect system requirements

•   Windows 8, Windows 7 SP1, Windows Vista SP2, Windows XP SP3
•   Minimum of 1280 x 1024 screen resolution with 256 colours
•   Microsoft.Net Frameworks 4.0 (this is provided in the downloaded file)
•   Note that you must have administrator rights to install HVAC Drive Connect

Any previous copy of HVAC Drive Connect should be uninstalled before proceeding with the installation (existing projects will not be lost). Included within HVAC Drive Connect is the *Parameter Reference Guide* for HVAC Drive.

7.3.1 Power-up the drive

1.   Start HVAC Drive Connect, and on the 'Project Management' screen select 'Scan serial RTU network' or 'Scan all connected drives'.
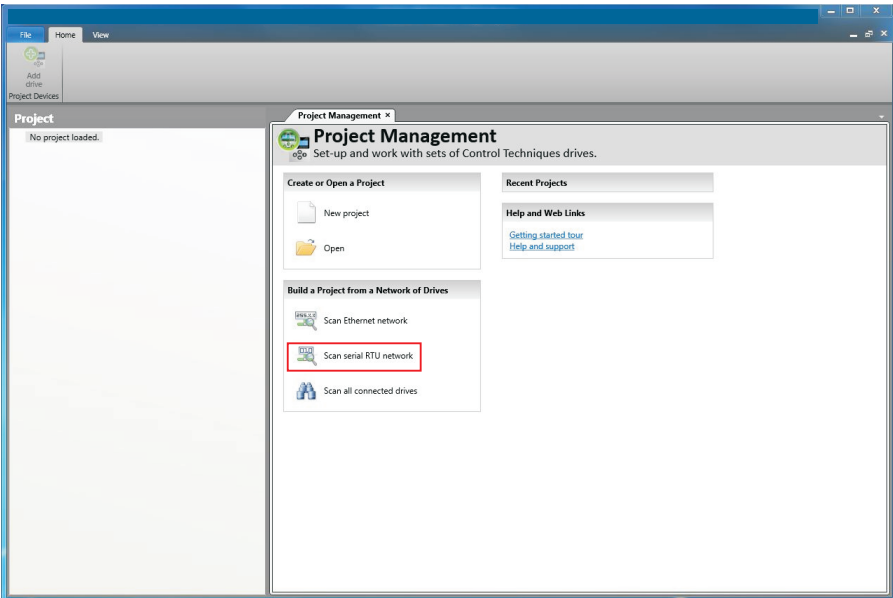
7.3.2 Select the discovered drive
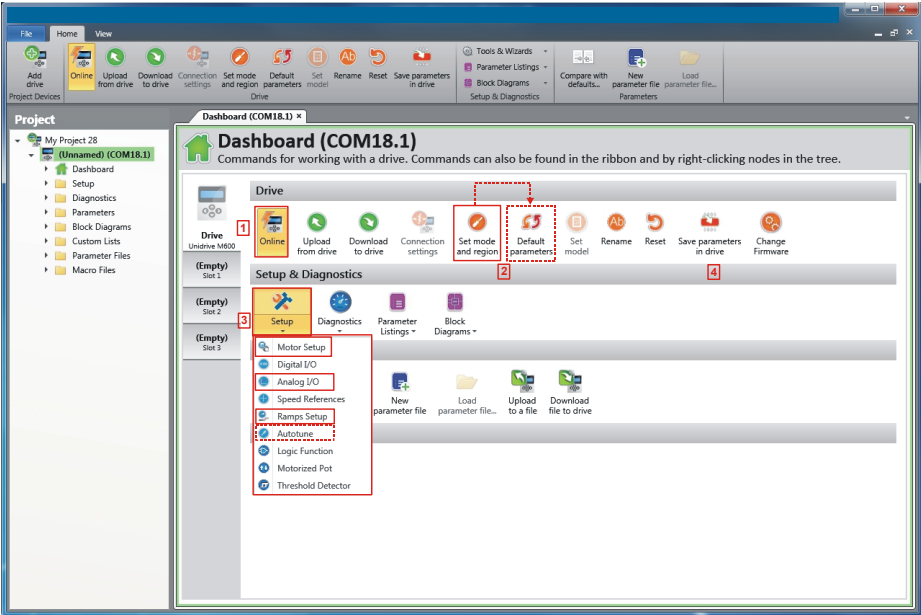
1. Select the 'Online' icon to connect with the drive. When a successful connection is made the icon will be highlighted orange.
2. Select 'Set mode and region'.
   If the required control mode is highlighted in the 'Drive Settings' dialog, then:
- Change the supply frequency, if required and select 'Apply', otherwise select 'Cancel'.
- Select 'Default parameters' from the Dashboard and in the 'Default Parameters' dialogue, select 'Apply'
   If the required control mode is not highlighted in the 'Drive Settings' dialog then:
- Select the required mode and supply frequency.
- Select 'Apply'.
3. Select 'Set-up' and perform the steps highlighted (dotted lines indicate a step which may not need to be performed (see below):

Action	Detail
Motor Set-up	HVAC Drive Connect contains a database for induction motors and permanent magnet motors. Provision is also made to enter motor nameplate data. The next section describes the use of the motor database for a Leroy Somer LSRPM motor used in RFC-S Sensorless mode.
Analog I/O	The motor thermistor can be selected in Pr **07.011**. Refer to the parameter help for Pr **07.011** for further information.
Ramps Set-up	Enter the required Acceleration rate and Deceleration rate
Autotune	Not required when using data from the motor database for a Leroy Somer LSRPM motor used in RFC-S Sensorless mode.

4. Select 'Save parameters in drive' to perform a parameter save. The drive is now ready to run.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

7.3.3 Use of the motor database for a Leroy Somer LSRPM motor for use in RFC-S Sensorless mode

- Select 'Motor Setup' from the 'Dashboard'.
- On the 'Motor Setup' screen, select 'Choose a motor'.
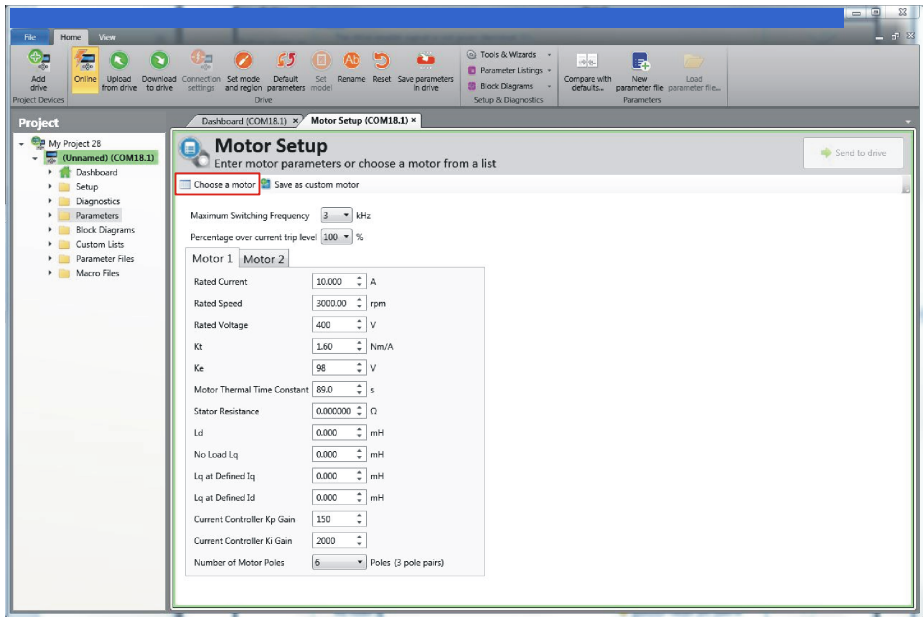
Select the required motor database:

Select the required motor from the list and click 'OK'
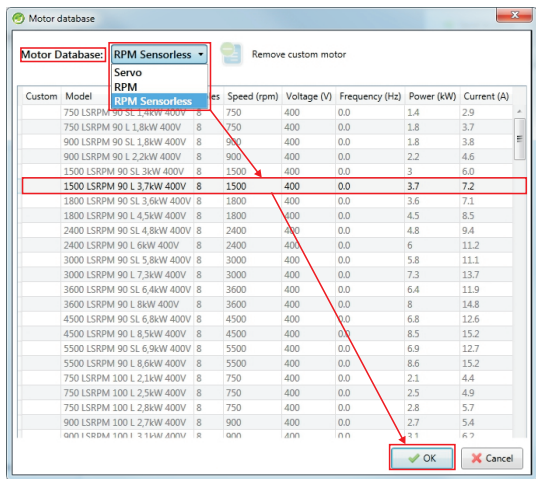
The data for the selected motor is displayed on the 'Motor Setup' screen. Click 'Send to drive' to set the associated parameters.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information
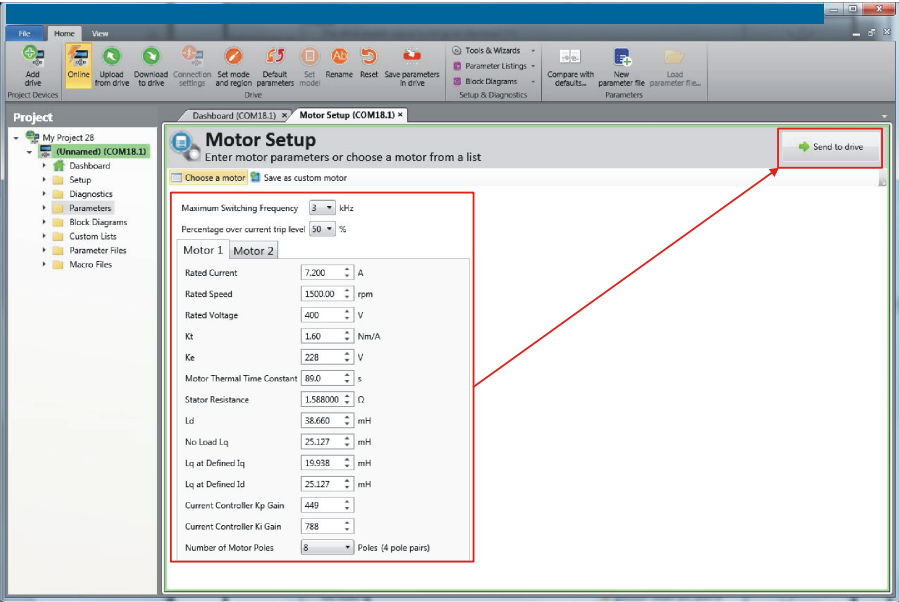
7.4 Diagnostics

If the drive trips, it is possible to interrogate the trip log from within HVAC Drive Connect.

Select 'Drive Trip Log' from the 'Dashboard'.
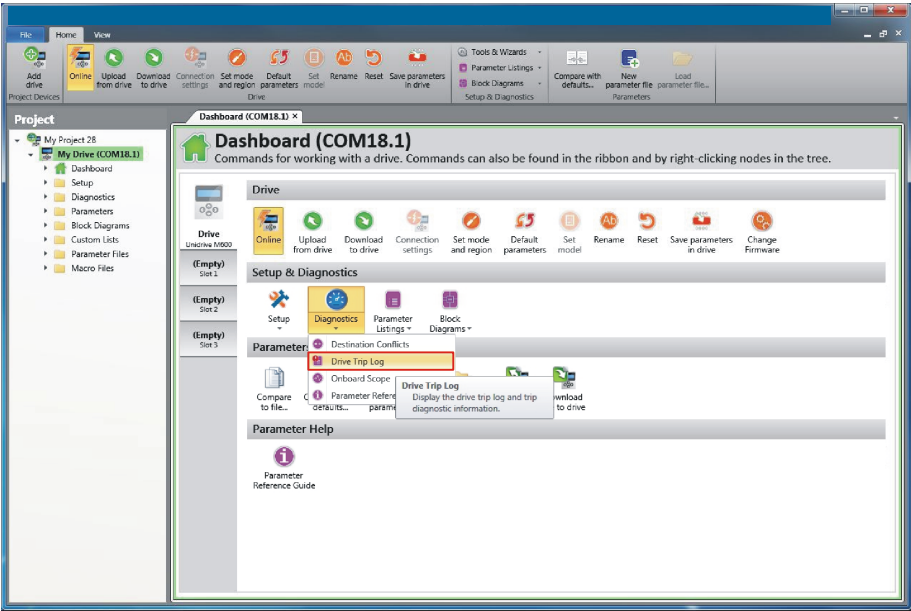
The drive trip log shows the trip responsible for stopping the autotune and a description of the trip.

8 Optimization

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance
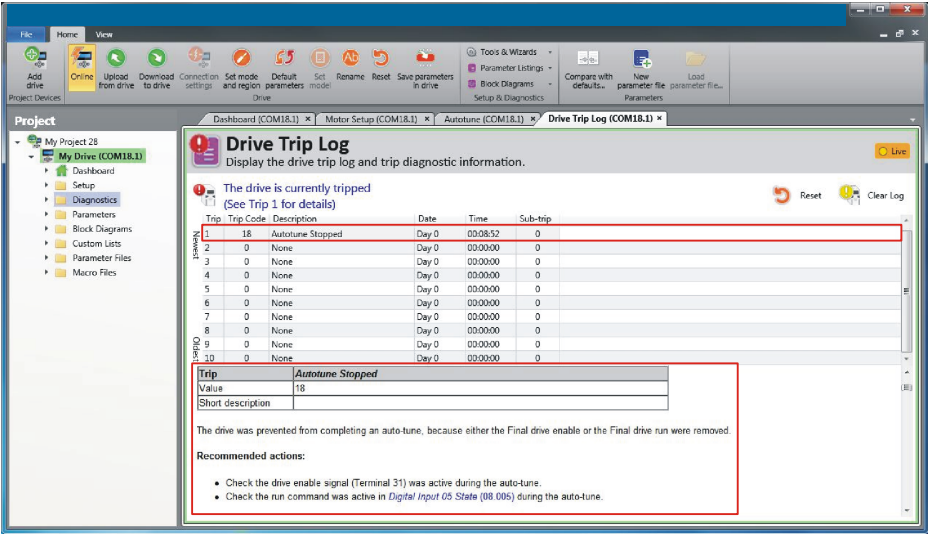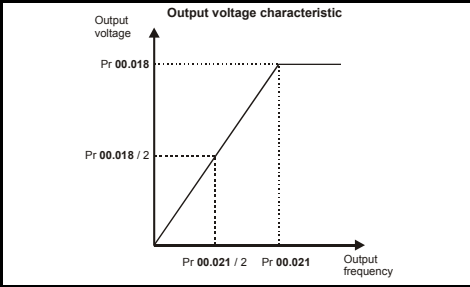
UL listing information

This chapter takes the user through methods of optimizing the drive set-up and maximize the performance. The auto-tuning features of the drive simplify the optimization tasks

8.1 Motor map parameters

8.1.1 Open loop motor control

Pr 00.020 {05.007} *Rated Current*	Defines the maximum continuous motor current

- The rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:
- Current limits (see section 8.4 *Switching frequency* on page 110, for more information).
- Motor thermal overload protection (see section 8.2 *Motor thermal protection* on page 107, for more information)
- Vector mode voltage control (see *Open Loop Control Mode* (00.014), later in this table)
- Slip compensation (see *Enable Slip Compensation* (05.027), later in this table)
- Dynamic V/F control

Pr 00.018 {05.009} *Rated Voltage*	Defines the voltage applied to the motor at rated frequency
Pr 00.021 {05.006} *Rated Frequency*	Defines the frequency at which rated voltage is applied

The *Rated Voltage* (00.018) and the *Rated Frequency* (00.021) are used to define the voltage to frequency characteristic applied to the motor (see *Open Loop Control Mode* (00.014), later in this table). The *Rated Frequency* (00.021) is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see *Rated Speed* (00.019), later in this table).

Output voltage characteristic

Output voltage

Pr **00.018**

Pr **00.018** / 2

Pr **00.021** / 2   Pr **00.021**   Output frequency

Pr 00.019 {05.008} *Rated Speed*	Defines the full load rated speed of the motor
Pr 00.017 {05.011} *Number Of Motor Poles*	Defines the number of motor poles

The motor rated speed and the number of poles are used with the motor rated frequency to calculate the rated slip of induction machines in Hz.

Rated slip (Hz) = Motor rated frequency - (Number of pole pairs x [Motor rated speed / 60]) =

$$00.021 = \left(\frac{00.017}{2} \times \frac{00.019}{60} \right)$$

If Pr **00.019** is set to 0 or to synchronous speed, slip compensation is disabled. If slip compensation is required this parameter should be set to the nameplate value, which should give the correct rpm for a hot machine. Sometimes it will be necessary to adjust this when the drive is commissioned because the nameplate value may be inaccurate. Slip compensation will operate correctly both below base speed and within the field-weakening region. Slip compensation is normally used to correct for the motor speed to prevent speed variation with load. The rated load rpm can be set higher than synchronous speed to deliberately introduce speed droop. This can be useful to aid load sharing with mechanically coupled motors.

Pr **00.017** is also used in the calculation of the motor speed display by the drive for a given output frequency. When Pr **00.017** is set to 'Automatic', the number of motor poles is automatically calculated from the rated frequency Pr **00.021**, and the motor rated speed Pr **00.019**.

Number of poles = 120 x (*Rated Frequency* (**00.021**) / *Rated Speed* (**00.019**) rounded to the nearest even number.

Pr 05.010 *Rated Power Factor*	Defines the angle between the motor voltage and current

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. The power factor is used in conjunction with the *Rated Current* (**00.020**), to calculate the rated active current and magnetising current of the motor. The rated active current is used extensively to control the drive, and the magnetising current is used in vector mode stator resistance compensation. It is important that this parameter is set up correctly. The drive can measure the motor rated power factor by performing a rotating autotune (see Autotune (Pr **00.024**), below).

Pr 00.024 {05.012} Autotune	

There are two autotune tests available in open loop mode, a stationary and a rotating test. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive.

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary test measures the *Stator Resistance* (**05.017**) and *Transient Inductance* (**05.024**) which are required for good performance in vector control modes (see *Open Loop Control Mode* (**00.014**), later in this table). The stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **05.010**. To perform a Stationary autotune, set Pr **00.024** to 1, and provide the drive with both an enable signal (on terminal 29) and a run signal (on terminal 24).

- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, as above, then a rotating test is performed in which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (**05.006**) x $^2/_3$, and the frequency is maintained at that level for 4 seconds. *Stator Inductance* (**05.025**) is measured and this value is used in conjunction with other motor parameters to calculate *Rated Power Factor* (**05.010**). To perform a Rotating autotune, set Pr **00.024** to 2, and provide the drive with both an enable signal (on terminal 29) and a run signal (on terminal 24).

Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminal 29, setting the *Drive Enable* (**06.015**) to OFF (0) or disabling the drive via the *Control Word* (**06.042**) and *Control Word Enable* (**06.043**).

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Pr 00.014 {05.014} *Open Loop Control Mode*

There are several voltage modes available which fall into two categories, vector control and fixed boost.

Vector control

Vector control mode provides the motor with a linear voltage characteristic from 0 Hz to motor *Rated Frequency* (**00.021**), and then a constant voltage above motor rated frequency. When the drive operates between motor rated frequency/50 and motor rated frequency/4, full vector based stator resistance compensation is applied. When the drive operates between motor rated frequency/4 and motor rated frequency/2 the stator resistance compensation is gradually reduced to zero as the frequency increases. For the vector modes to operate correctly the *Rated Power Factor* (**05.010**) and *Stator Resistance* (**05.017**) are required to be set up accurately. The drive can be made to measure these by performing an autotune (see Pr **00.024** *Autotune*). The drive can also be made to measure the stator resistance automatically every time the drive is enabled or the first time the drive is enabled after it is powered up, by selecting one of the vector control voltage modes.

(0) **Ur S** = The stator resistance is measured and the parameter for the selected motor map are over-written each time the drive is made to run. This test can only be done with a stationary motor where the flux has decayed to zero. Therefore this mode should only be used if the motor is guaranteed to be stationary each time the drive is made to run. To prevent the test from being done before the flux has decayed there is a period of 1 second after the drive has been in the ready state during which the test is not done if the drive is made to run again. In this case, previously measured values are used. Ur S mode ensures that the drive compensates for any change in motor parameters due to changes in temperature. The new value of stator resistance is not automatically saved to the drive's EEPROM.

(4) **Ur I** = The stator resistance is measured when the drive is first made to run after each power-up. This test can only be done with a stationary motor. Therefore this mode should only be used if the motor is guaranteed to be stationary the first time the drive is made to run after each power-up. The new value of stator resistance is not automatically saved to the drive's EEPROM.

(1) **Ur** = The stator resistance is not measured. The user can enter the motor and cabling resistance into the *Stator Resistance* (**05.017**). However this will not include resistance effects within the drive inverter. Therefore if this mode is to be used, it is best to use an autotune test initially to measure the stator resistance.

(3) **Ur_Auto** = The stator resistance is measured once, the first time the drive is made to run. After the test has been completed successfully the *Open Loop Control Mode* (**00.014**) is changed to Ur mode. The *Stator Resistance* (**05.017**) parameter is written to, and along with the *Open Loop Control Mode* (**00.014**), are saved in the drive's EEPROM. If the test fails, the voltage mode will stay set to Ur Auto and the test will be repeated next time the drive is made to run.

Fixed boost

Neither the stator resistance nor the voltage offset are used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **00.016**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed boost available:

(2) **Fixed** = This mode provides the motor with a linear voltage characteristic from 0 Hz to *Rated Frequency* (**00.021**), and then a constant voltage above rated frequency.

(5) **Square** = This mode provides the motor with a square law voltage characteristic from 0 Hz to *Rated Frequency* (**00.021**), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of the speed of the motor shaft. This mode should not be used if a high starting torque is required.

Pr 00.007 {05.014} *Open Loop Control Mode (cont)*

For both these modes, at low frequencies (from 0 Hz to ½ x Pr **00.021**) a voltage boost is applied defined by Pr **00.016** as shown below:

Output voltage characteristic (Fd)

Pr **00.016** + [(freq/Pr **00.021**)² x (Pr **00.018** - Pr **00.016**)]
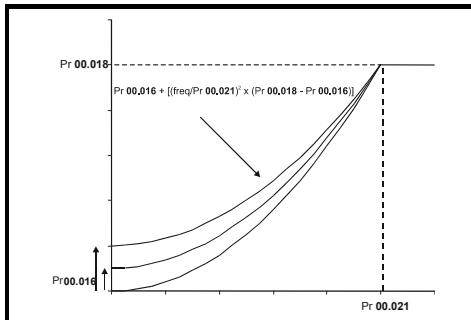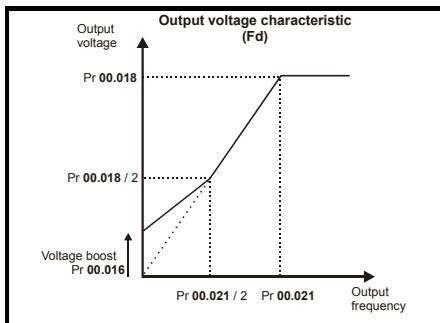
Pr 05.027 *Enable Slip Compensation*

When a motor, being controlled in open loop mode, has load applied a characteristic of the motor is that the output speed droops in proportion to the load applied as shown:
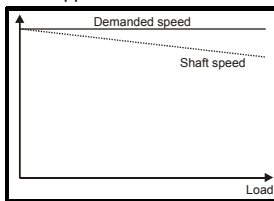
In order to prevent the speed droop shown above slip compensation should be enabled. To enable slip compensation Pr **05.027** must be set to a 1 (this is the default setting), and the motor rated speed must be entered in Pr **00.019** (Pr **05.008**).

The motor rated speed parameter should be set to the synchronous speed of the motor minus the slip speed. This is normally displayed on the motor nameplate, i.e. for a typical 18.5 kW, 50 Hz, 4 pole motor, the motor rated speed would be approximately 1465 rpm. The synchronous speed for a 50 Hz, 4 pole motor is 1500 rpm, so therefore the slip speed would be 35 rpm. If the synchronous speed is entered in Pr **00.019**, slip compensation will be disabled. If too small a value is entered in Pr **00.019**, the motor will run faster than the demanded frequency. The synchronous speeds for 50 Hz motors with different numbers of poles are as follows:

    2 pole = 3000 rpm, 4 pole = 1500 rpm, 6pole =1000 rpm, 8 pole = 750 rpm

8.1.2   RFC-A Sensorless mode

Induction motor without position feedback

Pr 00.020 {05.007} *Motor Rated Current*	Defines the maximum motor continuous current

The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:

- Motor thermal overload protection (see section 8.2 *Motor thermal protection* on page 107, for more information)
- Vector control algorithm

Pr 00.018 {05.009} *Rated Voltage*	Defines the voltage applied to the motor at rated frequency
Pr 00.021 {05.006} *Rated Frequency*	Defines the frequency at which rated voltage is applied

The motor rated voltage Pr **00.018** and the motor rated frequency Pr **00.021** are used to define the relationship between the voltage and frequency applied to the motor.
The motor rated voltage is used by the field controller to limit the voltage applied to the motor. Normally this is set to the nameplate value. To allow current control to be maintained, it is necessary for the drive to leave some 'headroom' between the motor terminal voltage and the maximum available drive output voltage. For good transient performance at high speed, the motor rated voltage should be set below 95 % of the minimum supply voltage to the drive.
The motor rated voltage and motor rated frequency are also used during the rotating autotune test (see Autotune Pr **00.024** later in this table) therefore, it is important that the correct value for motor rated voltage is used.

Pr 00.019 {05.008} *Rated Speed*	Defines the full load rated speed of the motor
Pr 00.017 {05.011} *Number Of Motor Poles*	Defines the number of motor poles

The motor rated speed and motor rated frequency are used to determine the full load slip of the motor which is used by the vector control algorithm.

Incorrect setting of this parameter has the following effects:

- Reduced efficiency of motor operation
- Reduction of maximum torque available from the motor
- Reduced transient performance
- Inaccurate control of absolute torque in torque control modes

The nameplate value is normally the value for a hot motor; however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate.

When Pr **00.017** is set to 'Automatic', the number of motor poles is automatically calculated from the motor *Rated Frequency* (**00.021**), and the motor *Rated Speed* (**00.019**).

Number of poles = 120 x (Motor *Rated Frequency* (**00.021**) / Motor *Rated Speed* (**00.019**) rounded to the nearest even number.

Pr 05.010 *Rated Power Factor*	Defines the angle between the motor voltage and current

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. If the *Stator Inductance* (**05.025**) is set to zero then the power factor is used in conjunction with the motor *Rated Current* (**00.020**) and other motor parameters to calculate the rated active and magnetising currents of the motor, which are used in the vector control algorithm. If the stator inductance has a non-zero value this parameter is not used by the drive, but is continuously written with a calculated value of power factor. The stator inductance can be measured by the drive by performing a rotating autotune (see *Autotune* (Pr **00.024**), later in this table).

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Pr 00.024 {05.012} *Autotune*

There are two autotune tests available in RFC-A mode, a stationary test, and a rotating test. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive.

It is highly recommended that a rotating autotune is performed (Pr **00.024** set to 2).

Autotune test 1:

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary autotune measures the *Stator Resistance* (**05.017**) and *Transient Inductance* (**05.024**) of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **04.013** and Pr **04.014** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **05.010**. To perform a stationary autotune, set Pr **00.024** to 1, and provide the drive with both an enable signal (on terminal 29) and a run signal (on terminal 24).

Autotune test 2:

- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, a rotating test is then performed in which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (**05.006**) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (**05.025**) is modified by the drive. The power factor is also modified for user information only, but is not used after this point as the stator inductance is used in the vector control algorithm instead. To perform a Rotating autotune, set Pr **00.024** to 2, and provide the drive with both an enable signal (on terminal 29) and a run signal (on terminal 24).

Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminal 29, setting the *Drive Enable* (**06.015**) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**)

Pr 04.013 / Pr 04.014 *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The *Current Controller Kp Gain* (**04.013**) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr **00.024**, earlier in this table) the drive measures the *Stator Resistance* (**05.017**) and *Transient Inductance* (**05.024**) of the motor and calculates the current loop gains.

This will give a step response with minimum overshoot after a step change of current reference. The proportional gain can be increased by a factor of 1.5 giving a similar increase in bandwidth; however, this gives a step response with approximately 12.5 % overshoot. The equation for the integral gain gives a conservative value. In some applications where it is necessary for the reference frame used by the drive to dynamically follow the flux very closely (i.e. high speed Sensorless RFC-A induction motor applications) the integral gain may need to have a significantly higher value.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Speed Loop Gains (Pr 00.014 {03.010}, Pr 00.015 {03.011}, Pr 00.016 {03.012})

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term.

Speed Controller Proportional Gain (Kp), Pr **00.014** {**03.010**}

If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the speed error for a given load. If the proportional gain is too high either the acoustic noise produced by speed feedback quantization becomes unacceptable, or the stability limit is reached.

Speed Controller Integral Gain (Ki), Pr **00.015** {**03.011**}

The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of the system, i.e. it reduces the positional displacement produced by applying a load torque to the motor. Unfortunately increasing the integral gain also reduces the system damping giving overshoot after a transient. For a given integral gain the damping can be improved by increasing the proportional gain. A compromise must be reached where the system response, stiffness and damping are all adequate for the application. For RFC-A Sensorless mode, it is unlikely that the integral gain can be increased much above 0.50.

Differential Gain (Kd), Pr **00.016** {**03.012**}

The differential gain is provided in the feedback of the speed controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced by under-damping, however, for most applications the proportional and integral gains alone are sufficient.

Speed demand

Insufficient proportional gain [**00.014**]

Excessive proportional gain [**00.014**]

Excessive integral gain [**00.015**]

Ideal response
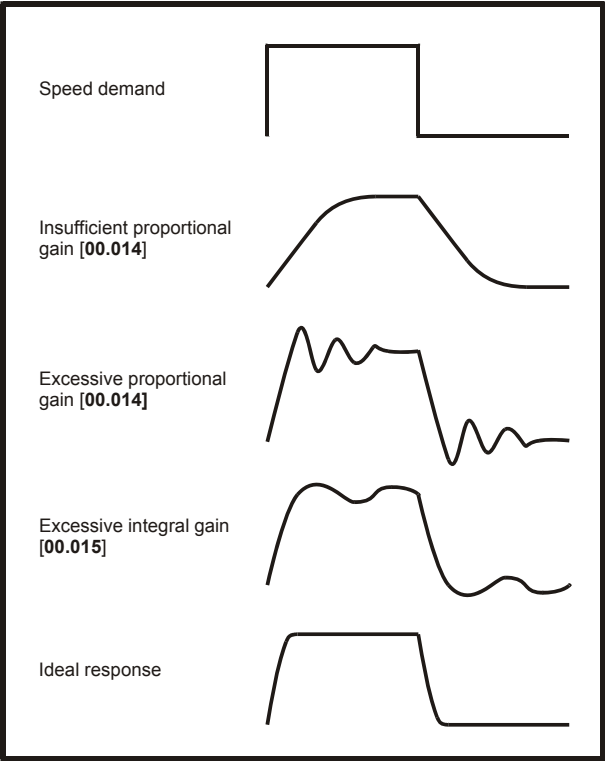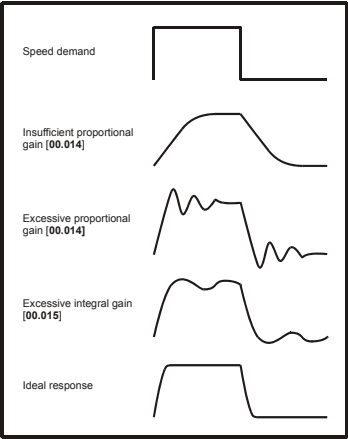
8.1.3   RFC-S Sensorless mode

Permanent magnet motor without Position feedback

Pr 00.020 {05.007} *Rated Current*	Defines the maximum motor continuous current

The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:

*   Motor thermal overload protection (see section 8.2 *Motor thermal protection* on page 107, for more information)

Pr 00.017 {05.011} *Number Of Motor Poles*	Defines the number of motor poles

The number of motor poles parameter defines the number of electrical revolutions in one whole mechanical revolution of the motor. This parameter must be set correctly for the control algorithms to operate correctly. When Pr **00.017** is set to "Automatic" the number of poles is 6.

Pr 00.024 {05.012} *Autotune*	

There are three autotune tests available in RFC-S sensorless mode, a stationary autotune and a locked rotor test.

*   Auto tune test 1: Stationary Autotune
The stationary autotune can be used to measure all the necessary parameters for basic control. The tests measures *Stator Resistance* (**05.017**), *Ld* (**05.024**) and *No Load Lq* (**05.072**). *The Stator Resistance* (**05.017**) and *Ld* (**05.024**) are then used to set up *Current controller Kp Gain* (**04.013**) and *Current Controller Ki Gain* (**04.014**). To perform a Stationary autotune, set Pr **00.024** to 1, and provide the drive with both an enable signal (on terminal 29) and a run signal (on terminal 24).

*   Autotune test 2: Rotating Autotune
In sensorless mode, if Rotating autotune is selected (Pr **00.024** = 2), then a stationary autotune is performed.

Following the completion of an autotune test the drive will go into the inhibit state. The drive must be placed into a controlled disable condition before the drive can be made to run at the required reference. The drive can be put in to a controlled disable condition by removing the Safe Torque Off signal from terminal 29, setting the drive Enable Parameter (**06.015**) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

*   Autotune test 6: Locked rotor test for load dependant parameters
This test is not implemented at the time of writing.

Pr 03.079 *Sensorless Mode Filter*	

When RFC-S sensorless mode is active the measured speed can include some ripple, which increases as the drive passes into field weakening. A filter is applied to the estimated speed and *Sensorless Mode Filter* (**03.079**) defines the time constant. The default time constant is 4 ms, but this can be extended to improve the filtering. This is particularly useful when using standard ramp or spinning start with a low friction high inertia load, and can prevent over voltage trips when the drive has no braking resistor.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Pr 00.040 {05.064} *RFC Low Speed Mode* /
Pr 00.041 {05.071} *Low Speed Sensorless Mode*
Current

(0) Injection mode
For low speed sensorless operation with signal injection (*RFC Low Speed Mode* (**05.064**) = 0) it is necessary to have a ratio of Lq/Ld = 1.1. Even if a motor has a larger ratio on no load, this ratio normally reduces as the q axis current is increased from zero. *Low Speed Sensorless Mode Current* (**05.071**) should be set at a level that is lower than the point where the inductance ratio falls to 1.1. The value of this parameter is used to define the drive current limits when signal injection is active and prevent loss of control of the motor.

(1) Non-salient mode
For low speed sensorless operation for non-salient motors (*RFC Low Speed Mode* (**05.064**) = 1) this defines a current applied in the d axis to aid starting. For most motors and application requiring up to 60 % torque on starting the default value is suitable. However the level of current may need to be increased to make the motor start.

(2) Current
This method, which applies a rotating current vector at the frequency defined by the speed reference, can be used with any motor with no saliency or moderate saliency. It should only be used with motors where more of the torque is produced in conjunction with the magnet flux rather than from saliency torque. This mode does not provide the same level of control at low speed as injection mode, but is easier to set up and more flexible than "Non-salient" mode. The following should be considered:

1. A current specified by *Low Speed Sensorless Mode Current* (**05.071**) is applied when low speed mode is active. This current should be sufficient to start the motor with the highest expected load. If the motor has some saliency with no-load applied, and a suitable saturation characteristic, the drive can detect the rotor position and apply the current at the correct angle to avoid starting transient. If the motor is non-salient as defined by the conditions for Inductance trip then the drive will not attempt to detect the rotor position and the current will be applied at an arbitrary angle. This could cause a starting transient if the level of current applied is high, and so *Low Speed Sensorless Mode Current* (**05.071**) should not be set to a higher level than necessary. To minimise the movement as a result of applying the current, it is increased over the period defined by *Sensorless Mode Current Ramp* (**05.063**) in the form of a squared characteristic (i.e. it is increased with a low rate of change at the beginning and the rate of change is gradually increased).
2. As the level of current when low speed mode is active is not dependent on the applied load, but is as defined by *Low Speed Sensorless Mode Current* (**05.071**), and so the motor may become too hot if low speed mode is active for a prolonged period of time.
3. Generally *Low Speed Sensorless Mode Current* (**05.071**) should be set to a level higher than the expected maximum load, and can be set to a much higher level than the load if the saliency and saturation characteristic allow the position of the rotor to be detected on starting. However, *Low Speed Sensorless Mode Current* (**05.071**) should be matched more closely to the expected load under the following conditions: the load inertia is high compared to the motor interia, or there is very little damping/loss in the load system, or where the q axis inductance of the motor changes significantly with load.

(3) Current no test
The "Current" method is used, but no attempt is made to determine the position of the rotor before applying the current. This can be selected for example, if the motor does not have a suitable saturation characteristic to allow the rotor position to be determined during starting, or if faster starting is required. The initial current vector angle will be at an arbitary position with respect to the actual rotor position. As the vector sweeps round it must make the rotor start to rotate. If the ramp rate is too high the rotor may not keep up with the current vector and the motor may not start. If this is the case then the ramp rate should be reduced and/or the current used to start the motor should be increased.

(4) Current step
The current starting modes normally provide a smooth transition between the low speed current mode and normal running at higher speeds. If the drive accelerates very rapidly and only spends short periods of time in each mode the transition smoothing can malfunction. "Current step" mode is similar to "Current no test" mode except that the transition smoothing is disabled. It is not advisable to use this mode unless it is necessary as torque current and torque transients will occur when changing between low speed and normal running operation.

(5) Current only
The "Current" method is used, but no attempt is made to determine the position of the rotor before applying the current. The system remains in this starting mode at all speeds and does not change to the normal operating algorithms. This provides a very basic open-loop control method, that is not recommended for most applications. Flux weakening is not possible, and so this method will not operate correctly when the motor voltage approaches the maximum voltage avaialble from the drive.

Pr 04.012 *Current Reference Filter 1 Time Constant*

Current Reference Filter 1 Time Constant (**04.012**) defines the time constant of a first order filter that can be applied to the *Final Current Reference* (**04.004**). The filter is provided to reduce acoustic noise and vibration produced as a result of position feedback quantisation. The filter introduces a lag in the speed controller loop, and so the speed controller gains may need to be reduced to maintain stability as the filter time constant is increased.

Pr 04.013 / 04.014 *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. The proportional gain (Pr **04.013**) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr **00.024**, earlier in this table) the drive measures the *Stator Resistance* (**05.017**) and *Transient Inductance* (**05.024**) of the motor and calculates the current loop gains.

Speed Loop Gains **(Pr 00.014 {03.010}, Pr 00.015 {03.011}, Pr 00.016 {03.012})**

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term.

Speed Controller Proportional Gain (Kp), Pr **00.014** {03.010}
If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the speed error for a given load. If the proportional gain is too high either the acoustic noise produced by speed feedback quantization becomes unacceptable, or the stability limit is reached.

Speed Controller Integral Gain (Ki), Pr **00.015** {03.011}
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of the system, i.e. it reduces the positional displacement produced by applying a load torque to the motor. Unfortunately increasing the integral gain also reduces the system damping giving overshoot after a transient. For a given integral gain the damping can be improved by increasing the proportional gain. A compromise must be reached where the system response, stiffness and damping are all adequate for the application.

Differential Gain (Kd), Pr **00.016** {03.012}
The differential gain is provided in the feedback of the speed controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced by under-damping, however, for most applications the proportional and integral gains alone are sufficient.

8.2 Motor thermal protection

A dual time constant thermal model is provided to estimate the motor temperature as a percentage of its maximum allowed temperature.

The motor thermal protection is modelled using losses in the motor. The losses in the motor are calculated as a percentage value, so that under these conditions the *Motor Protection Accumulator* (04.019) would eventually reach 100 %.

Percentage losses = 100 % x [Load related losses + Iron losses]

Where:

Load related losses = $(1 - K_{fe}) \times (I / (K_1 \times I_{Rated}))^2$

Iron losses = $K_{fe} \times (w / w_{Rated})^{1.6}$

Where:

I = *Current Magnitude* (04.001)

I_{Rated} = *Rated Current* (05.007)

K_{fe} = *Rated Iron Losses As Percentage Of Losses* (04.039) / 100 %

The *Motor Protection Accumulator* (04.019) is given by:

Pr **04.019** = Percentage Losses x $[(1 - K_2) (1 - e^{-t/\tau 1}) + K_2 (1 - e^{-t/\tau 2})]$

Where:

T = *Motor Protection Accumulator* (04.019)

K_2 = *Motor Thermal Time Constant 2 Scaling* (04.038) / 100 %

$\tau 1$ = *Motor Thermal Time Constant 1* (04.015)

$\tau 2$ = *Motor Thermal Time Constant 2* (04.037)

K_1 = Varies, see below

Figure 8-1   Motor thermal protection (Normal Duty)
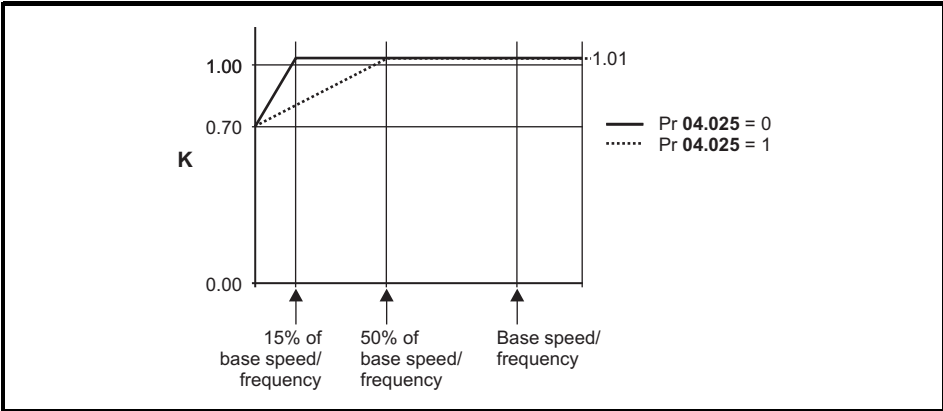
Both settings of Pr **04.025** are intended for motors where the cooling effect of the motor fan reduces with reduced motor speed, but with different speeds below which the cooling effect is reduced. If Pr **04.025** is 0 the characteristic is intended for motors where the cooling effect reduces with motor speed below 15 % of base speed/frequency. If Pr **04.025** is 1 the characteristic is intended for motors where the cooling effect reduces with motor speed below 50 % of base speed/frequency. The

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

maximum value for K1 is 1.01, so that above the knee of the characteristics the motor can operate continuously up to 101 % current.

When the estimated temperature in Pr **04.019** reaches 100 % the drive takes some action depending on the setting of Pr **04.016**. If Pr **04.016** is 0, the drive trips when Pr **04.019** reaches 100 %. If Pr **04.016** is 1, the current limit is reduced to (K - 0.05) x 100 % when Pr **04.019** reaches 100 %.

The current limit is set back to the user defined level when Pr **04.019** falls below 95 %. The thermal model temperature accumulator is reset to zero at power-up and accumulates the temperature of the motor while them drive remains powered-up. If the rated current defined by Pr **05.007** is altered, the accumulator is reset to zero. The default setting of the thermal time constant (Pr 04.015) is 89 s which is equivalent to an overload of 110 % for 165 s from cold.

8.3   Fire mode

Fire Mode is a configurable override function that is used to alter the operation of the drive based upon external inputs, typically a discrete digital input from a Building Management Fire Protection system.

> ⚠️ **WARNING**
>
> **Fire Mode - Important Warning**
> When Fire Mode is active the motor overload and thermal protection are disabled, as well as a number of drive protection functions. Fire Mode is provided for use only in emergency situations where the safety risk from disabling protection is less than the risk from the drive tripping - typically in smoke extraction operation to permit evacuation of a building. The use of Fire Mode itself causes a risk of fire from overloading of the motor or drive, so it must only be used after careful consideration of the balance of risks.
>
> Care must be taken to prevent inadvertent activation or de-activation of Fire Mode. Fire Mode is indicated by a flashing display text warning "Fire mode active".
>
> Care must be taken to ensure that parameters Pr **01.053** or Pr **01.054** are not inadvertently re-allocated to different inputs or variables. It should be noted that, by default, Pr **01.054** is controlled from digital input 4 and changing Pr **06.004** or Pr **08.024** can re-allocate this digital input to another parameter. These parameters are at access level 2 in order to minimize the risk of inadvertent or unauthorized changes. It is recommended that User Security be applied to further reduce the risk (see section 5.11 *Parameter access level and security* on page 70). These parameters may also be changed via serial communications so adequate precautions should be taken if this functionality is utilized.

01.053										Fire Mode Reference	
RW		Uni							US		
OL							0.0 Hz				
RFC-A	⇳	±SPEED_FREQ_MAX Hz/rpm			⇨	0.0 rpm					
RFC-S											

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

01.054			**Fire Mode Activate**							
RO		Bit						NC	US	
OL										
RFC-A	⇕		Off (0) or On (1)			⇨				
RFC-S										

Emergency ventilation or fire mode allows for the purging of air from a structure during a fire. It is enabled if Pr **01.053** is set to a non zero value and activated when Pr **01.054** is set to one. When activated, the pre-ramp reference (Pr **01.003**) is set to the value of Pr **01.053** and the normal drive controls are overridden as follows:

1. Drive enable is only controlled by the Enable input (Pr **06.015**). The control word (Pr **06.043**) cannot be used to disable the drive.
2. The internal run command is forced to be active. The normal drive sequencing bits (Pr **06.030** to Pr **06.034**) and the control word have no effect.
3. The limit switch functions (Pr **06.035** and Pr **06.036**) have no effect and will not stop the motor.
4. The hard speed reference is forced to zero. The hard speed reference should not be used when fire mode is likely to be activated as this will cause an abrupt change of speed.
5. The hand/off/auto function is disabled. If this system is in the hand state when fire mode is activated it will be forced to the off state, in order that the hand state is not active when fire mode is de-activated.
6. Keypad mode is disabled.
7. All latching mode states are reset.

When Pr **01.054** is subsequently set to zero the drive returns to normal operation.

Pr **01.054** can only be changed from a digital input and the default configuration allocates this to digital input 4.

> ⚠ **CAUTION**
>
> Care should be taken when modifying parameters as setting Pr **01.053** to zero inhibits the fire mode function and changing Pr **08.024** (*Digital Input 4 source*) could result in digital input 4 source to be allocated to a parameter other than Pr **01.054**.

If fire mode is activated when the drive is in a tripped state then the trip is reset.

Only the trips listed in the following table can be initiated while fire mode is active.

Trip number	String	Cause of trip
2	Over Volts	DC bus over-voltage
3	OI ac	AC instantaneous over-current
4	OI brake	Braking resistor instantaneous over current
5	PSU	Drive power supply fault
9	PSU 24V	24 V internal power supply overload
21	OHt inverter	Power device over temperature based on thermal model
31	EEPROM	EEPROM failure
36	User Save	User parameter save error
37	Power Down Save	Power down save parameter error
109	OI dc	Power module over current detected from on state voltage monitoring
200	Slot1 HF	Slot 1 option module failure
205	Slot2 HF	Slot 2 option module failure
210	Slot2 HF	Slot 3 option module failure
217 to 249	HF17 to HF32	Hardware faults
250	Slot4 HF	Slot 4 factory fit option failure

> **CAUTION**
>
> It is possible for the drive or motor to become damaged when operating in fire mode because some of the drive thermal protection trips are disabled.

8.4   Switching frequency

The default switching frequency is 3 kHz, however this can be increased up to a maximum of 16 kHz by Pr **05.018** (dependent on drive size). The available switching frequencies are shown below.

Table 8-1   Available switching frequencies

Drive size	Model	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
3	All	✓	✓	✓	✓	✓	✓	✓
4								
5								
6								
7								
8								
9A								
9E								
10E								
11E	400 V	✓	✓	✓	✓	✓		
11E	575 and 690 V	✓	✓	✓				

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

If the switching frequency is increased from 3 kHz the following apply:

1. Increased heat loss in the drive, which means that derating to the output current must be applied. See the derating tables for switching frequency and ambient temperature in the *Drive User Guide*.
2. Reduced heating of the motor - due to improved output waveform quality.
3. Reduced acoustic noise generated by the motor.
4. Increased sample rate on the speed and current controllers.

A trade off must be made between motor heating, drive heating and the demands of the application with respect to the sample time required.

Table 8-2 Sample rates for various control tasks at each switching frequency

	3, 6, 12 kHz	2, 4, 8, 16 kHz	Open loop	RFC-A / RFC-S
Level 1	3 kHz = 167μs 6 kHz = 83 μs 12 kHz = 83 μs	2 kHz = 250 μs 4 kHz = 125 μs 8 kHz = 62.5 μs 16 kHz = 62.5 μs	Peak limit	Current controllers
Level 2	250 μs	2 kHz -500 μs 4 kHz - 250 μs 8 kHz - 125 μs 16 kHz - 125 μs	Current limit and ramps	Speed controller and ramps
Level 3	1 ms		Voltage controller	
Level 4	4 ms		Time critical user interface	
Background			Non-time critical user interface	

8.5 High speed operation

8.5.1 Field weakening (constant power) operation

(Open loop and RFC-A mode only)

The drive can be used to run an induction machine above synchronous speed into the constant power region. The speed continues to increase and the available shaft torque reduces. The characteristics below show the torque and output voltage characteristics as the speed is increased above the rated value.

Figure 8-2 Torque and rated voltage against speed
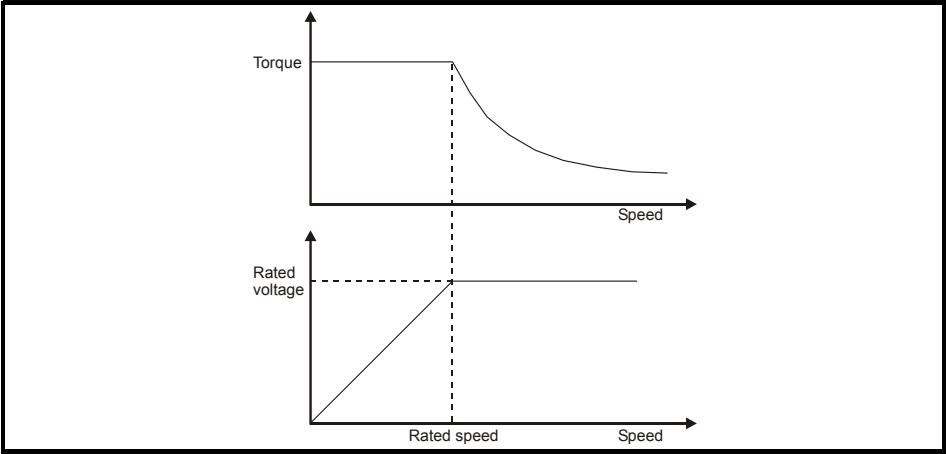
Care must be taken to ensure the torque available above base speed is sufficient for the application to run satisfactorily.

8.5.2 Permanent magnet motor high speed operation

High speed servo mode is enabled by setting Pr **05.022** =1. Care must be taken when using this mode with permanent magnet motor to avoid damaging the drive. The voltage produced by the permanent magnet motor magnets is proportional to speed. For high speed operation the drive must apply currents to the motor to counter-act the flux produced by the magnets. It is possible to operate the motor at very high speeds that would give a very high motor terminal voltage, but this voltage is prevented by the action of the drive.

If however, the drive is disabled (or tripped) when the motor voltages would be higher than the rating of the drive without the currents to counter-act the flux from the magnets, it is possible to damage the drive. If high speed mode is enabled the motor speed must be limited to the levels given in the table below unless an additional hardware protection system is used to limit the voltages applied to the drive output terminals to a safe level.

Drive voltage rating	Maximum motor speed (rpm)	Maximum safe line to line voltage at the motor terminals (V rms)
200	400 x 1000 / (Ke x √2)	400 / √2
400	800 x 1000 / (Ke x √2)	800 / √2
575	955 x 1000 / (Ke x √2)	955 / √2
690	1145 x 1000 / (Ke x √2)	1145 / √2

Ke is the ratio between r.m.s. line to line voltage produced by the motor and the speed in V/1000 rpm. Care must also be taken not to de-magnetize the motor. The motor manufacturer should always be consulted before using this mode.

By default, high speed operation is disabled (Pr **05.022** = 0).

It is also possible to enable high speed operation, and allow the drive to automatically limit the motor speed to the levels specified in the tables and generate an Overspeed. 1 trip if the levels are exceeded (Pr **05.022** = -1)

8.5.3 Maximum speed / frequency

In all operating modes (Open loop, RFC-A and RFC-S) the maximum output frequency is limited to 550 Hz. However, in RFC-S mode the speed is also limited by the voltage constant (Ke) of the motor. Ke is a specific constant for the servo motor being used. It can normally be found on the motor data sheet in V/k rpm (volts per 1,000 rpm).

8.5.4 Quasi-Square wave (open-loop only)

The maximum output voltage level of the drive is normally limited to an equivalent of the drive input voltage minus voltage drops within the drive (the drive will also retain a few percent of the voltage in order to maintain current control). If the motor rated voltage is set at the same level as the supply voltage, some pulse deletion will occur as the drive output voltage approaches the rated voltage level. If Pr **05.020** (Quasi-square wave enable) is set to 1 the modulator will allow over modulation, so that as the output frequency increases beyond the rated frequency the voltage continues to increase above the rated voltage. The modulation depth will increase beyond unity; first producing trapezoidal and then quasi-square waveforms.

This can be used for example:

• To obtain high output frequencies with a low switching frequency which would not be possible with space vector modulation limited to unity modulation depth,

or

• In order to maintain a higher output voltage with a low supply voltage.

The disadvantage is that the machine current will be distorted as the modulation depth increases above unity, and will contain a significant amount of low order odd harmonics of the fundamental output frequency. The additional low order harmonics cause increased losses and heating in the motor.

Safety
information

Product
information

Mechanical
installation

Electrical
installation

Getting started

Basic parameters
(Menu 0)

Running the
motor

Optimization

**NV Media Card
Operation**

Diagnostics and
maintenance

UL listing
information

9 NV Media Card Operation

9.1 Introduction

The Non-Volatile Media Card feature enables simple configuration of parameters, parameter back-up, storing / reading PLC programs and drive copying using a SMARTCARD or SD card storing / reading PLC programs. The drive offers backward compatibility for an Affinity SMARTCARD.

The NV Media Card can be used for:

- Parameter copying between drives
- Saving drive parameter sets
- Saving an onboard user program

The NV Media Card is located at the top of the module under the drive display (if installed) on the left-hand side.

Ensure the NV Media Card is inserted with the contacts facing the left-hand side of the drive.

The drive only communicates with the NV Media Card when commanded to read or write, meaning the card may be "hot swapped".

⚠ **WARNING**

Beware of possible live terminals when installing the NV Media Card.

Figure 9-1 Installation of the NV Media Card
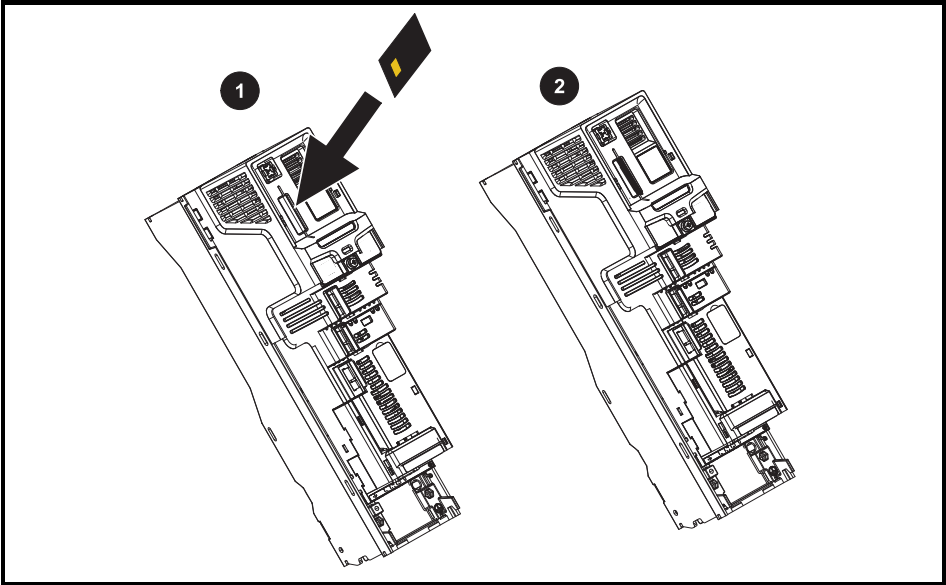
1. Installing the NV Media Card
2. NV Media Card installed

NV Media Card	Part number
SD Card Adaptor (memory card not included)	3130-1212
8 kB SMARTCARD	2214-4246
64 kB SMARTCARD	2214-1006

9.2 NV Media Card support

The NV Media Card can be used to store drive parameter sets and / or PLC programs set from the H300 in data blocks 001 to 499 on the card.

The H300 is compatible with an Affinity SMARTCARD and is able to read and translate the Affinity parameter set into a compatible parameter set for H300. This is only possible if the Affinity parameter set was transferred to the SMARTCARD using the difference from defaults transfer method (i.e. 4yyy transfer).

The H300 is not able to read any other type of Affinity data block on the card. Although it is possible to transfer difference from default data blocks from an Affinity into the H300, the following should be noted:

1. If a parameter from the source drive does not exist in the target drive then no data is transferred for that parameter.
2. If the data for the parameter in the target drive is out of range then the data is limited to the range of the target parameter.
3. If the target drive has a different rating to the source drive then the normal rules for this type of transfer apply.

Figure 9-2 Basic NV Media Card operation
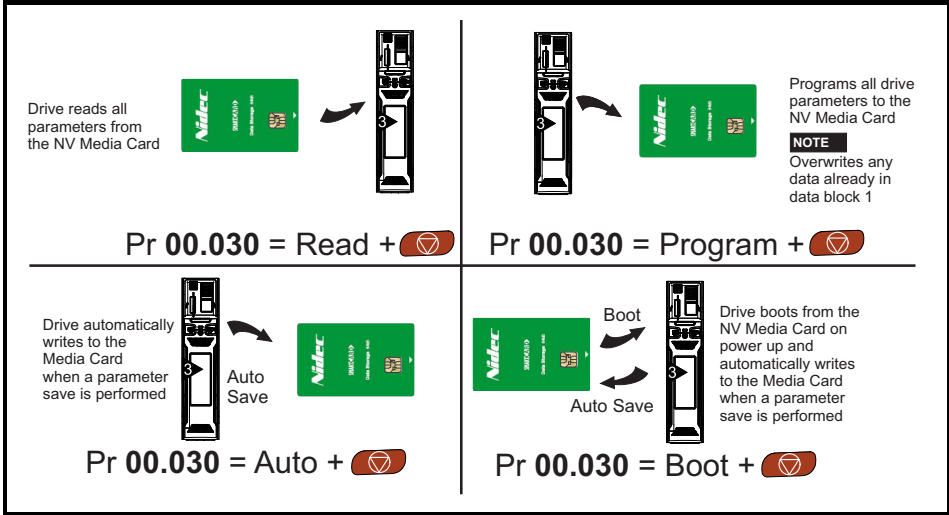
The whole card may be protected from writing or erasing by setting the read-only flag as detailed in the *Drive User Guide*.

The card should not be removed during data transfer, as the drive will produce a trip. If this occurs then either the transfer should be reattempted or in the case of a card to drive transfer, default parameters should be loaded.

9.3 Transferring data

Data transfer, erasing and protecting the information is performed by entering a code in Pr **mm.000** and then resetting the drive as shown in Table 9-1.

Table 9-1 SMARTCARD card codes

Code	Operation	SMARTCARD	SD card
2001	Transfer the drive parameters to parameter file 001 and sets the block as bootable. This will include the parameters from attached option modules.	✓	✓
4yyy	Transfer the drive parameters to parameter file yyy. This will include the parameters from attached option modules.	✓	✓
5yyy	Transfer the onboard user program to onboard user program file yyy.	✓	✓
6yyy	Load the drive parameters from parameter file yyy or the onboard user program from onboard user program file yyy.	✓	✓
7yyy	Erase file yyy.	✓	✓
8yyy	Compare the data in the drive with file yyy. If the files are the same then *Pr mm.000* (**mm.000**) is simply reset to 0 when the compare is complete. If the files are different a 'Card Compare' trip is initiated. All other NV media card trips also apply.	✓	✓
9555	Clear the warning suppression flag	✓	✓
9666	Set the warning suppression flag	✓	✓
9777	Clear the read-only flag	✓	✓
9888	Set the read-only flag	✓	✓
9999	Erase and format the NV media card	✓	

Where yyy indicates the block number 001 to 999.

NOTE   If the read only flag is set then only codes 6yyy or 9777 are effective.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

10   Diagnostics and maintenance

The keypad display on the drive gives various information about the status of the drive. The keypad display provides information on the following categories:

• Trip indications
• Alarm indications
• Status indications

> ⚠️ **WARNING**
>
> Users must not attempt to repair a drive if it is faulty, nor carry out fault diagnosis other than through the use of the diagnostic features described in this chapter.
> If a drive is faulty, it must be returned to an authorized Control Techniques distributor for repair.

10.1   Status modes (Keypad)

Figure 10-1   Keypad status modes

1. Drive healthy status
2. Trip status
3. Alarm status

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information
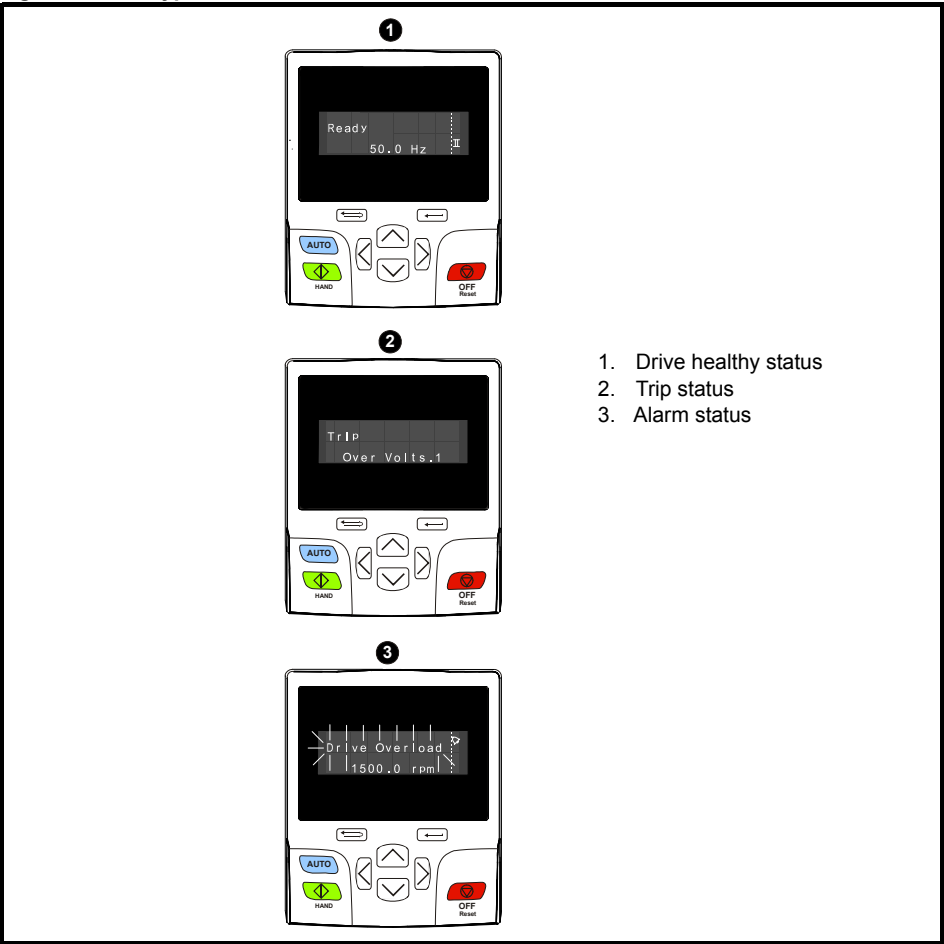
10.2 Trip indications

The output of the drive is disabled under any trip condition so that the drive stops controlling the motor. If the motor is running when the trip occurs it will coast to a stop.

During a trip condition, where a KI-HOA Keypad RTC is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip number, the sub-trip number is flashed alternately with the trip string unless there is space on the second row for both the trip string and the sub-trip number in which case both the trip string and sub-trip information is displayed separated by a decimal place.

The back-light of the KI-HOA Keypad RTC display will also flash during a trip condition.

Trips are listed alphabetically in Table 10-3 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr **10.001** 'drive healthy' using communication protocols. The most recent trip can be read in Pr **00.050** providing a trip number. It must be noted that the hardware trips (HF01 to HF20) do not have trip numbers. The trip number must be checked in Table 10-4 to identify the specific trip.

Example
1. Trip code 2 is read from Pr **00.050** via serial communications.
2. Checking Table 10-3 shows Trip 2 is an Over Volts trip.

No.	Trip
2	Over Volts
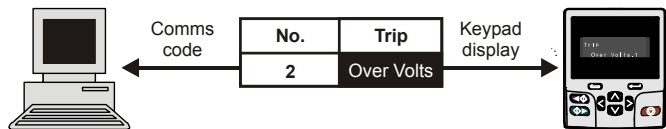
3. Look up Over Volts in Table 10-3.
4. Perform checks detailed under *Diagnosis*.

10.3 Identifying a trip / trip source

Some trips only contain a trip string whereas some other trips have a trip string along with a sub-trip number which provides the user with additional information about the trip.

A trip can be generated from a control system or from a power system. The sub-trip number associated with the trips listed in Table 10-1 is in the form xxyzz and used to identify the source of the trip.

Table 10-1 Trips associated with xxyzz sub-trip number

Over Volts	OHt dc bus
OI ac	Phase Loss
PSU	OI Snubber
OHt Inverter	OHt Rectifier
OHt Power	Temp Feedback
OHt Control	Power Data

The digits xx are 00 for a trip generated by the control system. For a single drive (not part of a multi-power module drive), if the trip is related to the power system then xx will have a value of 01, when displayed the leading zeros are suppressed.

The y digit is used to identify the location of a trip which is generated by a rectifier module connected to a power module (if xx is non zero). For a control system trip (xx is zero), the y digit, where relevant is defined for each trip. If not relevant, the y digit will have a value of zero.

The zz digits give the reason for the trip and are defined in each trip description.

Figure 10-2   Key to sub-trip number
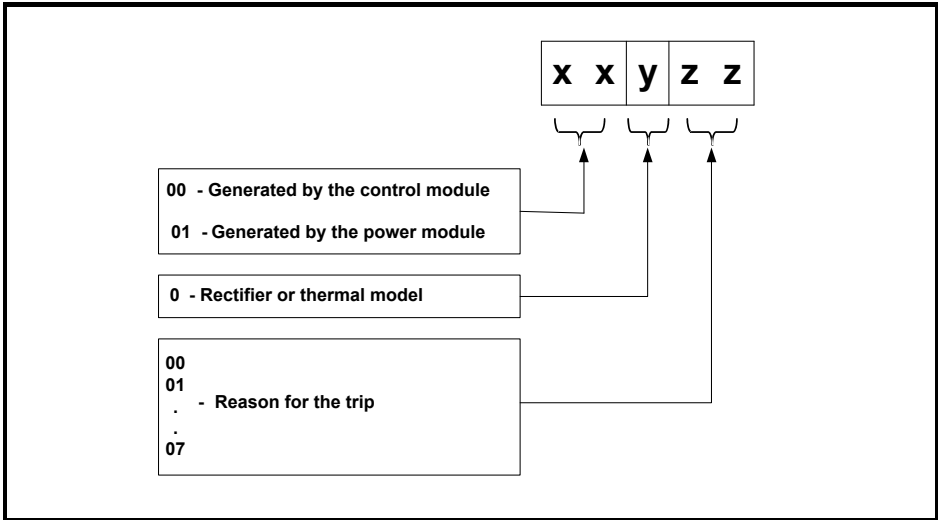
For example, if the drive has tripped and the lower line of the display shows 'OHt Control.2', with the help Table 10-2 below the trip can be interpreted as; an over temperature has been detected; the trip was generated by fault in the control module, the control board thermistor 2 over temperature.

Table 10-2   Sub-trip identification

Source	xx	y	zz	Description
Control system	00	0	01	Control board thermistor 1 over temperature
Control system	00	0	02	Control board thermistor 2 over temperature
Control system	00	0	03	Control board thermistor 3 over temperature

10.4 Trips, Sub-trip numbers

Table 10-3 Trip indications

Trip	Diagnosis
An Input 1 Loss	**Analog input 1 current loss**
28	*An Input 1 Loss* trip indicates that a current loss was detected in current mode on Analog input 1 (Terminal 5, 6). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. **Recommended actions:** • Check control wiring is correct • Check control wiring is undamaged • Check the *Analog Input 1 Mode* (07.007) • Current signal is present and greater than 3 mA
An Input 2 Loss	**Analog input 2 current loss**
29	*An Input 2 Loss* indicates that a current loss was detected in current mode on Analog input 2 (Terminal 7). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. **Recommended actions:** • Check control wiring is correct • Check control wiring is undamaged • Check the *Analog Input 2 Mode* (07.011) • Current signal is present and greater than 3 mA
An Output Calib	**Analog output calibration failed**
219	The zero offset calibration of one or both of the analogue outputs has failed. This indicates that the drive hardware has failed or a voltage is applied to the output via a low impedance, possibly due to a wiring error**.** The failed output can be identified by the sub-trip number. <table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Output 1 failed (Terminal 9)</td></tr><tr><td>2</td><td>Output 2 failed (Terminal 10)</td></tr></table> **Recommended actions:** • Check the wiring associated with analog outputs • Remove all the wiring that is connected to analog outputs and perform a re-calibration by power cycling the drive. • If trip persists replace the drive
App Menu Changed	**Customization table for an application module has changed**
217	The *App Menu Changed* trip indicates that the customization table for an application menu has changed. The menu that has been changed can be identified by the sub-trip number. <table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Menu 18</td></tr><tr><td>2</td><td>Menu 19</td></tr><tr><td>3</td><td>Menu 20</td></tr></table> If more than one menu has changed the lowest menu has priority. Drive user parameters must be saved to prevent this trip on the next power-up. **Recommended actions:** • Reset the trip and perform a parameter save to accept the new settings

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Autotune 1	**Position feedback did not change or required speed could not be reached**

	The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.

Sub-trip	Reason
1	The position feedback did not change when position feedback is being used during rotating autotune.
2	The motor did not reach the required speed during rotating autotune or mechanical load measurement.

11

Recommended actions:
- Ensure the motor is free to turn i.e. mechanical brake was released
- Ensure Pr **03.026** is set correctly (or appropriate 2nd motor map parameter)
- Check feedback device wiring is correct
- Check encoder mechanical coupling to the motor

Trip	Diagnosis
Autotune 2	**Position feedback direction incorrect**

The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number.

Sub-trip	Reason
1	The position feedback direction is incorrect when position feedback is being used during a rotating autotune
2	A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position.

12

Recommended actions:
- Check motor cable wiring is correct
- Check feedback device wiring is correct
- Swap any two motor phases

Trip	Diagnosis
Autotune 3	**Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction**

The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number.

Sub-trip	Reason
1	Measured inertia has exceeded the parameter range during a mechanical load measurement
2	The commutation signals changed in the wrong direction during a rotating autotune
3	The mechanical load test has been unable to identify the motor inertia

13

Recommended actions for sub-trip 2:
- Check motor cable wiring is correct
- Check feedback device U,V and W commutation signal wiring is correct

Recommended actions for sub-trip 3:
- Increase the test level.
- If the test was carried out at standstill repeat the test with the motor rotating within the recommended speed range.

Trip	Diagnosis
Autotune 7	**Motor number of poles / position feedback resolution set incorrectly**
17	An *Autotune 7* trip is initiated during a rotating autotune, if the motor poles or the position feedback resolution have been set up incorrectly where position feedback is being used. **Recommended actions:** • Check line per revolution for feedback device • Check the number of poles in Pr **05.011**
Autotune Stopped	**Autotune test stopped before completion**
18	The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed. **Recommended actions:** • Check the drive enable signal (Terminal 29) was active during the autotune • Check the run command was active in Pr **08.005** during autotune
Brake R Too Hot	**Braking resistor overload timed out (I^2t)**
19	The *Brake R Too Hot* indicates that braking resistor overload has timed out. The value in *Braking Resistor Thermal Accumulator* (10.039) is calculated using *Braking Resistor Rated Power* (10.030), *Braking Resistor Thermal Time Constant* (10.031) and *Braking Resistor Resistance* (10.061). The *Brake R Too Hot* trip is initiated when *Braking Resistor Thermal Accumulator* (10.039) reaches 100 %. **Recommended actions:** • Ensure the values entered in Pr **10.030**, Pr **10.031** and Pr **10.061** are correct • If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr **10.030**, Pr **10.031** or Pr **10.061** to 0 to disable the trip.
Card Access	**NV Media Card Write fail**
185	The *Card Access* trip indicates that the drive was unable to access the NV Media Card. If the trip occurs during the data transfer to the card then the file being written may be corrupted. If the trip occurs when the data being transferred to the drive then the data transfer may be incomplete. If a parameter file is transferred to the drive and this trip occurs during the transfer, the parameters are not saved to non-volatile memory, and so the original parameters can be restored by powering the drive down and up again. **Recommended actions:** • Check NV Media Card is installed / located correctly • Replace the NV Media Card
Card Boot	**The Menu 0 parameter modification cannot be saved to the NV Media Card**
177	Menu 0 changes are automatically saved on exiting edit mode. The *Card Boot* trip will occur if a write to a Menu 0 parameter has been initiated via the keypad by exiting edit mode and Pr **11.042** is set for auto or boot mode, but the necessary boot file has not been created on the NV Media Card to take the new parameter value. This occurs when Pr **11.042** is changed to Auto (3) or Boot (4) mode, but the drive is not subsequently reset. **Recommended actions:** • Ensure that Pr **11.042** is correctly set, and then reset the drive to create the necessary file on the NV Media Card • Re-attempt the parameter write to the Menu 0 parameter
Card Busy	**NV Media Card cannot be accessed as it is being accessed by an option module**
178	The *Card Busy* trip indicates that an attempt has been made to access a file on NV Media Card, but the NV Media Card is already being accessed by an option module. No data is transferred. **Recommended actions:** • Wait for the option module to finish accessing the NV Media Card and re-attempt the required function

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Card Compare	**NV Media Card file/data is different to the one in the drive**
188	A compare has been carried out between a file on the NV Media Card, a Card Compare trip is initiated if the parameters on the NV Media Card are different to the drive. **Recommended actions:** • Set Pr **mm.000** to 0 and reset the trip • Check to ensure the correct data block on the NV Media Card has been used for the compare**.**
Card Data Exists	**NV Media Card data location already contains data**
179	The *Card Data Exists* trip indicates that an attempt has been made to store data on a NV Media Card in a data block which already contains data. The data should be erased from the card first to prevent this trip. **Recommended actions:** • Erase the data in data location • Write data to an alternative data location
Card Drive Mode	**NV Media Card parameter set not compatible with current drive mode**
187	The *Card Drive Mode* trip is produced during a compare if the drive mode in the data block on the NV Media Card is different from the current drive mode. This trip is also produced if an attempt is made to transfer parameters from a NV Media Card to the drive if the operating mode in the data block is outside the allowed range of operating modes. **Recommended actions:** • Ensure the destination drive supports the drive operating mode in the parameter file. • Clear the value in Pr **mm.000** and reset the drive • Ensure destination drive operating mode is the same as the source parameter file
Card Error	**NV Media Card data structure error**
182	The *Card Error* trip indicates that an attempt has been made to access a NV media card, but an error has been detected in the data structure on the card. Resetting this trip will cause the drive to erase the <MCDF> folder from the NV media card (if it exists) and create the correct folder structure. On an SD card, whilst this trip is still present, missing directories will be created, and if the header file is missing it will be created. The following sub-trip numbers are used with this trip:

Sub-trip	Reason
1	The required folder and file structure is not present
2	The <000> file is corrupted.
3	Two or more files in the <MCDF\> folder have the same file identification number.

Recommended actions:
- Erase all the data block and re-attempt the process
- Ensure the card is located correctly
- Replace the NV Media Card

Trip	Diagnosis
Card Full	**NV Media Card full**
184	The *Card Full* trip indicates that an attempt has been made to create a data block on a NV Media Card, but there is not enough space left on the card. **Recommended actions:** • Delete a data block or the entire NV Media Card to create space • Use a different NV Media Card

Trip	Diagnosis
Card No Data	**NV Media Card data not found**
183	The *Card No Data* trip indicates that an attempt has been made to access non-existent file or block on a NV Media Card. No data is transferred. **Recommended actions:** • Ensure data block number is correct
Card Option	**NV Media Card trip; option modules installed are different between source drive and**
180	The *Card Option* trip indicates that parameter data or default difference data is being transferred from a NV Media Card to the drive, but the option module categories are different between source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the option modules that are different will be set to the default values and not the values from the card. This trip also applies if a compare is attempted between the data block and the drive. **Recommended actions:** • Ensure the correct option modules are installed. • Ensure the option modules are in the same option module slot as the parameter set stored. • Press the red reset button to acknowledge that the parameters for one or more of the option modules installed will be at their default values • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.
Card Product	**NV Media Card data blocks are not compatible with the drive derivative**

175

If *Drive Derivative* (**11.028**) or *Product Type* (**11.063**) are different between the source and target drives then this trip is initiated either at power-up or when the card is accessed. It will have one of the following sub-trip numbers:

Sub-trip	Reason
1	If *Drive Derivative* (**11.028**) is different between the source and target drives, this trip is initiated either at power-up or when the SD Card is accessed. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in parameter xx.000, and resetting the drive (this applies the warning suppression flag to the card).
2	If *Product Type* (**11.063**) is different between the source and target drives or if corruption is detected in the parameter file, this trip is initiated either at power-up or when the SD Card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card.
3	A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr **xx.000**, and resetting the drive (this applies the warning suppression flag to the card).

Recommended actions:
• Use a different NV Media Card
• This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Card Rating	**NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different**
186	The Card Rating trip indicates that parameter data is being transferred from a NV Media Card to the drive, but the current and / or voltage ratings are different between source and destination drives. This trip also applies if a compare (using Pr **mm.000** set to 8yyy) is attempted between the data block on a NV Media Card and the drive. The Card Rating trip does not stop the data transfer but is a warning that rating specific parameters with the RA attribute may not be transferred to the destination drive. **Recommended actions:** • Reset the drive to clear the trip • Ensure that the drive rating dependent parameters have transferred correctly • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.
Card Read Only	**NV Media Card has the Read Only bit set**
181	The *Card Read Only* trip indicates that an attempt has been made to modify a read-only NV Media Card or a read-only data block. A NV Media Card is read-only if the read-only flag has been set. **Recommended actions:** • Clear the read only flag by setting Pr **mm.000** to 9777 and reset the drive. This will clear the read-only flag for all data blocks in the NV Media Card • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.
Card Slot	**NV Media Card Trip; Option module application program transfer has failed**
174	The *Card Slot* trip is initiated, if the transfer of an option module application program to or from an application module failed because the option module does not respond correctly. If this happens this trip is produced with the sub-trip indicating the option module slot number. **Recommended actions:** • Ensure the source / destination option module is installed on the correct slot
Configuration	**The number of power modules installed is different from the modules expected**
111	The *Configuration* trip indicates that the *Number Of Power Modules Detected* (**11.071**) does not match the previous value stored. The sub-trip value indicates the number of power modules expected. **Recommended actions:** • Ensure that all the power modules are correctly connected • Ensure all the power modules have powered up correctly • Ensure that the value in Pr **11.071** is set to the number of power modules connected • Set Pr **11.035** to 0 to disable the trip if it is not required This trip is also initiated if the number of external rectifiers connected to each power module is less than the number defined by Number Of Rectifiers Expected (11.096). If this is the reason for the trip the sub-trip is 10x where x is the number of external rectifiers that should be connected. **Recommended actions:** • Ensure that all the external rectifiers are connected correctly. • Ensure that the value in *Number Of Rectifiers Expected* (**11.096**) is correct.
Control Word	**Trip initiated from the *Control Word* (06.042)**
35	The *Control Word* trip is initiated by setting bit 12 on the control word in Pr **06.042** when the control word is enabled (Pr **06.043** = On). **Recommended actions:** • Check the value of Pr **06.042**. • Disable the control word in *Control Word Enable* (Pr **06.043**) Bit 12 of the control word set to a one causes the drive to trip on Control Word When the control word is enabled, the trip can only be cleared by setting bit 12 to zero

Trip	Diagnosis
Current Offset	**Current feedback offset error**
225	The current feedback offset is too large to be trimmed correctly. The sub-trip relates to the output phase for which the offset error has been detected. <table><tr><th>Sub-trip</th><th>Phase</th></tr><tr><td>1</td><td>U</td></tr><tr><td>2</td><td>V</td></tr><tr><td>3</td><td>W</td></tr></table> **Recommended actions:** • Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled • Hardware fault – Contact the supplier of the drive
Data Changing	**Drive parameters are being changed**
97	A user action or a file system write is active that is changing the drive parameters and the drive has been commanded to enable, i.e. *Drive Active* (**10.002**) = 1.The user actions that change drive parameters are loading defaults, changing drive mode, or transferring data from an NV memory card or a position feedback device to the drive. The file system actions that will cause this trip to be initiated if the drive is enabled during the transfer are writing a parameter or macro file to the drive, or transferring a derivative or user program to the drive. It should be noted that none of these actions can be started if the drive is active, and so the trip only occurs if the action is started and then the drive is enabled. **Recommended actions:** Ensure the drive is not enabled when one of he following is being carried out: • Loading defaults • Changing drive mode • Transferring data from NV Media Card or position feedback device • Transferring user programs
Derivative ID	**There is a problem with the identifier associated with derivative image which**
247	There is a problem with the identifier associated with derivative image which customizes the drive. The reason for the trip is given by the sub-trip as follows: <table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>There should be a derivative image in the product but this has been erased.</td></tr><tr><td>2</td><td>The identifier is out of range.</td></tr><tr><td>3</td><td>The derivative image has been changed.</td></tr></table>

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Derivative	**Derivative Image error**

| | The *Derivative Image* trip indicates that an error has been detected in the derivative image. The sub-trip number indicates the reason for the trip. |

	Sub-trip	**Reason**	**Comments**
248	1 to 52	An error has been detected in the derivative image, contact the supplier of the drive.	
	61	The option module fitted in slot 1 is not allowed with the derivative image	Occurs when the drive powers-up or the image is programmed. The image tasks will not run.
	62	The option module fitted in slot 2 is not allowed with the derivative image	
	63	The option module fitted in slot 3 is not allowed with the derivative image	
	64	The option module fitted in slot 4 is not allowed with the derivative image	
	70	An option module that is required by the derivative image is not fitted in any slot	Occurs when the drive powers-up or the image is programmed. The image tasks will not run.
	71	An option module specifically required to be fitted in slot 1 not present	
	72	An option module specifically required to be fitted in slot 2 not present	
	73	An option module specifically required to be fitted in slot 3 not present	
	74	An option module specifically required to be fitted in slot 4 not present	
	80 to 81	An error has been detected in the derivative image, contact the supplier of the drive.	

| | **Recommended action:** |
| | Contact the supplier of the drive |

Destination	**Two or more parameters are writing to the same destination parameter**
199	The *Destination* trip indicates that destination output parameters of two or more logic functions (Menus 5, 7, 8, 9, 12 or 14) within the drive are writing to the same parameter.
	Recommended actions:
	• Set Pr **mm.000** to 'Destinations' or 12001 and check all visible parameters in all menus for parameter write conflicts

Drive Size	**Power stage recognition: Unrecognized drive size**
224	The *Drive Size* trip indicates that the control PCB has not recognized the drive size of the power circuit to which it is connected.
	Recommended action:
	• Ensure the drive is programmed to the latest firmware version
	• Hardware fault - return drive to supplier

Trip	Diagnosis
EEPROM Fail	**Default parameters have been loaded**
31	The *EEPROM Fail* trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number.

Sub-trip	Reason
1	The most significant digit of the internal parameter database version number has changed
2	The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded
3	The drive mode restored from internal non-volatile memory is outside the allowed range for the product or the derivative image does not allow the previous drive mode
4	The drive derivative image has changed
5	The power stage hardware has changed
6	The internal I/O hardware has changed
7	The position feedback interface hardware has changed
8	The control board hardware has changed
9	The checksum on the non-parameter area of the EEPROM has failed

The drive holds two banks of user save parameters and two banks of power down save parameters in non-volatile memory. If the last bank of either set of parameters that was saved is corrupted a User Save or Power Down Save trip is produced. If one of these trips occurs the parameters values that were last saved successfully are used. It can take some time to save parameters when requested by the user and if the power is removed from the drive during this process it is possible to corrupt the data in the non-volatile memory.

If both banks of user save parameters or both banks of power down save parameters are corrupted or one of the other conditions given in the table above occurs EEPROM Fail.xxx trip is produced. If this trip occurs it is not possible to use the data that has been saved previously, and so the drive will be in lowest allowed drive mode with default parameters. The trip can only be reset if Pr **mm.000** (mm.000) is set to 10, 11, 1233 or 1244 or if *Load Defaults* (11.043) is set to a non-zero value.

Recommended actions:
- Default the drive and perform a reset
- Allow sufficient time to perform a save before the supply to the drive is removed
- If the trip persists - return drive to supplier

Trip	Diagnosis
Encoder 9	**Position feedback is selected from a option module slot which does not have a feedback option module installed**
197	The *Encoder 9* trip indicates that position feedback source selected in Pr **03.026** is not valid **Recommended actions:** - Check the setting of Pr **03.026** - Ensure that the option slot selected in Pr **03.026** has a feedback option module installed

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
External Trip	**An External trip is initiated**
6	An *External Trip* has occurred. The cause of the trip can be identified from the sub trip number displayed after the trip string. See table below. An external trip can also be initiated by writing a value of 6 in Pr **10.038**.

Sub-trip	Reason
1	*External Trip Mode* (08.010) = 1 or 3 and Safe Torque Off input 1 is low
2	*External Trip Mode* (08.010) = 2 or 3 and Safe Torque Off input 2 is low
3	*External Trip* (10.032) = 1

Recommended actions:
- Check the Safe Torque Off signal voltage on terminal 29 equals to 24 V
- Check the value of Pr **08.009** which indicates the digital state of terminal 29, equates to 'on'.
- If external trip detection of the Safe Torque Off input is not required, set Pr **08.010** to Off (0).
- Check the value of Pr **10.032**.
- Select 'Destinations' (or enter 12001) in Pr **mm.000** and check for a parameter controlling Pr **10.032**.
- Ensure Pr **10.032** or Pr **10.038** (= 6) is not being controlled by serial comms

Trip	Diagnosis
HF01	**Data processing error: CPU address error**
	The *HF01* trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF02	**Data processing error: DMAC address error**
	The *HF02* trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF03	**Data processing error: Illegal instruction**
	The *HF03* trip indicates that an illegal instruction has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF04	**Data processing error: Illegal slot instruction**
	The *HF04* trip indicates that an illegal slot instruction has occurred.This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF05	**Data processing error: Undefined exception**
	The *HF05* trip indicates that an undefined exception error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF06	**Data processing error: Reserved exception**
	The *HF06* trip indicates that a reserved exception error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:
- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF07	**Data processing error: Watchdog failure**
	The *HF07* trip indicates that a watchdog failure has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF08	**Data processing error: CPU Interrupt crash**
	The *HF08* trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF09	**Data processing error: Free store overflow**
	The *HF09* trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF10	**Data processing error: Parameter routing system error**
	The *HF10* trip indicates that a Parameter routing system error has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF11	**Data processing error: Access to EEPROM failed**
	The *HF11* trip indicates that access to the drive EEPROM has failed. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF12	**Data processing error: Main program stack overflow**
	The *HF12* trip indicates that the main program stack over flow has occurred. The stack can be identified by the sub-trip number. This trip indicates that the control PCB on the drive has failed.

Sub-trip	Stack
1	Background tasks
2	Timed tasks
3	Main system interrupts

Recommended actions:

• Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
HF13	**Data processing error: Firmware incompatible with hardware**
	The *HF13* trip indicates that the drive firmware is not compatible with the hardware. This trip indicates that the control PCB on the drive has failed. The sub-trip number gives the actual ID code of the control board hardware.
	Recommended actions:
	• Re-program the drive with the latest version of the drive firmware • Hardware fault – Contact the supplier of the drive
HF14	**Data processing error: CPU register bank error**
	The *HF14* trip indicates that a CPU register bank error has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
HF15	**Data processing error: CPU divide error**
	The *HF15* trip indicates that a CPU divide error has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF16	**Data processing error: RTOS error**
	The *HF16* trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF17	**Data processing error: Clock supplied to the control board is out of specification**
	The *HF17* trip indicates that the clock supplied to the control board logic is out of specification. This trip indicates that the control PCB on the drive has failed.
	Recommended actions:
	• Hardware fault – Contact the supplier of the drive
HF18	**Data processing error: Internal flash memory has failed**
	The *HF18* trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	Option module initialization timed out
2	Programming error while writing menu in flash
3	Erase flash block containing setup menus failed
4	Erase flash block containing application menus failed
5	Incorrect setup menu CRC contained in flash
6	Incorrect application menu CRC contained in flash
7	Incorrect common application menu 18 CRC contained in flash
8	Incorrect common application menu 19 CRC contained in flash
9	Incorrect common application menu 20 CRC contained in flash

Trip	Diagnosis
	Recommended actions:
	• Hardware fault - Contact the supplier of the drive.
HF19	**Data processing error: CRC check on the firmware has failed**
	The *HF19* trip indicates that the CRC check on the drive firmware has failed.
	Recommended actions:
	• Re-program the drive
	• Hardware fault - Contact the supplier of the drive
HF20	**Data processing error: ASIC is not compatible with the hardware**
	The *HF20* trip indicates that the ASIC version is not compatible with the drive firmware. The ASIC version can be identified from the sub-trip number.
	Recommended actions:
	• Hardware fault - Contact the supplier of the drive
HF23 to HF25	**Hardware fault**
	Recommended actions:
	• Hardware fault - Contact the supplier of the drive

Trip	Diagnosis
I/O Overload	**Digital output overload**
26	The *I/O Overload* trip indicates that the total current drawn from 24 V user supply or from the digital output has exceeded the limit. A trip is initiated if one or more of the following conditions: • Maximum output current from one digital output is 100 mA. • The combined maximum output current from outputs 1 and 2 is 100 mA • The combined maximum output current from output 3 and +24 V output is 100 mA **Recommended actions:** • Check total loads on digital outputs • Check control wiring is correct • Check output wiring is undamaged

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Inductance	**This trip occurs in RFC-S mode when the drive has detected that the motor**
8	This trip occurs in RFC-S mode when the drive has detected that the motor inductances are not suitable for the operation being attempted. The trip is either caused because the ratio or difference between Ld and Lq is too small or because the saturation characteristic of the motor cannot be measured.

This trip occurs in RFC-S mode when the drive has detected that the motor inductances are not suitable for the operation being attempted. The trip is either caused because the ratio or difference between Ld and Lq is too small or because the saturation characteristic of the motor cannot be measured.

If the inductance ratio or difference is too small this is because one of the following conditions is true:

(No-load Lq (05.072)- Ld (05.024)) / Ld (05.024) < 0.1

(No-load Lq (05.072) - Ld (05.024)) < (K / Full Scale Current Kc (11.061))H

where:

Drive Rated voltage (11.033)	K
200 V	0.0073
400 V	0.0146
575 V	0.0174
690 V	0.0209

If the saturation characteristic of the motor cannot be measured this is because when the flux in the motor is changed the measured value of Ld does change sufficiently due to saturation to be measured. When half of *Rated Current* (05.007) is applied in the d axis of the motor in each direction the inductance must fall change at least (K / (2 x *Full Scale Current Kc* (11.061))) H.

The specific reasons for each of the sub-trips and recommended actions are given in the table below.

Sub-trip	Reason
1	The inductance ratio or difference is too small when the drive has been started in sensorless mode.
2	The saturation characteristic of the motor cannot be measured when the drive has been started in sensorless mode.
3	The inductance ratio or difference is too small when an attempt is made to determine the location of the motor flux during a stationary auto-tune in RFC-S mode. This trip is also produced when the inductance ratio or inductance difference is too small when carrying out a phasing test on starting in RFC-S mode. If position feedback is being used the measured value for *Position Feedback Phase Angle* (03.025) may not be reliable. Also the measured values of *Ld* (05.024) and *No-load Lq* (05.072) may not correspond to the d and q axis respectively.
4	The direction of the flux in the motor is detected by the change of inductance with different currents. This trip is initiated if the change cannot be detected when an attempt is made to perform a stationary auto-tune when position feedback is being used, or to perform a phasing test on starting in RFC-S mode.

Recommended actions for sub-trip 1:
• Ensure that RFC Low Speed Mode (05.064) is set to Non-salient (1), Current (2) or Current No test (3).

Recommended Actions For Sub-trip 2:
• Ensure that RFC Low Speed Mode (05.064) is set to Non-salient (1), Current (2) or Current No test (3).

Recommended actions for sub-trip 3:
• None. The trip acts as a warning.

Recommended actions for sub-trip 4:
• Stationary autotune is not possible. Perform a minimal movement or rotating autotune.
• Phasing test on starting is not possible. Use a position feedback device with commutation signals or absolute position.

Trip	Diagnosis
Inter-connect	**Multi-power module drive interconnection cable error**
103	The sub-trip "xx.0.00" indicates which power module has detected the fault where xx is the power module number. It should be noted that this trip is also initiated if the communication fails either when a rectifier signals a fault or a trip is reset. In this case, the sub-trip is the number of modules that are still communicating correctly.
Keypad Mode	**Keypad has been removed when the drive is receiving the speed reference from the keypad**
34	The *Keypad Mode* trip indicates that the drive is in keypad mode [*Reference Selector* (**01.014**) = 4 or 6 or M2 reference selector (**21.003** = 4 or 6 if motor map 2 is selected] and the keypad has been removed or disconnected from the drive. **Recommended actions:** • Re-install keypad and reset • Change *Reference Selector* (**01.014**) to select the reference from another source
Motor Too Hot	**Output current overload timed out (I^2t)**
20	The *Motor Too Hot* trip indicates a motor thermal overload based on the rated current (Pr **05.007**) and motor thermal time constant (Pr **04.015**). Pr **04.019** displays the motor temperature as a percentage of the maximum value. The drive will trip on *Motor Too Hot* when Pr **04.019** gets to 100 %. **Recommended actions:** • Ensure the load is not jammed / sticking • Check the load on the motor has not changed • If seen during an auto-tune test in RFC-S mode, ensure the motor rated current in Pr **05.007** is ≤ Heavy duty current rating of the drive • Tune the rated speed parameter (RFC-A mode only) • Check feedback signal for noise • Ensure the motor rated current is not zero

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Name Plate	**Electronic nameplate transfer has failed**

176	The *Name Plate* trip is initiated if an electronic name plate transfer between the drive and the motor has failed. The exact reason for the trip can be identified from the sub-trip number.

Sub-trip	Description
1	Not enough memory space to complete the transfer
2	Communication with encoder failed
3	The transfer has failed
4	The checksum of the stored object has failed

Recommended actions:
- Ensure that the device encoder memory has at least 128 bytes to store the nameplate data
- When writing the motor object (xx.000 = 11000), ensure that the device encoder memory has at least 256 bytes to store all the nameplate data.
- When transferring between option module and encoder, ensure that the option slot has a feedback option module installed.
- Check if the encoder has been initialized, *Position Feedback Initialized* (03.076).
- Verify the encoder wiring.

Trip	Diagnosis
OHt Brake	**Braking IGBT over-temperature**

101	The *OHt Brake* over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model.

Recommended actions:
- Check braking resistor value is greater than or equal to the minimum resistance value

Trip	Diagnosis
OHt Control	**Control stage over temperature**

This *OHt Control* trip indicates that a control stage over-temperature has been detected. From the sub-trip 'xxyzz', the Thermistor location is identified by 'zz'.

Source	xx	y	zz	Description
Control system	00	0	01	Control board thermistor 1 over
Control system	00	0	02	Control board thermistor 2 over
Control system	00	0	03	I/O board thermistor over

Recommended actions:
- Check enclosure / drive fans are still functioning correctly
- Check enclosure ventilation paths
- Check enclosure door filters
- Increase ventilation
- Reduce the drive switching frequency
- Check ambient temperature

The trip number **23** applies to the OHt Control section.

Trip	Diagnosis

OHt dc bus	DC bus over temperature

The *OHt dc bus* trip indicates a DC bus component over temperature based on a software thermal model. The drive includes a thermal protection system to protect the DC bus components within the drive. This includes the effects of the output current and DC bus ripple. The estimated temperature is displayed as a percentage of the trip level in Pr **07.035**. If this parameter reaches 100 % then an *OHt dc bus* trip is initiated. The drive will attempt to stop the motor before tripping. If the motor does not stop in 10 seconds the drive trips immediately.

Source	xx	y	zz	Description
Control	00	2	00	DC bus thermal model gives trip with

It is also possible in a multi-power module system for DC bus over-temperature to be detected from within the power stage. From this source the estimated temperature as a percentage of trip is not available and the trip is indicated as follows:

Source	xx	y	zz	Description
Control	01	0	00	Power stage gives trip with sub-trip 0

Recommended actions:
- Check the AC supply voltage balance and levels
- Check DC bus ripple level
- Reduce duty cycle
- Reduce motor load
- Check the output current stability. If unstable;
  Check the motor map settings with motor nameplate (Pr **05.006**, Pr **05.007**, Pr **05.008**, Pr **05.009**, Pr **05.010**, Pr **05.011**) – (All Modes)
  Disable slip compensation (Pr **05.027** = 0) – (Open loop)
  Disable dynamic V to F operation (Pr **05.013** = 0) - (Open loop)
  Select fixed boost (Pr **05.014** = Fixed) – (Open loop)
  Select high stability space vector modulation (Pr **05.020** = 1) – (Open loop)
  Disconnect the load and complete a rotating autotune (Pr **05.012**) – (RFC-A, RFC-S)
  Reduce speed loop gains (Pr **03.010**, Pr **03.011**, Pr **03.012**) – (RFC-A, RFC-S)
  Add a speed feedback filter value (Pr **03.042)** – (RFC-A, RFC-S)
  Add a current demand filter (Pr **04.012**) – (RFC-A, RFC-S)
  Check encoder signals for noise with an oscilloscope (RFC-A, RFC-S)
  Check encoder mechanical coupling - (RFC-A, RFC-S)

The **27** trip number appears in the leftmost column.

OHt Inverter	Inverter over temperature based on thermal model

This trip indicates that an IGBT junction over-temperature has been detected based on a firmware thermal model. The sub-trip indicates which model has initiated the trip in the form xxyzz as given below:

Source	xx	y	zz	Description
Control system	00	1	00	Inverter thermal model
Control system	00	3	00	Braking IGBT thermal model

Recommended actions with sub-trip 100:
- Reduce the selected drive switching frequency
- Ensure *Auto-switching Frequency Change Disable* (05.035) is set to Off
- Reduce duty cycle
- Increase acceleration / deceleration rates
- Reduce motor load
- Check DC bus ripple
- Ensure all three input phases are present and balanced

Recommended actions with sub-trip 300:
- Reduce the braking load.

The **21** trip number appears in the leftmost column.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
OHt Power	**Power stage over temperature**
22	This trip indicates that a power stage over-temperature has been detected. The sub-trip "xxyzz" indicates which thermistor is indicating the over-temperature. The thermsitor numbering is different for a single module type drive (i.e. no parallel board fitted) and a multi-module type drive (i.e. parallel board fitted with one or more power modules) as shown below: **Single module type drive:** 	Source	xx	y	zz	Description
---	---	---	---	---
Power system	01	0	zz	Thermistor location defined by zz in
Power system	01	Rectifier	zz	Thermistor location defined by zz in | **Multi-module type system:** | Source	xx	y	zz	Description
---	---	---	---	---
Power system	power module number	0	01	U phase power device
Power system	power module number	0	02	V phase power device
Power system	power module number	0	03	W phase power device
Power system	power module number	0	04	Rectifier
Power system	power module number	0	05	General power system
Power system	power module number	0	00	Braking IGBT	 Note that the power module that has caused the trip cannot be identified except for the braking IGBT temperature measurement **Recommended actions:** • Check enclosure / drive fans are still functioning correctly • Force the heatsink fans to run at maximum speed • Check enclosure ventilation paths • Check enclosure door filters • Increase ventilation • Reduce the drive switching frequency • Reduce duty cycle • Decrease acceleration / deceleration rates • Reduce motor load • Check the derating tables and confirm the drive is correctly sized for the application. • Use a drive with larger current / power rating

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
OI ac	**Instantaneous output over current detected**

| | The instantaneous drive output current has exceeded VM_DRIVE_CURRENT_MAX. This trip cannot be reset until 10 s after the trip was initiated. |

Source	xx	y	zz	Description
Control system	00	0	00	Instantaneous over-current trip when the measured a.c. current exceeds VM_DRIVE_CURRENT[MAX].
Power system	Power module number	0		

Recommended actions:

(Trip **3**)

- Acceleration/deceleration rate is too short
- If seen during auto-tune reduce the voltage boost
- Check for short circuit on the output cabling
- Check integrity of the motor insulation using an insulation tester
- Check feedback device wiring
- Check feedback device mechanical coupling
- Check feedback signals are free from noise
- Is motor cable length within limits for the frame size
- Reduce the values in the speed loop gain parameters - (Pr **03.010**, **03.011**, **03.012**) or (Pr **03.013**, **03.014**, **03.015**)
- Has the phase angle autotune been completed? (RFC-S mode only)
- Reduce the values in current loop gain parameters (RFC-A, RFC-S modes only)

Trip	Diagnosis
OI Brake	**Braking IGBT over current detected: short circuit protection for the braking IGBT activated**

| | The *OI Brake* trip indicates that over current has been detected in braking IGBT or braking IGBT protection has been activated. This trip cannot be reset until 10 s after the trip was |

Source	xx	y	zz	Description
Power system	Power module number	0	00	Braking IGBT instantaneous over-current trip

(Trip **4**)

initiated.

Recommended actions:

- Check brake resistor wiring
- Check braking resistor value is greater than or equal to the minimum resistance value
- Check braking resistor insulation

Trip	Diagnosis
OI dc	**Power module over current detected from IGBT on state voltage monitoring**
109	The *OI dc* trip indicates that the short circuit protection for the drive output stage has been activated. The table below shows where the trip has been detected..This trip cannot be reset until 10 s after the trip was initiated.

Source	xx	y	zz
Control system	00	0	00
Power system	Power module number	0	00

Recommended actions:
- Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester
- Replace the drive

Trip	Diagnosis
OI Snubber	**Snubber over-current detected**
92	The *OI Snubber* trip indicates that an over-current condition has been detected in the rectifier snubber circuit. The reason for the trip can be identified by the sub-trip number.

Source	xx	y	zz	Description
Power system	01	Rectifier number*	00	Rectifier snubber over-current trip detected.

* For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.

Recommended actions:
- Ensure the internal EMC Filter is installed
- Ensure the motor cable length does not exceed the maximum for selected switching frequency
- Check for supply voltage imbalance
- Check for supply disturbance such as notching from a DC drive
- Check the motor and motor cable insulation with an insulation tester
- Fit an output line reactor or sinusoidal filter

Trip	Diagnosis
Option Disable	**Option module does not acknowledge during drive mode changeover**
215	During drive mode changeover option modules must acknowledge that they have stopped accessing the communications system between the option slots and the drive. If an option module does not do this in the allowed time then this trip is produced.

Recommended trip:
- Reset the trip
- If the trip persists replace the option module

Trip	Diagnosis
Out Phase Loss	**Output phase loss detected**

The *Out Phase Loss* trip indicates that a phase loss has been detected at the drive output.

Note that if Reverse Output Phase Sequence (05.042) = 1 the physical output phases are reversed, and so sub-trip 3 refers to physical output phase V and sub-trip 2 refers to physical output phase W.

Sub-trip	Reason
1	U phase detected as disconnected when drive enabled to run
2	V phase detected as disconnected when drive enabled to run
3	W phase detected as disconnected when drive enabled to run
4	Output phase loss detected when the drive is running

98

Recommended action:
- Check motor and drive connections
- To disable the trip set *Output Phase Loss Detection Enable* (06.059) = 0

Trip	Diagnosis
Over Speed	**Motor speed has exceeded the over speed threshold**

7

In open loop mode, if the *Output Frequency* (05.001) exceeds the threshold set in *Over Speed Threshold* (03.008) in either direction an Over Speed trip is produced. In RFC-A and RFC-S mode, if the Speed Feedback (03.002) exceeds the Over Speed Threshold in Pr **03.008** in either direction an Over Speed trip is produced. If Pr **03.008** is set to 0.0 the threshold is then equal to 1.2 x the value set in Pr **01.006**.

In RFC-A and RFC-S modes if an SSI encoder is being used and P1 SSI Incremental Mode (03.047) is set to Off, an Over Speed trip will be produced when the encoder passes through the boundary between its maximum position and zero.

The above description relates to a standard over speed trip, however in RFC-S mode it is possible to produce an Overspeed trip with sub-trip 1. This is caused if the speed is allowed to exceed the safe level in RFC-S mode with flux weakening. See Enable High Speed Mode (05.022) for details.

Recommended actions:
- Check the motor is not being driven by another part of the system
- Reduce the *Speed Controller Proportional Gain* (03.010) to reduce the speed overshoot (RFC-A, RFC-S modes only)
- If an SSI encoder is being used set Pr **03.047** to 1

The above description relates to a standard Over Speed trip, however in RFC-S mode it is possible to produce an *Over Speed.1* trip. This is caused if the speed is allowed to exceed the safe level in RFC-S mode with flux weakening when *Enable High Speed Mode* (05.022) is set to -1.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Over Volts	**DC bus voltage has exceeded the peak level or maximum continuous level for 15**

2	The *Over Volts* trip indicates that the DC bus voltage has exceeded the VM_DC_VOLTAGE[MAX] or VM_DC_VOLTAGE_SET[MAX] for 15 s. The trip threshold varies depending on voltage rating of the drive as shown below.

Voltage rating	VM_DC_VOLTAGE[MAX]	VM_DC_VOLTAGE_SET[MAX]
200	415	410
400	830	815
575	990	970
690	1190	1175

Sub-trip Identification

Source	xx	y	zz
Control system	00	0	01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].
Control system	00	0	02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].

Recommended actions:
- Increase deceleration ramp (Pr **00.004**)
- Decrease the braking resistor value (staying above the minimum value)
- Check nominal AC supply level
- Check for supply disturbances which could cause the DC bus to rise
- Check motor insulation using an insulation tester

Trip	Diagnosis
Phase Loss	**Supply phase loss**
32	This trip indicates that the drive has detected an input phase loss or large supply imbalance. Phase loss can be detected directly from the supply where the drive has a thyristor base charge system (Frame size 7 and above). If phase loss is detected using this method the drive trips immediately and the xx part of the sub-trip is set to 01. In all sizes of drive phase loss is also detected by monitoring the ripple in the DC bus voltage in which case the drive attempts to stop the drive before tripping unless bit 2 of *Action On Trip Detection* (10.037) is set to one. When phase loss is detected by monitoring the ripple in the DC bus voltage the xx part of the sub-trip is zero.

Source	xx	y	zz
Control system	00	0	00: Phase loss detected from DC bus ripple
Power system (1)	Power module number	Rectifier number (2)	00: Phase loss detected directly from the supply

(1) Input phase loss detection can be disabled when the drive required to operate from the DC supply or from a single phase supply in *Input Phase Loss Detection Mode* (06.047).

(2) For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.

This trip does not occur in regen mode.

Recommended actions:
- Check the AC supply voltage balance and level at full load
- Check the DC bus ripple level with an isolated oscilloscope
- Check the output current stability
- Reduce the duty cycle
- Reduce the motor load
- Disable the phase loss detection, set Pr **06.047** to 2.
- Check for mechanical resonance with the load

Trip	Diagnosis
Phasing error	**This indicates that the phase offset angle is incorrect**
198	This indicates that the phase offset angle in *Position Feedback Phase Angle* (03.025) (or *M2 Position Feedback Phase Angle* (21.020) if the second motor map is being used) is incorrect if position feedback is being used and the drive is unable to control the motor correctly.

Recommended actions:
- Check the encoder wiring.
- Check the encoder signals for noise with an oscilloscope.
- Check encoder mechanical coupling.
- Perform an auto-tune to measure the encoder phase angle or manually enter the correct phase angle into *Position Feedback Phase Angle* (03.025).
- Spurious Phasing Error trips can sometimes be seen in very dynamic applications. This trip can be disabled by setting *Over Speed Threshold* (03.008) to a value greater than zero.

If sensorless control is being used this indicates that significant instability has occurred and the motor has accelerated without control.

Recommended actions:
- Ensure that the motor parameters are set-up correctly.
- Reduce the speed controller gains.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis			
Power Comms	**A Power Comms trip indicates a communications problem within the power system of the drive**			

A Power Comms trip indicates a communications problem within the power system of the drive. The reason for the trip can be identified by the sub-trip number.

	Type of drive	xx	y	zz
90	Control system	Power module number	Rectifier number*	00: Excessive communications errors detected by the rectifier module

* For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.

Recommended actions:
• Hardware fault – Contact the supplier of the drive

Trip	Diagnosis			
Power Data	**Power system configuration data error**			

The *Power Data* trip indicates that there is an error in the configuration data stored in the power system.

	Source	xx	y	zz	Description
220	Control system	00	0	02	There is no data table to be uploaded to the control board
	Control system	00	0	03	The power system data table is bigger than the space available in the control pod to store it.
	Control system	00	0	04	The size of the table given in the table is incorrect.
	Control system	00	0	05	Table CRC error.
	Control system	00	0	06	The version number of the generator software that produced the table is too low. i.e. a table from a newer generator is required that includes features that have been added to the table that may not be present.
	Power system	Power module number	0	00	The power data table used internally by the power module has an error. (For a multi-power module drive this indicates any error with the code tables in the power system).
	Power system	Power module number	0	01	The power data table that is uploaded to the control system on power up has an error.
	Power system	Power module number	0	02	The power data table used internally by the power module does not match the hardware identification of the power module.

Recommended actions:
• Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
Power Down Save	**Power down save error**
37	The *Power Down Save* trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory. **Recommended actions:** • Perform a 1001 save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up.
PSU	**Internal power supply fault**
5	The *PSU* trip indicates that one or more internal power supply rails are outside limits or overloaded.

Source	xx	y	Description
Control system	00	0	Internal power supply overload
Power system	Power module number	Rectifier number*	Rectifier internal power supply overload

*For a parallel power-module system the rectifier number will be zero as it is not possible to determine which rectifier has detected the fault.

Recommended actions:
• Remove any option modules and perform a reset
• Remove encoder connection and perform a reset
• Hardware fault within the drive – return the drive to the supplier

Trip	Diagnosis
PSU 24V	**24V internal power supply overload**
9	The total user load of the drive and option modules has exceeded the internal 24 V power supply limit. The user load consists of the drive digital outputs and main encoder supply. **Recommended actions:** • Reduce the load and reset • Provide an external 24 V power supply on control terminal 2 • Remove all option modules

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Rating Mismatch	**Power stage recognition: Multi module voltage or current rating mismatch**
223	The *Rating Mismatch* trip indicates that there is a voltage rating or current rating mismatch in a multi-module drive system. This trip is only applicable to modular drives that are connected in parallel. A mixture of power modules with different voltage or current ratings within the same multi-module drive system is not allowed and will cause a Rating Mismatch trip. **Recommended action:** • Ensure that all modules in a multi-modular drive system are of the same frame size and rating (voltage and current) • Hardware fault – Contact the supplier of the drive
Rectifier Set-up	**A rectifier has not been set-up correctly in a multi-power module system.**
94	A rectifier has not been set-up correctly in a multi-power module system. Recommended action: • Check the inter-power module wiring
Reserved	**Reserved trips**
01 95 102 104 - 108 161-168 170-173 222 228-246	These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.
Resistance	**Measured resistance has exceeded the parameter range**
33	This trip indicates that either the value being used for motor stator resistance is too high or that an attempt to do a test involving measuring motor stator resistance has failed. The maximum for the stator resistance parameters is generally higher than the maximum value that can be used in the control algorithms. If the value exceeds (VFS / v2) / *Full Scale Current Kc* (11.061), where VFS is the full scale DC bus voltage then this trip is initiated. If the value is the result of a measurement made by the drive then sub-trip 1 is applied, or if it is because the parameter has been changed by the user then sub-trip 3 is applied. During the stator resistance section of auto-tuning an additional test is performed to measured the drive inverter characteristics to provide the compensation necessary for dead-times. If the inverter characteristic measurement fails then sub-trip 2 is applied. {{SUBTABLE}} **Recommended actions:** • Check that the value that has been entered in the stator resistance does not exceed the allowed range (for the presently selected motor map) • Check the motor cable / connections • Check the integrity of the motor stator winding using an insulation tester • Check the motor phase to phase resistance at the drive terminals • Check the motor phase to phase resistance at the motor terminals • Ensure the stator resistance of the motor falls within the range of the drive model • Select fixed boost mode (Pr **05.014** = Fixed) and verify the output current waveforms with an oscilloscope • Replace the motor

Sub-trip	Reason
1	Measured stator resistance exceeded the allowed range
2	It was not possible to measure the inverter characteristic
3	The stator resistance associated with the presently selected motor map exceeds the allowed range

Trip	Diagnosis
Slot App Menu	**Application menu Customization conflict error**
216	The Slot App Menu trip indicates that more than one option slot has requested to customize the application menus 18, 19 and 20. The sub-trip number indicates which option slot has been allowed to customize the menus. **Recommended actions:** • Ensure that only one of the Application modules is configured to customize the application menus 18, 19 and 20
SlotX Different	**Option module in option slot X has changed**
204 209 214	The *SlotX Different* trip indicates that the option module in option slot X on the drive is a different type to that installed when parameters were last saved on the drive. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	No module was installed previously
2	A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu.
3	A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu.
4	A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus.
>99	Shows the identifier of the module previously installed.

Recommended actions:
• Turn off the power, ensure the correct option modules are installed in the correct option slots and re-apply the power.
• Confirm that the currently installed option module is correct, ensure option module parameters are set correctly and perform a user save in Pr **mm.000.**

Trip	Diagnosis
SlotX Error	**Option module in option slot X has detected a fault**
202 207 212	The *SlotX Error* trip indicates that the option module in option slot X on the drive has detected an error. The reason for the error can be identified by the sub-trip number. **Recommended actions:** • See relevant *Option Module User Guide* for details of the trip

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
SlotX HF	**Option module X hardware fault**
200 **205** **210**	The *SlotX HF* trip indicates that the option module in option slot X on the drive has indicated a hardware fault. The possible causes of the trip can be identified by the sub-trip number. **Recommended actions:** • Ensure the option module is installed correctly • Replace the option module • Replace the drive
SlotX Not Fitted	**Option module in option slot X has been removed**
203 **208** **213**	The *SlotX Not Fitted* trip indicates that the option module in option slot X on the drive has been removed since the last power up. **Recommended actions:** • Ensure the option module is installed correctly. • Re-install the option module. • To confirm that the removed option module is no longer required perform a save function in Pr **mm.000**.
SlotX Watchdog	**Option module watchdog function service error**
201 **206** **211**	The *SlotX Watchdog* trip indicates that the option module installed in Slot X has started the option watchdog function and then failed to service the watchdog correctly. **Recommended actions:** • Replace the option module
Soft Start	**Soft start relay failed to close, soft start monitor failed**
226	The *Soft Start* trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive

The sub-trip table within the SlotX HF row:

Sub-trip	Reason
1	The module category cannot be identified
2	All the required customized menu table information has not been supplied or the tables supplied are corrupt
3	There is insufficient memory available to allocate the comms buffers for this module
4	The module has not indicated that it is running correctly during drive power-up
5	Module has been removed after power-up or it has stopped working
6	The module has not indicated that it has stopped accessing drive parameters during a drive mode change
7	The module has failed to acknowledge that a request has been made to reset the drive processor
8	The drive failed to correctly read the menu table from the module during drive power up
9	The drive failed to upload menu tables from the module and timed out (5 s)
10	Menu table CRC invalid

Trip	Diagnosis
Stored HF	**Hardware trip has occurred during last power down**
221	The *Stored HF* trip indicates that a hardware trip (HF01 –HF19) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip i.e. stored HF.17. **Recommended actions:** • Enter 1299 in Pr **mm.000** and press reset to clear the trip
Sub-array RAM	**RAM allocation error**

The *Sub-array RAM* trip indicates that an option module, derivative image or user program image has requested more parameter RAM than is allowed. The RAM allocation is checked in order of resulting sub-trip numbers, and so the failure with the highest sub-trip number is given. The sub-trip is calculated as (parameter size) + (parameter type) + sub-array number.

Parameter size	Value
1 bit	1000
8 bit	2000
16 bit	3000
32 bit	4000
64 bit	5000

Parameter type	Value
Volatile	0
User save	100
Power-down save	200

227

Sub-array	Menus	Value
Applications menus	18-20	1
Derivative image	29	2
User program image	30	3
Option slot 1 set-up	15	4
Option slot 1 applications	25	5
Option slot 2 set-up	16	6
Option slot 2 applications	26	7
Option slot 3 set-up	17	8
Option slot 3 applications	27	9

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
Temp Feedback	**Internal thermistor has failed**

218	The *Temp Feedback* trip indicates that an internal thermistor has failed. The thermistor location can be identified by the sub-trip number.

Source	xx	y	zz
Control board	**00**	**00**	**01: Control board thermistor 1** **02: Control board thermistor 2** **03: I/O board thermistor**
Power system	Power module number	0	Zero for temperature feedback provided via power system comms. 21, 22 and 23 for direct ELV temperature feedback.
Power system	Power module number	Rectifier number*	Always zero

* For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.

Recommended actions:
• Hardware fault – Contact the supplier of the drive

Th Brake Res	**Brake resistor over temperature**

10	The *Th Brake Res* is initiated, If hardware based braking resistor thermal monitoring is connected and the resistor overheats. If the braking resistor is not used then this trip must be disabled with bit 3 of Action *On Trip Detection* (10.037) to prevent this trip. **Recommended actions:** • Check brake resistor wiring • Check braking resistor value is greater than or equal to the minimum resistance value • Check braking resistor insulation

Th Short Circuit	**Motor thermistor short circuit**

25	This trip indicates that a temperature sensor connected to an analogue input or terminal 15 on the position feedback interface has a low impedance (i.e. < 50 Ω). The cause of the trip can be identified by the sub-trip number.

Sub-trip	Reason
3	*Analog Input 3 Mode* (07.015) = 7 and the resistance of the thermistor connected to analog input 3 is less than 50 Ω.
4	*P1 Thermistor Short Circuit Detect* (03.123) = 1 and the resistance of the thermistor connected to the drive P1 position feedback interface is less than 50 Ω.

Recommended actions:
• Check thermistor continuity
• Replace motor / motor thermistor

Trip	Diagnosis
Thermistor	**Motor thermistor over-temperature**
24	The *Thermistor* trip indicates that the motor thermistor connected to terminal 8 (analog input 3) on the control connections or terminal 15 on the encoder terminal (15 way D-type connector) has indicated a motor over temperature. The cause of the trip can be identified by the sub-trip number

Sub-trip	Reason
3	Trip initiated from analog input 3
4	Trip initiated from P1 position feedback interface

Recommended actions:
- Check motor temperature
- Check threshold level (07.048)
- Check thermistor continuity

Trip	Diagnosis
Undefined	**Drive has tripped and the cause of the trip is Undefined**
110	The *Undefined* trip indicates that the power system has generated but did not identify the trip the power system. The cause of the trip is unknown. **Recommended actions:** • Hardware fault – return the drive to the supplier
User 24V	**User 24 V supply is not present on control terminals (1,2)**
91	A *User 24 V* trip is initiated, if *User Supply Select* (Pr **06.072**) is set to 1 or *Low Under Voltage Threshold Select* (06.067) = 1 and no user 24 V supply is present on control terminals 1 and 2. **Recommended actions:** • Ensure the user 24 V supply is present on control terminals 1 (0V) and 2 (24 V)

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Trip	Diagnosis
User Program	**On board user program error**

The *User Program* trip indicates that an error has been detected in the onboard user program image. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason	Comments
1	Divide by zero	
2	Undefined trip	
3	Attempted fast parameter access set-up with non-existent parameter	
4	Attempted access to non-existent parameter	
5	Attempted write to read-only parameter	
6	Attempted and over-range write	
7	Attempted read from write-only parameter	
30	The image has failed because either its CRC is incorrect, or there are less than 6 bytes in the image or the image header version is less than 5.	Occurs when the drive powers-up or the image is programmed. The image tasks will not run
31	The image requires more RAM for heap and stack than can be provided by the drive.	As 30
32	The image requires an OS function call that is higher than the maximum allowed	As 30
33	The ID code within the image is not valid	As 30
40	The timed task has not completed in time and has been suspended	
41	Undefined function called, i.e. a function in the host system vector table that has not been assigned.	As 40
52	Customized menu table CRC check failed	As 30
53	Customized menu table changed	Occurs when the drive powers-up or the image is programmed and the table has changed. Defaults are loaded for the derivative menu and the trip will keep occurring until drive parameters are saved.
61	The option module installed in slot 1 is not allowed with the derivative image	As 30
62	The option module installed in slot 2 is not allowed with the derivative image	As 30
63	The option module installed in slot 3 is not allowed with the derivative image	As 30
64	The option module installed in slot 4 is not allowed with the derivative image	As 30
70	An option module that is required by the derivative image is not installed in any slot.	As 30
71	An option module specifically required to be installed in slot 1 not present	As 30
72	An option module specifically required to be installed in slot 2 not present	As 30
73	An option module specifically required to be installed in slot 3 not present	As 30
74	An option module specifically required to be installed in slot 4 not present	As 30
80	Image is not compatible with the control board	Initiated from within the image code
81	Image is not compatible with the control board serial number	As 80

(Trip number for User Program: **249**)

Trip	Diagnosis
User Prog Trip	**Trip generated by an onboard user program**
96	This trip can be initiated from within an onboard user program using a function call which defines the sub-trip number. **Recommended actions:** • Check the user program
User Save	**User Save error / not completed**
36	The *User Save* trip indicates that an error has been detected in the user save parameters saved in non-volatile memory. For example, following a user save command, If the power to the drive was removed when the user parameters were being saved. **Recommended actions:** • Perform a user save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up. • Ensure that the drive has enough time to complete the save before removing the power to the drive.
User Trip	**User generated trip**
41 -89 **112 -159**	These trips are not generated by the drive and are to be used by the user to trip the drive through an application program. **Recommended actions:** • Check the user program
Watchdog	**Control word watchdog has timed out**
30	The *Watchdog* trip indicates that the control word has been enabled and has timed out **Recommended actions:** Once Pr **06.042** bit 14 has been changed from 0 to 1 to enable the watchdog, this must be repeated every 1s or a Watchdog trip will be initiated. The watchdog is disabled when the trip occurs and must be re-enabled if required when the trip is reset.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

Table 10-4 Serial communications look up table

No	Trip	No	Trip	No	Trip
1	Reserved 001	93	Inductor Too Hot	197	Encoder 9
2	Over Volts	94	Rectifier Set-Up	198	Phasing Error
3	OI ac	95	Reserved 95	199	Destination
4	OI Brake	96	User Prog Trip	200	Slot1 HF
5	PSU	97	Data Changing	201	Slot1 Watchdog
6	External Trip	98	Out Phase Loss	202	Slot1 Error
7	Over Speed	99	CAM	203	Slot1 Not installed
8	Inductance	100	Reset	204	Slot1 Different
9	PSU 24	101	OHt Brake	205	Slot2 HF
10	Th Brake Res	102	Reserved 102	206	Slot2 Watchdog
11	Autotune 1	103	Inter-connect	207	Slot2 Error
12	Autotune 2	104 - 108	Reserved 104 - 108	208	Slot2 Not installed
13	Autotune 3	109	OI dc	209	Slot2 Different
14	Autotune 4	110	Undefined	210	Slot3 HF
15	Autotune 5	111	Configuration	211	Slot3 Watchdog
16	Autotune 6	112 - 159	User Trip 112 - 159	212	Slot3 Error
17	Autotune 7	160	Island	213	Slot3 Not installed
18	Autotune Stopped	161 - 168	Reserved 161 - 168	214	Slot3 Different
19	Brake R Too Hot	169	Voltage Range	215	Option Disable
20	Motor Too Hot	170 - 173	Reserved 170 - 173	216	Slot App Menu
21	OHt Inverter	174	Card Slot	217	App Menu Changed
22	OHt Power	175	Card Product	218	Temp Feedback
23	OHt Control	176	Name Plate	219	An Output Calib
24	Thermistor	177	Card Boot	220	Power Data
25	Th Short Circuit	178	Card Busy	221	Stored HF
26	I/O Overload	179	Card Data Exists	222	Reserved 222
27	OHt dc bus	180	Card Option	223	Rating Mismatch
28	An Input Loss 1	181	Card Read Only	224	Drive Size
29	An Input Loss 2	182	Card Error	225	Current Offset
30	Watchdog	183	Card No Data	226	Soft Start
31	EEPROM Fail	184	Card Full	227	Sub-array RAM
32	Phase Loss	185	Card Access	228 - 246	Reserved 228 - 246
33	Resistance	186	Card Rating	247	Derivative ID
34	Keypad Mode	187	Card Drive Mode	248	Derivative Image
35	Control Word	188	Card Compare	249	User Program
36	User Save	189	Encoder 1	250	Slot4 HF
37	Power Down Save	190	Encoder 2	251	Slot4 Watchdog
38	Low Load	191	Encoder 3	252	Slot4 Error
39	Line Sync	192	Encoder 4	253	Slot4 Not installed
40 -89	User Trip 40 - 89	193	Encoder 5	254	Slot4 Different
90	Power Comms	194	Encoder 6	255	Reset Logs
91	User 24V	195	Encoder 7		
92	OI Snubber	196	Encoder 8		

The trips can be grouped into the following categories. It should be noted that a trip can only occur when the drive is not tripped or is already tripped but with a trip with a lower priority number.

Table 10-5 Trip categories

Priority	Category	Trips	Comments
1	Internal faults	HF01, HF02, HF03, HF04, HF05, HF06, HF07, HF08, HF09, HF10, HF11, HF12, HF13, HF14, HF15, HF16, HF17, HF18, HF19, HF20	These indicate internal problems and cannot be reset. All drive features are inactive after any of these trips occur. If an KI-Keypad is installed it will show the trip, but the keypad will not function.
1	Stored HF trip	{Stored HF}	This trip cannot be cleared unless 1299 is entered into *Parameter* (**mm.000**) and a reset is initiated.
2	Non-resettable trips	Trip numbers 218 to 247, {Slot1 HF}, {Slot2 HF}, {Slot3 HF} or {Slot4 HF}	These trips cannot be reset.
3	Volatile memory failure	{EEPROM Fail}	This can only be reset if Parameter **mm.000** is set to 1233 or 1244, or if *Load Defaults* (11.043) is set to a non-zero value.
3	Internal 24 V power supply	{PSU 24}	
4	NV Media Card trips	Trip numbers 174, 175 and 177 to 188	These trips are priority 5 during power-up.
5	Trips with extended reset times	{OI ac}, {OI Brake}, and OI dc}	These trips cannot be reset until 10 s after the trip was initiated.
5	Phase loss and d.c. link power circuit protection	{Phase Loss} and {Oht dc bus}	The drive will attempt to stop the motor before tripping if a {Phase Loss}. 000 trip occurs unless this feature has been disabled (see *Action On Trip Detection* (10.037). The drive will always attempt to stop the motor before tripping if an {Oht dc bus} occurs.
5	Standard trips	All other trips	

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

10.5 Internal / Hardware trips

Trips {HF01} to {HF20} are internal faults that do not have trip numbers. If one of these trips occurs, the main drive processor has detected an irrecoverable error. All drive functions are stopped and the trip message will be displayed on the drive keypad. If a non permanent trip occurs this may be reset by power cycling the drive. On power up after it has been power cycled the drive will trip on Stored HF. Enter 1299 in **mm.000** to clear the Stored HF trip.

10.6 Alarm indications

In any mode, an alarm is an indication given on the display by alternating the alarm string with the drive status string on the first row and showing the alarm symbol in the last character in the first row. If an action is not taken to eliminate any alarm except "Auto Tune and Limit Switch" the drive may eventually trip. Alarms are not displayed when a parameter is being edited, but the user will still see the alarm character on the upper row.

Table 10-6   Alarm indications

Alarm string	Description
Motor Overload	*Motor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Drive Overload	Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.

10.7 Status indications

Table 10-7   Status indications

Upper row string	Description	Drive output stage
Inhibit	The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr **06.015** is set to 0	Disabled
Ready	The drive is ready to run. The drive enable is active, but the drive inverter is not active because the final drive run is not active	Disabled
Stop	The drive is stopped / holding zero speed.	Enabled
Run	The drive is active and running	Enabled
Supply Loss	Supply loss condition has been detected	Enabled
Deceleration	The motor is being decelerated to zero speed / frequency because the final drive run has been deactivated.	Enabled
dc injection	The drive is applying dc injection braking	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display	Disabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode	Disabled
Heat	The motor pre-heat functions inactive	Enabled
Phasing	The drive is performing a 'phasing test on enable'.	Enabled

Table 10-8   Option module and NV Media Card and other status indications at power-up

First row string	Second row string	Status
Booting	**Parameters**	Parameters are being loaded
Drive parameters are being loaded from a NV Media Card		
Booting	**User Program**	User program being loaded
User program is being loaded from a NV Media Card to the drive		
Booting	**Option Program**	User program being loaded
User program is being loaded from a NV Media Card to the option module in slot X		
Writing To	**NV Card**	Data being written to NV Media Card
Data is being written to a NV Media Card to ensure that its copy of the drive parameters is correct because the drive is in Auto or Boot mode		
Waiting For	**Power System**	Waiting for power stage
The drive is waiting for the processor in the power stage to respond after power-up		
Waiting For	**Options**	Waiting for an option module
The drive is waiting for the Options Modules to respond after power-up		
Uploading From	**Options**	Loading parameter database
At power-up it may be necessary to update the parameter database held by the drive because an option module has changed or because an applications module has requested changes to the parameter structure. This may involve data transfer between the drive an option modules. During this period 'Uploading From Options' is displayed		

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

10.8 Programming error indications

Following are the error message displayed on the drive keypad when an error occurs during programming of drive firmware.

Table 10-9 Programming error indications

Error String	Reason	Solution
Error 1	There is not enough drive memory requested by all the option modules.	Power down drive and remove some of the option modules until the message disappears.
Error 2	At least one option module did not acknowledge the reset request.	Power cycle drive
Error 3	The boot loader failed to erase the processor flash	Power cycle drive and try again. If problem persists, return drive
Error 4	The boot loader failed to program the processor flash	Power cycle drive and try again. If problem persists, return drive
Error 5	One option module did not initialize correctly. Option module did not set Ready to Run flag.	Remove faulty option module.

10.9 Displaying the trip history

The drive retains a log of the last ten trips that have occurred. *Trip 0* (**00.050**) to *Trip 9* (**00.059**) store the most recent 10 trips that have occurred where *Trip 0* (**00.050**) is the most recent and *Trip 9* (**00.059**) is the oldest. When a new trip occurs it is written to *Trip 0* (**00.050**) and all the other trips move down the log, with oldest being lost. The date and time when each trip occurs are also stored in the date and time log, i.e. *Trip 0 Date* (**00.060**) to *Trip 9 Time* (**00.079**). The date and time are taken from *Date* (**00.034**) and *Time* (**00.035**). The date / time source can be selected with *Date / Time Selector* (**00.037**). Some trips have sub-trip numbers which give more detail about the reason for the trip. If a trip has a sub-trip number its value is stored in the sub-trip log, i.e. *Trip 0 Sub-trip Number* (**10.070**) to *Trip 9 Sub-trip Number* (**10.079**). If the trip does not have a sub-trip number then zero is stored in the sub-trip log.

If any parameter between Pr **00.050** and Pr **00.059** inclusive is read by serial communication, then the trip number in Table 10-4 is the value transmitted.

NOTE The trip logs can be reset by writing a value of 255 in Pr **10.038**.

10.10 Behavior of the drive when tripped

If the drive trips, the output of the drive is disabled so the load coasts to a stop. If any trip occurs the following read only parameters are frozen until the trip is cleared. This is to help in diagnose the cause of the trip.

Parameter	Description
01.001	Frequency / speed reference
01.002	Pre-skip filter reference
01.003	Pre-ramp reference
02.001	Post-ramp reference
03.001	Final speed ref
03.002	Speed feedback
03.003	Speed error
03.004	Speed controller output
04.001	Current magnitude
04.002	Active current
04.017	Reactive current
05.001	Output frequency
05.002	Output voltage
05.003	Power
05.005	DC bus voltage
07.001	Analog input 1
07.002	Analog input 2

If the parameters are not required to be frozen then this can be disabled by setting bit 4 of Pr **10.037**.

10.11 Routine maintenance

The drive should be installed in a cool, clean, well ventilated location. Contact of moisture and dust with the drive should be prevented.

Regular checks of the following should be carried out to ensure drive / installation reliability are maximized:

Environment	
Ambient temperature	Ensure the enclosure temperature remains at or below maximum specified
Dust	Ensure the drive remains dust free – check that the heatsink and drive fan are not gathering dust. The lifetime of the fan is reduced in dusty environments.
Moisture	Ensure the drive enclosure shows no signs of condensation
Enclosure	
Enclosure door filters	Ensure filters are not blocked and that air is free to flow
Electrical	
Screw connections	Ensure all screw terminals remain tight
Crimp terminals	Ensure all crimp terminals remains tight – check for any discoloration which could indicate overheating
Cables	Check all cables for signs of damage

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

10.11.1 Real time clock battery replacement

The keypads with the real time clock feature contain a battery to ensure the clock works when the drive is powered down. The battery has a long life time but if the battery needs to be replaced or removed, follow the instructions below.

Low battery voltage is indicated by ▯ low battery symbol on the keypad display.

Figure 10-3   KI-HOA Keypad RTC (rear view)
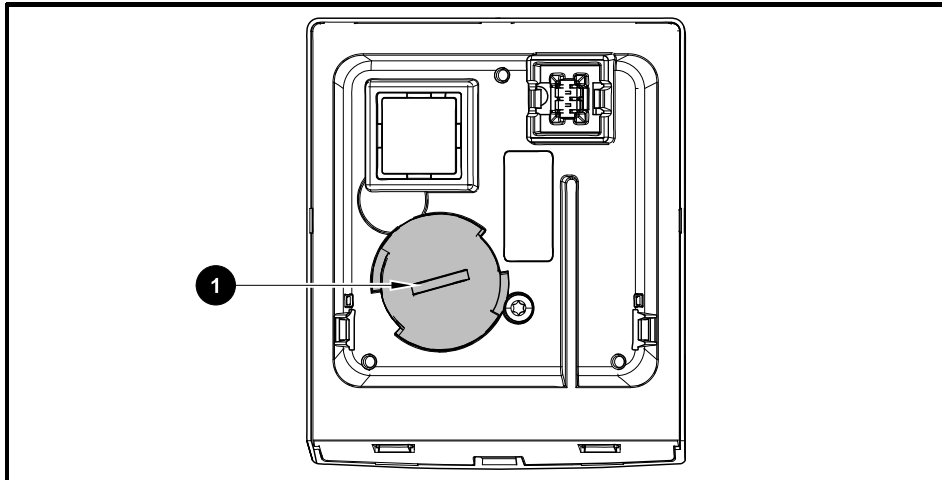
Figure 10-3 above illustrates the rear view of the KI-HOA Keypad RTC.

1. To remove the battery cover insert a flat head screwdriver into the slot as shown (1), push and turn anti-clockwise until the battery cover is released.
2. Replace the battery (the battery type is: CR2032).
3. Reverse point 1 above to replace battery cover.

   NOTE   Ensure the battery is disposed of correctly.

Please refer to *Drive User Guide* for drive cooling fan replacement procedure.

11 UL listing information

11.1 UL file reference

All products covered by this Guide are UL Listed to both Canadian and US requirements. The UL file reference is: NMMS/7.E171230.

Products that incorporate the Safe Torque Off function have been investigated by UL. The UL file reference is: FSPC.E171230.

11.2 Option modules, kits and accessories

All Option Modules, Control Pods and Installation Kits supplied by Nidec Industrial Automation for use with these drives are UL Listed.

11.3 Enclosure ratings

Drives are UL Open Type as supplied.

Drives fitted with a conduit box are UL Type 1.

Drives that are capable of through-hole mounting are UL Type 12 when installed with the high-IP insert (where provided), and the Type 12 sealing kit to prevent ingress of dust and water.

Remote Keypads are UL Type 12.

11.4 Mounting

Drives can be mounted directly onto a vertical surface. This is known as 'surface' or 'standard' mounting. Refer to section 3.4 *Surface mounting* on page 29 for further information.

Drives can be installed side by side with recommended spacing between them. This is known as 'bookcase' mounting. Refer to the *Drive User Guide* for further information.

Drives fitted with a conduit box can be mounted directly onto a wall or other vertical surface without additional protection. Suitable conduit boxes are available from Nidec Industrial Automation.

Some drives may be through-hole mounted. Mounting brackets and sealing kits are available from Nidec Industrial Automation. Refer to the *Drive User Guide* for further information.

Remote Keypads can be mounted on the outside of a UL Type 12 enclosure. A sealing and mounting kit is provided with the keypad.

11.5 Environment

Drives must be installed in a Pollution Degree 2 environment or better (dry, non-conductive pollution only). All drives are capable of delivering full rated output current at surrounding air temperatures up to 40 °C.

Drives may be operated in surrounding air temperatures up to 50 °C or 55 °C at de-rated current, depending on the model number. Refer to the *Drive User Guide* for further information.

11.6 Electrical Installation

TERMINAL TORQUE

Terminals must be tightened to the rated torque as specified in the Installation Instructions. Refer to section 3.4.2 *Terminal sizes and torque settings* on page 34 for further information.

WIRING TERMINALS

Drives must be installed using cables rated for 75 °C operation, copper wire only.

Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance

UL listing information

UL Listed closed-loop connectors sized according to the field wiring shall be used for all field wiring connections. Refer to section 3.4.2 *Terminal sizes and torque settings* on page 34 for further information.

BRANCH CIRCUIT PROTECTION

The fuses and circuit breakers required for branch circuit protection are contained in the Installation Instructions. Refer to section 2.4 *Ratings* on page 13

OPENING OF BRANCH CIRCUIT

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 should 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".

11.7   Motor overload protection and thermal memory retention

All drives 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 and the method of adjustment is provided in section 8.2 *Motor thermal protection* on page 107. Maximum current overload is dependent on the values entered into the current limit parameters (motoring current limit, regenerative current limit and symmetrical current limit entered as percentage) and the motor rated current parameter (entered in amperes).

The duration of the overload is dependent on motor thermal time constant. The time constant is programmable. The default overload protection is set such that the product is capable of 150 % of the current value entered into the motor rated current parameter for 60 seconds.

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

The method of adjustment of the overload protection is provided in the Installation Instructions shipped with the product.

 All models are provided with thermal memory retention.

11.8   Electrical supply
The drives are suitable for use on a circuit capable of delivering not more than 100,000 RMS Symmetrical Amperes, at rated voltage when protected by fuses as specified in the Installation Instructions.

Some smaller drives are suitable for use on a circuit capable of delivering not more than 10,000 RMS Symmetrical Amperes, at rated voltage when protected by circuit breakers as specified in the Installation Instructions.

11.9   External Class 2 supply
The external power supply used to power the 24 V control circuit shall be marked: "UL Class 2". The power supply voltage shall not exceed 24 Vdc.

11.10   Requirement for Transient Surge Suppression
This requirement applies to drives with rated input voltage = 575 V, Frame Size 7 only.

TRANSIENT SURGE SUPPRESSION SHALL BE INSTALLED ON THE LINE SIDE OF THIS EQUIPMENT AND SHALL BE RATED 575 Vac (PHASE TO GROUND), 575 Vac (PHASE TO PHASE), SUITABLE FOR OVERVOLTAGE CATEGORY III, AND SHALL PROVIDE PROTECTION

FOR A RATED IMPULSE VOLTAGE TO WITHSTAND VOLTAGE PEAK OF 6 kV AND A CLAMPING VOLTAGE OF MAXIMUM 2400 V.

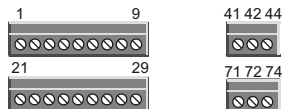## 11.11   Group Installation and Modular Drive Systems

Drives with DC+ and DC- supply connections, with 230 V or 480 V supply voltage rating, are UL approved for use in modular drive systems as inverters when supplied by the converter sections: Mentor MP25A, 45A, 75A, 105A, 155A or 210A range manufactured by Nidec Industrial Automation.

Alternatively, the inverters may be supplied by converters from the *HVAC drive -H300* range manufactured by Nidec Industrial Automation.
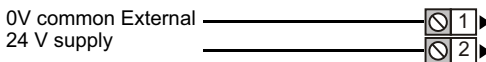
In these applications the inverters are required to be additionally protected by supplemental fuses.

Drives have not been evaluated for other Group Installation applications, for example where a single inverter is wired directly to two or more motors. In these applications, additional thermal overload protection is needed. Contact Nidec Industrial Automation for further details.
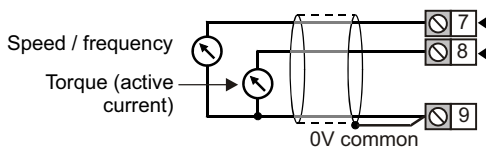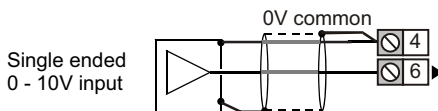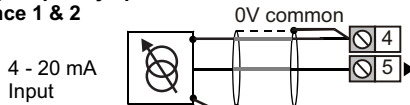
Safety information

Product information

Mechanical installation

Electrical installation

Getting started

Basic parameters (Menu 0)

Running the motor

Optimization

NV Media Card Operation

Diagnostics and maintenance
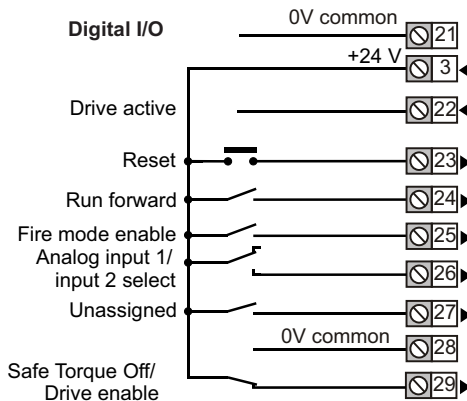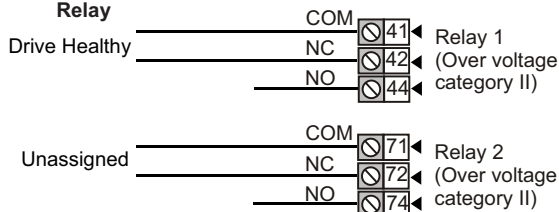
UL listing information

Aux 24 V supply

0V common External — | 1 ▶
24 V supply — | 2 ▶

Analog frequency/speed reference 1 & 2

0V common

4 - 20 mA Input — | 4 ▶
— | 5 ▶

0V common

Single ended 0 - 10V input — | 4 ▶
— | 6 ▶

Speed / frequency — | 7 ◀
— | 8 ◀

Torque (active current) — | 9

0V common

Digital I/O

0V common | 21
+24 V | 3 ◀
Drive active — | 22 ◀
Reset — | 23 ▶
Run forward — | 24 ▶
Fire mode enable — | 25 ▶
Analog input 1/ input 2 select — | 26 ▶
Unassigned — | 27 ▶
0V common | 28
Safe Torque Off/ Drive enable — | 29 ▶

Relay

COM | 41 ◀
Drive Healthy — NC | 42 ◀ Relay 1
NO | 44 ◀ (Over voltage category II)

COM | 71 ◀
Unassigned — NC | 72 ◀ Relay 2
NO | 74 ◀ (Over voltage category II)

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