EMERSON
Industrial Automation

User Guide

HVAC Drive H300

Model sizes 3-11

Universal Variable Speed AC drive for induction and permanent magnet motors

Part Number: 0479-0001-02
Issue: 2

Original Instructions

For the purposes of compliance with the EU Machinery Directive 2006/42/EC:

General information

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

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

Drive firmware version

This product is supplied with the latest firmware version. If this drive is to be connected to an existing system or machine, all drive firmware versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from an Emerson Industrial Automation Service Centre or Repair Centre. If there is any doubt please contact the supplier of the product.

The firmware version of the drive can be checked by looking at Pr **00.050** {**11.029**}.

Environmental statement

Emerson Industrial Automation is committed to minimising the environmental impacts of its manufacturing operations and of its products throughout their life cycle. To this end, we operate an Environmental Management System (EMS) which is certified to the International Standard ISO 14001. Further information on the EMS, our Environmental Policy and other relevant information is available on request, or can be found at

http://www.emersonindustrial.com/en-EN/controltechniques/aboutus/environment/Pages/environment.aspx

The electronic variable-speed drives manufactured by Emerson Industrial Automation have the potential to save energy and (through increased machine/process efficiency) reduce raw material consumption and scrap throughout their long working lifetime. In typical applications, these positive environmental effects far outweigh the negative impacts of product manufacture and end-of-life disposal.

Nevertheless, when the products eventually reach the end of their useful life, they must not be discarded but should instead be recycled by a specialist recycler of electronic equipment. Recyclers will find the products easy to dismantle into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, while other parts are secured with conventional fasteners. Virtually all parts of the product are suitable for recycling.

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, while smaller products come in strong cardboard cartons which themselves have a high recycled fibre content. If not re-used, these containers can be recycled. Polythene, used on the protective film and bags for wrapping product, can be recycled in the same way. Emerson Industrial Automations' packaging strategy prefers easily-recyclable materials of low environmental impact, and regular reviews identify opportunities for improvement.

When preparing to recycle or dispose of any product or packaging, please observe local legislation and best practice.

REACH legislation

EC Regulation 1907/2006 on the Registration, Evaluation, Authorisation and restriction of Chemicals (REACH) requires the supplier of an article to inform the recipient if it contains more than a specified proportion of any substance which is considered by the European Chemicals Agency (ECHA) to be a Substance of Very High Concern (SVHC) and is therefore listed by them as a candidate for compulsory authorisation.

For current information on how this requirement applies in relation to specific Emerson Industrial Automations' products, please approach your usual contact in the first instance. Emerson Industrial Automations' position statement can be viewed at:

www.emersonindustrial.com/en-EN/controltechniques/aboutus/environment/reachregulation/Pages/reachregulation.aspx

The information contained in this guide is for guidance only and does not form part of any contract. The accuracy cannot be guaranteed as Emerson have an ongoing process of development and reserve the right to change the specification of their products without notice.
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Moteurs Leroy-Somer SAS. Headquarters: Bd Marcellin Leroy, CS 10015, 16915 Angoulême Cedex 9, France. Share Capital: 65 800 512 €, RCS Angoulême 338 567 258.

Issue Number: 2

Drive Firmware: 04.13.00.00 onwards

For patent and intellectual property related information please go to: www.ctpatents.info.

How to use this guide

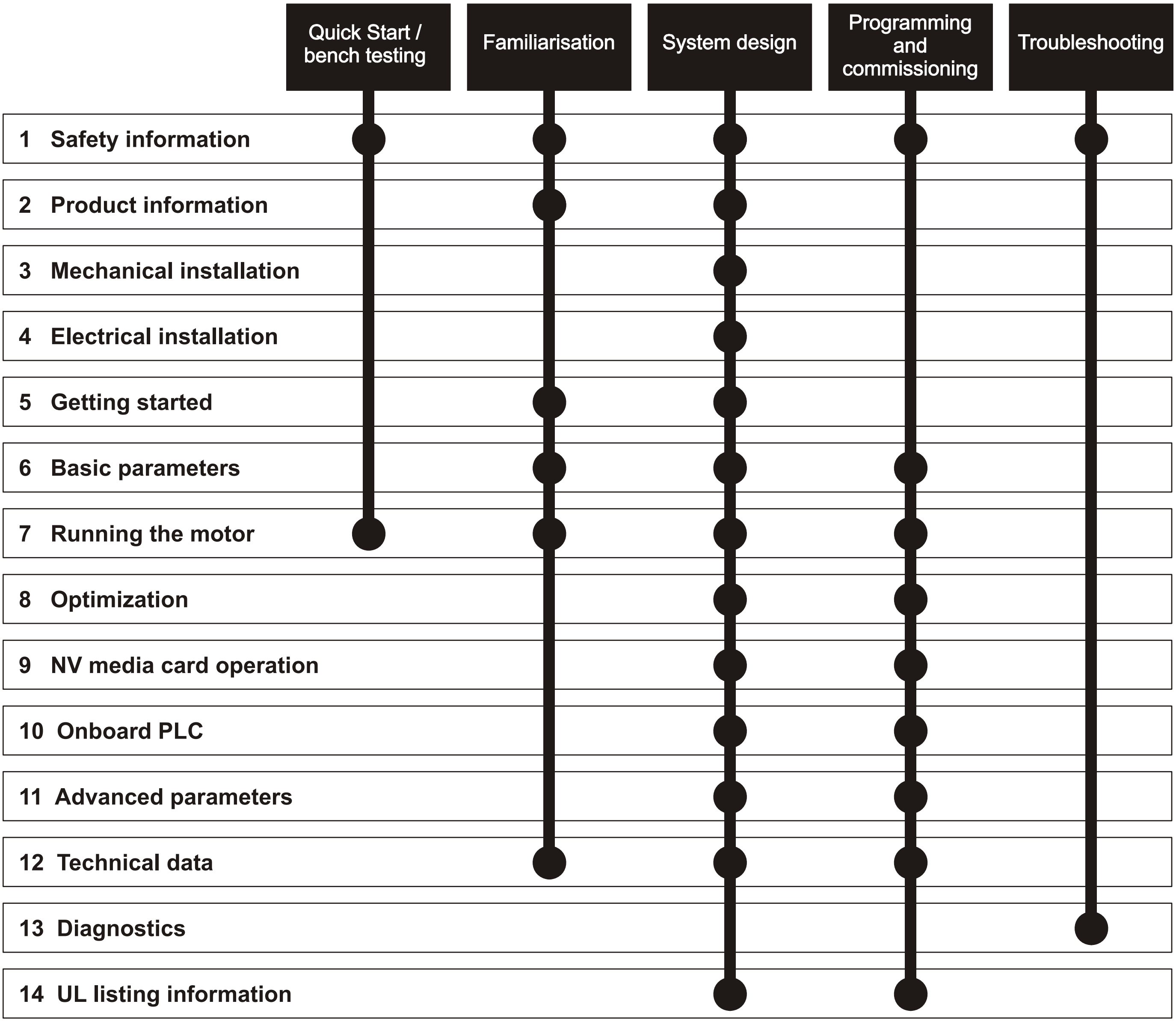
This user guide provides complete information for installing and operating the drive from start to finish.

The information is in logical order, taking the reader from receiving the drive through to fine tuning the performance.

NOTE

There are specific safety warnings throughout this guide, located in the relevant sections. In addition, Chapter 1 *Safety information* contains general safety information. It is essential that the warnings are observed and the information considered when working with or designing a system using the drive.

This map of the user guide helps to find the right sections for the task you wish to complete, but for specific information, refer to :



	Quick Start / bench testing	Familiarisation	System design	Programming and commissioning	Troubleshooting
1 Safety information	●	●	●	●	●
2 Product information		●	●		
3 Mechanical installation			●		
4 Electrical installation			●		
5 Getting started		●	●		
6 Basic parameters		●	●	●	
7 Running the motor	●	●	●	●	
8 Optimization			●	●	
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Contents

EU Declaration of Conformity

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This declaration is issued under the sole responsibility of the manufacturer. The object of the declaration is in conformity with the relevant Union harmonization legislation. The declaration applies to the variable speed drive products shown below:

Model number	Interpretation	Nomenclature aaaa - bbc ddddde
aaaa	Basic series	M100, M101, M200, M201, M300, M400, M600, M700, M701, M702, F300, H300, E200, E300, HS30, HS70, HS71, HS72, M000, RECT
bb	Frame size	01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11
c	Voltage rating	1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V
ddddd	Current rating	Example 01000 = 100 A
e	Drive format	A = 6P Rectifier + Inverter (internal choke), D = Inverter, E = 6P Rectifier + Inverter (external choke), T = 12P Rectifier + Inverter (external choke)

The model number may be followed by additional characters that do not affect the ratings.

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonized standards:

EN 61800-5-1:2007	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-3: 2004+A1:2012	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN 61000-6-2:2005	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments
EN 61000-6-4: 2007+ A1:2011	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
EN 61000-3-2:2014	Electromagnetic compatibility (EMC) - Part 3-2: Limits for harmonic current emissions (equipment input current ≤16 A per phase)
EN 61000-3-3:2013	Electromagnetic compatibility (EMC) - Part 3-3: Limitation of voltage changes, voltage fluctuations and flicker in public, low voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection

EN 61000-3-2:2014 Applicable where input current < 16 A. No limits apply for professional equipment where input power ≥1 kW.

These products comply with the Restriction of Hazardous Substances Directive (2011/65/EU), the Low Voltage Directive (2014/35/EU) and the Electromagnetic Compatibility Directive (2014/30/EU).

G Williams
Vice President, Technology
Date: 17th March 2016

These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. 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.

EU Declaration of Conformity (including 2006 Machinery Directive)

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This declaration is issued under the sole responsibility of the manufacturer. The object of the declaration is in conformity with the relevant Union harmonization legislation. The declaration applies to the variable speed drive products shown below:

Model No.	Interpretation	Nomenclature aaaa - bbc ddddde
aaaa	Basic series	M300, M400, M600, M700, M701, M702, F300, H300, E200, E300, HS30, HS70, HS71, HS72, M000, RECT
bb	Frame size	01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11
c	Voltage rating	1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V
ddddd	Current rating	Example 01000 = 100 A
e	Drive format	A = 6P Rectifier + Inverter (internal choke), D = Inverter, E = 6P Rectifier + Inverter (external choke), T = 12P Rectifier + Inverter (external choke)

The model number may be followed by additional characters that do not affect the ratings.

This declaration relates to these products when used as a safety component of a machine. Only the Safe Torque Off function may be used for a safety function of a machine. None of the other functions of the drive may be used to carry out a safety function.

These products fulfil all the relevant provisions of the Machinery Directive 2006/42/EC and the Electromagnetic Compatibility Directive (2014/30/EU).

EC type examination has been carried out by the following notified body:

TUV Rheinland Industrie Service GmbH
Am Grauen Stein
D-51105 Köln
Germany

EC type-examination certificate numbers:
01/205/5270.01/14 dated 2014-11-11
01/205/5387.01/15 dated 2015-01-29
01/205/5383.02/15 dated 2015-04-21

Notified body identification number: 0035

The harmonized standards used are shown below:

EN 61800-5-1:2007	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-5-2:2007	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
EN ISO 13849-1:2008	Safety of Machinery, Safety-related parts of control systems, General principles for design
EN ISO 13849-2:2008	Safety of machinery, Safety-related parts of control systems. Validation
EN 61800-3: 2004+A1:2012	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN 62061:2005	Safety of machinery, Functional safety of safety related electrical, electronic and programmable electronic control systems

Person authorised to complete the technical file:
P Knight
Conformity Engineer
Newtown, Powys, UK

G. Williams
Vice President, Technology
Date: 17th March 2016
Place: Newtown, Powys, UK

IMPORTANT NOTICE

These electronic drive products are intended to be used with appropriate motors, controllers, electrical protection components and other equipment to form complete end products or systems. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. 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.

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 Electrical safety - general warning

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

Specific warnings are given at the relevant places in this User Guide.

1.3 System design and safety of personnel

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

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

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 experience. They must read this safety information and this User Guide carefully.

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

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.

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

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.

1.4 Environmental limits

Instructions in this User Guide regarding transport, storage, installation and use of the drive must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

1.5 Access

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

1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided. For further information, refer to section 3.2.5 *Fire protection* on page 23.

1.7 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 User Guide contains instruction for achieving compliance with specific EMC standards.

Within the European Union, all machinery in which this product is used must comply with the following directives:

2006/42/EC Safety of machinery.
2014/30/EU: Electromagnetic Compatibility Directive.

1.8 Motor

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

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

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. 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 should not be relied upon.

It is essential that the correct value is entered in Pr **00.020** motor rated current. This affects the thermal protection of the motor.

1.9 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.

1.10 Electrical installation

1.10.1 Electric shock risk

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

AC supply cables and connections

Output cables and connections

Many internal parts of the drive, and external option units

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

1.10.2 Stored charge

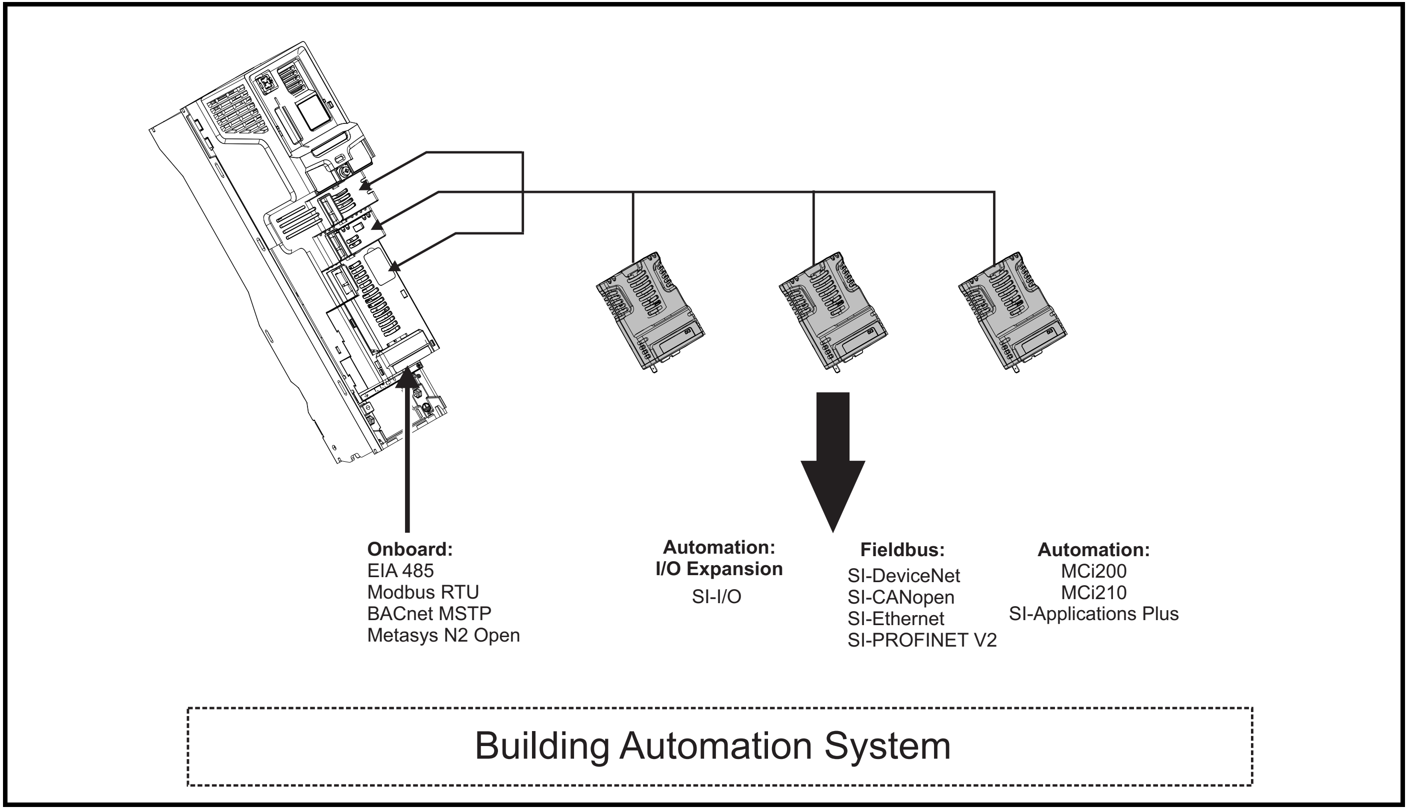
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

2 Product information

2.1 AC drive for fans, pumps and compressors

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
- Dual integrated form C relay outputs
- NV Media Card for parameter copying and data storage
- EIA-485 serial 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 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 5.9.1 *User Security Level / Access Level* on page 116). 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.

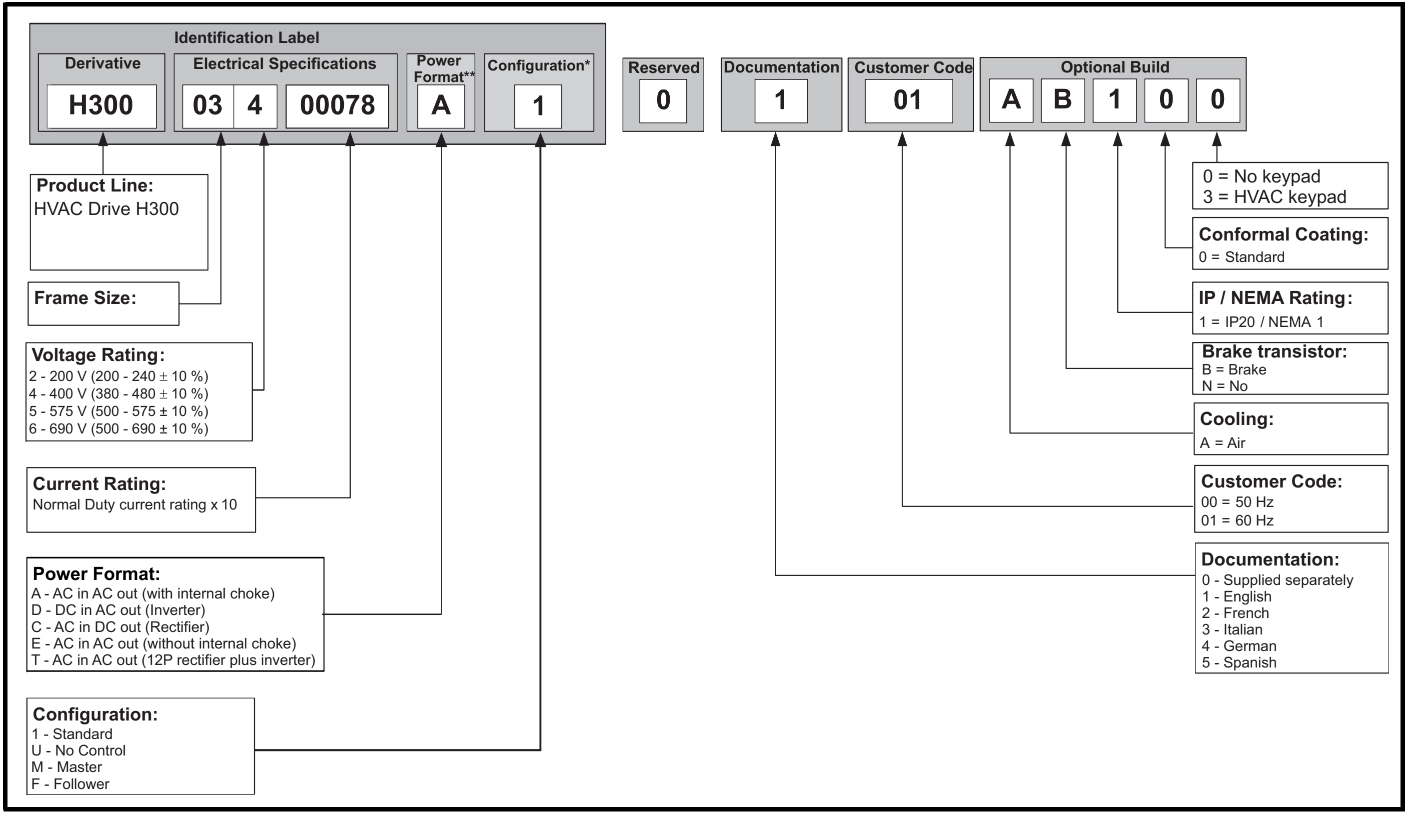
RTD's

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

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



* 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 Ratings

Normal Duty

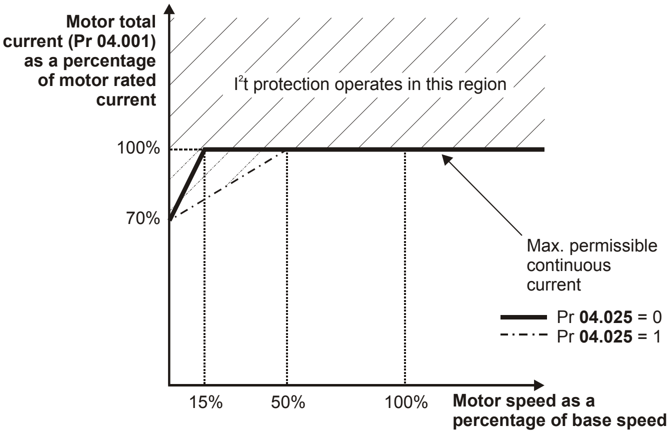
The H300 is optimzed for applications which use Self ventilated (TENV/TEFC) induction motors and require a low overload capability, and full torque at low speeds is not required (e.g. fans, pumps).
Self ventilated (TENV/TEFC) induction motors require increased protection against overload due to the reduced cooling effect of the fan at low speed. To provide the correct level of protection the I^2t software operates at a level which is speed dependent. This is illustrated in the graph below.

NOTE

The speed at which the low speed protection takes effect can be changed by the setting of *Low Speed Thermal Protection Mode* (04.025). The protection starts when the motor speed is below 15 % of base speed when Pr **04.025** = 0 (default) and below 50 % when Pr **04.025** = 1.

Operation of motor I^2t protection

Motor I^2t protection is fixed as shown below and is compatible with:
- Self ventilated (TENV/TEFC) induction motors



The continuous current ratings given are for maximum 40 °C (104 °F), 1000 m altitude and 3 kHz switching frequency. Derating is required for higher switching frequencies, ambient temperature >40 °C (104 °F) and high altitude. For further information, refer to Chapter 12 *Technical data* on page 257.

Table 2-1 200 V drive ratings (200 V to 240 V ±10 %)

Model		Normal Duty			
		Maximum continuous output current	Nominal power at 230 V	Motor power at 230 V	Peak current
		A	kW	hp	A
Frame size 3	03200066	6.6	1.1	1.5	7.2
	03200080	8	1.5	2	8.8
	03200110	11	2.2	3	12.1
	03200127	12.7	3	3	13.9
Frame size 4	04200180	18	4	5	19.8
	04200250	25	5.5	7.5	27.5
Frame size 5	05200300	30	7.5	10	33
Frame size 6	06200500	50	11	15	55
	06200580	58	15	20	63.8
Frame size 7	07200750	75	18.5	25	82.5
	07200940	94	22	30	103.4
	07201170	117	30	40	128.7
Frame size 8	08201490	149	37	50	163.9
	08201800	180	45	60	198
Frame size 9	09202160	216	55	75	237.6
	09202660	266	75	100	292.6
Frame size 10	10203250	325	90	125	357.5
	10203600	360	110	150	396

Table 2-2 400 V drive ratings (380 V to 480 V ±10 %)

Model		Normal Duty			
		Maximum continuous output current	Nominal power at 400 V	Motor power at 460 V	Peak current
		A	kW	hp	A
Frame size 3	03400034	3.4	1.1	1.5	3.7
	03400045	4.5	1.5	2.0	4.9
	03400062	6.2	2.2	3.0	6.8
	03400077	7.7	3.0	5.0	8.4
	03400104	10.4	4.0	5.0	11.4
	03400123	12.3	5.5	7.5	13.5
Frame size 4	04400185	18.5	7.5	10.0	20.3
	04400240	24.0	11.0	15.0	26.4
Frame size 5	05400300	30.0	15.0	20.0	33.0
Frame size 6	06400380	38.0	18.5	25.0	41.8
	06400480	48.0	22.0	30.0	52.8
	06400630	63.0	30.0	40.0	69.3
Frame size 7	07400790	79	37	50	86.9
	07400940	94	45	60	103.4
	07401120	112	55	75	123.2
Frame size 8	08401550	155	75	100	170.5
	08401840	184	90	125	202.4
Frame size 9	09402210	221	110	150	243.1
	09402660	266*	132	200	292.6
Frame size 10	10403200	320	160	250	352
	10403610	361	200	300	397.1
Frame size 11	11404370	437	225	350	480.7
	11404870	487*	250	400	535.7
	11405070	507*	280	450	557.7

* These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to Chapter 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257.

Table 2-3 575 V drive ratings (500 V to 575 V ±10 %)

Model		Normal Duty			
		Maximum continuous output current	Nominal power at 575 V	Motor power at 575 V	Peak current
		A	kW	hp	A
Frame size 5	05500039	3.9	2.2	3	4.3
	05500061	6.1	4	5	6.7
	05500100	10	5.5	7.5	11
Frame size 6	06500120	12	7.5	10	13.2
	06500170	17	11	15	18.7
	06500220	22	15	20	24.2
	06500270	27	18.5	25	29.7
	06500340	34	22	30	37.4
	06500430	43	30	40	47.3
Frame size 7	07500530	53	45	50	58.3
	07500730	73	55	60	80.3
Frame size 8	08500860	86	75	75	94.6
	08501080	108	90	100	118.8
Frame size 9	09501250	125	110	125	137.5
	09501500	150	110	150	165
Frame size 10	10502000	200	150	200	220
Frame size 11	11502480	248	185	250	272.8
	11502880	288*	225	300	316.8
	11503150	315*	250	350	346.5

* These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to Chapter 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257.

Table 2-4 690 V drive ratings (500 V to 690 V ±10 %)

Model		Normal Duty			
		Maximum continuous output current	Nominal power at 690 V	Motor power at 690 V	Peak current
		A	kW	hp	A
Frame size 7	07600230	23	18.5	25	25.3
	07600300	30	22	30	33
	07600360	36	30	40	39.6
	07600460	46	37	50	50.6
	07600520	52	45	60	57.2
	07600730	73	55	75	80.3
Frame size 8	08600860	86	75	100	94.6
	08601080	108	90	125	118.8
Frame size 9	09601250	125	110	150	137.5
	09601550	155	132	175	170.5
Frame size 10	10601720	172	160	200	189.2
	10601970	197	185	250	216.7
Frame size 11	11602250	225	200	250	247.5
	11602750	275*	250	300	302.5
	11603050	305*	280	400	335.5

* These ratings are for 2 kHz switching frequency. For ratings at 3 kHz switching frequency refer to Chapter 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257.

2.3.1 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. The exact value for a specific motor can be calculated using the equations detailed in Menu 4 in the *Parameter Reference Guide*.

Typical values are shown in the table below for RFC (RFC-A or RFC-S) and open loop (OL) modes:

Table 2-5 Typical overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
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.

2.4 Operating modes

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

Open loop mode

- Open loop vector mode
- Fixed V/F mode (V/Hz)
- Quadratic V/F mode (V/Hz)

RFC - A

- Without position feedback sensor (Sensorless)

RFC - S

- Without position feedback sensor (Sensorless)

2.4.1 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 for a 50 Hz motor.

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 for a 50 Hz motor.

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.

2.4.2 RFC-A Sensorless

Rotor **F**lux **C**ontrol for Asynchronous (induction) motors (**RFC-A**) encompasses closed loop vector control without a position feedback device.

Sensorless mode provides closed loop control without the need for position feedback 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.

2.4.3 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.

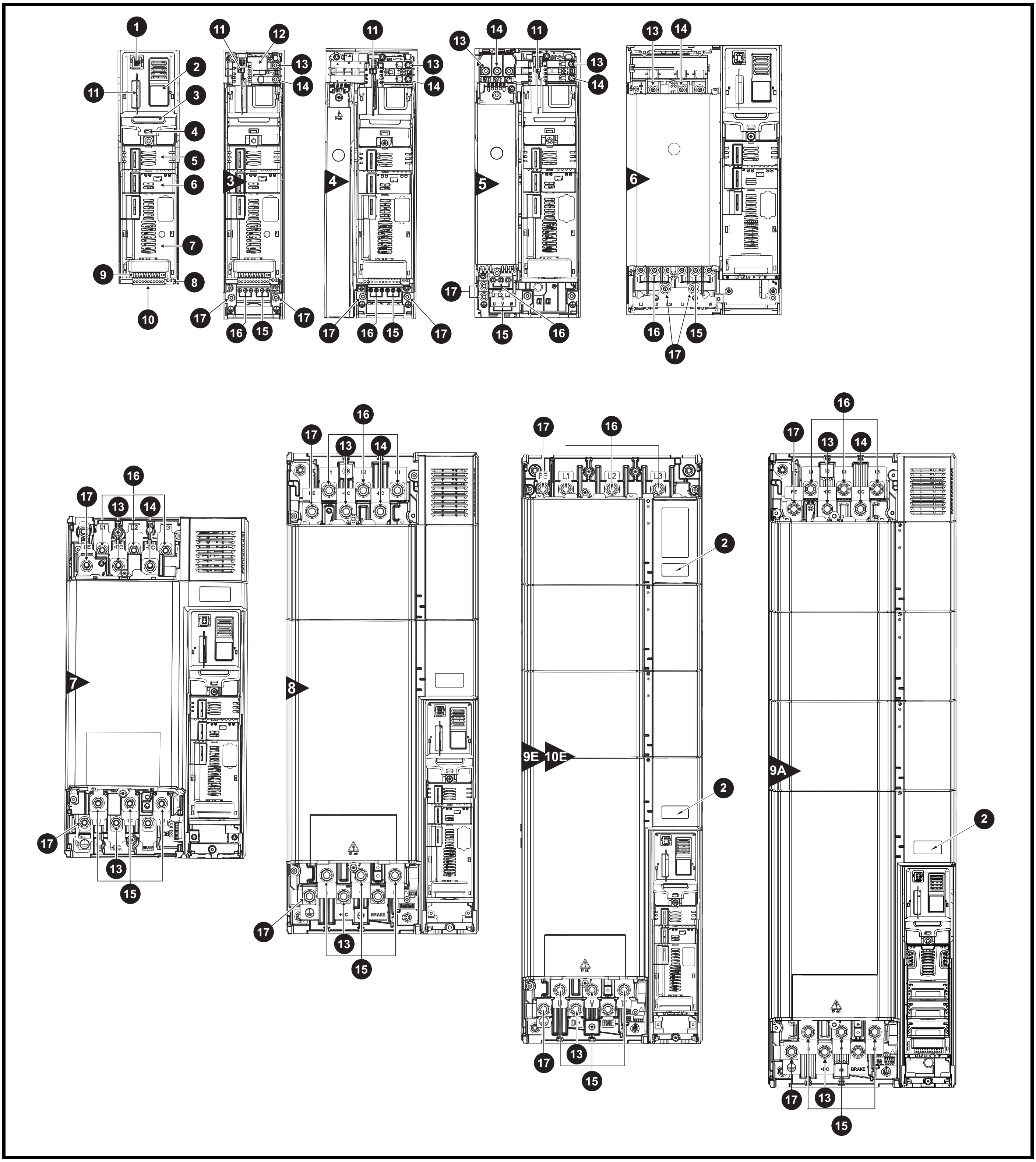
For use with permanent magnet brushless motors without a feedback device installed.

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.

2.5 Drive features

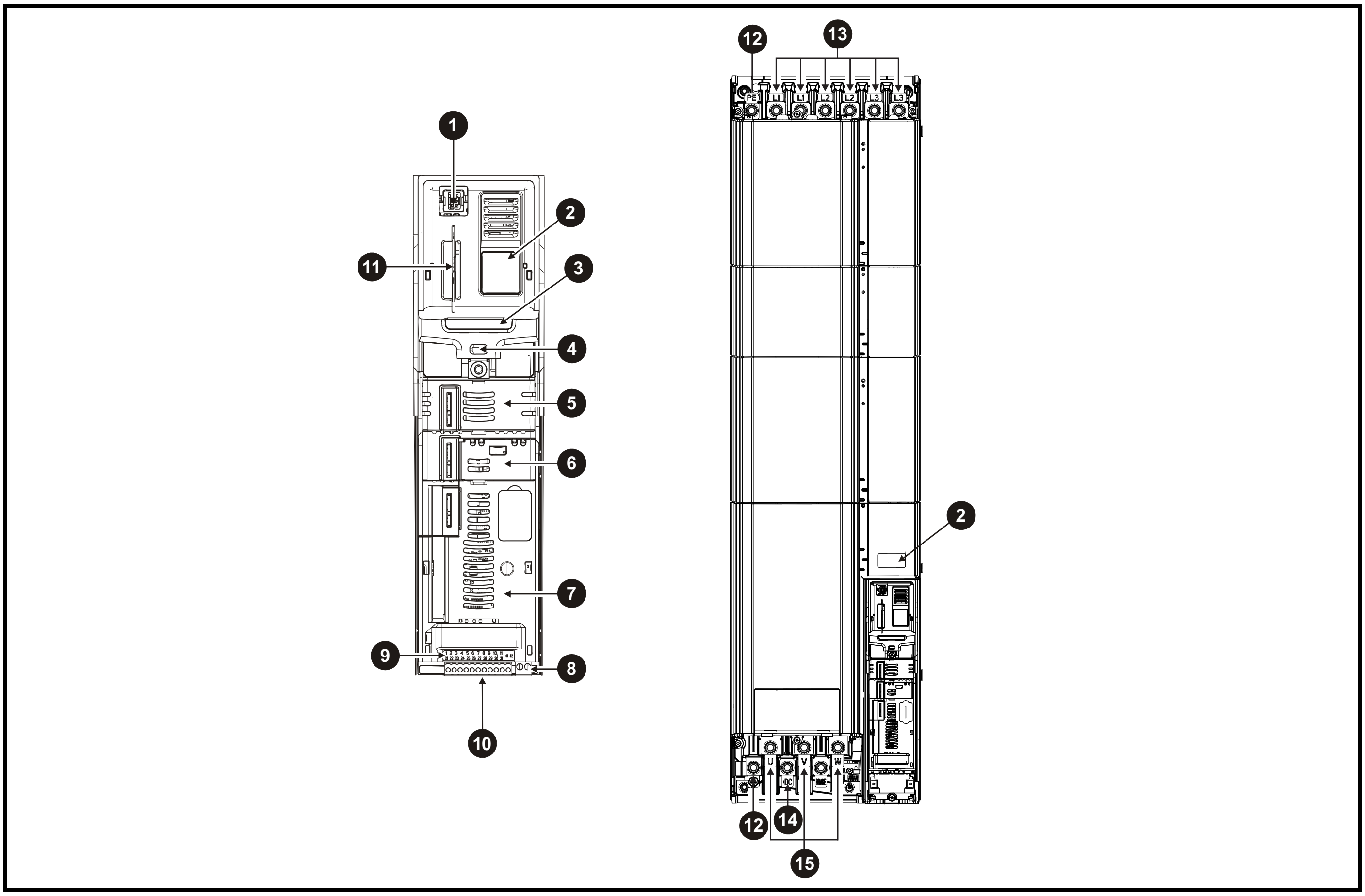
Figure 2-3 Features of the drive (size 3 to 10)



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. Control connections
10. Communications port
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 2-4 Features of the drive (size 11E)



Key

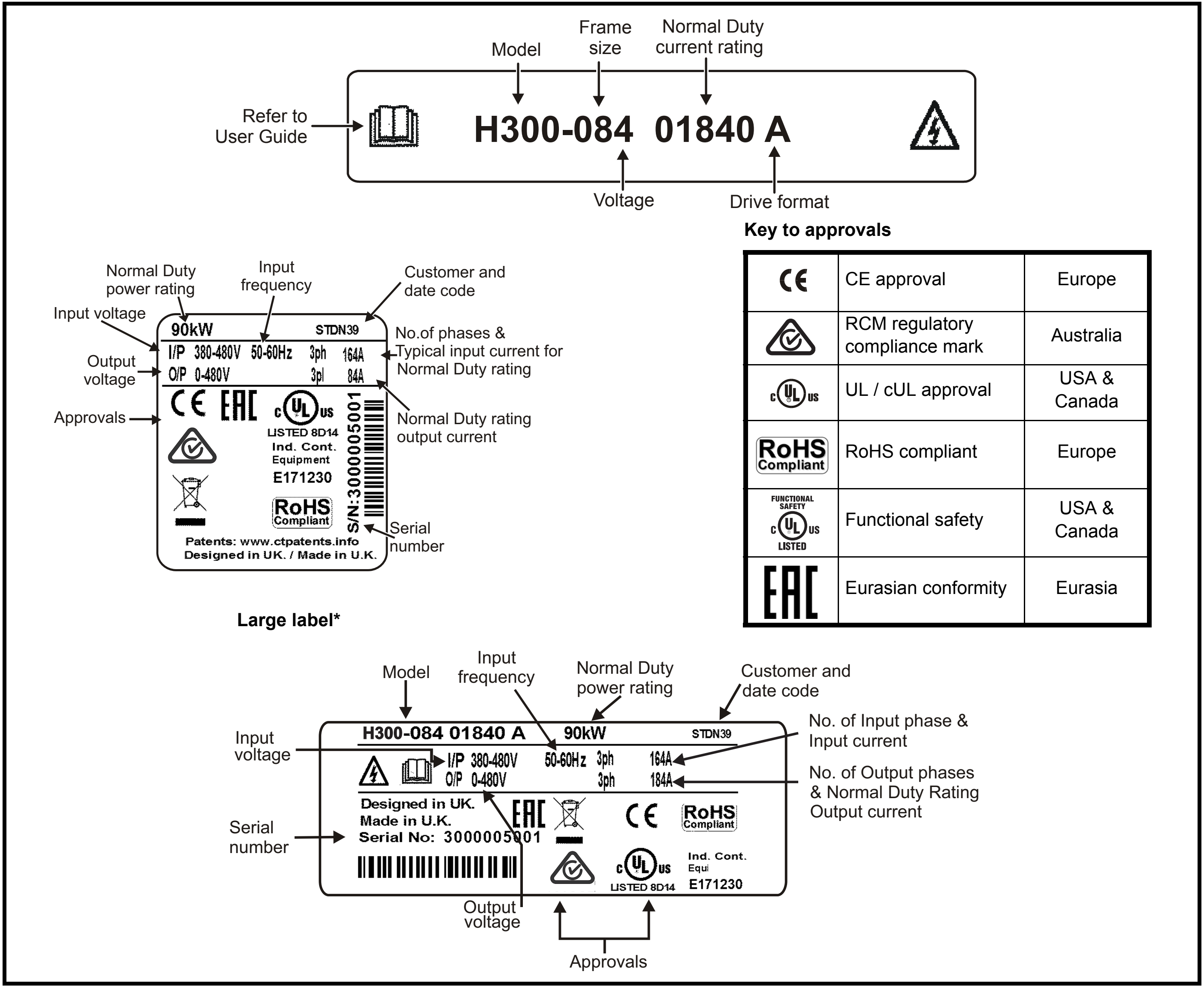
1. Keypad connection
2. Rating label
3. Identification label
4. Status LED
5. Option module slot 1
6. Option module slot 2
7. Option module slot 3
8. Relay connections
9. Control connections
10. Communications port
11. NV media card slot
12. Ground connections
13. AC supply connections*
14. DC bus +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

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

2.6 Nameplate description

See Figure 2-3 for location of rating labels.

Figure 2-5 Typical drive rating labels



Key to approvals

CE	CE approval	Europe
RCM	RCM regulatory compliance mark	Australia
c UL us	UL / cUL approval	USA & Canada
RoHS Compliant	RoHS compliant	Europe
FUNCTIONAL SAFETY c UL us LISTED	Functional safety	USA & Canada
EAC	Eurasian conformity	Eurasia

* 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

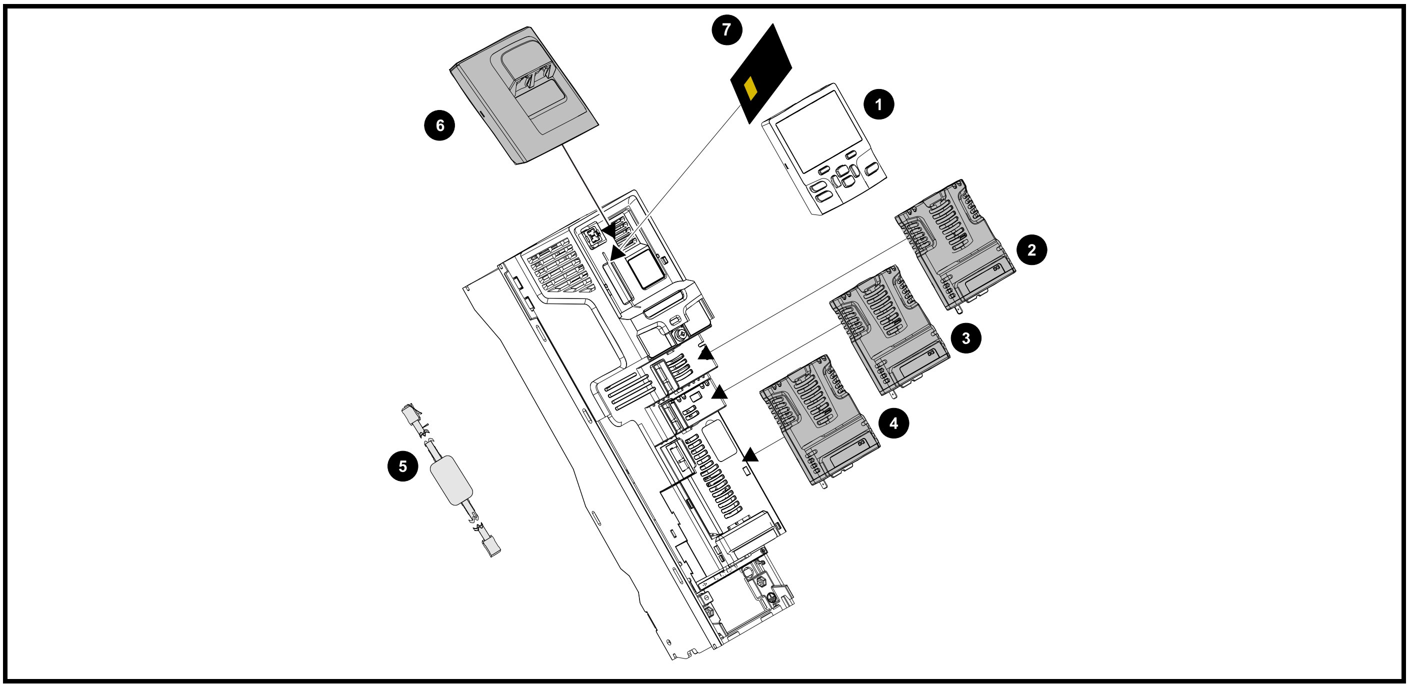
Date code format

The date code is split into two sections: a letter followed by a number. The letter indicates the year, and the number indicates the week number (within the year) in which the drive was built. The letters go in alphabetical order, starting with A in 1991 (B in 1992, C in 1993 etc).

Example:
A date code of **Y28** would correspond to week 28 of year 2015.

2.7 Options

Figure 2-6 Options available with the drive



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.

** For further information refer to section 9 *NV Media Card Operation* on page 165

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

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 2-6 Option module identification

Type	Option module	Color	Name	Further Details
Fieldbus		N/A	KI-485 Adaptor	**485 Comms Adaptor** 485 Comms adaptor provides EIA-485 communication interface. This adaptor supports 115 k Baud, node addresses between 1 to 16 and 8 1 NP M serial mode.
		Purple	SI-PROFIBUS	**Profibus option** PROFIBUS adapter for communications with the drive
		Medium Grey	SI-DeviceNet	**DeviceNet option** DeviceNet adapter for communications with the drive
		Light Grey	SI-CANopen	**CANopen option** CANopen adapter for communications with the drive
		Beige	SI-Ethernet	External Ethernet module that supports EtherNet/IP, Modbus TCP/IP and RTMoE. The module can be used to provide high speed drive access, global connectivity and integration with IT network technologies, such as wireless networking
		Yellow Green	SI-PROFINET V2	**PROFINET V2 option** PROFINET V2 adapter for communications with the drive
Automation (I/O expansion)		Orange	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)		Moss Green	MCi200	**Machine Control Studio Compatible Applications Processor** 2nd processor for running pre-defined and/or customer created application software.
		Moss Green	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.
		Black	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).

Table 2-7 Keypad identification

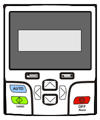
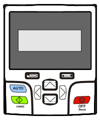
Type	Keypad	Name	Further Details
Keypad		KI-HOA Keypad RTC	**LCD keypad option** Keypad with a LCD display and Hand / Off / Auto buttons and RTC
		HOA Remote keypad	**Remote LCD keypad option** Remotely mounted keypad with an LCD display, Hand / Off / Auto buttons and real time clock

Table 2-8 Additional options

Type	Option	Name	Further Details
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

2.8 Items supplied with the drive

The drive is supplied with a copy of the *Getting Started Guide*, a safety information booklet, the Certificate of Quality and an accessory kit box including the items shown in Table 2-9.

Table 2-9 Parts supplied with the drive (size 3 to 8)

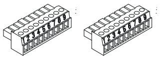
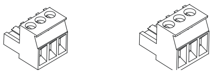
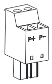
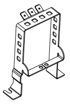
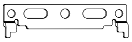
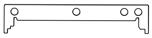
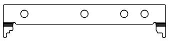
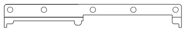
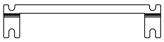
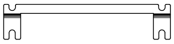
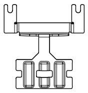
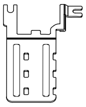
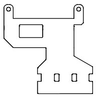
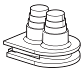
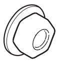
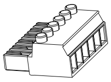
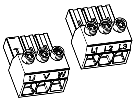
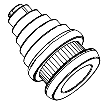
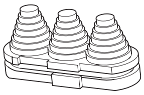
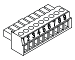
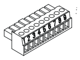
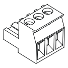
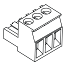
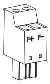
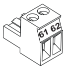
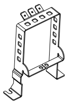
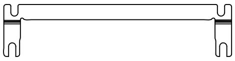
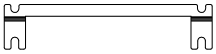
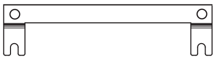
<table>
<tr><th>Description</th><th>Size 3</th><th>Size 4</th><th>Size 5</th><th>Size 6</th><th>Size 7</th><th>Size 8</th></tr>
<tr><td>Control connectors 1 to 9 and 21 to 29</td><td colspan="6">
x 1 x 1</td></tr>
<tr><td>Relay connector</td><td colspan="6">
x 1 x 1</td></tr>
<tr><td>24 V power supply connector</td><td colspan="3"></td><td colspan="3">
x 1</td></tr>
<tr><td>Grounding bracket</td><td colspan="6">
x 1</td></tr>
<tr><td>Surface mounting brackets</td><td>
x 2</td><td>
x 2</td><td>
x 2</td><td>
x 2</td><td>
x 2</td><td>
x 2</td></tr>
<tr><td>Grounding clamp</td><td colspan="2">
x 1</td><td>
x 1</td><td>
x 1</td><td colspan="2"></td></tr>
<tr><td>DC terminal cover grommets</td><td colspan="2">
x 2</td><td colspan="4"></td></tr>
<tr><td>Terminal nuts</td><td colspan="3"></td><td>
M6 x 11</td><td colspan="2"></td></tr>
<tr><td>Supply and motor connector</td><td colspan="2">
x 1</td><td>
x 1 x 1</td><td colspan="3"></td></tr>
<tr><td>Finger guard grommets</td><td colspan="2"></td><td>
x 3</td><td>
x 2</td><td colspan="2"></td></tr>
</table>

Table 2-10 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		
Relay connector	 x 1  x 1		
24 V power supply connectors	 x 1  x 1		
Grounding bracket	 x 1		
Surface mounting brackets	 x 2		 x 2  x 1

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:

- Through-hole mounting
- High IP as standard or through-panel mounting
- Enclosure sizing and layout
- Option module installing
- Terminal location and torque settings

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

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 (Ingress Protection) rating of the drive is installation dependent. For further information, refer to section 3.9 *Enclosing standard drive for high environmental protection* on page 51.

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.

For further information, refer to section 3.6 *Enclosure for standard drives* on page 47.

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 74*.

3.2.5 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.

For installation in the USA, a NEMA 12 enclosure is suitable.

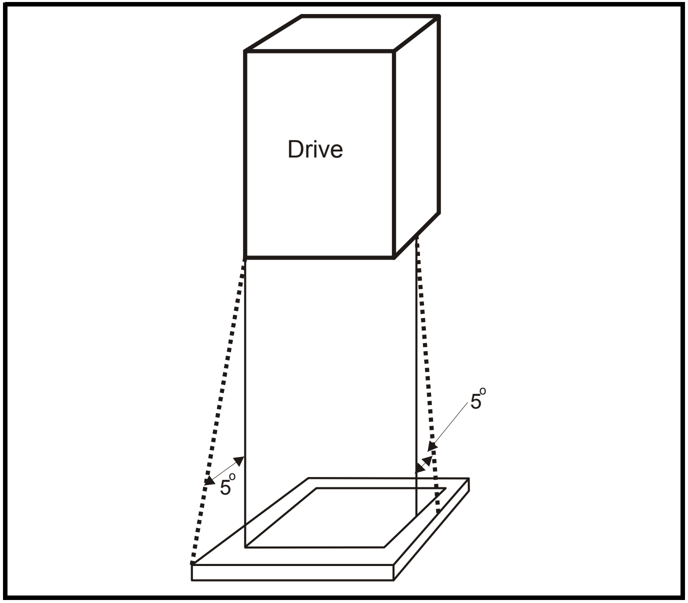
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

Enclosure can be metal and/or polymeric, polymer must meet requirements which can be summarized for larger enclosures as using materials meeting at least UL 94 class 5VB at the point of minimum thickness.

Air filter assemblies to be at least class V-2.

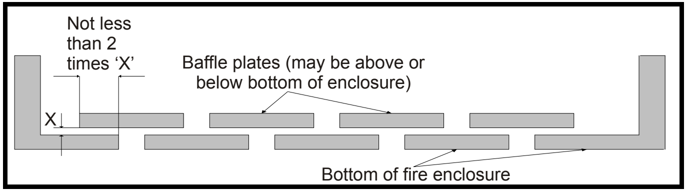
The location and size of the bottom shall cover the area shown in Figure 3-1. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

Figure 3-1 Fire enclosure bottom layout



The bottom, including the part of the side considered to be part of the bottom, must be designed to prevent escape of burning material - either by having no openings or by having a baffle construction. This means that openings for cables etc. must be sealed with materials meeting the 5VB requirement, or else have a baffle above. See Figure 3-2 for acceptable baffle construction. This does not apply for mounting in an enclosed electrical operating area (restricted access) with concrete floor.

Figure 3-2 Fire enclosure baffle construction



3.2.6 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 industrial 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, which must be located very close to the drives. Space must be made available for the filters and allowance made for carefully segregated wiring. Both levels of precautions are covered in section 4.11 *EMC (Electromagnetic compatibility) on page 95*.

3.2.7 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 Terminal cover removal

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

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 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.

3.3.1 Removing the terminal covers

Figure 3-3 Location and identification of terminal covers (size 3 to 10)

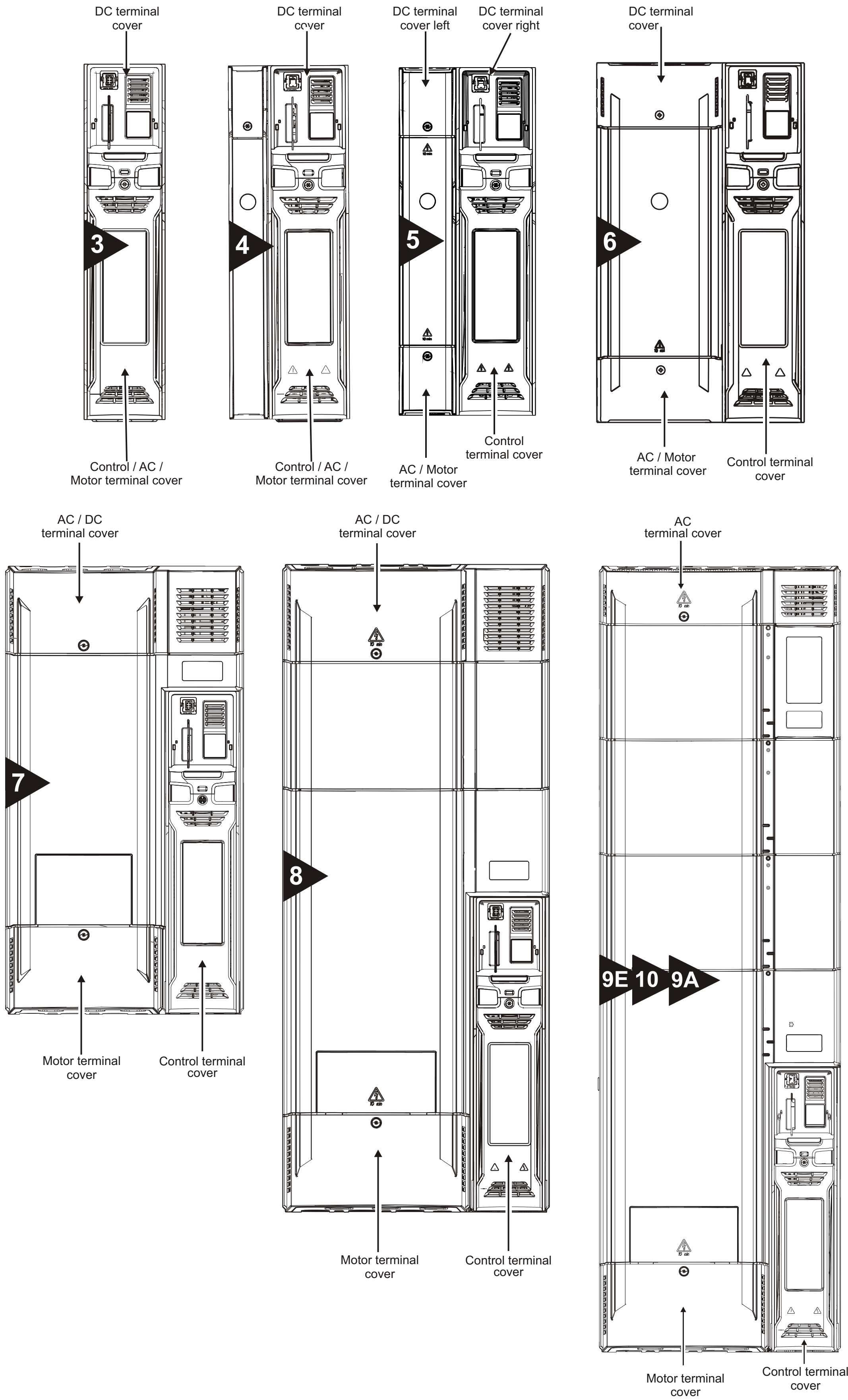


Figure 3-4 Location and identification of terminal covers (size 11)

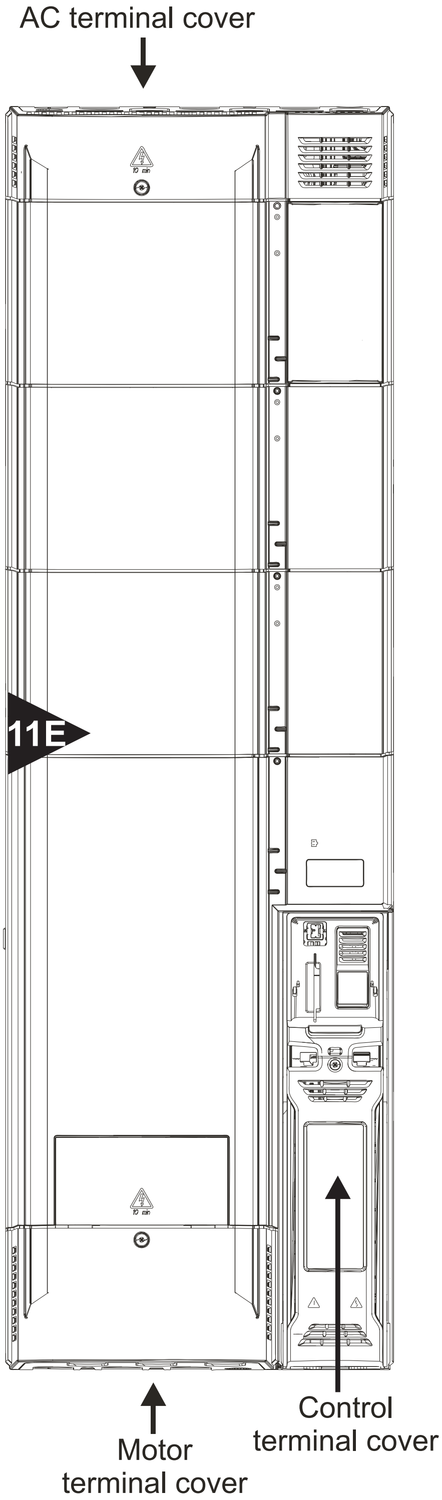
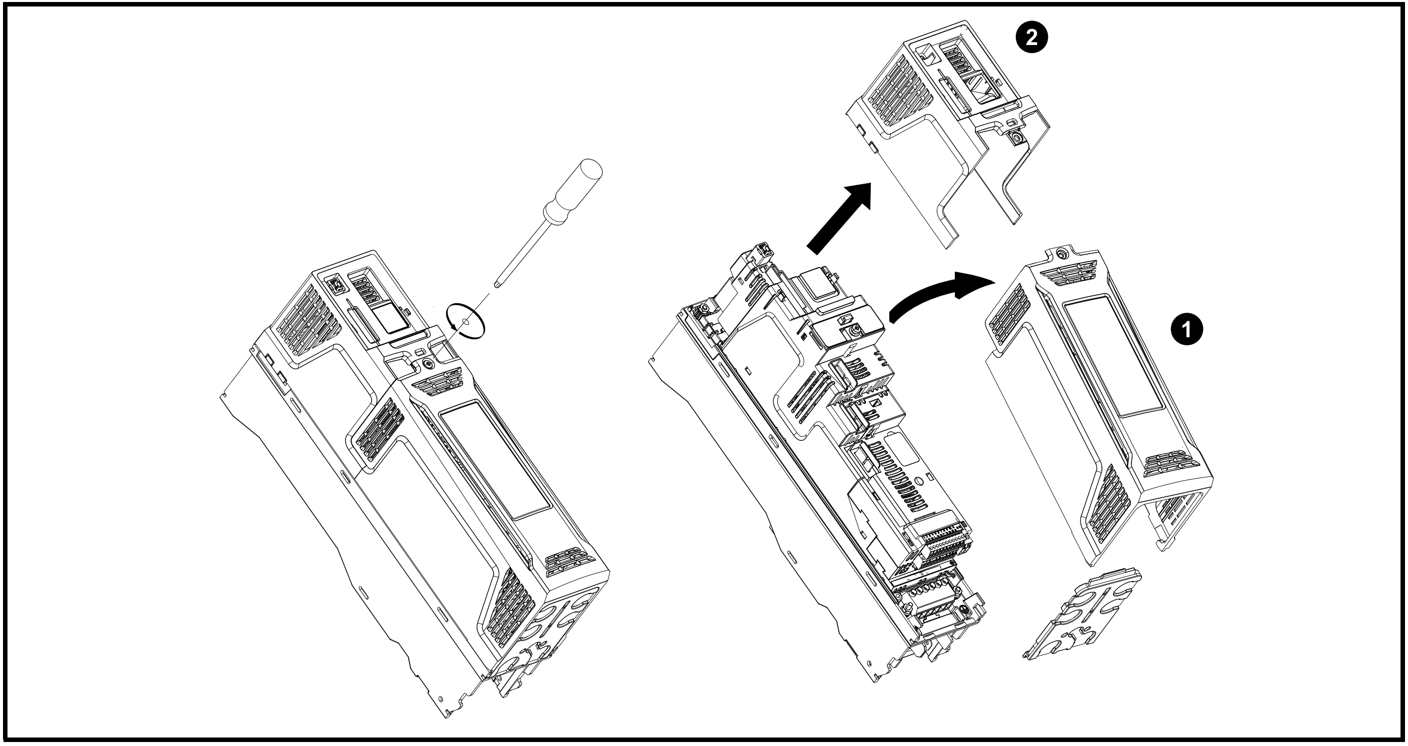


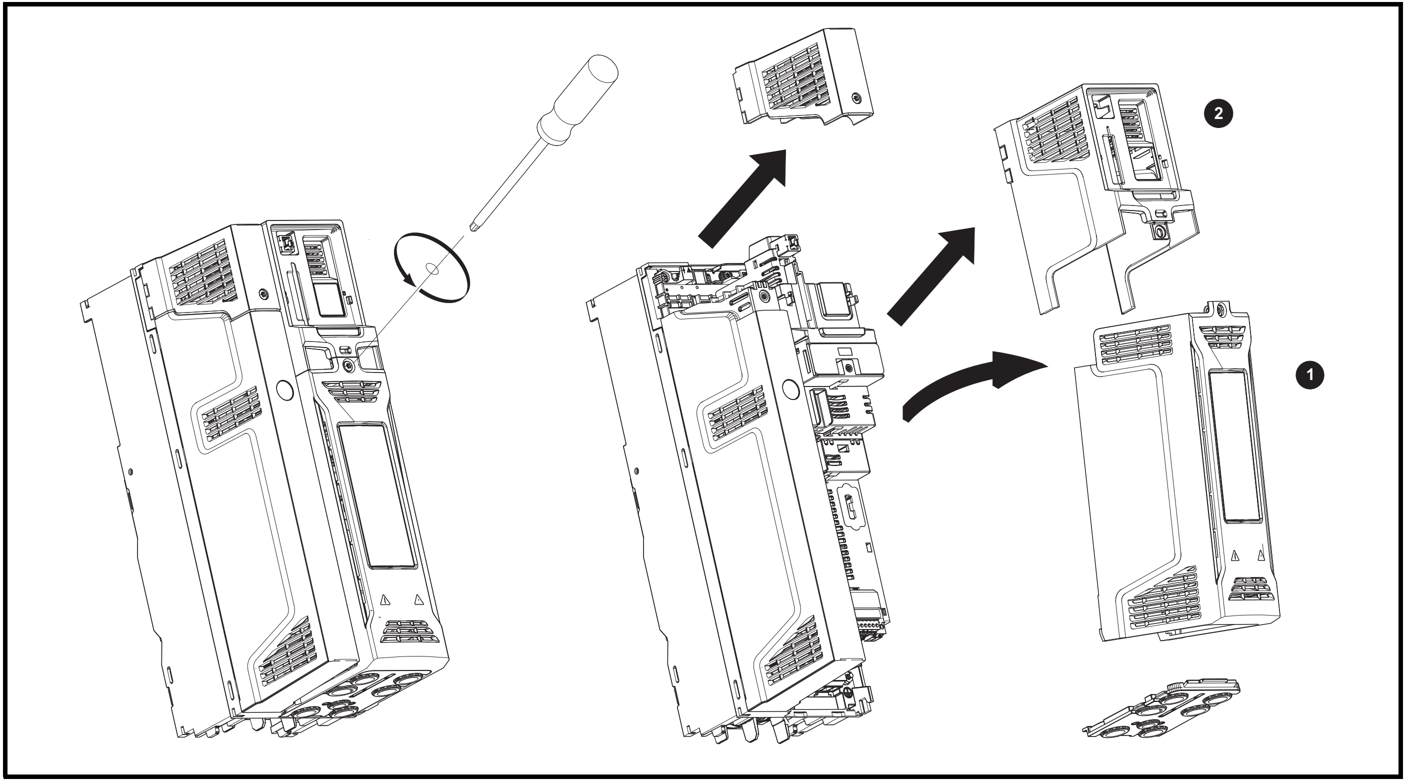
Figure 3-5 Removing the size 3 terminal covers



1. Control / AC / Motor terminal cover
2. DC cover

On size 3 drives, the Control / AC / Motor terminal cover must be removed before removal of the DC / Terminal cover. When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

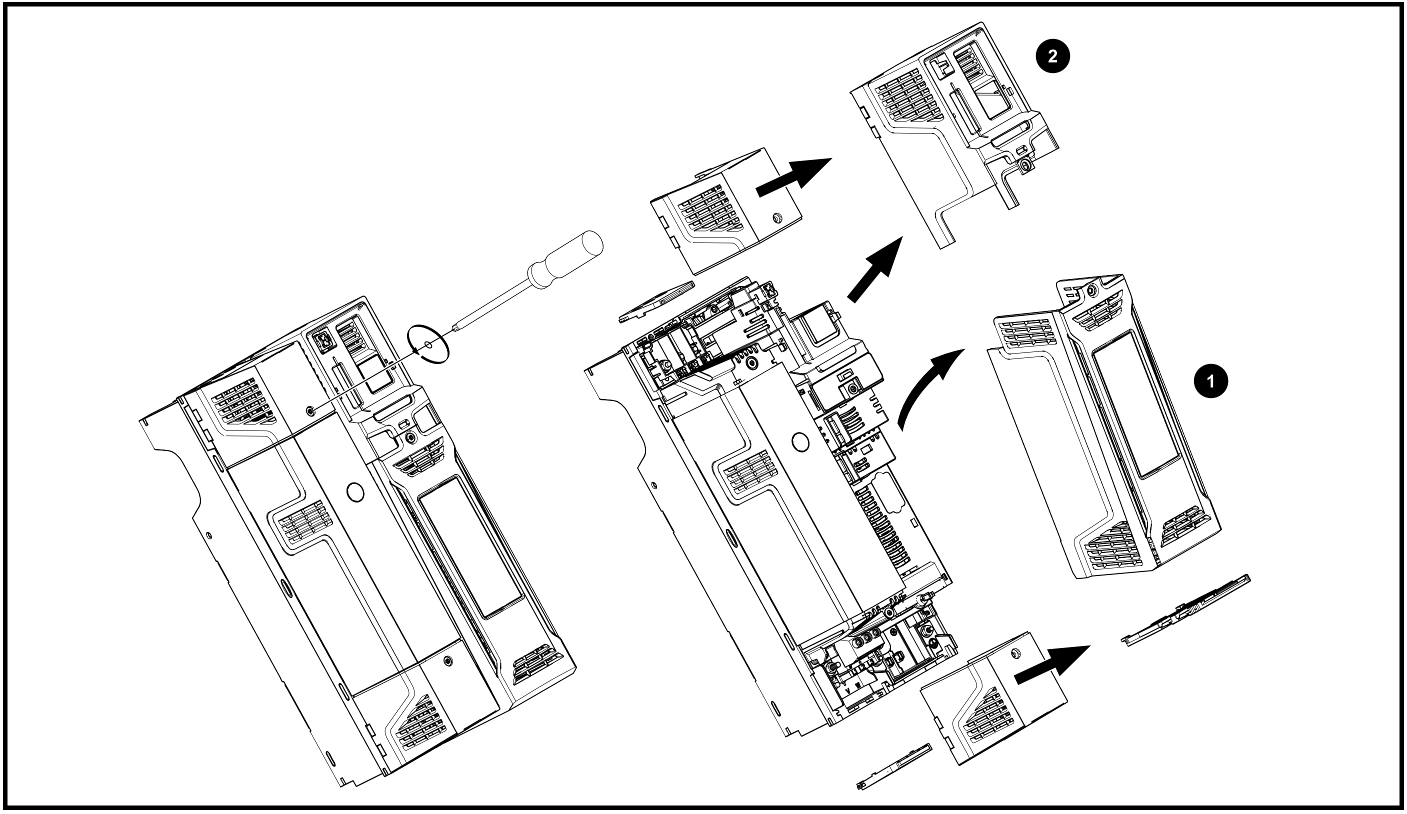
Figure 3-6 Removing the size 4 terminal covers



1. Control / AC / Motor terminal cover
2. DC cover

On size 4 drives, the Control / AC / Motor terminal cover must be removed before removal of the DC / Terminal cover. When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

Figure 3-7 Removing the size 5 terminal covers



1. Control terminal cover
2. DC cover

On size 5 drives, the Control terminal cover must be removed before removal of the DC / Terminal cover right. When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

Figure 3-8 Removing the size 6 terminal covers

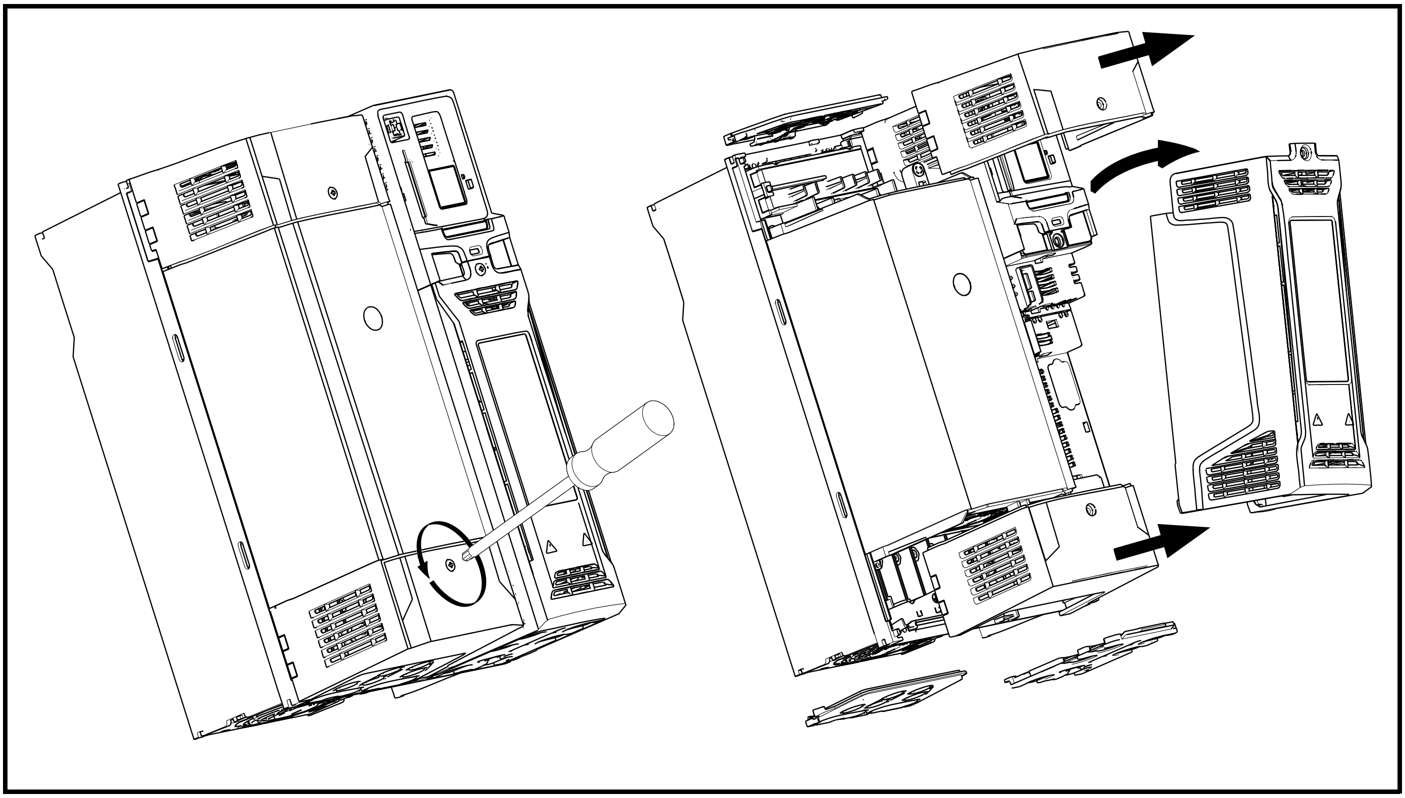
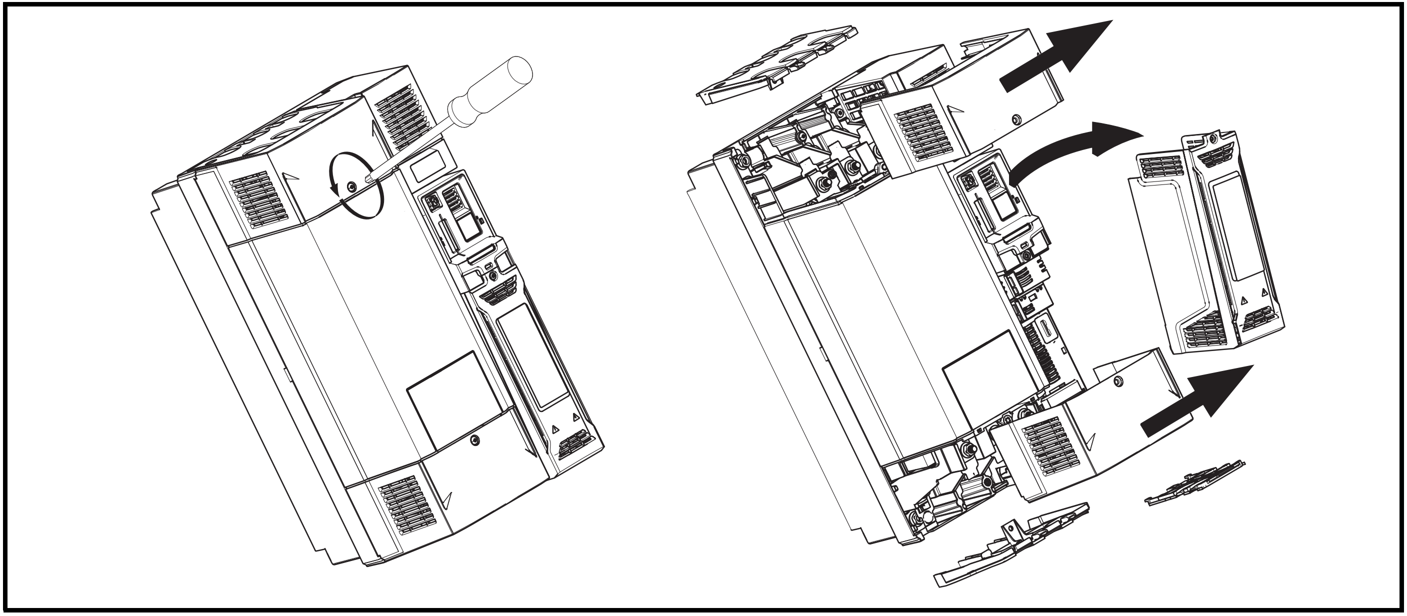


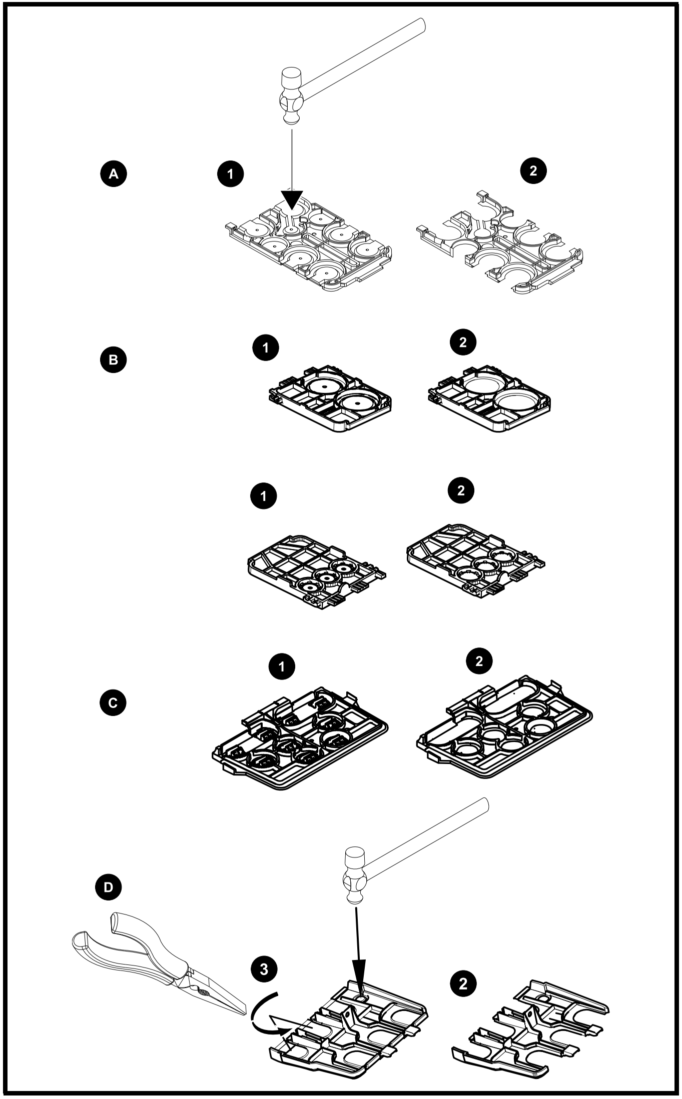
Figure 3-9 Removing the size 7 to 11 terminal covers (size 7 shown)



When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

3.3.2 Removing the finger-guard and DC terminal cover break-outs

Figure 3-10 Removing the finger-guard break-outs



A: All sizes. B: Size 5 only. C: Size 6 only. D: Size 7 to 10.

Place finger-guard on a flat solid surface and hit relevant break-outs with hammer as shown (1). Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed.

Grommet kits are available for size 7 to 10 finger guards. For size 8 to 10, two versions are available allowing for either single or double cable entries.

Table 3-1 Grommet kits

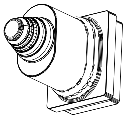
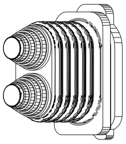
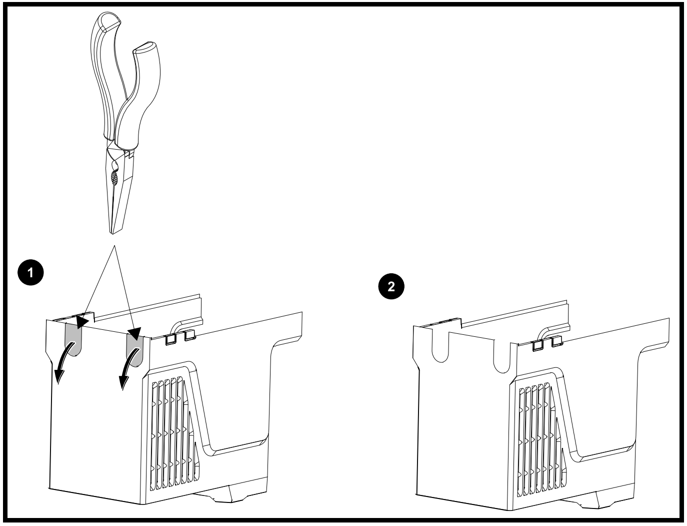
Drive size	Quantity of kits	Part number	Picture
Size 7 - Kit of 8 x single entry grommets	1	3470-0086	
Size 8 - Kit of 8 x single entry grommets	1	3470-0089	
Size 8 - Kit of 8 x double entry grommets	1	3470-0090	
Size 9 and 10 - Kit of 8 x double entry grommets	1	3470-0107	
Size 11 - kit of 8 x double entry grommets	2	3470-0107	

Figure 3-11 Removing the size 3 and 4 DC terminal cover break-outs



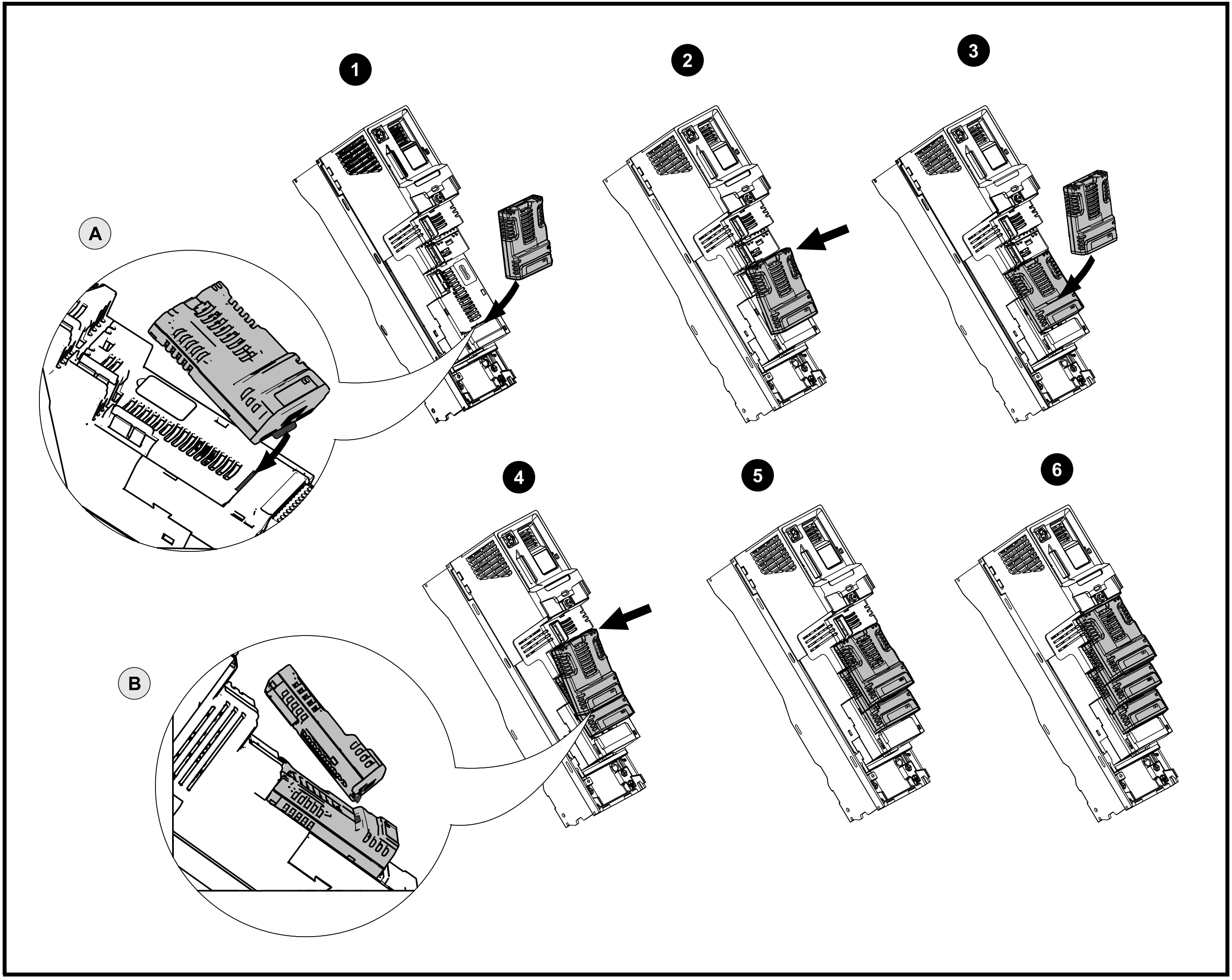
Grasp the DC terminal cover break-outs with pliers as shown (1) and pull down in the direction shown to remove. Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed. Use the DC terminal cover grommets supplied in the accessory box (Table 2-9 on page 21) to maintain the seal at the top of the drive.

3.4 Installing / removing option modules and keypads

CAUTION

Power down the drive before installing / removing the option module. Failure to do so may result in damage to the product.

Figure 3-12 Installation of a standard option module



Installing the first option module

NOTE

Option module slots must be used in the following order: slot 3, slot 2 and slot 1 (refer to Figure 2-3 *Features of the drive (size 3 to 10)* on page 16 for slot numbers).

- Move the option module in direction shown (1).
- Align and insert the option module tab in to the slot provided (2), this is highlighted in the detailed view (A).
- Press down on the option module until it clicks into place.

Installing the second option module

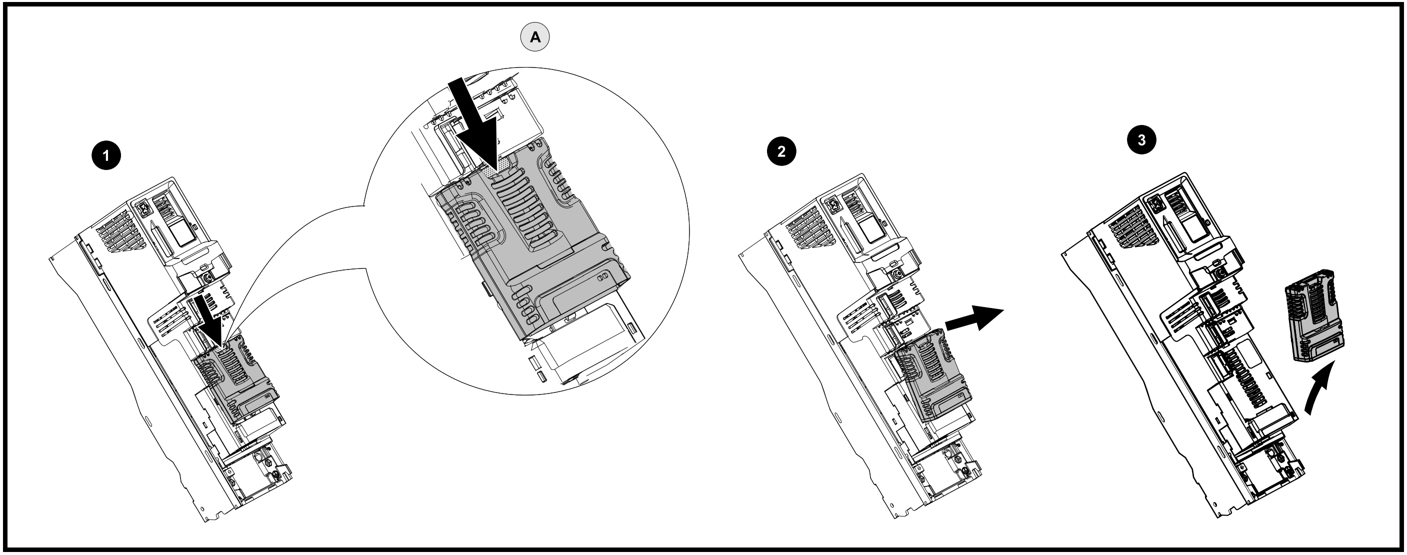
- Move the option module in direction shown (3).
- Align and insert the option module tab in to the slot provided on the already installed option module (4), this is highlighted in the detailed view (B).
- Press down on the option module until it clicks into place. Image (5) shows two option modules fully installed.

Installing the third option module

- Repeat the above process.

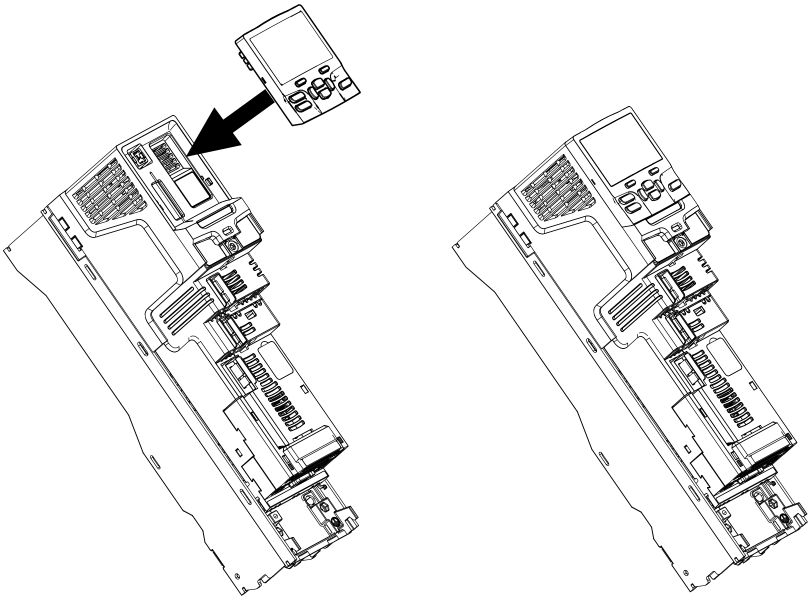
The drive has the facility for all three option module slots to be used at the same time, image (6) shows the three option modules installed.

Figure 3-13 Removal of a standard option module



- Press down on the tab (1) to release the option module from the drive housing, the tab is highlighted in the detailed view (A).
- Tilt the option module towards you as shown (2).
- Totally remove the option module in direction shown (3).

Figure 3-14 Installation and removal of the KI-Keypad



To install, align the keypad and press gently in the direction shown until it clicks into position.

To remove, reverse the installation instructions.

NOTE

The keypad can be installed / removed while the drive is powered up and running a motor, providing that the drive is not operating in keypad mode.

3.5 Dimensions and mounting methods

The drive can be either surface or through-panel mounted using the appropriate brackets. The following drawings show the dimensions of the drive and mounting holes for each method to allow a back plate to be prepared.

The Through-panel mounting kit is not supplied with the drive and can be purchased separately, below are the relevant part numbers:

Size	CT part number
3	3470-0053
4	3470-0056
5	3470-0067
6	3470-0055
7	3470-0079
8	3470-0083
9A	3470-0119
9E/10E	3470-0105
11E	3470-0126

WARNING

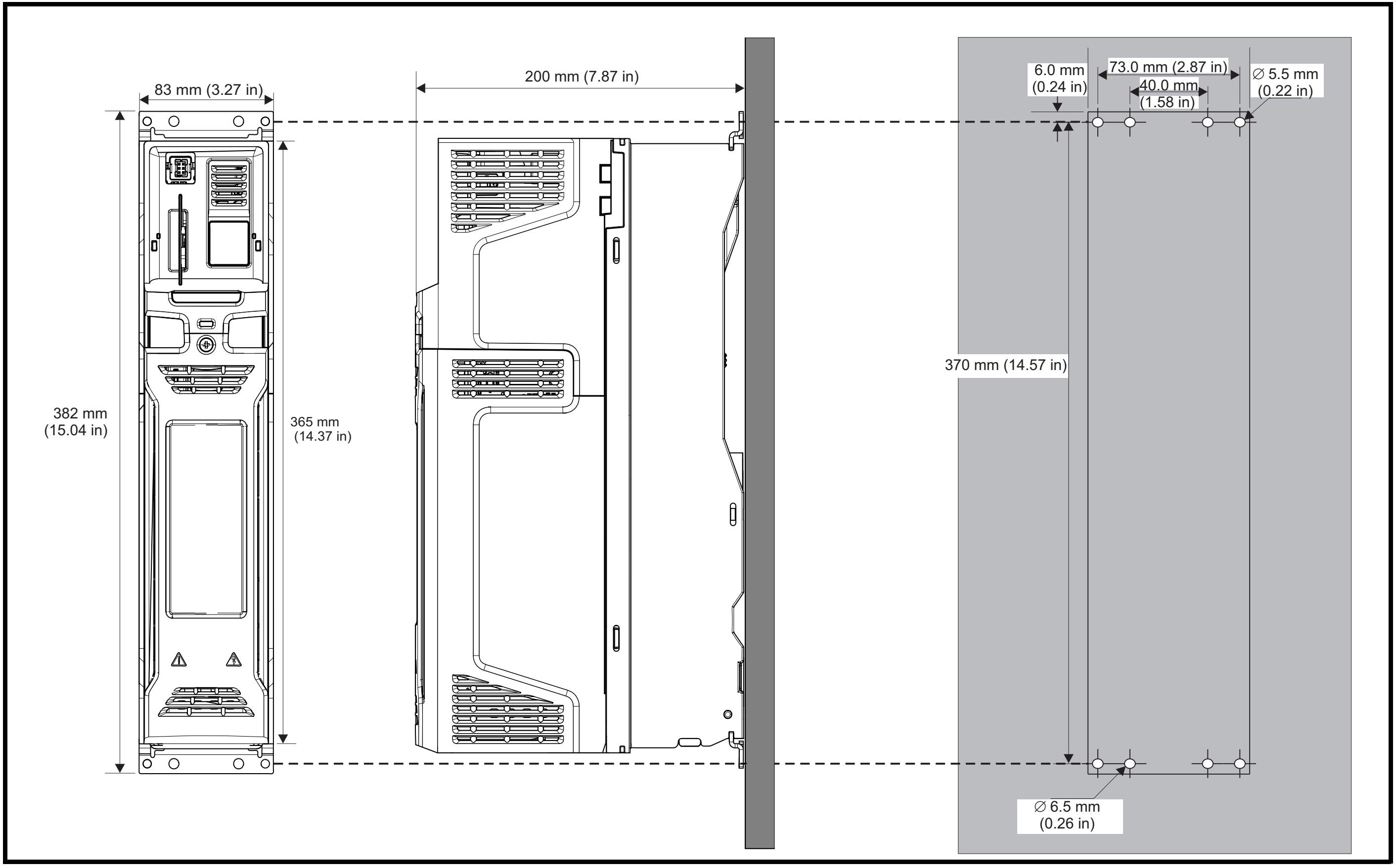
If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70 °C (158 °F). Human contact with the heatsink should be prevented.

WARNING

Many of the drives in this product range weigh in excess of 15 kg (33 lb). Use appropriate safeguards when lifting these models.
A full list of drive weights can be found in section 12.1.19 *Weights* on page 269.

3.5.1 Surface mounting

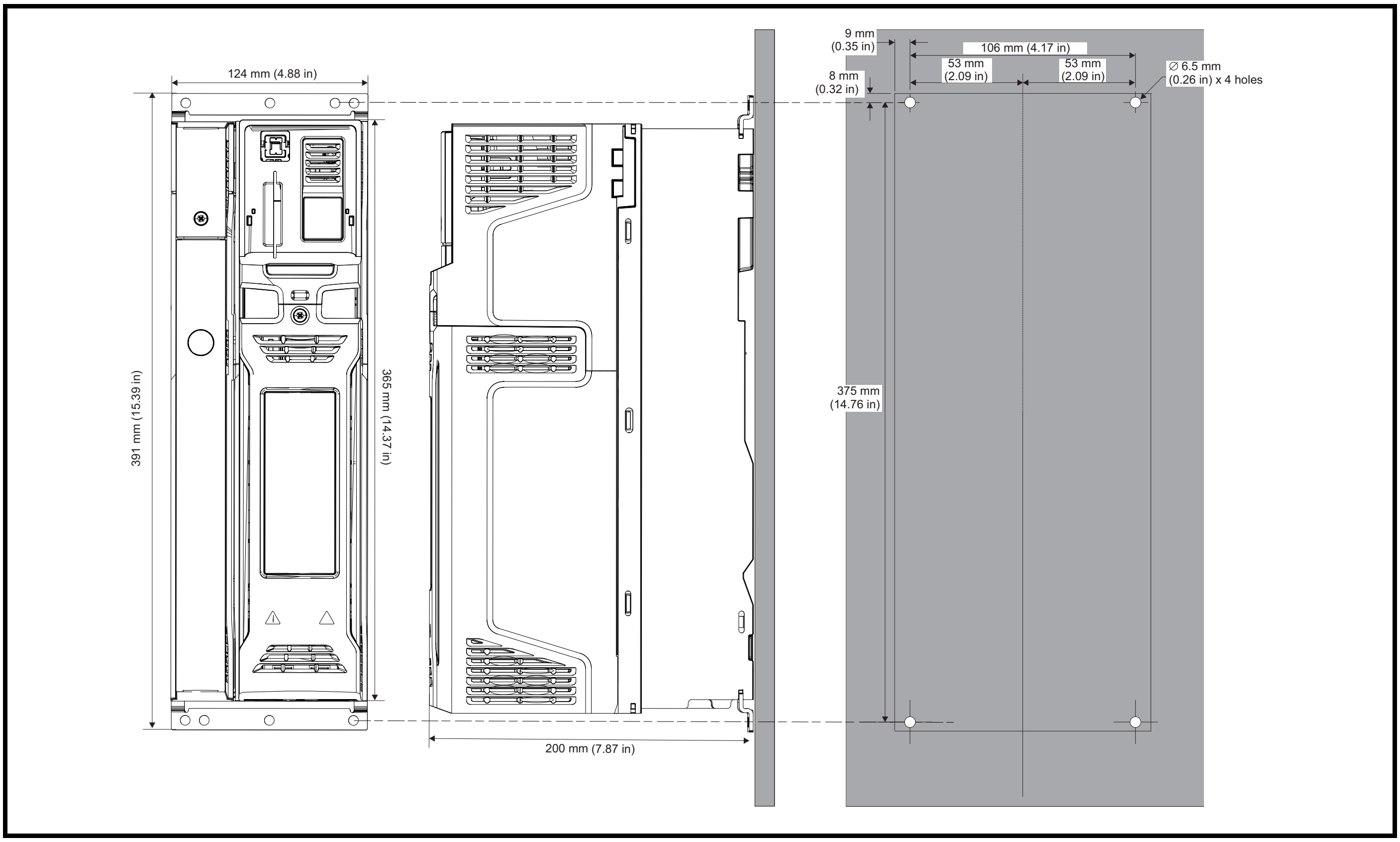
Figure 3-15 Surface mounting the size 3 drive



NOTE

Each mounting bracket contains 4 mounting holes, the outer holes (5.5 mm) x 2 should be used for mounting the drive to the backplate as this allows the heatsink fan to be replaced without removing the drive from the backplate. The inner holes (6.5 mm) x 2 are used for Unidrive SP size 1 retrofit applications. See Table 3-2 for further information.

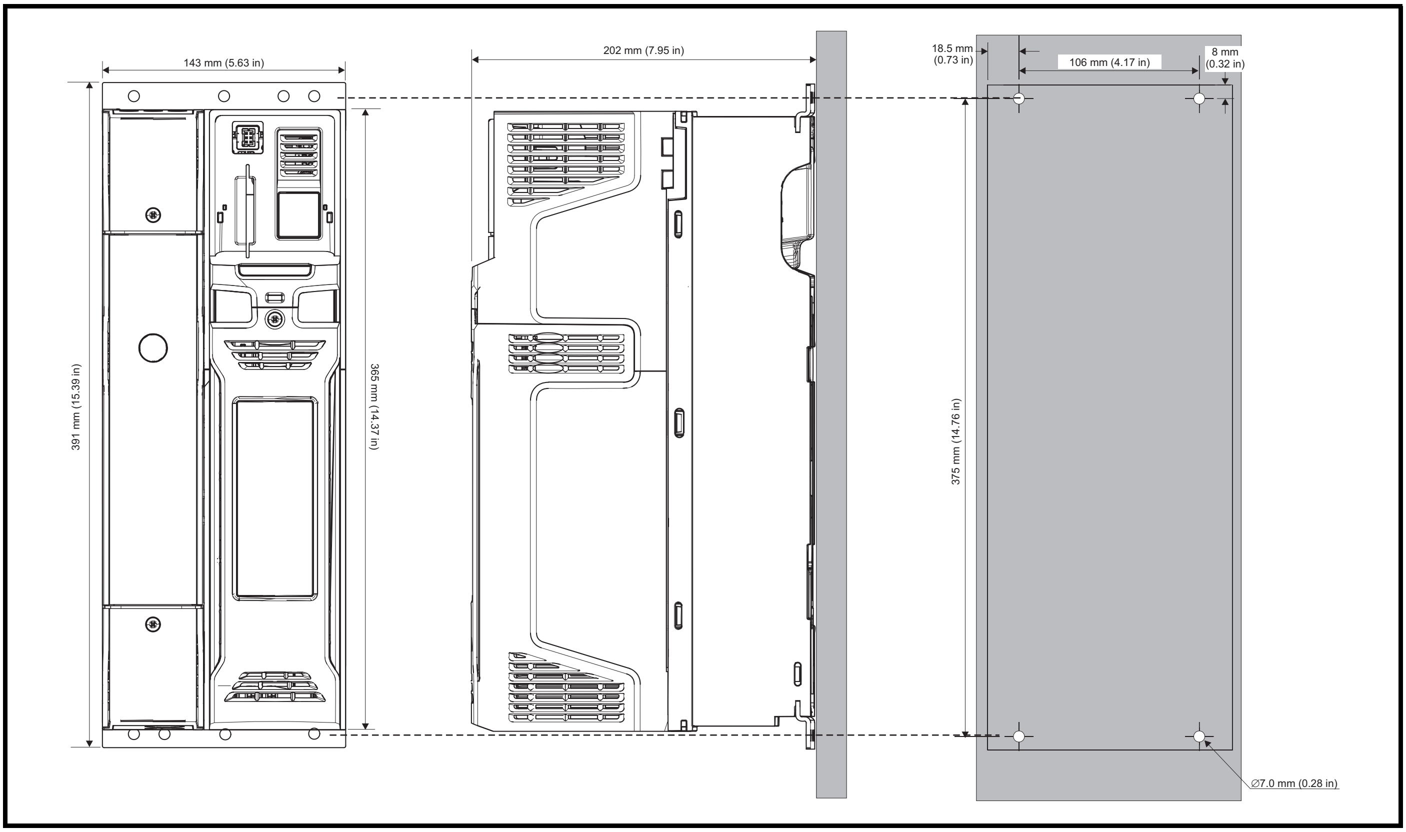
Figure 3-16 Surface mounting the size 4 drive



NOTE

The outer holes in the mounting bracket are to be used for surface mounting. See Table 3-2 for further information.

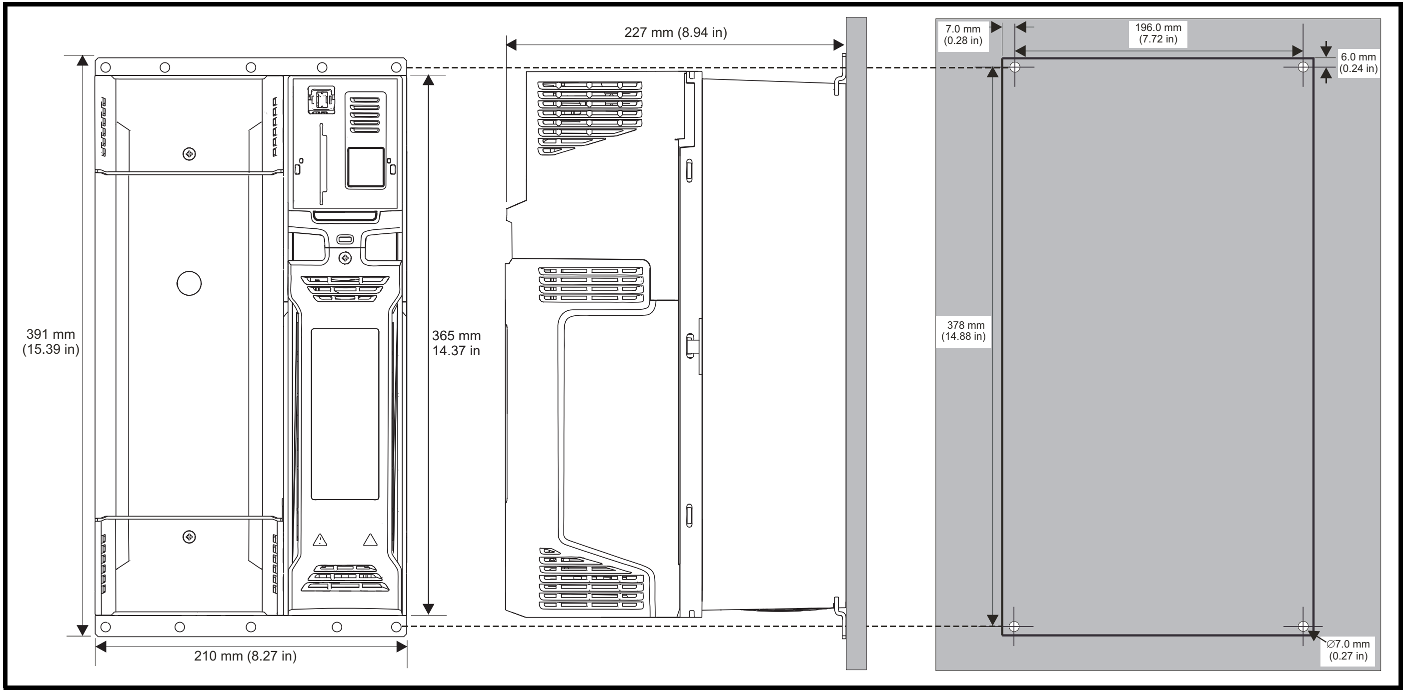
Figure 3-17 Surface mounting the size 5 drive



NOTE

The outer holes in the mounting bracket are to be used for surface mounting. See Table 3-2 for further information.

Figure 3-18 Surface mounting the size 6 drive



NOTE

The outer holes in the mounting bracket are to be used for surface mounting. See Table 3-2 for further information.

Figure 3-19 Surface mounting the size 7 drive

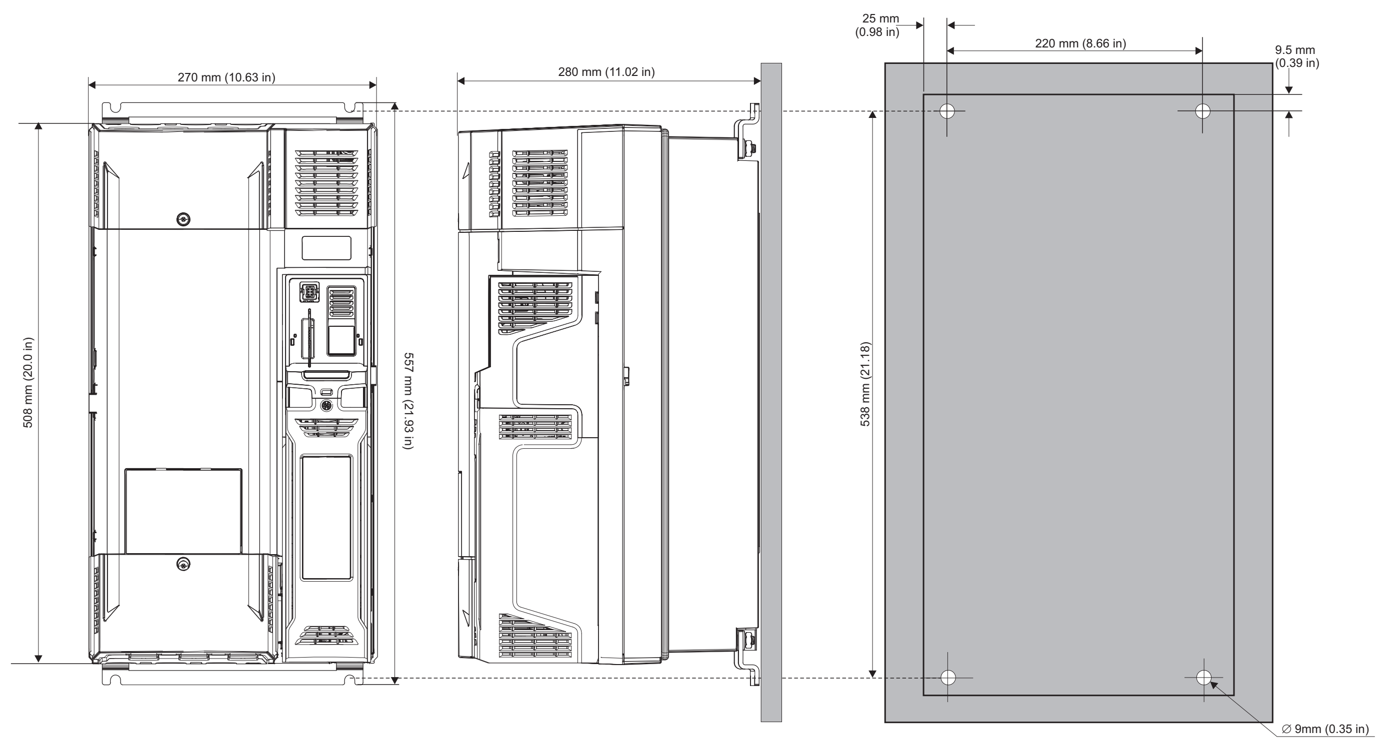


Figure 3-20 Surface mounting the size 8 drive

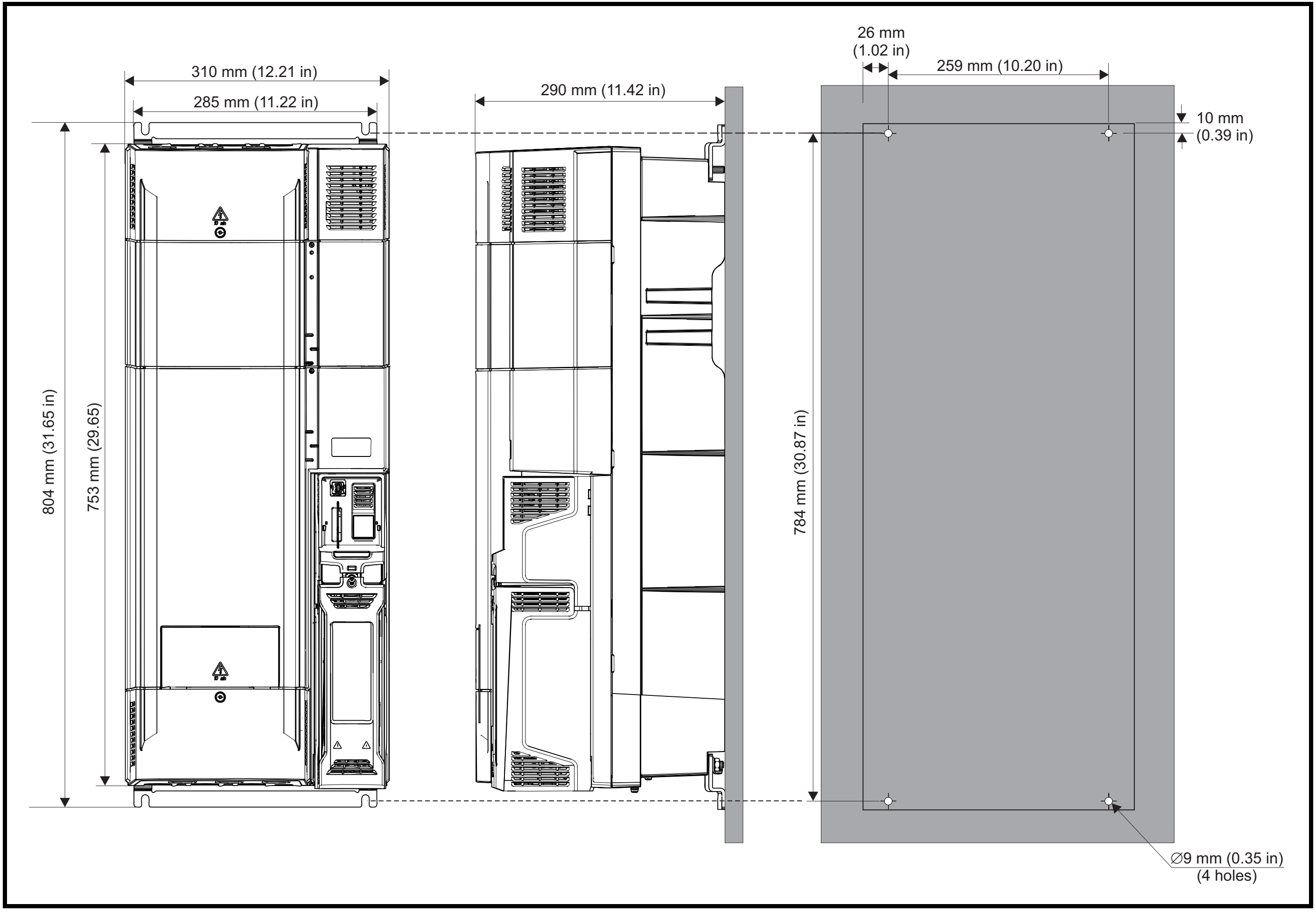


Figure 3-21 Surface mounting the size 9A

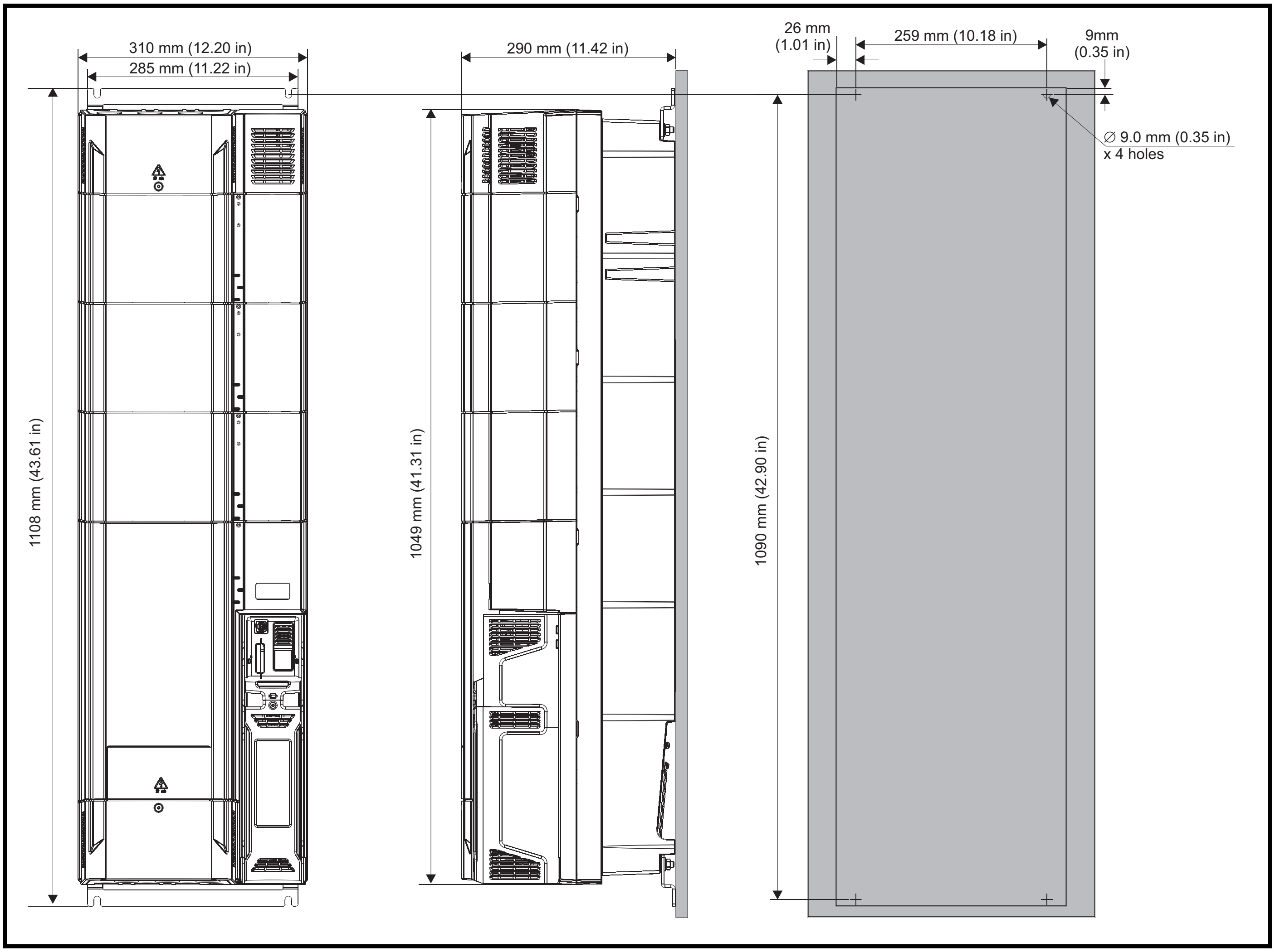


Figure 3-22   Surface mounting the size 9E and 10E

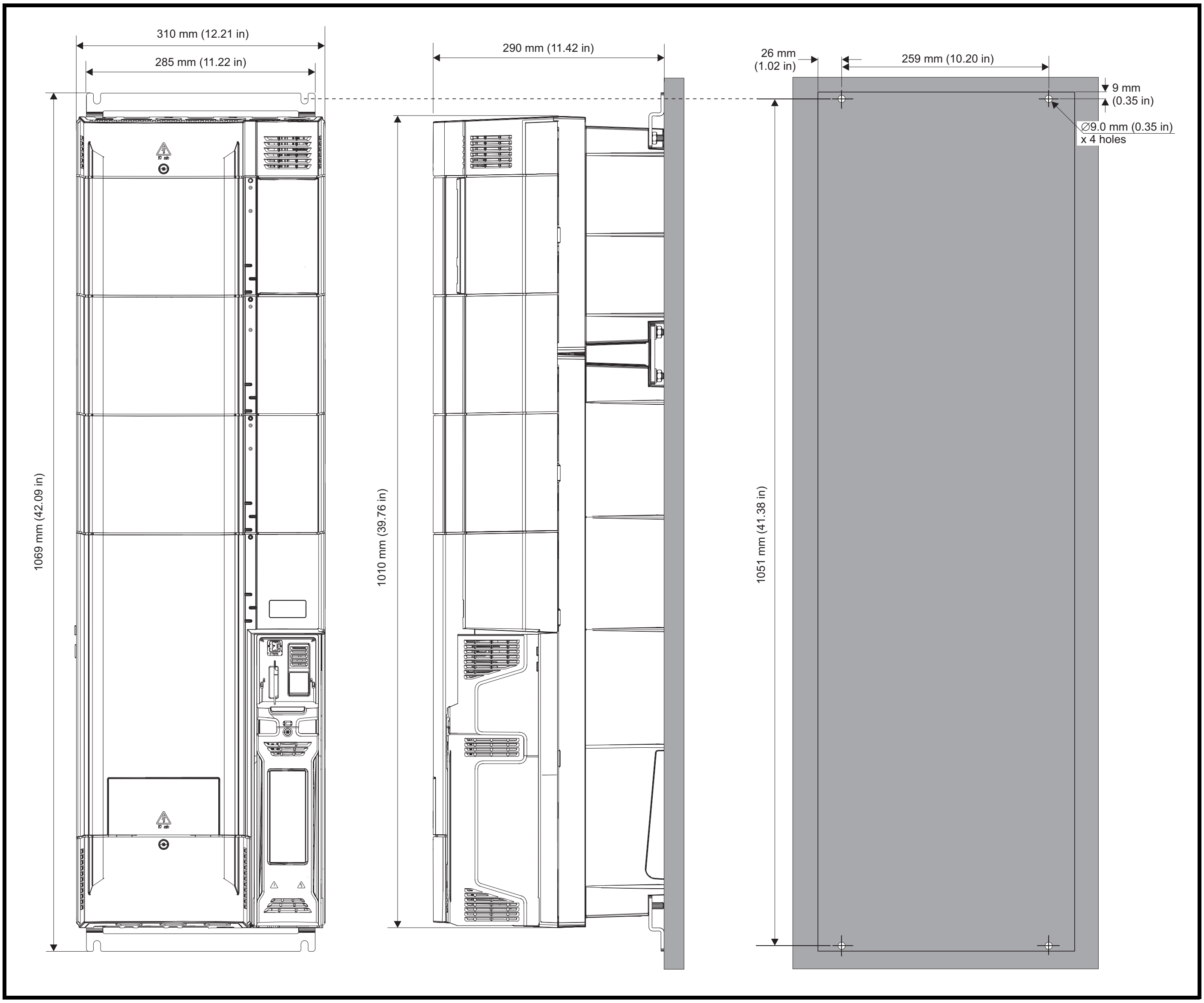
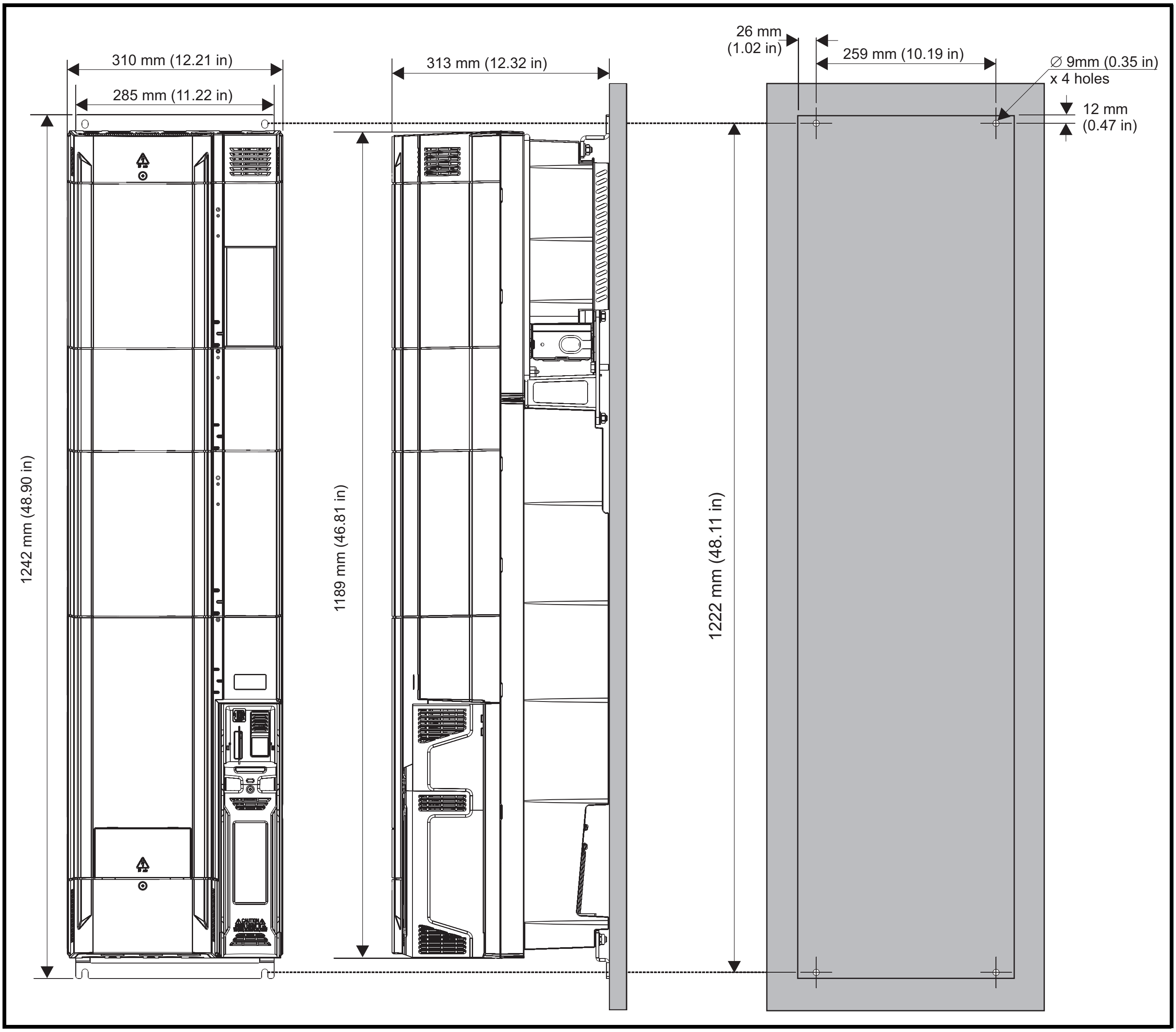
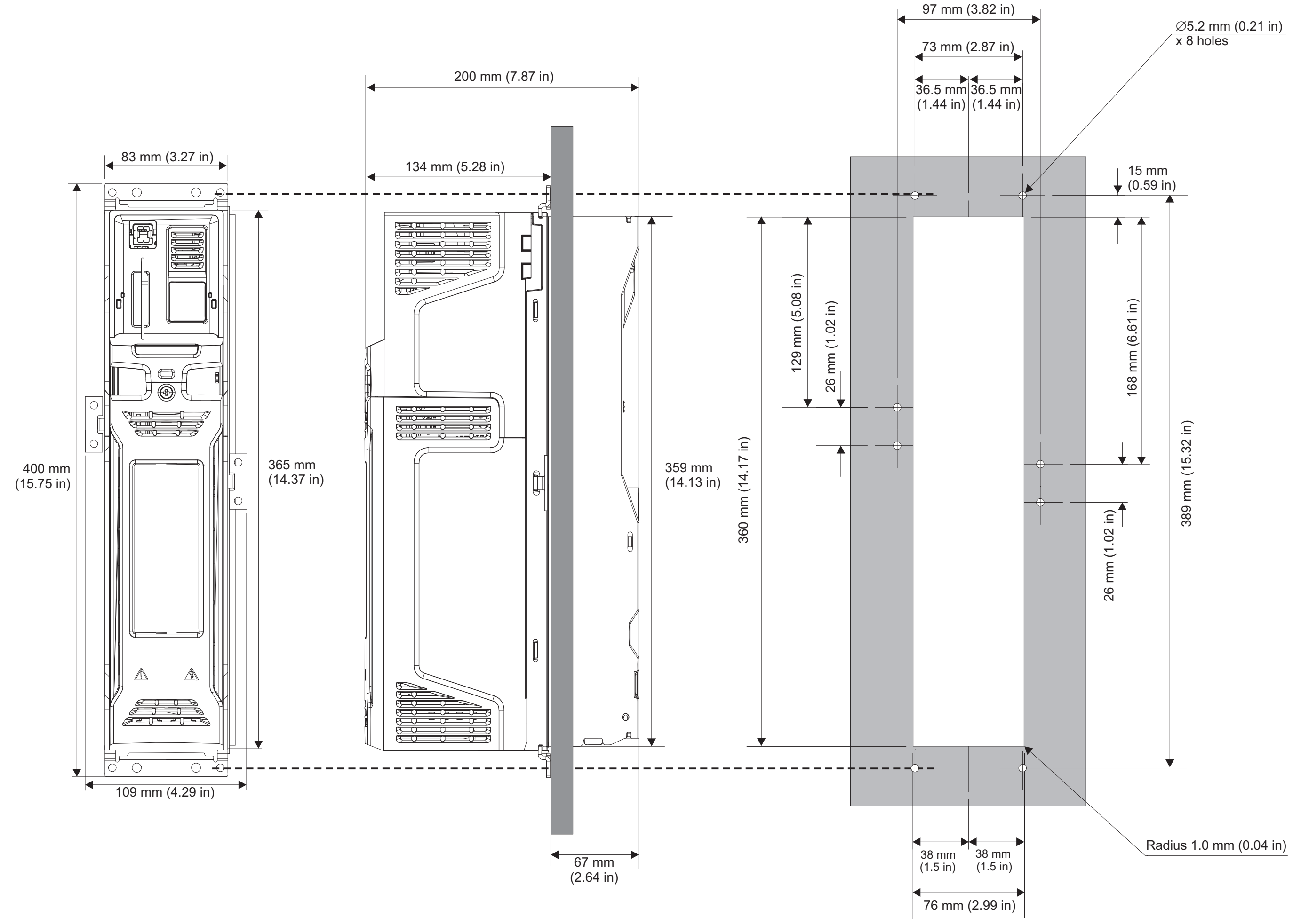


Figure 3-23   Surface mounting the size 11E



3.5.2 Through-panel mounting

Figure 3-24 Through-panel mounting the size 3 drive



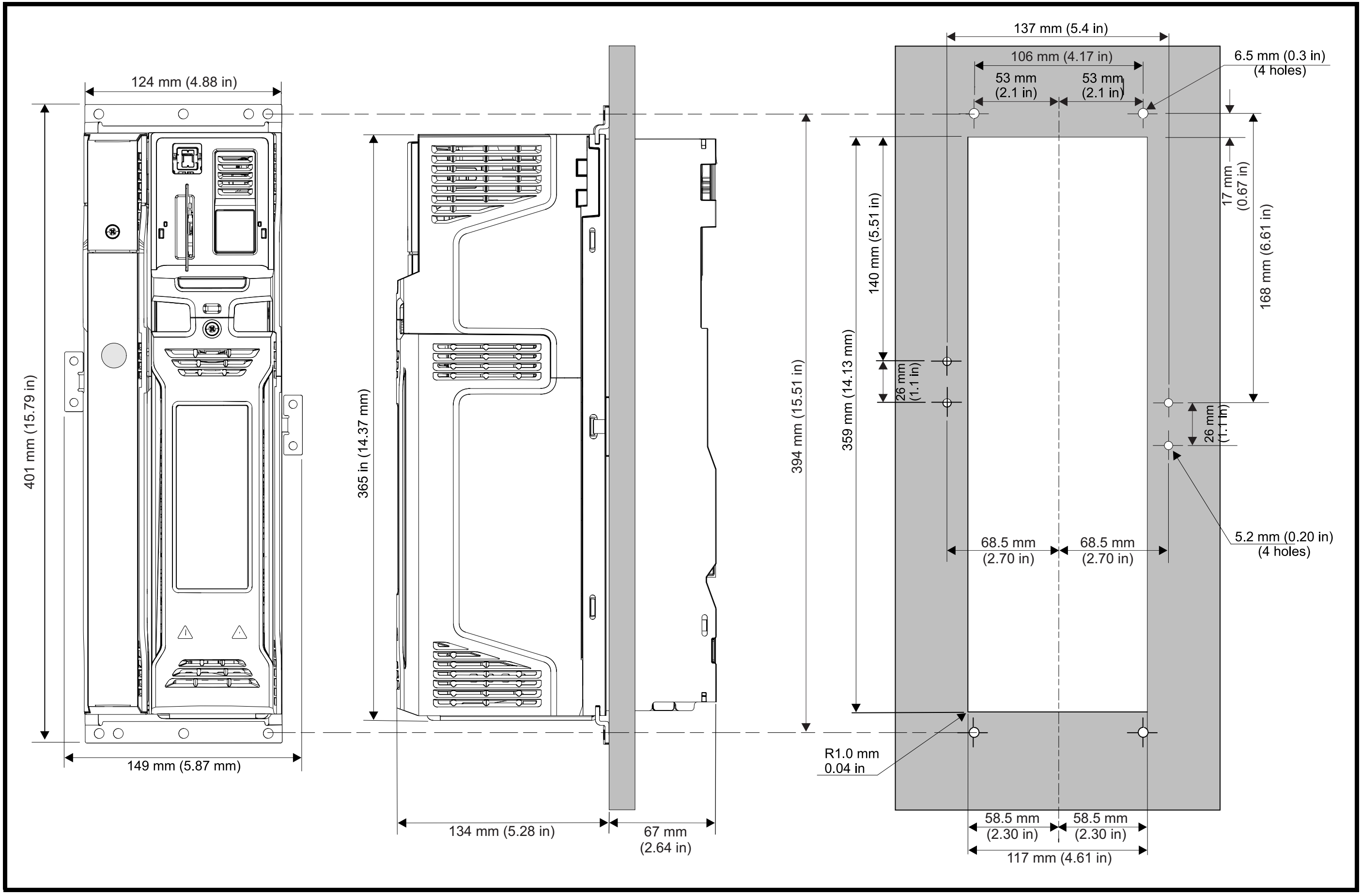


Figure 3-25 Through panel mounting the size 4 drive

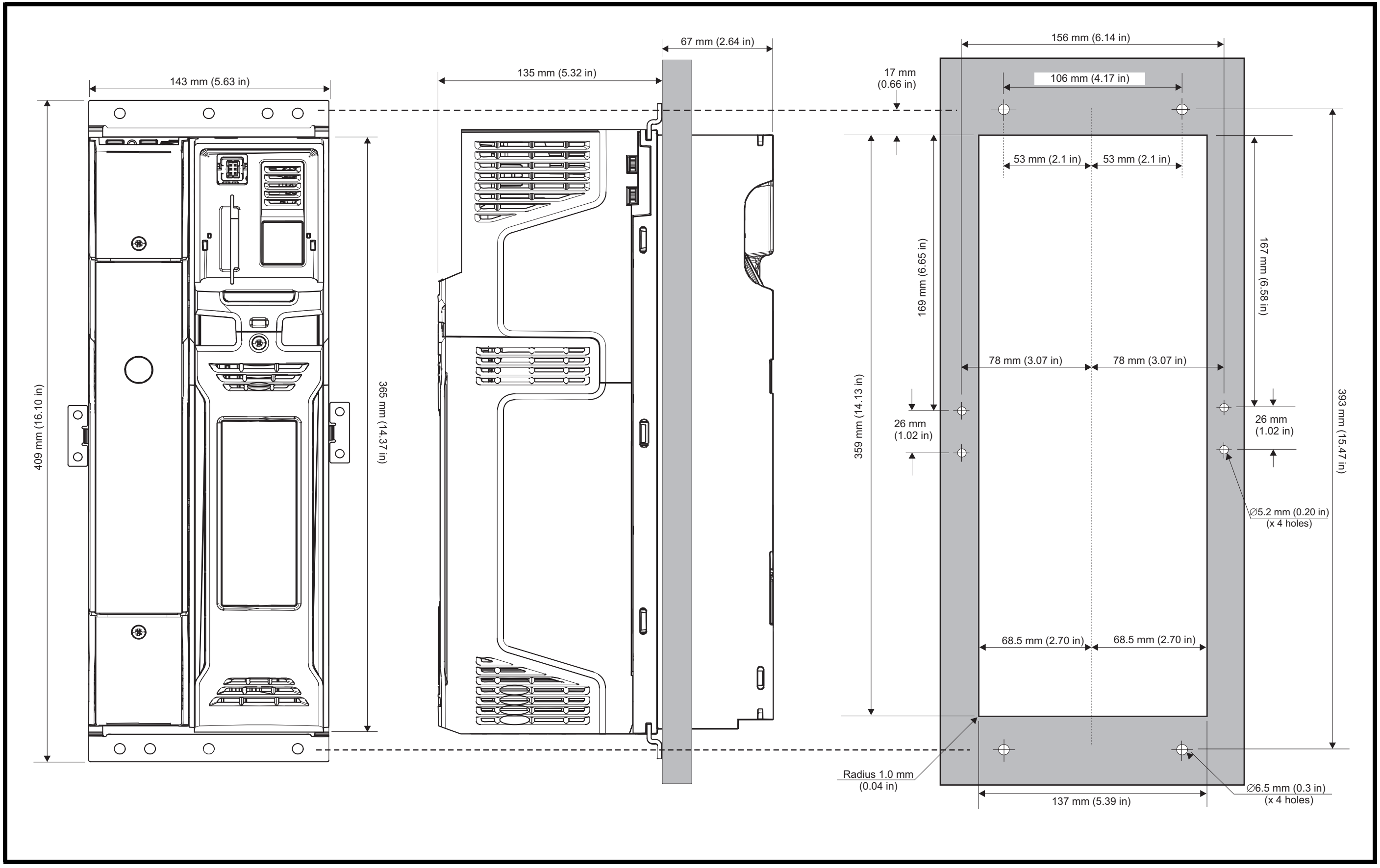
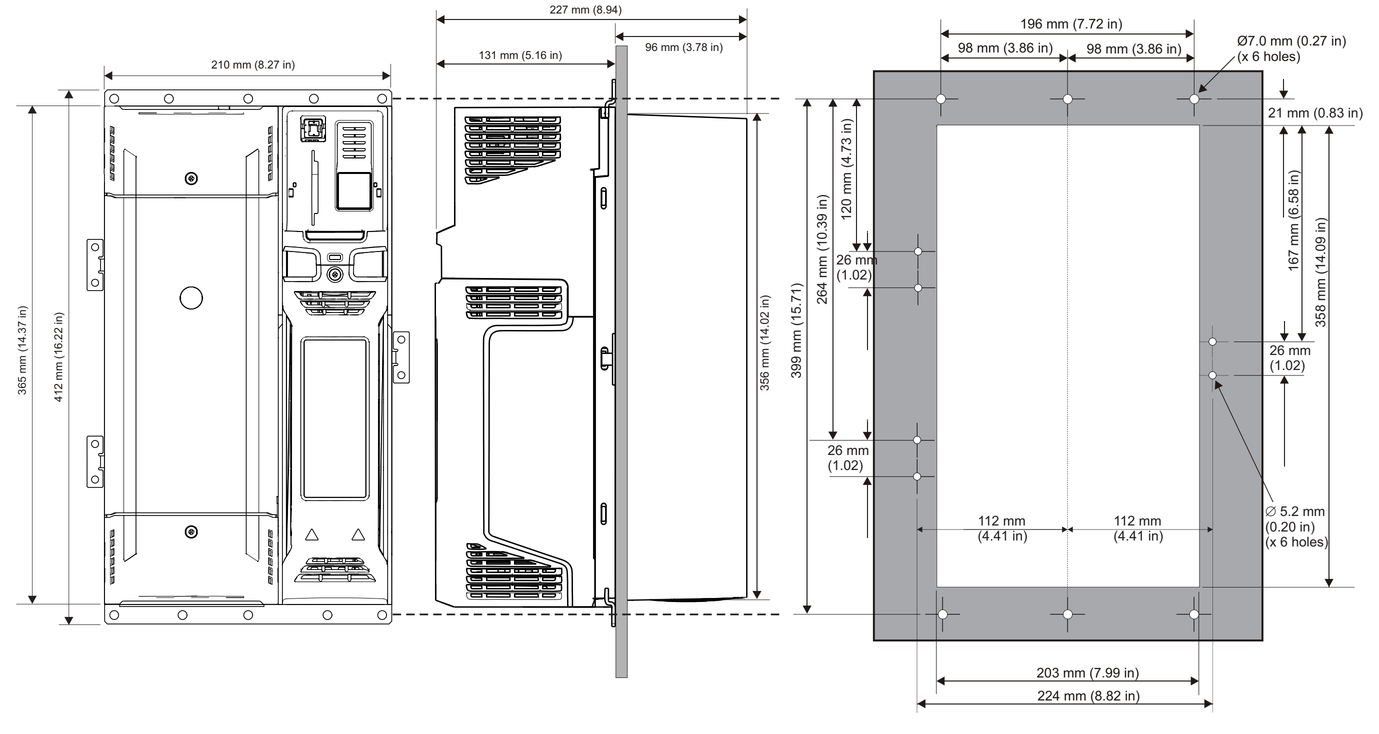


Figure 3-26 Through panel mounting the size 5 drive

Figure 3-27 Through panel mounting the size 6 drive



NOTE

The outer holes plus the hole located in the center of the bracket are to be used for through panel mounting.

Figure 3-28 Through panel mounting the size 7 drive

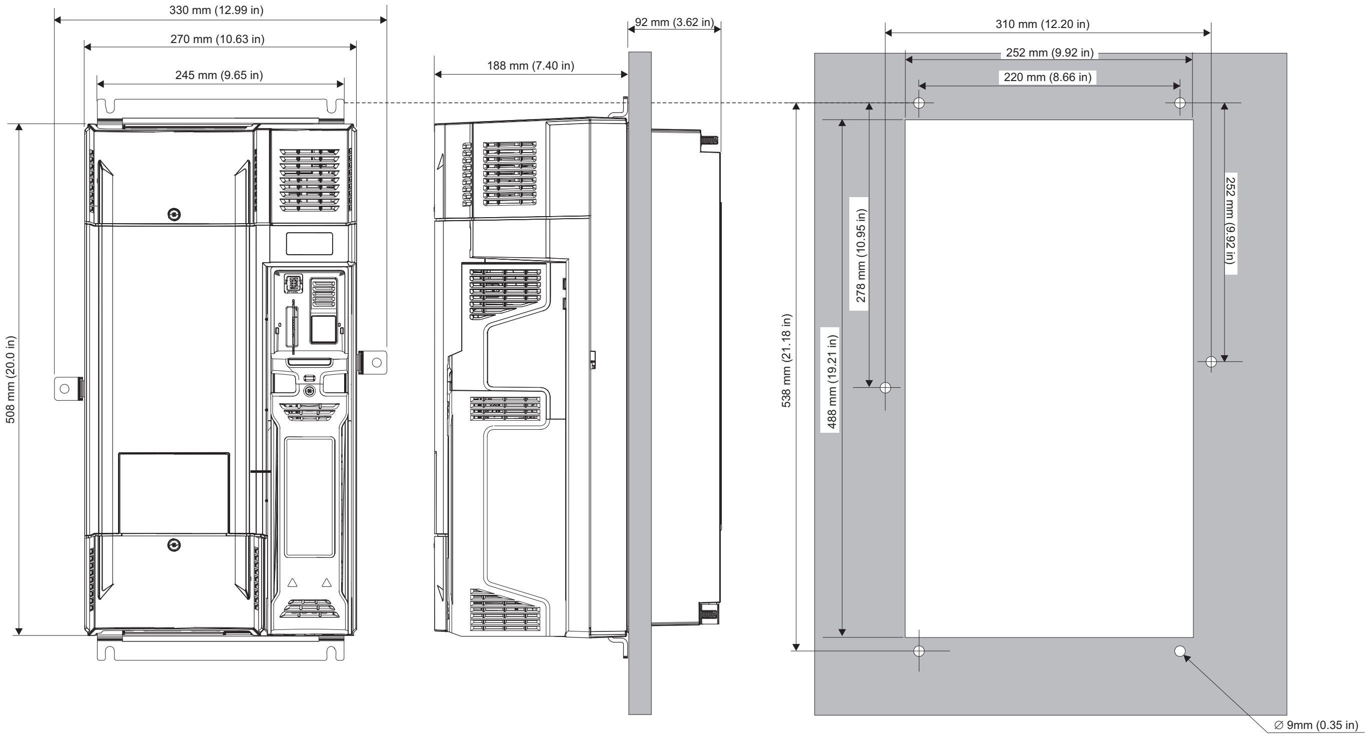


Figure 3-29 Through panel mounting the size 8 drive

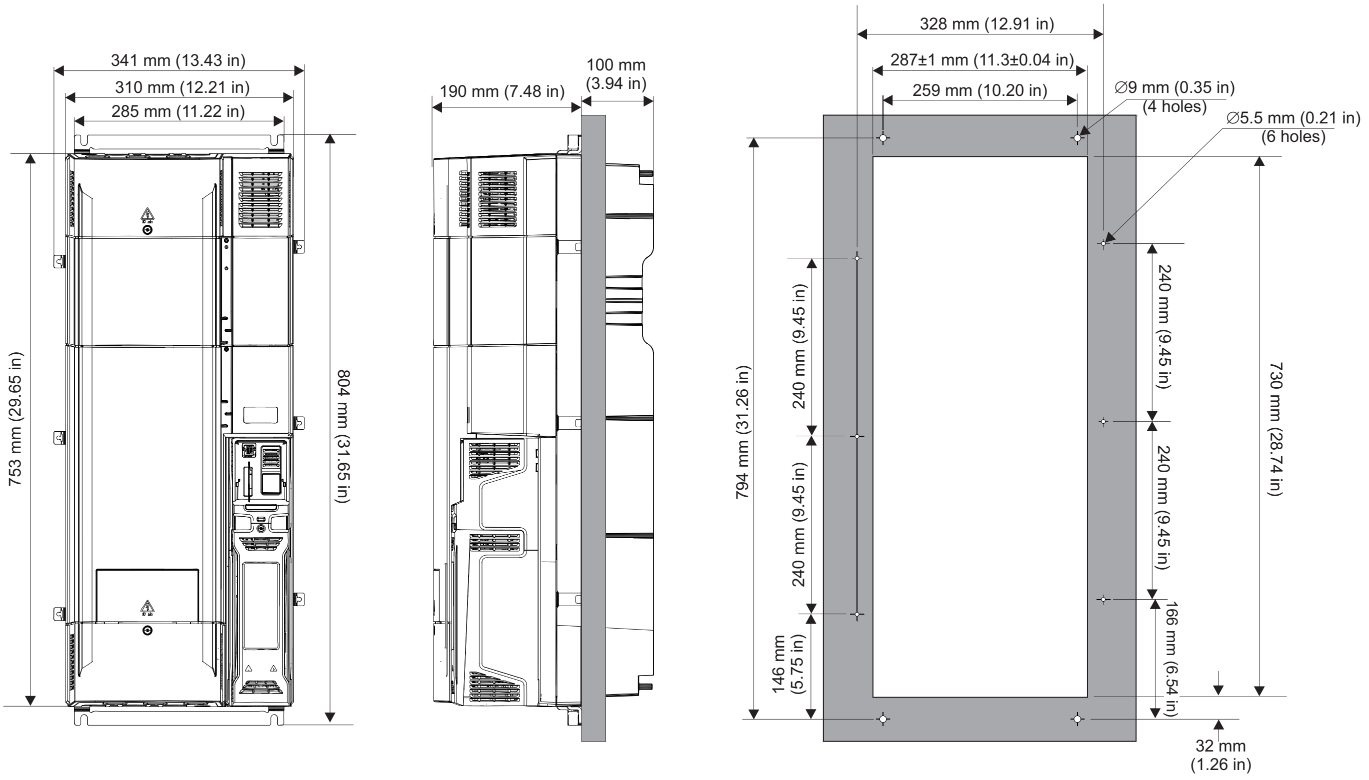


Figure 3-30 Through panel mount detail for size 9A

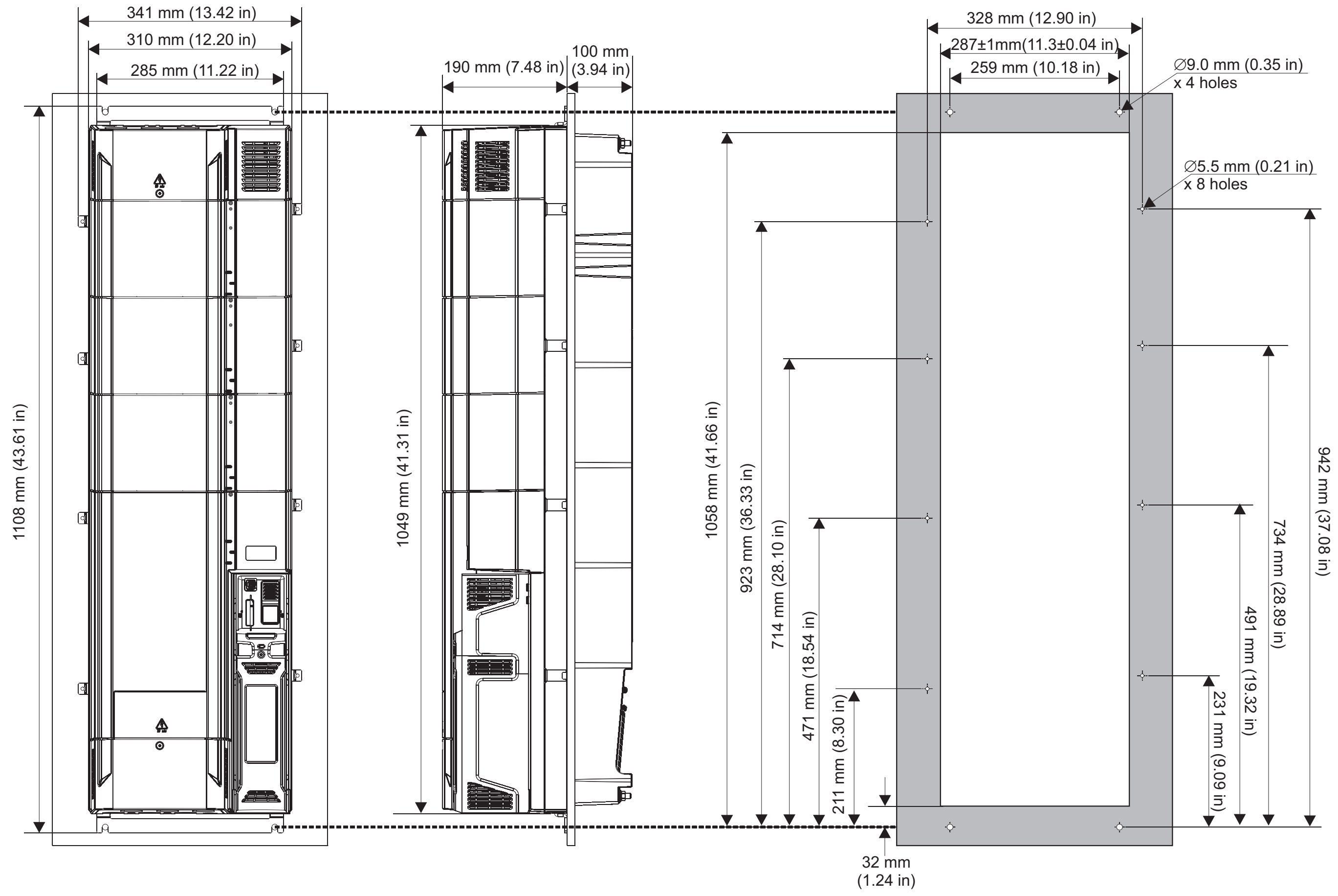


Figure 3-31 Through-panel mounting the size 9E and 10E

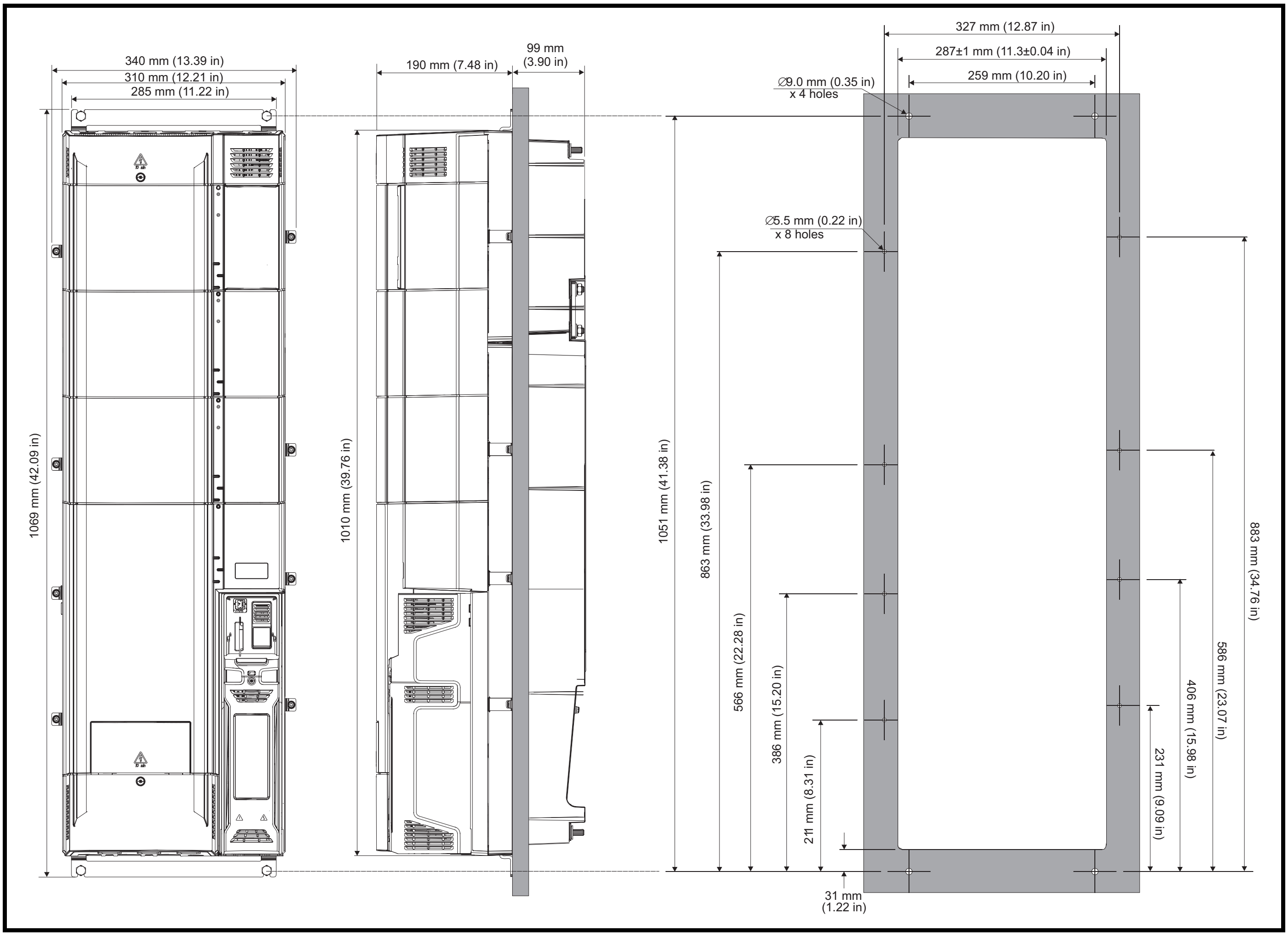
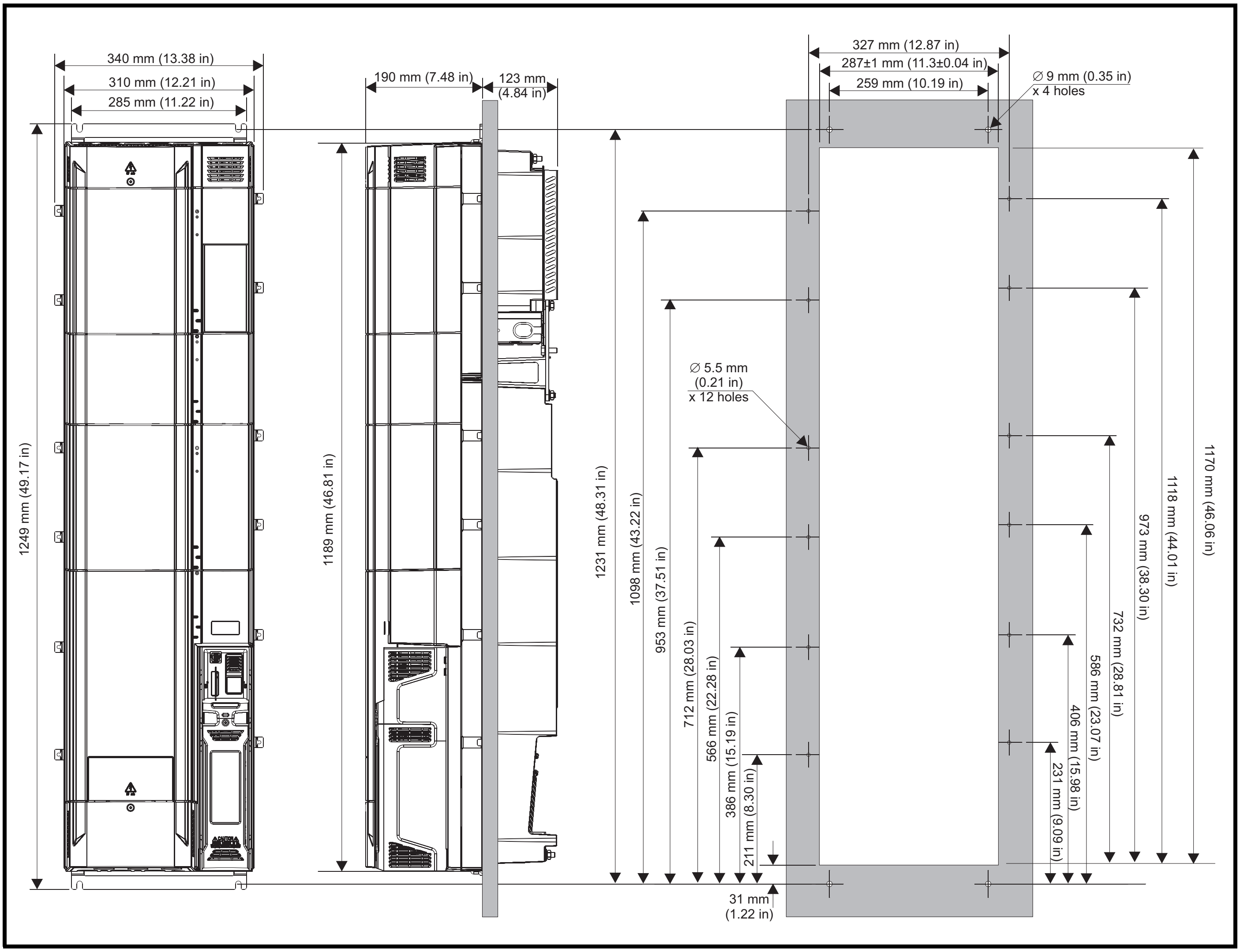
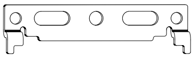
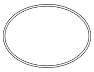
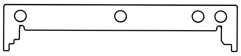
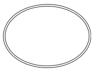
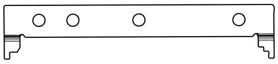
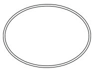
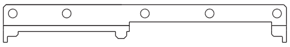
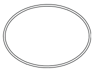
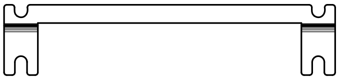
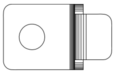
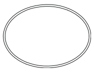
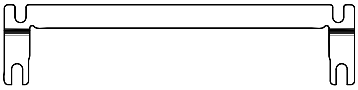
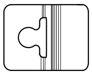
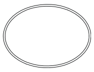
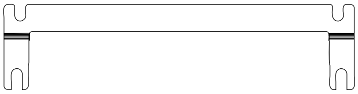
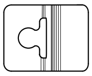
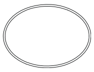


Figure 3-32 Through panel mounting the size 11E



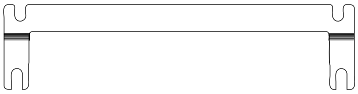
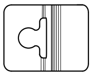
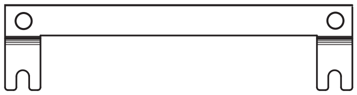
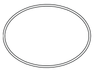
3.5.3 Mounting brackets

Table 3-2 Mounting brackets

Frame size	Surface mounting kit (supplied with drive)	Qty	Through-panel mounting kit (option)	Qty
3	 Outer hole size: 5.2 mm (0.20 in) Centre hole / slot size: 6.2 mm (0.24 in)	**x 2***	 Hole size: 5.2 mm (0.21 in)	**x 2**
				**x 1**
4	 Hole size: 6.5 mm (0.26 in)	**x 2***	 Hole size: 5.2 mm (0.21 in)	**x 2**
				**x 1**
5	 Hole size: 6.5 mm (0.26 in)	**x 2***	 Hole size: 5.2 mm (0.21 in)	**x 2**
				**x 1**
6	 Hole size: 6.5 mm (0.26 in)	**x 2***	 Hole size: 5.2 mm (0.21 in)	**x 3**
				**x 1**
7	 Hole size: 9 mm (0.35 in)	**x 2***	 Hole size: 9 mm (0.35 in)	**x 2**
				**x 1**
8	 Hole size: 9 mm (0.35 in)	**x 2***	 Hole size: 5.5 mm (0.22 in)	**x 6**
				**x 1**
9A, 9E and 10E	 Hole size: 9 mm (0.35 in)	**x 2***	 Hole size: 5.5 mm (0.22 in)	**x 8**
				**x 1**

* Surface mounting brackets are also used when through-panel mounting.

Table 3-3 Mounting brackets (size 11)

Frame size	Surface mounting kit (supplied with drive)	Qty	Through-panel mounting kit (option)	Qty
11E	 Hole size: 9 mm (0.35 in)	x 2*	 Hole size: 5.5 mm (0.22 in)	x 12
	 Hole size: 9 mm (0.35 in)	x 1		x 1

* Surface mounting brackets are also used when through-panel mounting.

3.6 Enclosure for standard drives

3.6.1 Recommended spacing between the drives

Figure 3-33 Recommended spacing between the drives

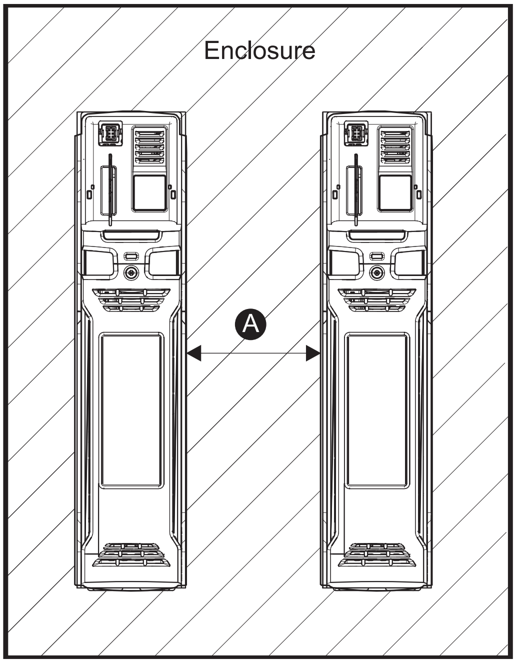


Table 3-4 Spacing required between the drives (without high IP bung)

Drive Size	Spacing (A)	
	40°C	50°C*
3	0 mm (0.00 in)	
4	0 mm (0.00 in)	
5	0 mm (0.00 in)	30 mm (1.18 in)
6	0 mm (0.00 in)	
7	30 mm (1.18 in)	
8	30 mm (1.18 in)	
9A / 9E	60 mm (2.37 in)	
10E / 11E		

* 50°C derating applies, refer to Table 12-3 *Maximum permissible continuous output current @ 50 °C (122 °F)* on page 260.

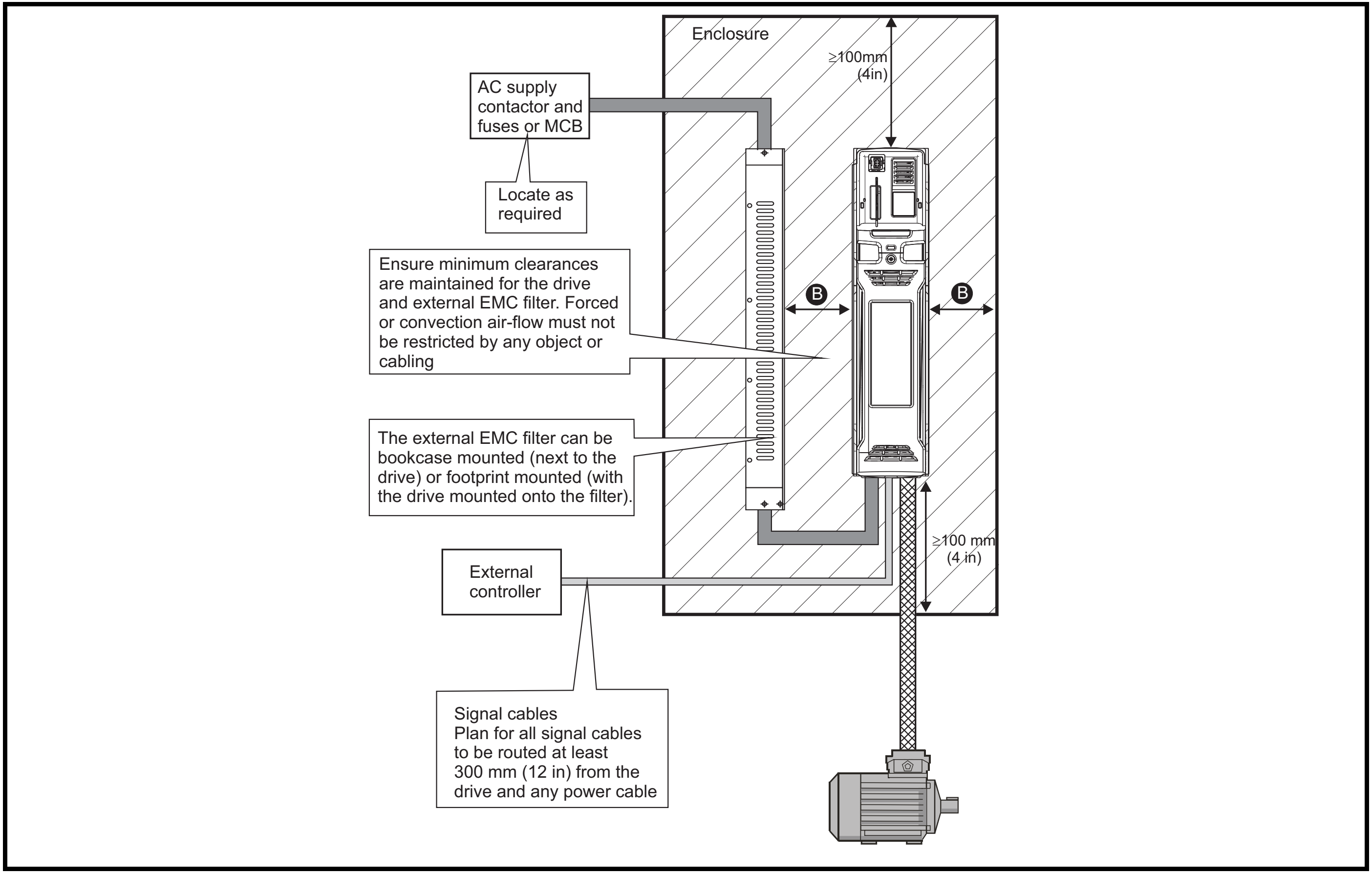
NOTE

When through-panel mounted, ideally drives should be spaced 45 mm (1.77 in) to maximize panel stiffness.

3.6.2 Enclosure layout

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

Figure 3-34 Enclosure layout (size 3 to 8)



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 100 mm (4 in) from the drive in all directions

Table 3-5 Spacing required between drive / enclosure and drive / EMC filter (size 3 to 8)

Drive Size	Spacing (B)
3	0 mm (0.00 in)
4	30 mm (1.18 in)
5	
6	
7	
8	

NOTE

Drive sizes 3 to 5 can be tile mounted where limited mounting space is available. The tile mounting kit is not supplied with the drive, it can be purchased separately.

Figure 3-35 Enclosure layout (size 9 to 11)

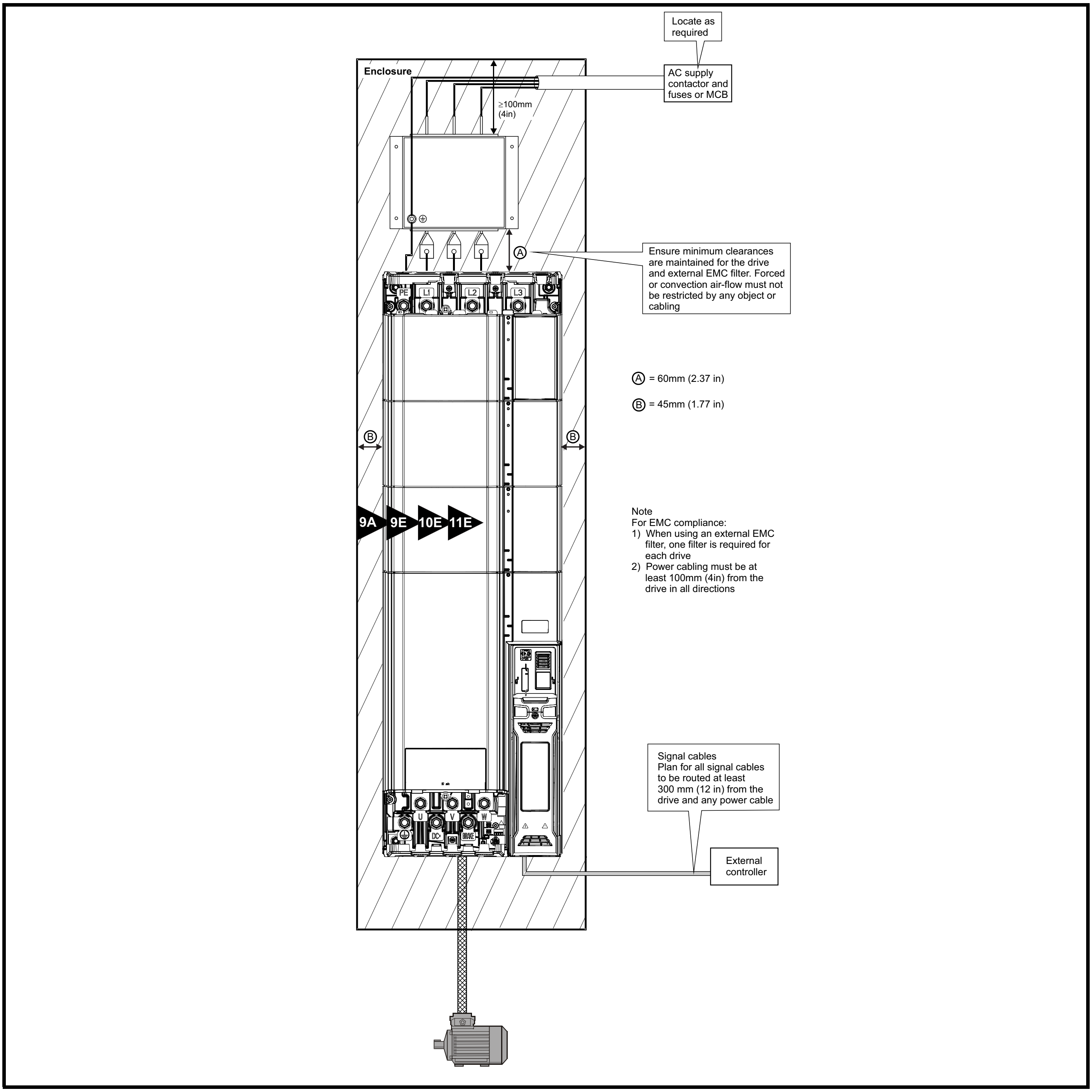


Table 3-6 Spacing required between drive / enclosure and drive (size 9 to 11)

Drive Size	Spacing (B)
9A/9E	45 mm (1.77 in)
10E/11E	

3.6.3 Enclosure sizing

1. Add the dissipation figures from section 12.1.2 *Power dissipation* on page 262 for each drive that is to be installed in the enclosure.
2. If an external EMC filter is to be used with each drive, add the dissipation figures from section 12.2.1 *EMC filter ratings* on page 282 for each external EMC filter that is to be installed in the enclosure.
3. If the braking resistor is to be mounted inside the enclosure, add the average power figures from for each braking resistor that is to be installed in the enclosure.
4. Calculate the total heat dissipation (in Watts) of any other equipment to be installed in the enclosure.
5. Add the heat dissipation figures obtained above. This gives a figure in Watts for the total heat that will be dissipated inside the enclosure.

Calculating the size of a sealed enclosure

The enclosure transfers internally generated heat into the surrounding air by natural convection (or external forced air flow); the greater the surface area of the enclosure walls, the better is the dissipation capability. Only the surfaces of the enclosure that are unobstructed (not in contact with a wall or floor) can dissipate heat.

Calculate the minimum required unobstructed surface area **A_e** for the enclosure from:

$$A_e = \frac{P}{k(T_{int} - T_{ext})}$$

Where:

A_e	Unobstructed surface area in m^2 (1 m^2 = 10.9 ft^2)
T_{ext}	Maximum expected temperature in ^oC *outside* the enclosure
T_{int}	Maximum permissible temperature in ^oC *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Heat transmission coefficient of the enclosure material in $W/m^2/^oC$

Example

To calculate the size of an enclosure for the following:

- Two drives operating at the Normal Duty rating
- External EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40°C
- Maximum ambient temperature outside the enclosure: 30°C

For example, if the power dissipation from each drive is 187 W and the power dissipation from each external EMC filter is 9.2 W.

Total dissipation: 2 x (187 + 9.2) =392.4 W

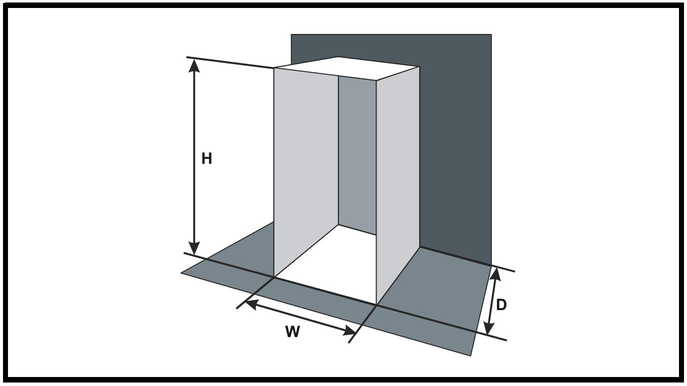
NOTE

Power dissipation for the drives and the external EMC filters can be obtained from Chapter 12 *Technical data* on page 257.

The enclosure is to be made from painted 2 mm (0.079 in) sheet steel having a heat transmission coefficient of 5.5 $W/m^2/^oC$. Only the top, front, and two sides of the enclosure are free to dissipate heat.

The value of 5.5 $W/m^2/^oC$ can generally be used with a sheet steel enclosure (exact values can be obtained by the supplier of the material). If in any doubt, allow for a greater margin in the temperature rise.

Figure 3-36 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

T_{int}	40 °C
T_{ext}	30 °C
k	5.5
P	392.4 W

The minimum required heat conducting area is then:

$$A_e = \frac{392.4}{5.5(40 - 30)}$$

= 7.135 m^2 (77.8 ft^2) (1 m^2 = 10.9 ft^2)

Estimate two of the enclosure dimensions - the height (H) and depth (D), for instance. Calculate the width (W) from:

$$W = \frac{A_e - 2HD}{H + D}$$

Inserting **H** = 2m and **D** = 0.6 m, obtain the minimum width:

$$W = \frac{7.135 - (2 \times 2 \times 0.6)}{2 + 0.6}$$

=1.821 m (71.7 in)

If the enclosure is too large for the space available, it can be made smaller only by attending to one or all of the following:

- Using a lower PWM switching frequency to reduce the dissipation in the drives
- Reducing the ambient temperature outside the enclosure, and/or applying forced-air cooling to the outside of the enclosure
- Reducing the number of drives in the enclosure
- Removing other heat-generating equipment

Calculating the air-flow in a ventilated enclosure

The dimensions of the enclosure are required only for accommodating the equipment. The equipment is cooled by the forced air flow.

Calculate the minimum required volume of ventilating air from:

$$V = \frac{3kP}{T_{int} - T_{ext}}$$

Where:

V	Air-flow in m^3 per hour (1 m^3/hr = 0.59 ft^3/min)
T_{ext}	Maximum expected temperature in °C *outside* the enclosure
T_{int}	Maximum permissible temperature in °C *inside* the enclosure
P	Power in Watts dissipated by *all* heat sources in the enclosure
k	Ratio of $\frac{P_o}{P_I}$

Where:

P_0 is the air pressure at sea level

P_I is the air pressure at the installation

Typically use a factor of 1.2 to 1.3, to allow also for pressure-drops in dirty air-filters.

Example

To calculate the size of an enclosure for the following:

- Three drives operating at the Normal Duty rating
- External EMC filter for each drive
- Braking resistors are to be mounted outside the enclosure
- Maximum ambient temperature inside the enclosure: 40 °C
- Maximum ambient temperature outside the enclosure: 30 °C

For example, dissipation of each drive: 101 W and dissipation of each external EMC filter: 6.9 W (max).

Total dissipation: 3 x (101 + 6.9) = 323.7 W

Insert the following values:

$\mathbf{T_{int}}$	40 °C
$\mathbf{T_{ext}}$	30 °C
k	1.3
P	323.7 W

Then:

$$V = \frac{\mathbf{3 \times 1.3 \times 323.7}}{\mathbf{40 - 30}}$$

= **126.2 m^3/hr (74.5 ft^3 /min)** (1 m^3/ hr = 0.59 ft^3/min)

3.7 Enclosure design and drive ambient temperature

Drive derating is required for operation in high ambient temperatures

Totally enclosing or through panel mounting the drive in either a sealed cabinet (no airflow) or in a well ventilated cabinet makes a significant difference on drive cooling.

The chosen method affects the ambient temperature value (T_{rate}) which should be used for any necessary derating to ensure sufficient cooling for the whole of the drive.

The ambient temperature for the four different combinations is defined below:

1. Totally enclosed with no air flow (<2 m/s) over the drive
   $T_{rate} = T_{int} + 5$ °C
2. Totally enclosed with air flow (>2 m/s) over the drive
   $T_{rate} = T_{int}$
3. Through panel mounted with no airflow (<2 m/s) over the drive
   T_{rate} = the greater of T_{ext} +5 °C, or T_{int}
4. Through panel mounted with air flow (>2 m/s) over the drive
   T_{rate} = the greater of T_{ext} or T_{int}

Where:

T_{ext} = Temperature outside the cabinet
T_{int} = Temperature inside the cabinet
T_{rate} = Temperature used to select current rating from tables in Chapter 12 *Technical data* on page 257.

3.8 Heatsink fan operation

The drive is ventilated by an internal heatsink mounted fan. The fan housing forms a baffle plate, channelling the air through the heatsink chamber. Thus, regardless of mounting method (surface mounting or through-panel mounting), the installing of additional baffle plates is not required.

Ensure the minimum clearances around the drive are maintained to allow air to flow freely.

The heatsink fan on all sizes is a variable speed fan. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system. The maximum speed at which the fan operates can be limited in Pr **06.045**. This could incur an output current derating. Refer to section 3.13.2 *Size 3 to 5 heatsink fan removal procedure* on page 67 for information on fan removal. Size 6 to 11 are also installed with a variable speed fan to ventilate the capacitor bank.

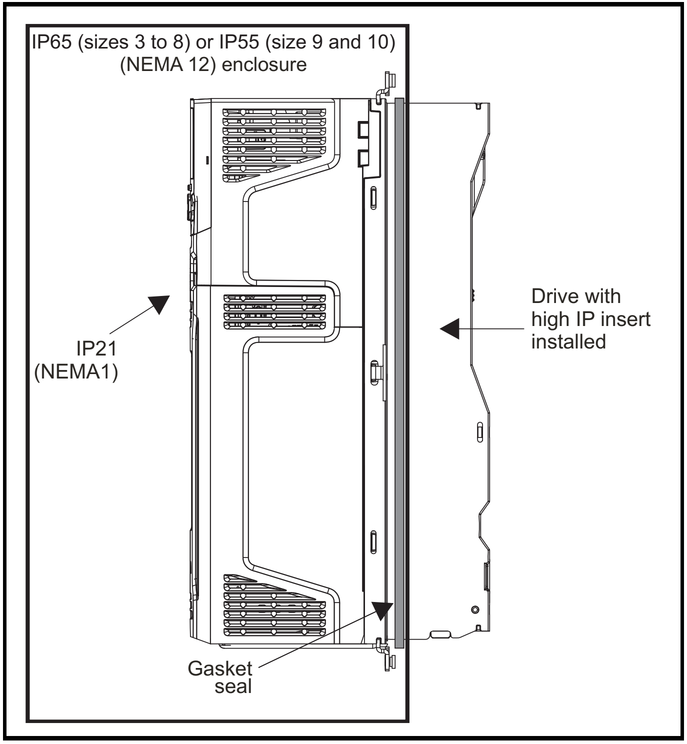
3.9 Enclosing standard drive for high environmental protection

An explanation of environmental protection rating is provided in section 12.1.9 *IP / UL Rating* .

The standard drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) (NEMA 1). However, it is possible to configure the drive to achieve IP65 rating (sizes 3 to 8) or IP55 (size 9, 10 and 11) (NEMA 12) at the rear of the heatsink for through-panel mounting (some current derating is required). Refer to section 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257 .

This allows the front of the drive, along with various switchgear, to be housed in a high IP enclosure with the heatsink protruding through the panel to the external environment. Thus, the majority of the heat generated by the drive is dissipated outside the enclosure maintaining a reduced temperature inside the enclosure. This also relies on a good seal being made between the heatsink and the rear of the enclosure using the gaskets provided.

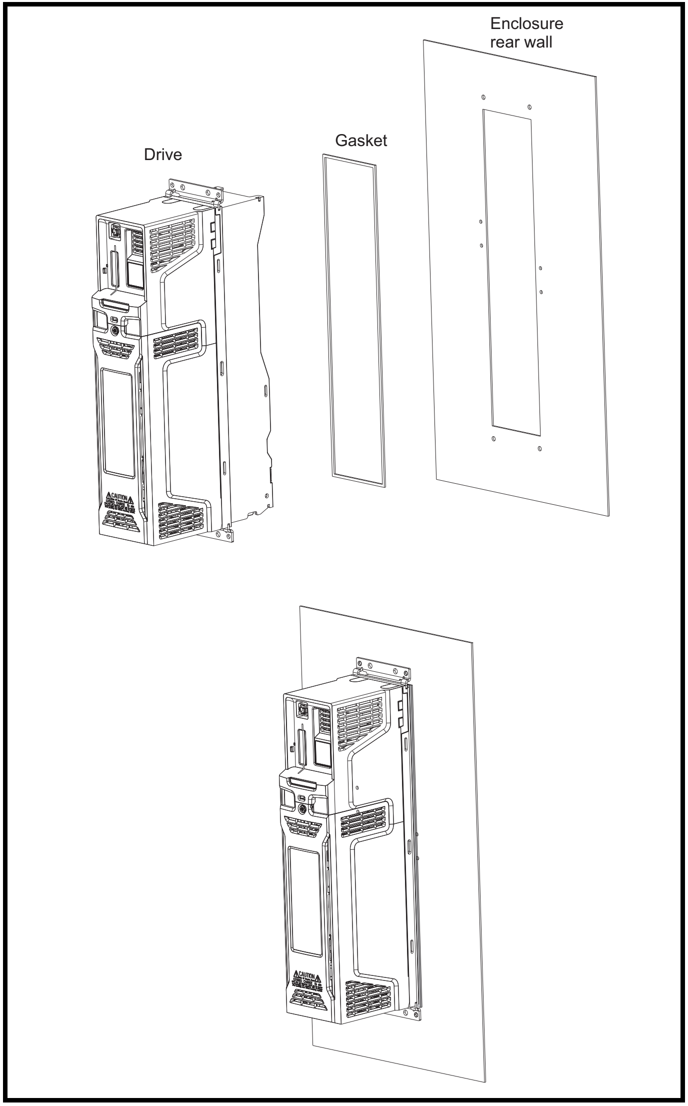
Figure 3-37 Example of IP65 (sizes 3 to 8) or IP55 (size 9 and 10) (NEMA 12) through-panel layout



The main gasket should be installed as shown in Figure 3-38.

On drive sizes 3, 4 and 5, in order to achieve the high IP rating at the rear of the heatsink it is necessary to seal a heatsink vent by installing the high IP insert as shown in Figure 3-40, Figure 3-41 and Figure 3-42.

Figure 3-38 Installing the gasket



To seal the space between the drive and the backplate, use two sealing brackets as shown in Figure 3-39.

Figure 3-39 Through panel mounting

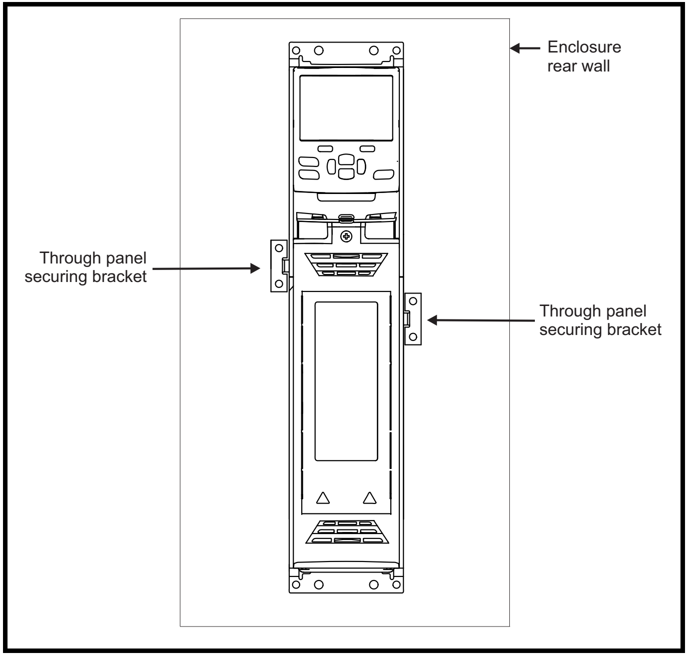
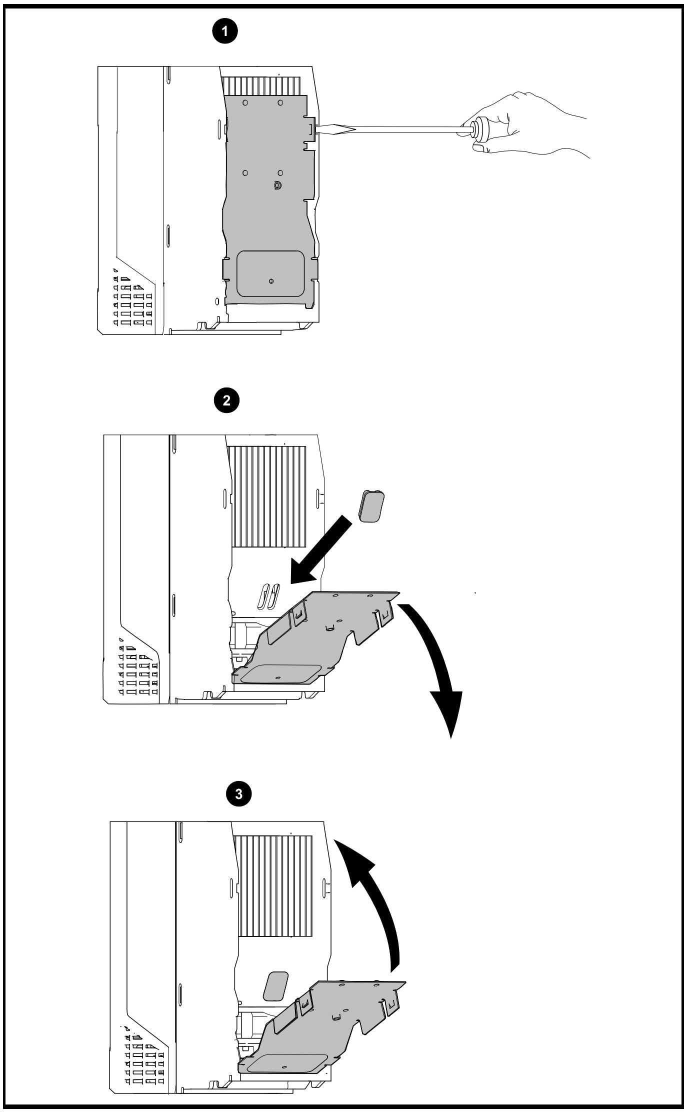


Figure 3-40 Installation of high IP insert for size 3

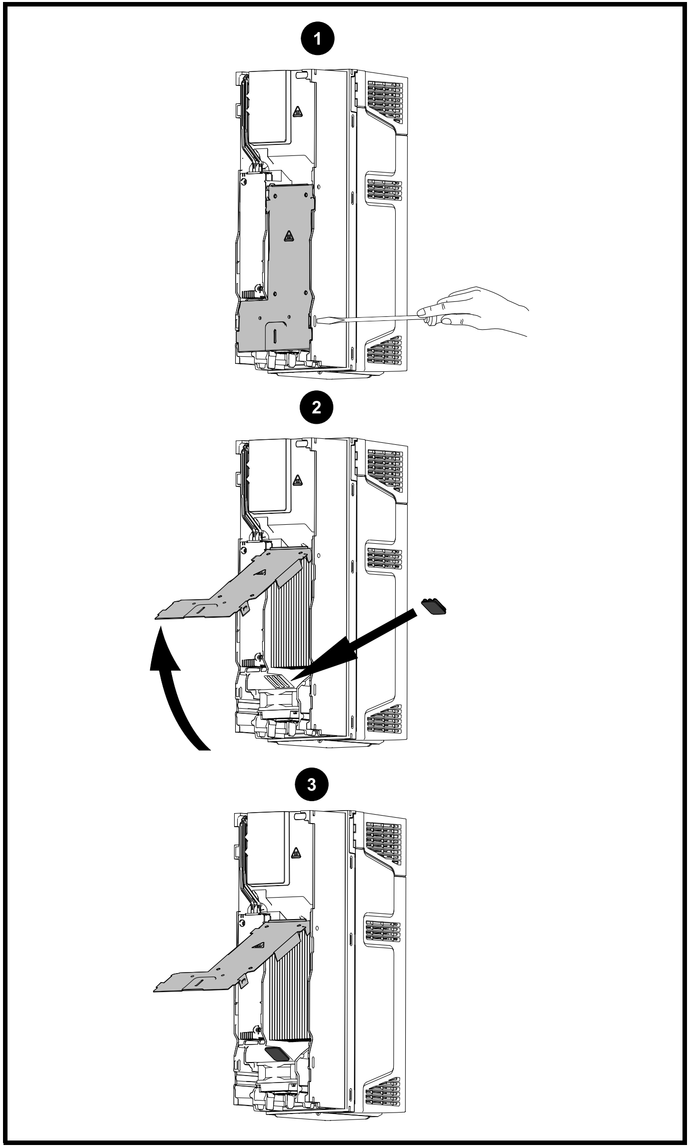


1. To install the high IP insert, firstly place a flat head screwdriver into the slot highlighted (1).
2. Pull the hinged baffle down to expose the ventilation hole, install the high IP insert into the ventilation hole in the heatsink (2). Ensure the high IP insert is securely installed by firmly pressing it into place (3).
3. Close the hinged baffle as shown (1).

To remove the high IP insert, reverse the above instructions.

The guidelines in Table 3-7 should be followed.

Figure 3-41 Installation of high IP insert for size 4

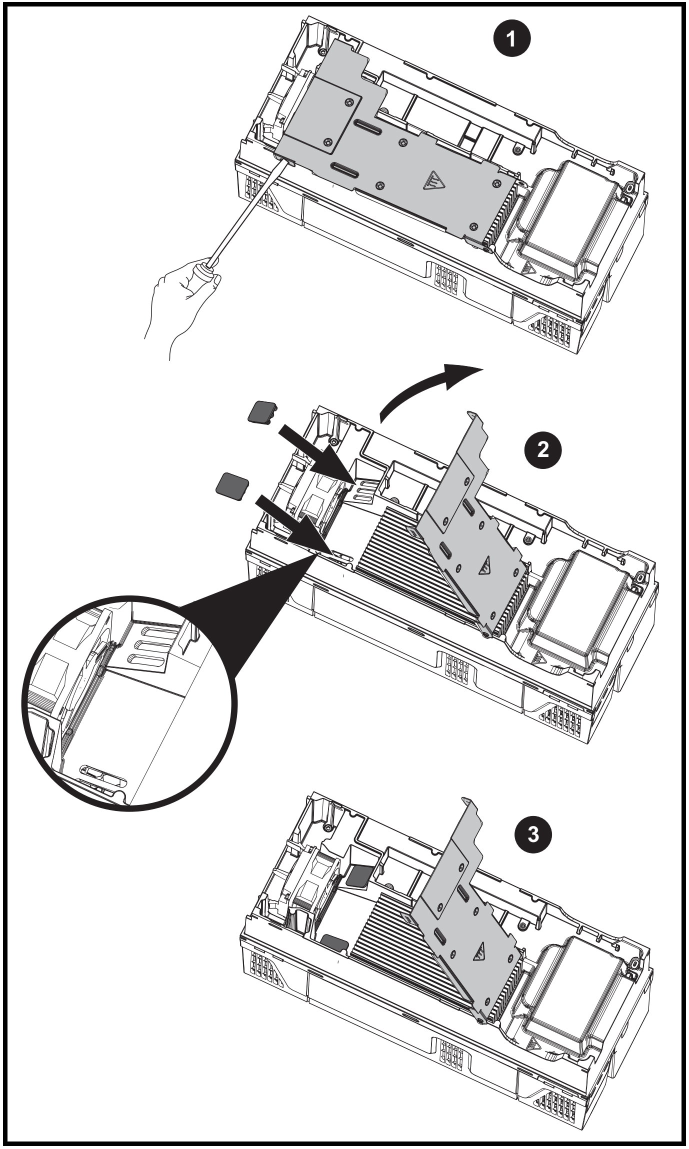


1. To install the high IP insert, firstly place a flat head screwdriver into the slot highlighted (1).
2. Pull the hinged baffle up to expose the ventilation hole, install the high IP insert into the ventilation hole in the heatsink (2).
3. Ensure the high IP insert is securely installed by firmly pressing it into place (3).
4. Close the hinged baffle as shown (1).

To remove the high IP insert, reverse the above instructions.

The guidelines in Table 3-7 should be followed.

Figure 3-42 Installation of high IP insert for size 5



1. To install the high IP insert, firstly place a flat head screwdriver into the slot highlighted (1).
2. Pull the hinged baffle up to expose the ventilation holes, install the high IP inserts into the ventilation holes in the heatsink (2).
3. Ensure the high IP inserts are securely installed by firmly pressing them into place (3).
4. Close the hinged baffle as shown (1).

To remove the high IP insert, reverse the above instructions.

The guidelines in Table 3-7 should be followed.

Table 3-7 Environment considerations

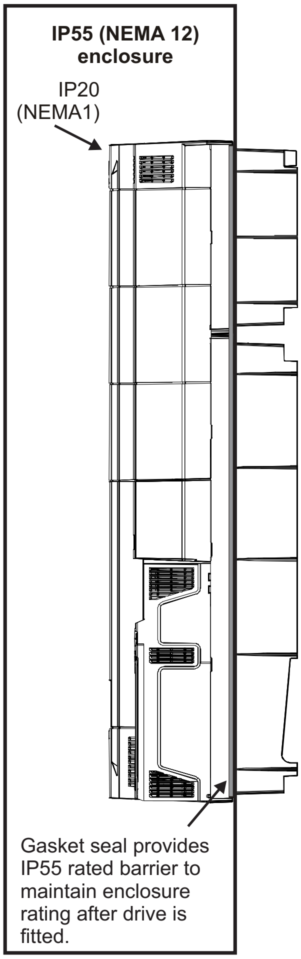
Environment	High IP insert	Comments
Clean	Not installed	
Dry, dusty (non-conductive)	Installed	Regular cleaning recommended
Dry, dusty (conductive)	Installed	
IP65 compliance	Installed	

NOTE

A current derating must be applied to the drive if the high IP insert is installed. Derating information is provided in section 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257.

Failure to do so may result in nuisance tripping.

Figure 3-43 Example of IP55 (NEMA 12) size 9 to 11 through-panel layout



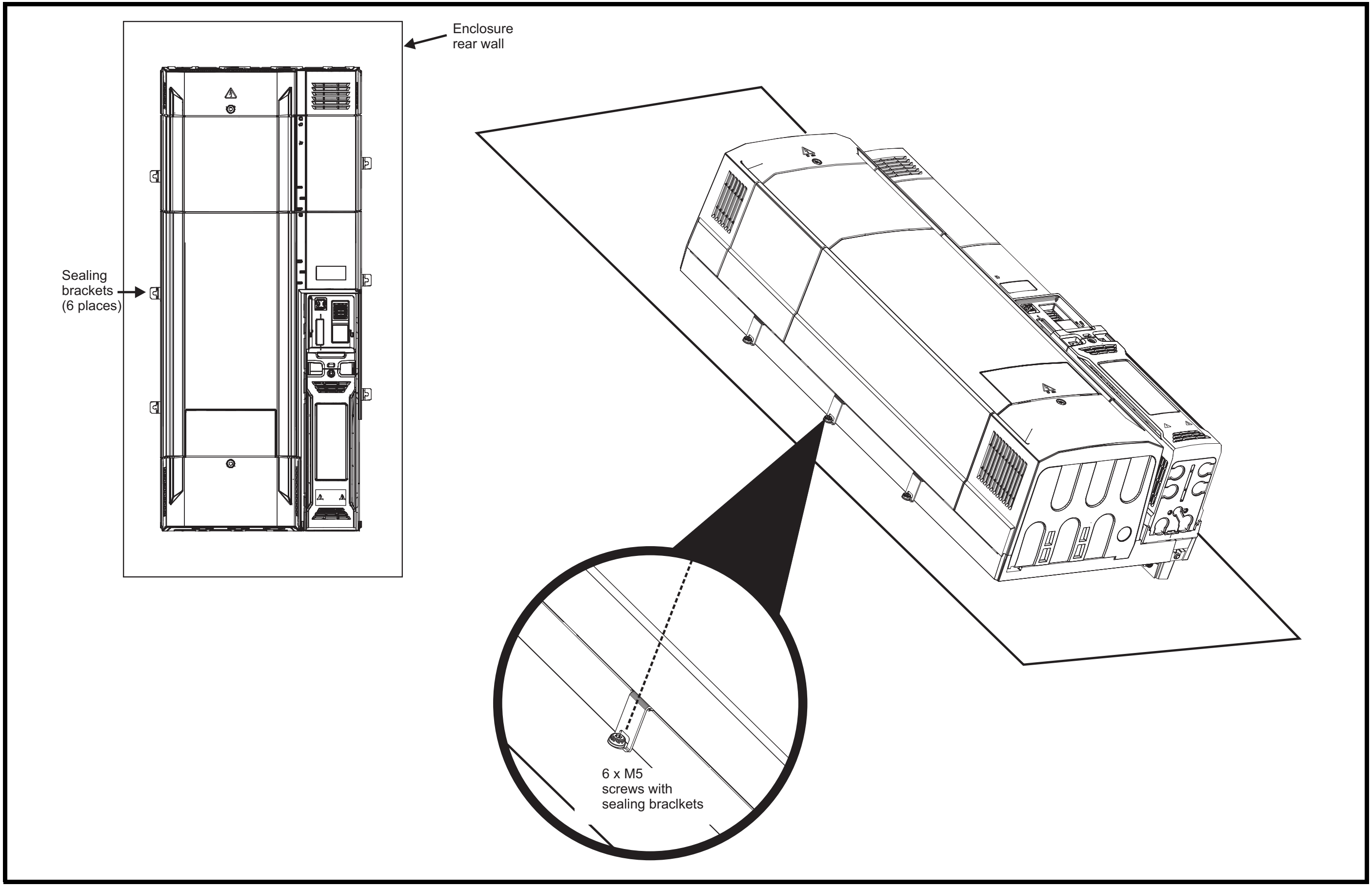
The main gasket should be installed as shown in Figure 3-38. Any screws / bolts that are used for mounting should be installed with M8 flat nylon washers to maintain a seal around the screw hole.

See Figure 3-44 on page 55, sealing clamps are supplied in the through panel mounting kit to aid compression of the gasket.

NOTE

The heatsink fans have conformal coated PCBs and have sealant at cable entry points. Dripping, splashing or sprayed water can impede the operation of the fan, therefore if the environment is such that the fan may be subjected to more than occasional dripping or sprayed water while operational, then suitable drip protection covers should be employed.

Figure 3-44 View showing sealing clamps provided in through hole mounting kit



NOTE

For detailed information regarding IP55 (NEMA 12) Through Panel Mounting see Figure 3-30 *Through panel mount detail for size 9A* on page 43, Figure 3-31 *Through-panel mounting the size 9E and 10E* on page 44 and Figure 3-32 *Through panel mounting the size 11E* on page 45.

NOTE

When designing an IP65 or IP55 enclosure, consideration should be made to the dissipation from the front of the drive.

Table 3-8 Power losses from the front of the drive when through-panel mounted

Frame size	Power loss
3	≤ 50 W
4	≤ 75 W
5	≤ 100 W
6	≤ 100 W
7	≤ 204 W
8	≤ 347 W
9A/9E/10E/11E	≤ 480 W

3.10 External EMC filter

The external EMCfilter details for each drive rating are provided in the table below.

Table 3-9 External EMC filter data

Model	CT part number	Weight	
		kg	lb
200 V			
03200066 to 03200127	4200-3230	1.9	4.20
04200180 to 04200250	4200-0272	4.0	8.82
05200300	4200-0312	5.5	12.13
06200500 to 06200580	4200-2300	6.5	14.3
07200750 to 07201170	4200-1132	6	13.2
08201490 to 08201800	4200-1972	9.6	21.1
09202160 to 09202660 (9A)	4200-3021	11	24.3
09202160 to 09202660 (9E)	4200-4460	12	26.5
10203250 to 10203600	4200-4460	12	26.5
400 V			
03400034 to 03400123	4200-3480	2.0	4.40
04400185 to 04400240	4200-0252	4.1	9.04
05400300	4200-0402	5.5	12.13
06400380 to 06400630	4200-4800	6.7	14.8
07400790 to 07401120	4200-1132	6	13.2
08401550 to 08401840	4200-1972	9.6	21.1
09402210 to 09402660 (9A)	4200-3021	11	24.25
09402210 to 09402660 (9E)	4200-4460	12	26.5
10403200 to 10403610	4200-4460	12	26.5
11404370 to 11405070	4200-0400	14.7	32.41
575 V			
05500039 to 05500100	4200-0122	5.5	12.13
06500120 to 06500430	4200-3690	7.0	15.4
07500530 to 07500730	4200-0672	6.2	13.7
08500860 to 08501080	4200-1662	9.4	20.7
09501250 to 09501500 (9A)	4200-1660	5.2	11.46
09501250 to 09501500 (9E)	4200-2210	10.3	22.7
10502000	4200-2210	10.3	22.7
11502480 to 11503150	4200-0690	16.75	36.9
690 V			
07600230 to 07600730	4200-0672	6	13.2
08600860 to 08601080	4200-1662	9.4	20.7
09601250 to 09601550 (9A)	4200-1660	5.2	11.5
09601250 to 09601550 (9E)	4200-2210	10.3	22.7
10601720 to 10601970	4200-2210	10.3	22.7
11602250 to 11603050	4200-0690	16.75	36.9

The external EMC filters for sizes 0 to 6 can be footprint mounted or bookcase mounted as shown in Figure 3-45 and Figure 3-46. The external EMC filters for sizes 7 to 11, are designed to be mounted above the drive as shown in Figure 3-47.

Mount the external EMC filter following the guidelines in section 4.11.6 *Compliance with generic emission standards* on page 100.

Figure 3-45
Footprint mounting the EMC filter

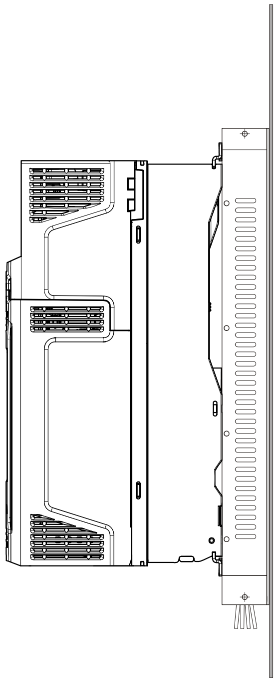


Figure 3-46
Bookcase mounting the EMC filter

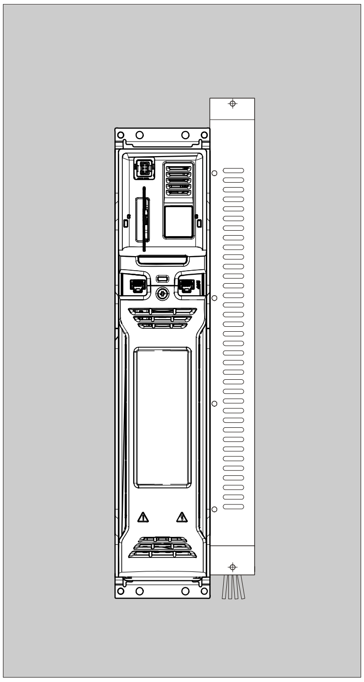


Figure 3-47
Size 7 to 11 mounting of the EMC filter

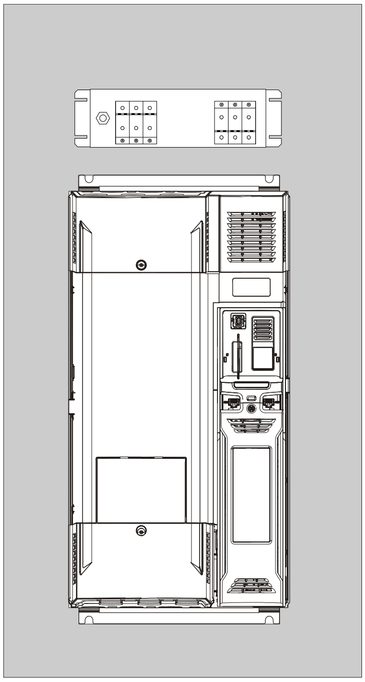
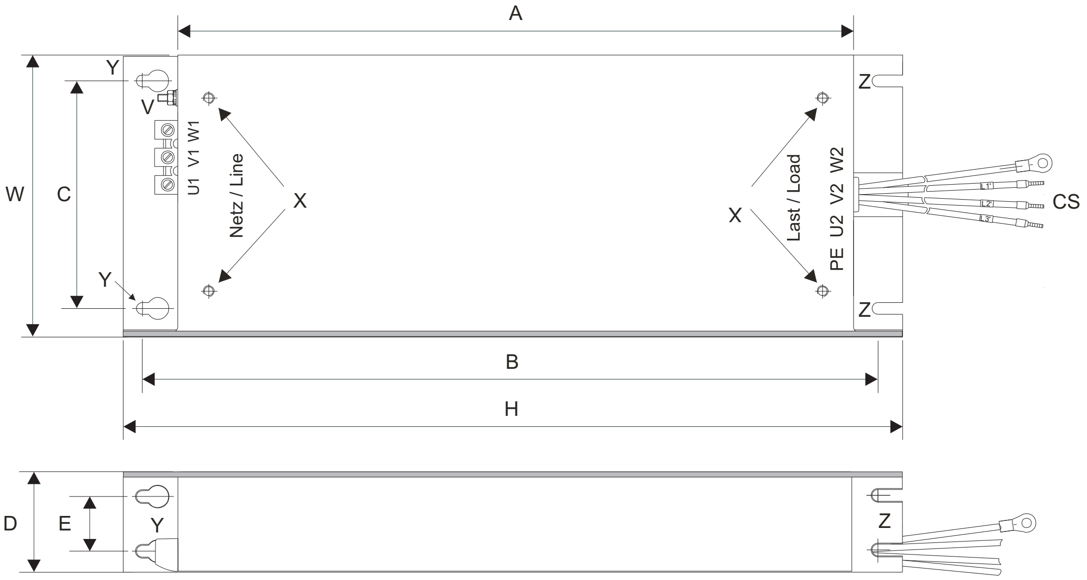


Figure 3-48 External EMC filter (size 3 to 6)



V: Ground stud

X: Threaded holes for footprint mounting of the drive

Y: Footprint mounting hole diameter

Z: Bookcase mounting slot diameter.

CS: Cable size

Table 3-10 Size 3 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS
4200-3230	384 mm (15.12 in)	414 mm (16.30 in)	56 mm (2.21 in)	41 mm (1.61 in)		426 mm (16.77 in)	83 mm (3.27 in)	M5	M5	5.5 mm (0.22 in)	5.5 mm (0.22 in)	2.5 mm^2 (14 AWG)
4200-3480												

Table 3-11 Size 4 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS
4200-0272	395 mm (15.55 in)	425 mm (16.73 in)	100 mm (3.94 in)	60 mm (2.36 in)	33 mm (1.30 in)	437 mm (17.2 in)	123 mm (4.84 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	6 mm^2 (10 AWG)
4200-0252												

Table 3-12 Size 5 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS
4200-0312	395 mm (15.55 in)	425 mm (16.73 in)	106 mm (4.17 in)	60 mm (2.36 in)	33 mm (1.30 in)	437 mm (17.2 in)	143 mm (5.63 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	10 mm^2 (8 AWG)
4200-0402												
4200-0122												2.5 mm^2 (14 AWG)

Table 3-13 Size 6 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS
4200-2300	392 mm (15.43 in)	420 mm (16.54 in)	180 mm (7.09 in)	60 mm (2.36 in)	33 mm (1.30 in)	434 mm (17.09 in)	210 mm (8.27 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	16 mm^2 (6 AWG)
4200-4800												
4200-3690												

Figure 3-49 External EMC filter (size 7 to 8)

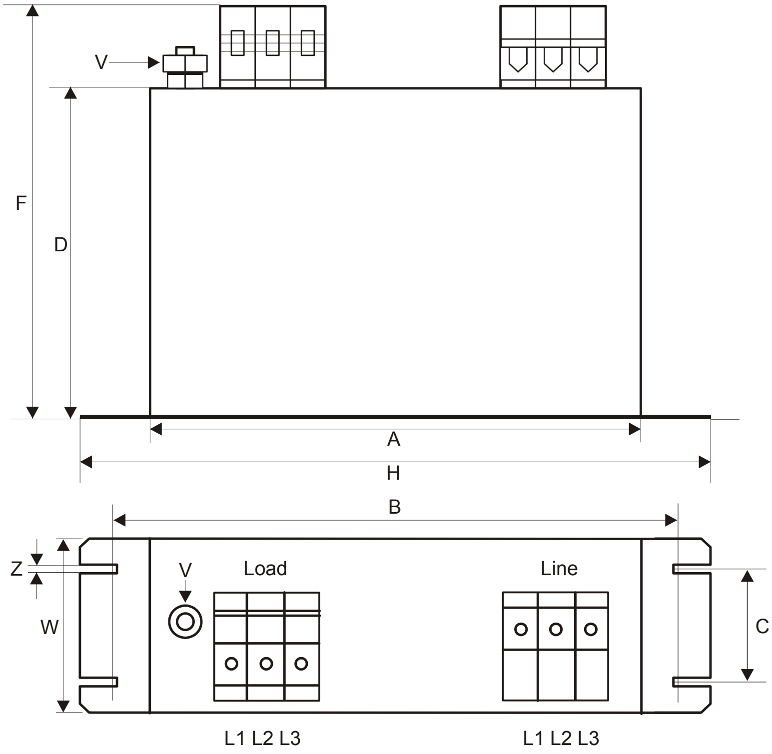


Table 3-14 Size 7 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z
4200-1132	240 mm (9.45 in)	255 mm (10.04 in)	55 mm (2.17 in)	150 mm (5.90 in)		205 mm (8.07 in)	270 mm (10.63 in)	90 mm (3.54 in)	M10			6.5 mm (0.26 in)
4200-0672												

Table 3-15 Size 8 external EMC filter dimensions

CT part number	A	B	C	D	E	F	H	W	V	X	Y	Z
4200-1972	260 mm (10.24in)	275 mm (10.83 in)	85 mm (3.35 in)	170 mm (6.69 in)		249mm (9.79 in)	300 mm (11.81 in)	120 mm (4.72 in)	M10			6.5 mm (0.26 in)
4200-1662												

Figure 3-50 External EMC filter (size 9A)

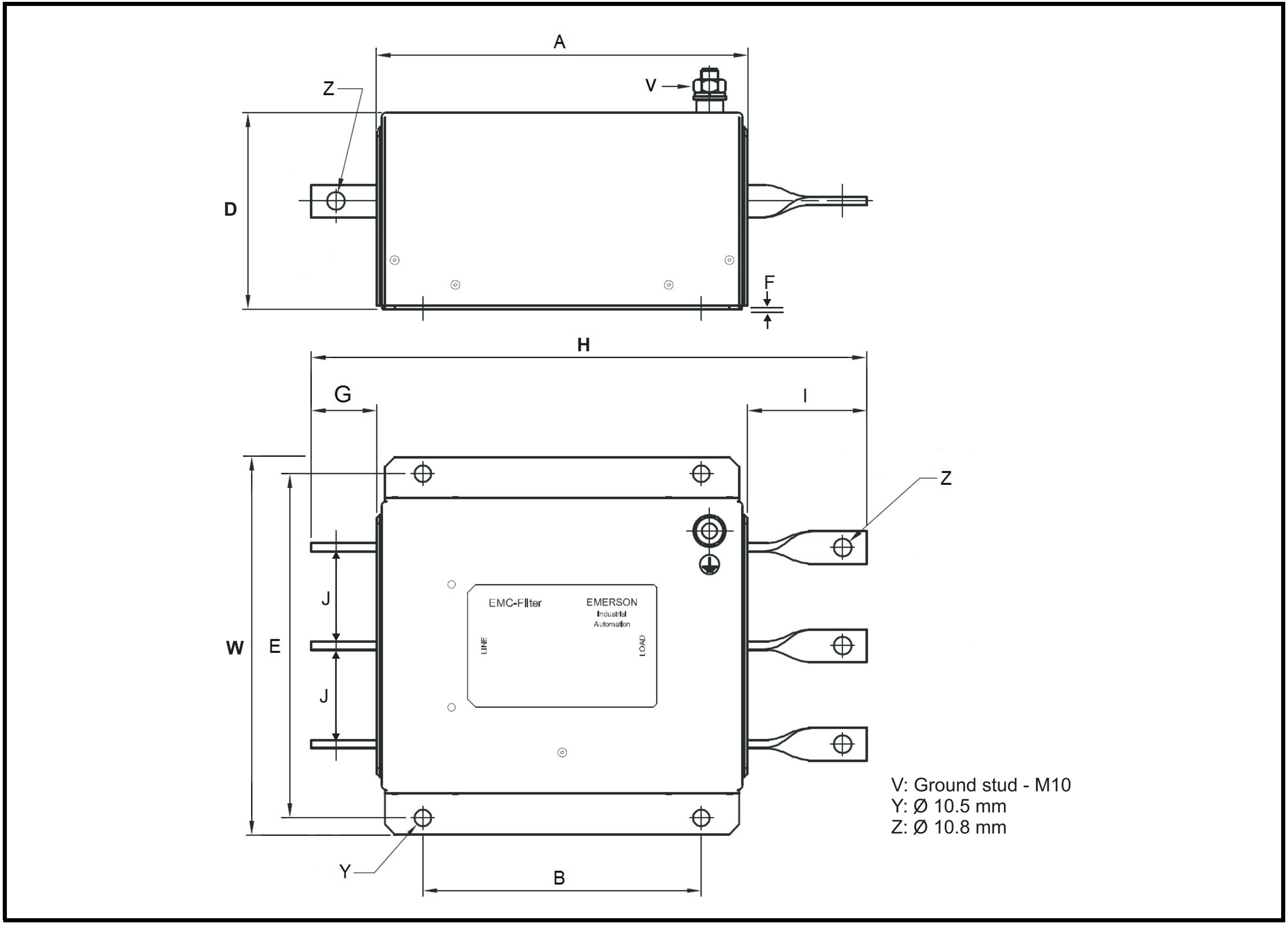


Table 3-16 Size 9A external EMC filter dimensions

CT part number	A	B	D	E	F	G	H	I	J	W
4200-3021	220 mm (8.66 in)	170 mm (6.70 in)	120 mm (4.72 in)	210 mm (8.27 in)	2 mm (0.08 in)	40 mm (1.57 in)	339 mm (13.34)	73 mm (2.87 in)	60 mm (2.36 in)	230 mm (9.06 in)
4200-1660	280 mm (11.02 in)	180 mm (7.09 in)	105 mm (4.13 in)	225 mm (8.86 in)	2 mm (0.08 in)	40 mm (1.57 in)	360 mm (14.17 in)	73 mm (2.87 in)	60 mm (2.36 in)	245 mm (9.65 in)

Figure 3-51 External EMC filter (size 9E and 10)

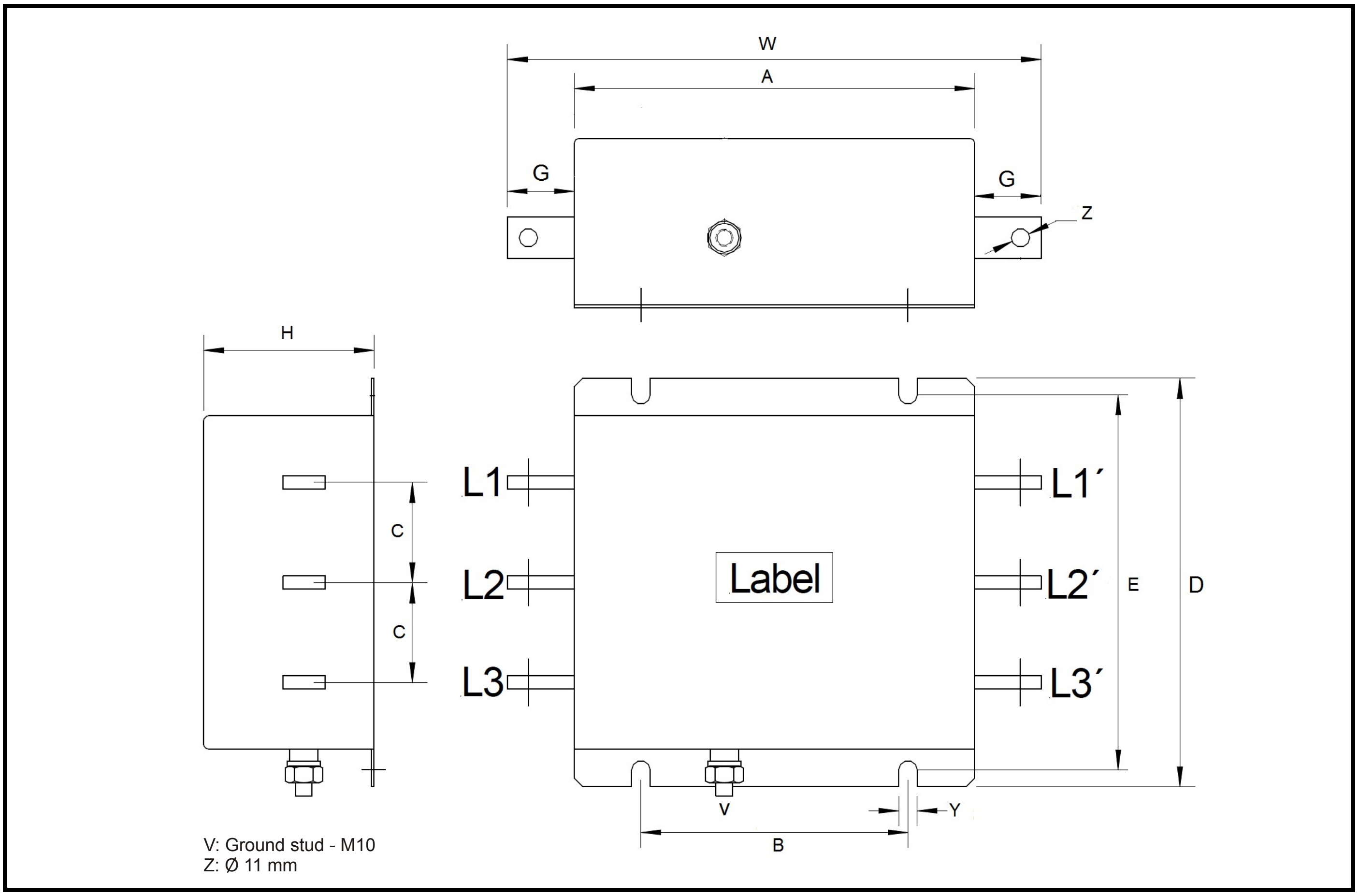


Table 3-17 Size 9E and 10E external EMC filter dimensions

CT part number	A	B	C	D	E	G	H	W	Y
4200-4460 4200-2210	280 mm (11.02)	180 mm (7.09)	57 mm (2.24 mm)	245 mm (9.65 in)	225 mm (8.86 in)	40 mm (1.57 in)	105 mm (4.13 in)	360 mm (14.7 in)	11 mm (0.43 in)

Figure 3-52 External EMC filter (size 11)

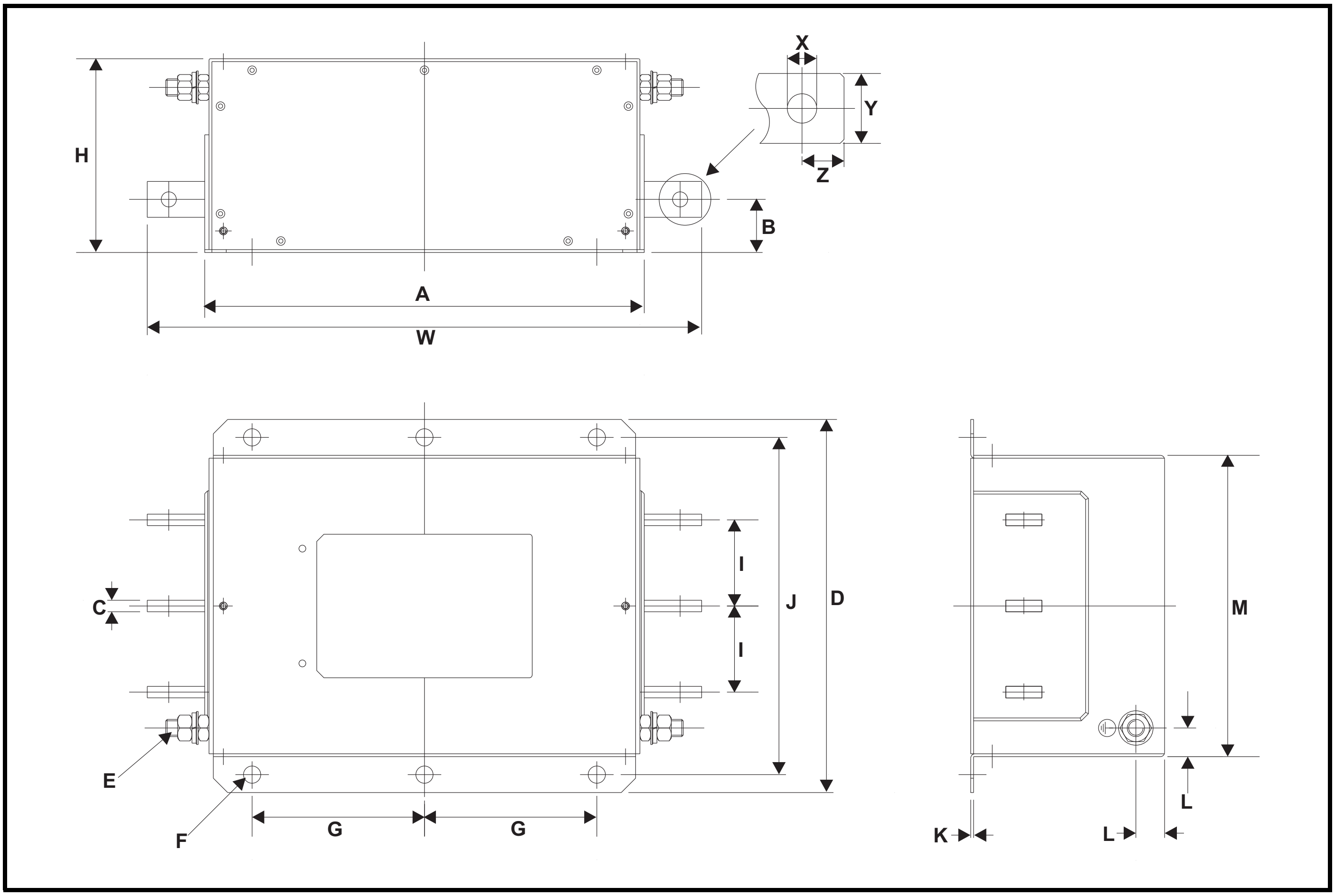


Table 3-18 Size 11 external EMC filter dimensions

CT part number	A	B	C	D	E	F	G	H	I	J	K	L	M	X	Y	Z	W
4200-0400 4200-0690	306 mm (12.05 in)	37 mm (1.46 in)	8 mm (0.32 in)	260 mm (10.2 in)	M12	12 mm (0.47 in)	120 mm (4.72 in)	135 mm (5.32 in)	60 mm (2.36 in)	235 mm (9.25 in)	2 mm (0.08 in)	20 mm (0.79 in)	210 mm (8.27 in)	10.5 mm (0.41 in)	25 mm (0.98 in)	15 mm (0.59 in)	386 mm (15.20 in)

3.11 Line reactor mounting dimensions for size 9E,10E and 11E

Figure 3-53 Input line reactor (INLX0X) for size 9 and 10

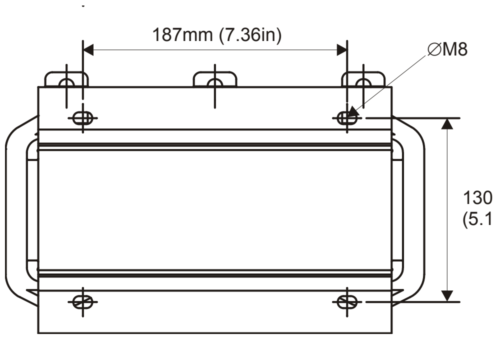
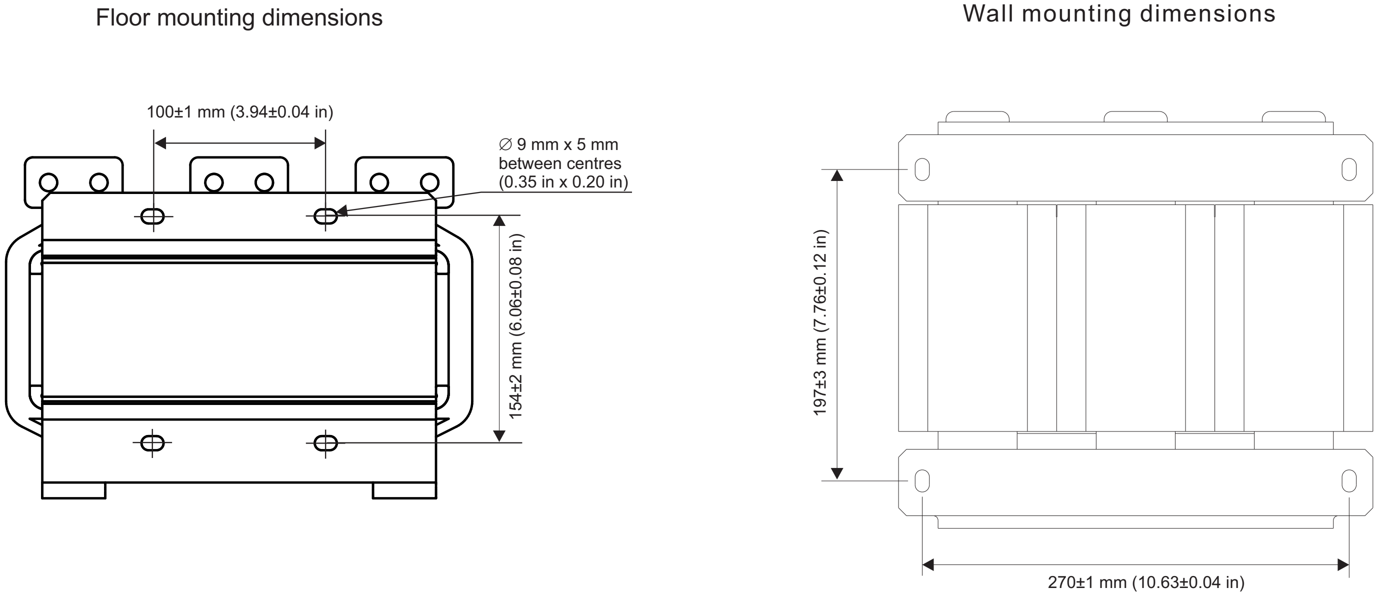


Figure 3-54 Input line reactor (INLX0X) for size 11

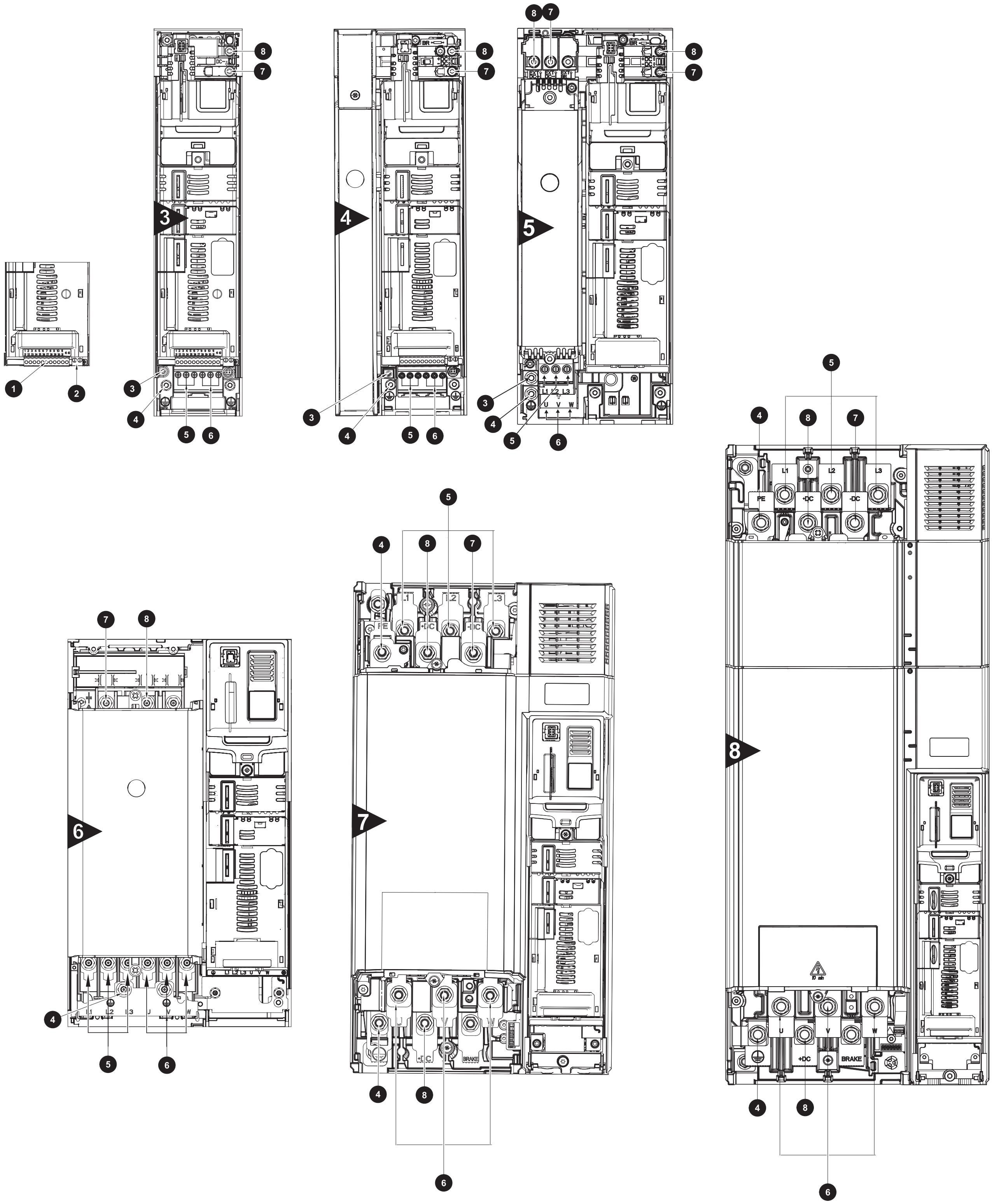


For overall dimensions and other details, refer to Chapter 4.2.3 *Drive model and input line reactor* on page 81.

3.12 Electrical terminals

3.12.1 Location of the power and ground terminals

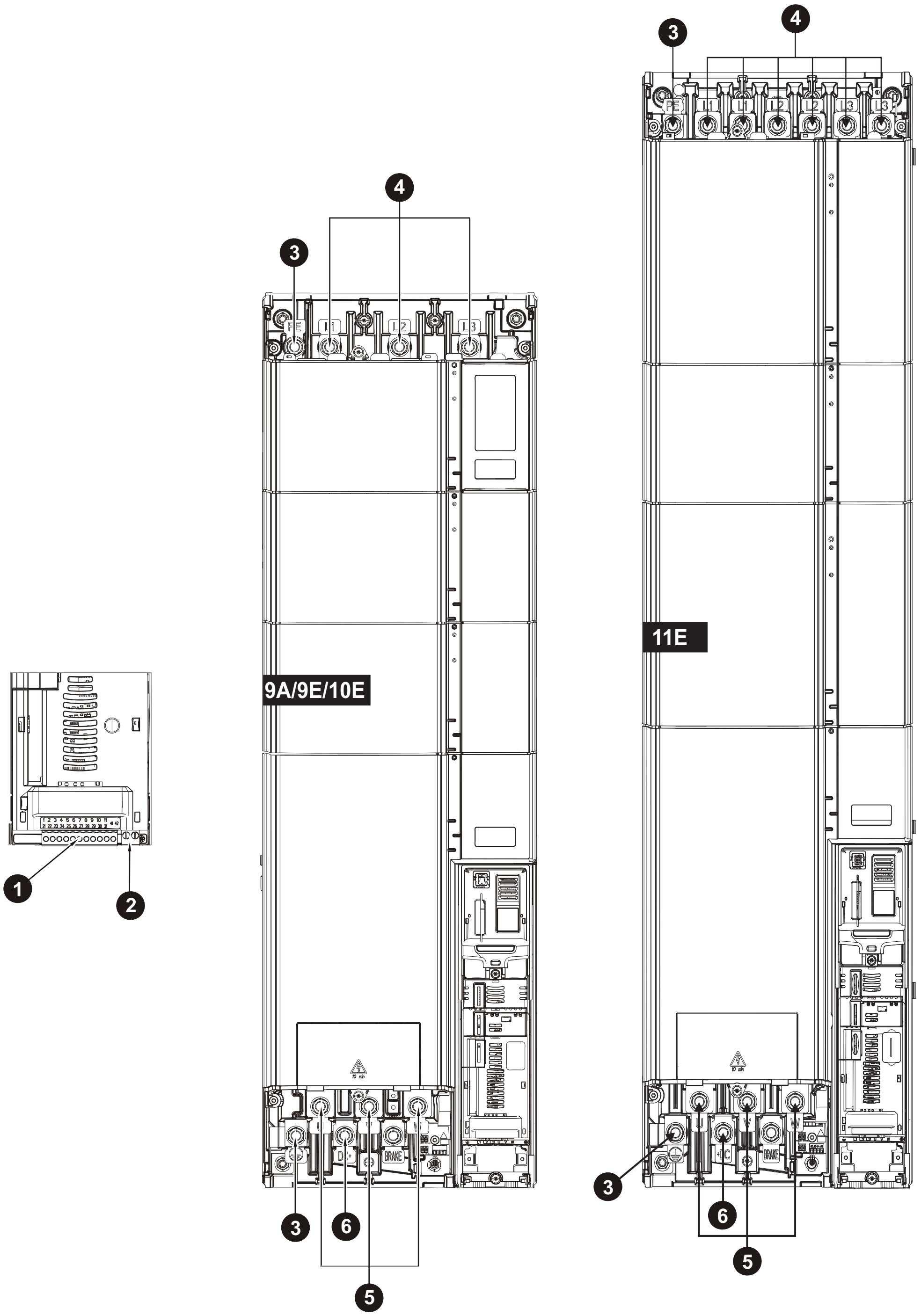
Figure 3-55 Locations of the power and ground terminals (size 3 to 8)



Key

1. Control terminals
2. Relay terminals
3. Additional ground connection
4. Ground connections
5. AC power terminals
6. Motor terminals
7. DC bus -
8. DC bus +

Figure 3-56 Location of the power and ground terminals (size 9A/9E, 10E and 11E)



Key

1. Control terminals
2. Relay terminals
3. Ground connections
4. AC power terminals
5. Motor terminals
6. DC bus +

3.12.2 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 3-19 Drive power terminal data

H300 frame size	AC and motor terminals		DC and braking		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)

Table 3-20 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 3-21 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	11 way control connectors	1.5 mm^2 (16 AWG)
	2 way relay connector	2.5 mm^2 (12 AWG)
3	6 way AC power connector	6 mm^2 (10 AWG)
4		
5	3 way AC power connector 3 way motor connector	8 mm^2 (8 AWG)
6	2 way low voltage power 24 V supply connector	1.5 mm^2 (16 AWG)
7		
8		
9A/9E		
10E/11E		

Table 3-22 External EMC filter terminal data

CT part number	Power connections			Ground connections	
	Bar hole diameter	**Max cable size**	**Max torque**	**Ground stud size**	**Max torque**
4200-1132	N/A	50 mm^2 (1/0 AWG)	8.0 N m (6.0lb ft)	M10	18 N m (13.3 lb ft)
4200-0672					
4200-1972		95 mm^2 (3/0 AWG)	20 N m (14.8 lb ft)		
4200-1662					
4200-0122		16 mm^2 (6 AWG)	2.3 N m (1.7 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-0252			1.8 N m (1.4 lb ft)		
4200-0272					
4200-0312					
4200-0402					
4200-3230		4 mm^2 (12 AWG)	0.8 N m (0.59 lb ft)	M5	3.0 N m (2.2 lb ft)
4200-3480		4 mm^2 (12 AWG)	0.8 N m (0.59 lb ft)	M5	
4200-2300		16 mm^2 (6 AWG)	2.3 N m (1.70 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-4800					
4200-3690					
4200-3021	10.8 mm	N/A	30 N m (22.1 lb ft)	M10	18 N m (13.3 lb ft)
4200-4460	11 mm				
4200-1660	10.8 mm				
4200-2210	11 mm				
4200-0400	10.5 mm			M12	25 N m (18.4 lb ft)
4200-0690	10.5 mm				

3.13 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

3.13.1 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 3-57 Keypad (rear view)

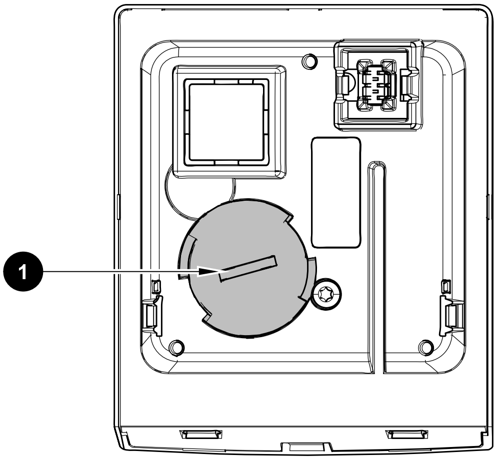


Figure 3-57 above illustrates a rear view of the keypad (KI-HOA Keypad RTC and HOA Keypad RTC).

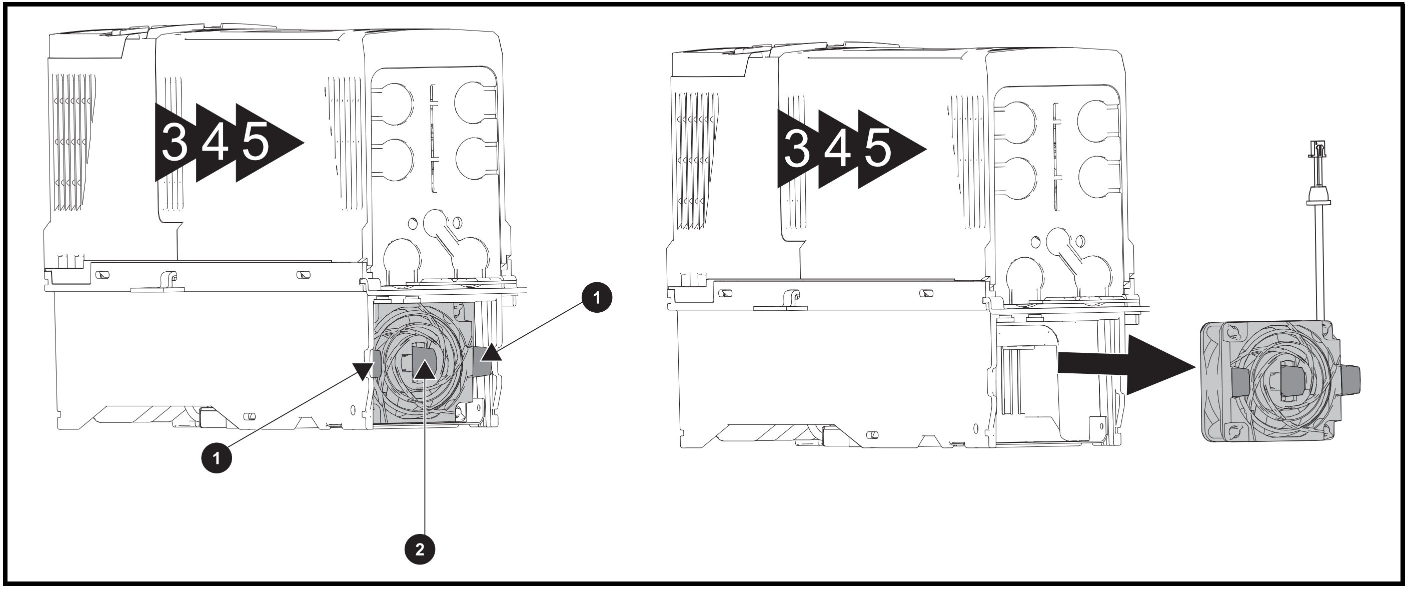
1. To remove the battery cover insert a flat head screwdriver into the slot as shown (1), push and turn anti-clockwise until the battery cover is released.
2. Replace the battery (the battery type is: CR2032).
3. Reverse point 1 above to replace battery cover.

NOTE

Ensure the battery is disposed of correctly.

3.13.2 Size 3 to 5 heatsink fan removal procedure

Figure 3-58 Removal of the size 3, 4 and 5 heatsink fan (size 3 shown)



Ensure the fan cable is disconnected from the drive prior to attempting fan removal.

1. Press the two tabs inwards to release the fan from the drive frame.
2. Using the central fan tab, withdraw the fan assembly from the drive housing.

Replace the fan by reversing the above instructions.

NOTE

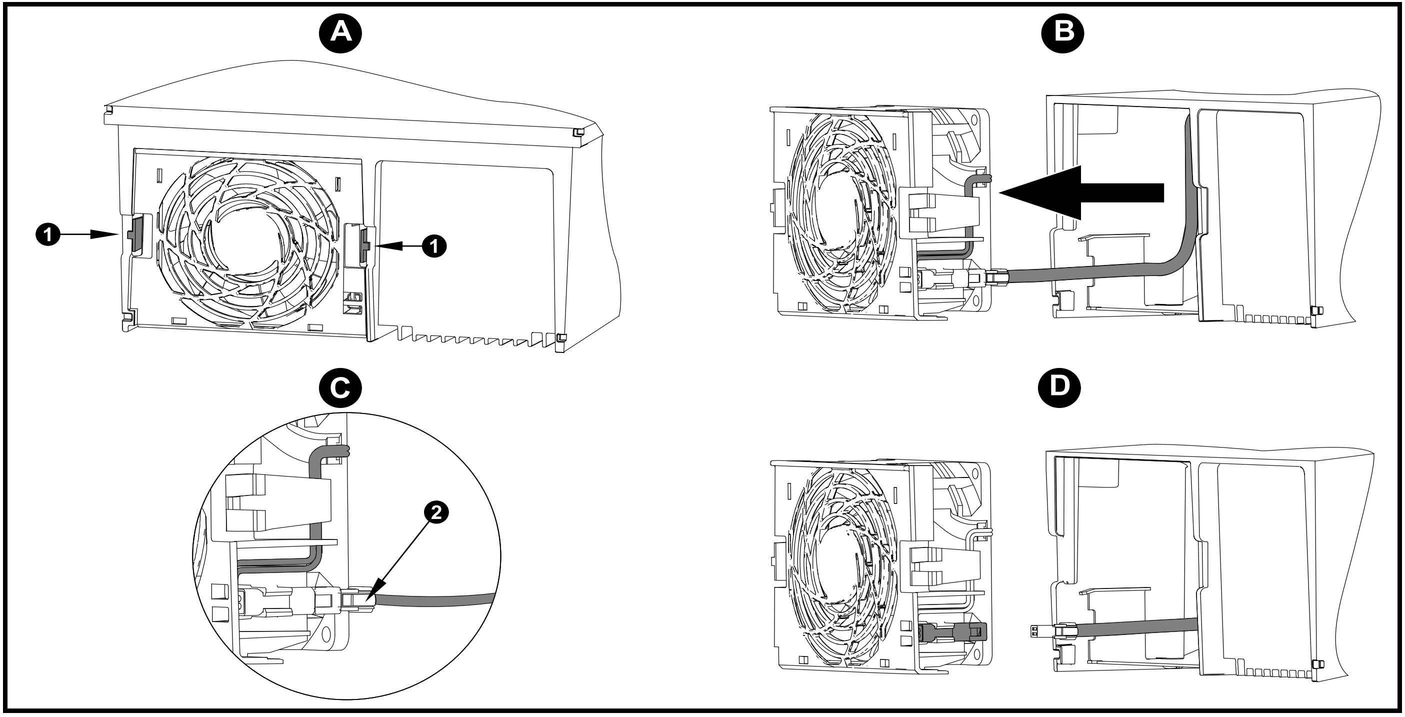
If the drive is surface mounted using the outer holes on the mounting bracket, then the heatsink fan can be replaced without removing the drive from the backplate.

Table 3-23 Size 3 to 5 heatsink fan part numbers

Model	Heatsink fan part number
Size 3	3251-0029
Size 4	3251-0245
Size 5	3251-0245

3.13.3 Size 6 heatsink fan removal procedure

Figure 3-59 Removal of the size 6 heatsink fan



A: Press the tabs (1) inwards to release the fan assembly from the underside of the drive.

B: Use the tabs (1) to withdraw the fan by pulling it away from the drive.

C: Depress and hold the locking release on the fan cable lead as shown (2).

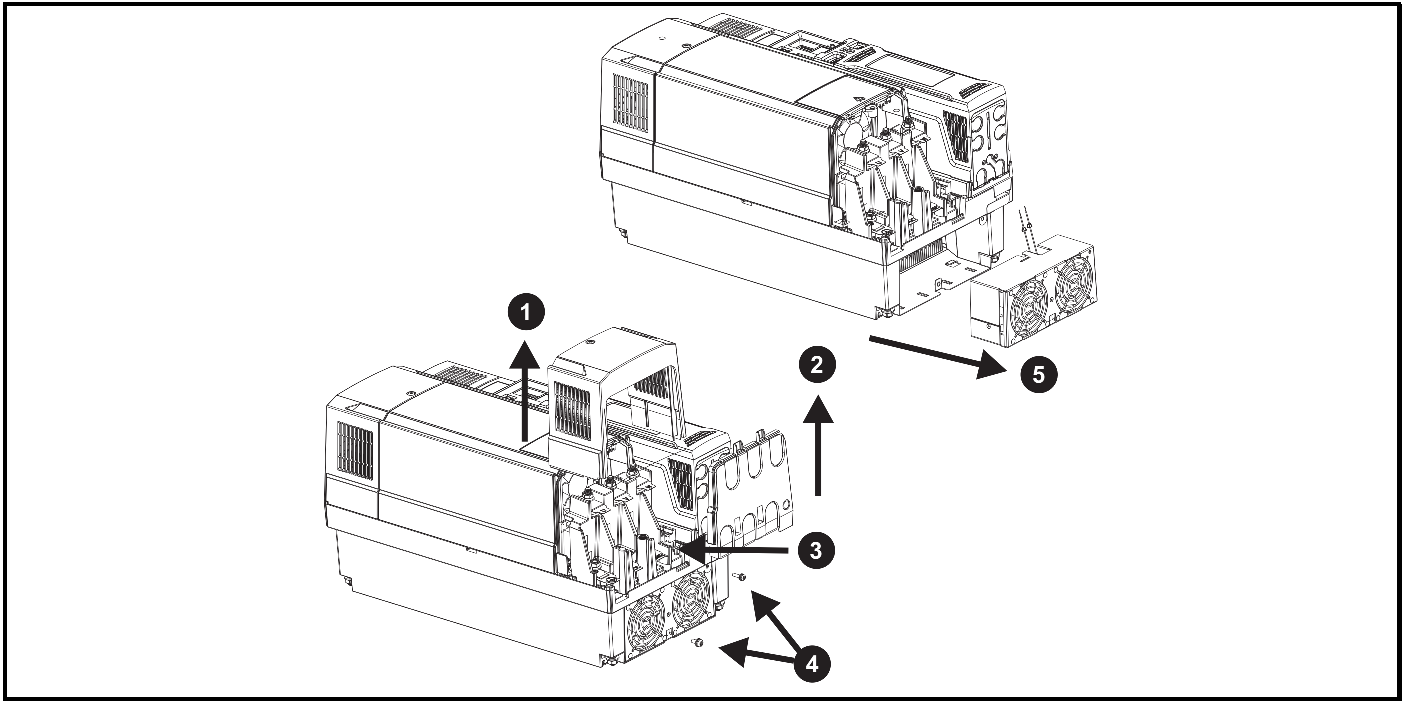
D: With the locking release depressed (2), take hold of the fan supply cable and carefully pull to separate the connectors.

Table 3-24 Size 6 heatsink fan part number

Model	Heatsink fan part number
Size 6	3251-0030

3.13.4 Size 7 heatsink fan replacement

Figure 3-60 Size 7 heatsink fan replacement



Size 7 heatsink fan removal procedure

1) Remove terminal cover

2) Remove finger guard

3) Disconnect fan cables from drive (making a note of the order) and push grommets down prior to attempting fan removal

4) Remove the mounting screws using a T20 and T25 torque driver

5) Withdraw fan housing from the drive

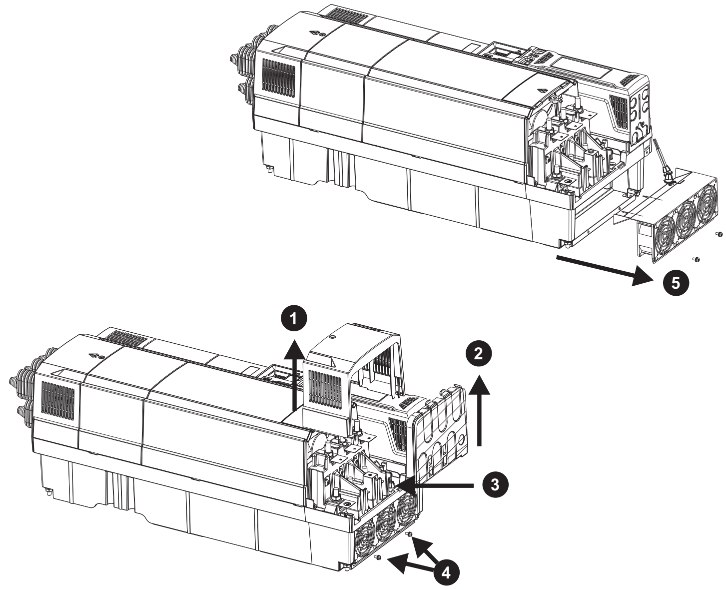
After fan(s) have been replaced, reverse the above steps to refit.

Table 3-25 Size 7 heatsink fan part number

Drive model	Heatsink fan part number
Size 7	3251-8247

3.13.5 Size 8 heatsink fan replacement

Figure 3-61 Size 8 heatsink fan replacement



Size 8 heatsink fan removal procedure

1) Remove terminal cover

2) Remove finger guard

3) Disconnect fan cables from drive (making a note of the order) and push grommet down prior to attempting fan removal

4) Remove the mounting screws using a T20 torque driver

5) Withdraw fan housing from the drive

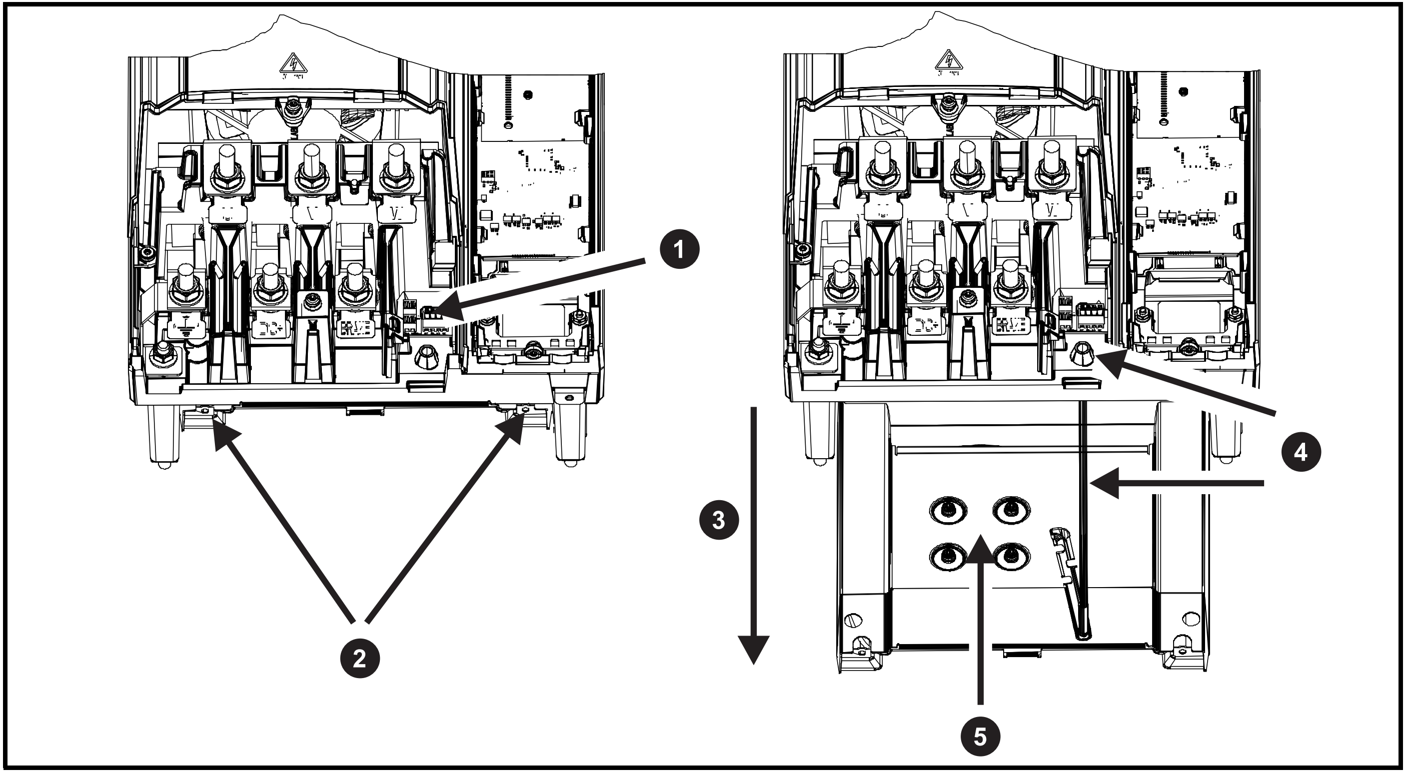
After fan(s) have been replaced, reverse the above steps to refit.

Table 3-26 Size 8 heatsink fan part number

Drive model	Heatsink fan part number
Size 8	3251-8240

3.13.6 Size 9 to 11 heatsink fan replacement

Figure 3-62 Size 9 to 11 Heatsink fan replacement



Heatsink fan removal procedure

1) Using a flat screwdriver remove the fan wires from the fan connector (making a note of the order).

2) Using a T20 Torque driver remove the two screws that retain the heatsink fan housing

3) Withdraw the heatsink fan housing from the drive in the direction shown

4) Pull the fan cable through the fan cable gland

5) Using a T20 Torque driver remove the four screws that retain the fan in the housing

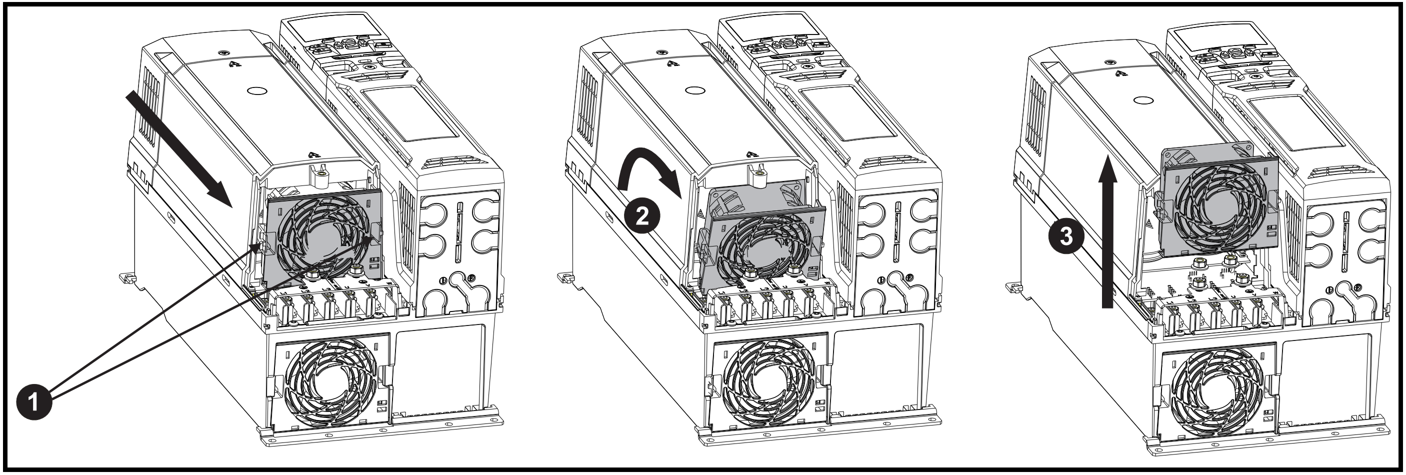
After fan has been replaced, reverse the above steps to refit.

Table 3-27 Heatsink fan part number

Drive model	Heatsink fan part number
Size 9 to 11	3251-1750

3.13.7 Size 6 auxiliary (capacitor bank) fan replacement

Figure 3-63 Removal of the size 6 auxiliary(capacitor bank) fan



- Press the tabs (1) inwards to release the fan assembly from the drive mid cover.
- Use the tabs (1) to withdraw the fan from the drive by pulling the fan assembly forward and tilting it at a slight angle (2).
- Pull the fan assembly up and away from the drive (3).
- Depress and hold the locking release on the fan cable lead.
- With the locking release depressed, take hold of the fan supply cable and carefully pull to separate the connectors.

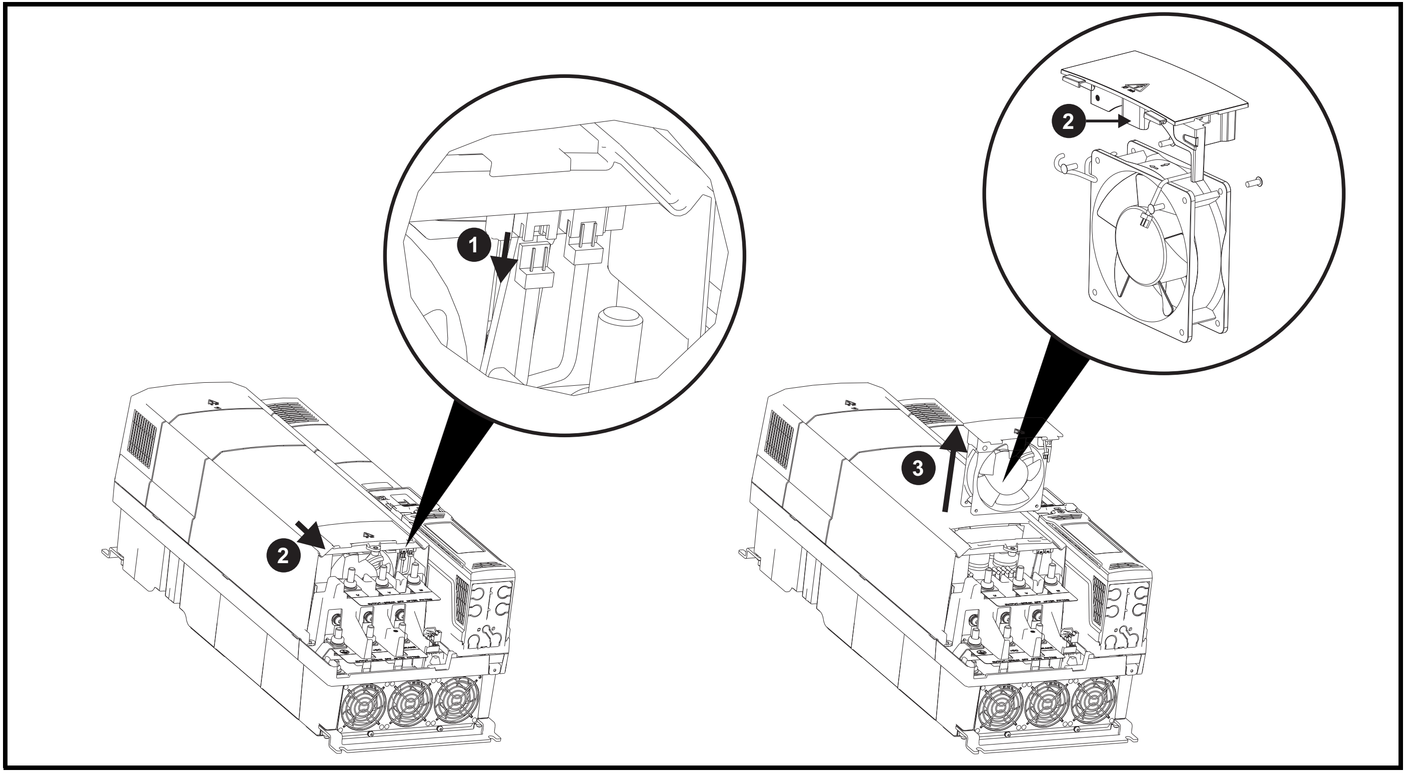
Replace the fan by reversing the above instructions.

Table 3-28 Size 6 auxiliary fan part number

Model	Auxiliary fan part number
Size 6	3251-0030

3.13.8 Size 7 to 11 auxiliary (capacitor bank) fan replacement

Figure 3-64 Size 7 to 11 auxiliary (capacitor bank) fan replacement



Size 7 to 11 auxiliary fan removal procedure

1) Disconnect the fan wiring connector shown

2) Slide fan housing in the direction shown using tongue shown in enlarged diagram of fan

3) Withdraw fan housing from the drive

After fan has been replaced, reverse the above steps to refit.

Table 3-29 Size 7 to 11 Auxiliary (capactitor bank) fan part numbers

Drive model	Auxiliary (capacitor bank fan part number
Size 7	3251-0041
Size 8	3251-2249
Size 9, 10 and 11 (575V and 690V)	3251-0042
Size 11 (400V)	3251-1202

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 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).

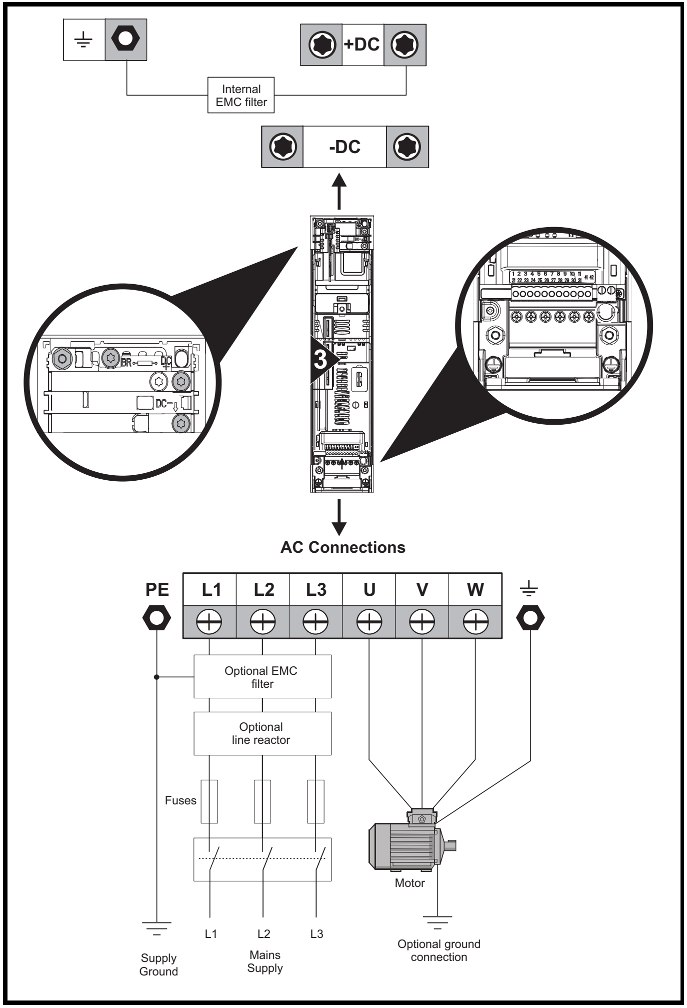
WARNING

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 Power connections

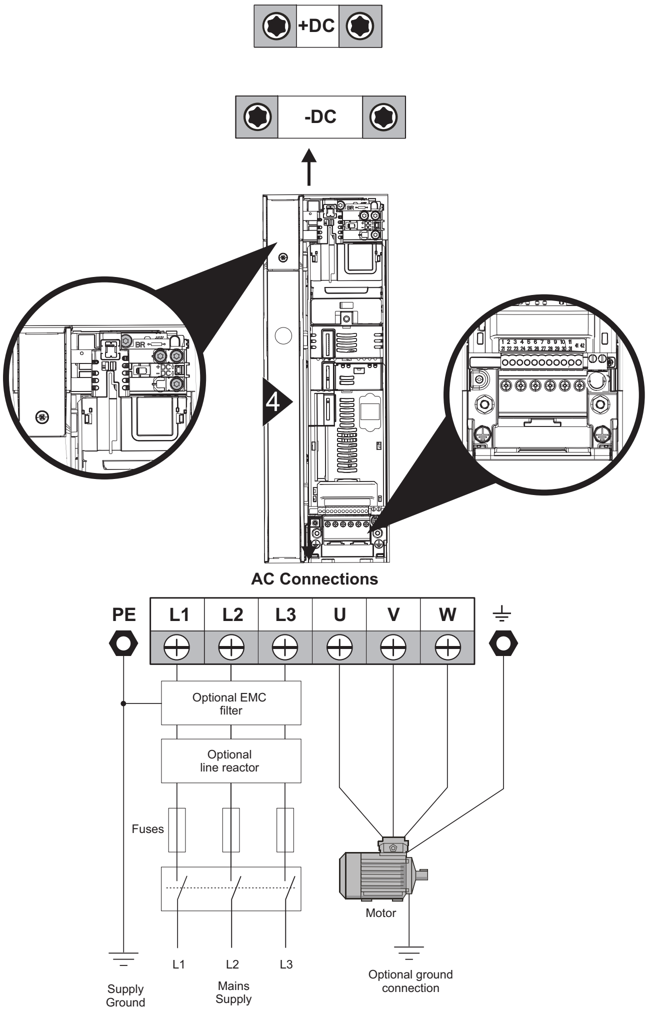
4.1.1 AC and DC connections

Figure 4-1 Size 3 power connections



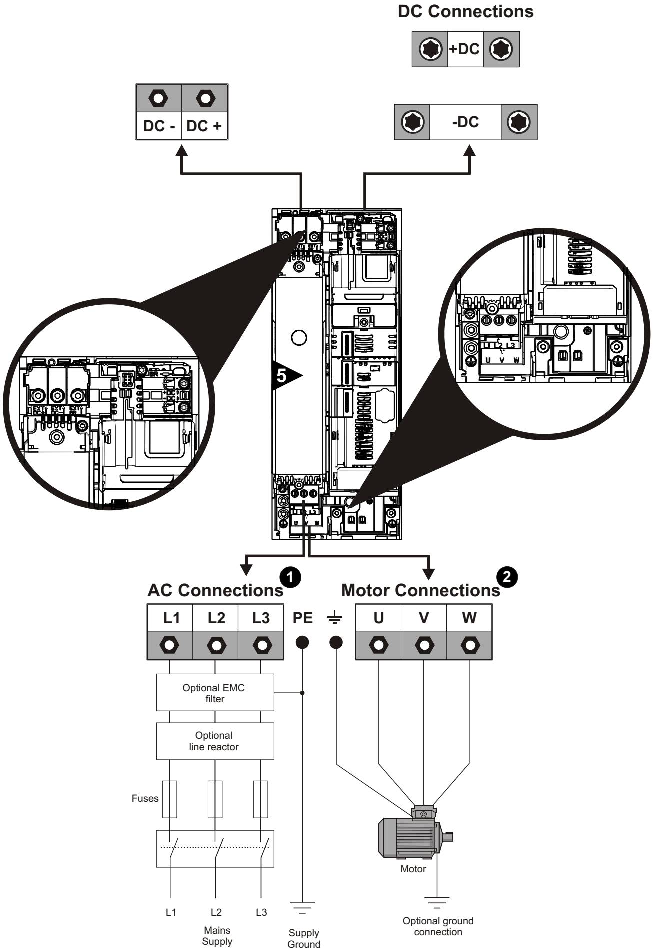
See Figure 4-8 for further information on ground connections.

Figure 4-2 Size 4 power connections



See Figure 4-8 for further information regarding ground connections.

Figure 4-3 Size 5 power connections



The upper terminal block (1) is used for AC supply connection.

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

See Figure 4-9 for further information on ground connections.

Figure 4-4 Size 6 power connections

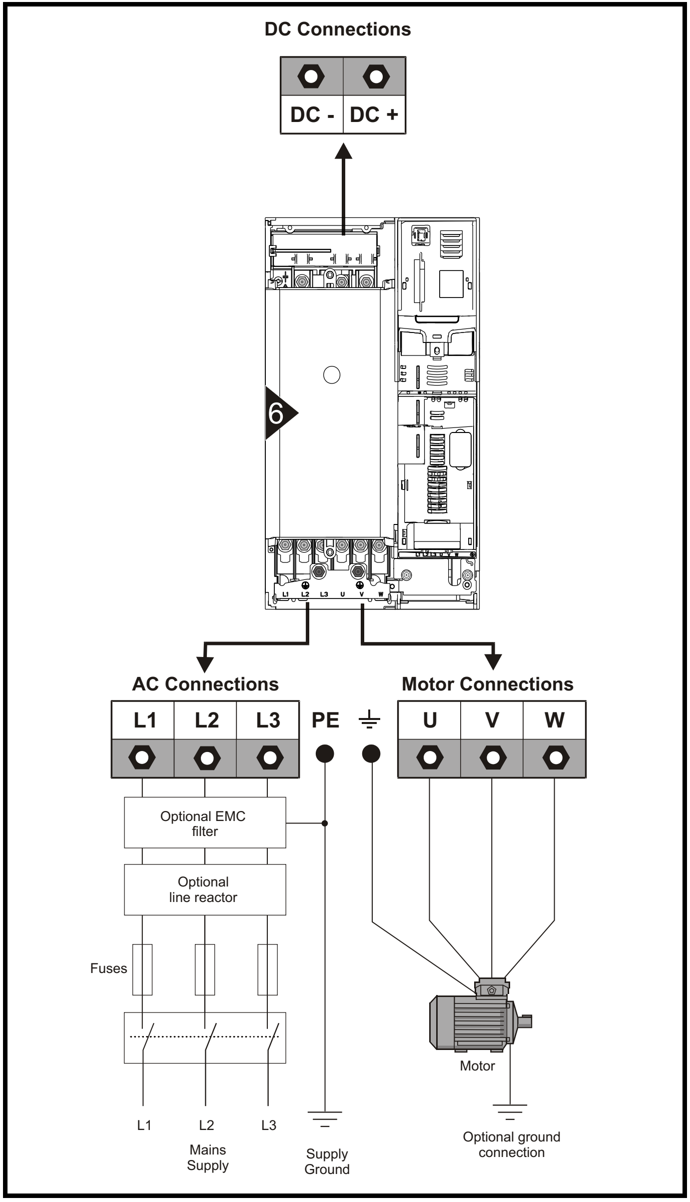


Figure 4-5 Size 7 and 8 power connections (Size 7 shown)

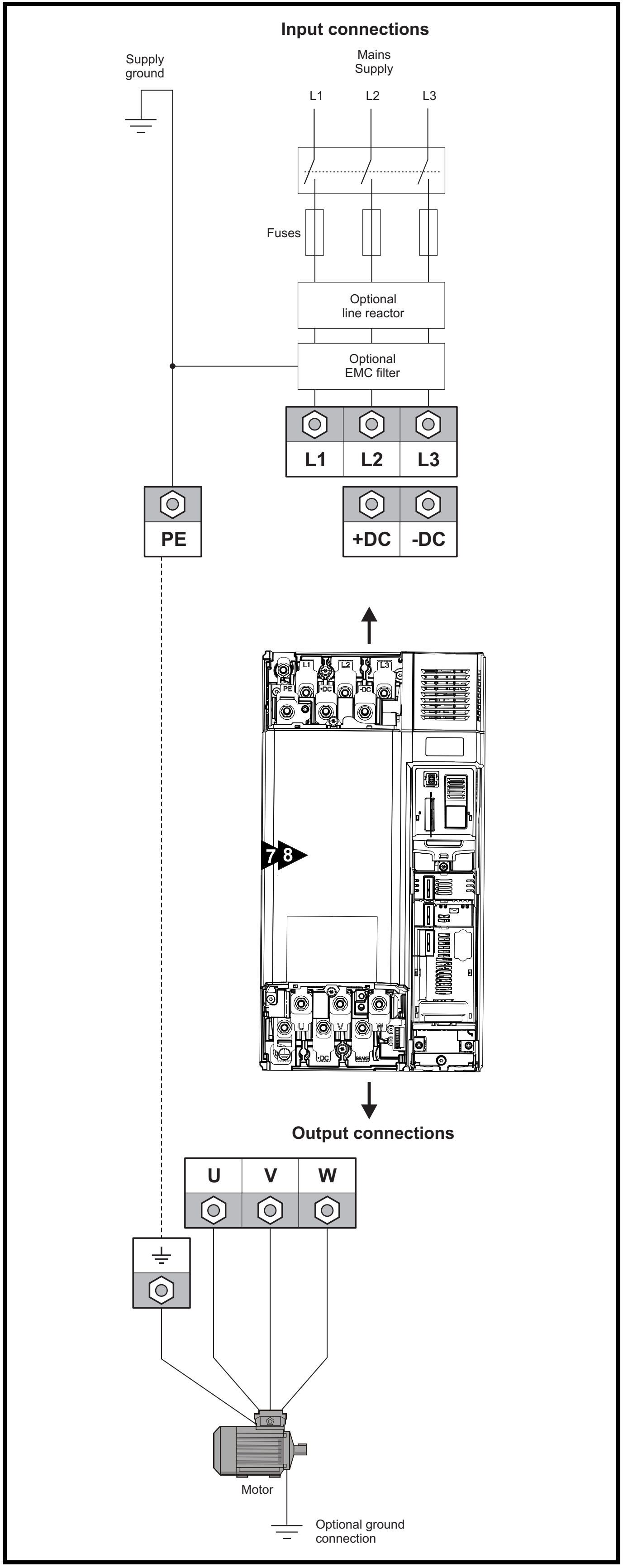


Figure 4-6 Size 9A Power and Ground Connections

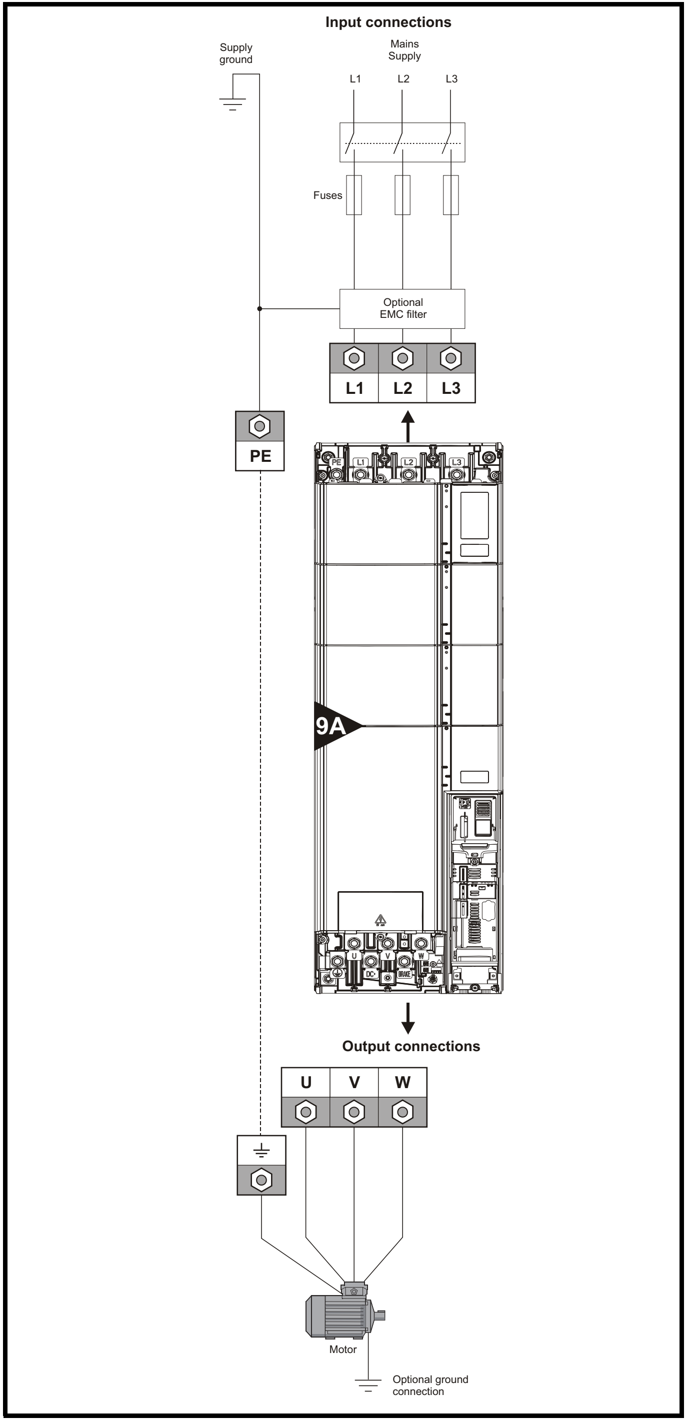
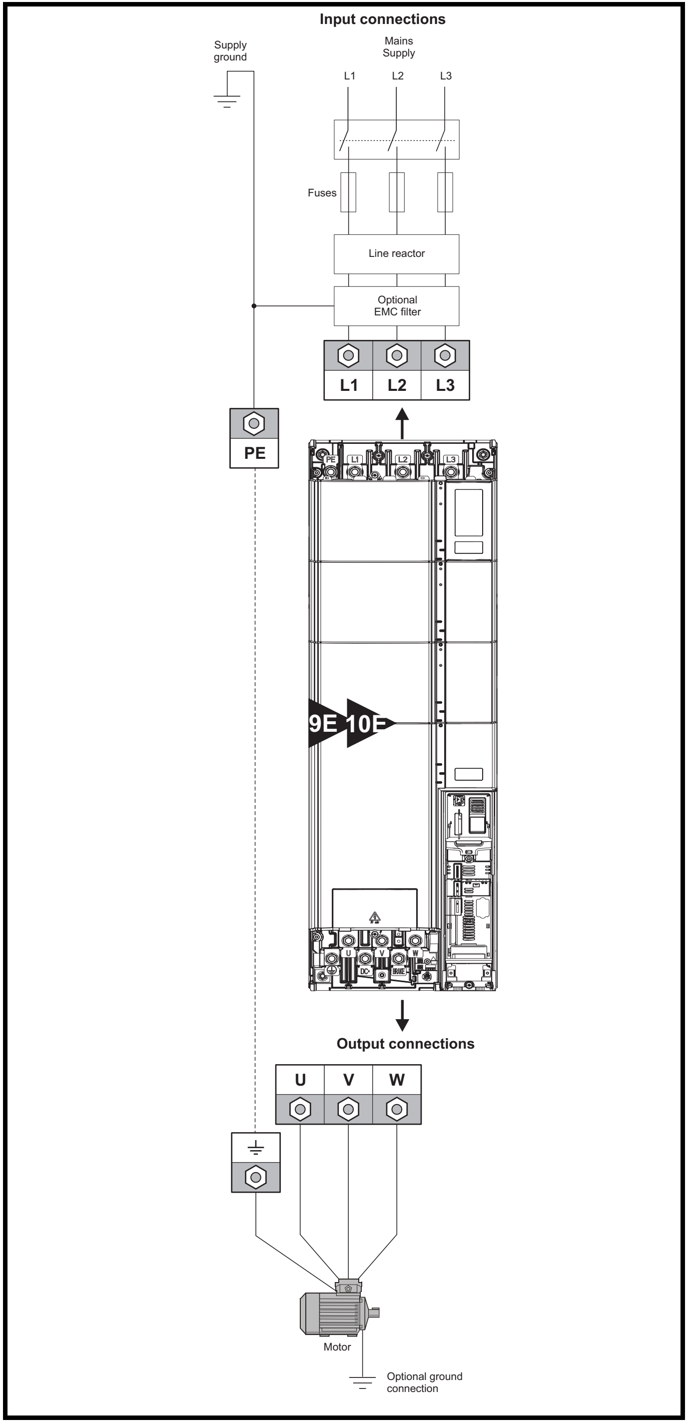


Figure 4-7 Size 9E and 10E power connections



WARNING

A separate line reactor (INLXXX) of at least the value shown in Table 4-13 and Table on page 81 must be used with size 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive.

4.1.2 Ground connections

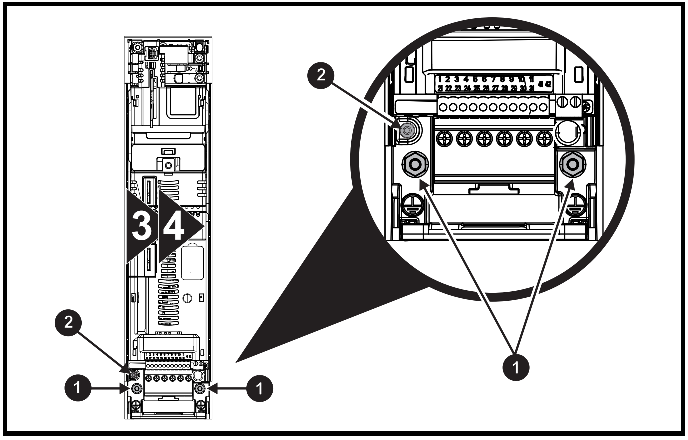
WARNING

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

Size 3 and 4

On sizes 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 connector. Refer to Figure 4-8 for additional ground connection.

Figure 4-8 Size 3 and 4 ground connections

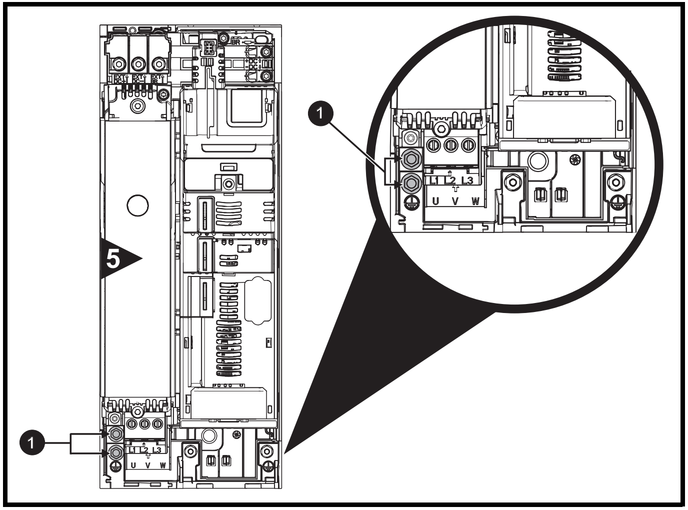


1. Ground connection studs.
2. Additional ground connection.

Size 5

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 4-9 for additional ground connection.

Figure 4-9 Size 5 ground connections

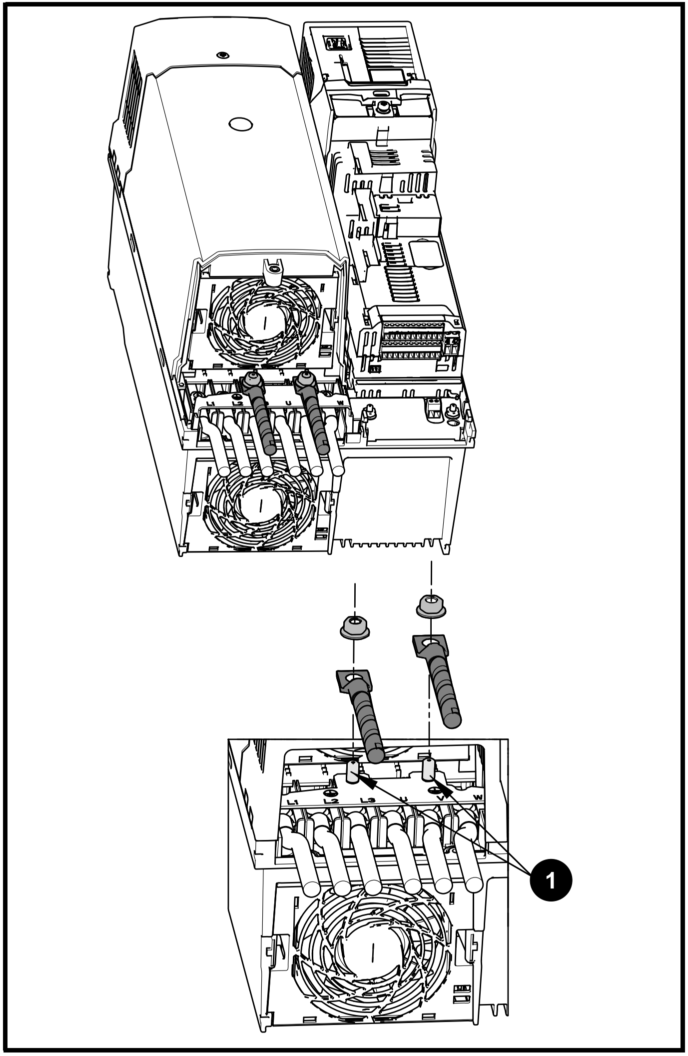


1. Ground connection studs.

Size 6

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 4-10 below.

Figure 4-10 Size 6 ground connections



1. Ground connection studs

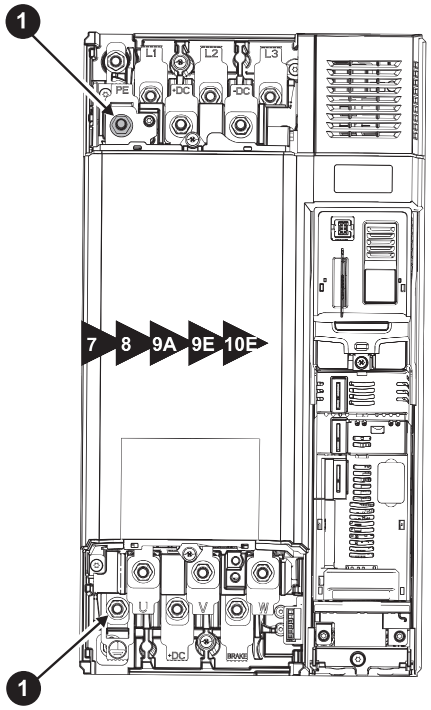
Size 7

On size 7, the supply and motor ground connections are made using the M8 studs located by the supply and motor connection terminals.

Size 8 to 10

On size 8 to 10, the supply and motor ground connections are made using the M10 studs located by the supply and motor connection terminals.

Figure 4-11 Size 7 to 10 ground connections



1. Ground connection studs.

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.

Figure 4-12 Size 11E ground connections

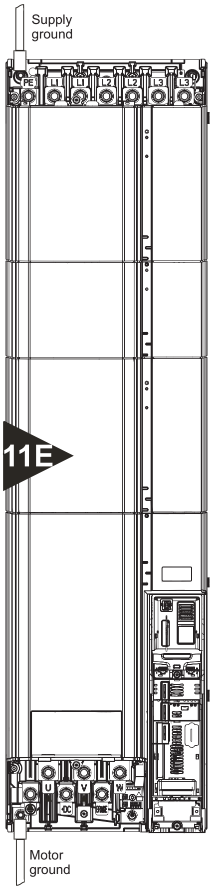


Table 4-1 Protective ground cable ratings

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 (an additional ground connection is provided on sizes 3, 4 and 5 for this purpose).
> 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

4.2 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

4.2.1 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 IEC60664-1. 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.

WARNING

Operation with IT (ungrounded) supplies:
Special attention is required when using internal or external EMC filters with ungrounded supplies, because in the event of a ground (earth) fault in the motor circuit the drive may not trip and the filter could be over-stressed. In this case, either the filter must not be used (removed) or additional independent motor ground fault protection must be provided.
For instructions on removal, refer to section 4.11.2 *Internal EMC filter* on page 97. For details of ground fault protection contact the supplier of the drive.

A ground fault in the supply has no effect in any case. If the motor must continue to run with a ground fault in its own circuit then an input isolating transformer must be provided and if an EMC filter is required it must be located in the primary circuit.

Unusual hazards can occur on ungrounded supplies with more than one source, for example on ships. Contact the supplier of the drive for more information.

4.2.2 Supplies requiring line reactors

Input line reactors reduce the risk of damage to the drive resulting from poor phase balance or severe disturbances on the supply network.

Where line reactors are to be used, reactance values of approximately 2 % are recommended. Higher values may be used if necessary, but may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

For all drive ratings, 2 % line reactors permit drives to be used with a supply unbalance of up to 3.5 % negative phase sequence (equivalent to 5% voltage imbalance between phases).

Severe disturbances may be caused by the following factors, for example:

- Power factor correction equipment connected close to the drive.
- Large DC drives having no or inadequate line reactors connected to the supply.
- Across the line (DOL) started motor(s) connected to the supply such that when any of these motors are started, the voltage dip exceeds 20 %.

Such disturbances may cause excessive peak currents to flow in the input power circuit of the drive. This may cause nuisance tripping, or in extreme cases, failure of the drive.

Drives of low power rating may also be susceptible to disturbance when connected to supplies with a high rated capacity.

Line reactors are particularly recommended for use with the following drive models when one of the above factors exists, or when the supply capacity exceeds 175 kVA:

03200066, 03200080, 03200110, 03200127,

03400034, 03400045, 03400062, 03400077

Model sizes 03400104 to 10601970 have an internal DC choke and model sizes 08201160 to 07600730 have internal AC line chokes so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions. Drive sizes 9E and 10E do not have internal input line reactors hence an external input line reactor must be used. For more information refer to Section 4.2.3 *Drive model and input line reactor*

When required, each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

Reactor current ratings

The current rating of the line reactors should be as follows:

Continuous current rating:
Not less than the continuous input current rating of the drive

Repetitive peak current rating:
Not less than twice the continuous input current rating of the drive

CAUTION

A separate line reactor (INLXXX) of at least the value shown in Table 4-2 and Table 4-3 must be used with size 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive.

4.2.3 Drive model and input line reactor

Table 4-2 Drive model and line reactor part number

Size	Drive model	Inductor model	Line reactor part number
3	03200066, 03200080	INL 2001	4401-0143
	03200110, 03200127	INL 2002	4401-0144
	03400034, 03400045	INL 4001	4401-0148
	03400062	INL 4002	4401-0149
	03400077, 03400104	INL 4011	4401-0234
	03400123	INL 4003	4401-0151
4	04200180	INL 2002	4401-0144
	04200250	INL 2003	4401-0145
	04400185	INL 4004	4401-0152
	04400240	INL 4005	4401-0153
5	05200300	INL 2008	4401-0226
	05400300	INL 4013	4401-0236
	05500039	INL 5007	4401-0242
	05500061	INL 5008	4401-0243
	05500100	INL 5009	4401-0244
6	06200500	INL 2004	4401-0146
	06200580	INL 2005	4401-0147
	06400380	INL 4006	4401-0154
	06400480	INL 4007	4401-0155
	06400630	INL 4008	4401-0156
	06500120	INL 5001	4401-0157
	06500170	INL 5002	4401-0158
	06500220	INL 5003	4401-0159
	06500270	INL 5004	4401-0160
	06500340	INL 5005	4401-0161
	06500430	INL 5006	4401-0223
7	07200750	INL 2009	4401-0227
	07200940	INL 2010	4401-0228
	07201170	INL 2011	4401-0229
	07400790	INL 4014	4401-0237
	07400940	INL 4015	4401-0238
	07401120	INL 4016	4401-0239
	07500530	INL 5006	4401-0223
	07500730	INL 5010	4401-0245
	07600230	INL 6001	4401-0248
	07600300	INL 6002	4401-0249
	07600360	INL 6003	4401-0250
	07600460	INL 6004	4401-0251
	07600520	INL 6005	4401-0252
	07600730	INL 6006	4401-0253
8	08201490	INL 2012	4401-0230
	08201800	INL 2013	4401-0231
	08401550	INL 4017	4401-0240
	08401840	INL 4018	4401-0241
	08500860	INL 5011	4401-0246
	08501080	INL 5012	4401-0247
	08600860	INL 6007	4401-0254
	08601080	INL 6008	4401-0255
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.

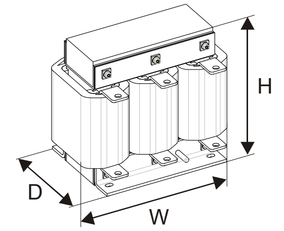
** May represent a more economic solution when operating below 420 A.

Table 4-3 Input line reactor ratings (2%)

Part number	Model	Current	Inductance	Overall width (W)	Overall depth (D)	Overall height (H)	Weight	Max ambient temp	Min airflow	Maximum losses
		A	µH	mm	mm	mm	kg	°C	m/s	W
4401-0143	INL 2001	13.5	790	156	70	125	1.8	50	0	42
4401-0144	INL 2002	20.6	480	156	80	125	2.4	50	0	43
4401-0145	INL 2003	26.8	320	156	80	125	2.5	50	0	48
4401-0148	INL 4001	6.6	2940	80	75	130	1.3	50	0	31
4401-0149	INL 4002	9.1	1620	156	70	125	1.8	50	0	42
4401-0234	INL 4011	13	1120	156	80	125	2.5	50	0	46
4401-0151	INL 4003	15.8	1050	156	80	125	2.6	50	0	47
4401-0152	INL 4004	18.7	790	156	60	145	3.5	50	0	62
4401-0153	INL 4005	24.3	610	156	75	145	4.9	50	0	59
4401-0226	INL 2008	32	260	156	60	145	3.30	50	0	64
4401-0146	INL 2004	48.8	170	156	75	145	4.8	50	0	59
4401-0147	INL 2005	56.6	150	156	120	130	4.9	50	0	58
4401-0236	INL 4013	32	480	156	75	145	4.9	50	0	63
4401-0154	INL 4006	36.5	400	206	140	200	8	50	0	78
4401-0155	INL 4007	46.2	320	206	140	200	9	50	0	84
4401-0156	INL 4008	60.6	240	255	125	195	11	50	0	104
4401-0242	INL 5007	4.3	492	80	75	130	1.4	50	0	35
4401-0243	INL 5008	6.8	311	156	70	125	1.8	50	0	39
4401-0244	INL 5009	11.4	1890	156	60	145	3.2	50	0	60
4401-0157	INL 5001	13.2	1600	156	60	145	3.5	50	0	60
4401-0158	INL 5002	18.7	1130	156	75	145	4.9	50	0	59
4401-0159	INL 5003	24.3	870	206	95	200	6	50	0	73
4401-0160	INL 5004	29.4	720	206	130	200	7.4	50	0	77
4401-0161	INL 5005	37.1	570	230	130	210	11	50	0	108
4401-0223	INL 5006	47	480	255	130	210	12.5	50	0	122
4401-0227	INL 2009	67	130	206	130	160	6.9	50	0	90
4401-0228	INL 2010	88	100	206	140	160	9	50	0	97
4401-0229	INL 2011	105	80	206	140	160	9.5	50	0	90
4401-0230	INL 2012	137	62	254	130	195	12.5	50	0	143
4401-0231	INL 2013	166	51	254	150	195	14	50	0	137
4401-0237	INL 4014	74	200	254	130	195	12	50	0	129
4401-0238	INL 4015	88	170	254	150	195	14	50	0	127
4401-0239	INL 4016	105	140	254	150	195	14	50	0	139
4401-0240	INL 4017	155	95	290	160	205	20	50	0	182
4401-0241	INL 4018	177	83	290	170	205	22	50	0	200
4401-0245	INL 5010	67	340	290	150	205	18	50	0	139
4401-0246	INL 5011	88	250	290	170	205	22	50	0	147
4401-0247	INL 5012	105	200	290	180	225	25	50	0	167
4401-0248	INL 6001	20	1270	206	95	200	5.8	50	0	71
4401-0249	INL 6002	26	980	206	130	200	7.4	50	0	80
4401-0250	INL 6003	32	880	206	140	200	10	50	0	84
4401-0251	INL 6004	39	650	254	130	210	12	50	0	123
4401-0252	INL 6005	45	580	254	130	210	12.5	50	0	124
4401-0253	INL 6006	67	410	290	150	205	18	50	0	123
4401-0254	INL 6007	88	300	290	170	205	22	50	0	169
4401-0255	INL 6008	105	240	290	180	225	25	50	0	204
4401-0181	INL 401	245	63	240	190	225	32	50	1	148
4401-0182	INL 402	370	44	276	200	225	36	50	1	205
4401-0183	INL 601	145	178	240	190	225	33	50	1	88
4401-0184	INL 602	202	133	276	200	225	36	50	1	116
4401-0181	INL 401	245	63	240	190	225	32	50	1	148
4401-0182	INL 402	339	44	276	200	225	36	50	1	205
4401-0274	INL 403L*	420	30	300	216	264	57	40	0	289
4401-0259	INL403*	557	30	300	216	264	57	40	0	330
4401-0183	INL 601	145	178	240	190	225	33	50	1	88
4401-0184	INL 602	192	133	276	200	225	36	50	1	116
4401-0261	INL 603*	331	93	300	216	264	58	40	0	320

* Natural cooling.

Figure 4-13 Input line reactor dimensions



4.2.4 Input inductor calculation

To calculate the inductance required (at **Y**%), use the following equation:

$$L = \frac{Y}{100} \times \frac{V}{\sqrt{3}} \times \frac{1}{2\pi fI}$$

Where:

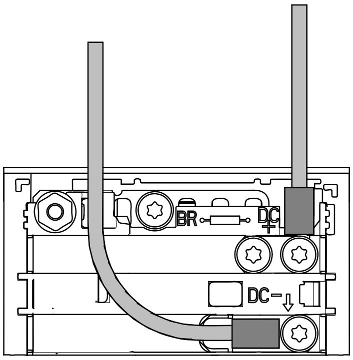
I = drive rated input current (A)
L = inductance (H)
f = supply frequency (Hz)
V = voltage between lines

4.3 Supplying the drive with DC

All drive sizes have the option to be powered from an external DC power supply. Refer to section 3.12 *Electrical terminals* on page 63 to identify the location of DC supply connections.

The DC supply connections for size 3 and 4 are located under the DC / Terminal cover. Figure 4-14 below shows DC supply connections and cable routing.

Figure 4-14 DC supply connections (size 3 shown)



NOTE

The Internal EMC filter and plastics have been removed from the above Figure 4-14 to demonstrate the routing of the DC cables.

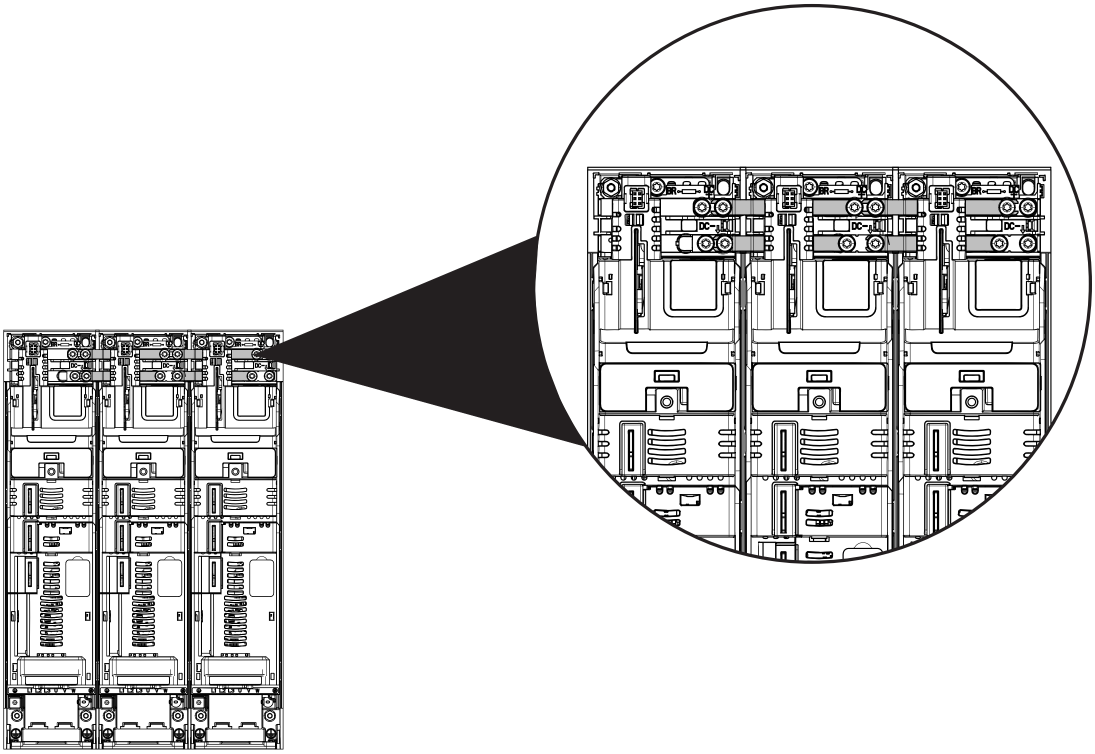
4.4 DC bus paralleling

DC bus paralleling using standard cable / busbars is supported by all frame sizes.

On frame sizes 3, 4, 5 and 6, terminal and enclosure design enables the DC bus of a number of drives to be connected together using pre-made busbars. The diagram below shows how the busbar links connect the DC bus of several drives together.

The connecting of the DC bus between several drives is typically used to return energy from a drive which is being overhauled by the load to a second motoring drive.

Figure 4-15 DC bus paralleling (size 3 shown)



There are limitations to the combinations of drives which can be used in this configuration.

For application data, contact the supplier of the drive.

NOTE

The DC bus paralleling kit is not supplied with the drive but available to order.

Table 4-4 DC bus paralleling kit part numbers

Size	CT part number
3	3470-0048
4	3470-0061
5	3470-0068
6	3470-0063

4.5 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, 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 Vdc 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 85.

Table 4-5 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

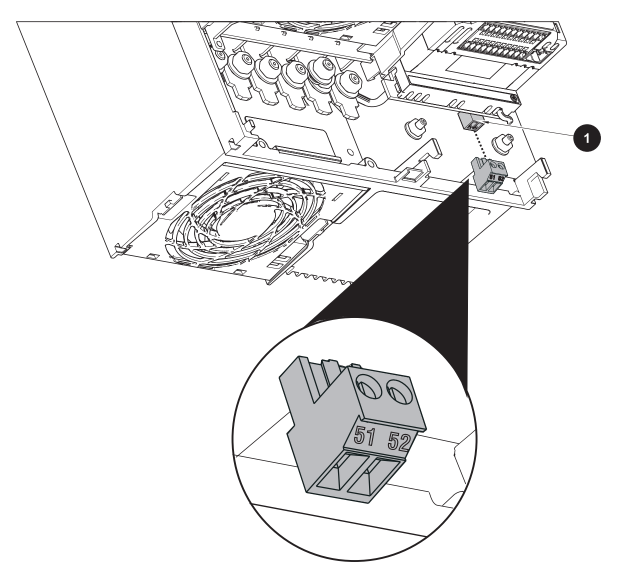
Minimum and maximum voltage values include ripple and noise. Ripple and noise values must not exceed 5 %.

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

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

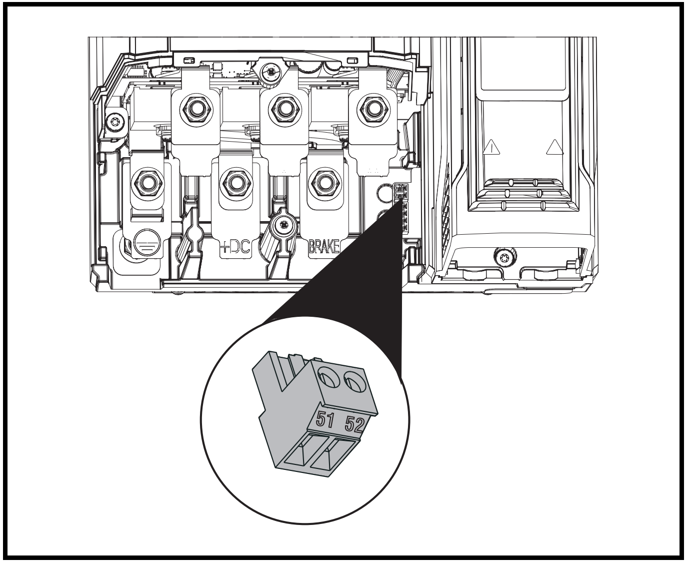
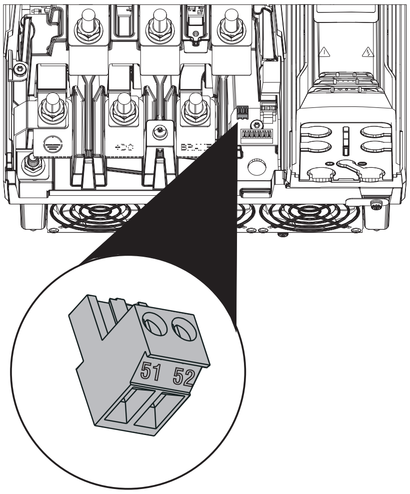


Figure 4-18 Location of the 24 Vdc power supply connection on size 8 to 11



4.6 Low voltage operation

With the addition of a 24 Vdc power supply to supply the control circuits, the drive is able to operate from a low voltage DC supply with a range from 24 Vdc to the maximum DC volts. It is possible for the drive to go from operating on a normal line power supply voltage to operating on a much lower supply voltage without interruption.

Going from low voltage operation to normal mains operation requires the inrush current to be controlled. This may be provided externally. If not, the drive supply can be interrupted to utilise the normal soft starting method in the drive.

To fully exploit the new low voltage mode of operation, the under voltage level is now user programmable. For application data, contact the supplier of the drive.

The working voltage range of the low voltage DC power supply is as follows:

Size 3 to 11

Minimum continuous operating voltage: 26 V

Minimum start up voltage: 32 V

Maximum over voltage trip threshold: 230 V drives: 415 V
400 V drives: 830 V
575 V drives: 990 V
690 V drives: 1190 V

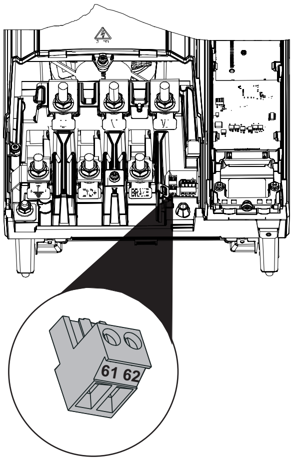
NOTE

*S*ize 9E, 10E and 11E drives do not have an accessible negative DC terminal. It is recommended that 9D, 10D and 11D drives are used as an alternative when this is needed, please refer to the *Modular Installation Guide* for further details.

In low voltage mode only, with frame size 9 to 11, a 24 V supply needs to be provided for the heatsink fan. The fan supply should be connected to terminal 61 and 62.

61	**0V common**
62	**+24 Vdc heatsink fan supply**
Size 9 to 11	
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	23.5 Vdc
Maximum continuous operating voltage	27 Vdc
Current consumption	Size 9 to 10 (all): 6A
Recommended power supply	24 V, 7 A
Recommended fuse	8A fast blow

Figure 4-19 Location of the heatsink fan supply connector on size 9 to 11



4.7 Heatsink fan supply

When operating on normal mains supply the heatsink fan on all drive sizes is supplied internally by the drive. When operating size 9 to 11 in low voltage mode it is necessary to connect an external 24V supply to terminal 61 and 62 if heatsink fan operation is required. Please see section 4.6 *Low voltage operation* on page 86 for more details.

4.8 Ratings

The input current is affected by the supply voltage and impedance.

Typical input current
The values of typical input current are given to aid calculations for power flow and power loss.

The values of typical input current are stated for a balanced supply.

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 bad balance. 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 supply fault current given in Table 4-6.

Table 4-6 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

WARNING

Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 4-7 shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 4-7 AC Input current and fuse ratings (200 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
03200066	8.2	10.4	15.8	16	25	gG	20	25	CC, J or T*
03200080	9.9	12.6	20.9	20					
03200110	14	17	25				25		
03200127	16	20	34	25					
04200180	17	20	30	25	25	gG	25	25	CC, J or T*
04200250	23	28	41	32	32		30	30	
05200300	24	31	52	40	40	gG	40	40	CC, J or T*
06200500	42	48	64	63	63	gG	60	60	CC, J or T*
06200580	49	56	85				60		
07200750	58	67	109	80	80	gG	80	80	CC, J or T*
07200940	73	84	135	100	100		100	100	
07201170	91	105	149	125	125		125	125	
08201490	123	137	213	200	200	gR	200	200	HSJ
08201800	149	166	243				225	225	
09202160	172	205	270	250	250	gR	250	250	HSJ
09202660	228	260	319	315	315		300	300	
10203250	277	305	421	400	400	gR	400	400	HSJ
10203600	333	361	494	450	450		450	450	

* These fuses are fast acting.

Table 4-8 AC Input current and fuse ratings (400 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
03400034	5	5	7	10	10	gG	10	10	CC, J or T*
03400045	6	7	9						
03400062	8	9	13						
03400077	11	13	21	20	20		20	20	
03400104	12		20						
03400123	14	16	25						
04400185	17	19	30	25	25	gG	25	25	CC, J or T*
04400240	22	24	35	32	32		30	30	
05400300	26	29	52	40	40	gG	35	35	CC, J or T*
06400380	32	36	67	63	63	gG	40	60	CC, J or T*
06400480	41	46	80				50		
06400630	54	60	90				60		
07400790	67	74	124	100	100	gG	80	80	CC, J or T*
07400940	80	88	145				100	100	
07401120	96	105	188	125	125		125	125	
08401550	137	155	267	250	250	gR	225	225	HSJ
08401840	164	177	303						
09402210	211	232	306	315	315	gR	300	300	HSJ
09402660	245	267	359				350	350	
10403200	306	332	445	400	400	gR	400	400	HSJ
10403610	370	397	523	450	450		450	450	
11404370	424	449	579	500	500	gR	600	600	HSJ
11404870	455	492	613						
11405070	502	539	752	630	630				

* These fuses are fast acting.

Table 4-9 AC Input current and fuse ratings (575 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
05500039	4	4	7	10	20	gG	10	10	CC, J or T*
05500061	6	7	9						
05500100	9	11	15	20			20	20	
06500120	12	13	22	20	40	gG	20	30	CC, J or T*
06500170	17	19	33	32			25		
06500220	22	24	41	40			30		
06500270	26	29	50	50	63		35	50	
06500340	33	37	63				40		
06500430	41	47	76	63			50		
07500530	41	45	75	50	50	gG	50	50	CC, J or T*
07500730	57	62	94	80	80		80	80	
08500860	74	83	121	125	125	gR	100	100	HSJ
08501080	92	104	165	160	160		150	150	
09501250	145	166	190	150	150	gR	150	150	HSJ
09501500	145	166	221	200	200		175	175	
10502000	177	197	266	250	250	gR	250	250	HSJ
11502480	240	265	327	400	400	gR	400	400	HSJ
11502880	285	310	395						
11503150	313	338	473						

* These fuses are fast acting.

Table 4-10 AC Input current and fuse ratings (690 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
07600230	18	20	32	25	50	gG	25	50	CC, J or T*
07600300	23	26	41	32			30		
07600360	28	31	49	40			35		
07600460	36	39	65	50			50		
07600520	40	44	75		80			80	
07600730	57	62	92	80			80		
08600860	74	83	121	125	125	gR	100	100	HSJ
08601080	92	104	165	160	160		150	150	
09601250	124	149	194	150	150	gR	150	150	HSJ
09601550	145	171	226	200	200		200	200	
10601720	180	202	268	225	225	gR	250	250	HSJ
10601970	202	225	313	250	250	gR	250	250	
11602250	225	256	379	400	400	gR	400	400	HSJ
11602750	217	302	425						
11603050	298	329	465						

* These fuses are fast acting.

NOTE

Ensure cables used suit local wiring regulations.

CAUTION

The nominal cable sizes below are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables.

Table 4-11 Cable ratings (200 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
03200066	1.5	4	B2	1.5	4	B2	14	10	14	10
03200080										
03200110	4			4			12		12	
03200127										
04200180	6	8	B2	6	8	B2	10	8	10	8
04200250	8			8			8		8	
05200300	10	10	B2	10	10	B2	8	8	8	8
06200500	16	25	B2	16	25	B2	4	3	4	3
06200580	25			25			3		3	
07200750	35	70	B2	35	70	B2	2	1/0	2	1/0
07200940							1		1	
07201170	70			70			1/0		1/0	
08201490	95	2 x 70	B2	95	2 x 70	B2	3/0	2 x 1	3/0	2 x 1
08201800	2 x 70			2 x 70			2 x 1		2 x 1	
09202160	2 x 70	2 x 185	B1	2 x 95	2 x 150	B2	2 x 2/0	2 x 500	2 x 2/0	2 x 350
09202660	2 x 95			2 x 120			2 x 4/0		2 x 4/0	
10203250	2 x 120	2 x 185	B1	2 x 120	2 x 150	C	2 x 250	2 x 500	2 x 250	2 x 350
10203600	2 x 150		C	2 x 120			2 x 300		2 x 300	

Table 4-12 Cable ratings (400 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
03400034	1.5	4	B2	1.5	4	B2	18	10	18	10
03400045							16		16	
03400062							14		14	
03400077	2.5			2.5						
03400104										
03400123							12		12	
04400185	4	6	B2	4	6	B2	10	8	10	8
04400240	6			6			8		8	
05400300	6	6	B2	6	6	B2	8	8	8	8
06400380	10	25	B2	10	25	B2	6	3	6	3
06400480	16			16			4		4	
06400630	25			25			3		3	
07400790	35	70	B2	35	70	B2	1	1/0	1	1/0
07400940	50			50			2		2	
07401120	70			70			1/0		1/0	
08401550	2 x 50	2 x 70	B2	2 x 50	2 x 70	B2	2 x 1	2 x 1/0	2 x 1	2 x 1/0
08401840	2 x 70			2 x 70			2 x 1/0		2 x 1/0	
09402210	2 x 70	2 x 185	B1	2 x 95	2 x 150	B2	2 x 3/0	2 x 500	2 x 2/0	2 x 350
09402660	2 x 95			2 x 120			2 x 4/0		2 x 4/0	
10403200	2 x 120	2 x 185	C	2 x 120	2 x 150	C	2 x 300	2 x 500	2 x 250	2 x 350
10403610	2 x 150			2 x 150			2 x 350		2 x 300	
11404370	4 x 95		C	2 x 185	2 x 185	C	4 x 3/0		2 x 400	
11404870				2 x 240	2 x 240		4 x 4/0			
11405070										

Table 4-13 Cable ratings (575 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
05500039	0.75	1.5	B2	0.75	1.5	B2	16	16	16	16
05500061	1			1			14		14	
05500100	1.5			1.5			14		14	
06500120	2.5	25	B2	2.5	25	B2	14	3	14	3
06500170	4			4			10		10	
06500220	6			6			10		10	
06500270	10			10			8		8	
06500340							6		6	
06500430	16						6		6	
07500530	16	25	B2	16	25	B2	4	3	4	3
07500730	25			25			3		3	
08500860	35	50	B2	35	50	B2	1	1	1	1
08501080	50			50						
09501250	2 x 70	2 x 185	B2	2 x 35	2 x 150	B2	2 x 1	2 x 500	2 x 3	2 x 350
09501500				2 x 50					2 x 1	
10502000	2 x 70	2 x 185	B2	2 x 70	2 x 150	B2	2 x 2/0	2 x 500	2 x 2/0	2 x 350
11502480	2 x 70		C	2 x 70		C	2 x 3/0			
11502880	2 x 95			2 x 95			2 x 4/0			
11503150	2 x 120			2 x 120			2 x 250			

Table 4-14 Cable ratings (690 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
07600230	10	25	B2	10	25	B2	8	3	8	3
07600300							6		6	
07600360							6		6	
07600460	16			16			4		4	
07600520	16			16			4		4	
07600730	25			25			3		3	
08600860	50	70	B2	50	70	B2	2	1/0	2	1/0
08601080	70			70			1/0		1/0	
09601250	2 x 50	2 x 185	B2	2 x 35	2 x 150	B2	2 x 1	2 x 500	2 x 3	2 x 350
09601550	2 x 70			2 x 50			2 x 1/0		2 x 1	
10601720	2 x 70	2 x 185	B2	2 x 70	2 x 150	B2	2 x 2/0	2 x 500	2 x 1/0	2 x 350
10601970	2 x 95						2 x 3/0		2 x 2/0	
11602250	2 x 70		C	2 x 70		C	2 x 3/0			
11602750	2 x 95			2 x 95			2 x 4/0			
11603050				2 x 95			2 x 250			

NOTE

PVC insulated cable should be used.

NOTE

Cable sizes are from IEC60364-5-52:2001 table A.52.C with correction factor for 40°C ambient of 0.87 (from table A52.14) for cable installation method as specified.

Installation class (ref: IEC60364-5-52:2001)

B1 - Separate cables in conduit.
B2 - Multicore cable in conduit.
C - Multicore cable in free air.

Cable size may be reduced if a different installation method is used, or if the ambient temperature is lower.

NOTE

The nominal output cable sizes 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 overload, the drive must be programmed with the correct motor rated current.

A fuse or other protection must be included in all live connections to the AC supply.

Fuse types

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

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.

NOTE

For information on ground cable sizes, refer to Table 4-12 *Size 11E ground connections* on page 79.

4.8.1 Main AC supply contactor

The recommended AC supply contactor type for size 3 and 10 is AC1.

4.9 Output circuit and motor protection

The output circuit has fast-acting electronic short-circuit protection which limits the fault current to typically no more than five times the rated output current, and interrupts the current in approximately 20 µs. No additional short-circuit protection devices are required.

The drive provides overload protection for the motor and its cable. For this to be effective, *Rated Current* (**00.020**) must be set to suit the motor.

WARNING

Rated Current (**00.020**) must be set correctly to avoid a risk of fire in the event of motor overload.

There is also provision for the use of a motor thermistor to prevent over-heating of the motor, e.g. due to loss of cooling.

4.9.1 Cable types and lengths

Since capacitance in the motor cable causes loading on the output of the drive, ensure the cable length does not exceed the values given in Table 4-15 to section 4-18.

Use 105 °C (221 °F) (UL 60/75 °C temp rise) PVC-insulated cable with copper conductors having a suitable voltage rating, for the following power connections:

- AC supply to external EMC filter (when used)
- AC supply (or external EMC filter) to drive
- Drive to motor
- Drive to braking resistor

Table 4-15 Maximum motor cable lengths (200 V drives)

200 V Nominal AC supply voltage							
Model	Maximum permissible motor cable length for each of the following switching frequencies						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
03200066	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03200080	100 m (330 ft)				75 m (245 ft)		
03200110	130 m (425 ft)			100 m (330 ft)			
03200127	200 m (660 ft)		150 m (490 ft)				
04200180	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04200250							
05200300	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06200500	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06200580							
07200750	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
07200940							
07201170							
08201490	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
08201800							
09202160	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
09202660							
10203250	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
10203600							

Table 4-16 Maximum motor cable lengths (400 V drives)

400 V Nominal AC supply voltage							
Model	Maximum permissible motor cable length for each of the following switching frequencies						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
03400034	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03400045	100 m (330 ft)				75 m (245 ft)		
03400062	130 m (425 ft)			100 m (330 ft)			
03400077	200 m (660 ft)		150 m (490 ft)				
03400104							
03400123							
04400185	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04400240							
05400300	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06400380	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06400480							
06400630							
07400790	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
07400940							
07401120							
08401550	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
08401840							
09402210	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
09402660							
10403200	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
10403610							
11404370	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)		
11404870							
11405070							

Table 4-17 Maximum motor cable lengths (575 V drives)

575 V Nominal AC supply voltage							
Model	**Maximum permissible motor cable length for each of the following switching frequencies**						
	2 kHz	**3 kHz**	**4 kHz**	**6 kHz**	**8 kHz**	**12 kHz**	**16 kHz**
05500039	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
05500061							
05500100							
06500120	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
06500170							
06500220							
06500270							
06500340							
06500430							
07500530	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
07500730							
08500860	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
08501080							
09501250	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
09501500							
10502000	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
11502480	250 m (820 ft)		187 m (614 ft)				
11502880							
11503150							

Table 4-18 Maximum motor cable lengths (690 V drives)

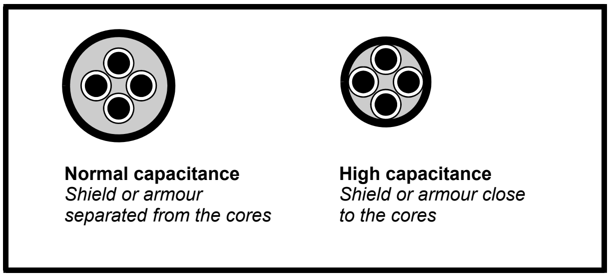
690 V Nominal AC supply voltage							
Model	**Maximum permissible motor cable length for each of the following switching frequencies**						
	2 kHz	**3 kHz**	**4 kHz**	**6 kHz**	**8 kHz**	**12 kHz**	**16 kHz**
07600230	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
07600300							
07600360							
07600460							
07600520							
07600730							
08600860	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
08601080							
09601250	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
09601550							
10601720	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
10601970							
11602250	250 m (820 ft)		187 m (614 ft)				
11602750							
11603050							

4.9.2 High-capacitance / reduced diameter cables

The maximum cable length is reduced from that shown in Section 4.9.1 *Cable types and lengths* if high capacitance or reduced diameter motor cables are used.

Most cables have an insulating jacket between the cores and the armor or shield; these cables have a low capacitance and are recommended. Cables that do not have an insulating jacket tend to have high capacitance; if a cable of this type is used, the maximum cable length is half that quoted in the tables, (Figure 4-20 shows how to identify the two types).

Figure 4-20 Cable construction influencing the capacitance



The maximum motor cable lengths specified in Section 4.9.1 *Cable types and lengths* is shielded and contains four cores. Typical capacitance for this type of cable is 130 pF/m (i.e. from one core to all others and the shield connected together).

4.9.3 Motor winding voltage

The PWM output voltage can adversely affect the inter-turn insulation in the motor. This is because of the high rate of change of voltage, in conjunction with the impedance of the motor cable and the distributed nature of the motor winding.

For normal operation with AC supplies up to 500 Vac and a standard motor with a good quality insulation system, there is no need for any special precautions. In case of doubt the motor supplier should be consulted. Special precautions are recommended under the following conditions, but only if the motor cable length exceeds 10 m:

- AC supply voltage exceeds 500 V
- DC supply voltage exceeds 670 V (i.e. regenerative / AFE supply)
- Operation of 400 V drive with continuous or very frequent sustained braking
- Multiple motors connected to a single drive

For multiple motors, the precautions given in section 4.9.4 *Multiple motors* on page 93 should be followed.

For the other cases listed, it is recommended that an inverter-rated motor be used taking into account the voltage rating of the inverter. This has a reinforced insulation system intended by the manufacturer for repetitive fast-rising pulsed voltage operation.

Users of 575 V NEMA rated motors should note that the specification for inverter-rated motors given in NEMA MG1 section 31 is sufficient for motoring operation but not where the motor spends significant periods braking. In that case an insulation peak voltage rating of 2.2 kV is recommended.

If it is not practical to use an inverter-rated motor, an output choke (inductor) should be used. The recommended type is a simple iron-cored component with a reactance of about 2 %. The exact value is not critical. This operates in conjunction with the capacitance of the motor cable to increase the rise-time of the motor terminal voltage and prevent excessive electrical stress.

4.9.4 Multiple motors

Open-loop only

If the drive is to control more than one motor, one of the fixed V/F modes should be selected (Pr **05.014** = Fixed or Squared). Make the motor connections as shown in Figure 4-21 and Figure 4-22. The maximum motor cable lengths specified in section 4.9.1 *Cable types and lengths* on page 92 apply to the sum of the total cable lengths from the drive to each motor.

It is recommended that each motor is connected through a protection relay since the drive cannot protect each motor individually. For ⅄ connection, a sinusoidal filter or an output inductor must be connected as shown in Figure 4-22, even when the cable lengths are less than the maximum permissible. For details of inductor sizes refer to the supplier of the drive.

Figure 4-21 Preferred chain connection for multiple motors

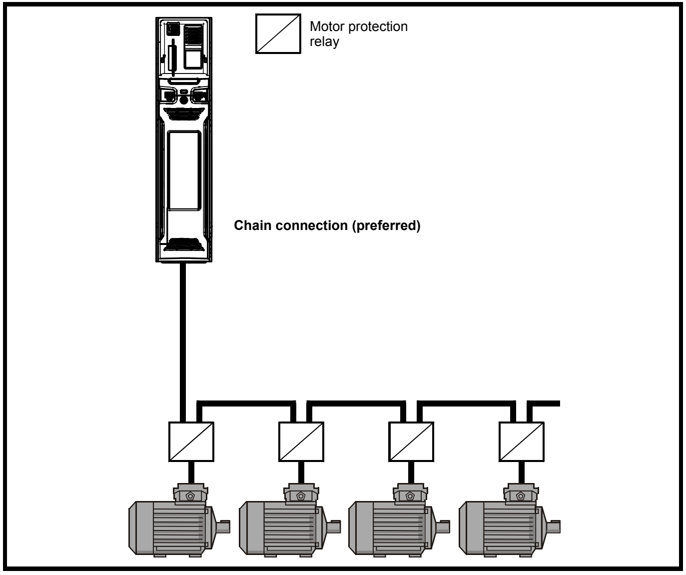
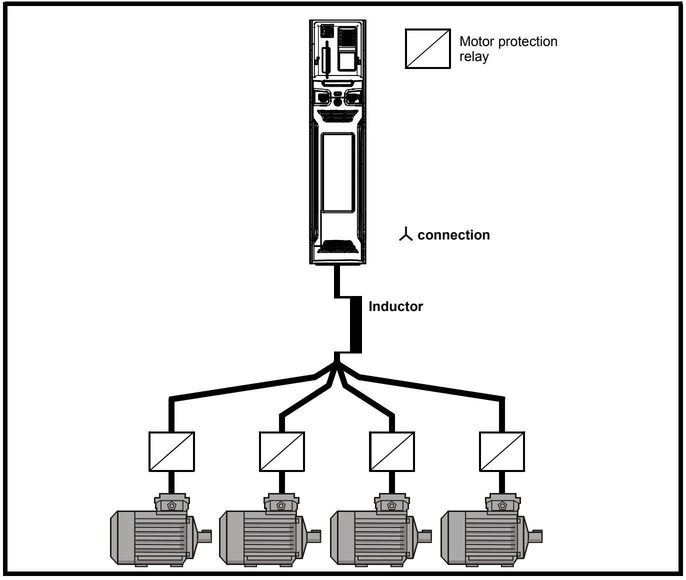


Figure 4-22 Alternative connection for multiple motors



4.9.5 ⅄ / Δ motor operation

The voltage rating for ⅄ and Δ connections of the motor should always be checked before attempting to run the motor.

The default setting of the motor rated voltage parameter is the same as the drive rated voltage, i.e.

400 V drive 400 V rated voltage
230 V drive 230 V rated voltage

A typical 3 phase motor would be connected in ⅄ for 400 V operation or Δ for 230 V operation, however, variations on this are common e.g. ⅄ 690 V Δ 400 V.

Incorrect connection of the windings will cause severe under or over fluxing of the motor, leading to a very poor output torque or motor saturation and overheating respectively.

4.9.6 Output contactor

> **WARNING**
> If the cable between the drive and the motor is to be interrupted by a contactor or circuit breaker, ensure that the drive is disabled before the contactor or circuit breaker is opened or closed. Severe arcing may occur if this circuit is interrupted with the motor running at high current and low speed.

A contactor is sometimes required to be installed between the drive and motor for safety purposes.

The recommended motor contactor is the AC3 type.

Switching of an output contactor should only occur when the output of the drive is disabled.

Opening or closing of the contactor with the drive enabled will lead to:

1. OI ac trips (which cannot be reset for 10 seconds)
2. High levels of radio frequency noise emission
3. Increased contactor wear and tear

The Drive Enable terminal (T31) when opened provides a Safe Torque Off function. This can in many cases replace output contactors.

For further information see section 4.15 *Safe Torque Off (STO)* on page 108.

4.10 Ground leakage

The ground leakage current depends upon whether the internal EMC filter is installed or not. The drive is supplied with the filter installed. Instructions for removing the internal filter are given in section 4.11.2 *Internal EMC filter* on page 97.

With internal filter installed:

Size 3 to 5:	28 mA* AC at 400 V 50 Hz
	30 μA DC with a 600 V DC bus (10 MΩ)
Size 7 to 11:	56 mA* AC at 400 V 50 Hz
	18 μA DC with a 600 V DC bus (33 MΩ)

* Proportional to the supply voltage and frequency.

With internal filter removed:**

<1 mA

**Please note that the internal filter is not removable on size 9E, 10E and 11E

> **WARNING**
> When the internal filter is installed the leakage current is high. In this case a permanent fixed ground connection must be provided, or other suitable measures taken to prevent a safety hazard occurring if the connection is lost.

4.10.1 Use of residual current device (RCD)

There are three common types of ELCB / RCD:

1. AC - detects AC fault currents
2. A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
3. B - detects AC, pulsating DC and smooth DC fault currents
   - Type AC should never be used with drives.
   - Type A can only be used with single phase drives
   - Type B must be used with three phase drives

> **WARNING**
> Only type B ELCB / RCD are suitable for use with 3 phase inverter drives.

If an external EMC filter is used, a delay of at least 50 ms should be incorporated to ensure spurious trips are not seen. The leakage current is likely to exceed the trip level if all of the phases are not energized simultaneously.

4.11 EMC (Electromagnetic compatibility)

The requirements for EMC are divided into three levels in the following three sections:

Section 4.11.4, General requirements for all applications, to ensure reliable operation of the drive and minimise the risk of disturbing nearby equipment. The immunity standards specified in Chapter 12 *Technical data* on page 257 will be met, but no specific emission standards are applied. Note also the special requirements given in *Surge immunity of control circuits - long cables and connections outside a building* on page 103 for increased surge immunity of control circuits where control wiring is extended.

Section 4.11.5, Requirements for meeting the EMC standard for power drive systems, IEC61800-3 (EN 61800-3:2004).

Section 4.11.6, Requirements for meeting the generic emission standards for the industrial environment, IEC61000-6-4, EN 61000-6-4:2007.

The recommendations of section 4.11.4 will usually be sufficient to avoid causing disturbance to adjacent equipment of industrial quality. If particularly sensitive equipment is to be used nearby, or in a non-industrial environment, then the recommendations of section 4.11.5 or section 4.11.6 should be followed to give reduced radio-frequency emission.

In order to ensure the installation meets the various emission standards described in:

- The EMC data sheet available from the supplier of the drive
- The Declaration of Conformity at the front of this manual
- Chapter 12 *Technical data* on page 257

The correct external EMC filter must be used and all of the guidelines in section 4.11.4 *General requirements for EMC* on page 99 and section 4.11.6 *Compliance with generic emission standards* on page 100 must be followed.

Table 4-19 Drive and EMC filter cross reference

Model	CT part number
200 V	
03200066 to 03200127	4200-3230
04200180 to 04200250	4200-0272
05200300	4200-0312
06200500 to 06200580	4200-2300
07200750 to 07201170	4200-1132
08201490 to 08201800	4200-1972
09202160 to 09202660 (9A)	4200-3021
09202160 to 09202660 (9E)	4200-4460
10203250 to 10203600	4200-4460
400 V	
03400034 to 03400123	4200-3480
04400185 to 04400240	4200-0252
05400300	4200-0402
06400380 to 06400630	4200-4800
07400790 to 07401120	4200-1132
08401550 to 08401840	4200-1972
09402210 to 09402660 (9A)	4200-3021
09402210 to 09402660 (9E)	4200-4460
10403200 to 10403610	4200-4460
11404370 to 11405070	4200-0400
575 V	
05500039 to 05500100	4200-0122
06500120 to 06500430	4200-3690
07500530 to 07500730	4200-0672
08500860 to 08501080	4200-1662
09501250 to 09501500 (9A)	4200-1660
09501250 to 09501500 (9E)	4200-2210
10502000	4200-2210
11502480 to 11503150	4200-0690
690 V	
07600230 to 07600730	4200-0672
08600860 to 08601080	4200-1662
09601250 to 09601550 (9A)	4200-1660
09601250 to 09601550 (9E)	4200-2210
10601720 to 10601970	4200-2210
11602250 to 11603050	4200-0690

WARNING

High ground leakage current
When an EMC filter is used, a permanent fixed ground connection must be provided which does not pass through a connector or flexible power cord. This includes the internal EMC filter.

NOTE

The installer of the drive is responsible for ensuring compliance with the EMC regulations that apply in the country in which the drive is to be used.

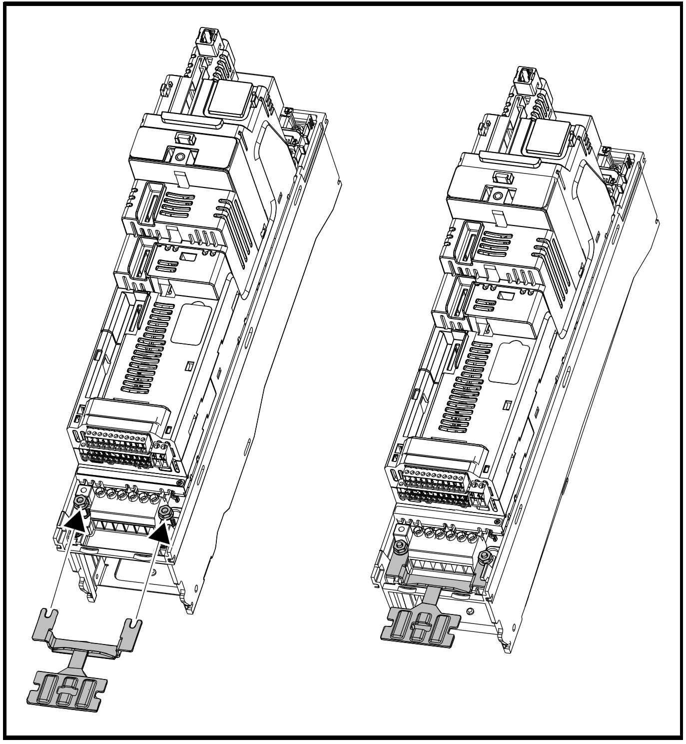
4.11.1 Grounding hardware

The drive is supplied with a grounding bracket and grounding clamp to facilitate EMC compliance. They provide a convenient method for direct grounding of cable shields without the use of "pig-tails". Cable shields can be bared and clamped to the grounding bracket using metal clips or clamps[1] (not supplied) or cable ties. Note that the shield must in all cases be continued through the clamp to the intended terminal on the drive, in accordance with the connection details for the specific signal.

[1] A suitable clamp is the Phoenix DIN rail mounted SK14 cable clamp (for cables with a maximum outer diameter of 14 mm).

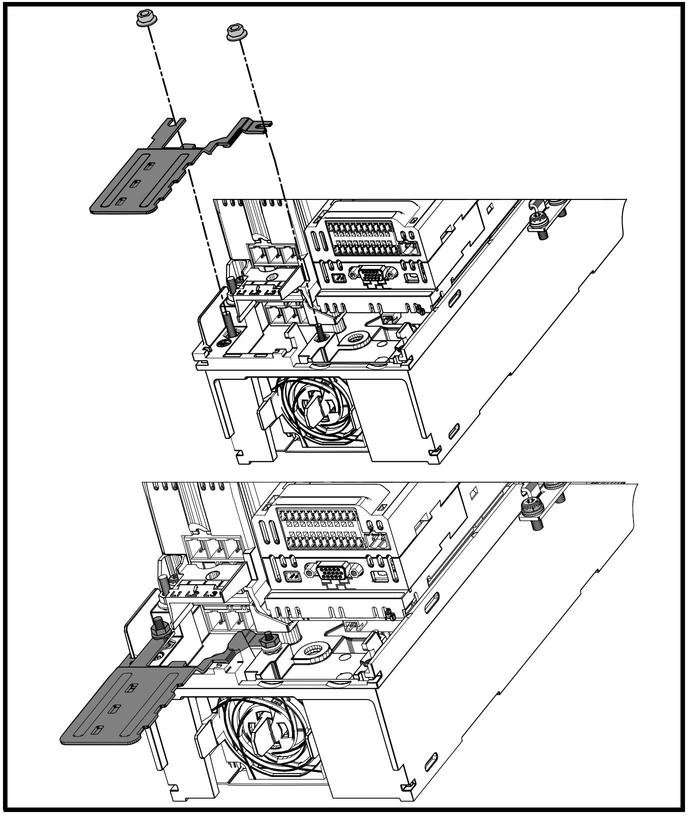
- See Figure 4-23, Figure 4-24 and Figure 4-25 for details on installing the grounding clamp.
- See Figure 4-26 for details on installing the grounding bracket.

Figure 4-23 Installation of grounding clamp (size 3 and 4)



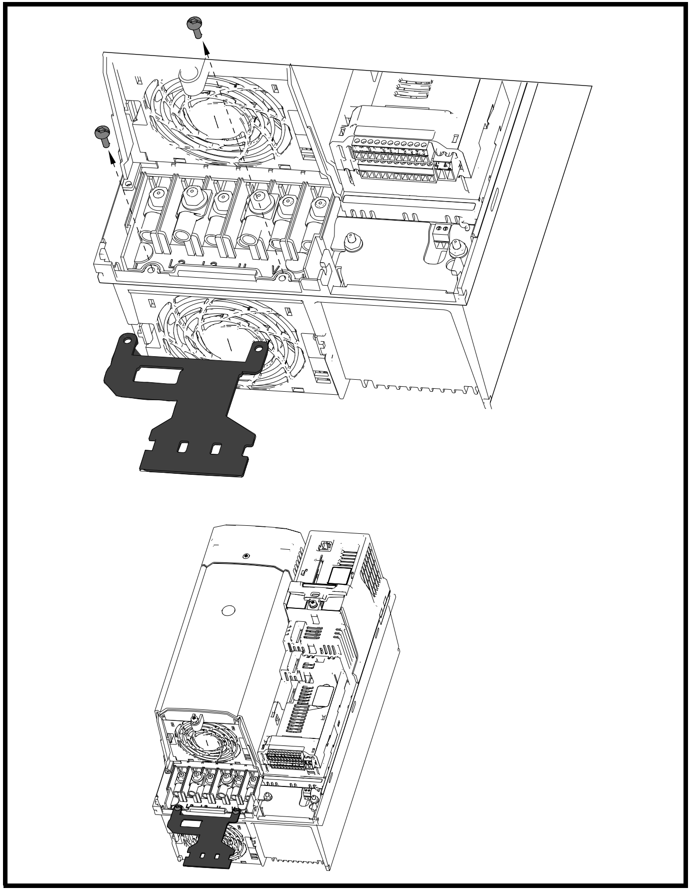
Loosen the ground connection nuts and slide the grounding clamp in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-24 Installation of grounding clamp (size 5)



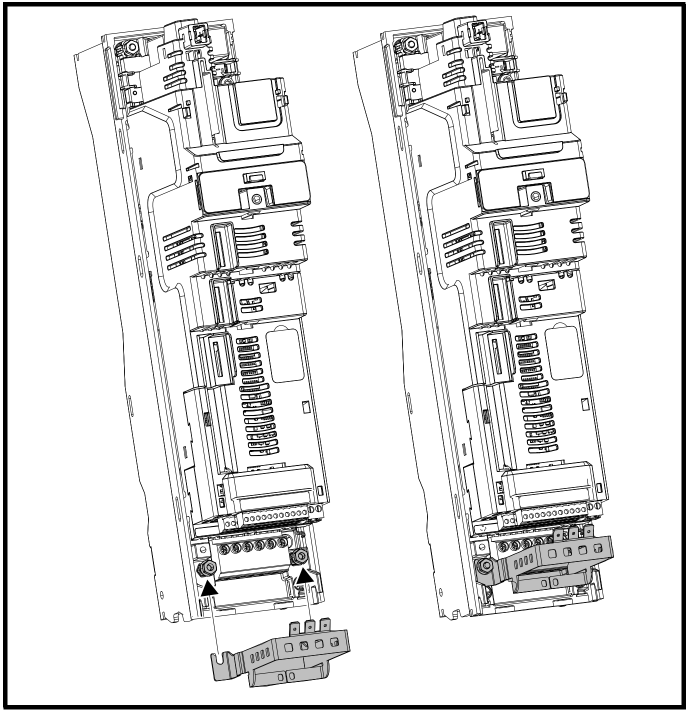
Loosen the ground connection nuts and slide the grounding clamp down onto the pillars in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-25 Installation of grounding clamp (size 6)



The grounding clamp is secured using the provided 2 x M4 x 10 mm fasteners. The fasteners should be tightened with the maximum torque of 2 N m (1.47 lb ft).

Figure 4-26 Installation of grounding bracket (all sizes -size 3 shown)



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.

4.11.2 Internal EMC filter

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

WARNING

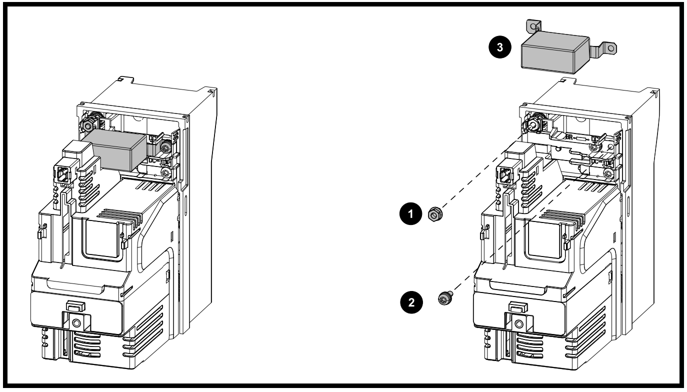
If the drive is used with ungrounded (IT) supplies, the internal EMC filter must be removed unless additional motor ground fault protection is installed.
For instructions on removal refer to section 4.11.2.
For details of ground fault protection contact the supplier of the drive.

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 - see section 4.11.5 *Compliance with EN 61800-3:2004 (standard for Power Drive Systems)* on page 100 and section 12.1.24 *Electromagnetic compatibility (EMC)* on page 278. For longer motor cables the filter continues to provide a useful reduction in emission levels, 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 where the ground leakage current of 28 mA for size 3 is unacceptable. See section 4.11.2 for details of removing and installing the internal EMC filter.

WARNING

The supply must be disconnected before removing the internal EMC filter.

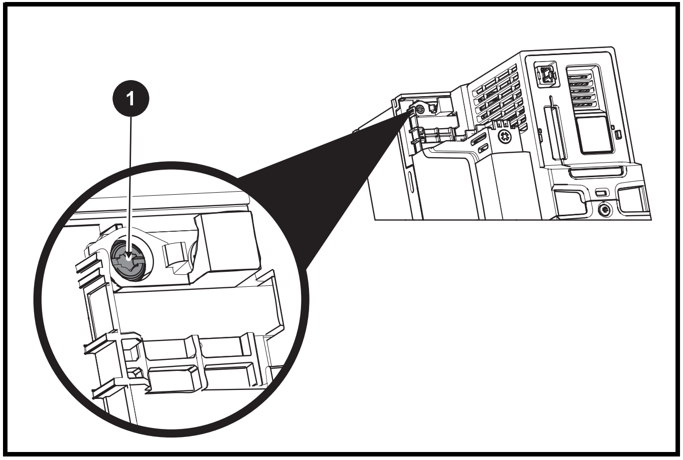
Figure 4-27 Removal of the size 3 internal EMC filter



Remove the screw and nut (1) and (2) as shown above.

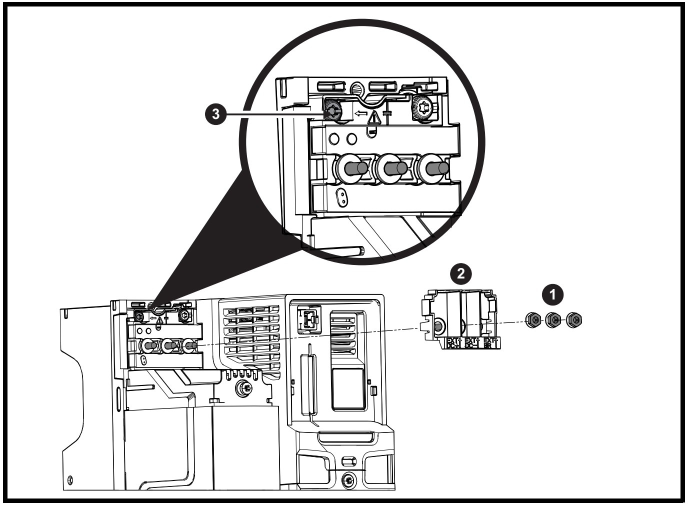
Lift away from the securing points and rotate away from the drive. Ensure the screw and nut are replaced and re-tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-28 Removal of the size 4 internal EMC filter



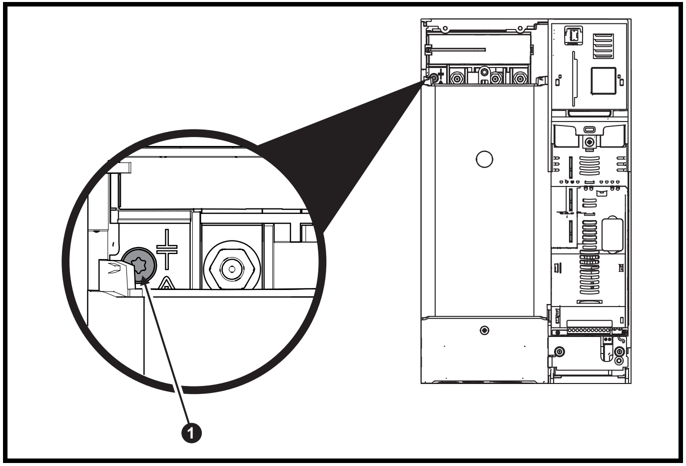
To electrically disconnect the Internal EMC filter, remove the screw as highlighted above (1).

Figure 4-29 Removal of the size 5 internal EMC filter



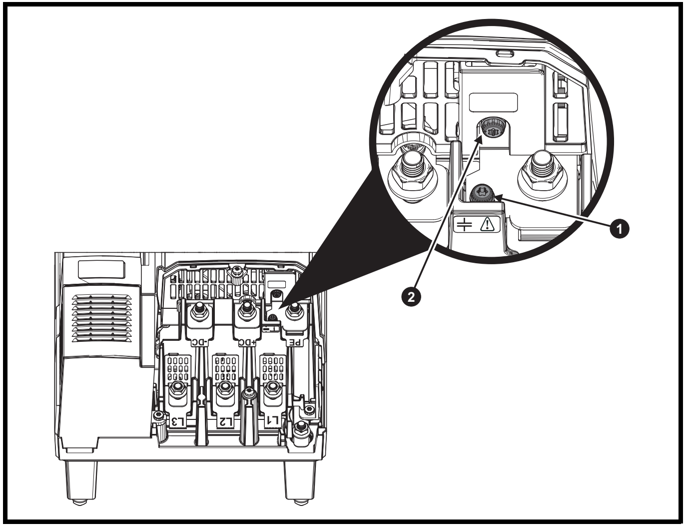
Remove the three M4 terminal nuts (1). Lift away the cover (2) to expose the M4 Torx internal EMC filter removal screw. Finally remove the M4 Torx internal EMC filter removal screw (3) to electrically disconnect the internal EMC filter.

Figure 4-30 Removal of the size 6 internal EMC filter



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

Figure 4-31 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

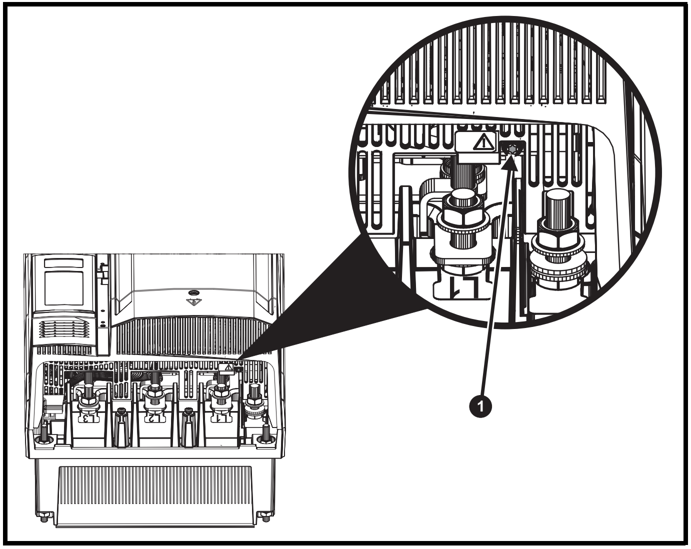
The Internal EMC filter on size 9E, 10E and 11E cannot be removed.

4.11.3 Line to ground varistors

WARNING

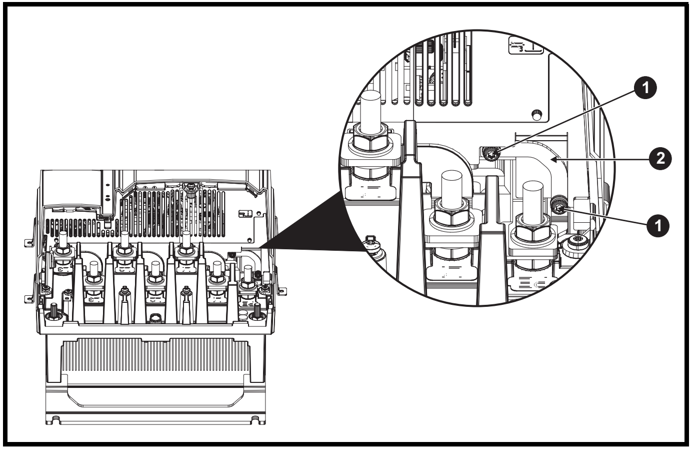
The line to ground varistors should only be removed in special circumstances such as ungrounded supplies with more than one source, for example on ships. Where the line to ground varistors are removed, ensure that line to ground transients are limited to values of category II. This is to ensure that 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 4-32 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 4-33 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).

NOTE

The line to ground varistors should only be removed in special circumstances.

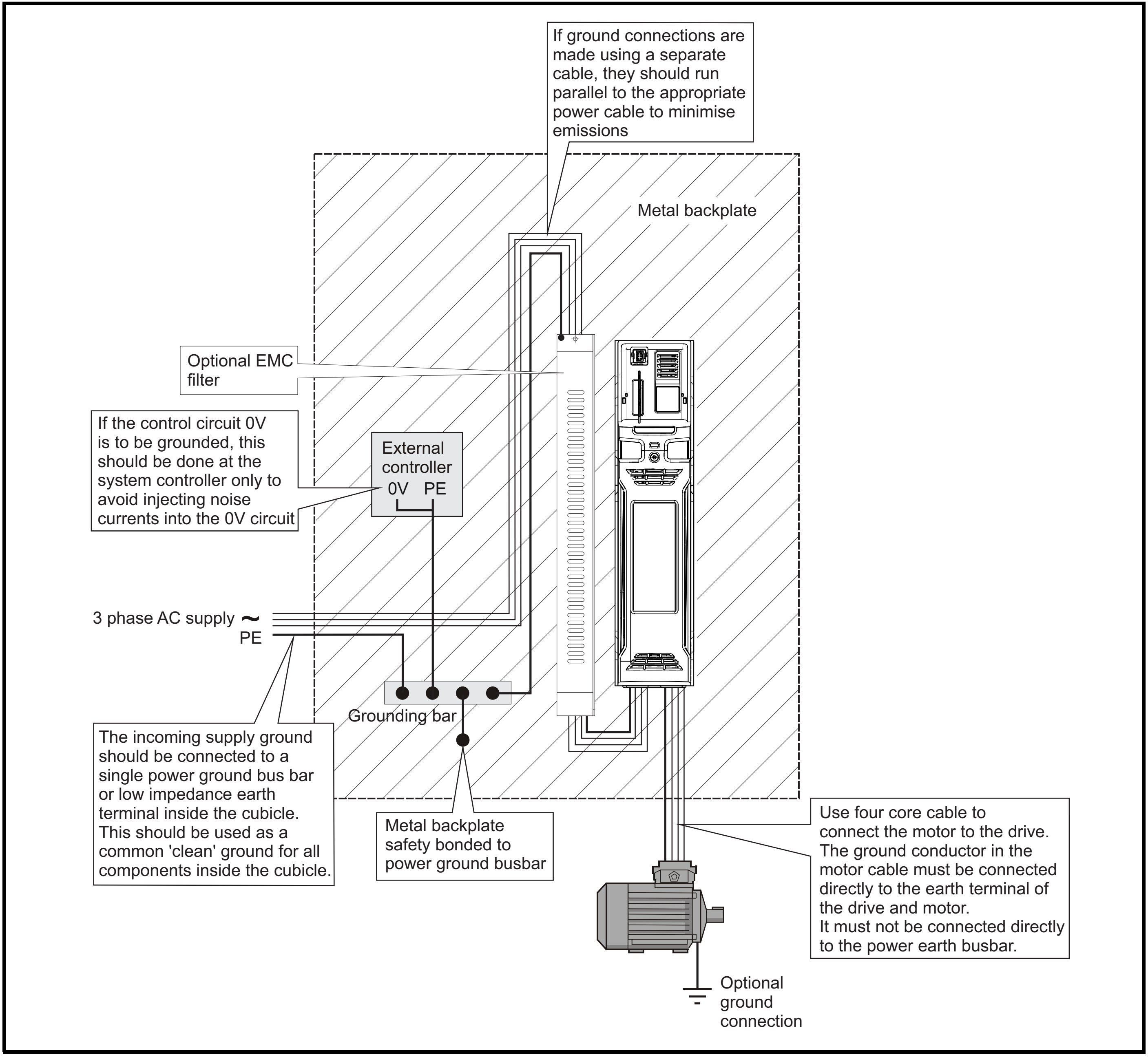
4.11.4 General requirements for EMC

Ground (earth) connections

The grounding arrangements should be in accordance with Figure 4-34, which shows a single drive on a back-plate with or without an additional enclosure.

Figure 4-34 shows how to configure and minimise EMC when using unshielded motor cable. However shielded cable is a better option, in which case it should be installed as shown in section 4.11.6 *Compliance with generic emission standards* on page 100.

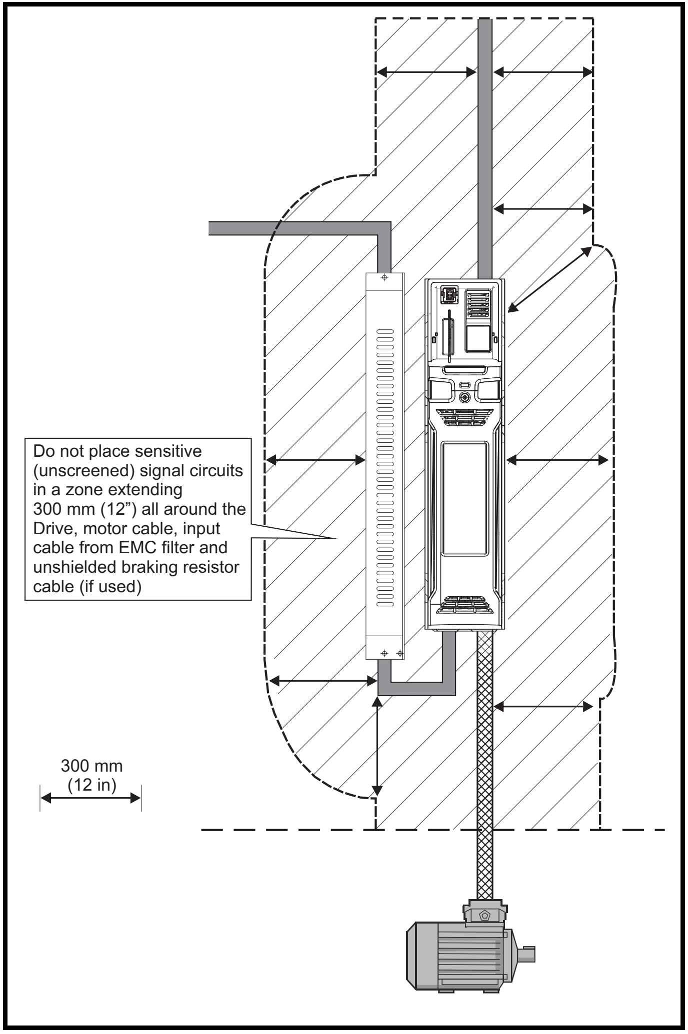
Figure 4-34 General EMC enclosure layout showing ground connections



Cable layout

Figure 4-35 indicates the clearances which should be observed around the drive and related 'noisy' power cables by all sensitive control signals / equipment.

Figure 4-35 Drive cable clearances



NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor) will pick up large pulse currents via the cable capacitance. The shield of these signal cables must be connected to ground close to the motor cable, to avoid this noise current spreading through the control system.

4.11.5 Compliance with EN 61800-3:2004 (standard for Power Drive Systems)

Meeting the requirements of this standard depends on the environment that the drive is intended to operate in, as follows:

Operation in the first environment

Observe the guidelines given in section 4.11.6 *Compliance with generic emission standards* on page 100. An external EMC filter will always be required.

CAUTION

This is a product of the restricted distribution class according to IEC 61800-3

In a residential environment this product may cause radio interference in which case the user may be required to take adequate measures.

Operation in the second environment

In all cases a shielded motor cable must be used, and an EMC filter is required for all drives with a rated input current of less than 100 A.

The drive contains an in-built filter for basic emission control. In some cases feeding the motor cables (U, V and W) once through a ferrite ring can maintain compliance for longer cable lengths.

For longer motor cables, an external filter is required. Where a filter is required, follow the guidelines in Section 4.11.6 *Compliance with generic emission standards* .

Where a filter is not required, follow the guidelines given in section 4.11.4 *General requirements for EMC* on page 99.

CAUTION

The second environment typically includes an industrial low-voltage power supply network which does not supply buildings used for residential purposes. Operating the drive in this environment without an external EMC filter may cause interference to nearby electronic equipment whose sensitivity has not been appreciated. The user must take remedial measures if this situation arises. If the consequences of unexpected disturbances are severe, it is recommended that the guidelines in Section 4.11.6 *Compliance with generic emission standards* be adhered to.

Refer to section 12.1.24 *Electromagnetic compatibility (EMC)* on page 278 for further information on compliance with EMC standards and definitions of environments.

Detailed instructions and EMC information are given in the *EMC Data Sheet* which is available from the supplier of the drive.

4.11.6 Compliance with generic emission standards

The following information applies to frame sizes 3 to 10.

Use the recommended filter and shielded motor cable. Observe the layout rules given in Figure 4-36 and Figure 4-39. Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-36 Supply and ground cable clearance (sizes 3 to 6)

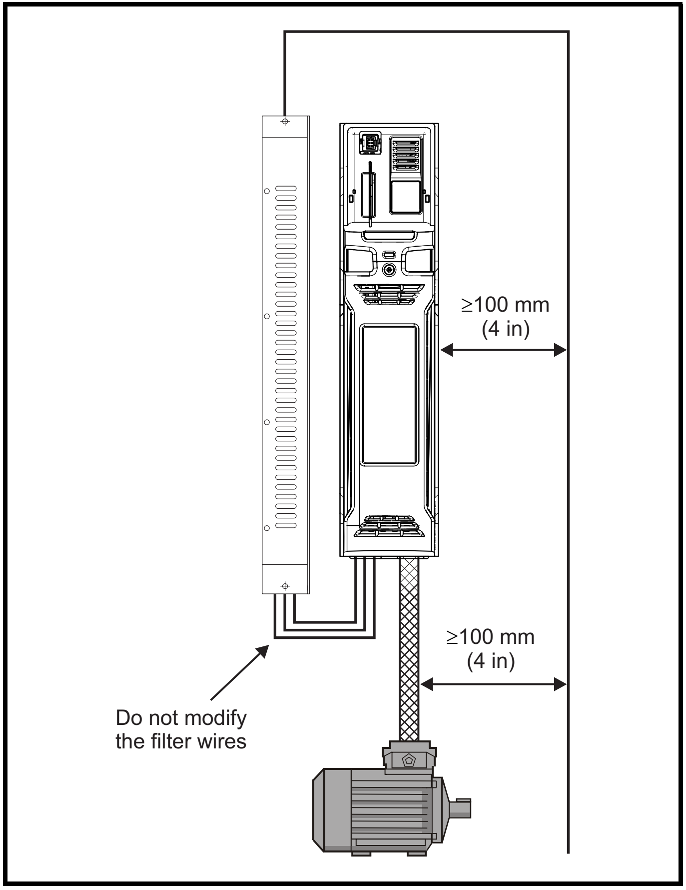
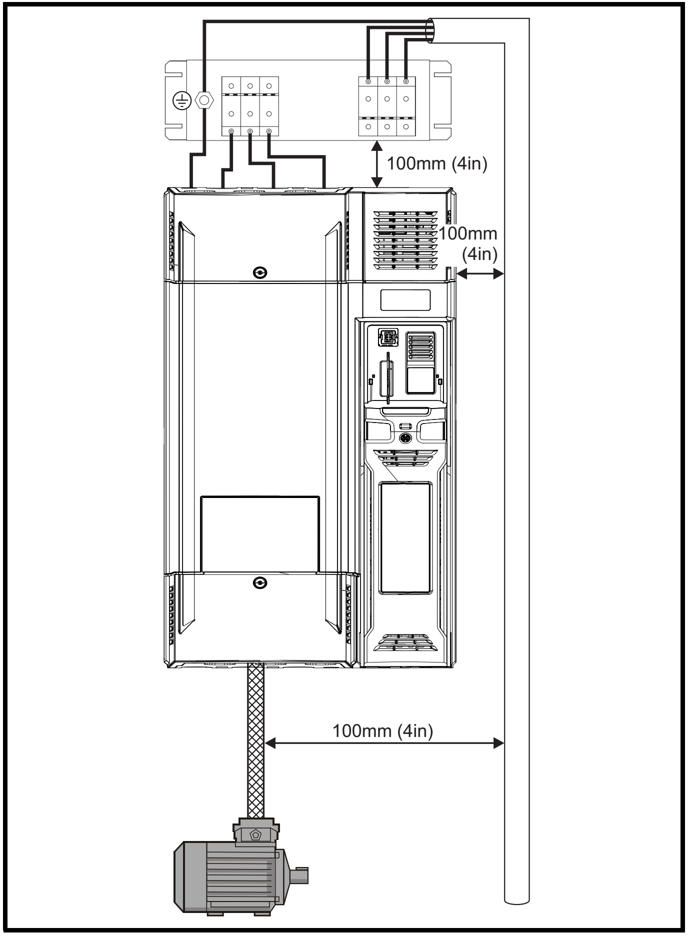
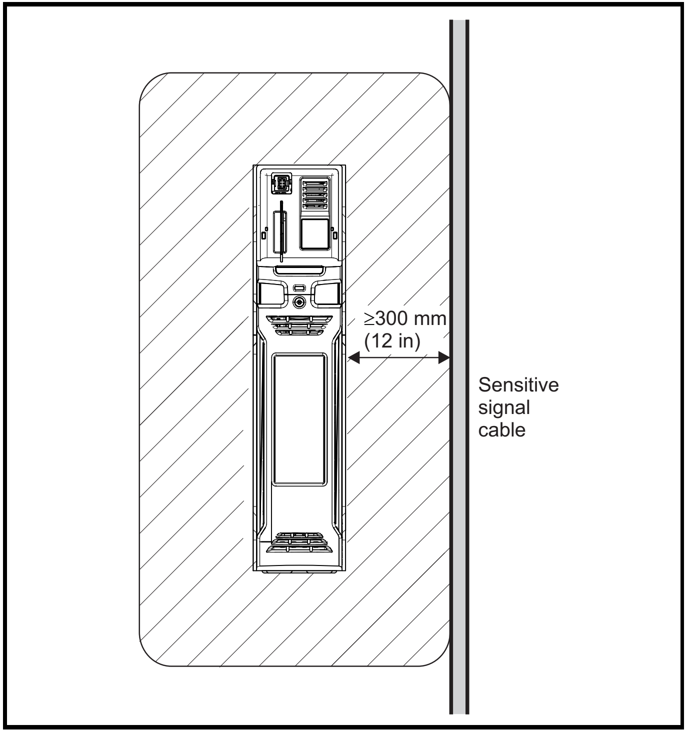


Figure 4-37 Supply and ground cable clearance (size 7 onwards)



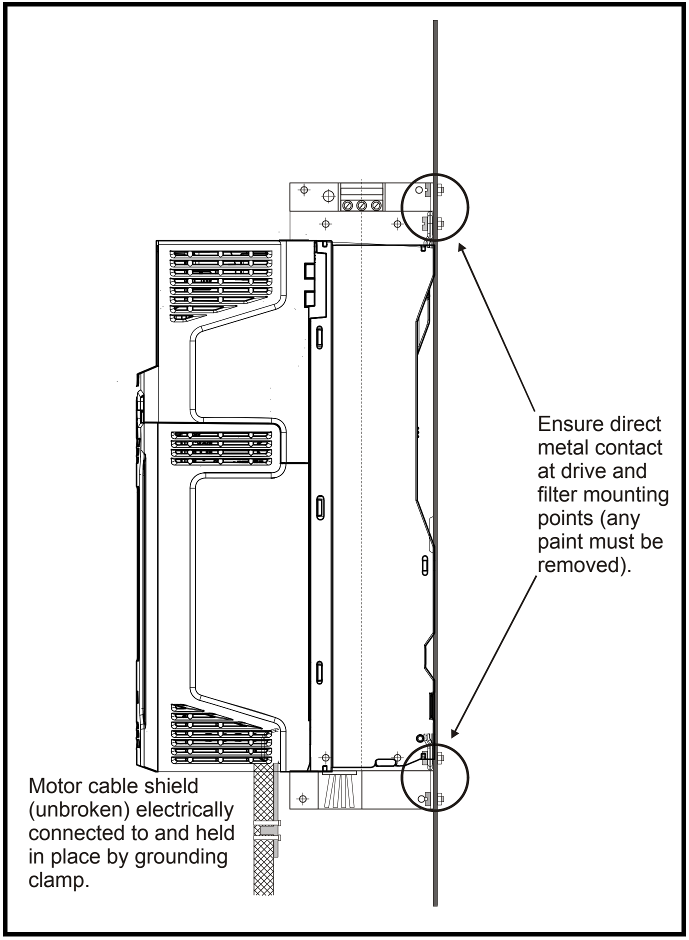
Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-38 Sensitive signal circuit clearance



Avoid placing sensitive signal circuits in a zone 300 mm (12 in) in the area immediately surrounding the power module. Ensure good EMC grounding.

Figure 4-39 Grounding the drive, motor cable shield and filter

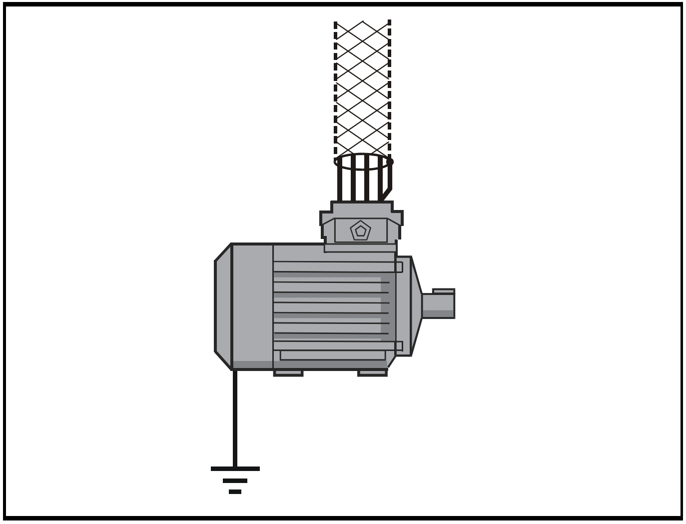


Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long.

A complete 360° termination of the shield to the terminal housing of the motor is beneficial.

From an EMC consideration it is irrelevant whether the motor cable contains an internal (safety) ground core, or if there is a separate external ground conductor, or where grounding is through the shield alone. An internal ground core will carry a high noise current and therefore it must be terminated as close as possible to the shield termination.

Figure 4-40 Grounding the motor cable shield

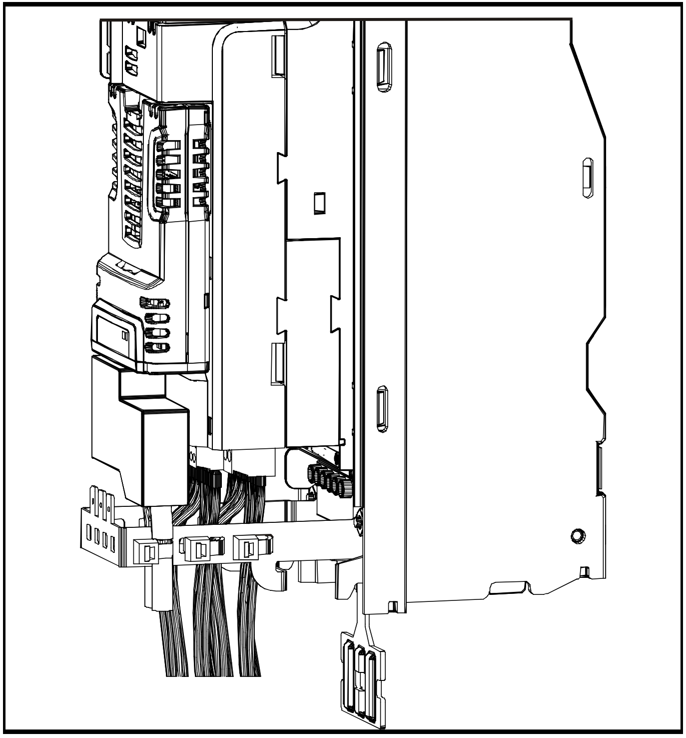


Unshielded wiring to the optional braking resistor(s) may be used provided the wiring runs internally to the enclosure.

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 as shown in Figure 4-41. Remove the outer insulating cover of the cable to ensure the shield(s) make direct contact with the bracket, but keep the shield(s) intact until as close as possible to the terminals

Alternatively, wiring may be passed through a ferrite ring, part number 3225-1004.

Figure 4-41 Grounding of signal cable shields using the grounding bracket



4.11.7 Variations in the EMC wiring

Interruptions to the motor cable

The motor cable should ideally be a single length of shielded or armored cable having no interruptions. In some situations it may be necessary to interrupt the cable, as in the following examples:

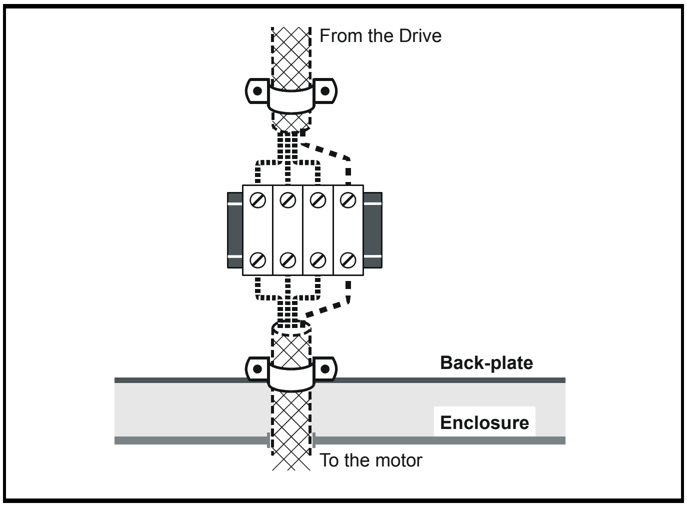
- Connecting the motor cable to a terminal block in the drive enclosure
- Installing a motor isolator / disconnect switch for safety when work is done on the motor

In these cases the following guidelines should be followed.

Terminal block in the enclosure

The motor cable shields should be bonded to the back-plate using uninsulated metal cable-clamps which should be positioned as close as possible to the terminal block. Keep the length of power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3 m (12 in) away from the terminal block.

Figure 4-42 Connecting the motor cable to a terminal block in the enclosure



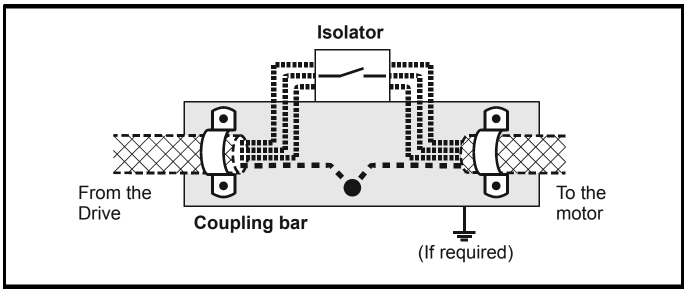
Using a motor isolator / disconnect-switch

The motor cable shields should be connected by a very short conductor having a low inductance. The use of a flat metal coupling-bar is recommended; conventional wire is not suitable.

The shields should be bonded directly to the coupling-bar using uninsulated metal cable-clamps. Keep the length of the exposed power conductors to a minimum and ensure that all sensitive equipment and circuits are at least 0.3 m (12 in) away.

The coupling-bar may be grounded to a known low-impedance ground nearby, for example a large metallic structure which is connected closely to the drive ground.

Figure 4-43 Connecting the motor cable to an isolator / disconnect switch



Surge immunity of control circuits - long cables and connections outside a building

The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.

These circuits meet the requirements of EN 61000-6-2:2005 (1 kV surge) provided the 0V connection is not grounded.

In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. This is a particular risk where the circuits extend outside the protection of a building.

As a general rule, if the circuits are to pass outside the building where the drive is located, or if cable runs within a building exceed 30 m, some additional precautions are advisable. One of the following techniques should be used:

1. Galvanic isolation, i.e. do not connect the control 0V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0V) wire.
2. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10 mm^2, or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression - for the analog and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-44 and Figure 4-45.

If a digital port experiences a severe surge its protective trip may operate (I/O Overload trip). For continued operation after such an event, the trip can be reset automatically by setting Pr **10.034** to 5.

Figure 4-44 Surge suppression for digital and unipolar inputs and outputs

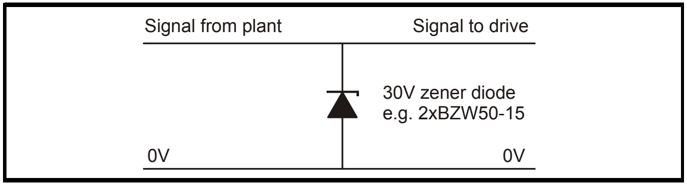
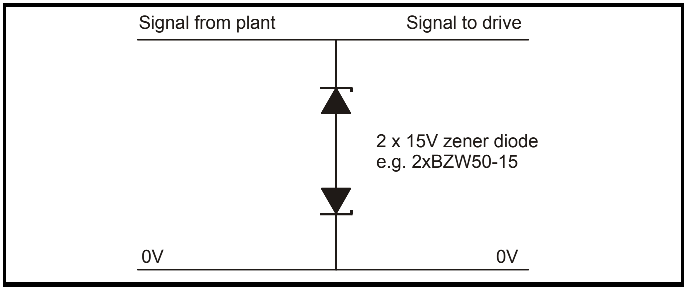


Figure 4-45 Surge suppression for analog and bipolar inputs and outputs



Surge suppression devices are available as rail-mounting modules, e.g. from Phoenix Contact:

Unipolar TT-UKK5-D/24 DC
Bipolar TT-UKK5-D/24 AC

These devices are not suitable for fast digital data networks, because the capacitance of the diodes adversely affects the signal. For data networks, follow the specific recommendations for the particular network.

4.12 Communications connections

The drive offers a double isolated 2 wire EIA-485 interface. The drive supports the Modbus RTU, BACnet MSTP and Metasys N2 open protocols. See Table 4-20 for the connection details.

Figure 4-46 Location of the comms connector

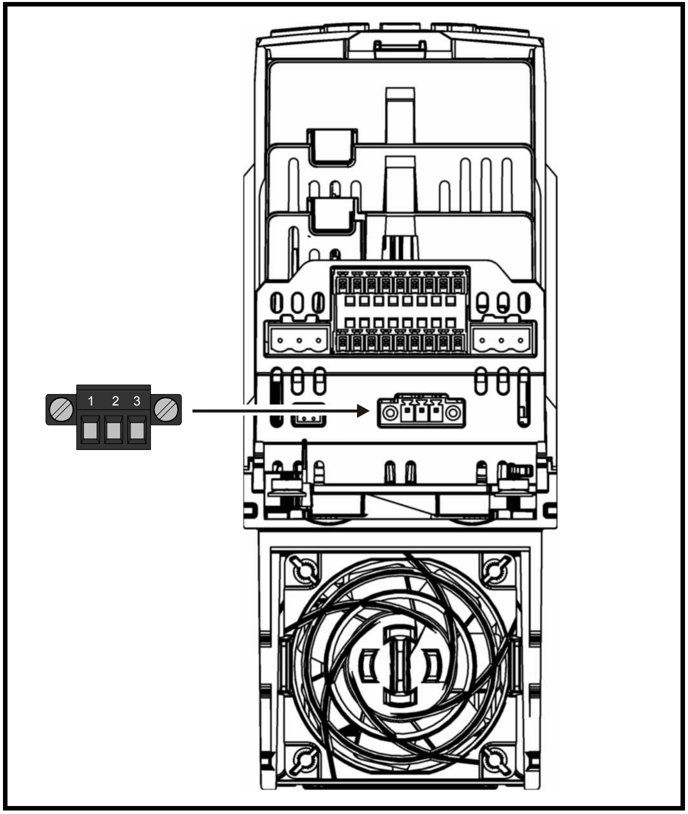


Table 4-20 Serial communication port pin-outs

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

4.12.1 Isolation of the EIA-485 serial communications port

The serial PC communications port is double insulated and meets the requirements for SELV in EN 50178:1998. Depending on network topology a termination resistor of 120 Ω maybe required.

WARNING

In order to meet the requirements for SELV in IEC60950 (IT equipment) it is necessary for the control computer to be grounded. Alternatively, when a lap-top or similar device is used which has no provision for grounding, an isolation device must be incorporated in the communications lead.

NOTE

This drive does not provide the necessary line polarization for correct operation of the EIA-485 port, the data lines (Rx Tx and /Rx /Tx) must be correctly biased in accordance with the relevant protocol specification, this is normally done in the communication master or controller. Please refer to the relevant communication protocol specification for more information.

4.13 Control connections

4.13.1 General

Table 4-21 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Single ended analog input	2	Mode, offset, invert, scaling, destination	5, 6
Analog output	2	Source, scaling, mode	7, 8
Digital input	3	Destination, invert, logic select	25, 26, 27
Digital input / output	3	Input / output mode select, destination / source, invert, logic select	22, 23, 24
Relay	2	Source, invert	41, 42, 71, 72
Drive enable (Safe Torque Off)	1		29
+24 V User output	1	Source, invert	3
0V common	5		1, 4, 9, 21, 28
+24 V External input	1	Destination, invert	2

Key:

Destination parameter:	Indicates the parameter which is being controlled by the terminal / function
Source parameter:	Indicates the parameter being output by the terminal
Mode parameter:	Analog - indicates the mode of operation of the terminal, i.e. voltage 0-10 V, current 4-20 mA etc. Digital - indicates the mode of operation of the terminal, i.e. positive / negative logic (the Drive Enable terminal is fixed in positive logic), open collector.

All analog terminal functions can be programmed in menu 7.
All digital terminal functions (including the relay) can be programmed in menu 8.

WARNING

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

WARNING

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

CAUTION

If any of the digital inputs (including the drive enable input) are connected in parallel with an inductive load (i.e. contactor coil), then suitable suppression (i.e. diode or varistor) should be used on the coil of the load. If no suppression is used then over voltage spikes can cause damage to the digital inputs and outputs on the drive.

CAUTION

Ensure the logic sense is correct for the control circuit to be used. Incorrect logic sense could cause the motor to be started unexpectedly.
Positive logic is the default state for the drive.

NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor) will pick up large pulse currents via the cable capacitance. The shield of these signal cables must be connected to ground close to the point of exit of the motor cable, to avoid this noise current spreading through the control system.

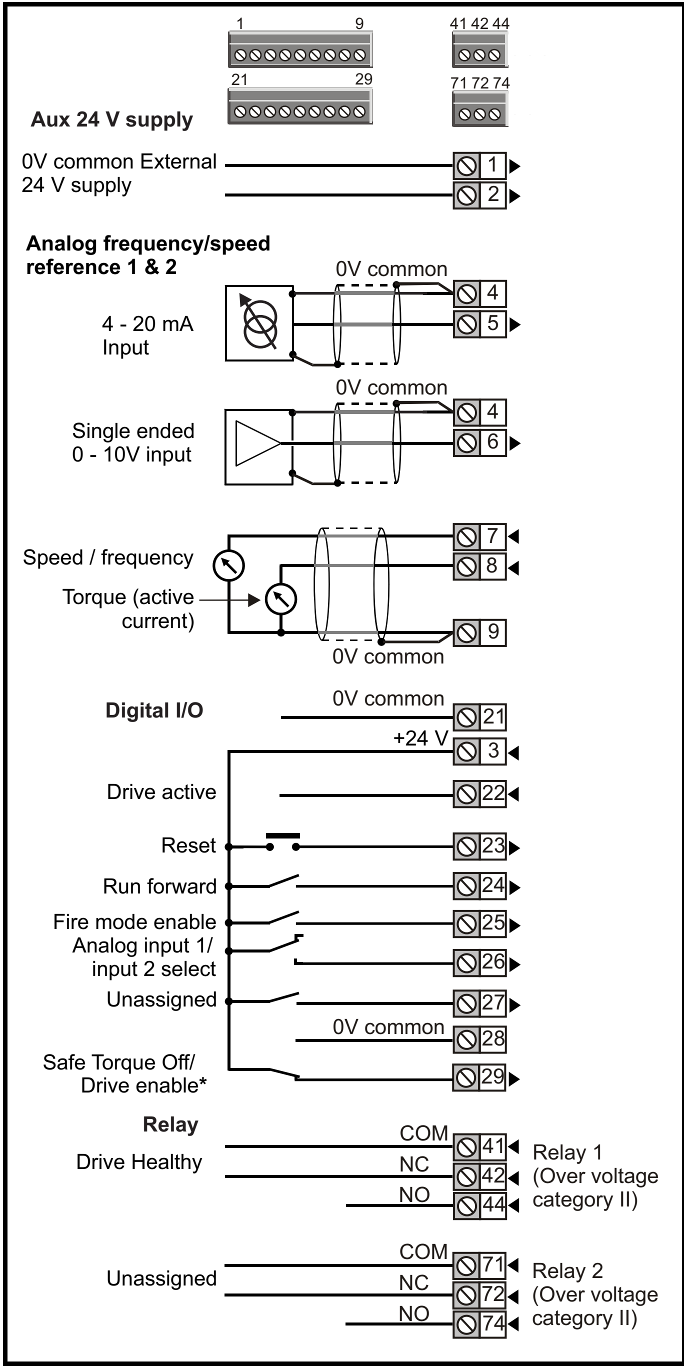
NOTE

The Safe Torque Off drive enable terminal is a positive logic input only. It is not affected by the setting of *Input Logic Polarity* (08.029).

NOTE

The common 0V from analog signals should, wherever possible, not be connected to the same 0V terminal as the common 0V from digital signals. Terminals 1, 4 and 9 should be used for connecting the 0V common of analog signals, and terminals 21 and 28 for digital signals. This is to prevent small voltage drops in the terminal connections causing inaccuracies in the analog signals.

Figure 4-47 Default terminal functions



*The Safe Torque Off / Drive enable terminal is a positive logic input only.

4.13.2 Control terminal specification

1	**0V common**
Function	**Common connection for all external devices**

2	**+24V external input**
Function	**To supply the control circuit without providing a supply to the power stage**
Programmability	Can be switched on or off to act as a digital input by setting the source Pr **08.063** and input invert Pr **08.053**
Nominal voltage	+24.0 Vdc
Minimum continuous operating voltage	+19.2 Vdc
Maximum continuous operating voltage	+28.0 Vdc
Minimum start-up voltage	21.6 Vdc
Recommended power supply	40 W 24 Vdc nominal
Recommended fuse	3 A, 50 Vdc

3	**+24 V user output (selectable)**
Terminal 3 default function	**+24 V user output**
Programmability	Can be switched on or off to act as a fourth digital output (positive logic only) by setting the source Pr **08.028** and source invert Pr **08.018**
Nominal output current	100 mA combined with DIO3
Maximum output current	100 mA 200 mA (total including all Digital I/O)
Protection	Current limit and trip
Sample / update period	2 ms when configured as an output (output will only change at the update rate of the source parameter if slower)

4	**0V common**
Function	**Common connection for all external devices**

5	**Analog input 1**
6	**Analog input 2**
Terminal 5 Default function	**Frequency / speed reference (Pr 1.036)**
Terminal 6 Default function	**Frequency / speed reference (Pr 1.037)**
Type of input AI 1 [AI 2]	Unipolar current and Bipolar single-ended analog voltage
Mode controlled by...	Pr **07.007** [07.011]
Operating in current mode (Default for terminal 5)	
Current ranges	0 to 20 mA ±5 %, 20 to 0 mA ±5 %, 4 to 20 mA ±5 %, 20 to 4 mA ±5 %
Maximum offset	250 μA
Absolute maximum voltage (reverse bias)	±36 V relative to 0V
Absolute maximum current	±30 mA
Equivalent input resistance	≤ 300 Ω
Operating in voltage mode (Default for terminal 6)	
Full scale voltage range	±10 V ±2 %
Maximum offset	±10 mV
Absolute maximum voltage range	±36 V relative to 0V
Input resistance	≥100 k Ω
Common to all modes	
Resolution	12 bits (11 bits plus sign)
Sample / update	250 μs with destinations Pr **01.036**, Pr **01.037** or Pr **03.022,** Pr **04.008** in RFC-A or RFC-S. 4 ms for open loop mode and all other destinations in RFC-A or RFC-S mode.
Operating in thermistor input mode	
Voltage range	±10 V ±2 %
Supported thermistor types	Din 4408, KTY 84, PT100, PT 1000, PT 2000, NI 1000
Internal pull-up voltage	5 V
Trip threshold resistance	User defined in Pr **07.055 [07.060]**
Reset resistance	User defined in Pr **07.056 [07.061]**
Short-circuit detection resistance	50 Ω ± 40 %
Common to all modes	
Resolution	12 bits (11 bits plus sign)
Sample / update period	4 ms

7	**Analog output 1**
8	**Analog output 2**

Terminal 7 default function	**OL> Motor FREQUENCY output signal** **RFC> SPEED output signal**
Terminal 8 default function	**Motor active current**
Type of output	Bipolar single-ended analog voltage or unipolar current
AOI [AO2] Mode controlled by...	Pr **07.021** [07.024]
Operating in Voltage mode (default)	
Voltage range	±10 V ±5 %
Maximum offset	±120 mV
Maximum output current	±20 mA
Load resistance	≥1 k Ω
Protection	20 mA max. Short circuit protection
Operating in current mode	
Current ranges	0 to 20 mA ±5%, 20 to 0 mA ±5% 4 to 20 mA ±5%, 20 to 4 mA ±5%
Common to all modes	
Resolution	10-bit
Sample / update period	250 µs (output will only change at update the rate of the source parameter if slower)

9	**0V common**
Function	**Common connection for all external devices**

21	**0V common**
Function	**Common connection for all external devices**

22	**Digital I/O 1**
23	**Digital I/O 2**
24	**Digital I/O 3**

Terminal 22 default function	**DRIVE ACTIVE output**
Terminal 23 default function	**DRIVE RESET input**
Terminal 24 default function	**RUN FORWARD input**
Type	Positive or negative logic digital inputs, positive logic voltage source outputs
Input / output mode controlled by...	Pr **08.031**, Pr **08.032** and Pr **08.033**
Operating as an input	
Logic mode controlled by...	Pr **08.029**
Absolute maximum applied voltage range	-3 V to +30 V
Impedance	>2 mA @15 V from IEC 61131-2, type 1, 6.6 k Ω
Input thresholds	10 V ±0.8 V from IEC 61131-2, type 1
Operating as an output	
Nominal maximum output current	100 mA (DIO1 & 2 combined) 100 mA (DIO3 & 24 V User Output Combined)
Maximum output current	100 mA 200 mA (total including all Digital I/O)
Common to all modes	
Voltage range	0V to +24 V
Sample / Update period	2 ms (output will only change at the update rate of the source parameter)

25	**Digital Input 4**
26	**Digital Input 5**

Terminal 25 default function	**FIRE MODE ENABLE input**
Terminal 26 default function	**Analog INPUT 1 / INPUT 2 select**
Type	Negative or positive logic digital inputs
Logic mode controlled by...	Pr **08.029**
Voltage range	0V to +24 V
Absolute maximum applied voltage range	-3 V to +30 V
Impedance	>2 mA @15 V from IEC 61131-2, type 1, 6.6 k Ω
Input thresholds	10 V ±0.8 V from IEC 61131-2, type 1
Sample / Update period	2 ms

27	**Digital Input 6**

Terminal 27 default function	**Unassigned input**
Type	Negative or positive logic digital inputs
Logic mode controlled by...	Pr **08.029**
Voltage range	0V to +24 V
Absolute maximum applied voltage range	-3 V to +30 V
Impedance	>2 mA @15 V from IEC 61131-2, type 1, 6.6 k Ω
Input thresholds	10 V ±0.8 V from IEC 61131-2, type 1
Sample / Update period	2 ms

28	**0V common**
Function	**Common connection for all external devices**

29	**Safe Torque Off function (drive enable)**
Type	Positive logic only digital input
Voltage range	0V to +24 V
Absolute maximum applied voltage	30 V
Logic Threshold	10 V ± 5 V
Low state maximum voltage for disable to SIL3 and PL e	5 V
Impedance	>4 mA @15 V from IEC 61131-2, type 1, 3.3 k Ω
Low state maximum current for disable to SIL3 and PL e	0.5 mA
Response time	Nominal: 8 ms Maximum: 20 ms
The Safe Torque Off function may be used in a safety-related application in preventing the drive from generating torque in the motor to a high level of integrity. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards. If the Safe Torque Off function is not required, this terminal is used for enabling the drive.	

Refer to section 4.15 *Safe Torque Off (STO)* on page 108 for further information.

41	**Relay 1 Common**
42	**Relay 1 Normally closed**
44	**Relay 1 Normally open**
Default function	**Drive Healthy indicator**
Contact voltage rating	240 Vac, Installation over-voltage category II
Contact maximum current rating	2 A AC 240 V 4 A DC 30 V resistive load 0.5 A DC 30 V inductive load (L/R = 40 ms)
Contact minimum recommended rating	12 V 100 mA
Contact type	Common - 41 Normally closed - 42 Normally open - 44
Default contact condition	Closed when power applied and drive is healthy
Update period	4 ms

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

*see Figure 4-16 to Figure 4-18 on page 86 for location.

71	**Relay 2 Common**
72	**Relay 2 Normally closed**
74	**Relay 2 Normally open**
Default function	**UNASSIGNED**
Contact voltage rating	240 Vac, Installation over-voltage category II
Contact maximum current rating	2 A AC 240 V 4 A DC 30 V resistive load 0.5 A DC 30 V inductive load (L/R = 40 ms)
Contact minimum recommended rating	12 V 100 mA
Contact type	Common - 71 Normally closed - 72 Normally open - 74
Default contact condition	Closed when power applied and drive is healthy
Update period	4 ms

WARNING

To prevent the risk of a fire hazard in the event of a fault, a fuse or other over-current protection must be installed in the relay circuit.

4.14 Building automation network connections

Table 4-22 Specifications

1	**RX TX**
2	**Isolated ground**
3	**RX\ TX**
Cable specification	Shielded twisted pair Characteristic impedance: 100 to 130 W Capacitance between conductors: <100 pF Maximum length: 1200 m with AWG 18 cable
Termination resistor	120 W

4.15 Safe Torque Off (STO)

The Safe Torque Off function provides a means for preventing the drive from generating torque in the motor, with a very high level of integrity. It is suitable for incorporation into a safety system for a machine. It is also suitable for use as a conventional drive enable input.

The safety function is active when the STO input is in the logic-low state as specified in the control terminal specification. The function is defined according to EN 61800-5-2 and IEC 61800-5-2 as follows. (In these standards a drive offering safety-related functions is referred to as a PDS(SR)):

'Power, that can cause rotation (or motion in the case of a linear motor), is not applied to the motor. The PDS(SR) will not provide energy to the motor which can generate torque (or force in the case of a linear motor)'.

This safety function corresponds to an uncontrolled stop in accordance with stop category 0 of IEC 60204-1.

The Safe Torque Off function makes use of the special property of an inverter drive with an induction motor, which is that torque cannot be generated without the continuous correct active behavior of the inverter circuit. All credible faults in the inverter power circuit cause a loss of torque generation.

The Safe Torque Off function is fail-safe, so when the Safe Torque Off input is disconnected the drive will not operate the motor, even if a combination of components within the drive has failed. Most component failures are revealed by the drive failing to operate. Safe Torque Off is also independent of the drive firmware. This meets the requirements of the following standards, for the prevention of operation of the motor.

Machinery Applications

The Safe Torque Off Function has been independently assessed by Notified Body, TüV Rheinland for use as a safety component of a machine:

Prevention of unintended motor operation: The safety function "Safe Torque Off" can be used in applications up to Cat 4. PL e according to EN ISO 13849-1, SIL 3 according to EN 61800-5-2/ EN 62061/ IEC 61508 and in lift applications according to EN 81-1 and EN81-2

Type examination certificate No.	Date of issue	Models
01.205/5270.01/14	2014-11-11	H300

This certificate is available for download from the TüV Rheinland website at: http://www.tuv.com

Safety Parameters as verified by TüV Rheinland:

According to IEC 61508-1 to 07 / EN 61800-5-2 / EN 62061

Type	Value	Percentage of SIL 3 allowance
Proof test interval	20 years	
High demand or a continuous mode of operation		
PFH (1/h)	4.21×10^{-11} 1/h	<1 %
Low demand mode of operation (not EN 61800-5-2)		
PFDavg	3.68×10^{-6}	< 1 %

According to EN ISO 13849-1

Type	Value	Classification
Category	4	
Performance Level (PL)	e	
$MTTF_D$	>2500 years	High
DC_{avg}	≥99 %	High
Mission time	20 years	

NOTE

Logic levels comply with IEC 61131-2:2007 for type 1 digital inputs rated at 24 V. Maximum level for logic low to achieve SIL3 and PL e 5 V and 0.5 mA.

UL Approval

The Safe Torque Off function has been independently assessed by Underwriters Laboratories (UL). The on-line certification (yellow card) reference is: FSPC.E171230.

Safety Parameters as verified by UL:

According to IEC 61508-1 to 7

Type	Value
Safety Rating	SIL 3
SFF	> 99 %
PFH (1/h)	4.43×10^{-10} 1/h (<1 % of SIL 3 allowance)
HFT	1
Beta Factor	2 %
CFF	Not applicable

According to EN ISO 13849-1

Type	Value
Category	4
Performance Level (PL)	e
$MTTF_D$	2574 years
Diagnostic coverage	High
CCF	65

Note on response time of Safe Torque Off, and use with safety controllers with self-testing outputs:

Safe Torque Off has been designed to have a response time of greater than 1 ms so that it is compatible with safety controllers whose outputs are subject to a dynamic test with a pulse width not exceeding 1 ms.

Note on the use of servo motors, other permanent-magnet motors, reluctance motors and salient-pole induction motors:

When the drive is disabled through Safe Torque Off, a possible (although highly unlikely) failure mode is for two power devices in the inverter circuit to conduct incorrectly.

This fault cannot produce a steady rotating torque in any AC motor. It produces no torque in a conventional induction motor with a cage rotor. If the rotor has permanent magnets and/or saliency, then a transient alignment torque may occur. The motor may briefly try to rotate by up to 180° electrical, for a permanent magnet motor, or 90° electrical, for a salient pole induction motor or reluctance motor. This possible failure mode must be allowed for in the machine design.

WARNING

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.

WARNING

Safe Torque Off inhibits the operation of the drive, this includes inhibiting braking. If the drive is required to provide both braking and Safe Torque Off in the same operation (e.g. for emergency stop) then a safety timer relay or similar device must be used to ensure that the drive is disabled a suitable time after braking. The braking function in the drive is provided by an electronic circuit which is not fail-safe. If braking is a safety requirement, it must be supplemented by an independent fail-safe braking mechanism.

WARNING

Safe Torque Off does not provide electrical isolation.
The supply to the drive must be disconnected by an approved isolation device before gaining access to power connections.

With Safe Torque Off there are no single faults in the drive which can permit the motor to be driven. Therefore it is not necessary to have a second channel to interrupt the power connection, nor a fault detection circuit.

It is important to note that a single short-circuit from the Safe Torque Off input to a DC supply of >5 V could cause the drive to be enabled. This can be excluded under EN ISO 13849-2 by the use of protected wiring. The wiring can be protected by either of the following methods:

- By placing the wiring in a segregated cable duct or other enclosure.

or

- By providing the wiring with a grounded shield in a positive-logic grounded control circuit. The shield is provided to avoid a hazard from an electrical fault. It may be grounded by any convenient method; no special EMC precautions are required.

WARNING

It is essential to observe the maximum permitted voltage of 5 V for a safe low (disabled) state of Safe Torque Off. The connections to the drive must be arranged so that voltage drops in the 0V wiring cannot exceed this value under any loading condition. It is strongly recommended that the Safe Torque Off circuit be provided with a dedicated 0V conductor which should be connected to terminal 28 at the drive.

Safe Torque Off over-ride

The drive does not provide any facility to over-ride the Safe Torque Off function, for example for maintenance purposes.

5 Getting started

This chapter introduces the user interfaces, menu structure and security levels of the drive.

5.1 Understanding the display

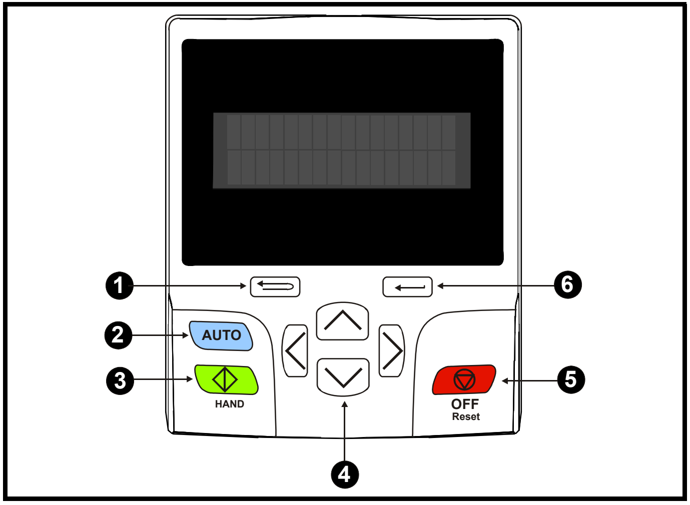
The KI-HOA keypad RTC can only be mounted on the drive. The HOA keypad RTC can be mounted on the drive or remotely mounted.

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 5-2.

When the drive is powered up the lower row will show the power up parameter defined by *Parameter Displayed At Power-Up* (11.022).

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



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

NOTE

The red stop 🟥 button is also used to reset the drive.

The parameter value is correctly displayed in the lower row of the keypad display, see table below.

Table 5-1 Keypad display formats

Display formats	Value
IP Address	127.000.000.000
MAC Address	01ABCDEF2345
Time	12:34:56
Date	31-12-11 or 12-31-11
Version number	01.02.02.00
Character	ABCD
32 bit number with decimal point	21474836.47
16 bit binary number	0100001011100101

Table 5-2 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	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 is pressed, the parameter value will be restored to the value it had on entry to edit mode.
- Three control buttons are used to select Hand / Off / Auto modes (see below).

NOTE

Low battery voltage is indicated by 🔋 low battery symbol on the keypad display. Refer to section 3.13.1 *Real time clock battery replacement* on page 66 for information on battery replacement.

Figure 5-2 *Display modes* on page 111, shows an example of moving between menus and editing parameters.

5.2.2 Hand / Off / Auto

Hand / Off / Auto functions are enabled if Pr **1.052** is set to a non-zero value, otherwise the keypad buttons are allocated as follows:

- Blue AUTO - Forward/Reverse
- Green 🟩 - Run
- Red 🟥 - Reset

When Hand / Off / Auto functions are enabled (Pr **1.052** set to either 1, 2 or 3), then the keypad buttons will be allocated as follows:

- Blue AUTO - Auto
- Green 🟩 - Hand
- Red 🟥 - Off/Reset

The value in Pr **1.052** selects Hand/Off/Auto mode on power-up as shown in Table 5-3.

Table 5-3 Hand/Off/Auto mode

Pr 1.052	Power up
0	Hand/Off/Auto disabled
1	Auto Mode
2	Off Mode
3	See table Table 5-4

Table 5-4 Power-up modes if Pr 1.052 = 3

Power-down	Power-up
Hand	Off
Off	Off
Auto	Auto

Auto

In Auto mode, the reference for the motor speed/frequency will be selected by the value set in Pr **0.005**.

Hand

The speed/frequency reference Pr **0.005** is automatically set to keypad reference. The motor speed is determined by the value in the keypad control mode reference Pr **1.017**, which can be adjusted by pressing the Up/Down arrows on the keypad.

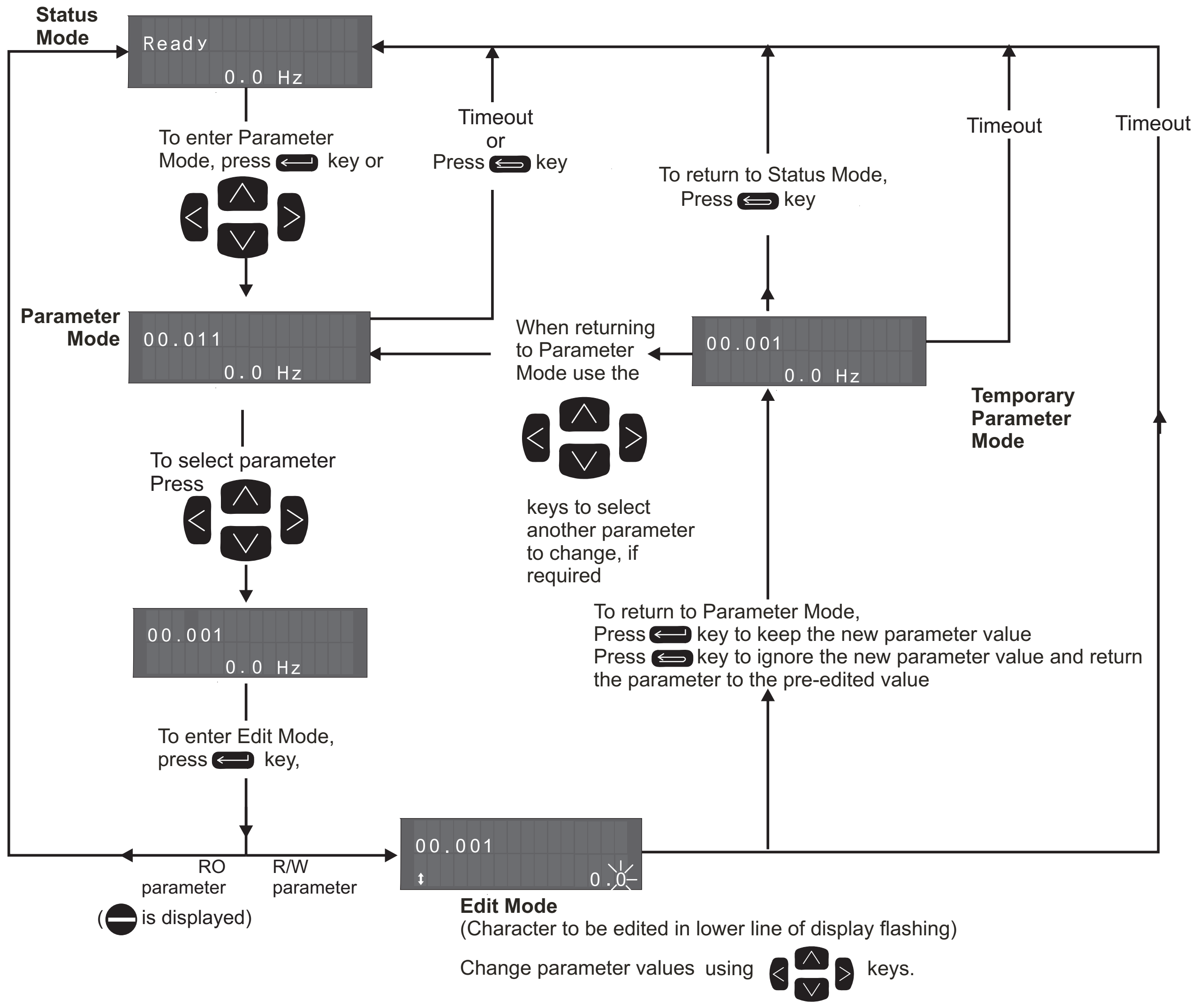
When Hand is selected from Auto, Pr **1.017** will be set to the value of the *Pre-ramp reference* (Pr **1.003**) on mode transition, so the current motor speed is maintained.

If Hand mode is selected from Off mode, the motor will ramp up to the speed determined by the value in Pr **1.017**.

Off

In Off mode, the motor will be stopped. The speed/frequency reference (Pr **0.005**) is automatically set to keypad reference allowing the value in the *keypad control mode reference* (Pr **1.017**) to be modified by pressing the Up/Down arrow keys. If Hand mode is then selected, the motor will ramp up to the speed determined by the value in Pr **1.017**.

Figure 5-2 Display modes



NOTE

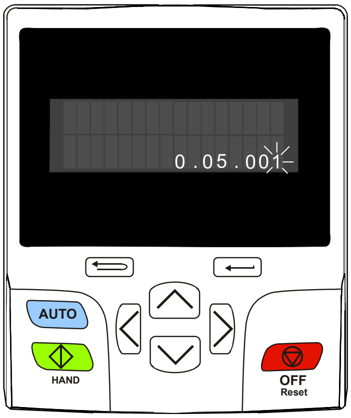
The navigation keys can only be used to move between menus if Pr **00.031** has been set to show 'All Menus'. Refer to section 5.9 *Parameter access level and security* on page 116.

5.2.3 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



5.2.4 Keypad shortcuts

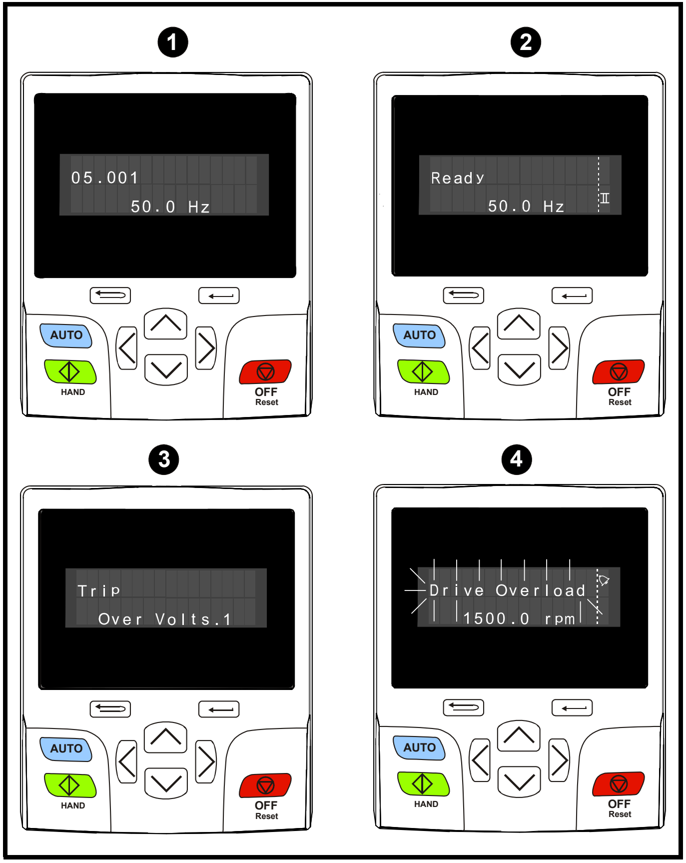
In ‘parameter mode’:

- 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 Heathy status**

If the drive is healthy 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 Table 13-3 *Trip indications* on page 286**.**

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

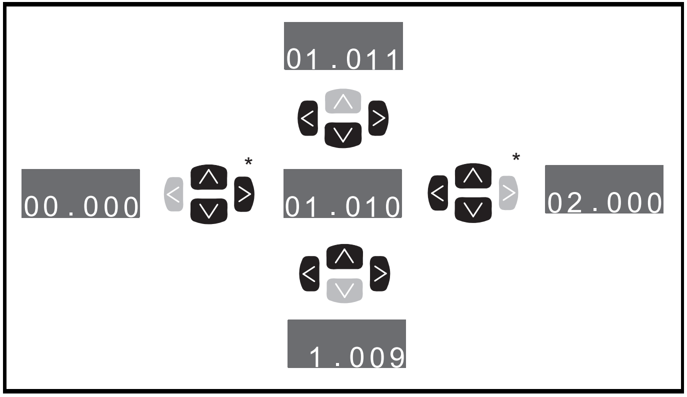
For new parameter-values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *Saving parameters* on page 115.

5.3 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 5.9 *Parameter access level and security* on page 116

Figure 5-5 Parameter navigation



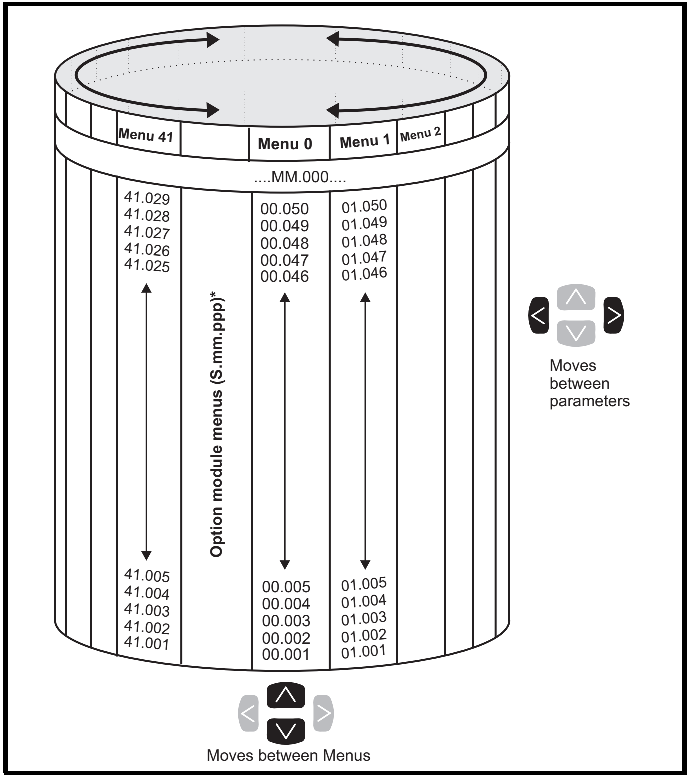
* Can only be used to move between menus if all menus have been enabled (Pr **00.031**). Refer to section 5.9 *Parameter access level and security* on page 116.

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 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.

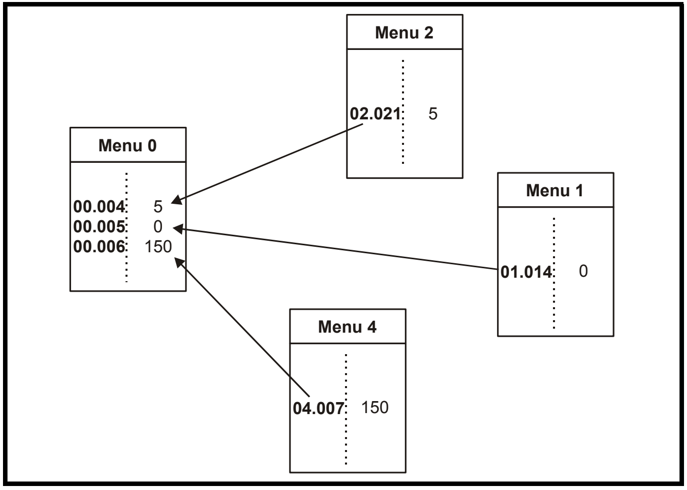
5.4 Menu 0

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. The parameters displayed in Menu 0 can be configured in Menu 22.

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* on page 119.

Figure 5-7 Menu 0 copying



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.

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 parameter number of the option module’s internal menus and parameter.

Table 5-5 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	Reserved menu
29	Building Automation communications configuration
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.

5.5.1 KI-HOA Keypad RTC

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. Below are the keypad set-up parameters.

Table 5-6 Keypad 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.

5.5.2 Display messages

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

Table 5-7 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. 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
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 function is active	Enabled
Phasing	The drive is performing a ‘phasing test on enable’	Enabled

5.5.3 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 5-8 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.

Table 5-9 Option module and NV media card and other status indications at power-up

<table>
<tr><th>First row string</th><th>Second row string</th><th>Status</th></tr>
<tr><td>Booting</td><td>Parameters</td><td>Parameters are being loaded</td></tr>
<tr><td colspan="3">Drive parameters are being loaded from a NV Media Card</td></tr>
<tr><td>Booting</td><td>User Program</td><td>User program being loaded</td></tr>
<tr><td colspan="3">User program is being loaded from a NV Media Card to the drive</td></tr>
<tr><td>Booting</td><td>Option Program</td><td>User program being loaded</td></tr>
<tr><td colspan="3">User program is being loaded from a NV Media Card to the option module in slot X</td></tr>
<tr><td>Writing To</td><td>NV Card</td><td>Data being written to NV Media Card</td></tr>
<tr><td colspan="3">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</td></tr>
<tr><td>Waiting For</td><td>Power System</td><td>Waiting for power stage</td></tr>
<tr><td colspan="3">The drive is waiting for the processor in the power stage to respond after power-up</td></tr>
<tr><td>Waiting For</td><td>Options</td><td>Waiting for an option module</td></tr>
<tr><td colspan="3">The drive is waiting for the options modules to respond after power-up</td></tr>
<tr><td>Uploading From</td><td>Options</td><td>Loading parameter database</td></tr>
<tr><td colspan="3">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</td></tr>
</table>

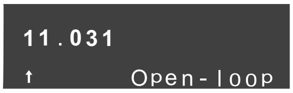
5.6 Changing the operating mode

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 **06.015** 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:

<table>
<tr><th colspan="2">Pr 11.031 setting</th><th>Operating mode</th></tr>
<tr><td> </td><td>1</td><td>Open-loop</td></tr>
<tr><td> </td><td>2</td><td>RFC-A</td></tr>
<tr><td> </td><td>3</td><td>RFC-S</td></tr>
</table>

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

5. Either:

- Press the red ▽ 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 1001 in Pr **mm.000**)
2. Either:

- Press the red ▽ reset button
- Toggle the reset digital input, or
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

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 🔴 reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

5.9 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 5-10.

Table 5-10 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.

5.9.1 User Security Level / Access Level

The drive provides a number of different levels of security that can be set by the user via *User Security Status* (11.044); these are shown in the table below.

User Security Status (Pr 11.044)	Description
Menu 0 (0)	All writable parameters are available to be edited but only parameters in Menu 0 are visible
All menus (1)	All parameters are visible and all writable parameters are available to be edited
Read- only Menu 0 (2)	Access is limited to Menu 0 parameters only. All parameters are read-only
Read-only (3)	All parameters are read-only however all menus and parameters are visible
Status only (4)	The keypad remains in status mode and no parameters can be viewed or edited
No access (5)	The keypad remains in status mode and no parameters can be viewed or edited. Drive parameters cannot be accessed via a comms/ fieldbus interface in the drive or any option module

5.9.2 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.

5.9.3 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.

5.10 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 5.9 *Parameter access level and security* on page 116 for further information regarding access level.

5.11 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 5.9 *Parameter access level and security* on page 116 for further information regarding access level.

5.12 Communications

As standard the H300 drive is provided with a 2 wire EIA-485 interface located beneath the control terminals, see Figure 4-46 *Location of the comms connector* on page 103. It allows communication to other devices via three building automation network protocols (Modbus RTU, BACnet MSTP and Metasys N2 Open).

5.12.1 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 (see section 4.12 *Communications connections* on page 103 for connection and isolation details).The communications port applies a 2 unit load to the communications network.

USB/EIA-232 to EIA-485 Communications

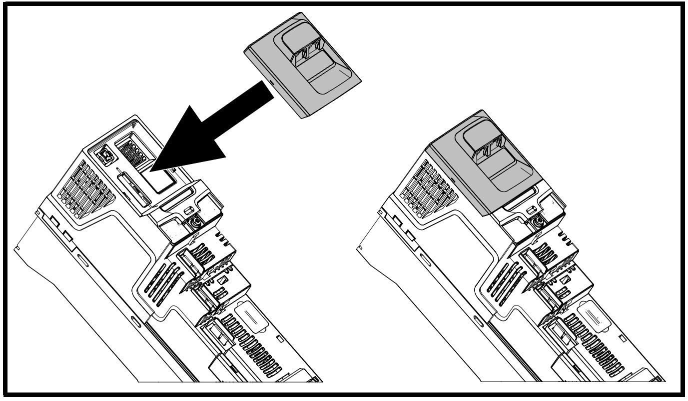
An external USB/EIA-232 hardware interface such as a PC cannot be used directly with the 2-wire EIA-485 interface of the drive.

To gain access to the drive parameters (including connection to HVAC Connect), a KI-485 Adaptor should be installed as shown in Figure 5-8 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 5-8 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.

Serial communications set-up parameters

The following parameters need to be set according to the system requirements.

<table>
<tr><th colspan="3">Serial communications set-up parameters</th></tr>
<tr><td><i>Serial Mode</i> (11.024)
{00.035}</td><td>
<table>
<tr><th>Data Bits</th><th>Stop Bits</th><th>Parity</th><th>Register Mode</th><th>Pr 11.024</th></tr>
<tr><td>8</td><td>2</td><td>NP</td><td>Standard</td><td>0</td></tr>
<tr><td>8</td><td>1</td><td>NP</td><td>Standard</td><td>1</td></tr>
<tr><td>8</td><td>1</td><td>EP</td><td>Standard</td><td>2</td></tr>
<tr><td>8</td><td>1</td><td>OP</td><td>Standard</td><td>3</td></tr>
<tr><td>8</td><td>2</td><td>NP</td><td>Modified</td><td>4</td></tr>
<tr><td>8</td><td>1</td><td>NP</td><td>Modified</td><td>5</td></tr>
<tr><td>8</td><td>1</td><td>EP</td><td>Modified</td><td>6</td></tr>
<tr><td>8</td><td>1</td><td>OP</td><td>Modified</td><td>7</td></tr>
<tr><td>7</td><td>2</td><td>NP</td><td>Standard</td><td>8</td></tr>
<tr><td>7</td><td>1</td><td>NP</td><td>Standard</td><td>9</td></tr>
<tr><td>7</td><td>1</td><td>EP</td><td>Standard</td><td>10</td></tr>
<tr><td>7</td><td>1</td><td>OP</td><td>Standard</td><td>11</td></tr>
<tr><td>7</td><td>2</td><td>NP</td><td>Modified</td><td>12</td></tr>
<tr><td>7</td><td>1</td><td>NP</td><td>Modified</td><td>13</td></tr>
<tr><td>7</td><td>1</td><td>EP</td><td>Modified</td><td>14</td></tr>
<tr><td>7</td><td>1</td><td>OP</td><td>Modified</td><td>15</td></tr>
</table>
</td><td>This parameter defines the supported data formats used by the EIA-485 comms port on the drive. This parameter can be changed via the drive keypad, via a option module or via the comms interface itself.</td></tr>
<tr><td><i>Serial Baud Rate</i>
(11.025)
{00.036}</td><td>300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600(8), 76800(9), 115200 (10)</td><td>This parameter can be changed via the drive keypad, via a option module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20 ms before sending a new message using the new baud rate.</td></tr>
<tr><td><i>Serial Address</i>
(11.023)
{00.037}</td><td>1 to 247</td><td>This parameter defines the serial address and an addresses between 1 and 247 are permitted.</td></tr>
</table>

See Chapter 10 *Building Automation on page 170* for further information

about the three building automation network (BAN) protocols available with the HVAC drive H300.

NOTE

This drive does not provide the necessary line polarization for correct operation of the EIA-485 port, the data lines (Rx Tx and /Rx /Tx) must be correctly biased in accordance with the relevant protocol specification, this is normally done in the communication master or controller. Please refer to the relevant communication protocol specification for more information.

6 Basic parameters

6.1 Menu 0: Basic parameters

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.

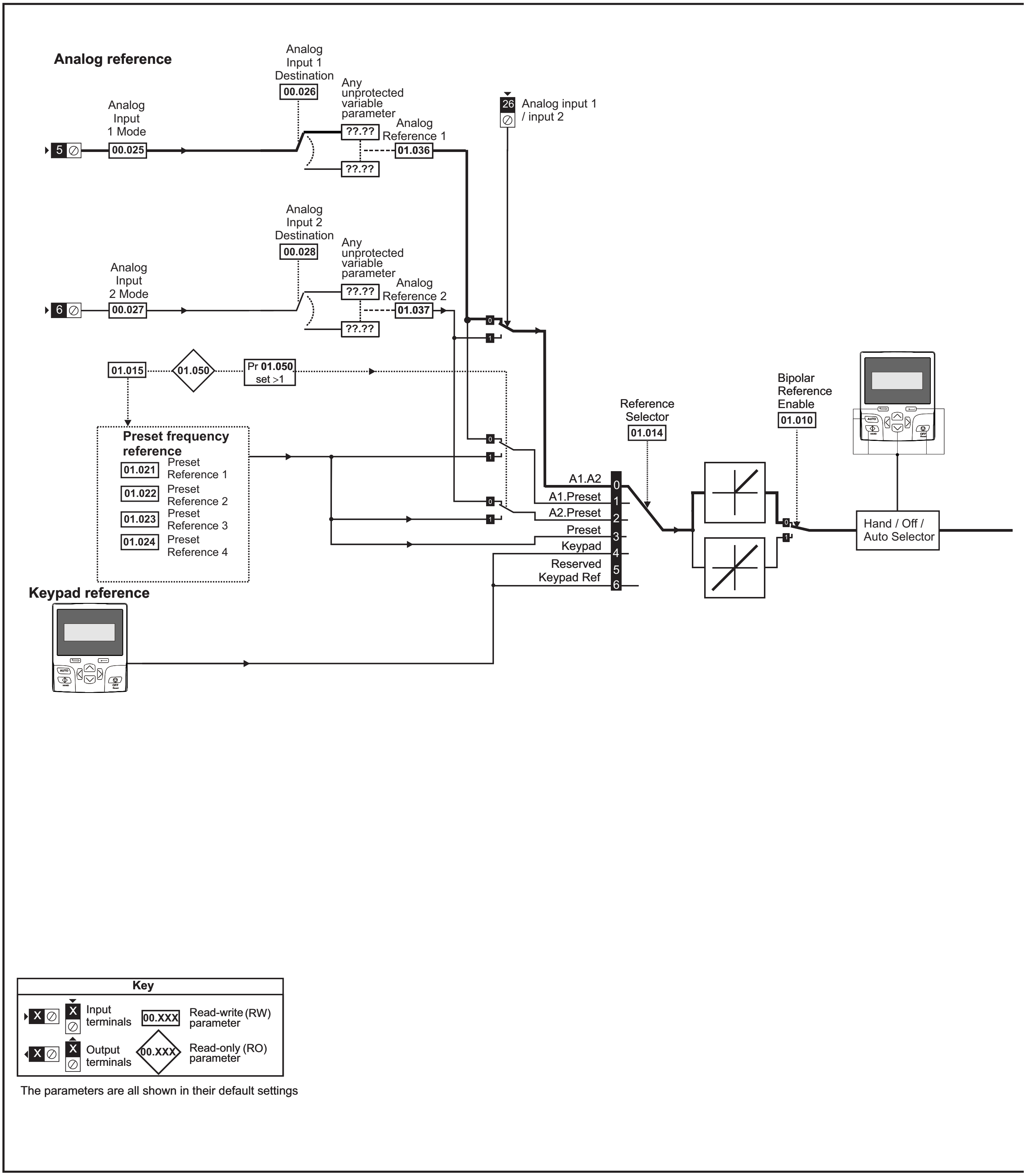
Parameter			Range			Default			Type					
			OL	**RFC-A**	**RFC-S**	**OL**	**RFC-A**	**RFC-S**						
00.001	Motor Rpm	**{05.004}**	±180000 rpm						RO	Num	ND	NC	PT	FI
	Speed Feedback	**{03.002}**		VM_SPEED rpm					RO	Num	ND	NC	PT	FI
00.002	Output Frequency	**{05.001}**	VM_SPEED_FREQ_ REF Hz	±2000.0 Hz					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 from 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
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 690V drive: 690V			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		

Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
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
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
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

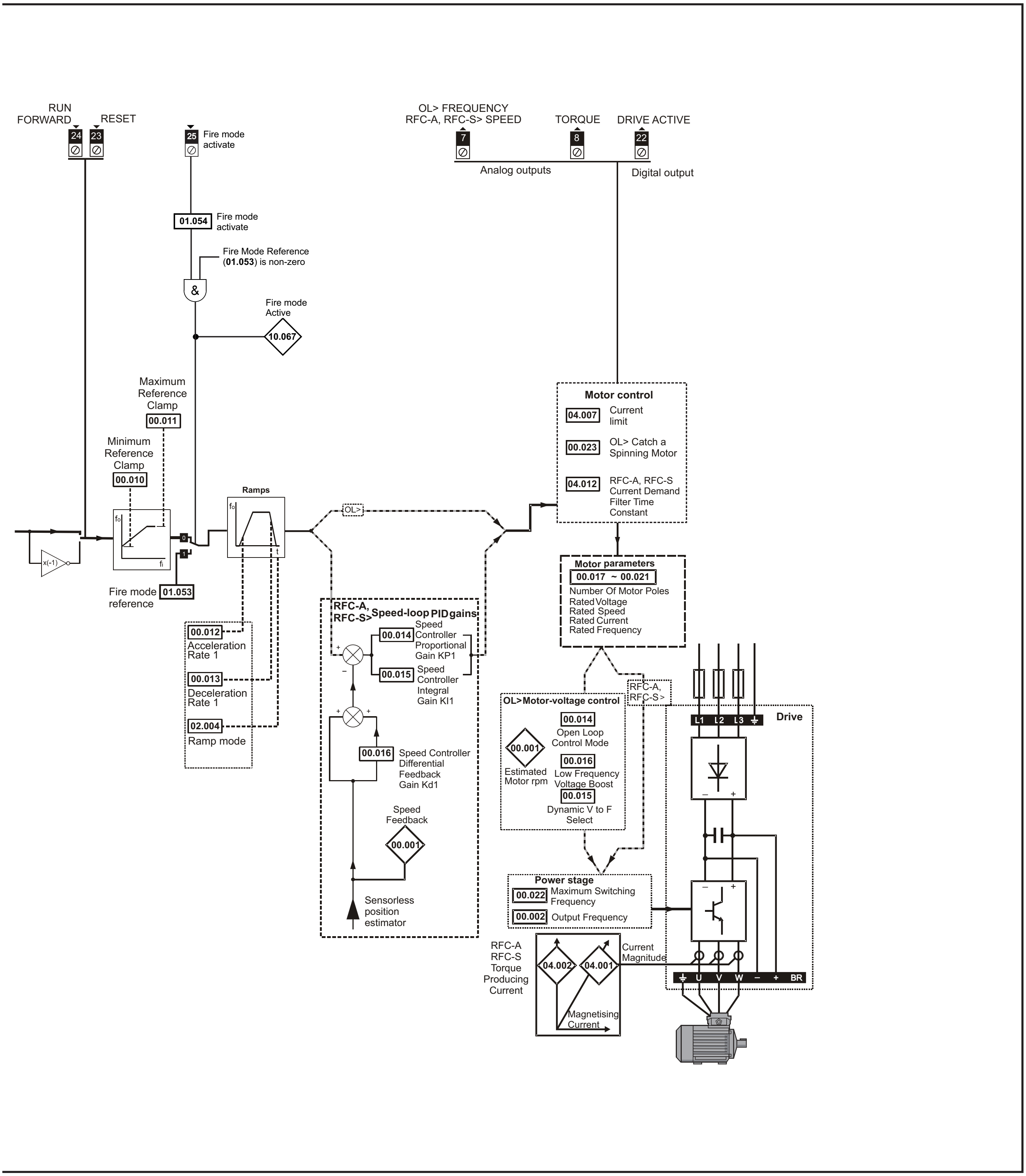
Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.063	Trip 1 Time	**{10.044}**	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	PS
00.064	Trip 2 Date	**{10.045}**	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	PS
00.065	Trip 2 Time	**{10.046}**	00:00:00 to 23:59:59						RO	Time	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

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter						

Figure 6-1 Menu 0 logic diagram



The parameters are all shown in their default settings


RUN FORWARD
RESET
24
23
25
Fire mode activate
01.054
Fire mode activate
Fire Mode Reference (01.053) is non-zero
&
Fire mode Active
10.067
OL> FREQUENCY
RFC-A, RFC-S> SPEED
TORQUE
DRIVE ACTIVE
7
8
22
Analog outputs
Digital output
Maximum Reference Clamp
00.011
Minimum Reference Clamp
00.010
x(-1)
f0
fi
0
1
Fire mode reference
01.053
Ramps
f0
t
OL>
Motor control
04.007
Current limit
00.023
OL> Catch a Spinning Motor
04.012
RFC-A, RFC-S Current Demand Filter Time Constant
Motor parameters
00.017 ~ 00.021
Number Of Motor Poles
Rated Voltage
Rated Speed
Rated Current
Rated Frequency
00.012
Acceleration Rate 1
00.013
Deceleration Rate 1
02.004
Ramp mode
RFC-A, RFC-S>
Speed-loop PID gains
00.014
Speed Controller Proportional Gain KP1
00.015
Speed Controller Integral Gain KI1
00.016
Speed Controller Differential Feedback Gain Kd1
+
−
+
+
Speed Feedback
00.001
Sensorless position estimator
OL>Motor-voltage control
00.001
Estimated Motor rpm
00.014
Open Loop Control Mode
00.016
Low Frequency Voltage Boost
00.015
Dynamic V to F Select
RFC-A, RFC-S>
Drive
L1
L2
L3
−
+
Power stage
00.022
Maximum Switching Frequency
00.002
Output Frequency
RFC-A RFC-S Torque Producing Current
04.002
04.001
Current Magnitude
Magnetising Current
U
V
W
−
+
BR

6.2 Parameter descriptions

6.2.1 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 xx.000

Value	Equivalent value	String	Action
0	0	**[No Action]**	
1001	1	**[Save parameters]**	Save parameters under all conditions
6001	2	**[Load file 1]**	Load the drive parameters or user program file from NV media card file 001
4001	3	**[Save to file 1]**	Transfer the drive parameters to parameter file 001
6002	4	**[Load file 2]**	Load the drive parameters or user program file from NV media card file 002
4002	5	**[Save to file 2]**	Transfer the drive parameters to parameter file 002
6003	6	**[Load file 3]**	Load the drive parameters or user program file from NV media card file 003
4003	7	**[Save to file 3]**	Transfer the drive parameters to parameter file 003
12000	8	**[Show non-default]**	Displays parameters that are different from defaults
12001	9	**[Destinations]**	Displays parameters that are set
1233	10	**[Reset 50Hz Defs]**	Load parameters with standard (50 Hz) defaults
1244	11	**[Reset 60Hz Defs]**	Load parameters with US (60 Hz) defaults
1070	12	**[Reset modules]**	Reset all option modules
11001	13	**[Read Enc. NP P1]**	No function on the H300
11051	14	**[Read Enc. NP P2]**	

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 165 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.

To allow easy access to some commonly used functions, refer to the table overleaf. Equivalent values and strings are also provided in the table above.

6.3 Full descriptions

Table 6-3 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
Num	Number: can be uni-polar or bi-polar
Txt	Text: the parameter uses text strings instead of numbers.
Bin	Binary parameter
IP	IP Address parameter
Mac	Mac Address parameter
Date	Date parameter
Time	Time parameter
Chr	Character parameter
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will be transferred to the destination drive by non-volatile storage media when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the values will be transferred if only the current rating is different and the file is a difference from default type file.
ND	No default: The parameter is not modified when defaults are loaded
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.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs.

6.3.1 Parameter x.00

00.000 {mm.000}	**Parameter zero**								
⇳	0 to 65,535	⇨							

6.3.2 Monitoring

00.001 {05.004}	**Motor Rpm**								
RO	Num				ND	NC	PT	FI	
OL	⇳	±180000 rpm	⇨						

Open-loop

Pr **00.001** (**05.004**) indicates the value of the motor speed that is estimated from the following:

02.001 *Post Ramp Reference*
00.017 *Number Of Motor Poles*

00.001 {03.002}	**Speed Feedback**								
RO	Num				ND	NC	PT	FI	
RFC-A **RFC-S**	⇳	VM_SPEED rpm	⇨						

RFC-A / RFC-S

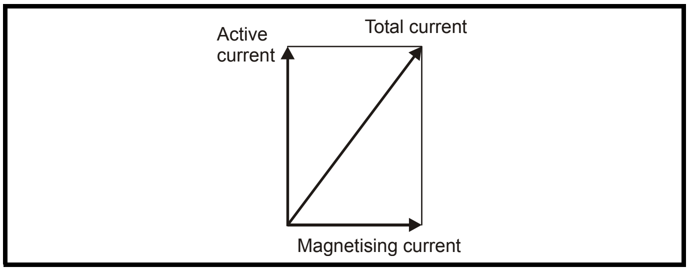
Pr **00.001** (**03.002**) indicates the value of the motor speed which is obtained from the speed feedback.

00.002 {05.001}	**Output Frequency**								
RO	Num				ND	NC	PT	FI	
OL	⇳	VM_SPEED_FREQ_REF Hz	⇨						
RFC-A **RFC-S**		±2000.0 Hz	⇨						

Pr **00.002** (**05.001**) displays the frequency at the drive output.

00.003 {04.001}	**Current Magnitude**								
RO	Bit				ND	NC	PT	FI	
OL **RFC-A** **RFC-S**	⇳	0.000 to VM_DRIVE_CURRENT_UNIPOLAR A	⇨						

Pr **00.003** displays the rms value of the output current of the drive in each of the three phases. The phase currents consist of an active component and a reactive component, which can form a resultant current vector as shown in the following diagram:



The active current is the torque producing current and the reactive current is the magnetizing or flux-producing current.

00.004 {05.003}	**Output Power**								
RO	Num				ND	NC	PT	FI	
OL **RFC-A** **RFC-S**	⇳	VM_POWER kW	⇨						

The output power (**05.003**) is the power flowing via the a.c. terminals of the drive. The power is derived as the dot product of the the output voltage and current vectors, and so this is correct even if the motor parameters are incorrect and the motor model does not align the reference frame with the flux axis of a motor in RFC-A mode. For Open-loop, RFC-A and RFC-S modes, a positive value of power indicates power flowing from the drive to the motor.

6.3.3 Status information

00.005 {11.029}	**Software Version**			
RO	Num	ND	NC	PT
OL	⇳	0 to 99999999	⇨	
RFC-A				
RFC-S				

The parameter displays the software version of the drive

6.3.4 Speed limits

00.010 {01.007}	**Minimum Reference Clamp**			
RW	Num			US
OL	⇳	VM_NEGATIVE_REF_CLAMP1 Hz / rpm	⇨	0.0 Hz
RFC-A				0.0 rpm
RFC-S				

Open-loop

Set Pr **00.010** at the required minimum output frequency of the drive for both directions of rotation. The drive speed reference is scaled between Pr **00.010** and Pr **00.011**. [**00.010**] is a nominal value; slip compensation may cause the actual frequency to be higher.

RFC-A / RFC-S

Set Pr **00.010** at the required minimum motor speed for both directions of rotation. The drive speed reference is scaled between Pr **00.010** and Pr **00.011.**

00.011 {01.006}	**Maximum Reference Clamp 1**			
RW	Num			US
OL	⇳	VM_POSITIVE_REF_CLAMP1 Hz / rpm	⇨	50Hz default: 50.0 Hz 60Hz default: 60.0 Hz
RFC-A				50Hz default:1500.0 rpm 60Hz default:1800.0 rpm
RFC-S				

(The drive has additional over-speed protection).

Open-loop

Set Pr **00.011** at the required maximum output frequency for both directions of rotation. The drive speed reference is scaled between Pr **00.010** and Pr **00.010**. [**00.011**] is a nominal value; slip compensation may cause the actual frequency to be higher.

RFC-A / RFC-S

Set Pr **00.011** at the required maximum motor speed for both directions of rotation. The drive speed reference is scaled between Pr **00.010** and Pr **00.011**.

For operating at high speeds see section 8.4 *High speed operation* on page 160.

6.3.5 Ramps

00.012 {02.011}	**Acceleration Rate 1**			
RW	Num			US
OL	⇳	0.0 to VM_ACCEL_RATE	⇨	20.0 s to Pr **01.006**
RFC-A		0.000 to VM_ACCEL_RATE		20.000 s to Pr **01.006**
RFC-S				

Set Pr **00.012** to the required rate of acceleration.

Note that larger values produce lower acceleration. The rate applies in both directions of rotation.

00.013 {02.021}	**Deceleration Rate 1**			
RW	Num			US
OL	⇳	0.0 to VM_ACCEL_RATE	⇨	20.0 s from Pr **01.006**
RFC-A		0.000 to VM_ACCEL_RATE		20.000 s from Pr **01.006**
RFC-S				

Set Pr **00.013** to the required rate of deceleration.

Note that larger values produce lower deceleration. The rate applies in both directions of rotation.

6.3.6 Voltage boost, (open-loop), Speed-loop PID gains (RFC-A / RFC-S)

00.014 {05.014}	**Open-loop Control Mode**			
RW	Txt			US
OL	⇳	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Current 1P (6)	⇨	Ur I (4)

Open-loop

There are seven voltage modes available, which fall into three categories, vector control, fixed boost and single phase current output. For further details, refer to section 8.1.1 *Open loop motor control* on page 149.

00.014 {03.010}	**Speed Controller Proportional Gain Kp1**			
RW	Num			US
RFC-A	⇳	0.0000 to 200.000 s/rad	⇨	0.0300 s/rad
RFC-S				

RFC-A/ RFC-S

Pr **00.014** (**03.010**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-4 *Menu 3 RFC-A, RFC-S logic diagram* on page 212 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to section 8 *Optimization* on page 149.

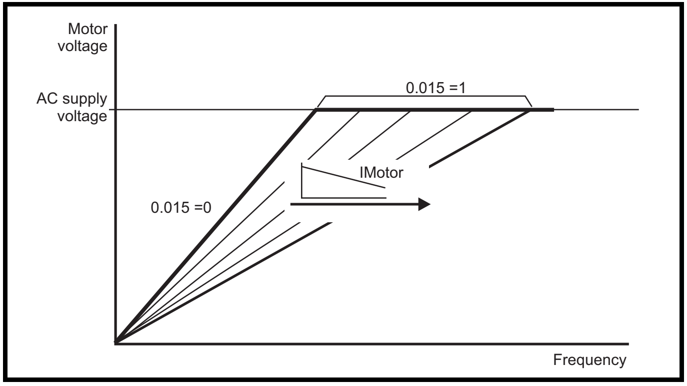
00.015 {05.013}	**Dynamic V to F Select**			
RW	Bit			US
OL	⇳	Off (0) or On (1)	⇨	On (1)

Open-loop

Set Pr **00.015** (**05.013**) at 0 when the V/f characteristic applied to the motor is to be fixed. It is then based on the rated voltage and frequency of the motor.

Set Pr **00.015** at 1 when reduced power dissipation is required in the motor when it is lightly loaded. The V/f characteristic is then variable resulting in the motor voltage being proportionally reduced for lower motor currents. Figure shows the change in V/f slope when the motor current is reduced.

Figure 6-2 Fixed and variable V/f characteristics



00.015 {03.011}	**Speed Controller Integral Feedback Gain Ki 1**			
RW	Num			US
RFC-A **RFC-S**	⇳	0.00 to 655.35 s^2/rad	⇨	0.10s^2/rad

RFC-A / RFC-S

Pr **00.015** (**03.011**) operates in the feedback path of the speed-control loop in the drive. See section 11-4 *Menu 3 RFC-A, RFC-S logic diagram* on page 212 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to section 8 *Optimization* on page 149.

00.016 {05.015}	**Low Frequency Voltage Boost**			
00.016 {03.012}	**Speed Controller Differential Feedback Gain Kd 1**			
RW	Num			US
OL	⇳	.0 to 25.0 %	⇨	1.0 %
RFC-A **RFC-S**	⇳	0.00000 to 0.65535 1/rad	⇨	0.00000 1/rad

6.3.7 Motor parameters

00.017 {05.011}	**Number Of Motor Poles**			
RW	Num			US
OL **RFC-A**	⇳	Automatic (0) to 480 Poles (240)	⇨	Automatic (0)
RFC-S			⇨	8 Poles (4)

Open-loop

This parameter is used in the calculation of motor speed, and in applying the correct slip compensation. When Automatic (0) is selected, the number of motor poles is automatically calculated from the *Rated Frequency* (**00.021**) and the *Rated Speed* rpm (**00.019**). The number of poles = 120 * rated frequency / rpm rounded to the nearest even number.

RFC-A

This parameter must be set correctly for the vector control algorithms to operate correctly. When Automatic (0) is selected, the number of motor poles is automatically calculated from the *Rated Frequency* (**00.021**) and the *Rated Speed* rpm (**00.019**) rpm. The number of poles = 120 * rated frequency / rpm rounded to the nearest even number.

RFC-S

This parameter must be set correctly for the vector control algorithms to operate correctly. When auto is selected the number of poles is set to 6.

00.018 {05.009}	**Rated Voltage**			
RW	Num	RA		US
OL **RFC-A** **RFC-S**	⇳	±VM_AC_VOLTAGE_SET	⇨	200 V drive: 230 V 50Hz default 400 V drive: 400 V 60Hz default 400 V drive: 460 V 575 V drive: 575 V 690 V drive: 690 V

Open-loop and RFC-A

Enter the value from the rating plate of the motor.

00.019 {05.008}	**Rated Speed**			
RW	Num			US
OL	⇳	0 to 33000 rpm	⇨	50 Hz default: 1500 rpm 60 Hz default: 1800 rpm
RFC-A	⇳	0.00 to 33000.00 rpm	⇨	50 Hz default: 1450 rpm 60 Hz default: 1750 rpm
RFC-S	⇳	0.00 to 33000.00 rpm	⇨	3000.00 rpm

Open-loop

This is the speed at which the motor would rotate when supplied with its base frequency at rated voltage, under rated load conditions (= synchronous speed - slip speed). Entering the correct value into this parameter allows the drive to increase the output frequency as a function of load in order to compensate for this speed drop.

Slip compensation is disabled if Pr **00.019** is set to 0 or to synchronous speed, or if Pr **05.027** is set to 0.

If slip compensation is required, this parameter should be set to the value from the rating plate of the motor, 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.

RFC-A

Rated load rpm is used with motor rated frequency to determine the full load slip of the motor which is used by the vector control algorithm. Incorrect setting of this parameter can result in the following:

- Reduced efficiency of motor operation
- Reduction of maximum torque available from the motor
- Failure to reach maximum speed
- Over-current trips
- Reduced transient performance
- Inaccurate control of absolute torque in torque control modes

The nameplate value is normally the value for a hot machine, however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. The rated full load rpm can be optimized by the drive (For further information, refer to section 8.1.2 *RFC-A Sensorless mode* on page 152).

RFC-S

The rated speed is not used by the motor control algorithms, but is used by the motor thermal protection system.

00.020 {05.007}	**Rated Current**								
RW	Num				RA			US	

OL	⇳	0.000 to VM_RATED_CURRENT A	⇨	Maximum rated current (11.060) A
RFC-A				
RFC-S				

Enter the name-plate value for the motor rated current.

00.021 {05.006}	**Rated Frequency**								
00.021 {05.033}	**Volts per 1000 rpm**								
RW	Num							US	

OL	⇳	0.0 to 550.0 Hz	⇨	50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz
RFC-A	⇳	0.0 to 550.0 Hz		
RFC-S	⇳	0 to 10000 V / 1000 rpm	⇨	98 V / 1000 rpm

Enter the value from the rating plate of the motor.

00.022 {05.018}	**Maximum Switching Frequency**								
RW	Txt					RA		US	

OL	⇳	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)	⇨	3 kHz (1)
RFC-A				
RFC-S				

This parameter defines the required switching frequency. The drive may automatically reduce the actual switching frequency (without changing this parameter) if the power stage becomes too hot. A thermal model of the IGBT junction temperature is used based on the heatsink temperature and an instantaneous temperature drop using the drive output current and switching frequency. The estimated IGBT junction temperature is displayed in Pr **07.034**. If the temperature exceeds 145 °C the switching frequency is reduced if this is possible (i.e >3 kHz). Reducing the switching frequency reduces the drive losses and the junction temperature displayed in Pr **07.034** also reduces. If the load condition persists the junction temperature may continue to rise again above 145 °C and the drive cannot reduce the switching frequency further the drive will initiate an 'OHt Inverter' trip. Every second the drive will attempt to restore the switching frequency to the level set in Pr **00.022**.

The full range of switching frequencies is not available on all ratings of Unidrive M. See section 8.3 *Switching frequency* on page 159 for the maximum available switching frequency for each drive rating.

00.023 {06.009}	**Catch A Spinning Motor OL and RFC-A**								
RW	Txt							US	

OL	⇳	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)	⇨	Disable (0)
RFC-A				

Open-loop

When the drive is enabled with Pr **00.023** = 0, the output frequency starts at zero and ramps to the required reference. When the drive is enabled when Pr **00.023** has a non-zero value, the drive performs a start-up test to determine the motor speed and then sets the initial output frequency to the synchronous frequency of the motor. Restrictions may be placed on the frequencies detected by the drive as follows:

Pr 00.023	Pr string	Function
0	Disable	Disabled
1	Enable	Detect all frequencies
2	Fwd only	Detect positive frequencies only
3	Rev only	Detect negative frequencies only

RFC-A mode

If sensorless mode is being used then it is recommended that catch a spinning motor is disabled if the motor will always be stationary when the drive is enabled as this gives a smooth start and avoids unwanted transient movement of the motor on starting. If catch a spinning motor is enabled, but the motor is at standstill or rotating slowly it is likely than some unwanted movement will occur. This can be reduced by reducing Magnetising Current Limit (**04.049**), however if this is reduced too much, especially with larger motors, and over-current trip may occur on starting. It is possible, although not likely, that the drive does not correctly detect the speed of the motor when sensorless control is active. If this is the case Spin Start Boost (**05.040**) can be increased to correct this.

00.024 {05.012}	**Auto-tune**								
RW	Num					NC			

OL	⇳	0 to 2	⇨	0
RFC-A	⇳	0 to 2	⇨	
RFC-S	⇳	0, 1, 2, 6	⇨	

Open-Loop

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.

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 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**). 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).

Autotune test 2:

- 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**).

RFC-A

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 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**).

RFC-S

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

Autotune test 1:

- The stationary autotune can be used to measure all the necessary parameters for basic control. The tests measure *Stator Resistance* (**05.017**), *Ld* (**05.024**) and *No Load Lq* (**05.072**) The *Stator Resistance* (**05.017**) and the 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:

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

Autotune test 6:

- Locket rotor test for load dependant parameters. This test is not impemented at the time of writing.

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**).

00.025 {07.707}	**Analog Input 1 Mode**								
RW	Txt							US	

OL **RFC-A** **RFC-S**	⇕	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)

In modes 2 and 3, a current loop loss trip is generated if the current falls below 3 mA.

In modes -4, -3, 2 and 3 the analog input level goes to 0.0 % if the input current falls below 3 mA.

In modes -2 and -1 the analog input remains at the value it had in the previous sample before the current fell below 3 mA.

Pr Value	Pr string	Comments
-4	4-20 mA Low	4-20 mA low value on current loss (1)
-3	20-4 mA Low	20-4 mA low value on current loss (1)
-2	4-20 mA Hold	4-20 mA hold at level before loss on current loss
-1	20-4 mA Hold	20-4 mA hold at level before loss on current loss
0	0-20 mA	
1	20-0 mA	
2	4-20 mA Trip	4-20 mA trip on current loss
3	20-4 mA Trip	20-4 mA trip on current loss
4	4-20 mA	
5	20-4 mA	
6	Volt	
7	Therm Short Cct	Temperature Measurement Input With Short Circuit Detection
8	Thermistor	Temperature Measurement Without Short Circuit Detection
9	Therm No Trip	Temperature Measurement Input With No Trips

00.026 {07.010}	**Analog Input 1 Destination**								
RW	Num		DE				PT	US	

OL **RFC-A** **RFC-S**	⇕	00.000 to 59.999	⇨	01.036

Pr 00.026 sets the destination of analog input 1

00.027 {07.011}	**Analog Input 2 Mode**								
RW	Txt							US	
OL **RFC-A** **RFC-S**	⇳	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)	⇨	Volt (6)					

In modes 2 and 3, a current loop loss trip is generated if the current falls below 3 mA.

In modes -4, -3, 2 and 3 the analog input level goes to 0.0 % if the input current falls below 3 mA.

In modes -2 and -1 the analog input remains at the value it had in the previous sample before the current fell below 3 mA.

Pr Value	Pr string	Comments
-4	4-20 mA Low	4-20 mA low value on current loss (1)
-3	20-4 mA Low	20-4 mA low value on current loss (1)
-2	4-20 mA Hold	4-20 mA hold at level before loss on current loss
-1	20-4 mA Hold	20-4 mA hold at level before loss on current loss
0	0-20 mA	
1	20-0 mA	
2	4-20 mA Trip	4-20 mA trip on current loss
3	20-4 mA Trip	20-4 mA trip on current loss
4	4-20 mA	
5	20-4 mA	
6	Volt	
7	Therm Short Cct	Temperature Measurement Input With Short Circuit Detection
8	Thermistor	Temperature Measurement Without Short Circuit Detection
9	Therm No Trip	Temperature Measurement Input With No Trips

00.028 {07.014}	**Analog Input 2 Destination**								
RW	Num		DE				PT	US	
OL **RFC-A** **RFC-S**	⇳	00.000 to 59.999	⇨	01.036					

Pr **00.028** sets the destination of analog input 2

00.029 {07.058}	**Analog Input 2 Thermistor Type**								
RW	Txt							US	
OL **RFC-A** **RFC-S**	⇳	DIN44082 (0) KTY84 (1) PT100 (2) PT1000 (3) PT2000 (4) NI1000 (5)	⇨	DIN44082(0)					

Analog Input 2 Thermistor Type (**00.029**) selects the type of temperature feedback device used with analog Input 2 when *Analog Input 2 Mode* (**00.027**) is set-up for temperature feedback mode. When a temperature feedback mode is selected, 5V is applied to the output via a 3.3K Ω resistor to supply current through the temperature measuring device.

00.030 {11.030}	**User Security Code**								
RW	Num	ND	NC	PT				US	
OL **RFC-A** **RFC-S**	⇳	0 to 2147483647	⇨	0					

If any number other than 0 is programmed into this parameter, user security is applied so that no parameters except Pr 00.031 can be adjusted with the keypad. When this parameter is read via a keypad, it appears as 0. For further details refer to section 5.9.3 *User Security Code* on page 116.

00.031 {11.044}	**User Security Status**								
RW	Txt	ND		PT					
OL **RFC-A** **RFC-S**	⇳	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)	⇨	Menu 0 (0)					

This parameter controls access via the drive keypad as follows:

Security level	Description
0 (Menu 0)	All writable parameters are available to be edited but only parameters in Menu 0 are visible.
1 (All Menus)	All writable parameters are visible and available to be edited.
2 (Read-only Menu 0)	All parameters are read-only. Access is limited to Menu 0 parameters only.
3 (Read-only)	All parameters are read-only however all menus and parameters are visible.
4 (Status Only)	The keypad remains in status mode and no parameters can be viewed or edited.
5 (No Access)	The keypad remains in status mode and no parameters can be viewed or edited. Drive parameters cannot be accessed via a comms / fieldbus interface in the drive or any option module.

The keypad can adjust this parameter even when user security is set.

00.032 {11.044}	**NV Media Card Data Previously Loaded**								
RO	Num		NC	PT					
OL **RFC-A** **RFC-S**	⇳	0 to 999	⇨	0					

This parameter shows the number of the data block last transferred from a SMARTCARD to the drive.

00.033 {11.042}		**Parameter Cloning**							
RW	Txt		NC					US	
OL **RFC-A** **RFC-S**	⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)			⇨	None (0)			

* Only a value of 3 or 4 in this parameter is saved.

NOTE

If Pr **00.033** is equal to 1 or 2, this value is not transferred to the EEPROM or the drive. If Pr **00.033** is set to a 3 or 4 the value is transferred.

Pr String	Pr value	Comment
None	0	Inactive
Read	1	Read parameter set from the NV Media Card
Program	2	Programming a parameter set to the NV Media Card
Auto	3	Auto save
Boot	4	Boot mode

For further information, please refer to section 9 *NV Media Card Operation* on page 165.

00.034 {06.016}		**Date**							
RW	Date	ND	NC	PT					
OL **RFC-A** **RFC-S**	⇳	00-00-00 to 31-12-99			⇨				

Date (**00.034**), Time (**00.035** and Day Of Week (**00.036**) show the date and time as selected by Date/Time Selector (**00.037**). Date (**00.034**) stores the date in dd.mm.yy format regardless of the setting made in Date Format (**00.038**) however if the parameter is viewed using a keypad the date will be displayed in the format selected in Date Format (**00.038**). If a real time clock is selected from an option module then the days, months and years are from the real time clock and the day of the week is displayed in Day Of Week (**00.036**). Otherwise the days have a minimum value of 0 and roll over after 30, the months have a minimum value of 0 and roll over after 11, and Day Of Week (**00.036**) is always 0 (Sunday).

If when setting the date/time this parameter is being written via comms or from and applications module then the value should be written in standard dd/mm/yy format as described below.

The value of this parameter as seen over comms or to an applications module is as follows.

Value = (day[1..31] x 10000) + (month[1..12] x 100) + year[0..99]

00.035 {06.017}		**Time**							
RW	Time	ND	NC	PT					
OL **RFC-A** **RFC-S**	⇳	00:00:00 to 23:59:59			⇨				

See Date (**00.034**)

00.036 {06.018}		**Day of Week**							
RO	Txt	ND	NC	PT					
OL **RFC-A** **RFC-S**	⇳	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)			⇨				

See Date (**00.034**)

00.037 {06.019}		**Date / Time Selector**							
RW	Txt							US	
OL **RFC-A** **RFC-S**	⇳	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)			

When the Date/Time Selector (**00.037**) = 0, the Date (**00.034**) and Time (**00.035**) can be written by the user and the values in these parameters are transferred to the real time clocks in the keypad or any option modules that support this feature that are fitted to the drive. When Date/Time Selector (**00.037**) is changed to any other value, the real time clocks are allowed to run normally again. When Date/Time Selector (**00.037**) is changed from any value to 0 the date and time from a real time clock, if present, is automatically loaded into Date (**00.034**) and Time (**00.035**), so that this date and time is used as the initial value for editing. If more than one real time clock is present the date/time from the keypad is used, if present, and if not then the date/time from the lowest number slot with a real time clock is used.

Date (**00.034**) and Time (**00.035**) are used by the timers in Menu 09 and for time stamping trips. These features will continue to use the originally selected clock even if Date/Time Selector (**00.037**) is changed until a drive reset is initiated. If Date/Time Selector (**00.037**) has been changed and a reset is initiated Timer 1 Repeat Function (**09.039**) and Timer 2 Repeat Function (**09.049**) are set to zero to disable the timers, and the trip dates and times (**00.060** to **00.079**) are reset to zero.

Date / Time selector (**00.037**) is used to select the drive date and time as shown in the table below.

Date/Time Selector (06.019)	Date/Time Source
0: Set	Date and time parameters can be written by the user.
1: Power	Time since the drive was powered up.
2: Running	Accumulated drive running time since the drive was manufactured.
3: Acc Power	Accumulated powered-up time since the drive was manufactured.
4: Local Keypad	If a keypad fitted to the front of the drive includes a real time clock, then the date/time from this clock is displayed, otherwise the date/time is set to zero.
5: Remote Keypad	If a keypad connected to the user comms port of the drive with a EIA-485 includes a real time clock, then the date/time from this clock is displayed, otherwise the date/time is set to zero.
6: Slot 1	As 4 above, but for option slot 1.
7: Slot 2	As 4 above, but for option slot 2.
8: Slot 3	As 4 above, but for option slot 3.
9: Slot 4	As 4 above, but for option slot 4.

00.038 {06.020}	**Date Format**			
RW	Txt			US
OL **RFC-A** **RFC-S**	⇳	Std (0) or US (1)	⇨	US (1)

Date Format (**00.038**) selects the display style for Date (**00.034**), Timer 1 Start Date (**09.035**), Timer 1 Stop Date (**09.037**), Timer 2 Start Date (**09.045**), Timer 2 Stop Date (**09.047**), and for the trip time stamping date parameters (**10.041**, **10.043**, **10.045**, **10.047**, **10.049**, **10.051**, **10.053**, **10.055**, **10.057** and **10.059)** when displayed on a keypad connected to the drive. The format selection made in this parameter does not affect the value of these parameters if they are read using comms or by an applications program.

If Date Format (**00.038**) is 0 then standard format is used and the date is displayed on the keypad as dd.mm.yy and if Date Format (**00.038**) is 1 then US format is used and the date is displayed on the keypad as mm.dd.yy.

6.3.8 Additional parameters for RFC-S sensorless control

00.040 {05.064}	**RFC Low Speed Mode**			
RW	Txt			US
OL **RFC-A**	⇳		⇨	
RFC-S	⇳	Injection (0), Non-salient (1), Current (2), Current No Test (3)	⇨	Non salient (1)

If sensorless mode is being used and is active (i.e. *Sensorless Mode Active* (**03.078**) = 1) and the motor speed is below *Rated Speed* (**00.019**) / 10 then a special low speed algorithm must be used to control the motor. *RFC Low Speed Mode* (**00.040**) is used to select the algorithm to be used.

0: Injection

A high frequency signal is injected into the motor to detect the motor flux axis. This can be used in a similar way to operation with position feedback except that for the drive to remain stable the speed controller bandwidth may need to be limited to 10 Hz or less and the current limit may need to be limited (see *Low Speed Sensorless Mode Current* (**00.041**)).

1: Non-salient

If the ratio Lq/Ld < 1.1 on no load then the injection mode cannot be used and this mode should be used instead. This mode does not provide the same level of control as injection mode and has the following restrictions:

- Speed control is possible, but not torque control.
- Spinning start is not possible and the motor must start from standstill.
- Below *Rated Speed* (**00.019** / 10 it will not be possible to produce more than approximately 60 % to 70 % of rated torque.
- There may be some movement of the motor shaft in either direction as the motor starts.
- It is not possible to measure the motor inertia using auto-tuning with *Auto-tune* (**00.024**) = 4.
- Normally the ramp rate should not be slower than 5 s/1000 rpm when operating in the region below *Rated Speed* (**00.019**) / 10.
- This mode is not intended to control the motor for prolonged periods below *Rated Speed* (**00.019**) / 10, but is intended to allow the motor to be started from standstill to run outside the low speed region.
- This mode is not intended to allow motor reversals. If the direction does need to be reversed, the motor should be stopped and any oscillations must die away, before the motor is restarted in the other direction.

Low Speed Sensorless Mode Current (**00.041**) defines a current applied in the motor d axis to aid starting. The default value is suitable for most motors with a load of up to 60% rated torque. However, in some applications this level may need to be adjusted.

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. Only speed control can be used when low speed mode operation is active.
2. A current specified by Low Speed Sensorless Mode Current (**00.041**) 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 (**00.041**) 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).
3. It is not possible to measure the motor inertia using auto-tuning with Auto-tune (**00.023**) = 4.
4. 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 (**00.041**), and so the motor may become too hot if low speed mode is active for a prolonged period of time.
5. Generally Low Speed Sensorless Mode Current (**00.041**) 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 (**00.041**) 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.

00.041 {05.071}	**Low Speed Sensorless Mode Current Limit**			
RW	Num		RA	US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	0.0 to 1000.0 %	⇨	20.0 %

Injection mode

For low speed sensorless operation with signal injection (*RFC Low Speed Mode* (**00.040**) = 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 Limit* (**00.041**) 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.

Non-salient mode

For low speed sensorless operation for non-salient motors (*RFC Low Speed Mode* (**00.040**) = 1) defines a current applied in the d axis to aid starting. For most motors and applications 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.

00.042 {05.072}	**No-load Lq**			
RW	Num		RA	US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	0.0000 to 500.000 mH		0.000 mH

Motor q axis inductance with no current in the motor.

00.043 {05.075}	**Iq Test Current For Inductance Measurement**			
RW	Num			US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	0 to 200 %	⇨	100 %

Maximum test current level used for Iq during auto-tuning when measuring the motor inductance and phase offset as a percentage of *Rated Current* (**00.020**). This value is also used by the sensorless control algorithm to define the motor inductance and a reference frame phase offset at different levels of Iq. The values of *Lq At The Defined Iq Test Current* (**00.045**), and Phase Offset At Iq Test Current (**00.044**), should be the values which correspond to the test current level. For most motors, *Phase Offset At Iq Test Current* (**00.044**) will be zero and have little effect on the performance, however Lq is likely to vary significantly with Iq and should be set up correctly for good performance. *If Lq At The Defined Iq Test Current* (**00.045**), or *Iq Test Current For Inductance Measurement* (**00.043**) are zero, then the estimate of Lq will not be affected by the level of Iq, and if *Phase Offset At Iq Test Current* (**00.044**) or *Iq Test Current For Inductance Measurement* (**00.043**) are zero the phase offset will not be affected by the level of Iq.

00.044 {05.077}	**Phase Offset At Iq Test Current**			
RW	Num		RA	US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	±90.0 °	⇨	0.0 °

This parameter defines the offset of the point of minimum inductance as an electrical angle from the point with no current in the motor, to the point with a level of Iq equivalent to *Iq Test Current For Inductance Measurement* (**00.043**). When the value is left at its default value of zero, no compensation for phase offset with changes in Iq are made. *Phase Offset At Iq Test Current* (**00.044**) is used for low speed RFC sensorless control using injection mode. A positive value advances the point of minimum inductance with positive Iq. See *RFC Low Speed Mode* (**00.040)**. For most motors a value of zero is acceptable.

00.045 {05.078}	**Lq At The Defined Iq Test Current**			
RW	Num		RA	US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	0.000 to 500.000 mH	⇨	0.000 mH

Motor q axis inductance with no current in the d axis and the current defined by *Iq Test Current For Inductance Measurement* (**00.043**) in the q axis of the motor. If this parameter is left at its default value of zero, then no compensation is made to the value of Lq with changes in Iq.

00.046 {05.082}	**Id Test Current For Inductance Measurement**			
RW	Num			US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	-100 to 0 %	⇨	- 50 %

Minimum test current level used for Id during auto-tuning when measuring the motor inductance as a percentage of *Rated Current* (**00.020**). This is then used in a similar way as *Iq Test Current For Inductance Measurement* (**00.043**), to estimate the value of Lq used in the control algorithms as Id changes. If *Lq At The Defined Id Test Current* (**00.047**), or *Id Test Current for Inductance Measurement* (**00.046)** are set to zero, then no compensation is made for changes in Lq with Id.

00.047 {05.084}	**Lq At The Id Test Current**			
RW	Num		RA	US
OL	⇳		⇨	
RFC-A				
RFC-S	⇳	0.000 to 500.000 mH	⇨	0.000 mH

Motor q axis inductance with no current in the q axis and the current defined by *Id Test Current for Inductance Measurement* (**00.046**) in the d axis of the motor. If this parameter is left at its default value of zero then no compensation is made to the value of Lq with changes in Id.

00.048 {10.034}	**Number Of Auto Reset Attempts**

RW	Txt							US	

OL	⇳	None (0), 1 (1), (2), 3 (3), 4 (4), 5 (5), Infinite (6)	⇨	5 (5)
RFC-A				
RFC-S				

00.049 {10.035}	**Auto Reset Delay**

RW	Num							US	

OL	⇳	00 to 600.0s	⇨	5.0s
RFC-A				
RFC-S				

If Number Of Auto-reset Attempts (**00.048**) = 0 then no auto-reset attempts are made. Any other value will cause the drive to automatically reset following a trip for the number of times programmed after a delay defined by Auto-reset Delay (**00.049**) subject to the minimum reset time allowed for the type of trip. Note that for some trips the minimum is 10s. The auto-reset count is only incremented when the trip is the same as the previous trip otherwise it is reset to 0.

When the auto-reset count reaches the programmed value, any further trip of the same value will not cause an auto-reset. If the number of auto-reset attempts defined by Number Of Auto-reset Attempts (**00.048**) has not been reached and there has been no trip for 5 minutes then the auto-reset count is cleared. Auto reset will not occur after any trips with priority levels 1, 2 or 3 as defined in section 13.2 *Trip indications* on page 284. When a manual reset occurs the auto-reset counter is reset to zero.

If Number Of Auto-reset Attempts (**00.048**) = 6 the auto-reset counter is held at zero, and so there is no limit on the number of auto-reset attempts.

00.050 {10.020}	**Trip 0 to Trip 9**
to	
00.059 {10.029}	

RO	Txt	ND	NC	PT					PS

OL	⇳	0 to 255	⇨	
RFC-A				
RFC-S				

00.060 {10.041}	Trip 0 Date
00.062 {10.043}	Trip 1 Date
00.064 {10.045}	Trip 2 Date
00.066 {10.047}	Trip 3 Date
00.068 {10.049}	Trip 4 Date
00.070 {10.051}	Trip 5 Date
00.072 {10.053}	Trip 6 Date
00.074 {10.055}	Trip 7 Date
00.076 {10.057}	Trip 8 Date
00.078 {10.059}	Trip 9 Date

RO	Txt	ND	NC	PT					PS

OL	⇳	00-00-00 to 31-12-99	⇨	
RFC-A				
RFC-S				

00.061 {10.042}	Trip 0 Time
00.063 {10.044}	Trip 1 Time
00.065 {10.046}	Trip 2 Time
00.067 {10.048}	Trip 3 Time
00.069 {10.050}	Trip 4 Time
00.071 {10.052}	Trip 5 Time
00.073 {10.054}	Trip 6 Time
00.075 {10.056}	Trip 7 Time
00.077 {10.058}	Trip 8 Time
00.079 {10.060}	Trip 9 Time

RO	Time	ND	NC	PT				PS	

OL	⇳	00-00-00 to 23:59:59	⇨	
RFC-A				
RFC-S				

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**).

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.

For information on tuning the drive for the best performance, see *Chapter 8 Optimization* on page 149.

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

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 deactivation 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 **1.053** or Pr **1.054** are not inadvertently re-allocated to different inputs or variables. It should be noted that, by default, Pr **1.054** is controlled from digital input 4 and changing Pr **8.024** 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 5.9 *Parameter access level and security* on page 116). These parameters may also be changed via serial communications so adequate precautions should be taken if this functionality is utilized.

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 7.3 *Quick start commissioning / start-up* on page 141.

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

Drive control method	Requirements
Auto mode	Drive enable Speed reference Run forward
Hand mode	Drive enable
Serial communications	Drive enable Serial communications link

Table 7-2 Minimum requirements for each mode of operation

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

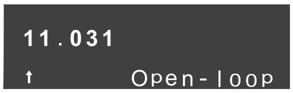
7.2 Changing the operating mode

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

Procedure

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

1. Enter either of the following values in Pr **mm.000**, as appropriate:
   1253 (50 Hz AC supply frequency)
   1254 (60 Hz AC supply frequency) Change
2. Change the setting of Pr **00.030** to L2 to allow access to Pr **11.031**
3. Change the setting of Pr **11.031** as follows:

Pr 11.031 setting		Operating mode
 11.031 ↑ Open-loop	1	Open-loop
 11.031 ↕ RFC-A	2	RFC-A
 11.031 ↕ RFC-S	3	RFC-S

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

4. Either:

- Press the red reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100 (ensure that Pr. **mm.000** returns to 0).

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

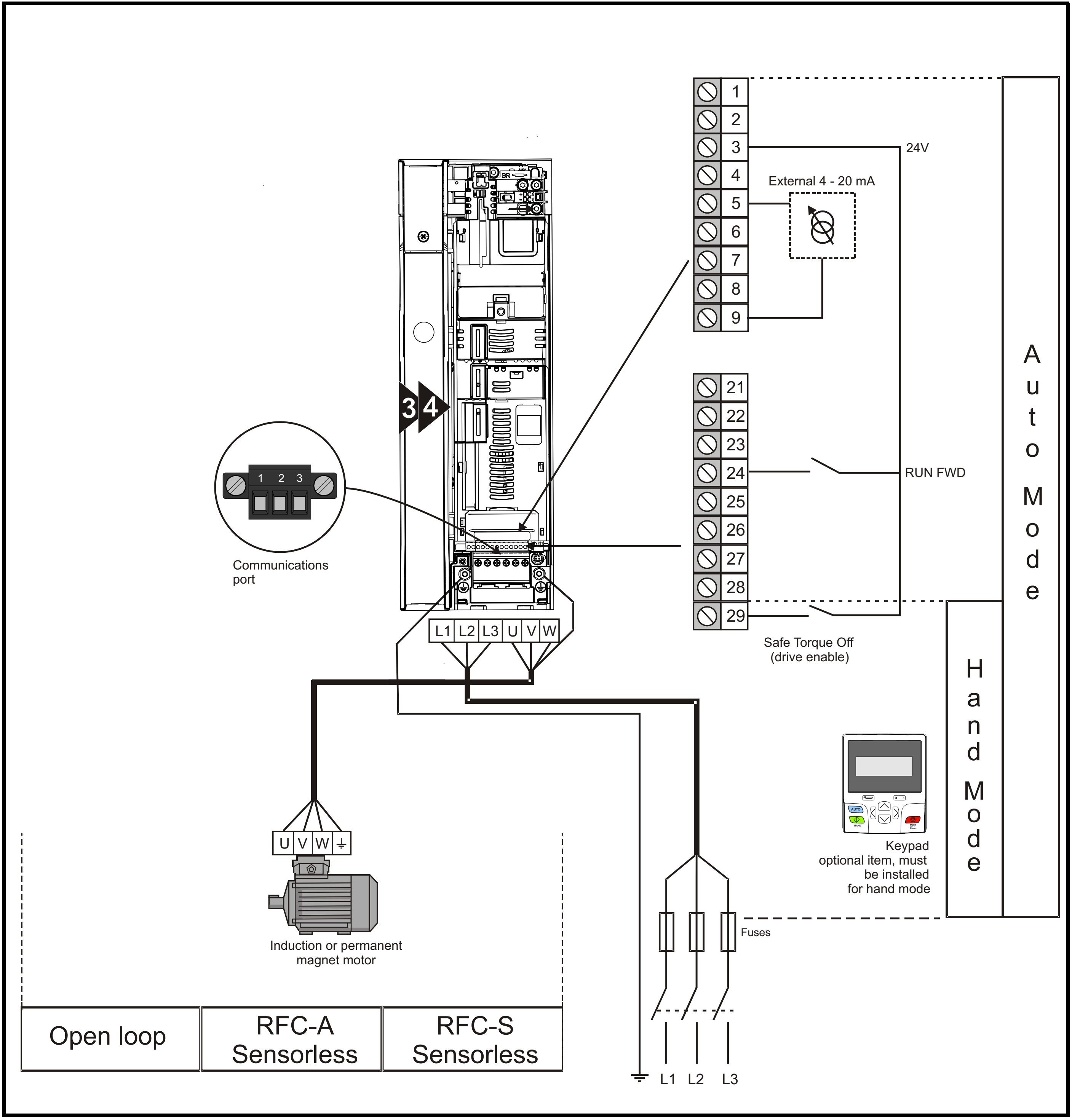


Figure 7-2 Minimum connections to get the motor running in any operating mode (size 5)

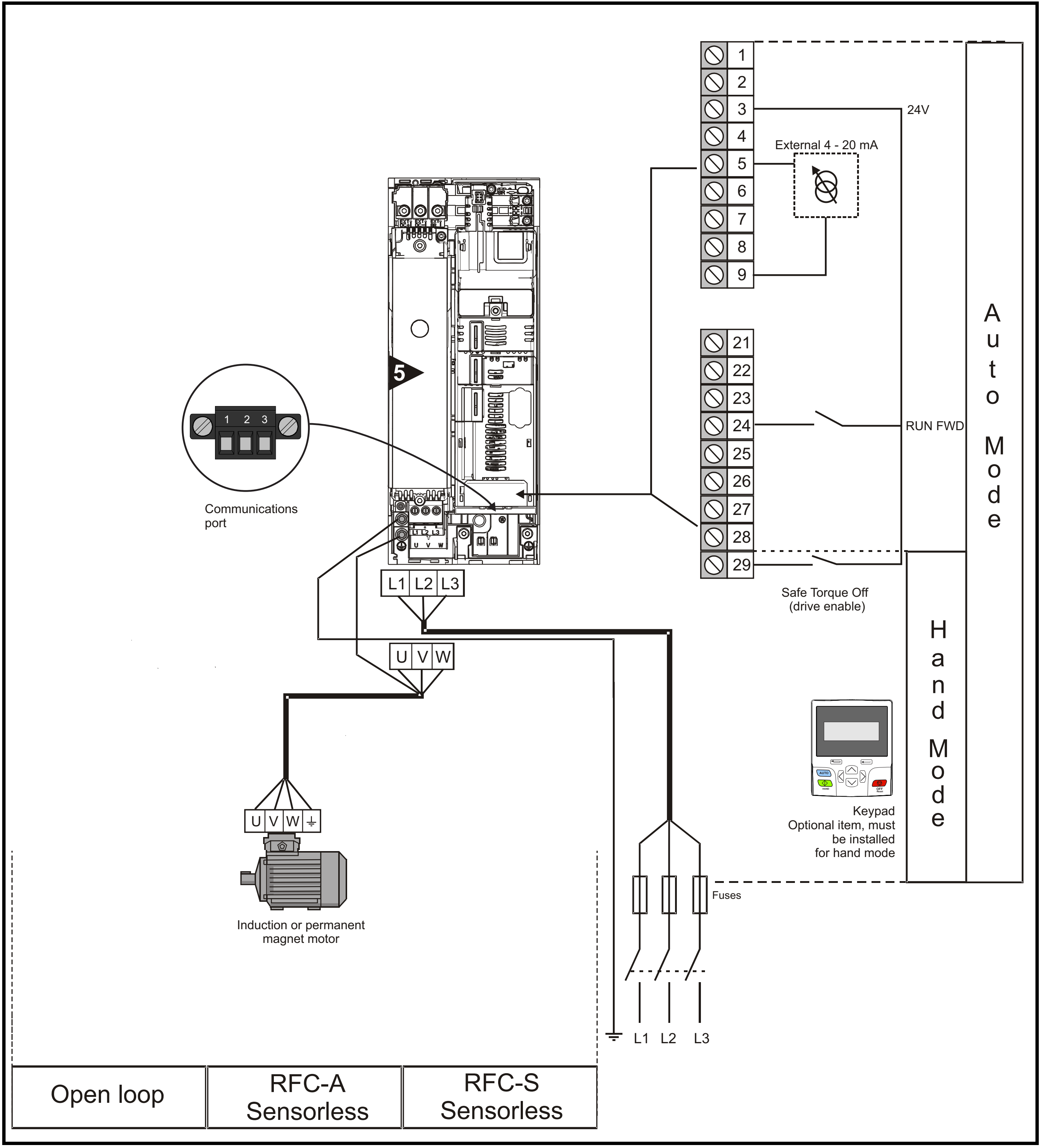


Figure 7-3 Minimum connections to get the motor running in any operating mode (size 6)

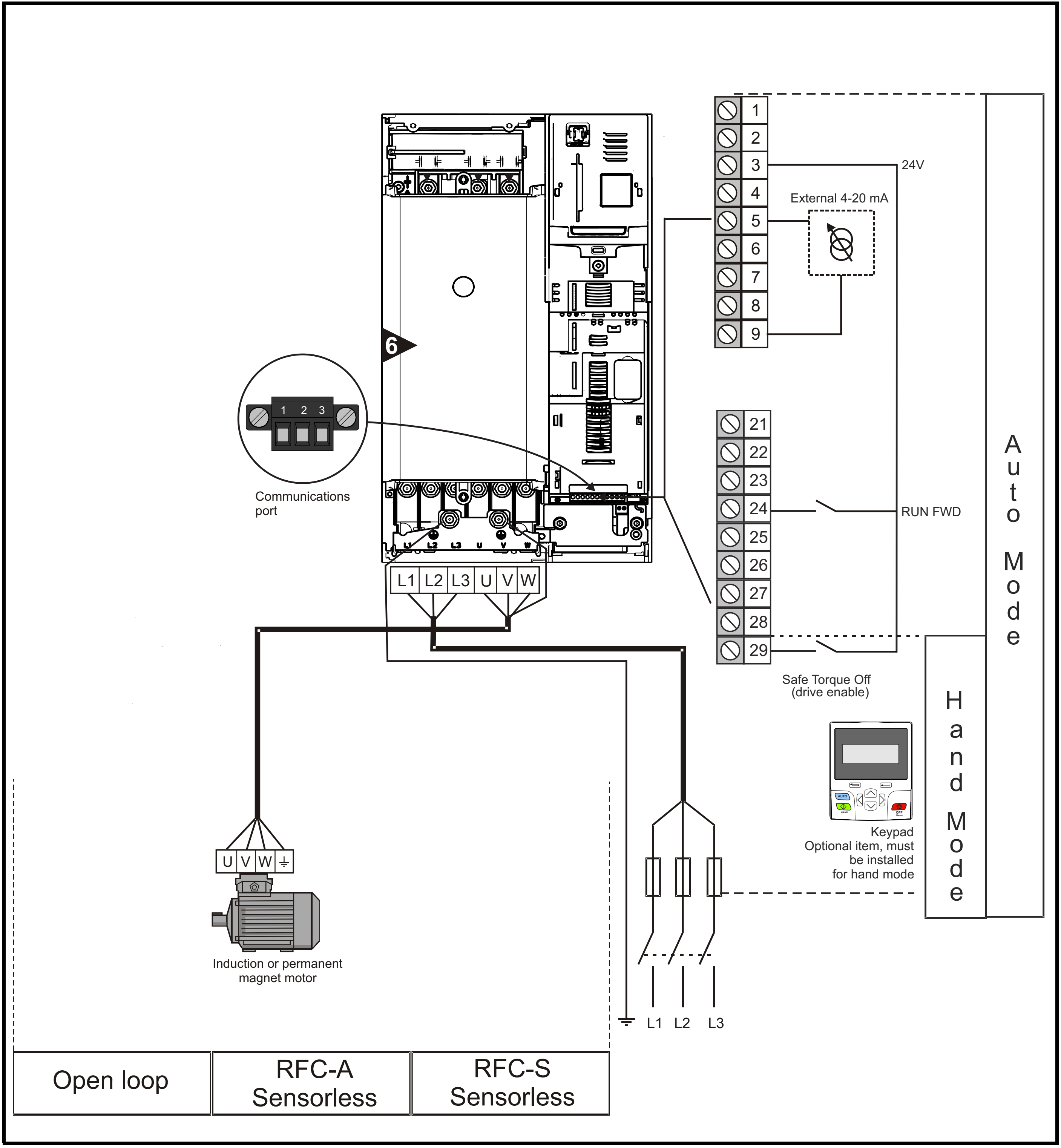
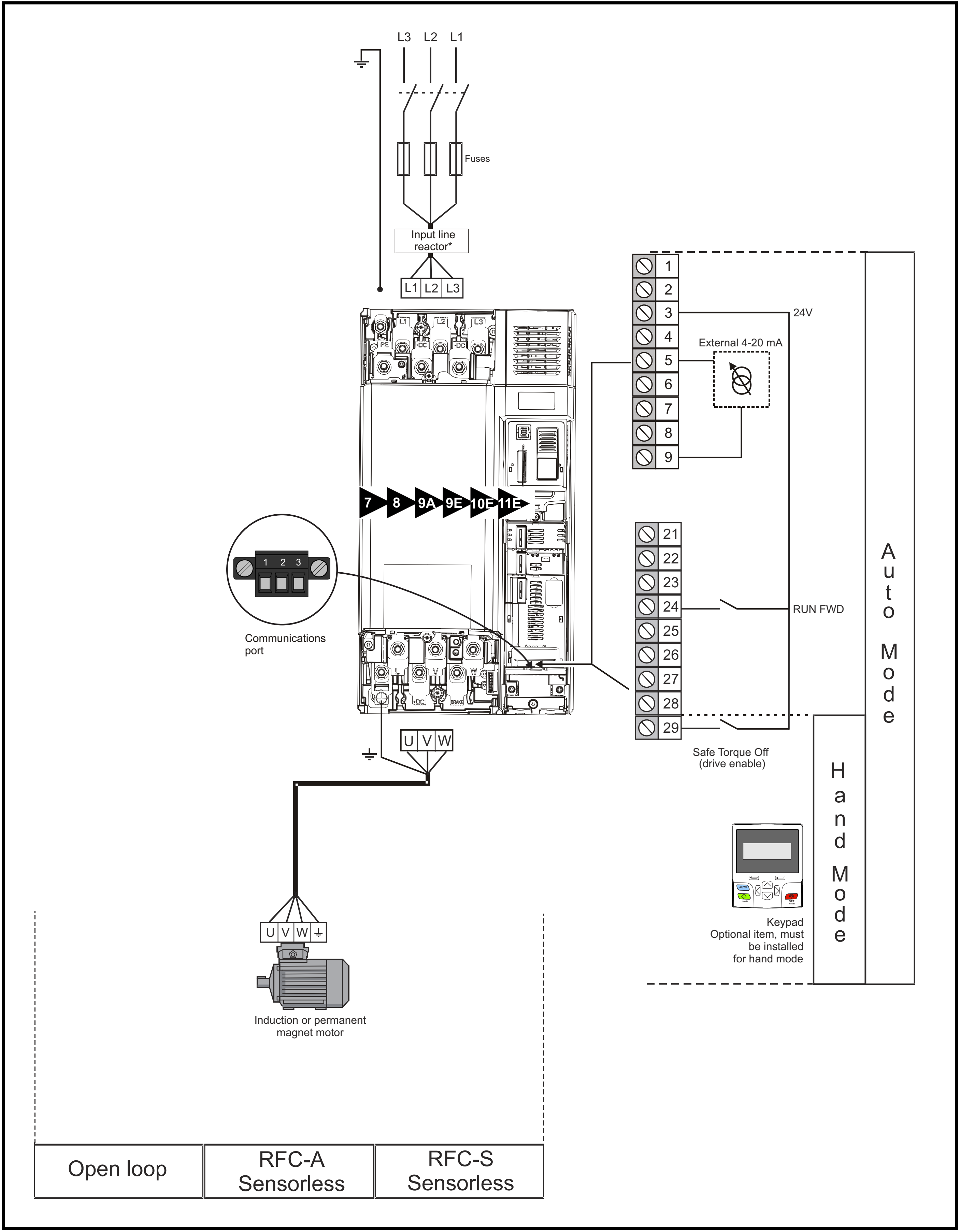


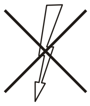
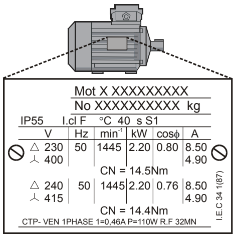
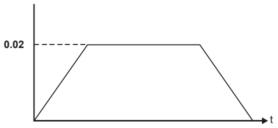
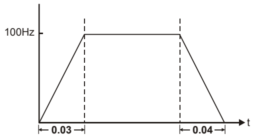
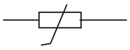
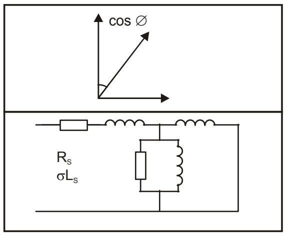
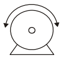
Figure 7-4 Minimum connections to get the motor running in any operating mode (size 7 onwards)



* Required for size 9E and 10.

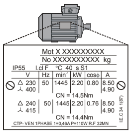
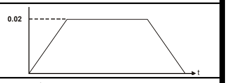
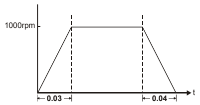
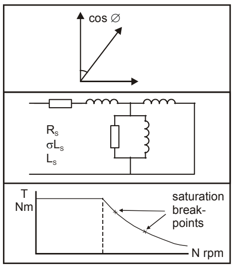
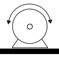
7.3 Quick start commissioning / start-up

7.3.1 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 115. Ensure: • Drive displays 'Inhibit' If the drive trips, see Chapter 13 *Diagnostics* on page 284.	
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 ⅄ or △ 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 **1.006**) • Deceleration rate in Pr **00.013** (s from Pr **1.006**)	
Motor thermistor set-up	The motor thermistor can be selected in Pr **07.011**. Refer to Pr **07.011** for further information.	
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 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 13 *Diagnostics* on page 284. • 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	

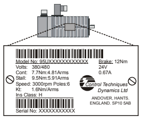
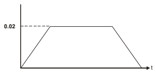
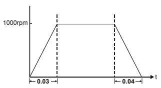
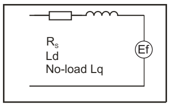
7.3.2 RFC - A Sensorless

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 115, otherwise restore parameter defaults (See section 5.8 *Restoring parameter defaults* on page 116. Ensure: - Drive displays 'Inhibit' If the drive trips, see *Chapter 13 Diagnostics* on page 284.	
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 ⅄ or Δ 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 **1.006**) - Deceleration rate in Pr **00.013** (s from Pr **1.006)**	
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 display will flash 'Autotune' while the drive is performing the autotune. - Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips, see *Chapter 13 Diagnostics* on page 284. - 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	

7.3.3 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 Chapter 5.6 *Changing the operating mode* on page 115, otherwise restore parameter defaults (see Chapter 5.8 *Restoring parameter defaults* on page 116). Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 13 *Diagnostics* on page 284.	
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 **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.012** (s to Pr **1.006**) • Deceleration rate in Pr **00.013** (s from Pr **1.006**)	
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 run signal (terminal 24). • Close the drive enable signal (terminal 29). The upper row of the display will flash 'Auto Tune' while the drive is performing the test. • Wait for the drive to display 'Ready' or 'Inhibit'. If the drive trips it cannot be reset until the drive enable signal (terminal 29) has been removed. See *Chapter 13 Diagnostics* on page 284. • Remove the drive enabled and run signal from the drive.	
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. There are three modes available, with the mode chosen based on the saliency of 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	

7.4 Quick start commissioning / start-up using HVAC Drive Connect (V02.00.05 onwards)

HVAC Drive Connect is a Windows™ based software commissioning/start-up tool for H300 drives. 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).

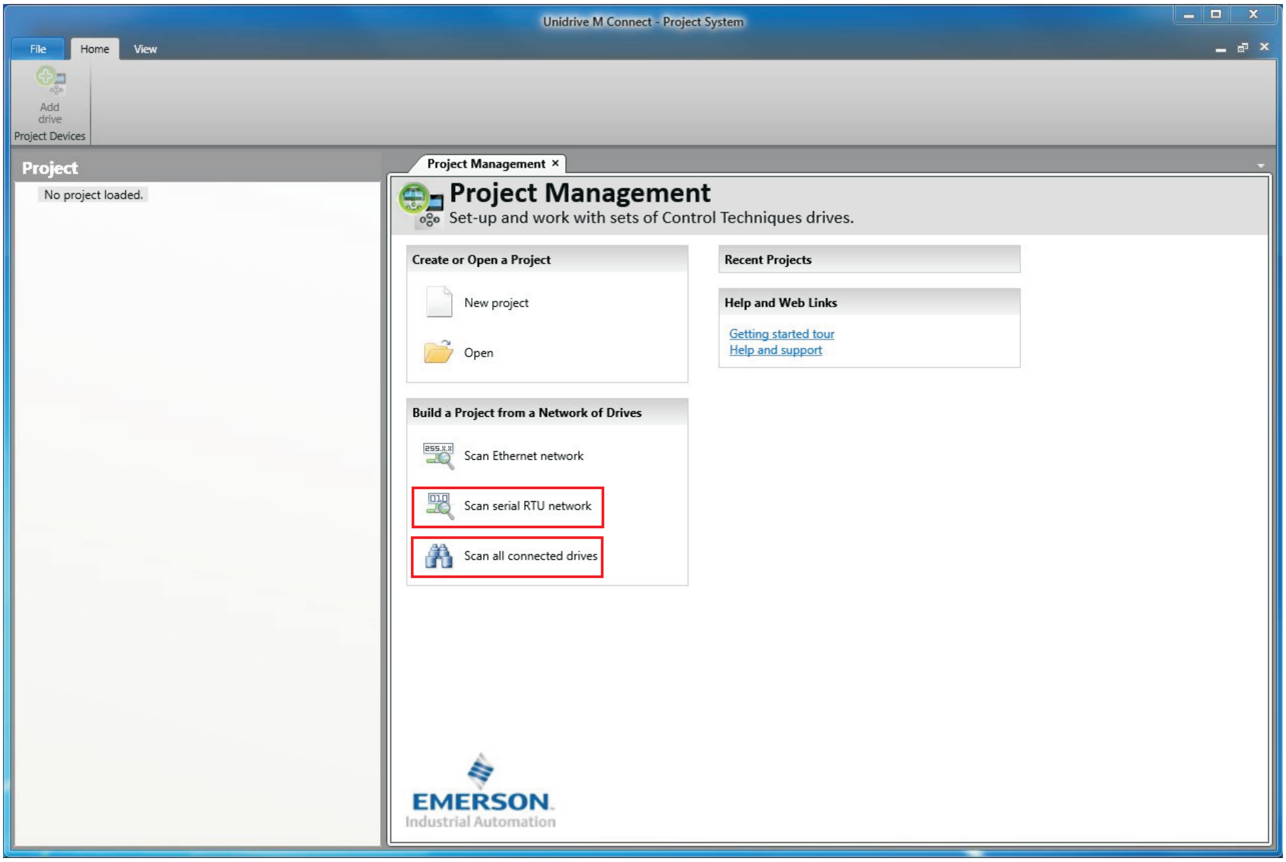
HVAC Drive Connect system requirements

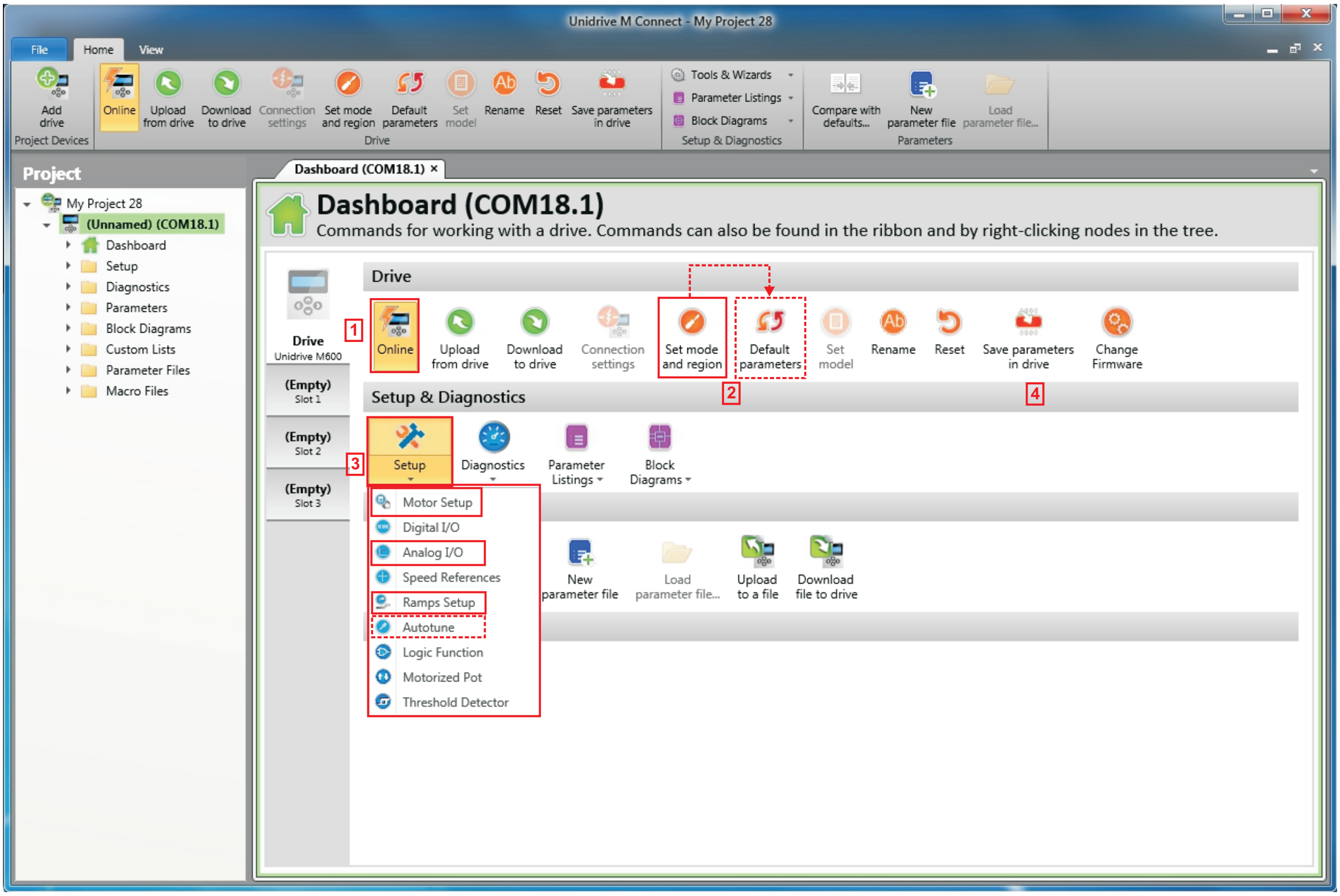
- Windows 8, Windows 7 SP1, Windows Vista SP2, Windows XP SP3
- Minimum of 1280 x 1024 screen resolution with 256 colours
- Microsoft.Net Frameworks 4.0 (this is provided in the downloaded file)
- Note that you must have administrator rights to install HVAC Drive Connect

Any previous copy of HVAC Drive Connect should be uninstalled before proceeding with the installation (existing projects will not be lost). Included within the software is the *Parameter Reference Guide* for H300.

7.4.1 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’. 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’ dialogue, 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’ dialogue then:
   - Select the required mode and supply frequency.
   - Select ‘Apply’.

3. Select ‘Setup’ and perform the steps highlighted (dotted lines indicate a step which may not need to be performed (see overleaf):

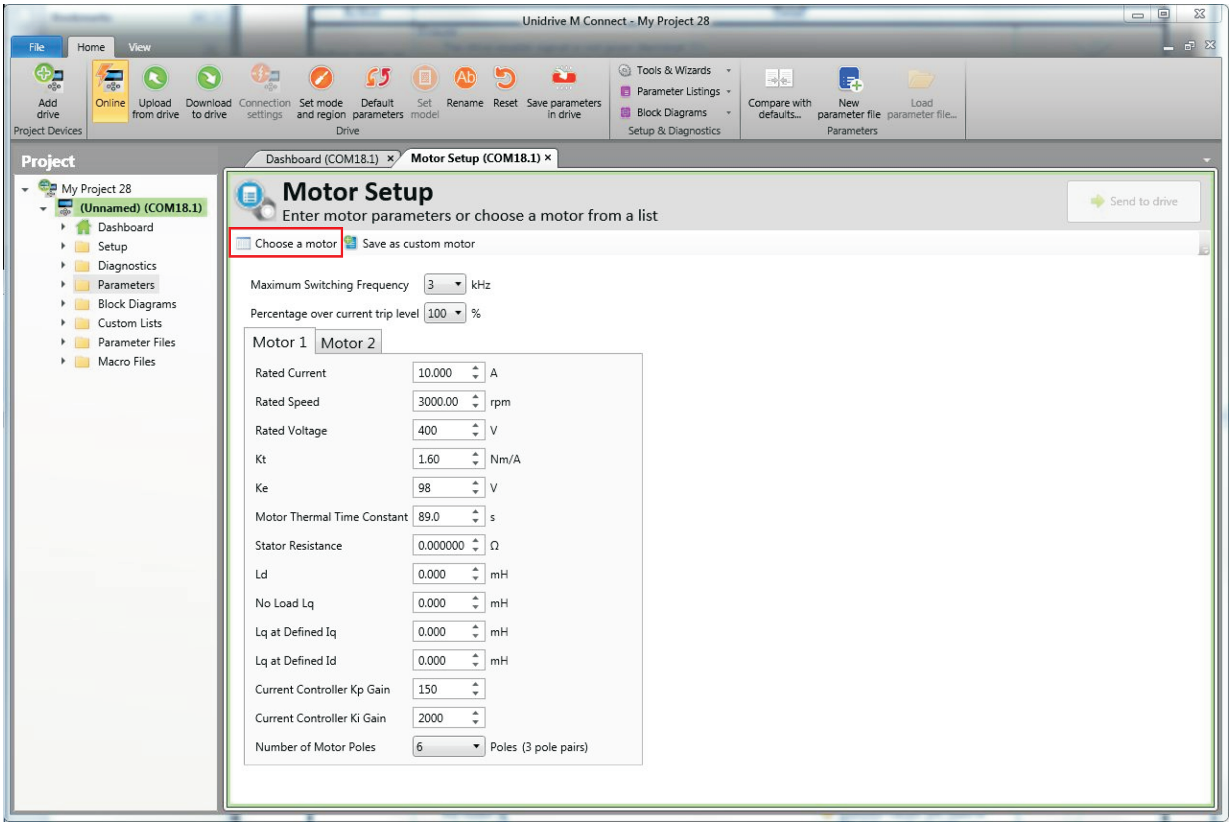
Action	Detail
Motor Setup	HVAC Drive Connect contains a database for induction motors and permanent magnet motors. Provision is also made to enter motor nameplate data. The next section describes the use of the motor database for a Leroy Somer LSRPM motor used in RFC-S Sensorless mode.
Analog I/O	The motor thermistor can be selected in Pr **07.011**. Refer to the parameter help for Pr **07.011** for further information.
Ramps Setup	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.

7.4.2 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'.



Motor Setup

Enter motor parameters or choose a motor from a list

Maximum Switching Frequency 3 kHz

Percentage over current trip level 100 %

Rated Current 10.000 A

Rated Speed 3000.00 rpm

Rated Voltage 400 V

Kt 1.60 Nm/A

Ke 98 V

Motor Thermal Time Constant 89.0 s

Stator Resistance 0.000000 Ω

Ld 0.000 mH

No Load Lq 0.000 mH

Lq at Defined Iq 0.000 mH

Lq at Defined Id 0.000 mH

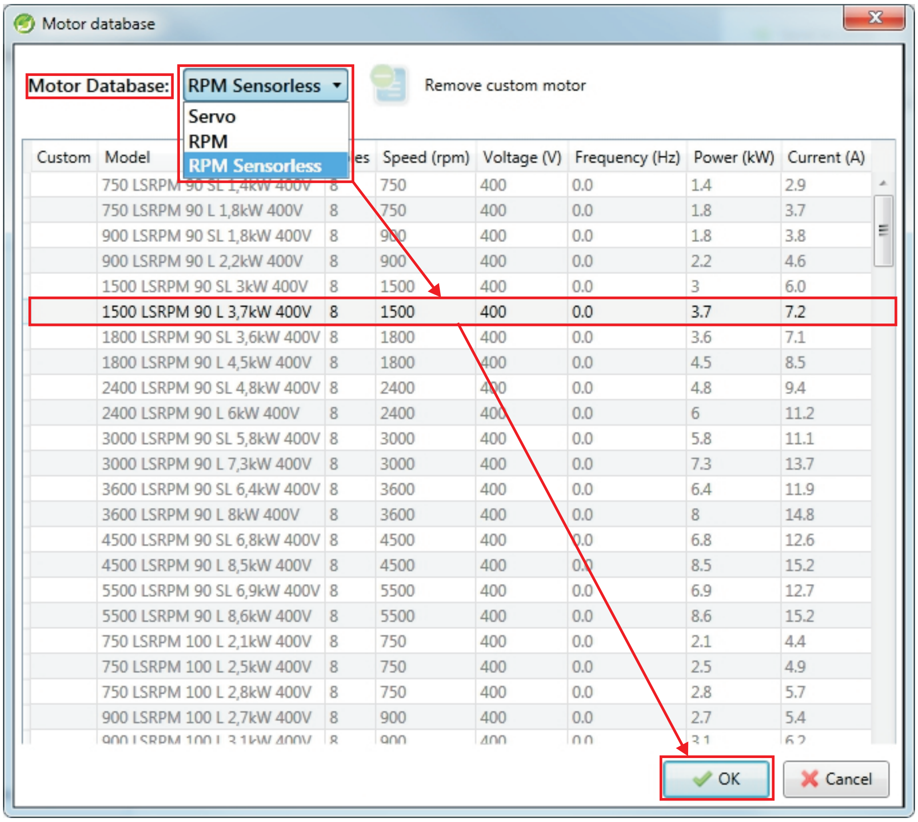
Current Controller Kp Gain 150

Current Controller Ki Gain 2000

Number of Motor Poles 6 Poles (3 pole pairs)

Select the required motor database:

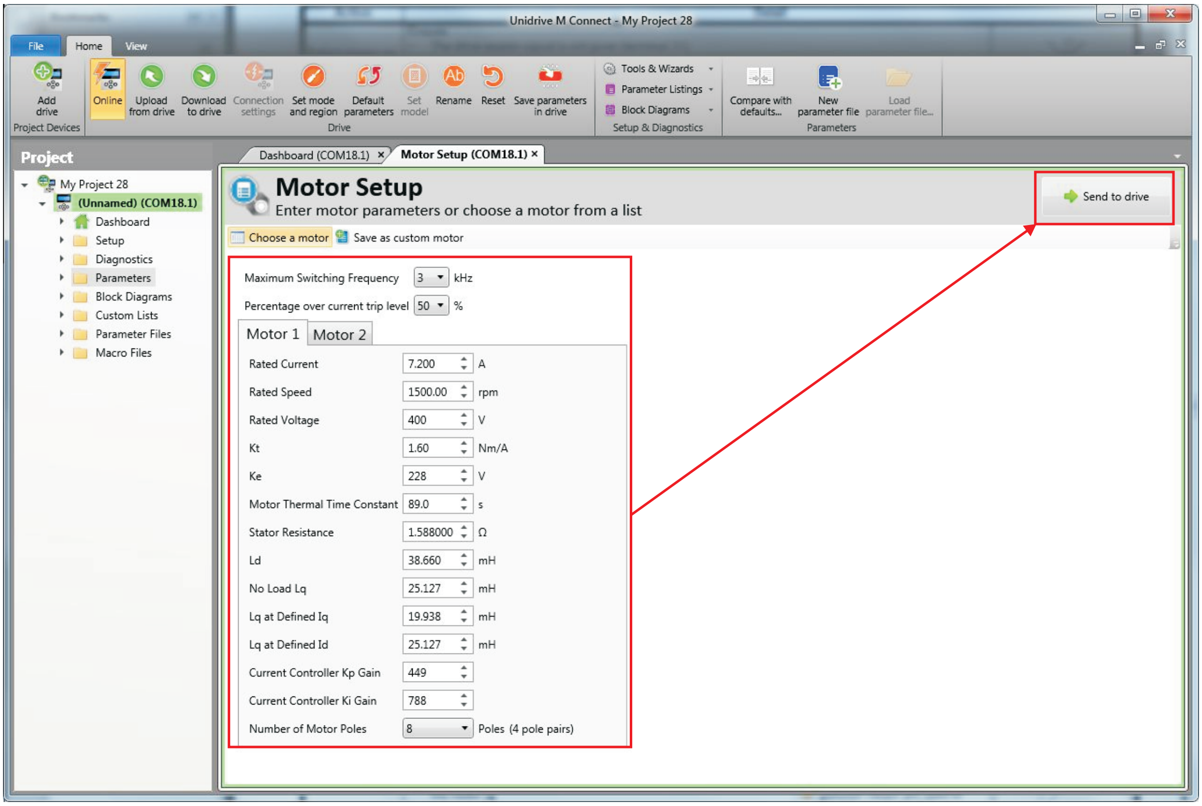
Select the required motor from the list and click 'OK'.



Motor Database: RPM Sensorless

Custom	Model	es	Speed (rpm)	Voltage (V)	Frequency (Hz)	Power (kW)	Current (A)
	750 LSRPM 90 SL 1,4kW 400V	8	750	400	0.0	1.4	2.9
	750 LSRPM 90 L 1,8kW 400V	8	750	400	0.0	1.8	3.7
	900 LSRPM 90 SL 1,8kW 400V	8	900	400	0.0	1.8	3.8
	900 LSRPM 90 L 2,2kW 400V	8	900	400	0.0	2.2	4.6
	1500 LSRPM 90 SL 3kW 400V	8	1500	400	0.0	3	6.0
	1500 LSRPM 90 L 3,7kW 400V	8	1500	400	0.0	3.7	7.2
	1800 LSRPM 90 SL 3,6kW 400V	8	1800	400	0.0	3.6	7.1
	1800 LSRPM 90 L 4,5kW 400V	8	1800	400	0.0	4.5	8.5
	2400 LSRPM 90 SL 4,8kW 400V	8	2400	400	0.0	4.8	9.4
	2400 LSRPM 90 L 6kW 400V	8	2400	400	0.0	6	11.2
	3000 LSRPM 90 SL 5,8kW 400V	8	3000	400	0.0	5.8	11.1
	3000 LSRPM 90 L 7,3kW 400V	8	3000	400	0.0	7.3	13.7
	3600 LSRPM 90 SL 6,4kW 400V	8	3600	400	0.0	6.4	11.9
	3600 LSRPM 90 L 8kW 400V	8	3600	400	0.0	8	14.8
	4500 LSRPM 90 SL 6,8kW 400V	8	4500	400	0.0	6.8	12.6
	4500 LSRPM 90 L 8,5kW 400V	8	4500	400	0.0	8.5	15.2
	5500 LSRPM 90 SL 6,9kW 400V	8	5500	400	0.0	6.9	12.7
	5500 LSRPM 90 L 8,6kW 400V	8	5500	400	0.0	8.6	15.2
	750 LSRPM 100 L 2,1kW 400V	8	750	400	0.0	2.1	4.4
	750 LSRPM 100 L 2,5kW 400V	8	750	400	0.0	2.5	4.9
	750 LSRPM 100 L 2,8kW 400V	8	750	400	0.0	2.8	5.7
	900 LSRPM 100 L 2,7kW 400V	8	900	400	0.0	2.7	5.4
	900 LSRPM 100 L 3,1kW 400V	8	900	400	0.0	3.1	6.2

The data for the selected motor is displayed on the 'Motor Setup' screen. Click 'Send to drive' to set the associated parameters.



Motor Setup

Enter motor parameters or choose a motor from a list

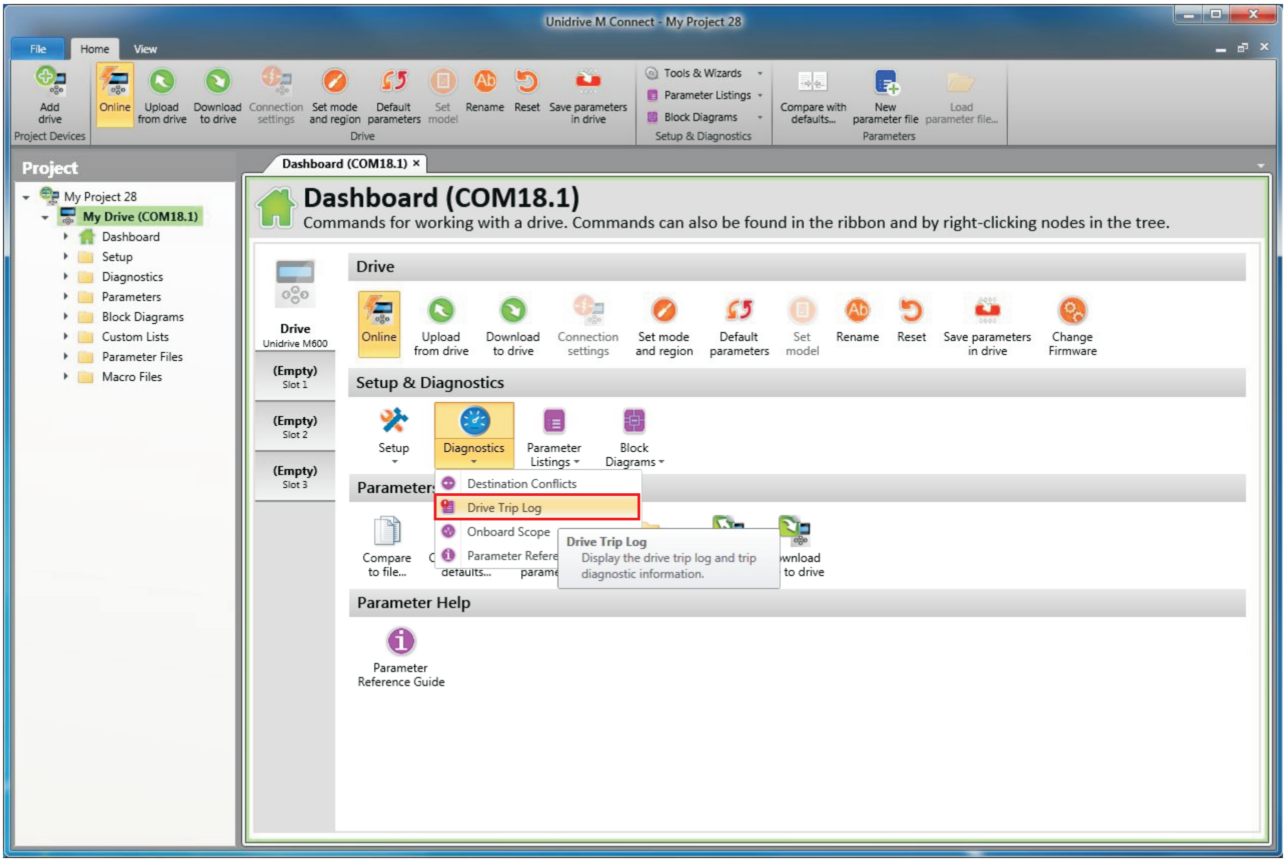
Maximum Switching Frequency 3 kHz
Percentage over current trip level 50 %

Rated Current 7.200 A
Rated Speed 1500.00 rpm
Rated Voltage 400 V
Kt 1.60 Nm/A
Ke 228 V
Motor Thermal Time Constant 89.0 s
Stator Resistance 1.588000 Ω
Ld 38.660 mH
No Load Lq 25.127 mH
Lq at Defined Iq 19.938 mH
Lq at Defined Id 25.127 mH
Current Controller Kp Gain 449
Current Controller Ki Gain 788
Number of Motor Poles 8 Poles (4 pole pairs)

7.5 Diagnostics

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

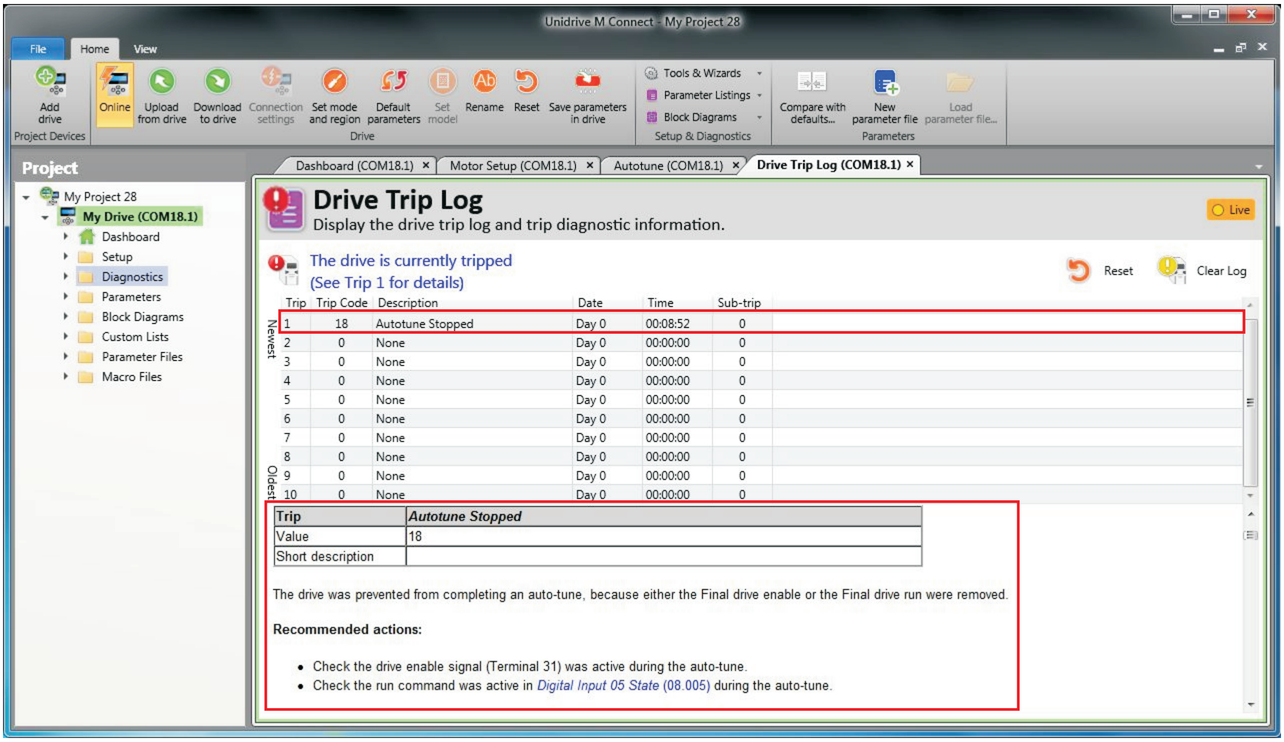
Select 'Drive Trip Log' from the 'Dashboard'.



Commands for working with a drive. Commands can also be found in the ribbon and by right-clicking nodes in the tree.

Drive Trip Log
Display the drive trip log and trip diagnostic information.

The drive trip log shows the trip responsible for stopping the autotune and a description of the trip.



Drive Trip Log

Display the drive trip log and trip diagnostic information.

The drive is currently tripped
(See Trip 1 for details)

Trip	Trip Code	Description	Date	Time	Sub-trip
1	18	Autotune Stopped	Day 0	00:08:52	0
2	0	None	Day 0	00:00:00	0
3	0	None	Day 0	00:00:00	0
4	0	None	Day 0	00:00:00	0
5	0	None	Day 0	00:00:00	0
6	0	None	Day 0	00:00:00	0
7	0	None	Day 0	00:00:00	0
8	0	None	Day 0	00:00:00	0
9	0	None	Day 0	00:00:00	0
10	0	None	Day 0	00:00:00	0

Trip	*Autotune Stopped*
Value	18
Short description	

The drive was prevented from completing an auto-tune, because either the Final drive enable or the Final drive run were removed.

Recommended actions:

- Check the drive enable signal (Terminal 31) was active during the auto-tune.
- Check the run command was active in *Digital Input 05 State* (08.005) during the auto-tune.

8 Optimization

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

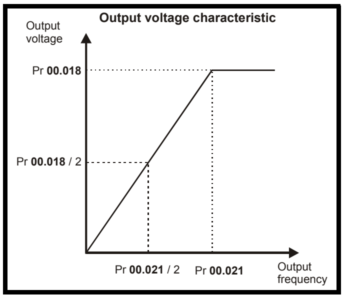
Pr 00.020 {05.007} *Rated Current* | **Defines the maximum continuous motor current**

- 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 8.3 *Switching frequency* on page 159, for more information).
- Motor thermal overload protection (see section 8.2 *Motor thermal protection* on page 158, 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).



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

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 {5.012} 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).

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, *Stator Resistance* (05.017) and *Voltage Offset At Zero Current* (05.058) are all 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 and voltage offset 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 and the voltage offset are measured and the parameters 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 values of stator resistance and voltage offset are not automatically saved to the drive's EEPROM.(4)

(4) **Ur I** = The stator resistance and voltage offset are 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 values of stator resistance and voltage offset are not automatically saved to the drive's EEPROM.

(1) **Ur** = The stator resistance and voltage offset are 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 and voltage offset.

(3) **Ur_Auto** = The stator resistance and voltage offset are 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) and *Voltage Offset At Zero Current* (05.058)) parameters are 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

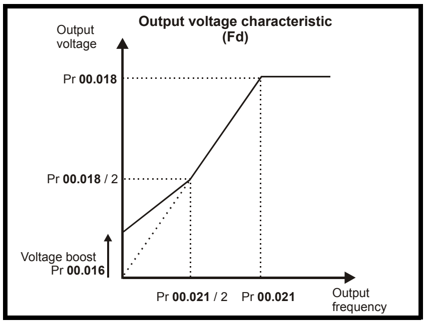
Neither the stator resistance nor the voltage offset are used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **00.016**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed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

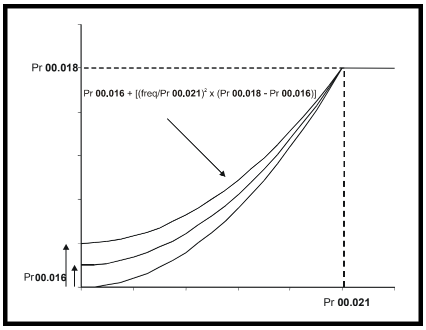
(2) **Fixed** = This mode provides the motor with a linear voltage characteristic from 0 Hz to *Rated Frequency* (00.021), and then a constant voltage above rated frequency.

(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 00.014 {05.014} *Open Loop Control Mode (cont)*

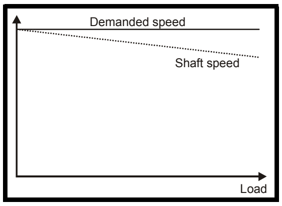
For both these modes, at low frequencies (from 0Hz to ½ x Pr **00.021**) a voltage boost is applied defined by Pr **00.016** as shown below:





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

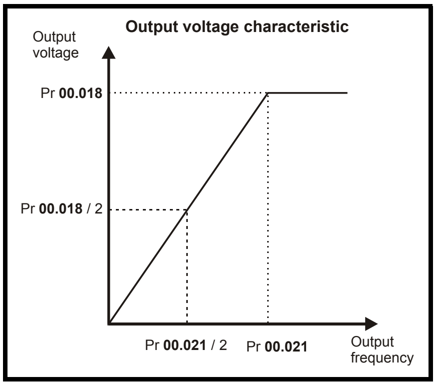
Pr 00.020 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

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 158, 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 *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 motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see motor *Rated Speed* (00.019), later in this table).



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. Either a fixed value can be entered in this parameter or an optimization system may be used to automatically adjust this parameter (see *Motor Parameter Adaptive Control* (05.016), later in this table).

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).

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.

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**}

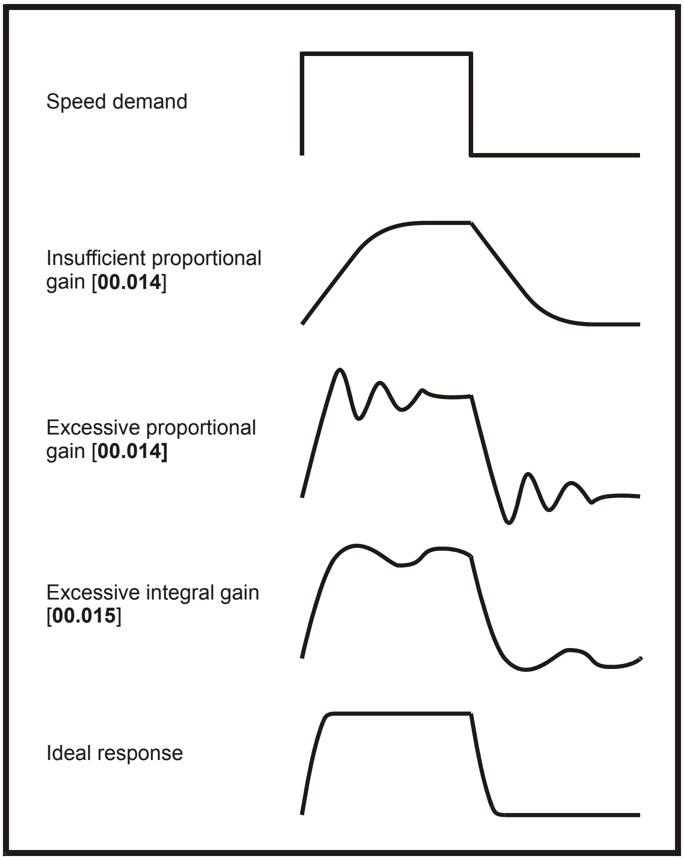
If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, 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.



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 158, 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 two autotune tests available in RFC-S sensorless mode, a stationary autotune and an inertia measurement test.

- Autotune 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* (05.068). *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.

- Autotune test 3: Locked rotor test for load dependant parameters

This test is not implemented at the time of writing.

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**).

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. This is particularly useful when using standard ramp or spinning start with a low friction high inertia load, and can prevent over voltage trips.

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 Curren*t (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.

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 / 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 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.

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 the integral gain may need to have a significantly higher value.

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**}

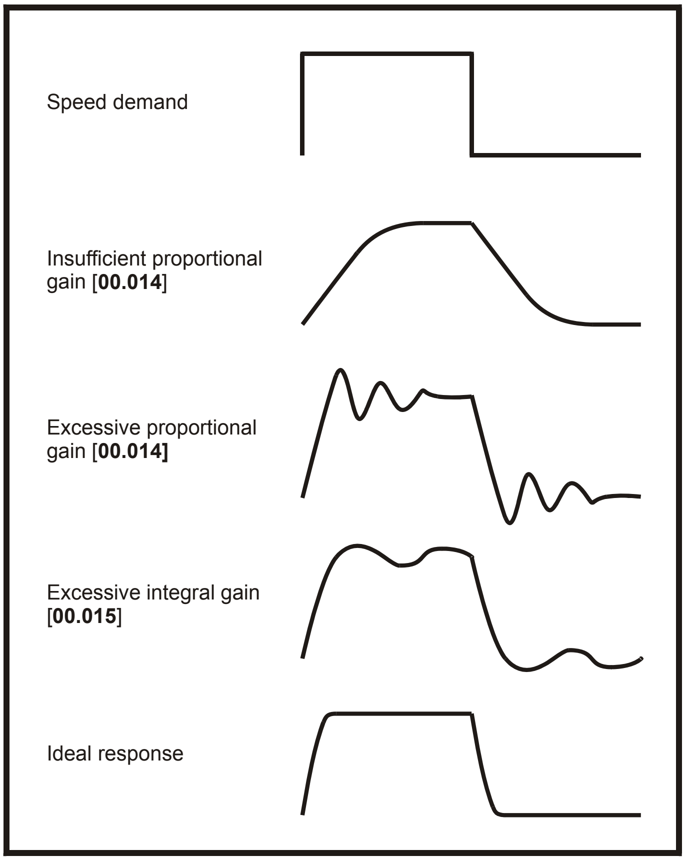
If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, 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)

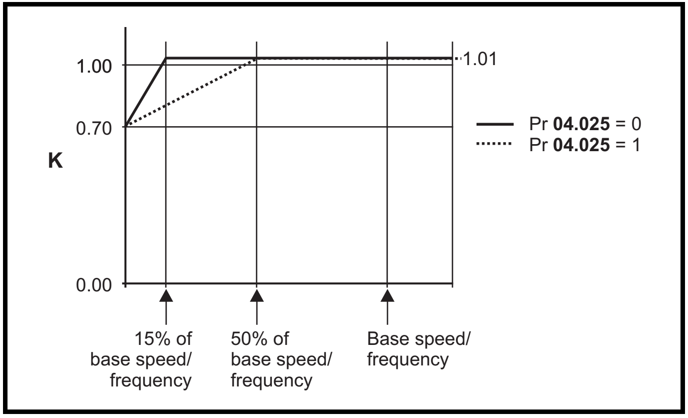
K_2 = *Motor Thermal Time Constant 2 Scaling* (04.038) / 100 %

$\tau 1$ = *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 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 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								
9								
10								
11	400 V	✓	✓	✓	✓	✓		
11	575 and 690 V	✓	✓	✓				

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 *section 12.1.1 Power and current ratings (Derating for switching frequency and temperature)* on page 257.
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	

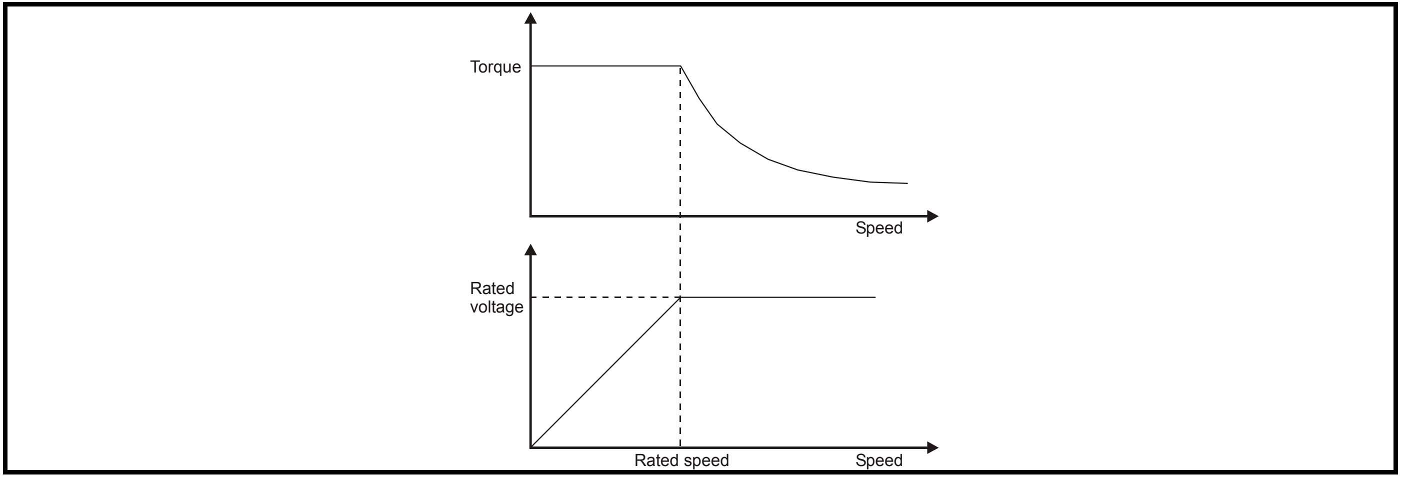
8.4 High speed operation

8.4.1 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. Figure 8-2 shows 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.

8.4.2 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)

8.4.3 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).

8.4.4 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.

8.4.5 Fire mode

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 **1.053** or Pr **1.054** are not inadvertently re-allocated to different inputs or variables. It should be noted that, by default, Pr **1.054** is controlled from digital input 4 and changing Pr **8.024** 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 5.9 *Parameter access level and security* on page 116). These parameters may also be changed via serial communications so adequate precautions should be taken if this functionality is utilized.

1.053	**Fire mode reference**								
RW	Uni							US	
OL	⇕	SPEED_FREQ_MAX Hz/rpm	⇨	0.0 Hz					
RFC				0.0 rpm					

1.054	**Fire mode activation**								
RO	Bit						NC	US	
⇕	OFF (0) or On (1)	⇨							

Emergency ventilation or fire mode allows for the purging of air from a structure during a fire. It is enabled if Pr **1.053** is set to a non zero value and activated when Pr **1.054** is set to one. When activated, the pre-ramp reference (Pr **1.003**) is set to the value of Pr **1.053** and the normal drive controls are overridden as follows:

1. Drive enable is only controlled by the Enable input (Pr **6.015**). The control word (Pr **6.043**) cannot be used to disable the drive.
2. The internal run command is forced to be active. The normal drive sequencing bits (Pr **6.030** to Pr **6.034**) and the control word have no effect.
3. The limit switch functions (Pr **6.035** and Pr **6.036**) 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, so that 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 **1.054** is subsequently set to zero the drive returns to normal operation.

Pr **1.054** 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 **1.053** to zero inhibits the fire mode function and changing Pr **8.024** (*Digital Input 4 source*) could result in digital input 4 source to be allocated to a parameter other than Pr **1.054**.

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.

8.4.6 Advanced process PID

The Advanced Process PID comprises two PID controllers. PID 1 can be configured to operate as follows (refer to Pr **14.059** for details).

- Single setpoint and single feedback
- Single setpoint and dual feedback
- Dual setpoints and dual feedback

PID 2 always operates as a single setpoint, single feedback controller.

When a feedback signal requires square root conversion (e.g. airflow), square root scaling can be applied to PID 1 feedback (see Pr **14.058,** Pr **14.060**, Pr **14.061** and Pr **14.062**). PID 1 also includes a pre-sleep boost level facility (see Pr **14.028** and Pr **14.029**) to reduce frequent transitions into sleep mode when the PID is used.

The PID system is always active even when the output destination parameters are not set to a valid destination parameter. This allows the PID controllers to be used independently from the drive via a building automation network.

14.001	**PID 1 output**								
14.031	**PID 2 output**								
RO	Bi					NC	PT		
⇕	±100.00	⇨							

Pr **14.001** is the output (limited by Pr **14.013** and Pr **14.014**) from PID 1 before scaling (Pr **14.015**) is applied. It is derived from the following algorithm:

Output = Error x [Kp + Ki/s + Kds/(0.064s + 1)]

Where:

Error = Reference (Pr **14.003**, Pr **14.025**) - Feedback (Pr **14.004**)
Kp = proportional gain (Pr **14.010**)
Ki = integral gain (Pr **14.011**)
Kd = differential gain (Pr **14.012**)

Therefore with an error of 100% and Kp = 1.000, the output produced by the proportional term is 100%. With an error of 100% and Ki = 1.000 the output produced by the integral term will increase linearly by 100% every second. With an error that is increasing by 100% per second and Kd = 1.000 the output produced by the differential term will be 100%. A filter with a 64 ms time constant is applied to the differential term to reduce noise.

14.002	**PID main reference source parameter**								
RW	Uni						PT	US	
⇕	Pr **0.000** to Pr **50.099**	⇨	Pr **0.000**						

14.003	**PID 1 reference source parameter**								
14.033	**PID 2 reference source parameter**								
RW	Uni						PT	US	
⇕	Pr **0.000** to Pr **50.099**	⇨	Pr **0.000**						

The PID reference is the sum of the digital reference (Pr **14.025**) and the value from the location defined by the source parameter (Pr **14.003**). Before the reference is applied to the controller algorithm, it can be scaled by setting Pr **14.023** to a value other than one and/or inverted by setting Pr **14.005** = 1.

14.004	**PID 1 feedback source parameter**								
14.034	**PID 2 feedback source parameter**								
RW	Uni						PT	US	
⇕	Pr **0.000** to Pr **50.099**	⇨	Pr **0.000**						

The feedback is the sum of the digital feedback (Pr **14.026**) and the value from the location defined by the source parameter (Pr **14.004**). Before the reference is applied to the controller algorithm, it can be scaled by setting Pr **14.024** to a value other than one and/or inverted by setting Pr **14.006** = 1.

14.005	**PID 1 reference invert**								
14.035	**PID 2 reference invert**								
RW	Bit							US	
⇕	OFF (0) or On (1)	⇨	OFF (0)						

14.006	**PID 1 feedback invert**								
14.036	**PID 2 feedback invert**								
RW	Bit							US	
⇕	OFF (0) or On (1)	⇨	OFF (0)						

14.007	**PID 1 reference slew-rate limit**								
14.037	**PID 2 reference slew-rate limit**								
RW	Uni							US	
⇕	0.0 to 3200.0 s	⇨	0.0						

Pr **14.007** defines the time taken for the reference input to ramp from 0 to 100% following a 0 to 100% step change in input.

14.008	**PID 1 enable**								
RW	Bit							US	
⇕	OFF (0) or On (1)	⇨	OFF (0)						

PID 1 is enabled when Pr **14.008** = 1 and both the parameter sources defined by Pr **14.009** and Pr **14.027** have a value of one. (The source value for Pr **14.009** or Pr **14.027** appears as one if the parameter is set to 0.0.) By default, Pr **14.009** is set to **10.001** (Drive Heathy) so that the PID controller is disabled if the drive is tripped. When the PID controller is disabled the output is zero and all the internal state variables (i.e. integrator accumulator etc.) are held at zero.

14.009	**PID 1 optional enable source parameter 1**								
RW	Uni						PT	US	
⇕	Pr **0.000** to Pr **50.099**	⇨	Pr **0.000**						

14.010	**PID 1 proportional gain**								
14.040	**PID 2 proportional gain**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.011	**PID 1 integral gain**								
14.041	**PID 2 integral gain**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.012	**PID 1 differential gain**								
14.042	**PID 2 differential gain**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.013	**PID 1 output upper limit**								
14.043	**PID 2 output upper limit**								
RW	Uni							US	
⇕	0.00 to 100.00 %	⇨	100.00						

14.014	**PID 1 output lower limit**								
14.044	**PID 2 output lower limit**								
RW	Uni							US	
⇕	±100.00 %	⇨	-100.00						

If Pr **14.018** is zero, the upper limit (Pr **14.013**) defines the maximum positive output for the PID controller and the lower limit defines the minimum positive or maximum negative output. If symmetrical limits are selected, i.e. Pr **14.018** =c1, then the upper limit defines the maximum positive or negative magnitude for the PID output. When any of the limits is active then the integrator accumulator is held.

14.015	**PID 1 output scaling**								
14.045	**PID 2 output scaling**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.016	**PID 1 output destination parameter**								
14.046	**PID 2 output destination parameter**								
RW	Uni		DE				PT	US	
⇕	Pr **0.000** to Pr **50.099**	⇨	Pr **0.000**						

14.017	**PID 1 integrator hold**								
14.047	**PID 2 integrator hold**								
RW	Bit					NC		US	
⇕	OFF (0) or On (1)	⇨	OFF (0)						

When this parameter is set to OFF (0) the integrator operates normally. Setting this parameter to On (1) will cause the integrator value to be held. Setting this parameter does not prevent the integrator from being reset to zero if the PID controller is disabled.

14.018	**PID 1 symmetrical limit enable**								
14.048	**PID 2 symmetrical limit enable**								
RW	Bit							US	
⇕	OFF (0) or On (1)	⇨	OFF (0)						

14.019	**PID 1 main reference**								
14.049	**PID 2 main reference**								
RO	Bi					NC	PT	US	
⇕	±100.00 %	⇨							

14.020	**PID 1 reference**								
14.050	**PID 2 reference**								
RO	Bi					NC	PT	US	
⇕	±100.00 %	⇨							

14.021	**PID 1 feedback**								
14.051	**PID 2 feedback**								
RO	Bi					NC	PT	US	
⇕	±100.00 %	⇨							

14.022	**PID 1 error**								
14.052	**PID 2 error**								
RO	Bi					NC	PT	US	
⇕	±100.00 %	⇨							

14.023	**PID 1 reference scaling**								
14.053	**PID 2 reference scaling**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.024	**PID 1 feedback scaling**								
14.054	**PID 2 feedback scaling**								
RW	Uni							US	
⇕	0.000 to 4.000	⇨	1.000						

14.025	**PID 1 digital reference**								
14.055	**PID 2 digital reference**								
RW	Bi					NC			
⇕	±100.00 %	⇨	0.00						

14.026	**PID 1 digital feedback**								
14.055	**PID 2 digital feedback**								
RW	Bi					NC			
⇕	±100.00 %	⇨	0.00						

14.027	**PID 1 optional enable source parameter 2**								
RW	Uni						PT	US	
⇕	0.00 to 50.99	⇨	0.00						

14.028	**PID 1 pre-sleep boost level**								
RW	Uni							US	
⇕	0.00 to 100.00 %	⇨	0.00						

14.029	**Maximum boost time**								
RW	Uni							US	
⇕	0.0 to 250.0 s	⇨	0.0						

14.030	**PID 1 pre-sleep boost level enable**								
RO	Bit					NC	PT		
⇕	OFF (0) or On (1)	⇨							

If PID is used to control the motor output via Menu 1 and sleep mode is enabled, then the drive will automatically stop the motor when the output drops below the sleep/wake threshold. The feedback may then fall causing the output and hence the feedback to rise again. Setting Pr **14.028** and Pr **14.029** to non zero values results in the value in Pr **14.028** being added to the PID reference for a length of time defined in Pr **14.029** when the drive attempts to enter sleep mode.. This will reduce the frequency of the transitions into sleep mode. Pr **14.030** indicates when the boost system is enabled.

14.038	**PID 2 enable**								
RW	Uni							US	
⇕	0 to 2	⇨	0						

Parameter value	PID enable state
0	PID 2 disabled; output is zero and integrator reset to zero
1	PID 2 enabled
2	PID 2 enable state follows PID 1 enable state

14.058	**PID 1 feedback output scaling**								
RW	Uni							US	
	0.000 to 4.000		0.000						

Pr **14.058** allows scaling to be applied to the combined feedback signal from PID controller 1 and PID controller 2 after the square root function has been applied.

14.060	**PID 1 Square root enable**								
14.061	**PID 2 Square root enable**								
RW	Bit							US	
	OFF (0) or On (1)		OFF (0)						

14.062	**Combined PID square root enable**								
RW	Uni							US	
	OFF (0) or On (1)		OFF (0)						

The square root functions in the feedback paths are enabled or disabled with Pr **14.060**, Pr **14.061** and Pr **14.062**.

When the square root function is enabled, the following algorithm is applied to the feedback.

Square root function output = Sign(Feedback) x 100.00% x v(|Feedback| / 100.00%)

where Sign(Feedback) is 1 if the feedback is positive or -1 is the feedback is negative.

14.059	**PID mode selector**								
RW	Uni							US	
	0 to 7		0						

Single setpoint, single feedback (Pr **14.059** = 0 or 1)

The two PID controllers operate independently. The feedback for PID2 is always from the PID2 feedback input. PID1 feedback can select one of two sensors as shown in the table below.

Parameter 14.059	Final PID1 feedback
0	PID1 feedback
1	PID2 feedback

Single setpoint, dual feedback (Pr **14.059** = 2 to 5)

PID1 feedback is from two sensors, which can be configured as shown in the table below.

Parameter 14.059	Final PID1 feedback
2	PID1 feedback + PID2 feedback
3	Lowest of PID1 feedback and PID2 feedback
4	Highest of PID1 feedback and PID2 feedback
5	(PID1 feedback + PID2 feedback) / 2

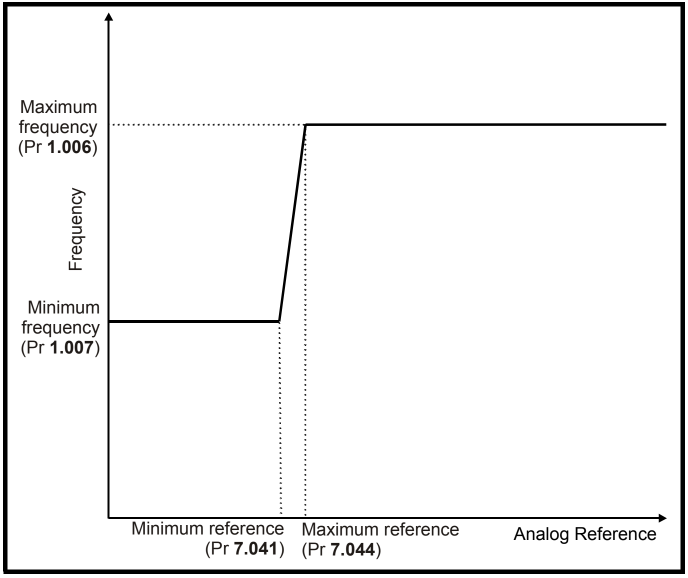
Dual setpoint, dual feedback (Pr **14.059** = 6 to 7)

When PID mode 6 or 7 is selected the controller operates in a dual zone mode. In this mode the reference and feedback quantities from each PID controller are used to calculate two controller errors. These two errors are then checked and the zone with the larger or smaller absolute value of error (depending upon mode selected) is used as the error signal to the PID1 controller.

Parameter 14.059	PID1 Error
6	Lowest of |PID1 Error| or |PID2 Error|
7	Highest of |PID1 Error| or |PID2 Error|

8.4.7 Analog reference profile

If analog input 2 is used as a reference, then the following reference profile can be configured.



For example, if the following is required:

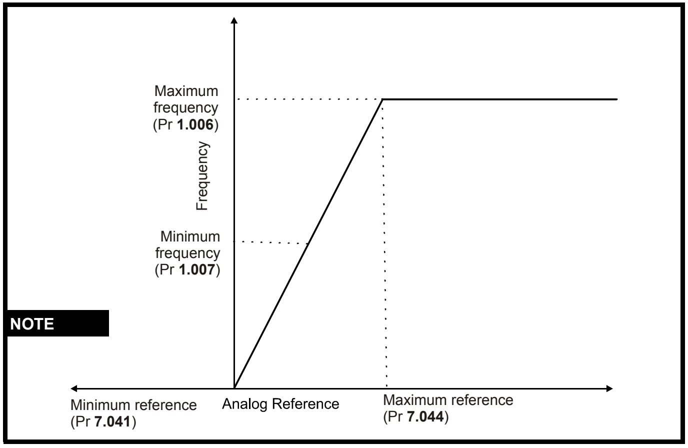
- Output frequency = 20 Hz when analog reference < 25%,
- Output frequency = 60 Hz when analog reference > 75%,
- Output frequency = linear ramp between 20 and 60 Hz when analog reference is between 25 and 75 %, then the parameters should be set as follows:
- Pr **1.006** = 60
- Pr **1.007** = 20
- Pr **7.041** = 25
- Pr **7.044** = 75

NOTE

If Pr **7.041** is greater than or equal to Pr **7.044**, analog input 2 (Pr **7.002**) will be forced to 0%, so the output frequency will always be equal to the value in Pr **1.007**.

NOTE

If Pr **7.041** is negative and Pr **7.044** positive, the minimum reference will be forced to zero, so the profile will be as shown below.



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.

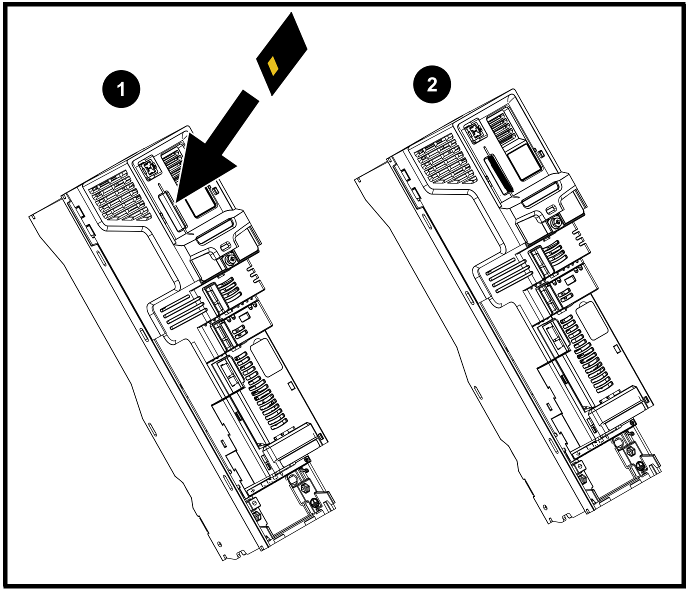
Ensure the NV Media Card is inserted with the contacts facing the left-hand side of the drive.

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

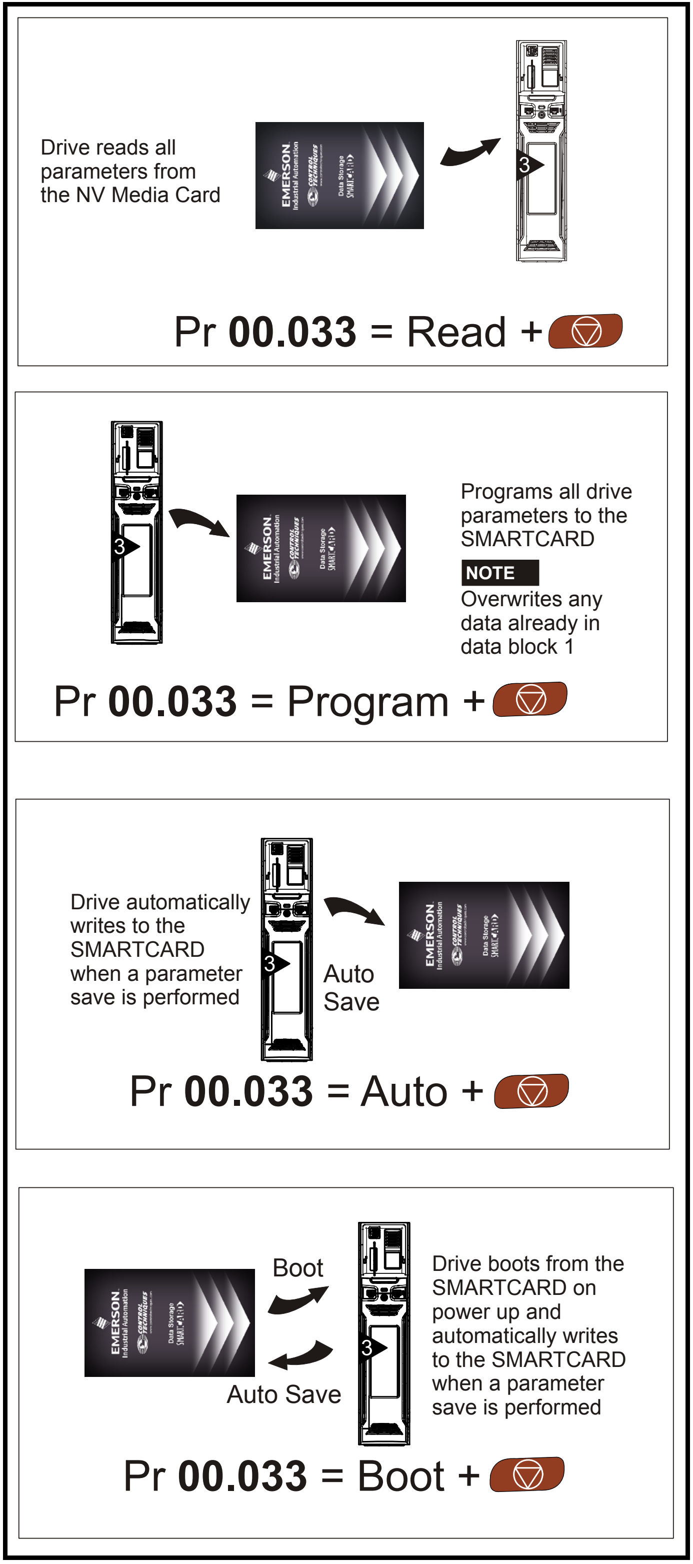
The NV Media Card can be used to store drive parameter sets and / or PLC programs set from the H300 in data blocks 001 to 499 on the card.

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 HVAC drive 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 HVAC drive 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



Drive reads all parameters from the NV Media Card

Pr **00.033** = Read +

Programs all drive parameters to the SMARTCARD

NOTE

Overwrites any data already in data block 1

Pr **00.033** = Program +

Drive automatically writes to the SMARTCARD when a parameter save is performed

Pr **00.033** = Auto +

Drive boots from the SMARTCARD on power up and automatically writes to the SMARTCARD when a parameter save is performed

Pr **00.033** = Boot +

The whole card may be protected from accidental writing or erasing by setting the read-only flag as detailed in section 9.3.9 *9888 / 9777 - Setting and clearing the NV Media Card read only flag* on page 167.

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 and SD 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.

9.3.1 Writing to the NV Media Card

4yyy - Writes defaults differences to the NV Media Card

The data block only contains the parameter differences from the last time default settings were loaded.

All parameters except those with the NC (Not copied) coding bit set are transferred to the NV Media Card. In addition to these parameters all menu 20 parameters (except Pr **20.000**), can be transferred to the NV Media Card.

Writing a parameter set to the NV Media Card (Pr 11.042 = Program (2))

Setting Pr **11.042** to Program (2) and resetting the drive will save the parameters to the NV Media Card, i.e. this is equivalent to writing 4001 to Pr **mm.000**. All NV Media Card trips apply except 'Card Change'. If the data block already exists it is automatically overwritten. When the action is complete this parameter is automatically reset to None (0).

9.3.2 Reading from the NV Media Card

6yyy - Reading from NV Media Card

When the data is transferred back to the drive, using 6yyy in Pr **mm.000**, it is transferred to the drive RAM and the EEPROM. A parameter save is not required to retain the data after-power down. Set up data for any option modules installed stored on the card are transferred to the drive. If the option modules installed are different between source and destination drives, the menus for the option module slots where the option module categories are different are not updated from the card and will contain their default values after the copying action. The drive will produce a 'Card Option' trip if the option module installed to the source and the destination drives are different or are in different slots. If the data is being transferred to the drive with different voltage or current rating a 'Card Rating' trip will occur.

The following drive rating dependant parameters (RA coding bit set) will not be transferred to the destination drive by a NV Media Card when the voltage rating of the destination drive is different from the source drive and the file is a parameter file. However, drive rating dependent parameters will be transferred if only the current rating is different. If drive rating dependant parameters are not transferred to the destination drive they will contain their default values.

Pr **02.008** *Standard Ramp Voltage*

Pr **04.005** to Pr **04.007** *Motoring Current Limits*

Pr **04.024**, *User Current Maximum Scaling*

Pr **05.007** *Rated Current*

Pr **05.009** *Rated Voltage*

Pr **05.010** *Rated Power Factor*

Pr **05.017** *Stator Resistance*

Pr **05.018** *Maximum Switching Frequency*

Pr **05.024** *Transient Inductance*

Pr **05.025** *Stator Inductance*

Pr **06.006** *Injection Braking Level*

Pr **06.048** *Supply Loss Detection Level*

Pr **06.065** *Standard Under Voltage Threshold*

Pr **06.066** *Low Under Voltage Threshold*

Reading a parameter set from the NV Media Card (Pr 11.042 = Read (1))

Setting Pr **11.042** to Read (1) and resetting the drive will transfer the parameters from the card into the drive parameter set and the drive EEPROM, i.e. this is equivalent to writing 6001 to Pr **mm.000**.

All NV Media Card trips apply. Once the parameters are successfully copied this parameter is automatically reset to None (0). Parameters are saved to the drive EEPROM after this action is complete.

9.3.3 Auto saving parameter changes (Pr 11.042 = Auto (3))

This setting causes the drive to automatically save any changes made to menu 0 parameters on the drive to the NV Media Card. The latest menu 0 parameter set in the drive is therefore always backed up on the NV Media Card. Changing Pr **11.042** to Auto (3) and resetting the drive will immediately save the complete parameter set from the drive to the card, i.e. all parameters except parameters with the NC coding bit set. Once the whole parameter set is stored only the individual modified menu 0 parameter setting is updated.

Advanced parameter changes are only saved to the NV Media Card when Pr **mm.000** is set to 'Save Parameters' or 1001 and the drive reset.

All NV Media Card trips apply, except 'Card Change'. If the data block already contains information it is automatically overwritten.

If the card is removed when Pr **11.042** is set to 3 Pr **11.042** is then automatically set to None (0).

When a new NV Media Card is installed Pr **11.042** must be set back to Auto (3) by the user and the drive reset so the complete parameter set is rewritten to the new NV Media Card if auto mode is still required.

When Pr **11.042** is set to Auto (3) and the parameters in the drive are saved, the NV Media Card is also updated, and therefore the NV Media Card becomes a copy of the drives stored configuration.

At power up, if Pr **11.042** is set to Auto (3), the drive will save the complete parameter set to the NV Media Card. The drive will display 'Card Write' during this operation. This is done to ensure that if a user puts a new NV Media Card in during power down the new NV Media Card will have the correct data.

NOTE

When Pr **11.042** is set to Auto (3) the setting of Pr **11.042** itself is saved to the drive EEPROM but not the NV Media Card.

9.3.4 Booting up from the NV Media Card on every power up (Pr 11.042 = Boot (4))

When Pr **11.042** is set to Boot (4) the drive operates the same as Auto mode except when the drive is powered-up. The parameters on the NV Media Card will be automatically transferred to the drive at power up if the following are true:

- A card is inserted in the drive
- Parameter data block 1 exists on the card
- The data in block 1 is type 1 to 4 (as defined in Pr **11.038**)
- Pr **11.042** on the card set to Boot (4)

The drive will display 'Booting Parameters during this operation. If the drive mode is different from that on the card, the drive gives a 'Card Drive Mode' trip and the data is not transferred.

If 'Boot' mode is stored on the copying NV Media Card this makes the copying NV Media Card the master device. This provides a very fast and efficient way of re-programming a number of drives.

NOTE

'Boot' mode is saved to the card, but when the card is read, the value of Pr **11.042** is not transferred to the drive.

9.3.5 Booting up from the NV Media Card on every power up (Pr mm.000 = 2001)

It is possible to create a bootable parameter data block by setting Pr **mm.000** to 2001 and initiating a drive reset. This data block is created in one operation and is not updated when further parameter changes are made.

Setting Pr **mm.000** to 2001 will overwrite the data block 1 on the card if it already exists.

9.3.6 8yyy - Comparing the drive full parameter set with the NV Media Card values

Setting 8yyy in Pr **mm.000**, will compare the NV Media Card file with the data in the drive. If the compare is successful Pr **mm.000** is simply set to 0. If the compare fails a 'Card Compare' trip is initiated.

9.3.7 7yyy / 9999 - Erasing data from the NV Media Card values

Data can be erased from the NV Media Card either one block at a time or all blocks in one go.

- Setting 7yyy in Pr **mm.000** will erase NV Media Card data block yyy
- Setting 9999 in Pr **mm.000** will erase all the data blocks on a SMARTCARD, but not on an SD Card.

9.3.8 9666 / 9555 - Setting and clearing the NV Media Card warning suppression flag

If the option modules installed to the source and destination drive are different or are in different slots the drive will produce a 'Card Option' trip. If the data is being transferred to a drive of a different voltage or current rating a 'Card Rating' trip will occur. It is possible to suppress these trips by setting the warning suppression flag. If this flag is set the drive will not trip if the option module(s) or drive ratings are different between the source and destination drives. The options module or rating dependent parameters will not be transferred.

- Setting 9666 in Pr **mm.000** will set the warning suppression flag
- Setting 9555 in Pr **mm.000** will clear the warning suppression flag

9.3.9 9888 / 9777 - Setting and clearing the NV Media Card read only flag

The NV Media Card may be protected from writing or erasing by setting the read only flag. If an attempt is made to write or erase a data block when the read only flag is set, a 'Card Read Only' trip is initiated. When the read only flag is set only codes 6yyy or 9777 are effective.

- Setting 9888 in Pr **mm.000** will set the read only flag
- Setting 9777 in Pr **mm.000** will clear the read only flag

9.4 Data block header information

Each data block stored on a NV Media Card has header information detailing the following:

- *NV Media Card File Number* (11.037)
- *NV Media Card File Type* (11.038)
- *NV Media Card File Version* (11.039)
- *NV Media Card File Checksum* (11.040)

The header information for each data block which has been used can be viewed in Pr **11.038** to Pr **11.040** by increasing or decreasing the data block number set in Pr **11.037**. If there is no data on the card Pr **11.037** can only have a value of 0.

9.5 NV Media Card parameters

Table 9-2 Key to parameter table coding

RW	Read / Write	ND	No default value
RO	Read only	NC	Not copied
Num	Number parameter	PT	Protected parameter
Bit	Bit parameter	RA	Rating dependant
Txt	Text string	US	User save
Bin	Binary parameter	PS	Power-down save
FI	Filtered	DE	Destination

11.036 {00.032}	**NV Media Card File Previously Loaded**								
RO	Num					NC	PT		
OL **RFC-A** **RFC-S**	⇕	0 to 999	⇨	0					

This parameter shows the number of the data block last transferred from a NV Media Card to the drive. If defaults are subsequently reloaded this parameter is set to 0.

11.037	**NV Media Card File Number**								
RW	Num								
OL **RFC-A** **RFC-S**	⇕	0 to 999	⇨	0					

This parameter should have the data block number which the user would like the information displayed in Pr **11.038**, Pr **11.039** and Pr **11.040**.

11.038	**NV Media Card File Type**								
RO	Txt				ND	NC	PT		
OL **RFC-A** **RFC-S**	⇕	None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6)	⇨						

Displays the type/mode of the data block selected with Pr **11.037**.

Pr 11.038	String	Type / mode
0	None	No file selected
1	Open-loop	Open-loop mode parameter file
2	RFC-A	RFC-A mode parameter file
3	RFC-S	RFC-S mode parameter file
4	Regen	Regen mode parameter file
5	User Prog	Onboard user program file
6	Option App	Option module application file

11.039	**NV Media Card File Version**								
RO	Num				ND	NC	PT		
OL **RFC-A** **RFC-S**	⇕	0 to 9999	⇨						

Displays the version number of the file selected in Pr **11.037**.

11.040	**NV Media Card File Checksum**								
RO	Num				ND	NC	PT		
OL **RFC-A** **RFC-S**	⇕	--2147483648 to 2147483647	⇨						

Displays the checksum of the data block selected in Pr **11.037**.

11.042 {00.033}	**Parameter Cloning**								
RW	Txt					NC		US*	
OL **RFC-A** **RFC-S**	⇕	None (0), Read (1), Program (2), Auto (3), Boot (4)	⇨	None (0)					

* Only a value of 3 or 4 in this parameter is saved.

NOTE

If Pr **11.042** is equal to 1 or 2, this value is not transferred to the drive or saved to the EEPROM. If Pr **11.042** is set to 3 or 4 the value is saved to the EEPROM

None (0) = Inactive

Read (1) = Read parameter set from the NV Media Card

Program (2) = Program a parameter set to the NV Media Card

Auto (3) = Auto save

Boot (4) = Boot mode

11.072	**NV Media Card Create Special File**								
RW	Num					NC			
OL **RFC-A** **RFC-S**	⇕	0 to 1	⇨	0					

If *NV Media Card Create Special File* (11.072) = 1 when a parameter file is transferred to an NV media card the file is created as a macro file. *NV Media Card Create Special File* (11.072) is reset to 0 after the file is created or the transfer fails.

11.073	**NV Media Card Type**								
RO	Txt				ND	NC	PT		
OL **RFC-A** **RFC-S**	⇕	None (0), SMART Card (1), SD Card (2)	⇨						

This will display the type of media card inserted; it will contain one of the following values:

"None" (0) - No NV Media Card has been inserted.

"SMART Card" (1) - A SMARTCARD has been inserted.

"SD Card" (2) - A FAT formatted SD card has been inserted.

11.075	**NV Media Card Read-only Flag**								
RO	Bit				ND	NC	PT		
OL **RFC-A** **RFC-S**	⇕	Off (0) or On (1)	⇨						

NV Media Card Read-only Flag (11.075) shows the state of the read-only flag for the currently installed card.

11.076	**NV Media Card Warning Suppression Flag**								
RO	Bit				ND	NC	PT		
OL	⇕	Off (0) or On (1)	⇨						
RFC-A									
RFC-S									

NV Media Card Warning Suppression Flag (11.076) shows the state of the warning flag for the currently installed card.

11.077	**NV Media Card File Required Version**								
RW	Num				ND	NC	PT		
OL	⇕	0 to 9999	⇨						
RFC-A									
RFC-S									

The value of *NV Media Card File Required Version* (11.077) is used as the version number for a file when it is created on an NV Media Card. *NV Media Card File Required Version* (11.077) is reset to 0 when the file is created or the transfer fails.

9.6 NV Media Card trips

After an attempt to read, write or erase data from a NV Media Card a trip is initiated if there has been a problem with the command.

See Chapter 13 *Diagnostics* on page 284 for more information on NV Media Card trips.

10 Building Automation

10.1 Introduction

The HVAC drive H300 supports the following protocols:

- Modbus RTU
- BACnet MSTP
- Metasys N2 Open

As standard the H300 Drive is provided with a 2 wire EIA-485 interface located beneath the control terminals (see Figure 10-1). All three protocols use this communication interface.

Figure 10-1 Location of the comms connector

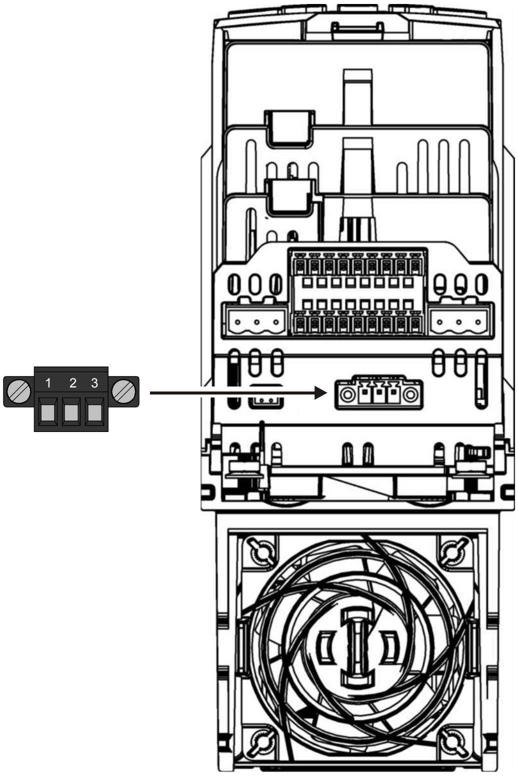


Table 10-1 Serial communication port pin-outs

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

10.2 Building automation network communications set up parameters

10.2.1 Serial Address

Serial Address (Pr **11.023**) selects the MAC/Node Address for all protocols.

Table 10-2 Protocols

		Allowable MAC Address Values		
Protocol	**Master / Slave**	**Minimum**	**Maximum**	**Broadcast**
Modbus RTU	Slave	1	247	0
BACnet*	Master	0	127	255
MetaSys N2	Slave	1	255	0

If a MAC address is selected that is greater than or less than those allowed by the currently selected protocol then the actual address used will be the maximum valid address value. The parameter value will change to reflect the value being used.

*The BACnet module is a master device. As such it will instigate an *I-Am* broadcast message onto the BACnet network at power-up and on each subsequent drive reset.

10.2.2 Serial Mode

Serial Mode (Pr **11.024**) defines the data format used by the serial comms interface. The bits in the value of Serial Mode define the data format as follows:

Table 10-3 Serial mode bits

Bits	3	2	1 and 0
Format	Number of data bits 0 = 8 bits 1 = 7 bits	Register mode 0 = Standard 1 = Modified	Stop bits and Parity 0 = 2 stop bits, no parity 1 = 1 stop bit, no parity 2 = 1 stop bit, even parity 3 = 1 stop bit, odd parity

For the Modbus RTU protocol bit, 3 should always be set to 0 as 8 data bits are required. The parameter value can be extended with the remaining communication protocols if required.

Bit 2 selects either standard or modified register mode. The menu and parameter numbers are derived for each mode as given in the table below. Standard mode is compatible with Unidrive SP. Modified mode is provided to allow register numbers up to 255 to be addressed.

Table 10-4 Register mode

Register mode	Register address
Standard	(mm x 100) + ppp - 1 where mm ≤ 162 and ppp ≤ 99
Modified	(mm x 256) + ppp - 1 where mm ≤ 63 and ppp ≤ 255

Table 10-5 Serial mode

Pr 11.024	Description
0	8 2 NP
1	8 1 NP
2	8 1 EP
3	8 1 OP
4	8 2 NP M
5	8 1 NP M
6	8 1 OP M
7	8 1 OP M
8	7 2 NP
9	7 1 NP
10	7 1 EP
11	7 1 OP
12	7 2 NP M
13	7 1 NP M
14	7 1 EP M
15	7 1 OP M

Changing the parameters does not immediately change the serial communications settings. Revised values will only be used after the next power-up or if *Reset Serial Communications* (Pr **11.020**) is set to one.

10.2.3 Serial baud rate

Serial Baud Rate (Pr **11.025**) defines the baud rate used by the serial comms interface.

Table 10-6 Serial baud rate

Pr 11.025	Description
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400
8	57600
9	76800
10	115200

Revised values will only be used after the next power-up or if *Reset Serial Communications* (Pr **11.020**) is set to one.

10.2.4 Building automation network (BAN) protocol selection

Building automation network (BAN) protocol selection (Pr **29.001**) selects the network protocol:

Table 10-7 BAN protocol

Pr 29.001	Protocol
0	Modbus RTU
1	BACnet MSTP
2	MetaSys N2 Open

The following process should be followed to change the communication protocol:

1. Select the required protocol in Pr **29.001**.
2. Perform a parameter save.
3. Power cycle the drive.

10.2.5 BACnet MS/TP Maximum Master MAC Address

(Pr **29.003**) BACnet use only

This is highest address that the drive will use when looking for the next master on the network with which token passing can be achieved.

If a value greater than 127 is entered then the value used will be 127. The parameter value will change to 127 to reflect this.

10.2.6 Device Object Identifier

(Pr **29.004**) BACnet use only

This number uniquely defines this device on the entire network.

10.2.7 Communications lost detection time-out period

Communications Lost Detection Time-Out Period (Pr **29.005**) sets the period in seconds that the drive will wait to see a valid communications frame on the network before taking the action specified in *Communications Lost Action* (Pr **29.006**).

10.2.8 Communications lost action

Communications Lost Action (Pr **29.006**) determines the drive action when communication is lost.

BACnet

The network is monitored for the presence of an active token; should this token disappear for the time specified, the drive will take the configured action.

MetaSys

The network is monitored for any message. Receipt of a valid message (regardless of intended destination) will be seen as communications being healthy. If no valid message is received within the time specified, the drive will take the configured action.

The following action is taken when loss of communication is recognized:

Table 10-8 Communications lost action

Pr 29.006	Action	Comment
0	Do nothing	The drive will continue as it was before communications was lost
1	Trip the drive	The drive will trip when communications is lost (sub trip 50)
2	Move to a fixed speed	Preset speed 8 is used to define this speed, see below

The move to fixed speed option will only operate if the drive is configured to use preset speed 1 as the reference at the time communications is lost.

Every time there is a transition from the communications healthy state to the communications lost state the reference value set in preset speed 8 will be transferred to preset speed 1 causing the drive to run at the speed defined in preset speed 8.

The drive will continue to run at this speed until such time as the user manually changes preset speed 1 via the keypad or communications returns and a new speed reference is provided via the building automation network

10.3 CT Modbus RTU specification (EIA-485)

This section describes the adaptation of the MODBUS RTU protocol offered on Control Techniques' products.

MODBUS RTU is a master slave system with half-duplex message exchange. The Control Techniques (CT) implementation supports the core function codes to read and write registers. A scheme to map between MODBUS registers and CT parameters is defined. The CT implementation also defines a 32 bit extension to the standard 16 bit register data format.

10.3.1 MODBUS RTU

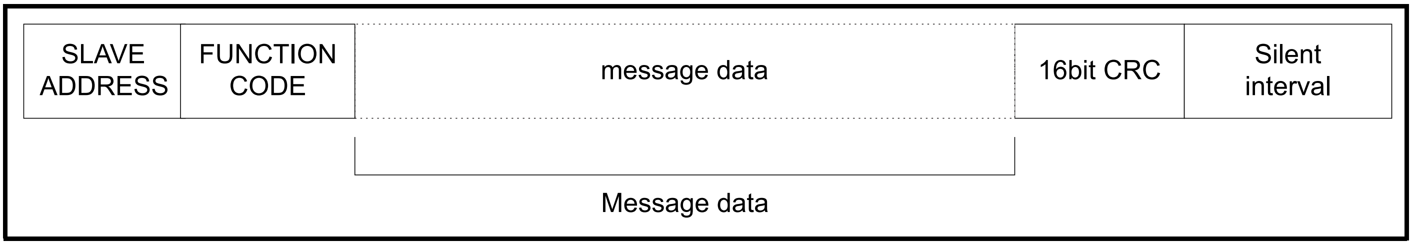
Physical layer

Attribute	Description
Normal physical layer for multi-drop operation	EIA-485 2 wire
Bit stream	Standard UART asynchronous symbols with Non Return to Zero (NRZ)
Symbol	Each symbol consists of:- 1 start bit 8 data bits (transmitted least significant bit first) 2 stop bits*
Baud rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200

* The drive will accept a packet with 1 or 2 stop bits but will always transmit 2 stop bits

RTU framing

The frame has the following basic format

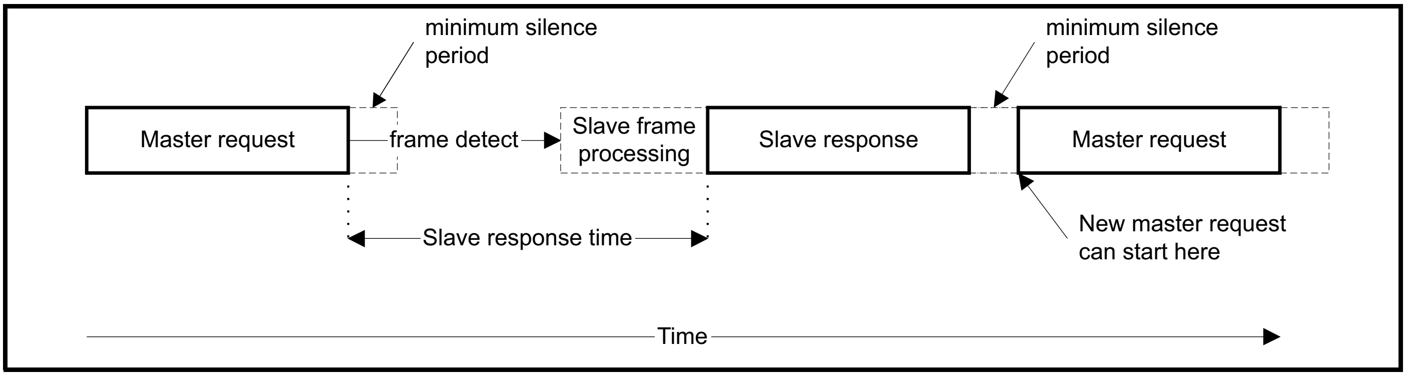


The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without any gaps greater or equal to the silence period. If an erroneous gap is inserted then receiving nodes may start frame processing early in which case the CRC will fail and the frame will be discarded.

MODBUS RTU is a master slave system. All master requests, except broadcast requests, will lead to a response from an individual slave. The slave will respond (i.e. start transmitting the response) within the quoted maximum slave response time (this time is quoted in the data sheet for all Control Techniques products). The minimum slave response time is also quoted but will never be less that the minimum silent period defined by 3.5 character times.

If the master request was a broadcast request then the master may transmit a new request once the maximum slave response time has expired.

The master must implement a message time out to handle transmission errors. This time out period must be set to the maximum slave response time + transmission time for the response.



10.3.2 Slave address

The first byte of the frame is the slave node address. Valid slave node addresses are 1 through 247 decimal. In the master request this byte indicates the target slave node; in the slave response this byte indicates the address of the slave sending the response.

Global addressing

Address zero addresses all slave nodes on the network. Slave nodes suppress the response messages for broadcast requests.

10.3.3 MODBUS registers

The MODBUS register address range is 16 bit (65536 registers) which at the protocol level is represented by indexes 0 through 65535.

PLC registers

Modicon PLCs typically define 4 register 'files' each containing 65536 registers. Traditionally, the registers are referenced 1 through 65536 rather than 0 through 65535. The register address is therefore decremented on the master device before passing to the protocol.

File type	Description	Supported
1	Read only bits ("coil")	Use register
2	Read / write bits ("coil")	Use register
3	Read only 16bit register	Yes
4	Read / write 16bit register	Yes

The register *file* type code is NOT transmitted by MODBUS and all register files can be considered to map onto a single register address space. However, specific function codes are defined in MODBUS to support access to the "coil" registers. All standard CT drive parameters are mapped to register file '4' and the coil function codes are not required.

CT parameter mapping

The Modbus register address is 16 bits in size, of which the upper two bits are used for data type selection leaving 14 bits to represent the parameter address, taking into account the slave increments the address value by 1, this results in a theoretical maximum parameter address of Pr **163.84** (limited to Pr **162.99** in software) when the default standard addressing mode (see *Serial Mode* Pr **11.024**) is used.

To access a parameter number above 99 in any drive menu then the modified addressing mode must be used (see *Serial Mode* Pr **11.024**), this will allow access to parameter numbers up to 255 but also limit the maximum menu number to 63.

The Modbus slave device increments the register address by 1 before processing the command, this effectively prevents access to parameter Pr **00.000** in the drive or option module.

The tables below shows how the start register address is calculated for both addressing modes.

Parameter	Addressing mode	Protocol register
0.mm.ppp	Standard	mm x 100 + ppp - 1
	Modified	mm x 256 + ppp - 1

Examples					
		16-bit		32-bit	
		Decimal	Hex	Decimal	Hex
0.01.021	Standard	120	0x00 78	16504	0x40 78
	Modified	276	0x01 14	16660	0x41 14
0.01.000	Standard	99	0x00 63	16483	0x40 63
	Modified	255	0x00 FF	16639	0x40 FF
0.03.161	Standard	N/A	N/A	N/A	N/A
	Modified	928	0x03 A0	17312	0x43 A0

Data types

The MODBUS protocol specification defines registers as 16 bit signed integers. All CT devices support this data size. Refer to the section 10.3.7 *Extended data types* on page 177 for detail on accessing 32 bit register data.

10.3.4 Data consistency

All CT devices support a minimum data consistency of one parameter (16 bit or 32 bit data). Some devices support consistency for a complete multiple register transaction.

10.3.5 Data encoding

MODBUS RTU uses a 'big-endian' representation for addresses and data items (except the CRC, which is 'little-endian'). This means that when a numerical quantity larger than a single byte is transmitted, the MOST significant byte is sent first. So for example

16 - bits	0x1234	would be sent as	0x12, 0x34
32 - bits	0x12345678	would be sent as	0x12, 0x34, 0x56, 0x78

10.3.6 Function codes

The function code determines the context and format of the message data. Bit 7 of the function code is used in the slave response to indicate an exception.

The following function codes are supported:

Code	Description
3	Read multiple 16 bit registers
6	Write single register
16	Write multiple 16 bit registers
23	Read and write multiple 16 bit registers

FC03 Read multiple

Read a contiguous array of registers. The slave imposes an upper limit on the number of registers, which can be read. If this is exceeded the slave will issue an exception code 2.

Table 10-9 Master request

Byte	Description
0	Slave destination node address 1 through 247, 0 is global (broadcast)
1	Function code 0x03
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers MSB
5	Number of 16 bit registers LSB
6	CRC LSB
7	CRC MSB

Table 10-10 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x03
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

FC06 Write single register

Writes a value to a single 16 bit register. The normal response is an echo of the request, returned after the register contents have been written. The register address can correspond to a 32 bit parameter but only 16 bits of data can be sent.

Table 10-11 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global (broadcast)
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

Table 10-12 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

FC16 Write multiple

Writes a contiguous array of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 10-13 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global (broadcast)
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers MSB
5	Number of 16 bit registers LSB
6	Length of register data to write (in bytes)
7	Register data 0 MSB
8	Register data 0 LSB
7+byte count	CRC LSB
8+byte count	CRC MSB

Table 10-14 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers written MSB
5	Number of 16 bit registers written LSB
6	CRC LSB
7	CRC MSB

FC23 Read/Write multiple

Writes and reads two contiguous arrays of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 10-15 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global (broadcast)
1	Function code 0x17
2	Start register address to read MSB
3	Start register address to read LSB
4	Number of 16 bit registers to read MSB
5	Number of 16 bit registers to read LSB
6	Start register address to write MSB
7	Start register address to write LSB
8	Number of 16 bit registers to write MSB
9	Number of 16 bit registers to write LSB
10	Length of register data to write (in bytes)
11	Register data 0 MSB
12	Register data 0 LSB
11+byte count	CRC LSB
12+byte count	CRC MSB

Table 10-16 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x17
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

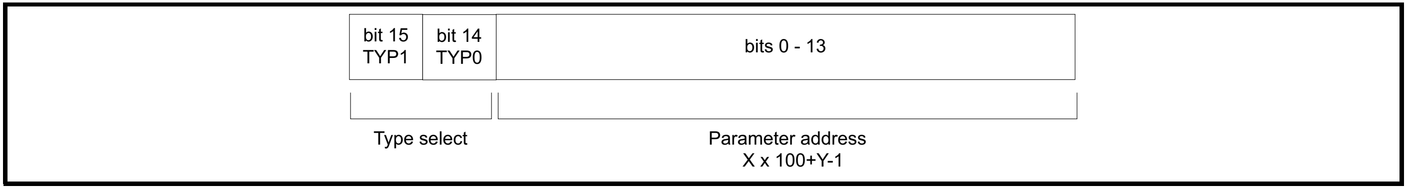
10.3.7 Extended data types

Standard MODBUS registers are 16bit and the standard mapping maps a single Pr **xx.yyy** (e.g.Pr **01.021**) to a single MODBUS register. To support 32 bit data types (integer and float) the MODBUS multiple read and write services are used to transfer a contiguous array of 16bit registers.

Slave devices typically contain a mixed set of 16 bit and 32 bit registers. To permit the master to select the desired 16 bit or 32 bit access the top two bits of the register address are used to indicate the selected data type.

NOTE

The selection is applied for the whole block access.



The 2bit type field selects the data type according to the table below:

Type field bits 15-14	Selected data type	Comments
00	INT16	backward compatible
01	INT32	-
10	Float32	Not supported
11	Reserved	-

If a 32 bit data type is selected then the slave uses two consecutive 16 bit MODBUS registers (in 'big endian'). The master must also set the correct 'number of 16 bit registers'.

Example, read Pr **20.021** through Pr **20.024** as 32 bit parameters using FC03 from node 8:

Table 10-17 Master request

Byte	Value (Hex)	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x47	Start register address Pr **20.021** (16384 + 2021 - 1) = 18404 = 0x47E4
3	0xE4	
4	0x00	Number of 16bit registers to read Pr **20.021** through Pr **20.024** is 4x32 bit registers = 8x16 bit registers
5	0x08	
6	CRC LSB	CRC
7	CRC MSB	CRC

Table 10-18 Slave response

Byte	Value (Hex)	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x10	Length of data (bytes) = 4x32 bit registers = 16 bytes
3-6	-	Pr **20.021** data
7-10	-	Pr **20.022** data
11-14	-	Pr **20.023** data
15-18	-	Pr **20.024** data
19	CRC LSB	CRC
20	CRC MSB	CRC

Reads when actual parameter type is different from selected

The slave will send the least significant word of a 32 bit parameter if that parameter is read as part of a 16 bit access.

The slave will sign extend the least significant word if a 16 bit parameter is accessed as a 32 bit parameter. The number of 16 bit registers must be even during a 32 bit access.

Example, If Pr **01.028** is a 32 bit parameter with a value of 0x12345678, Pr **01.029** is a signed 16 bit parameter with a value of 0xABCD, and Pr **01.030** is a signed 16 bit parameter with a value of 0x0123.

Read	Start register address	Number of 16 bit registers	Response (Hex)	Comments
Pr **01.028**	127	1	0x5678	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
Pr **01.028**	16511*	2	0x12345678	Full 32 bit access
Pr **01.028**	16511*	1	Exception 2	Number of words must be even for 32 bit access
Pr **01.029**	128	1	0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of data
Pr **01.029**	16512*	2	0xFFFFABCD	32 bit access to a 16 bit register will return 32 bit sign extended data
Pr **01.030**	16513*	2	0x00000123	32 bit access to a 16 bit register will return 32 bit sign extended data
Pr **01.028 to** Pr **01.029**	127	2	0x5678, 0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
Pr **01.028 to** Pr **01.029**	16511*	4	0x12345678, 0xFFFFABCD	Full 32 bit access

* Bit 14 is set to allow 32 bit access.

Writes when actual parameter type is different from selected

The slave will allow writing a 32 bit value to a 16 bit parameter as long as the 32 bit value is within the normal range of the 16 bit parameter.

The slave will allow a 16 bit write to a 32 bit parameter. The slave will sign extend the written value, therefore the effective range of this type of write will be -32768 to +32767.

Examples, if Pr **01.028** has a range of ±100000, and Pr **01.029** has a range of ±10000.

Write	Start register address	Number of 16bit registers	Data (Hex)	Comments
Pr **01.028**	127	1	0x1234	Standard 16 bit write to a 32bit register. Value written = 0x00001234
Pr **01.028**	127	1	0xABCD	Standard 16 bit write to a 32bit register. Value written = 0xFFFFABCD
Pr **01.028**	16511	2	0x00001234	Value written = 0x00001234
Pr **01.029**	128	1	0x0123	Value written = 0x0123
Pr **01.029**	16512	2	0x00000123	Value written = 0x00000123

* Bit 14 is set to allow 32 bit access

10.3.8 Exceptions

The slave will respond with an exception response if an error is detected in the master request. If a message is corrupted and the frame is not received or the CRC fails then the slave will not issue an exception. In this case the master device will time out. If a write multiple (FC16 or FC23) request exceeds the slave maximum buffer size then the slave will discard the message. No exception will be transmitted in this case and the master will time out.

Exception message format

The slave exception message has the following format.

Byte	Description
0	Slave source node address
1	Original function code with bit 7 set
2	Exception code
3	CRC LSB
4	CRC MSB

Exception codes

The following exception codes are supported.

Code	Description
1	Function code not supported
2	Register address out of range, or request to read too many registers

Parameter over range during block write FC16

The slave processes the write block in the order the data is received. If a write fails due to an out of range value then the write block is terminated. However, the slave does not raise an exception response, rather the error condition is signalled to the master by the number of successful writes field in the response.

Parameter over range during block read/write FC23

There will be no indication that there has been a value out of range during a FC23 access.

10.3.9 CRC

The CRC is a 16 bit cyclic redundancy check using the standard CRC-16 polynomial x16 + x15 + x2 + 1. The 16 bit CRC is appended to the message and transmitted LSB first.

The CRC is calculated on ALL the bytes in the frame.

10.3.10 Device compatibility parameters

All devices have the following compatibility parameters defined:

Parameter	Description
Device ID	Unique device identification code
Minimum slave response time	The minimum delay between the end of a message from the master and the time at which the master is ready to receive a response from the slave.
Maximum slave response time	When global addressing, the master must wait for this time before issuing a new message. In a network of devices, the slowest time must be used
Baud rate	Baud rate used by Modbus RTU
32 bit float data type supported	If this data type is not supported then an over range error will be raised if this data type is used
Maximum buffer size	Determines the maximum block size.

10.4 BACnet specification

The tables in the following sections describe the BACnet objects that are available on the drive. The device object is also produced when queried by a master on the network.

The *Present Value* property of each of the objects can be accessed in the manner indicated in the right-hand column of each of the object tables. The three access types are as follows:

Code	Type	Description
RO	Read only	The present value of these objects can only be read
RW	Read/write	The present value property of these objects can be both read from and written to. Writes from different BACnet devices will overwrite each other
C	Commanded	The present value property of these objects can be both read from and written to. Writes are accompanied by a priority level in the range 1 to 16, the underlying drive parameter is set to the value written at the highest priority level. All commandable objects support a writeable relinquish default property. The value of this property becomes the present value when no priority is provided.

The supported properties for each of the supported object types are given in the table below:

Object Property	Binary input	Binary output	Binary value	Analog input	Analog output	Analog value
Object_Identifer	✓	✓	✓	✓	✓	✓
Object_Name	✓	✓	✓	✓	✓	✓
Object_Type	✓	✓	✓	✓	✓	✓
Present_Value	✓	✓	✓	✓	✓	✓
Status_Flags	✓	✓	✓	✓	✓	✓
Event_State	✓	✓	✓	✓	✓	✓
Reliability	✓	✓	✓	✓	✓	✓
Out_Of_Service	✓	✓	✓	✓	✓	✓
Units	x	x	x	✓	✓	✓
Priority_Array*	x	✓	✓	x	✓	✓
Relinquish_ Default*	x	✓	✓	x	✓	✓
Polarity**	✓	✓	x	x	x	x

*Only commandable objects will have priority_array and Relinquish_Default properties.

**The polarity property is read-only for all objects that support it, and can only be changed via the invert parameter associated with the input/output represented by the object.

Analog input objects

Object ID (AI*n*)	Object name	Description	Present value access mode
1	Drive analog input 1	Analog input 1 on drive (Pr **07.001**)	RO
2	Drive analog input 2	Analog input 2 on drive (Pr **07.002**)	RO
3	Drive analog input 3	Analog input 3 on drive (Pr **07.003**)	RO
4	Module x analog input 1	The first available analog input on a Solutions Module.	RO
↓	↓	↓	↓
n	Module x analog input *n*	The nth available analog input on a Solutions Module	RO

Analog output objects

To control an analog output via BACnet the source parameter for the output must be set to a read/write parameter on menu 18. (Pr **18.011** to Pr **18.030** are acceptable).

Object ID (AO*n*)	Object name	Description	Present value access mode
1	Drive analog output 1	Analog output 1 on drive	C
2	Drive analog output 2	Analog output 2 on drive	C
3	Module x analog output 1	The first available analog output on a Solutions Module	C
↓	↓	↓	↓
n	Module x analog output 1	The first available analog output on a Solutions Module	C

Device object properties

The following list describes the Device Object properties supported on the BAN interface with H300.

Table 10-19 Device Object properties

Device Object Property
APDU-timeout
Application software version
Database revision
Firmware revision
Local date
Local time
Max-APDU-length-accepted
Model name
Number of APDU retries
Object identifier
Object-list
Object-name
Object-type
Protocol object types supported
Protocol-version
Segmentation-supported
System-status
Vendor-identifier
Vendor-name

Table 10-20 Analog value objects

Object ID (AV*n*)	Object name	Description	Present value access mode
1	Drive parameter	The drive parameter to read/write	RW
2	Parameter value	The new value for the parameter, or the value read from the parameter	RW
3	Parameter read/write	Whether the parameter should be read or written (1 = write, 2 = read)	RW
4	Speed reference	The required output frequency/speed reference (Pr **01.021**)	C
5	Maximum speed reference	The maximum reference clamp value (Pr **01.006**)	RW
6	Output current	Motor output current magnitude (Pr **04.001**)	RO
7	Output torque	Motor output torque (Pr **04.020**) as a percentage of full load	RO
8	Output frequency	Drive output frequency (Pr **05.001**)	RO
9	Output speed	Motor speed (Pr **05.004**)	RO
10	Output power	Drive output power (Pr **05.003**)	RO
11	Drive status word	Drive status word (Pr **10.040**)	RO
12	User trip parameter	User trip (Pr **10.38**)	RW
13	Last trip	Last drive trip (Pr **10.020**)	RO
14	Filter change (dt)	Time between filter changes (Pr **06.021**)	RW
15	Time to next filter change	Time before filter change due (Pr **06.023**)	RO
16	Energy meter (MWH)	Energy meter (MWh) (Pr **06.025**)	RO
17	Energy meter (KWH)	Energy meter (kWh) (Pr **06.026**)	RO
18	PID 1 digital reference	Digital reference for PID 1 (Pr **14.025**)	C
19	PID 1 digital feedback	Digital feedback for PID 1 (Pr **14.026**)	C
20	PID 1 reference	Sum of all reference inputs to PID 1 (Pr **14.020**)	RO
21	PID 1 feedback	Sum of all feedback inputs to PID 1 (Pr **14.021**)	RO
22	PID 1 output	The output from PID 1 (Pr **14.001**)	RO
23	PID 2 digital reference	Digital reference for PID 2 (Pr **14.055**)	C
24	PID 2 digital feedback	Digital feedback for PID 2 (Pr **14.056**)	C
25	PID 2 reference	Sum of all reference inputs to PID 2 (Pr **14.050**)	RO
26	PID 2 feedback	Sum of all feedback inputs to PID 2 (Pr **14.051**)	RO
27	PID 2 output	The output from PID 2 (Pr **14.031**)	RO
28	Universal parameter access	User selectable parameter 1 (Pr **29.010**)	RW/RO/C
29	Universal parameter access	User selectable parameter 2 (Pr **29.011**)	RW/RO/C
30	Universal parameter access	User selectable parameter 3 (Pr **29.012**)	RW/RO/C
31	Universal parameter access	User selectable parameter 4 (Pr **29.013**)	RW/RO/C
32	Universal parameter access	User selectable parameter 5 (Pr **29.014**)	RW/RO/C
33	Universal parameter access	User selectable parameter 6 (Pr **29.015**)	RW/RO/C
34	Universal parameter access	User selectable parameter 7 (Pr **29.016**)	RW/RO/C
35	Universal parameter access	User selectable parameter 8 (Pr **29.017**)	RW/RO/C
36	Universal parameter access	User selectable parameter 9 (Pr **29.018**)	RW/RO/C
37	Universal parameter access	User selectable parameter 10 (Pr **29.019**)	RW/RO/C

Table 10-21 Binary input objects

Object ID (BIn)	Object name	Description	Present value access mode
1	Drive binary input 1	Digital input 1 on drive (bi-dir Pr **08.001**)	RO
2	Drive binary input 2	Digital input 2 on drive (bi-dir Pr **08.002**)	RO
3	Drive binary input 3	Digital input 3 on drive (bi-dir Pr **08.003**)	RO
4	Drive binary input 4	Digital input 4 on drive (bi-dir Pr **08.004**)	RO
5	Drive binary input 5	Digital input 5 on drive (bi-dir Pr **08.005**)	RO
6	Drive binary input 6	Digital input 6 on drive (bi-dir Pr **08.006**)	RO
7	Drive binary input 7	Drive enable input (Pr **08.009**)	RO

Table 10-22 Binary output objects

Object ID (BOn)	Object name	Description	Present value access mode
1	Drive binary output 1	Digital output 1 on drive (bi-dir Pr **08.001**)	C
2	Drive binary output 2	Digital output 2 on drive (bi-dir Pr **08.002**)	C
3	Drive binary output 3	Digital output 3 on drive (bi-dir Pr **08.003**)	C
4	Drive binary output 4	24V Output (Pr **08.008**)	C
5	Drive binary relay 1	Drive relay 1 (Pr **08.007**)	C
6	Drive binary relay 2	Drive relay 2 (Pr **08.045**)	C

To control a binary output via BACnet the source parameter for the output must be set to a read/write bit parameter on menu 18. (Pr **18.031** to Pr **18.050** are acceptable).

Table 10-23 Binary value objects

Object ID (BVn)	Object name	Description	Present value access mode
1	Reset energy meter	Reset drive energy meter (Pr **06.024**)	RW
2	Filter change required	Filter change required/done (Pr **06.022**)	RW*
3	Drive run forward	Run forward (Pr **06.030**)	C
4	Drive Heathy	Drive Heathy indication (Pr **10.001**)	RO
5	Drive warning	Drive warning/alarm state (Pr **10.019**)	RO
6	Drive reset	Drive reset (Pr **10.033**)	RW**

* Filter change required / done (Pr **06.022**) can only be set to inactive (Boolean FALSE)

Drive reset (Pr **10.033) will be initiated when set from inactive (Boolean FALSE) to active (Boolean TRUE)

10.5 Metesys N2 specification

All Metasys command messages consist of three main parts: **beginning**, **middle**, and **end**. These message segments are described in the following sections.

Beginning

The beginning of each message (shown in bold) always contains the **Start Of Message** (**SOM**) character (**>**) followed by two characters representing the **address** of the intended Metasys device (01-FF).

Example: **>01**120A0297® read binary input attribute 2

In the above example, > is the start of message character and **01** is the Metasys device address.

Middle

The middle of a Metasys message (shown in bold) contains one or more hex characters. The first hex character is the Command; the characters that follow depend on the supplied command.

Example: >01**120A02**97® read binary input attribute 2

In the above example, "**1**" is the "Write Field" command. "**2**" is the "region" (binary input). "**0A**" is the Metasys object number (0A = 10 parameter Pr **08.009**) "**02**" is the attribute number (status).

End

The end of a Metasys message (shown in bold) always contains three characters: two characters representing the checksum followed by a carriage return (0x0A). The "®" character is used in these examples to represent the carriage return.

Example: >01120A02**97®** read binary input attribute 2

Compute the checksum by adding the hexadecimal values of all the ASCII characters in the message EXCLUDING the start of command character (>). Use the last two least significant digits as the checksum.

Checksum Example

Example: >01120A02**97**® is a valid Metasys message that includes a checksum.

Where **01120A02** is the data used to calculate the checksum.

NOTE

The start of message character is NOT part of the checksum calculation.

To produce the checksum add the decimal values of the ASCII characters that make up the command, convert the sum to Hex, and use the last two digits as the checksum:

Converting the characters (**01120A02**) to their ASCII hexadecimal equivalents, we have:

0x30 + 0x31 + 0x31 + 0x32 + 0x30 + 0x41 + 0x30 + 0x32 = 0x197

Retaining the last two least significant digits of the sum, the checksum is **0x97**

10.5.1 Region types

Metasys users will be able to configure any drive parameter and have "point access" to a subset of drive parameters. A "change of state" query will return a status indication of those "points" that changed recently plus the new current value. Alarms and warnings are also supported. In general, any Metasys commands that are identified to be "optional" are not supported by the H300 drive.

The sections below detail the Metasys N2 regions, points, commands, alarms and warnings supported by the H300 drive.

The Metasys protocol supports seven different kinds of "points"; these delineations are called regions. The supported region types are listed in the table below.

Table 10-24 Region types

Metasys Point Types		
Region	**Name**	**Description**
1	Analog Inputs	Drive Numeric Parameters that are Read-only
2	Binary Inputs	Drive Bit Parameters that are Read-only
3	Analog Outputs	Drive Numeric Parameters that are Read-Write
4	Binary Outputs	Drive Bit Parameters that are Read-Write and Read-only
5	Internal Float Values	H300 private floating point parameters
6	Internal Integer Values	Not used
7	Internal Byte Values	Not used

Within each region, there may be up to 256 "points" which are a selected group of drive parameters that can be accessed. The points available in the drive are detailed in the sections below.

10.5.2 Analog Inputs

Analog input points are numeric parameters (real) that are read-only.

NOTE

The drive only supports integer parameters with implied decimal point, any such parameter returned by a Metasys query will be in IEEE floating point (not the internal representation in the drive). An analog input cannot be written to but can be overridden. Note that analog inputs, being read-only, cannot be updated on the drive. In this case, overriding an analog input will only change what the Metasys network sees as the value of that point.

Point 24 to 28 have limited functionality, they do not support attribute 1 and 8 to 12.

Table 10-25 Analog input points

Point	Parameter	Description	Access	Latch on trip
0	**04.001**	Motor output current magnitude	RO	Yes
1	**04.020**	Motor output torque % full load	RO	No
2	**05.001**	Drive output frequency	RO	Yes
3	**05.004**	Motor Speed	RO	No
4	**05.003**	Drive output power	RO	Yes
5	**10.040**	Drive status word	RO	No
6	**10.020**	Last drive trip	RO	No
7	**06.023**	Time to next filter change	RO	No
8	**06.025**	Energy meter (MWh)	RO	No
9	**06.026**	Energy meter (kWh)	RO	No
10	**14.020**	Sum of all reference inputs to PID 1	RO	No
11	**14.021**	Sum of all feedback inputs to PID 1	RO	No
12	**14.001**	The output from PID 1	RO	No
13	**14.050**	Sum of all reference inputs to PID 2	RO	No
14	**14.051**	Sum of all feedback inputs to PID 2	RO	No
15	**14.031**	The output from PID 2	RO	No
16	**07.001**	Analog input 1 on drive	RO	Yes
17	**07.002**	Analog input 2 on drive	RO	Yes
18	Reserved	Reserved		
19	UP **29.010**	User Selectable Parameter 1 as BAN Object	RO	No
20	UP **29.011**	User Selectable Parameter 2 as BAN Object	RO	No
21	UP **29.012**	User Selectable Parameter 3 as BAN Object	RO	No
22	UP **29.013**	User Selectable Parameter 4 as BAN Object	RO	No
23	UP **29.014**	User Selectable Parameter 5 as BAN Object	RO	No
24	UP **29.015**	User Selectable Parameter 6 as BAN Object	RO	No
25	UP **29.016**	User Selectable Parameter 7 as BAN Object	RO	No
26	UP **29.017**	User Selectable Parameter 8 as BAN Object	RO	No
27	UP **29.018**	User Selectable Parameter 9 as BAN Object	RO	No
28	UP **29.019**	User Selectable Parameter 10 as BAN Object	RO	No

Table 10-26 Supported attributes for analog inputs

Attribute	Name	Format	Commands	Notes
1	Object Configuration	Byte	Read, Write	Except for point 24 to 28
2	Object Status	Byte	Read	Response returns status and current value
3	Analog Input Value	Float	Read, Override	Response returns status and current value
8	Low alarm Limit	Float	Read, Write	Except for point 24 to 28
9	Low Warning Limit	Float	Read, Write	Except for point 24 to 28
10	High Warning Limit	Float	Read, Write	Except for point 24 to 28
11	High Alarm Limit	Float	Read, Write	Except for point 24 to 28
12	Differential	Float	Read, Write	Not implemented in this release. Except for point 24 to 28

Object configuration

The Analog Input Object Configuration byte has the following format:

Table 10-27 Analog input object configuration byte

Description	Not used	Not used	Not used	Warning Enable	Alarm Enable	Not used	Not used	COS Enable
Bit	7	6	5	4	3	2	1	0

It is possible to read and write to the Object Configuration byte. Setting the "COS Enable" bit will enter this point into the set of points to be scanned for change whenever a "Poll without Acknowledge" command is received.

Setting the "Warning Enable" and the "Alarm Enable" bits will cause an alarm/warning threshold check to be performed whenever this point is read (status or current value) which may then set the COS alarm/warning bits in the status byte.

Object status

The Analog Input Object Status byte has the following format:

Table 10-28 Analog input object status byte

Description	Not used	COS Status 2	COS Status 1	COS Status 0	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

The "Reliable/Unreliable" bit will be set if the drive has tripped and the parameter is latched on trip.

The "Override Active" bit will be set if an analog input point is overridden. This indicates that the current value being read is an "override" and does not necessarily reflect the value existing in the drive. This action would normally be done during testing of the Metasys building automation network. The only way to clear the "override active" bit is to issue an "Override Release Request" command for this point.

The three COS-status (change of state) bits indicate if an alarm or warning condition exists, as shown below.

Table 10-29 COS status bits

COS Status 2	COS Status 1	COS Status 0	Meaning
0	0	0	Normal – no alarm or warning
0	1	1	Low Warning
1	0	0	Low Alarm
1	0	1	High Warning
1	1	0	High Alarm

These bits are re-evaluated whenever the status or current value of the Analog Input Point is queried. They are also re-evaluated whenever a "Poll without Acknowledge" command is received and this point's "COS-enable" bit is set.

It is not possible to "override" the Analog Input Status attribute; the only permissible operation is "Read".

Analog input value

The current value is returned as a 32-bit (4 byte) IEEE floating point number.This attribute may be read and may also optionally be "overridden". Overriding the Analog Input Value attribute will freeze its value to the specified setting until an "override release" is issued for that point. Analog Inputs are all read-only so that an "override" command will not change the value in the drive itself.

Alarm and Warning Limits

The alarm/warning limits are returned as 32-bit (4 byte) IEEE floating point numbers. To implement a working alarm/warning system, enter appropriate values (in percent of full scale) into the four alarm/warning limit values. These four points can be read and written, see attributes 8, 9, 10 and 11 in Table 10-26.

10.5.3 Binary Inputs

Binary Input points are drive bit parameters (byte) that are read-only. Binary Input cannot be written to; they may be "overridden" it if desired. Note that Binary Inputs, being read-only, cannot be updated on the drive. In this case, overriding a binary input will only change what the Metasys network sees as the value of that point.

Binary inputs are allocated point numbers in the numerical order in which they are defined on their respective option module. Drive binary inputs are allocated first followed by any binary inputs on the option module in slot 1 (if fitted) and then any on the module in slot 2 (if fitted).

Table 10-30 Binary input points

Point	Parameter	Description	Access
0	Pr **06.022**	Filter change required	RO
1	Pr **10.001**	Drive healthy indication	RO
2	Pr **10.019**	Drive warning/alarm state	RO
3	Pr **08.001**	Digital Input 1 on drive (bi-directional)	RO
4	Pr **08.002**	Digital Input 2 on drive (bi-directional)	RO
5	Pr **08.003**	Digital Input 3 on drive (bi-directional)	RO
6	Pr **08.004**	Digital Input 4 on drive	RO
7	Pr **08.005**	Digital Input 5 on drive	RO
8	Pr **08.006**	Digital Input 6 on drive	RO
9	Pr **08.009**	Drive enable state	RO

Each binary input point has two attributes that can be read and updated:

Table 10-31 Binary input point attributes

Attribute	Name	Format	Commands
1	Object Configuration	Byte	Read, Write
2	Object Status	Byte	Read, Override

Object configuration

The Binary Input Object Configuration byte has the following format:

Table 10-32 Binary input- object configuration byte

Description	Not used	Not used	Not used	Not used	Alarm Enable	Not used	Normal State	COS Enable
Bit	7	6	5	4	3	2	1	0

It is possible to read and write to the Object Configuration byte.

Setting the "COS Enable" bit will enter this point into the set of points to be scanned for change whenever a "Poll without Acknowledge" command is received.

The "Normal State" bit serves as a reference for alarm checking. If the "current state" in the status attribute is different from the "Normal State" bit and the alarms have been enabled, then the "Normal/Alarm" bit in the status will be asserted.

Setting the "Alarm Enable" bits will cause an alarm check to be performed whenever this point is read (status or current value) which may then set the COS normal/alarm bit in the status byte.

Object Status

The Binary Input Object Status byte has the following format:

Table 10-33 Binary input object status byte

Description	Not used	Current state	Not used	Normal / Alarm	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

The "Reliable/Unreliable" bit will be set if the binary input is not set as input (point 3-5 only).

The "Override Active" bit will be set if a binary input point is overridden. This indicates that the current state being read is an "override" and does not reflect the value existing in the drive. This action would normally be done during testing of the Metasys building automation network. The only way to clear the "override active" bit is to issue an "Override Release Request" command for this point.

The "Normal/Alarm" bit will set if the "Current State" does not match the "normal state" in the Object Configuration attribute and the "alarm enabled" bit is set in the Object Configuration attribute.

The "Current State" bit is normally the state of the "binary Input" on the drive. If this point is "overridden", then the "Current State" represents the override value and will remain so until the "Override Release" command is given for this Point.

These bits are re-evaluated whenever the status or current value of the Binary Input Point is queried. They are also re-evaluated whenever a "Poll without Acknowledge" command is received and this point's "COS-enable" bit is set.

The Binary Input Status attribute cannot be written to; the only permissible operations is "Read".

10.5.4 Analog Outputs

Analog Output points are floating point drive analog output parameters (float) that are read-write. An Analog Output cannot be written to; but can be "overridden" if desired. Note that Analog Outputs, being read-write, can be updated on the drive. In this case, overriding an analog output will change the value on the drive as well as change what the Metasys network sees as the value of that point.

Analog outputs are allocated point numbers in the numerical order in which they are defined on their respective option module.

Table 10-34 Analog Output Points

Point	Parameter	Description	Access
0	Pr **01.021**	Preset Speed # 1	RW
1	Pr **01.006**	Maximum reference clamp	RW
2	Pr **10.038**	User trip	RW
3	Pr **06.021**	Time between Filter Changes	RW
4	Pr **14.025**	PID 1 Digital Reference	RW
5	Pr **14.026**	PID 1 Digital Feedback	RW
6	Pr **14.055**	PID 2 Digital Reference	RW
7	Pr **14.056**	PID 1 Digital Feedback	RW
8	Pr **07.019**	Analog Output 1 Source	RW
9	Pr **07.022**	Analog Output 2 Source	RW

Each Analog Output point has three attributes that can be read and updated.

Table 10-35 Analog output point attributes

Attribute	Name	Format	Commands	Notes
1	Object Configuration	Byte	Read, Write	-
2	Object Status	Byte	Read	Status reply also returns current value
3	Current Value	Float	Read, Override	Value reply also returns status

Object Configuration

The Analog Output Object Configuration byte has the following format:

Table 10-36 Analog output- object configuration byte

Description	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	COS Enable
Bit	7	6	5	4	3	2	1	0

It is possible to read and write to the Object Configuration byte.

Setting the "COS Enable" bit will enter this point into the set of points to be scanned for change whenever a "Poll without Acknowledge" command is received.

Object Status

The Analog Output Object Status byte has the following format:

Table 10-37 Analog output- object status byte

Description	Not used	Not used	Not used	Not used	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

The "Reliable/Unreliable" bit will be set if the analog output source is not valid and/or not 16 bit parameter.

The "Override Active" bit will be set if an Analog Output point is overridden. This indicates that the current value being read is an "override" and does not reflect the value existing in the drive. This action would normally be done during testing of the Metasys building automation network. The only way to clear the "override active" bit is to issue an "Override Release Request" command for this point.

These bits are re-evaluated when the status or current value of the Analog Output Point is queried. They are also re-evaluated whenever a "Poll without Acknowledge" command is received and this point's "COS-enable" bit is set.

The Analog Output Status attribute cannot be written to; the only permissible operation is "Read".

Current Value

The current value is returned as a 32-bit (4 byte) IEEE floating point number. This attribute can be read and also "overridden". Overriding the Analog Output Value attribute will freeze its value to the specified setting until an "override release" is issued for that point. Analog Inputs are all read-write so that an "override" command WILL change the value in the drive itself.

10.5.5 Binary Outputs

Binary Output points are drive bit parameters (byte) that are a combination of read-write and read-only. A Binary Output cannot be written to; rather it can be "overridden" if desired. Note that Binary Outputs, those being read-only, cannot be updated on the drive. In this case, overriding a binary input will only change what the Metasys network sees as the value of that point. The first three points, however, are Read-Write and can be updated on the drive by the "override" command.

Binary outputs are allocated point numbers in the numerical order in which they are defined on their respective option module.

Table 10-38 Binary Output points

Point	Parameter	Description	Access
0	Pr **6.030**	Sequencing Bit – Run Forward	RW
1	Pr **10.033**	Drive Reset	W
2	Pr **6.024**	Reset energy meter	RW
3	Pr **8.001**	Digital Output 1 on drive (bi-directional)	RO
4	Pr **8.002**	Digital Output 2 on drive (bi-directional)	RO
5	Pr **8.003**	Digital Output 3 on drive (bi-directional)	RO
6	Pr **8.008**	24 Volt Output State	RO
7	Pr **8.007**	Relay 1 State Indicator	RO
8	Pr **8.045**	Relay 2 State Indicator	RO

Each binary input point has two attributes that can be read and updated.

Table 10-39 Binary output point attributes

Attribute	Name	Format	Commands	Notes
1	Object Configuration	Byte	Read, Write	-
2	Object Status	Byte	Read, Override	-
3	Minimum On-time	Integer	-	Not implemented
4	Minimum Off-time	Integer	-	Not implemented
5	Maximum Cycles/Hr	Integer	-	Not implemented

Object Configuration

The Binary Output Object Configuration byte has the following format:

Table 10-40 Binary output configuration byte

Description	Not used	Not used	Not used	Not used	Not used	Not used	Not used	COS Enable
Bit	7	6	5	4	3	2	1	0

It is possible to read and write to the Object Configuration byte.

Setting the "COS Enable" bit will enter this point into the set of points to be scanned for change whenever a "Poll without Acknowledge" command is received.

Object Status

The Binary Output Object Status byte has the following format:

Table 10-41 Binary output status byte

Description	Not used	Current state	Not used	Not used	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

The "Reliable/Unreliable" bit will be set if:

- the digital output source is not valid
- and/or the source is not 1 bit parameter
- the terminal is not selected as output

The "Override Active" bit will be set if a Binary Output point is overridden. This indicates that the current state being read is an "override" and does not reflect the value existing in the drive. This action would normally be done during testing of the Metasys building automation network. The only way to clear the "override active" bit is to issue an "Override Release Request" command for this point.

The "Current State" bit reflects the value of the drive's binary output. Any of the Binary Output points may be overridden. However, only the first two are read-write and can thus update the bit value in the drive.

These bits are re-evaluated whenever the status or current values of the Binary Output Point are queried. They are also re-evaluated whenever a "Poll without Acknowledge" command is received and this point's "COS-enable" bit is set.

The Binary Output Status attribute cannot be written to; the only permissible operation is "Read" or "Override".

10.5.6 Internal Float Values (used to access specified drive parameters)

Internal float points are not associated with any drive parameter; rather they are resident in the Metasys controller. The three defined Internal Float points are given a specific behaviour that allows the Metasys user to manipulate them to gain access to any drive parameter. Use Attribute number 1 or 2 to read the Status byte and the Internal Float value for each point.

Table 10-42 Internal float value points

Point	Parameter	Description	Access	Notes
0	Internal Float 0	Menu/Parameter (specified as a float where 1.25 is parameter #1.25)	RW	Reading returns the status and Menu/ Parameter as a float
1	Internal Float 1	Value (specified as a float) e.g. 1.0 = 1 for bit parameters, 62.5 for decimal parameters.	RW	Reading returns the status and the Value as a float
2	Internal Float 2	Read/Write Command Code 0 = Idle, 1 = Write, 2 = Read	RW	Reading returns the status and the Command Code as a float

Object Status

The Internal Float Object Status byte has the following format:

Table 10-43 Internal float value status byte

Description	Not used	Not used	Not used	Not used	Not used	Not used	Not used	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

The "Reliable/Unreliable" bit will be set if the drive has tripped.

The Internal Float Points do not participate in COS polling operations

Table 10-44 Attributes supported for Internal Float Values

Attribute	Name	Commands
1	Object Status	Read
2	Current Value	Read, Override

The Internal Float Status attribute cannot be written to; the only permissible operation is "Read".

Writing to the Current Value of Internal Float, Point 1 changes the value on the drive if the parameter exists and the Internal Float, Point 2 Command Code is 1.

Current Value

The current value of each point is returned as a 32-bit (4 byte) IEEE floating point number.

Using the Internal Float Points to Access any Drive Parameter

A very specific sequence must be followed to use the Internal Float Points to gain access to any drive parameter.

Read a drive parameter

- Write the desired menu and parameter number (mm.ppp) to Internal Float, Point 0
- Write the "read" command code (2) to Internal Float, Point 2
- Read the mm.ppp Internal Float, Point 0 to ensure that it has been cleared to zero indicating data is ready
- Read the Internal Float, Point 1 which will return the floating point value of the requested parameter

Write a drive parameter

- Write the desired menu and parameter number (mm.ppp) to Internal Float, Point 0
- Write the "write" command code (1) to Internal Float, Point 2
- Write the new parameter value to Internal Float, Point 1

NOTE

Internal Integer Values and Internal Byte Values. While the Metasys protocol provides for Internal Integer Points and Internal Byte Points, Control Techniques has not implemented any functionality for them. Attempts to access Internal Integer and Internal Byte Points will result in an error message.

Table 10-45

Point	Parameter	Description
0	N/A	Not implemented

10.5.7 List of Metasys Commands Supported

Table 10-46 List of Metasys commands supported

Command	
Synch Time Command	Write Binary Output Command
Poll Without Ack Message	Write Internal Parameter Command
Read Analog Input Command	Override Analog Input Command
Read Binary Input Command	Override Binary Input Command
Read Analog Output Command	Override Analog Output Command
Read Binary Output Command	Override Binary Output Command
Read Internal Parameter Command	Override Internal Parameter Command
Write Analog Input Command	Override Release Request
Write Binary Input Command	Identify Device Type Command
Write Analog Output Command	-

Table 10-47 List of Metasys commands NOT supported

Command	
Read Memory Command	Read Binary Input Attributes Request
Warm Start	Read Analog Output Attributes Request
Status Update Request	Read Binary Output Attributes Request
Write Internal Parameter Command	Upload Request
Write Analog Input Attributes Request	Upload Record
Write Binary Input Attributes Request	Upload Complete
Write Analog Output Attributes Request	Download Request
Write Binary Output Attributes Request	Download Record
Read Analog Input Attributes Request	Download Complete

Change of State Support

The H300 Metasys Protocol handler permits Change-of-State (COS) queries. This allows the network to poll a Metasys node (H300) to determine which points have changed value since the last query. The response to such a poll is a list of those points that have changed, including the region number, point number, status and current value. It is possible that the COS response contains multiple points that have changed. The report that a point has changed state is only given once, future COS polls will go unanswered until the point actually changes state again. This is a great convenience to the Metasys user in that the network doesn't have to continually poll a large number of points to detect a change; rather a list of these points is sent to the H300 node and polling queries will result in just the specified points being checked for change. The results are culled into a single response message. Best of all, if nothing happened since the last poll, there is no response (just a short acknowledgement).

Selecting Points for COS Polling

Analog Input, Binary Input, Analog Output and Binary Output Points all can be selected for COS polling. The user must set the COS_Enable bit beforehand. For example, to place the "Drive Healthy" Pr **10.001** into the COS polling list, we just need to write to its configuration byte and set the COS_Enable bit.

Table 10-48 Binary input- object configuration byte

Description	Not used	Not used	Not used	Not used	Alarm Enable	Not used	Normal State	COS Enable
Bit	7	6	5	4	3	2	1	0

Set COS Enable bit to place Binary Input, Point 2 (Drive Healthy) into the COS polling list.

How a Change-of-State is evaluated

The algorithm used to determine that a point "changed state" and should be included in the COS reply message depends on the point being checked.

Table 10-49 Change of state evaluation

Point type	Region	COS Detection method
Analog Inputs	1	COS detected when “current value” transitions into one of the four alarm/warning regions (high Alarm, High Warning, Low Warning and Low Alarm) or when “current value” transitions back to Normal.
Binary Inputs	2	COS detected when “current state” bit value changes logic state.
Analog Outputs	3	COS detected when “current value” changes
Binary Outputs	4	COS detected when “current state” bit value changes logic state.
Internal Floats	5	Internal Float Points do not participate in COS operations.

COS is Only Returned Once

When a COS enabled point changes state, this fact is reported only once when the node is "polled". Future COS polls will not return COS data for that point until it changes state again.

Only COS "Poll Without Acknowledge" Message is Supported

The Control Techniques Metasys protocol handler only supports "Poll without Ack" queries.

Alarm Processing

Alarm processing is available for Analog Input and Binary Input points only. The alarm condition is evaluated only when the point is read via a "read" command or a "COS" poll.

Alarms for Analog Inputs

The Analog Input point must have alarms and warnings enabled to participate in alarm processing. The alarm and warning enable bits reside in the Configuration Attribute.

Table 10-50 Analog input object configuration byte

Description	Not used	Not used	Not used	Warning Enable	Alarm Enable	Not used	Not used	COS Enable
Bit	7	6	5	4	3	2	1	0

Turning on the "COS enable" bit will also cause the point's alarm/warning status to be evaluated whenever a COS polling message is received.

The alarm information is contained in three COS Status bits of the Analog Input Object Status Byte, as shown below.

Table 10-51 Analog input object status byte

Description	Not used	COS Status 2	COS Status 1	COS Status 0	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

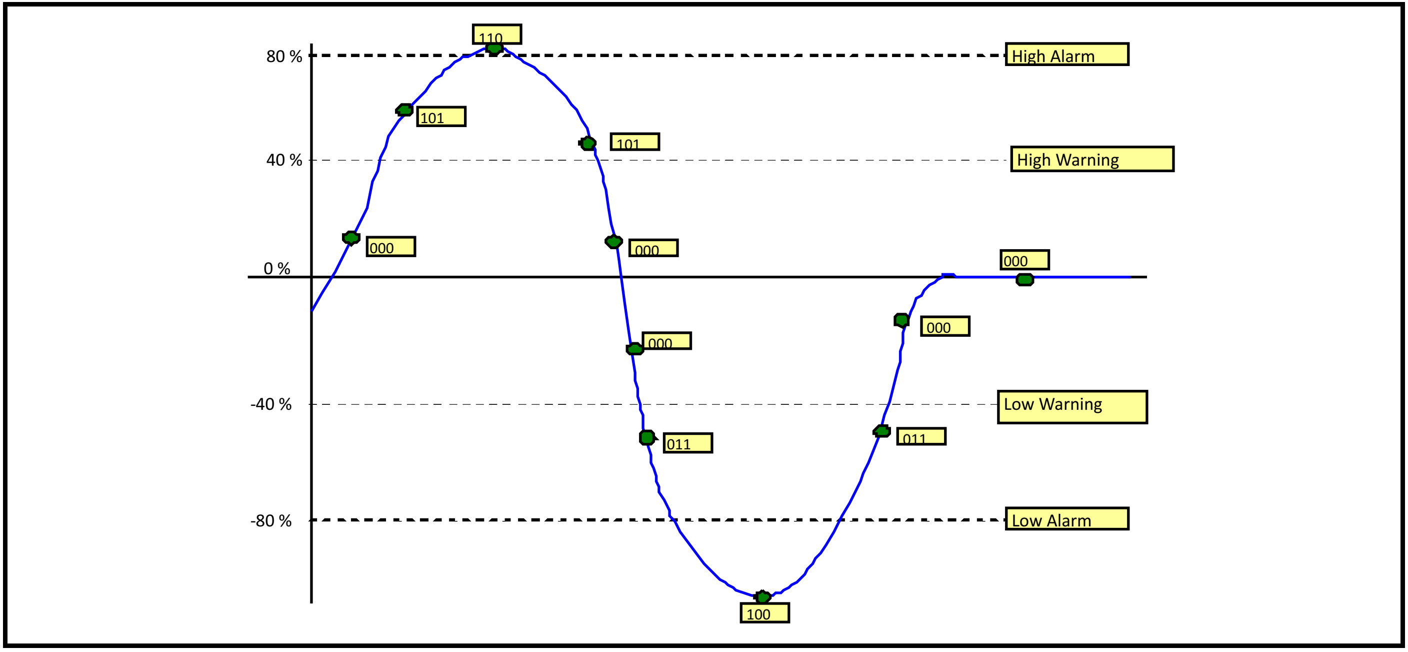
The meaning of the COS Status bits is shown in the following state table:

Table 10-52 COS status bit state table

COS Status 2	COS Status 1	COS Status 0	Description
0	0	0	Normal – no warning or alarm condition
0	1	1	Low Warning
1	0	0	Low Alarm
1	0	1	High Warning
1	1	0	High Alarm

Overleaf is a depiction of an analog input signal traversing all alarm/warning regions.

Figure 10-2 Alarm/Warning Bits for Various Measurement Points



Alarms for Binary Inputs

An alarm for Binary Input points will be raised when the "current state" returned in the Status attribute bit 6 differs from the "normal state" stored in the Configuration attribute bit 1. The alarms have to be "enabled" for this to occur (bit 3 of the Configuration attribute).

Table 10-53 Binary input- object configuration byte

Description	Not used	Not used	Not used	Not used	Alarm Enable	Not used	Normal State	COS Enable
Bit	7	6	5	4	3	2	1	0

The alarm will be indicated in bit 4 of the Binary Input status attribute.

Table 10-54 Binary input object status byte

Description	Not used	Current state	Not used	Normal / Alarm	Not used	Not used	Override active	Reliable / Unreliable
Bit	7	6	5	4	3	2	1	0

11 Advanced parameters

This is a quick reference to all parameters in the drive showing units, ranges limits etc, with block diagrams to illustrate their function. Full descriptions of the parameters can be found in the *Parameter Reference Guide*.

WARNING

These advanced parameters are listed for reference purposes only. The lists in this chapter do not include sufficient information for adjusting these parameters. Incorrect adjustment can affect the safety of the system, and damage the drive and or external equipment. Before attempting to adjust any of these parameters, refer to the *Parameter Reference Guide*.

Table 11-1 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
13	Standard motion control
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	Reserved menu
29	Building Automation Network Setup
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.

Operation mode abbreviations:

Open-loop:
Sensorless control for induction motors

RFC-A Sensorless:
Asynchronous Rotor Flux Sensorless Control for induction motors

RFC-S Sensorless: Synchronous Rotor Flux Sensorless Control for synchronous motors including permanent magnet motors.

Default abbreviations:

Standard default value (50 Hz AC supply frequency)

USA default value (60 Hz AC supply frequency)

NOTE

Parameter numbers shown in brackets {...} are the equivalent Menu 0 parameters. Some Menu 0 parameters appear twice since their function depends on the operating mode.

The Range - RFC-A / S column applies to both RFC-A and RFC-S. For some parameters, this column applies to only one of these modes, this is indicated accordingly in the Default columns.

In some cases, the function or range of a parameter is affected by the setting of another parameter. The information in the lists relates to the default condition of any parameters affected in this way.

Table 11-2 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
Num	Number: can be uni-polar or bi-polar
Txt	Text: the parameter uses text strings instead of numbers.
Bin	Binary parameter
IP	IP Address parameter
Mac	Mac Address parameter
Date	Date parameter
Time	Time parameter
Chr	Character parameter
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will be transferred to the destination drive by non-volatile storage media when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the values will be transferred if only the current rating is different and the file is a difference from default type file.
ND	No default: The parameter is not modified when defaults are loaded
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.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs.

Table 11-3 Feature look-up table

Feature	Related parameters (Pr)												
Acceleration rates	02.010	02.011 to 02.019		02.032	02.033	02.034	02.002						
Analog speed reference 1	01.036	07.010	07.001	07.007	07.008	07.009	07.025	07.026	07.030				
Analog speed reference 2	01.037	07.014	01.041	07.002	07.011	07.012	07.013	07.028	07.031				
Analog I/O	Menu 7												
Analog input 1	07.001	07.007	07.008	07.009	07.010	07.025	07.026	07.028	07.030	07.040	07.043	07.051	
Analog input 2	07.002	07.011	07.012	07.013	07.014	07.022	07.023	07.027	07.031	07.041	07.044		
Analog output 1	07.019	07.020	07.021	07.033									
Analog output 2	07.022	07.023	07.024										
Application menu	Menu 18		Menu 19		Menu 20								
At speed indicator bit	03.006	03.007	03.009	10.006	10.005	10.007							
Auto reset	10.034	10.035	10.036	10.001									
Autotune	05.010	05.012	05.017	05.024	05.025								
Catch a spinning motor	06.009	05.040											
Coast to stop	06.001												
Comms	11.023 to 11.026												
Copying	11.042	11.036 to 11.040											
Cost - per kWh electricity	06.016	06.017	06.024	06.025	06.026	06.040							
Current controller	04.013	04.014											
Current feedback	04.001	04.002	04.017	04.004	04.012	04.020	04.023	04.024	04.026	10.008	10.009	10.017	
Current limits	04.005	04.006	04.007	04.018	04.015	04.019	04.016	05.007	05.010	10.008	10.009	10.017	
DC bus voltage	05.005	02.008											
DC injection braking	06.006	06.007	06.001										
Deceleration rates	02.020	02.021 to 02.029		02.004	02.035 to 02.037		02.002	02.008	06.001	10.030	10.031	10.039	02.009
Defaults	11.043	11.046											
Digital I/O	Menu 8												
Digital I/O read word	08.020												
Digital I/O T22	08.001	08.011	08.021	08.031									
Digital I/O T23	08.002	08.012	08.022	08.032									
Digital I/O T24	08.003	08.013	08.023	08.033									
Digital input T25	08.004	08.014	08.024										
Digital input T26	08.005	08.015	08.025	08.039									
Digital input T27	08.006	08.016	08.026	08.039									
Digital output T3	08.008	08.018	08.028										
Direction	10.013	06.030	06.031	01.003	10.014	02.001	03.002	08.003	08.004	10.040			
Drive active	10.002	10.040											
Drive derivative	11.028												
Drive Healthy	10.001	08.027	08.007	08.017	10.036	10.040							
Dynamic performance	05.026												
Dynamic V/F	05.013												
Enable	06.015	08.009	08.010										
External trip	10.032	08.010	08.007										
Fan speed	06.045												
Fast disable	06.029												
Field weakening - induction motor	01.006	05.028											
Field weakening - PM motor	05.022	01.006	05.009										
Fire mode	01.053	01.054											
Filter change	06.019	06.018											
Frequency reference selection	01.014	01.015											
High stability space vector modulation	05.019												
I/O sequencer	06.004	06.030	06.031	06.032	06.033	06.034	06.042	06.043	06.041				
Inertia compensation	02.038	05.012	04.022	03.018									
Keypad reference	01.017	01.014	01.043	01.051	06.012	06.013							
Line power supply loss	06.003	10.015	10.016	05.005									
Logic function 1	09.001	09.004	09.005	09.006	09.007	09.008	09.009	09.010					
Logic function 2	09.002	09.014	09.015	09.016	09.017	09.018	09.019	09.020					
Maximum speed	01.006												
Menu 0 set-up	Menu 22												
Minimum speed	01.007	10.004											
Modules - number of	11.035												
Motor map	05.006	05.007	05.008	05.009	05.010	05.011							
Motorized potentiometer	09.021	09.022	09.023	09.024	09.025	09.026	09.027	09.028					

Feature	Related parameters (Pr)												
Offset speed reference	01.004	01.038	01.009										
Onboard PLC	11.047 to 11.051												
Open loop vector mode	05.014	05.017	05.023										
Operating mode	00.048	11.031	03.024	05.014									
Output	05.001	05.002	05.003	05.004									
Overspeed threshold	03.008												
PID controller	Menu 14												
Positive logic	08.029												
Power up parameter	11.022	11.021											
Preset speeds	01.015	01.021 to 01.028			01.016	01.014	01.042	01.045 to 01.048			01.050		
Programmable logic	Menu 9												
Quasi square operation	05.020												
Ramp (accel / decel) mode	02.004	02.008	06.001	02.002	02.003	10.030	10.031	10.039					
Rated speed	05.008												
Regenerating	10.010	10.011	10.030	10.031	06.001	10.012	10.039	10.040					
Relay outputs	08.007	08.017	08.027	8.045	8.055	8.065							
Reset	10.033	08.002	08.022	10.034	10.035	10.036	10.001						
RFC-A Sensorless	03.024	03.042	04.012										
S ramp	02.006	02.007											
Sample rates	05.018												
Safe Torque Off input	08.009	08.010											
Security code	11.030	11.044											
Serial comms	11.023 to 11.026												
Skip speeds	01.029	01.030	01.031	01.032	01.033	01.034	01.035						
Slip compensation	05.027	05.008											
NV media card	11.036 to 11.040			11.042									
Firmware version	11.029	11.034											
Speed controller	03.010 to 03.017			03.019	03.020	03.021							
Speed feedback	03.002	03.003	03.004										
Speed feedback - drive	03.026												
Speed reference selection	01.014	01.015	01.049	01.050	01.001								
Status word	10.040												
Supply	06.044	05.005											
Switching frequency	05.018	05.035	07.034	07.035									
Thermal protection - drive	05.018	05.035	07.004	07.005	07.006	07.032	07.035	10.018					
Thermal protection - motor	04.015	05.007	04.019	04.016	04.025	07.015							
Thermistor inputs	7.007	7.001	7.053	7.011	7.002	7.058							
Threshold detector 1	12.001	12.003 to 12.007											
Threshold detector 2	12.002	12.023 to 12.027											
Time - filter change	06.019	06.018											
Time - powered up log	06.020	06.021	06.028										
Time - run log	06.022	06.023	06.028										
Torque	04.003	04.026	05.032										
Torque mode	04.008	04.011	04.009	04.010									
Trip detection	10.037	10.038	10.020 to 10.029										
Trip log	10.020 to 10.029			10.041 to 10.051			06.028	10.070 to 10.079					
Under voltage	05.005	10.016	10.015										
V/F mode	05.015	05.014											
Variable selector 1	12.008 to 12.015												
Variable selector 2	12.028 to 12.035												
Velocity feed forward	01.039	01.040											
Voltage controller	05.031												
Voltage mode	05.014	05.017	05.023	05.015									
Voltage rating	11.033	05.009	05.005										
Voltage supply	06.044	05.005											
Warning	10.019	10.012	10.017	10.018	10.040								

11.1 Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum values which is dependent on one of the following:

- The settings of other parameters
- The drive rating
- The drive mode
- Combination of any of the above

The tables below give the definition of variable minimum/maximum and the maximum range of these.

VM_AC_VOLTAGE	Range applied to parameters showing AC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 930
Definition	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE[MIN] = 0

VM_AC_VOLTAGE_SET	Range applied to the AC voltage set-up parameters
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 690
Definition	VM_AC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE_SET[MIN] = 0

VM_ACCEL_RATE	Maximum applied to the ramp rate parameters
Units	s / 100 Hz, s / 1000 rpm, s / 1000 mm/s
Range of [MIN]	Open-loop: 0.0 RFC-A, RFC-S: 0.000
Range of [MAX]	Open-loop: 0.0 to 3200.0 RFC-A, RFC-S: 0.000 to 3200.000
Definition	A maximum needs to be applied to the ramp rate parameters because the units are a time for a change of speed from zero to a defined level or to maximum speed. The defined level is 100 Hz for Open-loop mode and 1000rpm or 1000mm/s for RFC-A and RFC-S modes. If the change of speed is to the maximum speed then changing the maximum speed changes the actual ramp rate for a given ramp rate parameter value. The variable maximum calculation ensures that longest ramp rate (parameter at its maximum value) is not slower than the rate with the defined level, i.e. 3200.00 s / Hz for Open-loop mode, and 3200.000 s / 1000 rpm or 3200.000 s / 1000 mm/s for RFC-A and RFC-S modes. The maximum frequency/speed is taken from *Maximum Reference Clamp* (01.006) if *Select Motor 2 Parameters* (11.045) = 0, or *M2 Maximum Reference Clamp* (21.001) if *Select Motor 2 Parameters* (11.045) = 1. Open-loop mode VM_ACCEL_RATE[MIN] = 0.0 If Ramp Rate Units (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 Otherwise: VM_ACCEL_RATE[MAX] = 3200.0 x Maximum frequency / 100.0 RFC-A, RFC-S modes VM_ACCEL_RATE[MIN] = 0.000 If Ramp Rate Units (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.000 Otherwise: VM_ACCEL_RATE[MAX] = 3200.000 x Maximum speed / 1000.0

VM_DC_VOLTAGE	Range applied to parameters showing DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1190
Definition	VM_DC_VOLTAGE[MAX] is the full scale DC bus voltage feedback (over voltage trip level) for the drive. This level is drive voltage rating dependent. See Table 11-4 VM_DC_VOLTAGE[MIN] = 0

VM_DC_VOLTAGE_SET	Range applied to DC voltage reference parameters
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1150
Definition	VM_DC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_DC_VOLTAGE_SET[MIN] = 0

VM_DRIVE_CURRENT	Range applied to parameters showing current in A
Units	A
Range of [MIN]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) or Kc value for the drive and is given by *Full Scale Current Kc* (11.061). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]

VM_DRIVE_CURRENT_UNIPOLAR	Unipolar version of VM_DRIVE_CURRENT
Units	A
Range of [MIN]	0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT_UNIPOLAR[MAX] = VM_DRIVE_CURRENT[MAX] VM_DRIVE_CURRENT_UNIPOLAR[MIN] = 0.000

VM_HIGH_DC_VOLTAGE	Range applied to parameters showing high DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1500
Definition	VM_HIGH_DC_VOLTAGE[MAX] is the full scale DC bus voltage feedback for the high DC bus voltage measurement which can measure the voltage if it goes above the normal full scale value. This level is drive voltage rating dependent. See Table 11-4 VM_HIGH_DC_VOLTAGE[MIN] = 0

VM_LOW_UNDER_VOLTS	Range applied the low under-voltage threshold
Units	V
Range of [MIN]	24
Range of [MAX]	24 to 1150
Definition	If *Back-up Mode Enable* (06.068) = 0: VM_LOW_UNDER_VOLTS[MAX] = VM_STD_UNDER_VOLTS[MIN] If *Back-up Mode Enable* (06.068) = 1: VM_LOW_UNDER_VOLTS[MAX] = VM_STD_UNDER_VOLTS[MIN] / 1.1. VM_LOW_UNDER_VOLTS[MIN] = 24.

VM_MIN_SWITCHING_FREQUENCY	Range applied to the minimum switching frequency parameter
Units	User units
Range of [MIN]	0
Range of [MAX]	0 to 6
Definition	VM_MIN_SWITCHING_FREQUENCY[MAX] = *Maximum Switching Frequency* (05.018) VM_MIN_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes, or 1 for Regen mode (subject to the maximum)

VM_MOTOR1_CURRENT_LIMIT **VM_MOTOR2_CURRENT_LIMIT**	Range applied to current limit parameters
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0 **Open-loop** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos(sin^{-1}(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** sin ϕ I_{Trated} = Pr **05.007** x cos ϕ cos ϕ = Pr **05.010** I_{MaxRef} is 0.7 x Pr **11.061** when the motor rated current set in Pr **05.007** is the lower of 0.7 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty). **RFC-A** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos(sin^{-1}(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** x sin ϕ_1 ITrated = Pr 05.007 x cos ϕ_1 ϕ_1 = cos-1 (Pr **05.010**) + ϕ_2. ϕ_1 is calculated during an autotune. See the variable minimum / maximum calculations in the *Parameter Reference Guide* for more information regarding ϕ_2. I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is the lower of 0.9 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty). **RFC-S and Regen** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{MaxRef} / Pr **05.007**) x 100 % Where: I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is the lower of 0.9 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty).

<table>
<tr><th>VM_NEGATIVE_REF_CLAMP1
VM_NEGATIVE_REF_CLAMP2</th><th>Limits applied to the negative frequency or speed clamp</th></tr>
<tr><td>Units</td><td>Open-loop: Hz
RFC-A, RFC-S: rpm or mm/s</td></tr>
<tr><td>Range of [MIN]</td><td>Open-loop: -550.0 to 0.0
RFC-A, RFC-S: -50000.0 to 0.0</td></tr>
<tr><td>Range of [MAX]</td><td>Open-loop: 0.0 to 550.0
RFC-A, RFC-S: 0.0 to 50000.0</td></tr>
<tr><td>Definition</td><td>
<table>
<tr><th><i>Negative Reference Clamp Enable</i> (01.008)</th><th><i>Bipolar Reference Enable</i> (01.010)</th><th>VM_NEGATIVE_REF_ CLAMP1[MIN]</th><th>VM_NEGATIVE_REF_ CLAMP1[MAX]</th></tr>
<tr><td>0</td><td>0</td><td>0.0</td><td>Pr 01.006</td></tr>
<tr><td>0</td><td>1</td><td>0.0</td><td>0.0</td></tr>
<tr><td>1</td><td>X</td><td>-VM_POSITIVE_REF_CLAMP[MAX]</td><td>0.0</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>VM_POSITIVE_REF_CLAMP1
VM_POSITIVE_REF_CLAMP2</th><th>Limits applied to the positive frequency or speed reference clamp</th></tr>
<tr><td>Units</td><td>Open-loop: Hz
RFC-A, RFC-S: rpm or mm/s</td></tr>
<tr><td>Range of [MIN]</td><td>Open-loop: 0.0
RFC-A, RFC-S: 0.0</td></tr>
<tr><td>Range of [MAX]</td><td>Open-loop: 550.0
RFC-A, RFC-S: 0.0 to 50000.0</td></tr>
<tr><td>Definition</td><td>VM_POSITIVE_REF_CLAMP1[MAX] defines the range of the positive reference clamp, <i>Maximum Reference Clamp</i> (01.006), which in turn limit the references. In RFC-A and RFC-S modes a limit is applied so that the position feedback does not exceed the speed where the drive can no longer interpret the feedback signal correctly as given in the table below. The limit is based on the position feedback device selected with <i>Motor Control Feedback Select</i> (03.026). It is possible to disable this limit if the <i>RFC Feedback Mode</i> (03.024) ≥ 1 so that the motor can be operated at a speed above the level where the drive can interpret the feedback in sensorless mode. It should be noted that the position feedback device itself may have a maximum speed limit that is lower than those given in the table. Care should be taken not to exceed a speed that would cause damage to the position feedback device.
<table>
<tr><th>Feedback device</th><th>VM_POSITIVE_REF_CLAMP1[MAX]</th></tr>
<tr><td>AB,
AB Servo</td><td>(500 kHz x 60 / rotary lines per revolution) rpm
(500 kHz / linear line pitch in mm) mm/s</td></tr>
<tr><td>FD, FR,
FD Servo, FR Servo</td><td>(500 kHz x 60 / rotary lines per revolution)/2 rpm
(500 kHz / linear line pitch in mm)/2 mm/s</td></tr>
<tr><td>SC,
SC Hiper, SC EnDat,
SC SSI, SC Servo</td><td>(500 kHz x 60 / sine waves per revolution) rpm
(500 kHz x linear line pitch in mm) mm/s</td></tr>
<tr><td>Any other device</td><td>50000.0 rpm or mm/s</td></tr>
</table>
In open-loop mode VM_POSITIVE_REF_CLAMP1[MAX] is fixed at 550.0 Hz
In RFC mode a limit is applied to the speed reference of 550 x 60 / Motor pole pairs. Therefore, with a 4 pole motor the limit for VM_POSITIVE_REF_CLAMP1[MAX] will be 16,500 rpm.
VM_POSITIVE_REF_CLAMP1[MIN] = 0.0
VM_POSITIVE_REF_CLAMP2 is defined in the same way as VM_POSITIVE_REF_CLAMP1 except VM_POSITIVE_REF_CLAMP2[MAX] defines the range of the positive reference clamp, <i>M2 Maximum Reference Clamp</i> (21.001), which in turn limits the references.</td></tr>
</table>

VM_POWER	Range applied to parameters that either set or display power
Units	kW
Range of [MIN]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_POWER[MAX] is rating dependent and is chosen to allow for the maximum power that can be output by the drive with maximum a.c. output voltage, at maximum controlled current and unity power factor. VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000 VM_POWER[MIN] = -VM_POWER[MAX]

VM_RATED_CURRENT	Range applied to rated current parameters
Units	A
Range of [MIN]	0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_RATED_CURRENT [MAX] = *Maximum Rated Current* (11.060) and is dependent on the drive rating. This is the Normal Duty rating of the drive. VM_RATED_CURRENT [MIN] = 0.00

VM_SPEED	Range applied to parameters showing speed
Units	Open-loop, RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop, RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop, RFC-A, RFC-S: 0.0 to 50000.0
Definition	This variable minimum/maximum defines the range of speed monitoring parameters. To allow headroom for overshoot the range is set to twice the range of the speed references. VM_SPEED[MAX] = 2 x VM_SPEED_FREQ_REF[MAX] VM_SPEED[MIN] = 2 x VM_SPEED_FREQ_REF[MIN]

<table>
<tr><th>VM_SPEED_FREQ_KEYPAD_REF</th><th>Range applied Keypad Control Mode Reference (01.017)</th></tr>
<tr><td>Units</td><td>Open-loop: Hz RFC-A, RFC-S: rpm or mm/s</td></tr>
<tr><td>Range of [MIN]</td><td>Open-loop: -550.0 to 550.0 RFC-A, RFC-S: -50000.0 to 50000.0</td></tr>
<tr><td>Range of [MAX]</td><td>Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0</td></tr>
<tr><td>Definition</td><td>
<p>This variable maximum is applied to <i>Keypad Control Mode Reference</i> (01.017). The maximum applied to these parameters is the same as other frequency reference parameters.</p>
<p>VM_SPEED_FREQ_USER_REFS [MAX] = VM_SPEED_FREQ_REF[MAX]</p>
<p>However the minimum is dependent on <i>Negative Reference Clamp Enable</i> (01.008) and <i>Bipolar Reference Enable</i> (01.010).</p>
<table>
<tr><th>Negative Reference Clamp Enable (01.008)</th><th>Bipolar Reference Enable (01.010)</th><th>VM_SPEED_FREQ_USER_REFS[MIN]</th></tr>
<tr><td>0</td><td>0</td><td>If <i>Select Motor 2 Parameters</i> (11.045) = 0 <i>Minimum Reference Clamp</i> (01.007), otherwise <i>M2 Minimum Reference Clamp</i> (21.002)</td></tr>
<tr><td>0</td><td>1</td><td>-VM_SPEED_FREQ_REF[MAX]</td></tr>
<tr><td>1</td><td>0</td><td>0.0</td></tr>
<tr><td>1</td><td>1</td><td>-VM_SPEED_FREQ_REF[MAX]</td></tr>
</table>
</td></tr>
</table>

VM_SPEED_FREQ_REF	Range applied to the frequency or speed reference parameters
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.0 to 0.0 RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	This variable minimum/maximum is applied throughout the frequency and speed reference system so that the references can vary in the range from the minimum to maximum clamps. VM_SPEED_FREQ_REF[MIN] = -VM_SPEED_FREQ_REF[MAX].

Negative Reference Clamp Enable (01.008)	**VM_SPEED_FREQ_REF[MAX] if Select Motor 2 Parameters (11.045) = 0**	**VM_SPEED_FREQ_REF[MAX] if Select Motor 2 Parameters (11.045) = 1**
0	*Maximum Reference Clamp* (01.006)	M2 Maximum Reference Clamp (21.001)
1	*Maximum Reference Clamp* (01.006) or |*Minimum Reference Clamp* (01.007)| whichever the larger	*M2 Maximum Reference Clamp* (21.001) or |M2 *Minimum Reference Clamp* (21.002)| whichever the larger

VM_SPEED_FREQ_REF_UNIPOLAR	Unipolar version of VM_SPEED_FREQ_REF
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: 0.0 RFC-A, RFC-S: 0.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_SPEED_FREQ_REF_UNIPOLAR[MAX] = VM_SPEED_FREQ_REF[MAX] VM_SPEED_FREQ_REF_UNIPOLAR[MIN] = 0.0

VM_SPEED_FREQ_USER_REFS	Range applied to some analog reference parameters
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.00 to 550.00 RFC-A, RFC-S: -50000.0 to 50000.0
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_SPEED_FREQ_USER_REFS[MAX] = VM_SPEED_FREQ_REF[MAX]

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_SPEED_FREQ_USER_REFS [MIN]**
0	0	Pr **01.007**
0	1	-VM_SPEED_FREQ_REF[MAX]
1	0	0.0
1	1	-VM_SPEED_FREQ_REF[MAX]

VM_STD_UNDER_VOLTS	Range applied the standard under-voltage threshold
Units	V
Range of [MIN]	0 to 1150
Range of [MAX]	0 to 1150
Definition	VM_STD_UNDER_VOLTS[MAX] = VM_DC_VOLTAGE_SET / 1.1 VM_STD_UNDER_VOLTS[MIN] is voltage rating dependent. See Table 11-4

VM_SUPPLY_LOSS_LEVEL	Range applied to the supply loss threshold
Units	V
Range of [MIN]	0 to 1150
Range of [MAX]	0 to 1150
Definition	VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX] VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 11-4

VM_SWITCHING_FREQUENCY	Range applied to the maximum switching frequency parameters
Units	User units
Range of [MIN]	0
Range of [MAX]	0 to 6
Definition	VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent VM_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes, or 1 for Regen mode (subject to the maximum)

VM_TORQUE_CURRENT	Range applied to torque and torque producing current parameters (where this is used in Regen mode it refers to the active current)
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	see below

***Select Motor 2 Parameters* (11.045)**	**VM_TORQUE_CURRENT [MAX]**
0	VM_MOTOR1_CURRENT_LIMIT[MAX]
1	VM_MOTOR2_CURRENT_LIMIT[MAX]

VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]

VM_TORQUE_CURRENT_UNIPOLAR	Unipolar version of VM_TORQUE_CURRENT
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX] VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0 *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to *Percentage Load* (04.020), *Torque Reference* (04.008) and *Torque Offset* (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX] varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

VM_USER_CURRENT	Range applied to torque reference and percentage load parameters with one decimal place
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024) VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX] *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to *Percentage Load* (04.020), *Torque Reference* (04.008) and Torque Offset (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX] varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

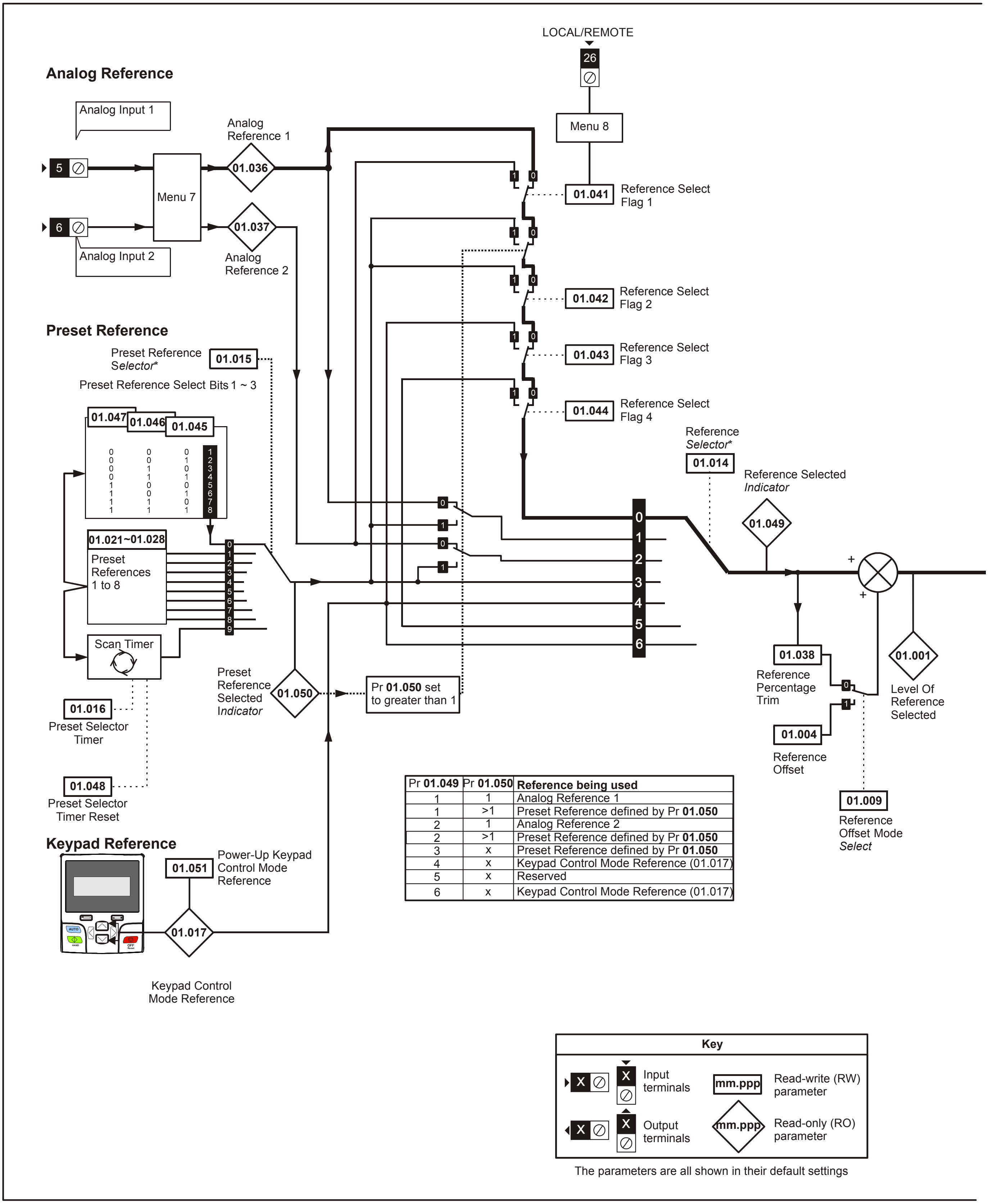
VM_USER_CURRENT_HIGH_RES	Range applied to torque reference and percentage load parameters with two decimal places
Units	%
Range of [MIN]	-1000.00 to 0.00
Range of [MAX]	0.00 to 1000.00
Definition	VM_USER_CURRENT_HIGH_RES[MAX] = *User Current Maximum Scaling* (04.024) with an additional decimal place VM_USER_CURRENT_HIGH_RES[MIN] = -VM_USER_CURRENT_HIGH_RES[MAX] *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to *Percentage Load* (04.020), *Torque Reference* (04.008) and Torque Offset (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX] varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

Table 11-4 Voltage ratings dependant values

Variable min/max	Voltage level (V)			
	200 V	400 V	575 V	690 V
VM_DC_VOLTAGE_SET[MAX]	400	800	955	1150
VM_DC_VOLTAGE[MAX]	415	830	990	1190
VM_AC_VOLTAGE_SET[MAX]	265	530	635	765
VM_AC_VOLTAGE[MAX]	325	650	780	930
VM_STD_UNDER_VOLTS[MIN]	175	330	435	435
VM_SUPPLY_LOSS_LEVEL[MIN]	205	410	540	540
VM_HIGH_DC_VOLTAGE	1500	1500	1500	1500

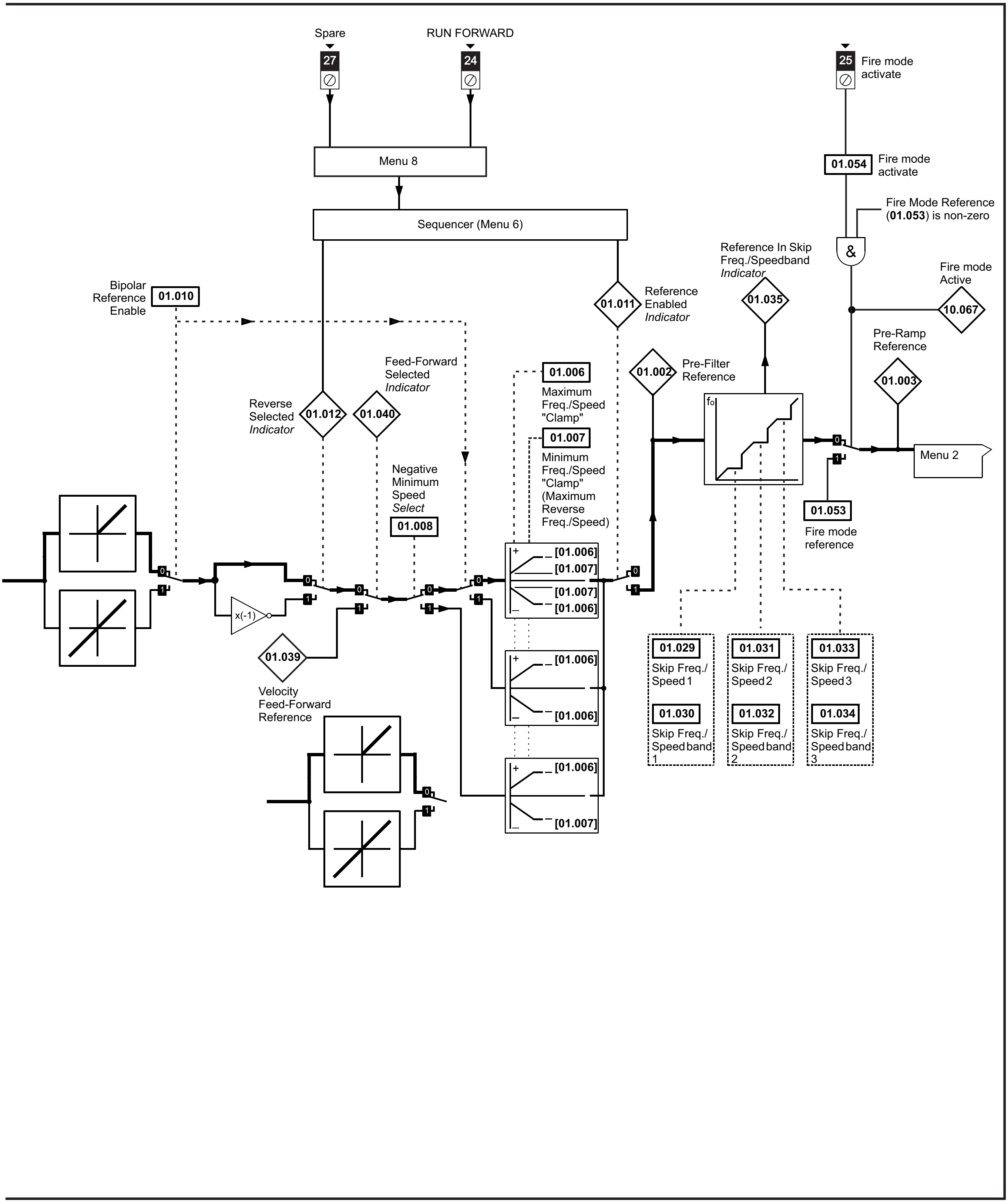
11.2 Menu 1: Frequency / speed reference

Figure 11-1 Menu 1 logic diagram



Pr **01.049**	Pr **01.050**	**Reference being used**
1	1	Analog Reference 1
1	>1	Preset Reference defined by Pr **01.050**
2	1	Analog Reference 2
2	>1	Preset Reference defined by Pr **01.050**
3	x	Preset Reference defined by Pr **01.050**
4	x	Keypad Control Mode Reference (01.017)
5	x	Reserved
6	x	Keypad Control Mode Reference (01.017)

The parameters are all shown in their default settings

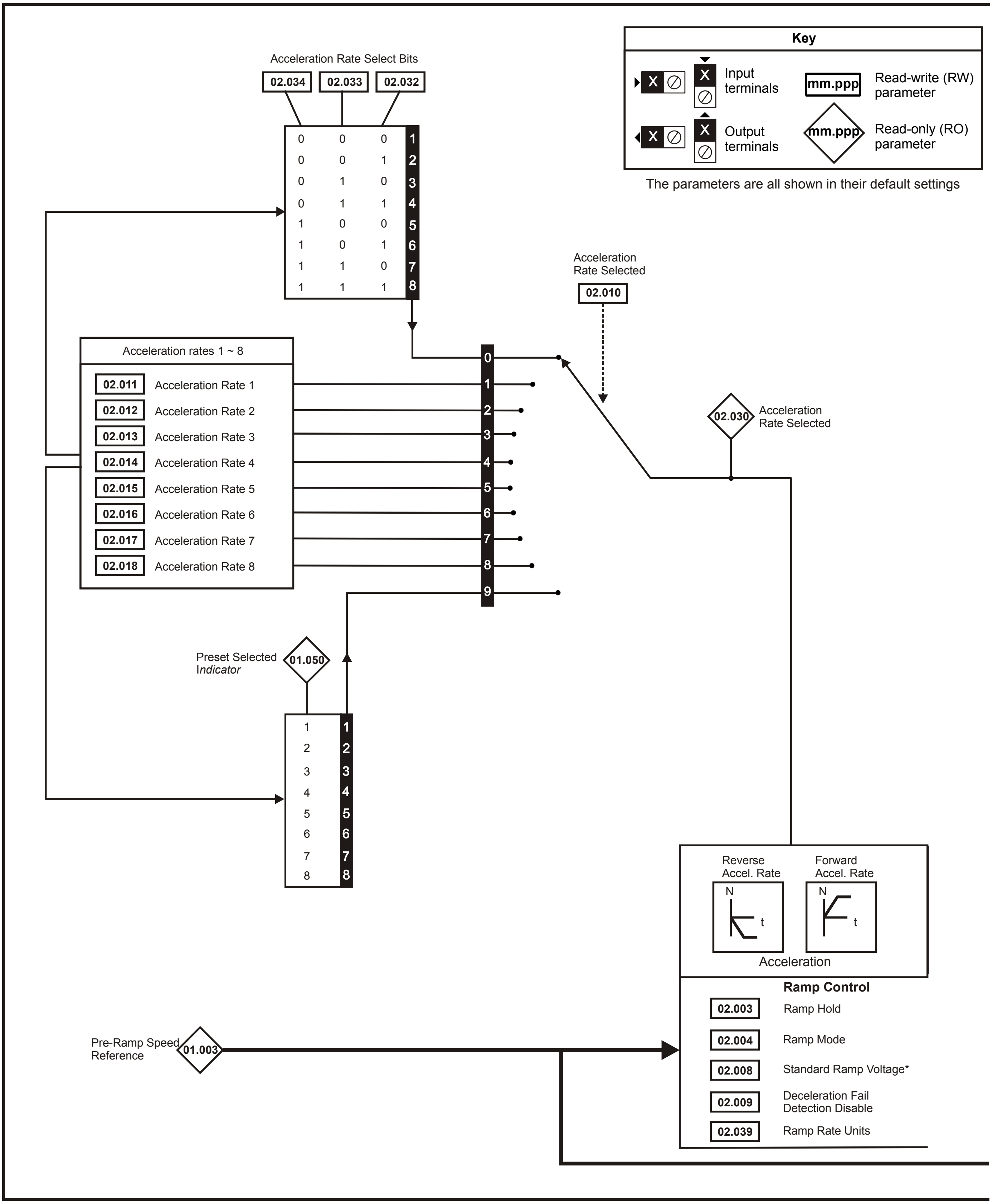

Spare
27
RUN FORWARD
24
25
Fire mode activate
Menu 8
Sequencer (Menu 6)
01.054
Fire mode activate
Fire Mode Reference (01.053) is non-zero
&
Fire mode Active
10.067
Bipolar Reference Enable
01.010
01.011
Reference Enabled Indicator
Reference In Skip Freq./Speedband Indicator
01.035
Pre-Ramp Reference
01.003
Feed-Forward Selected Indicator
01.006
Maximum Freq./Speed "Clamp"
01.007
Minimum Freq./Speed "Clamp" (Maximum Reverse Freq./Speed)
01.002
Pre-Filter Reference
Reverse Selected Indicator
01.012
01.040
Negative Minimum Speed Select
01.008
f₀
Menu 2
01.053
Fire mode reference
0
1
x(-1)
01.039
Velocity Feed-Forward Reference
[01.006]
[01.007]
[01.007]
[01.006]
[01.006]
[01.006]
[01.006]
[01.007]
+
–
01.029
Skip Freq./ Speed 1
01.030
Skip Freq./ Speedband 1
01.031
Skip Freq./ Speed 2
01.032
Skip Freq./ Speedband 2
01.033
Skip Freq./ Speed 3
01.034
Skip Freq./ Speedband 3

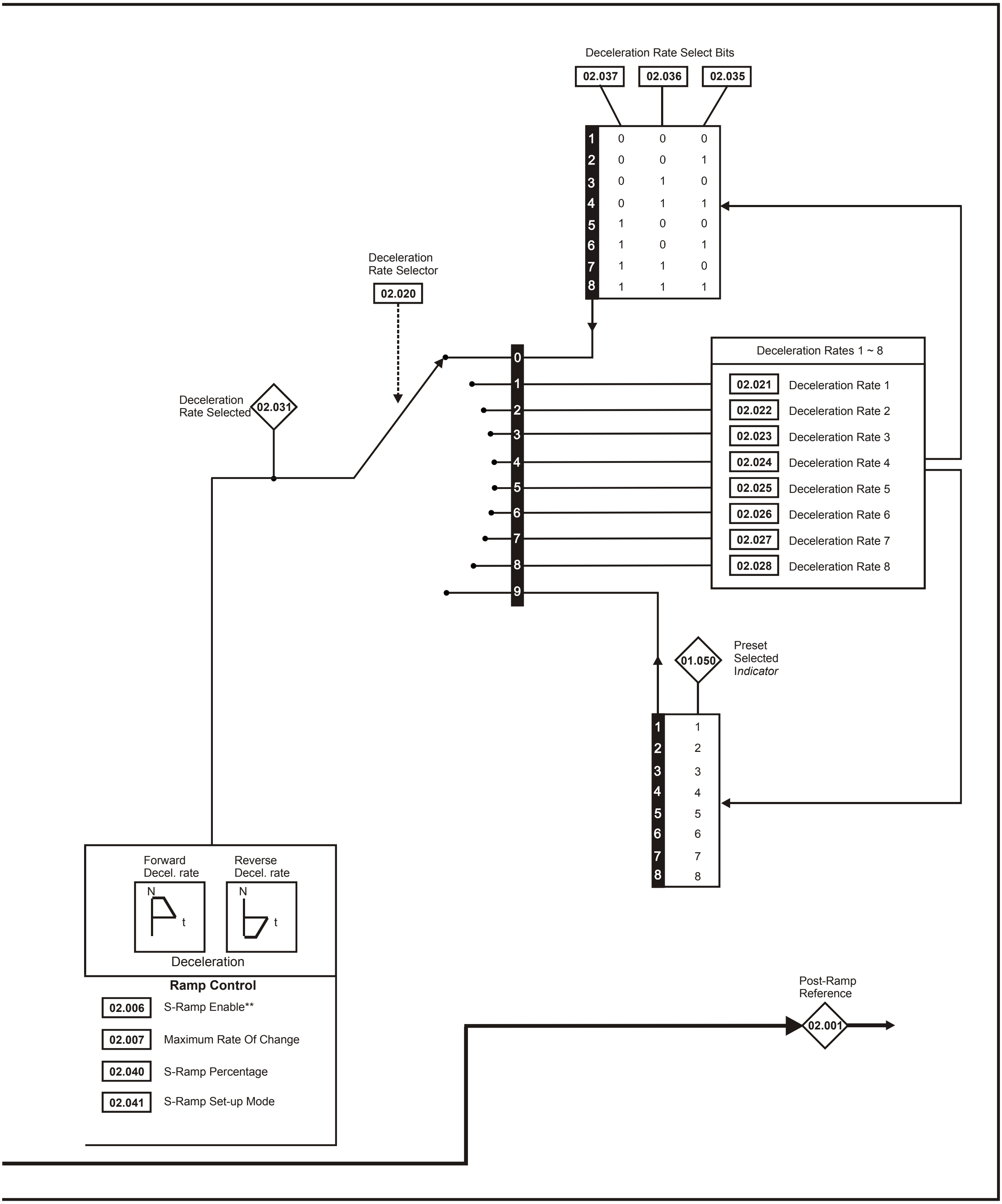
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
01.001	Reference Selected	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.002	Pre-Skip Filter Reference	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.003	Pre-Ramp Reference	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.004	Reference Offset	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm	0.0			RW	Num				US
01.006	Maximum Reference Clamp	VM_POSITIVE_REF_CLAMP1 Hz	VM_POSITIVE_REF_CLAMP1 rpm	50Hz: 50.0 60Hz: 60.0	50Hz: 1500.0 60Hz: 1800.0	3000.0	RW	Num				US
01.007	Minimum Reference Clamp	VM_NEGATIVE_REF_CLAMP1 Hz	VM_NEGATIVE_REF_CLAMP1 rpm	0.0			RW	Num				US
01.008	Negative Reference Clamp Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
01.009	Reference Offset Select	Off (0) or On (1)		Off (0)			RW	Bit				US
01.010	Bipolar Reference Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
01.011	Reference On	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.012	Reverse Select	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.014	Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2) Preset (3), Keypad (4) Keypad Ref (6)		A1 A2 (0)			RW	Txt	ND			US
01.015	Preset Selector	0 to 9		0			RW	Num				US
01.016	Preset Selector Time	0.0 to 400.0 s		10.0 s			RW	Num				US
01.017	Keypad Control Mode Reference	VM_SPEED_FREQ_USER_REFS		0.0			RO	Num		NC	PT	PS
01.021	Preset Reference 1	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.022	Preset Reference 2	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.023	Preset Reference 3	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.024	Preset Reference 4	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.025	Preset Reference 5	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.026	Preset Reference 6	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.027	Preset Reference 7	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.028	Preset Reference 8	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.029	Skip Reference 1	0.0 to 550.0 Hz	0 to 33000 rpm	0.0	0		RW	Num				US
01.030	Skip Reference Band 1	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.031	Skip Reference 2	0.0 to 550.0 Hz	0 to 33000 rpm	0.0	0		RW	Num				US
01.032	Skip Reference Band 2	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.033	Skip Reference 3	0.0 to 550.0 Hz	0 to 33000 rpm	0.0	0		RW	Num				US
01.034	Skip Reference Band 3	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.035	Reference In Rejection Zone	Off (0) or On (1)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.036	Analog Reference 1	VM_SPEED_FREQ_USER_REFS Hz	VM_SPEED_FREQ_USER_REFS rpm	0.00	0.0		RO	Num		NC		
01.037	Analog Reference 2	±VM_SPEED_FREQ_USER_REFS Hz	±VM_SPEED_FREQ_USER_REFS rpm	0.0	0.0		RO	Num		NC		
01.038	Percentage Trim	±100.00 %		0.00 %			RW	Num		NC		
01.039	Speed Feed-forwards	VM_SPEED_FREQ_REF					RO	Num	ND	NC	PT	
01.040	Speed Feed-forwards Select	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.041	Reference Select Flag 1	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.042	Reference Select Flag 2	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.043	Reference Select Flag 3	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.044	Reference Select Flag 4	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.045	Preset Select Flag 1	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.046	Preset Select Flag 2	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.047	Preset Select Flag 3	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.048	Preset Selector Timer Reset	Off (0) or On (1)		Off (0)			RW	Bit		NC	PT	
01.049	Reference Selected Indicator	1 to 6					RO	Num	ND	NC	PT	
01.050	Preset Selected Indicator	1 to 8					RO	Num	ND	NC	PT	
01.051	Power-up Keypad Control Mode Reference	Reset (0), Last (1), Preset (2)		Reset (0)			RW	Txt				US
01.052	Hand / Off / Auto operating mode	0 to 3		1			RW	Num				US
01.053	Fire mode reference	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.054	Fire mode activate	Off (0) or On (1)		Off (0)			RO	Bit		NC		

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.3 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram




Deceleration Rate Select Bits
02.037
02.036
02.035
1 0 0 0
2 0 0 1
3 0 1 0
4 0 1 1
5 1 0 0
6 1 0 1
7 1 1 0
8 1 1 1
Deceleration Rate Selector
02.020
Deceleration Rate Selected
02.031
0
1
2
3
4
5
6
7
8
9
Deceleration Rates 1 ~ 8
02.021 Deceleration Rate 1
02.022 Deceleration Rate 2
02.023 Deceleration Rate 3
02.024 Deceleration Rate 4
02.025 Deceleration Rate 5
02.026 Deceleration Rate 6
02.027 Deceleration Rate 7
02.028 Deceleration Rate 8
Preset Selected Indicator
01.050
1 1
2 2
3 3
4 4
5 5
6 6
7 7
8 8
Forward Decel. rate
Reverse Decel. rate
N
t
N
t
Deceleration
Ramp Control
02.006 S-Ramp Enable**
02.007 Maximum Rate Of Change
02.040 S-Ramp Percentage
02.041 S-Ramp Set-up Mode
Post-Ramp Reference
02.001

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
02.001	Post Ramp Reference	VM_SPEED_FREQ_ REF Hz	VM_SPEED_FREQ_ REF rpm				RO	Num	ND	NC	PT	
02.003	Ramp Hold	Off (0) or On (1)		Off (0)			RW	Bit				US
02.004	Ramp Mode	Standard (1), Std boost (2)	Standard (1)	Standard (1)			RW	Txt				US
02.006	S Ramp Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
02.007	Maximum Rate Of Change Of Acceleration	0.0 to 300.0 s^2/100 Hz	0.000 to 100.000 s^2/1000 rpm	3.1	1.500	0.030	RW	Num				US
02.008	Standard Ramp Voltage	VM_DC_VOLTAGE_SET V		200 V drive: 375 V 400 V drive 50 Hz: 750 V 400 V drive 60 Hz: 775 V 575 V drive: 895 V 690 V: 1075 V			RW	Num		RA		US
02.009	Deceleration Fail Detection Disable	Off (0) or On (1)		Off (0)			RW	Bit				US
02.010	Acceleration Rate Selector	0 to 9		0			RW	Num				US
02.011	Acceleration Rate 1	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.012	Acceleration Rate 2	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.013	Acceleration Rate 3	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.014	Acceleration Rate 4	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.015	Acceleration Rate 5	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.016	Acceleration Rate 6	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.017	Acceleration Rate 7	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.018	Acceleration Rate 8	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.020	Deceleration Rate Selector	0 to 9		0			RW	Num				US
02.021	Deceleration Rate 1	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.022	Deceleration Rate 2	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.023	Deceleration Rate 3	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.024	Deceleration Rate 4	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.025	Deceleration Rate 5	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.026	Deceleration Rate 6	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.027	Deceleration Rate 7	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.028	Deceleration Rate 8	0.0 to VM_ACCEL_RATE s	0.000 to VM_ACCEL_RATE s	20.0 s	20.000 s		RW	Num				US
02.030	Acceleration Rate Selected	0 to 8					RO	Num	ND	NC	PT	
02.031	Deceleration Rate Selected	0 to 8					RO	Num	ND	NC	PT	
02.032	Acceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.033	Acceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.034	Acceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.035	Deceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.036	Deceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.037	Deceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.039	Ramp Rate Units	Off (0) = 100 Hz or On (1) = Maximum frequency	Off (0) = 1000 rpm or 1000 mm/s (0) or On (1) = Maximum speed	On (1) = Maximum frequency	On (1) = Maximum speed		RW	Bit				US
02.040	S Ramp Percentage	0.0 to 50.0 %		0.0 %			RW	Num				US
02.041	S Ramp Set-up Mode	Single (0), Percentage (1)		Single (0)			RW	Txt				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.4 Menu 3: Speed feedback and speed control

Figure 11-3 Menu 3 Open-loop logic diagram

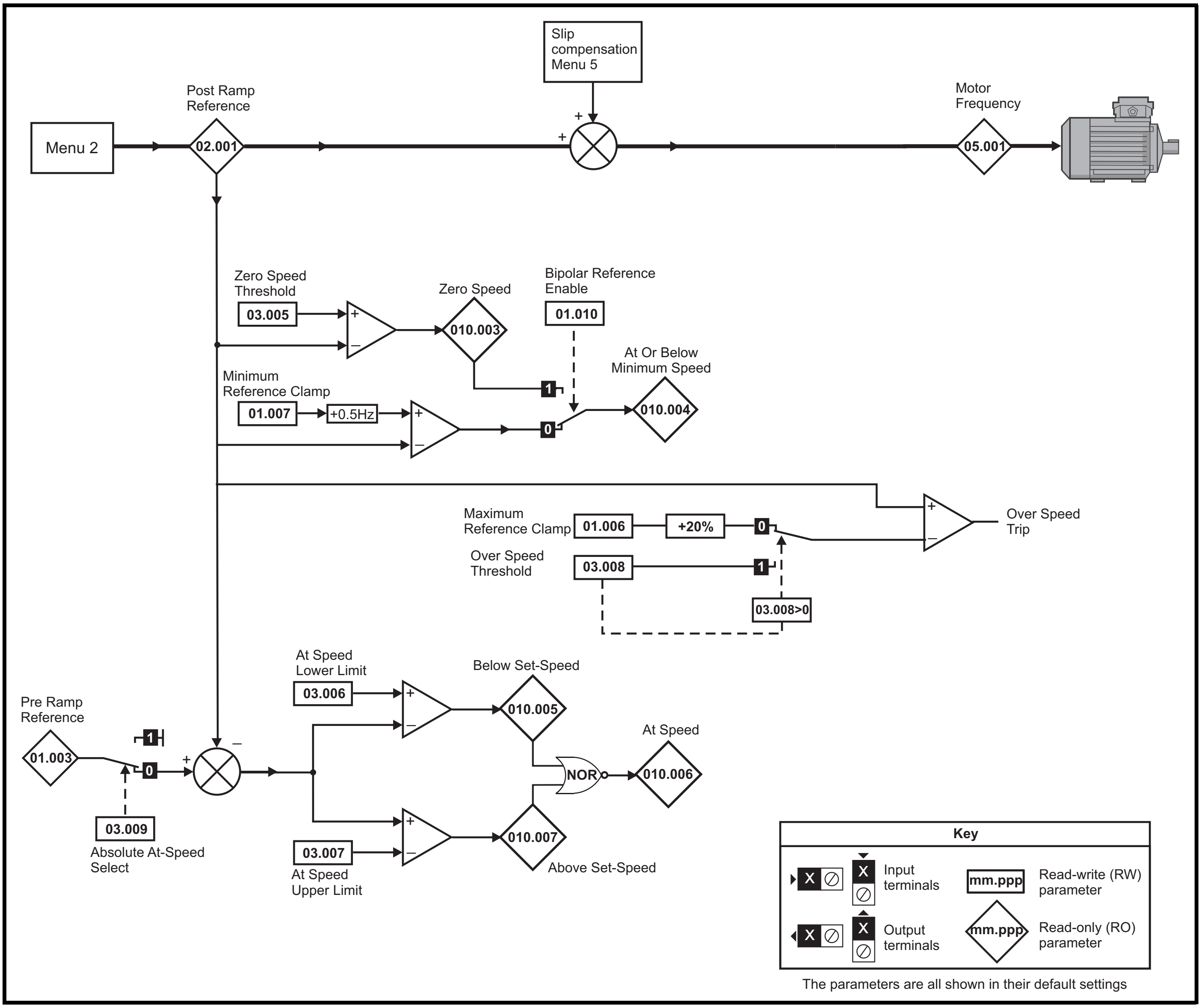
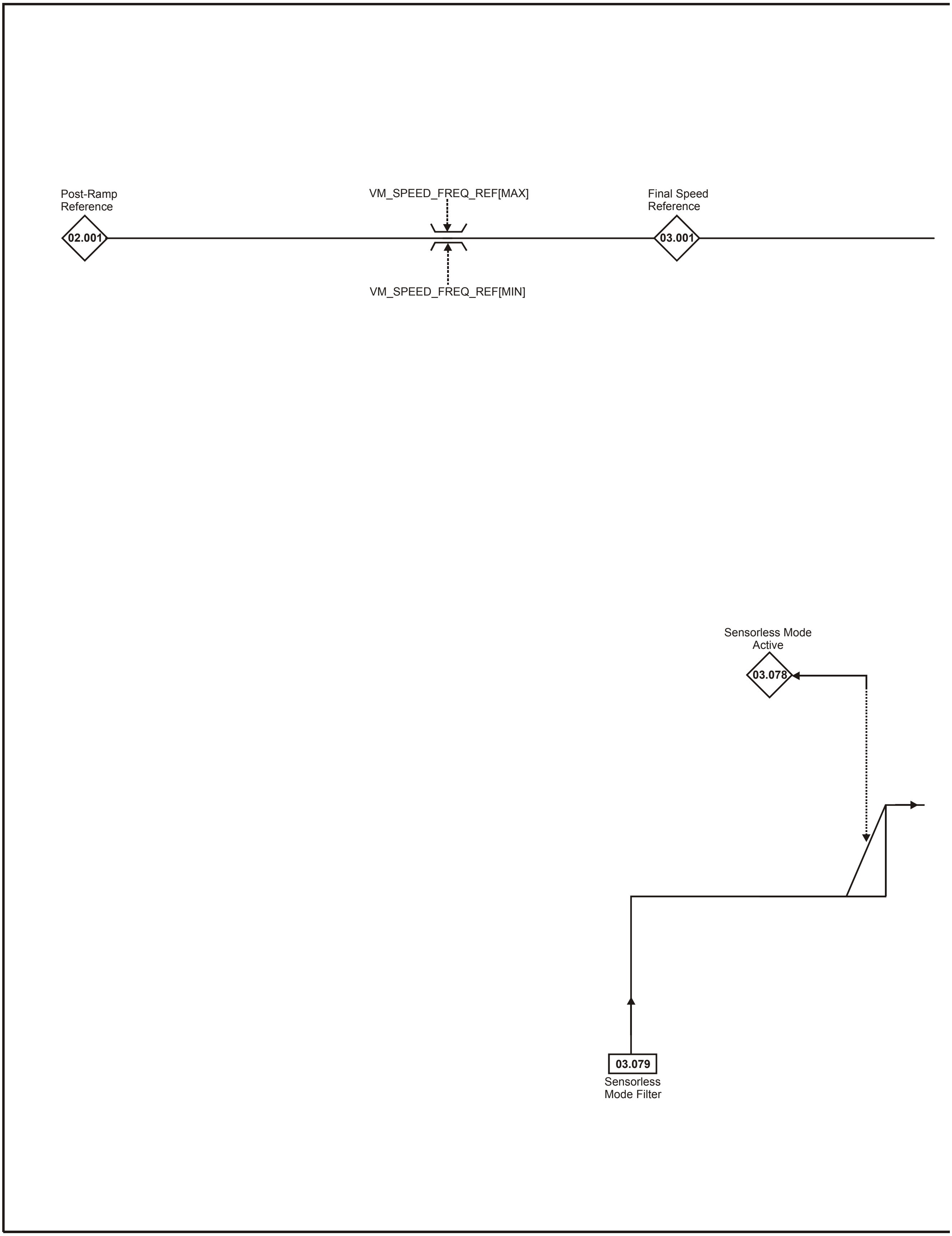
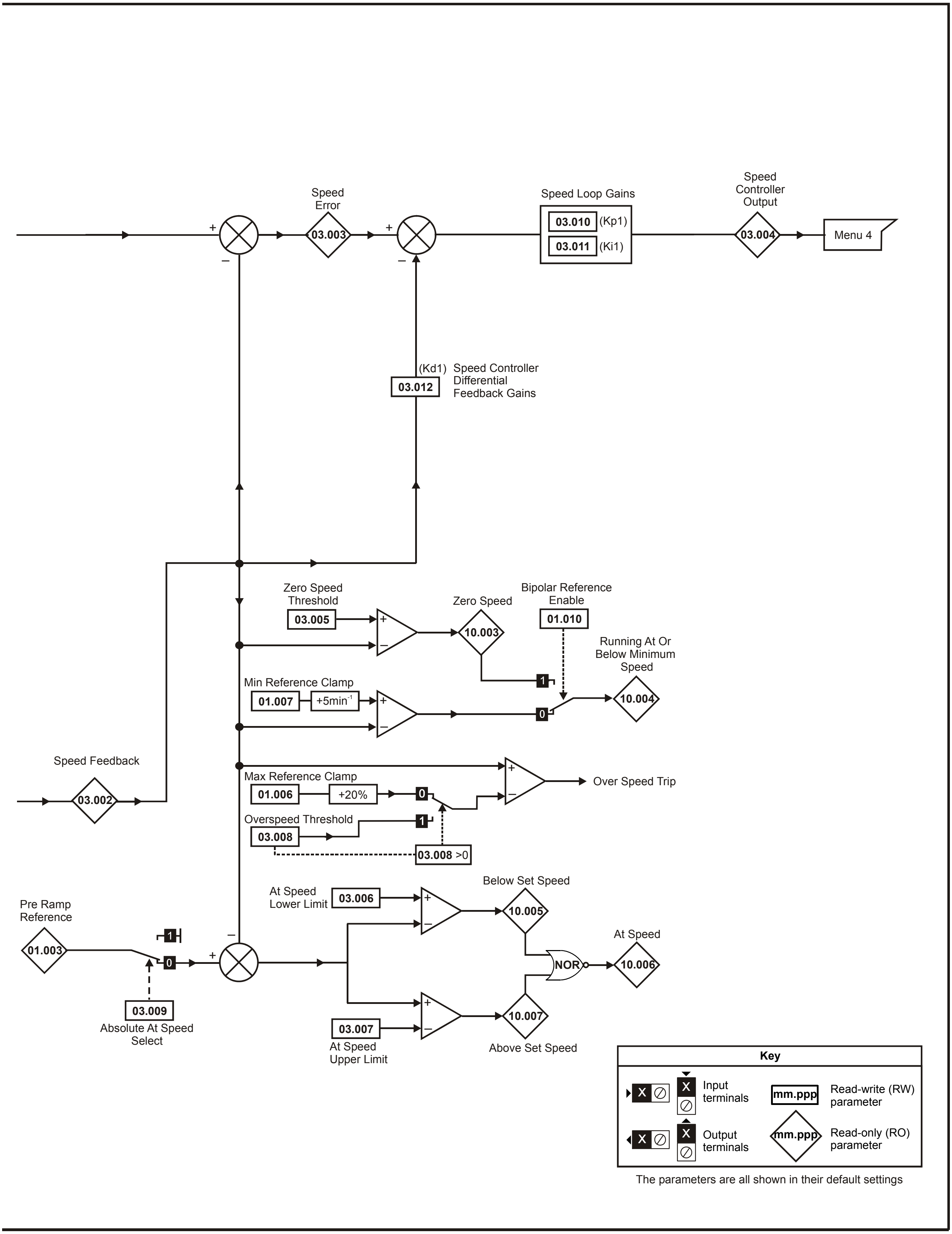


Figure 11-4 Menu 3 RFC-A, RFC-S logic diagram



NOTE

* Automatic change over if the relevant ‘bit’ of *Position Feedback Initialized* (03.076) is 0.


Speed Error
03.003
Speed Loop Gains
03.010 (Kp1)
03.011 (Ki1)
Speed Controller Output
03.004
Menu 4
(Kd1) Speed Controller Differential Feedback Gains
03.012
Zero Speed Threshold
03.005
Zero Speed
10.003
Bipolar Reference Enable
01.010
Running At Or Below Minimum Speed
10.004
Min Reference Clamp
01.007
+5min⁻¹
Speed Feedback
03.002
Max Reference Clamp
01.006
+20%
Over Speed Trip
Overspeed Threshold
03.008
03.008 >0
At Speed Lower Limit
03.006
Below Set Speed
10.005
Pre Ramp Reference
01.003
At Speed
NOR
10.006
03.009
Absolute At Speed Select
03.007
At Speed Upper Limit
10.007
Above Set Speed
Key
Input terminals
mm.ppp Read-write (RW) parameter
Output terminals
mm.ppp Read-only (RO) parameter
The parameters are all shown in their default settings

Parameter		**Range**			**Default**			**Type**					
		OL	**RFC-A**	**RFC-S**	**OL**	**RFC-A**	**RFC-S**						
03.001	Final Speed Reference		VM_SPEED					RO	Num	ND	NC	PT	FI
03.002	Speed Feedback		VM_SPEED					RO	Num	ND	NC	PT	FI
03.003	Speed Error		VM_SPEED					RO	Num	ND	NC	PT	FI
03.004	Speed Controller Output		VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
03.005	Zero Speed Threshold	0.0 to 20.0 Hz	0 to 200 rpm		1.0 Hz	5 rpm		RW	Num				US
03.006	At Speed Lower Limit	0.0 to 550.0 Hz	0 to 33000 rpm		1.0 Hz	5 rpm		RW	Num				US
03.007	At Speed Upper Limit	0.0 to 550.0 Hz	0 to 33000 rpm		1.0 Hz	5 rpm		RW	Num				US
03.008	Over Speed Threshold	0.0 to 550.0 Hz	0 to 40000 rpm		0.0 Hz	0 rpm		RW	Num				US
03.009	Absolute At Speed Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.010	Speed Controller Proportional Gain Kp1		0.0000 to 200.0000 s/rad			0.0300 s/rad		RW	Num				US
03.011	Speed Controller Integral Gain Ki1		0.00 to 655.35 s^2/rad			0.10 s^2/rad		RW	Num				US
03.012	Speed Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
03.078	Sensorless Mode Active		Off (0) or On (1)					RO	Bit	ND	NC	PT	
03.079	Sensorless Mode Filter		4 (0), 8 (1), 16 (2),32 (3), 64 (4) ms			4 (0) ms		RW	Txt				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.5 Menu 4: Torque and current control

Figure 11-5 Menu 4 Open loop logic diagram

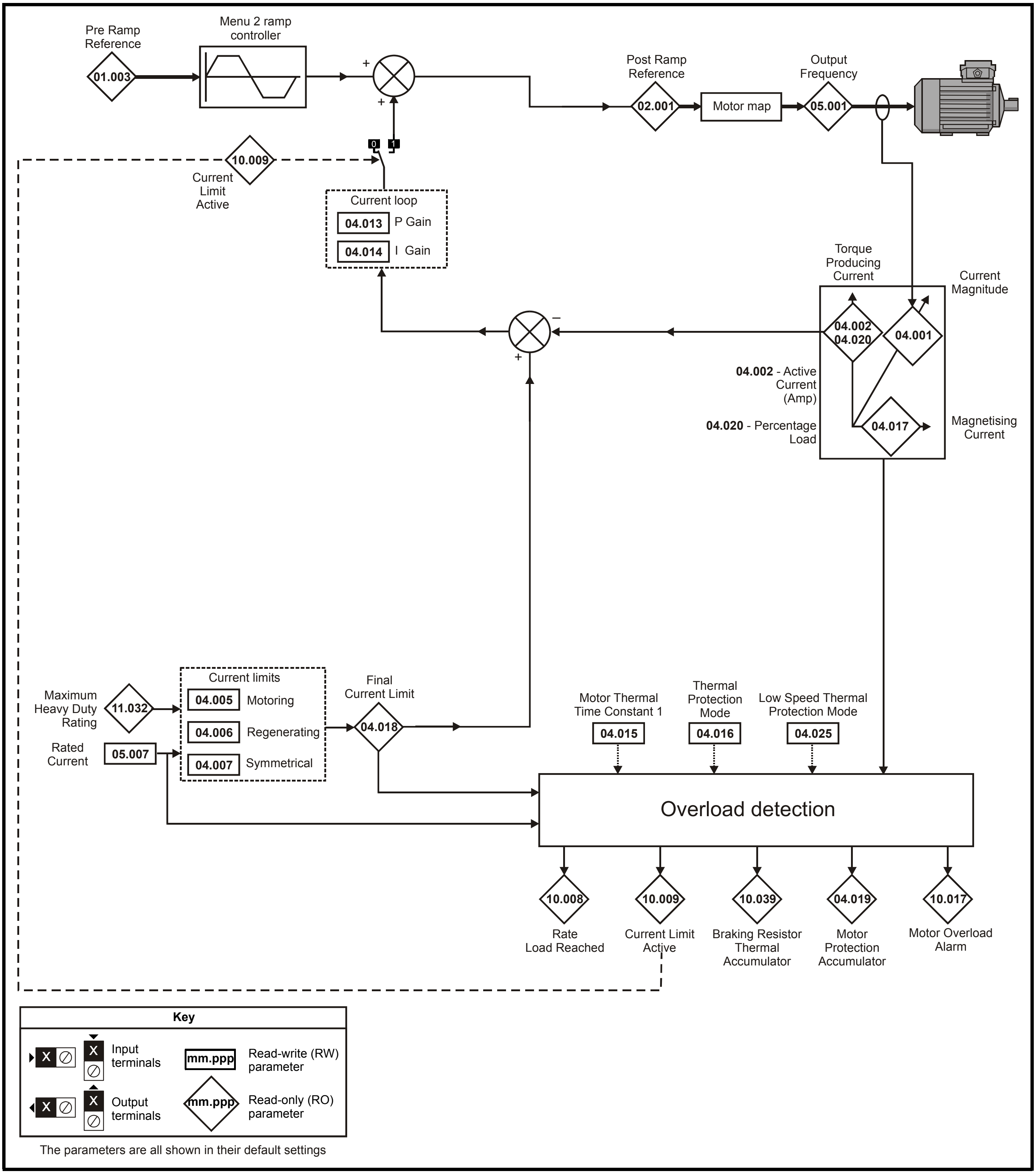


Figure 11-6 Menu 4 RFC-A logic diagram

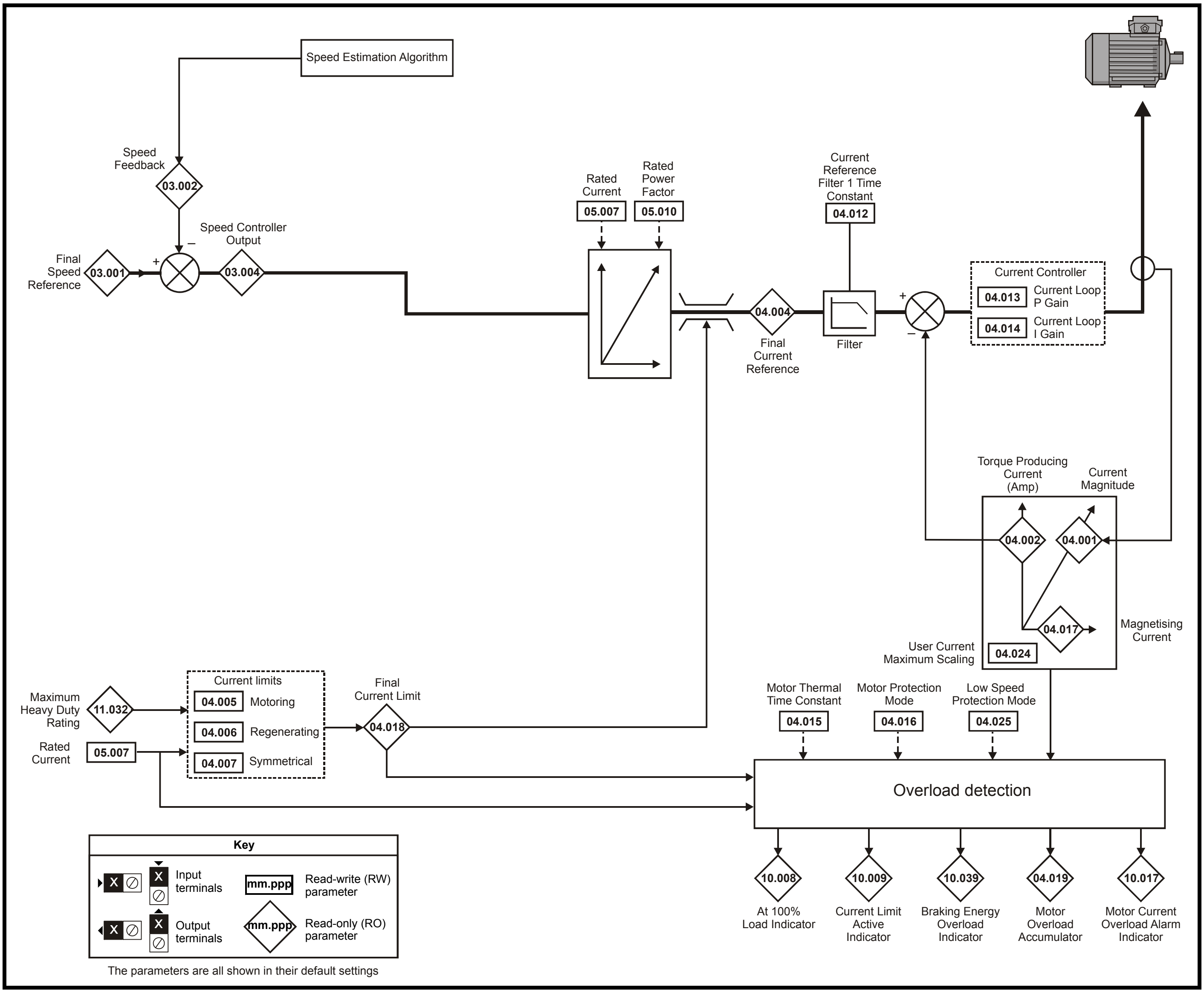
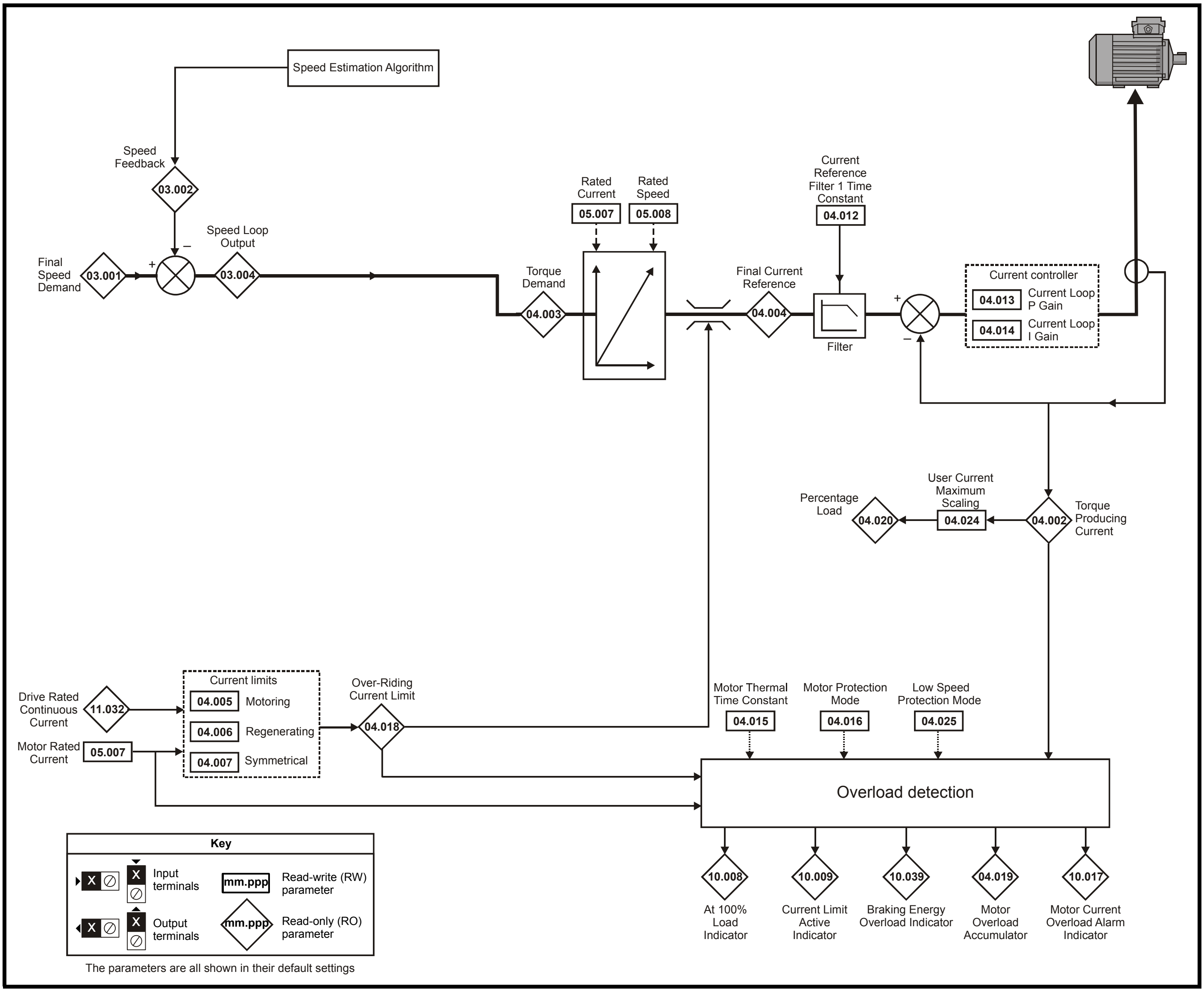


Figure 11-7 Menu 4 RFC-S logic diagram

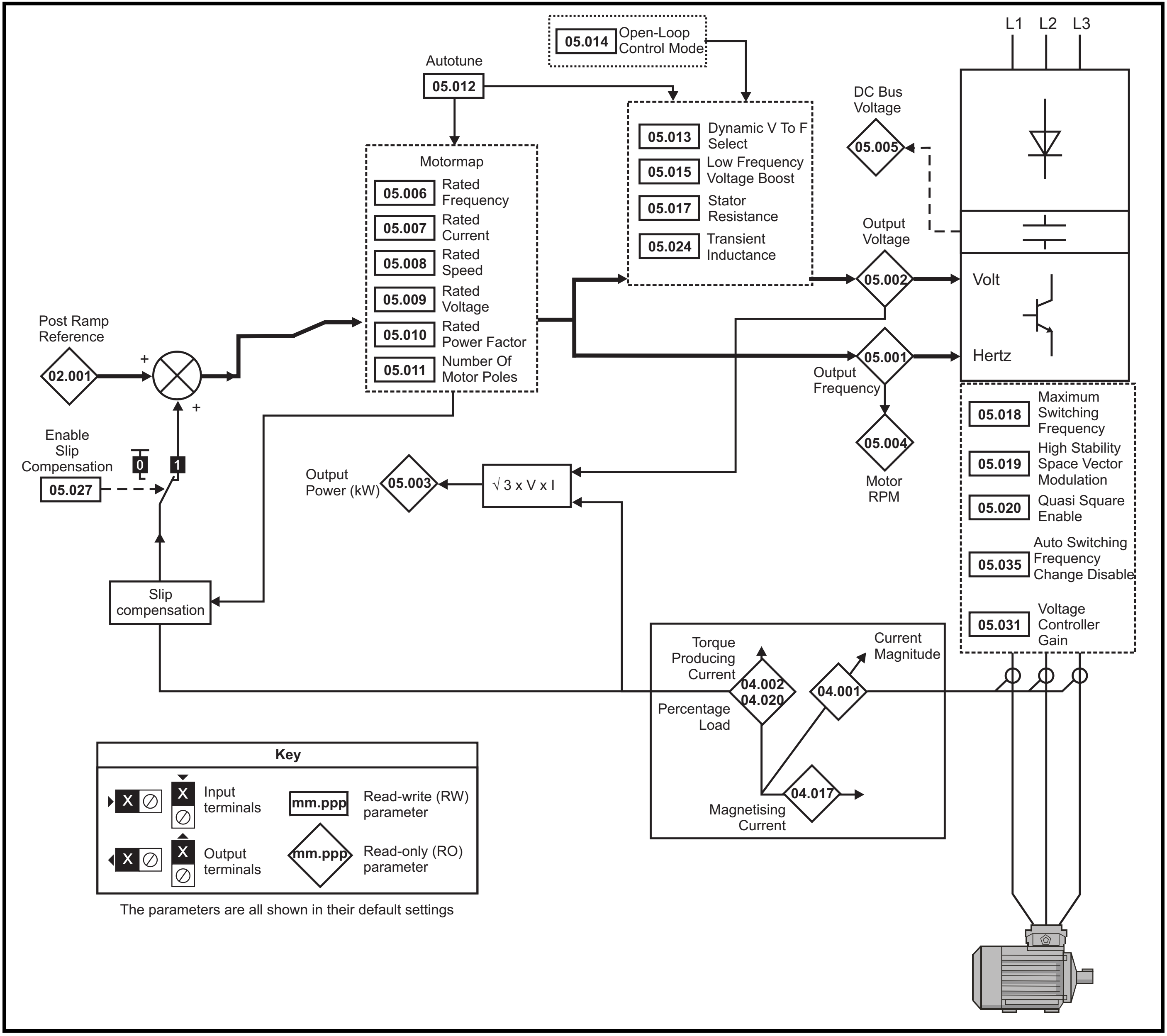


Parameter		**Range(⇳)**		**Default(⇨)**			**Type**					
		OL	**RFC-A / S**	**OL**	**RFC-A**	**RFC-S**						
04.001	Current Magnitude	0.000 to VM_DRIVE_CURRENT_UNIPOLAR A					RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current / Iq	VM_DRIVE_CURRENT A					RO	Num	ND	NC	PT	FI
04.003	Final Torque Reference	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
04.004	Final Current Reference	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
04.005	Motoring Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		110.0 %			RW	Num		RA		US
04.006	Regenerating Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		110.0 %			RW	Num		RA		US
04.007	Symmetrical Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		110.0 %			RW	Num		RA		US
04.012	Current Reference Filter 1 Time Constant		0.0 to 25.0 ms		1.0 ms		RW	Num				US
04.013	Current Controller Kp Gain	0 to 30000		20	150		RW	Num				US
04.014	Current Controller Ki Gain	0 to 30000		40	2000		RW	Num				US
04.015	Motor Thermal Time Constant 1	1.0 to 3000.0 s		89.0 s			RW	Num				US
04.016	Thermal Protection Mode	00 to 11		00			RW	Bin				US
04.017	Magnetising Current / Id	VM_DRIVE_CURRENT A					RO	Num	ND	NC	PT	FI
04.018	Final Current Limit	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	
04.019	Motor Protection Accumulator	0.0 to 100.0 %					RO	Num	ND	NC	PT	PS
04.020	Percentage Load	VM_USER_CURRENT %					RO	Num	ND	NC	PT	FI
04.021	Current feedback filter disable	Off (0) or On (1)		Off (0)			RW	Bit				US
04.024	User Current Maximum Scaling	0.0 to VM_TORQUE_CURRENT_UNIPOLAR		110.0 %			RW	Num		RA		US
04.025	Low Speed Thermal Protection Mode	0 to 1		0			RW	Num				US
04.026	Percentage Torque	0.0 to VM_USER_CURRENT %					RO	Num	ND	NC	PT	FI
04.027	Low load detection level	0.0 to100%		0.0 %			RW	Num				US
04.028	Low load detection speed / frequency threshold	VM_SPEED_FREQ_REF_UNIPOLAR		0.0 Hz	0.0 rpm		RW	Num				US
04.029	Enable trip on low load	Off (0) or On (1)		Off (0)			RW	Bit				US
04.036	Motor Protection Accumulator Power-Up Value	Power down (0), Zero (1), Real time (2)		Power down (0)			RW	Txt				US
04.037	Motor Thermal Time Constant 2	1.0 to 3000.0 s		89.0 s			RW	Num				US
04.038	Motor Thermal Time Constant 2 Scaling	0 to 100 %		0 %			RW	Num				US
04.039	Rated Iron Losses As Percentage Of Losses	0 to 100 %		0 %			RW	Num				US
04.041	Rated Torque	0.00 to 50000.00 Nm		0.00 Nm			RW	Num				US
04.049	Magnetising Current Limit		0.0 to 100.0 %		100.0 %		RW	Num				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

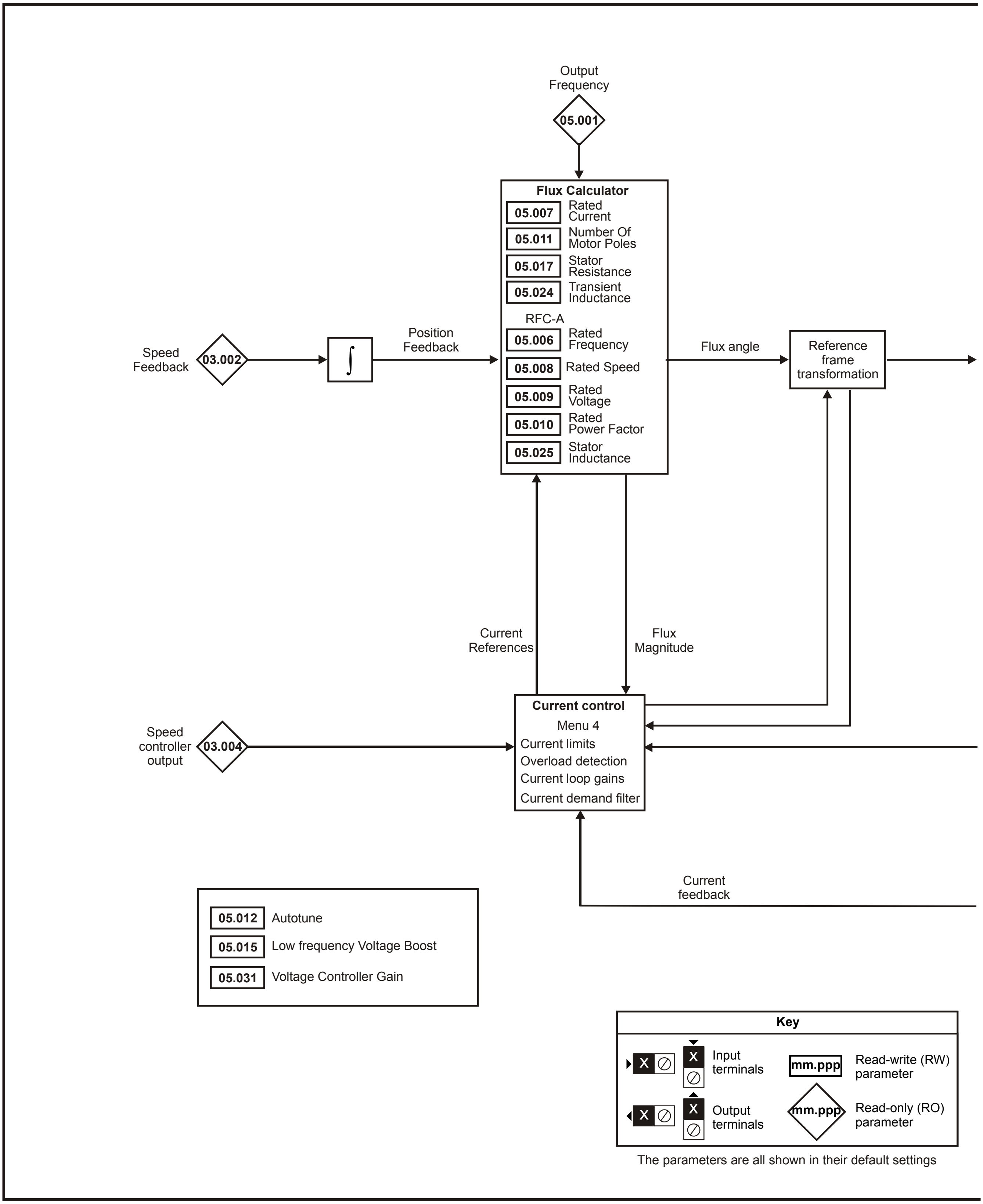
11.6 Menu 5: Motor control

Figure 11-8 Menu 5 Open-loop logic diagram

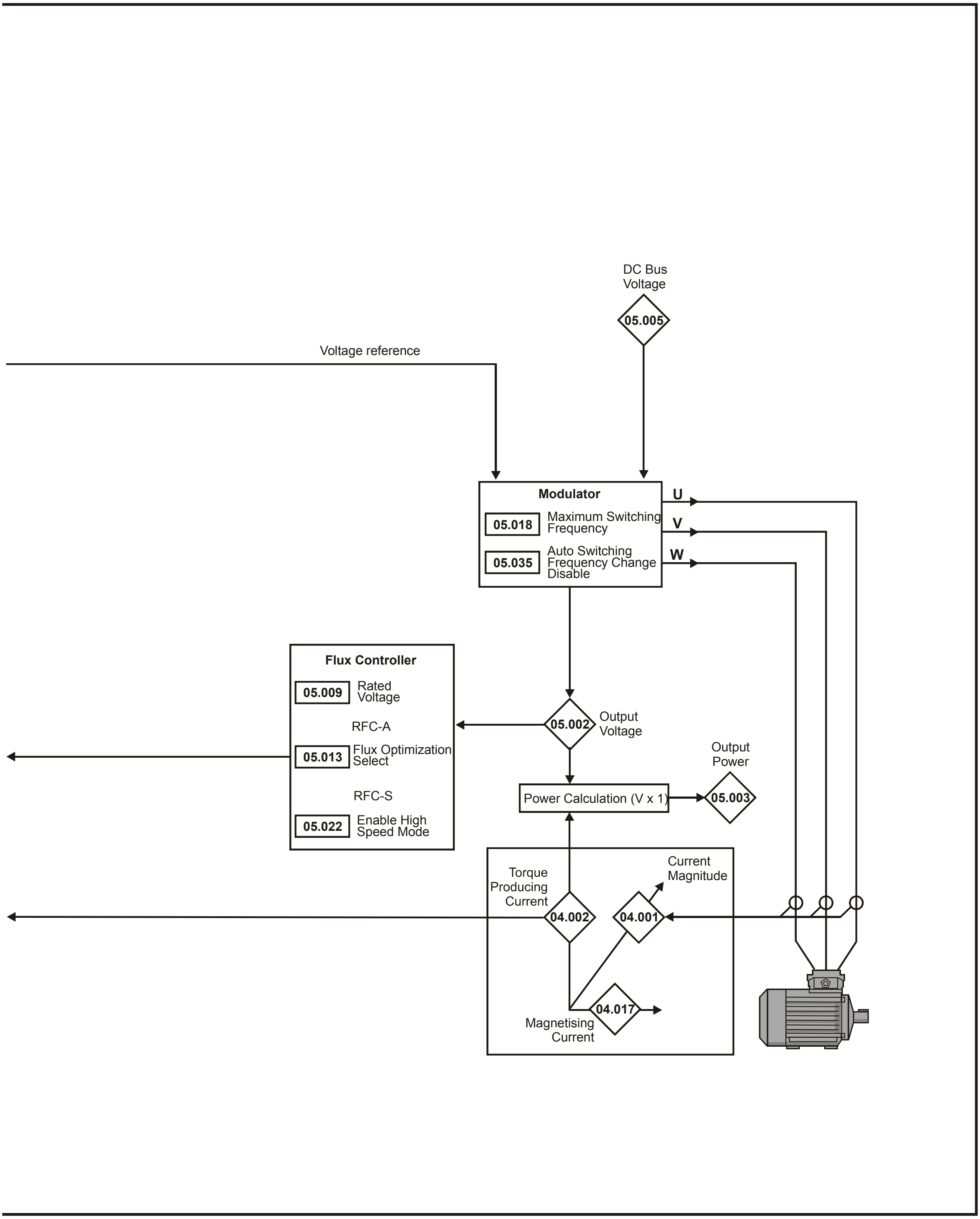


The parameters are all shown in their default settings

Figure 11-9 Menu 5 RFC-A, RFC-S logic diagram



The parameters are all shown in their default settings


DC Bus Voltage
05.005
Voltage reference
Modulator
05.018
Maximum Switching Frequency
05.035
Auto Switching Frequency Change Disable
U
V
W
Flux Controller
05.009
Rated Voltage
RFC-A
05.013
Flux Optimization Select
RFC-S
05.022
Enable High Speed Mode
05.002
Output Voltage
Output Power
Power Calculation (V x 1)
05.003
Torque Producing Current
04.002
Current Magnitude
04.001
04.017
Magnetising Current

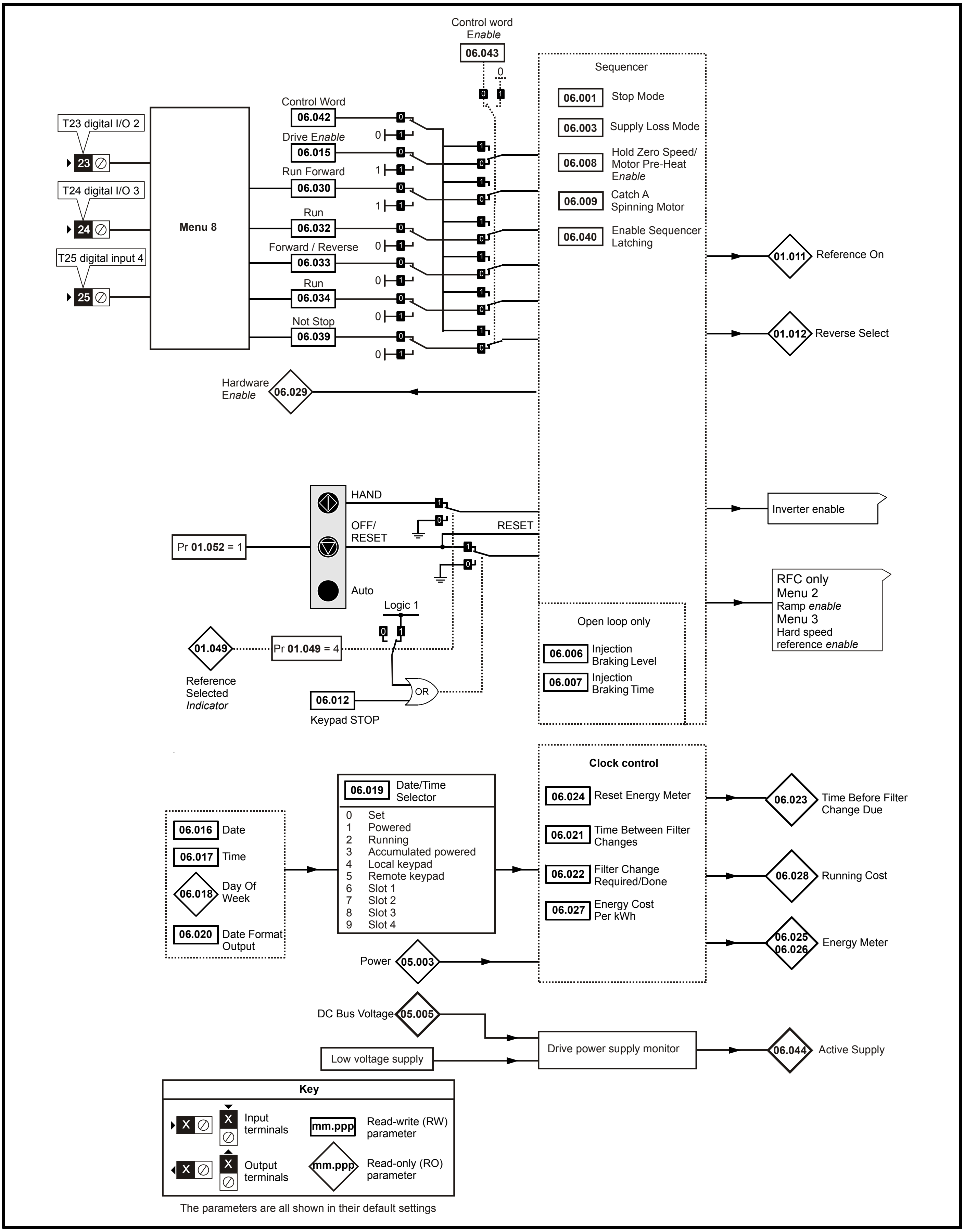
Parameter		Range(⇕)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.001	Output Frequency	VM_SPEED_ FREQ_REF Hz	±2000.0 Hz					RO	Num	ND	NC	PT	FI
05.002	Output Voltage	0 to VM_AC_VOLTAGE V						RO	Num	ND	NC	PT	FI
05.003	Output Power	VM_POWER kW						RO	Num	ND	NC	PT	FI
05.004	Motor Rpm	±180000 rpm						RO	Num	ND	NC	PT	FI
05.005	D.C. Bus Voltage	0 to VM_DC_VOLTAGE V						RO	Num	ND	NC	PT	FI
05.006	Rated Frequency	0.0 to 550.0 Hz			50Hz: 50.0 60Hz: 60.0			RW	Num				US
05.007	Rated Current	0.000 to VM_RATED_CURRENT A			Maximum Rated Current 11.060			RW	Num		RA		US
05.008	Rated Speed	0 to 33000 rpm	0.00 to 33000.00 rpm		50Hz - 1500 rpm 60Hz - 1800 rpm	50Hz - 1450.00 rpm 60Hz - 1750.00 rpm	3000.00 rpm	RW	Num				US
05.009	Rated Voltage	0 to VM_AC_VOLTAGE_SET V			200 V drive: 230 V Eur - 400 V drive: 400 V USA - 400 V drive: 460 V 575 V drive: 575 V 690 V drive: 690 V			RW	Num		RA		US
05.010	Rated Power Factor	0.000 to 1.000			0.850			RW	Num		RA		US
05.011	Number Of Motor Poles	Automatic (0) to 480 Poles (240)			Automatic (0)		8 Poles (4)	RW	Txt				US
05.012	Autotune	0 to 2		0, 1, 2, 6	0			RW	Num		NC		
05.013	Open Loop> Dynamic V To F Select	Off (0) or On (1)			On (1)			RW	Bit				US
	RFC-A> Flux Optimization Select		Off (0) or On (1)			Off (0)		RW	Bit				US
05.014	Open-loop Control Mode	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Current 1P (6)			Ur I (4)			RW	Txt				US
05.015	Open-loop / RFC-A > Low Frequency Voltage Boost	0.0 to 25.0 %			3.0 %			RW	Num				US
	RFC-S> Minimal Movement Phasing Test Current			1% (0), 2% (1), 3% (2), 6% (3), 12% (4), 25% (5), 50% (6), 100% (7)			1% (0)	RW	Num				US
05.016	Minimal Movement Phasing Test Angle			0.00 to 25.00 °			0.00 °	RW	Num				US
05.017	Stator Resistance	0.000000 to 1000.000000 Ω			0.000000 Ω			RW	Num		RA		US
05.018	Maximum Switching Frequency	0 to VM_SWITCHING_FREQUENCY kHz			3 kHz (1)			RW	Txt		RA		US
05.019	High Stability Space Vector Modulation	Off (0) or On (1)			Off (0)			RW	Bit				US
05.020	Quasi-square Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
05.022	Enable High Speed Mode			Limit (-1), Disable (0), Enable (1)			Limit (-1)	RW	Bit				US
05.024	Transient Inductance / Ld	0.000 to 500.000 mH			0.000 mH			RW	Num		RA		US
05.025	Stator Inductance	0.00 to 5000.00 mH			0.00 mH			RW	Num		RA		US
05.027	Open-Loop> Enable Slip Compensation	Off (0) or On (1)			On (1)			RW	Bit				US
	RFC-A Flux Control Gain		0.1 to 10.0			1.0		RW	Bit				US
05.028	Torque Linearisation Disable			Off (0) or On (1)			Off (0)	RW	Bit				US
05.031	Voltage Controller Gain	1 to 30			1			RW	Num				US
05.033	Volts per 1000 rpm			0 to 10000 V			98 V	RW	Num				US
05.034	Percentage Flux		0.0 to 150.0 %					RO	Num	ND	NC	PT	FI
05.035	Auto-switching Frequency Change	Enabled (0), Disabled (1), No Ripple Detect (2)			Enabled (0)			RW	Txt				US
05.036	Auto-switching Frequency Step Size	1 to 2			2			RW	Num				US
05.037	Switching Frequency	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)						RO	Txt	ND	NC	PT	

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.038	Minimum Switching Frequency	0 to VM_MIN_SWITCHING_FREQUENCY kHz			2 kHz (0)			RW	Txt				US
05.039	Maximum Inverter Temperature Ripple	20 to 60 °C			60 °C			RW	Num				US
05.040	Spin Start Boost	0.0 to 10.0			1.0			RW	Num				US
05.041	Voltage Headroom		0 to 20 %			0 %	10 %	RW	Num				US
05.042	Reverse Output Phase Sequence	Off (0) or On (1)			Off (0)			RW	Bit				US
05.063	Sensorless Mode Current Ramp			0.00 to 1.00 s			0.20 s	RW	Num				US
05.064	RFC Low Speed Mode			Injection (0), Non-salient (1), Current (2), Current No Test (3)			Non-salient (1)	RW	Txt				US
05.065	Saliency Torque Control Select			Disabled (0), Low (1), High (2), Auto (3)			Disabled (0)	RW	Txt				US
05.066	Active Saliency Torque Mode			Disabled (0), Low (1), High (2)				RO	Txt	ND	NC	PT	
05.067	Required Over-current Trip Level			0 to 100 %			0 %	RW	Num				US
05.068	Actual Over-current Trip Level			0 to 500 %				RO	Num	ND	NC	PT	
05.070	Inverted Saturation Characteristic			Off (0) or On (1)			Off (0)	RW	Bit				US
05.071	Low Speed Sensorless Mode Current Limit			0.0 to 1000.0 %			20.0 %	RW	Num		RA		US
05.072	No-load Lq			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.075	Iq Test Current For Inductance Measurement			0 to 200 %			100 %	RW	Num				US
05.077	Phase Offset At Iq Test Current			±90.0 °			0.0 °	RW	Num		RA		US
05.078	Lq At The Defined Iq Test Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.082	Id Test Current for Inductance Measurement			-100 to 0 %			-50 %	RW	Num				US
05.084	Lq At The Defined Id Test Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.088	Estimated Lq			0.000 to 500.000 mH				RO	Num	ND	NC	PT	FI
05.089	Rated Torque Angle			0 to 90 °				RO	Num	ND	NC	PT	

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.7 Menu 6: Sequencer and clock

Figure 11-10 Menu 6 logic diagram



The parameters are all shown in their default settings

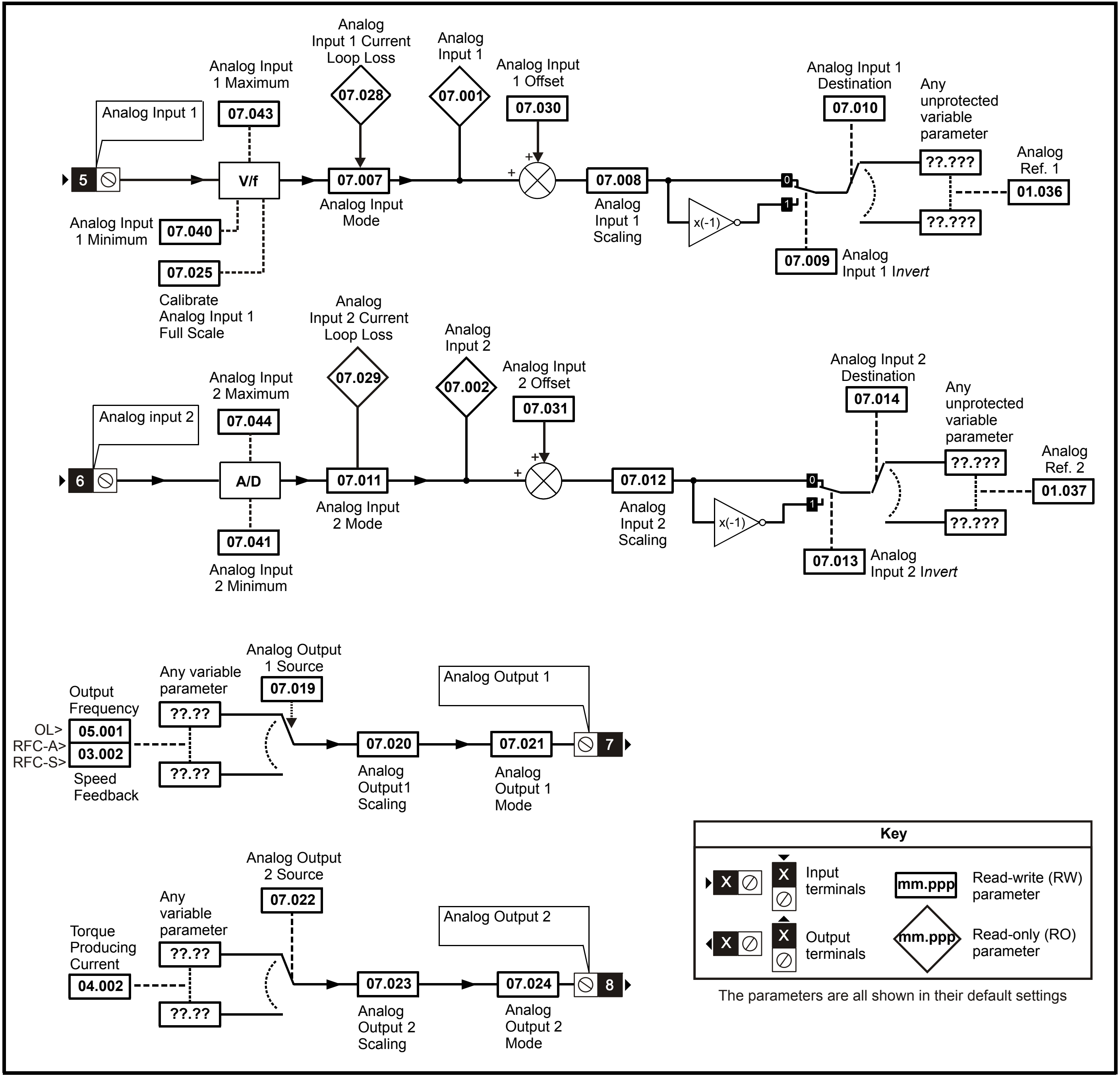
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.001	Stop Mode	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4)	Coast (0), Ramp (1),	Ramp (1)			RW	Txt				US
06.003	Supply Loss Mode	Disable (0), Ramp Stop (1), Ride Thru (2)	Disable (0), Ramp Stop (1), Ride Thru (2), Limit Stop (3)	Disable (0)			RW	Txt				US
06.006	Injection Braking Level	0.0 to 150.0 %		100.0 %			RW	Num		RA		US
06.007	Injection Braking Time	0.0 to 100.0 s		1.0 s			RW	Num				US
06.008	Hold Zero Speed	Off (0) or On (1)		Off (0)			RW	Bit				US
06.009	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)			RW	Txt				US
06.010	Enable Conditions	000000000000 to 111111111111					RO	Bin	ND	NC	PT	
06.011	Sequencer State Machine Inputs	0000000 to 1111111					RO	Bin	ND	NC	PT	
06.015	Drive Enable	Off (0) or On (1)		On (1)			RW	Bit				US
06.016	Date	00-00-00 to 31-12-99					RW	Date	ND	NC	PT	
06.017	Time	00:00:00 to 23:59:59					RW	Time	ND	NC	PT	
06.018	Day Of Week	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)					RO	Txt	ND	NC	PT	
06.019	Date/Time Selector	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
06.020	Date Format	Std (0) or US (1)		US (1)			RW	Txt				Us
06.021	Time Between Filter Changes	0 to 30000 Hours		0 Hours			RW	Num				US
06.022	Filter Change Required / Change Done	Off (0) or On (1)					RW	Bit	ND	NC		
06.023	Time Before Filter Change Due	0 to 30000 Hours					RO	Num	ND	NC	PT	PS
06.024	Reset Energy Meter	Off (0) or On (1)		Off (0)			RW	Bit				
06.025	Energy Meter: MWh	±999.0 MWh					RO	Num	ND	NC	PT	PS
06.026	Energy Meter: kWh	±99.99 kWh					RO	Num	ND	NC	PT	PS
06.027	Energy Cost Per kWh	0.0 to 600.0		0.0			RW	Num				US
06.028	Running Cost	±32000					RO	Num	ND	NC	PT	
06.029	Hardware Enable	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.030	Run Forward	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.032	Run Reverse	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.033	Forward/Reverse	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.034	Run	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.039	Not Stop	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.040	Enable Sequencer Latching	Off (0) or On (1)		Off (0)			RW	Bit				US
06.041	Drive Event Flags	00 to 11		00			RW	Bin		NC		
06.042	Control Word	000000000000000 to 111111111111111		000000000000000			RW	Bin		NC		
06.043	Control Word Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.044	Active Supply	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.045	Cooling Fan control	0 to 11		10			RW	Num				US
06.047	Input Phase Loss Detection Mode	Full (0), Ripple Only (1), Disabled (2)		Full (0)			RW	Txt				US
06.048	Supply Loss Detection Level	0 to VM_SUPPLY_LOSS_LEVEL		200 V drive: 205 V 400 V drive: 410 V 575 V drive: 540 V 690 V drive: 540 V			RW	Num		RA		US
06.051	Hold Supply Loss Active	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.052	Motor Pre-heat Current Magnitude	0 to 100 %		0 %			RW	Num				US
06.053	Sleep / Wake Threshold	±VM_SPEED_FREQ_REF_UNIPOLAR		0.0			RW	Num				US
06.054	Sleep Time	0.0 to 250.0 s		10.0 s			RW	Num				US
06.055	Wake Time	0.0 to 250.0 s		10.0 s			RW	Num				US
06.056	Sleep Required	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.057	Sleep Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.058	Output Phase Loss Detection Time	0.5 s (0), 1.0 s (1), 2.0 s (2), 4.0 s (3)		0.5 s (0)			RW	Txt				US
06.059	Output Phase Loss Detection Enable	Disabled (0), Enabled (1)		Disabled (0)			RW	Bit				US
06.060	Standby Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.061	Standby Mode Mask	0000000 to 1111111		0000000			RW	Bin				US

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.065	Standard Under Voltage Threshold	VM_STD_UNDER_VOLTS		200 V drive: 175 V 400 V drive: 330 V 575 V drive: 435 V 690 V drive: 435 V			RW	Num		RA		US
06.066	Low Voltage Under Voltage Threshold	24 to VM_LOW_UNDER_VOLTS		200 V drive: 175 V 400 V drive: 330 V 575 V drive: 435 V 690 V drive: 435 V			RW	Num		RA		US
06.067	Low Under Voltage Threshold Select	Off (0) or On (1)		Off (0)			RW	Bit				US
06.068	Back Up Supply Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.069	Under-Voltage System Contactor Close	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.070	Under-Voltage System Contactor Closed	Off (0) or On (1)		Off (0)			RW	Bit				
06.071	Slow Rectifier Charge Rate Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.072	User Supply Select	Off (0) or On (1)		Off (0)			RW	Bit				US
06.084	Date And Time Offset	±24.00 Hours		0.00 Hours			RW	Num				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.8 Menu 7: Analog I/O

Figure 11-11 Menu 7 logic diagram



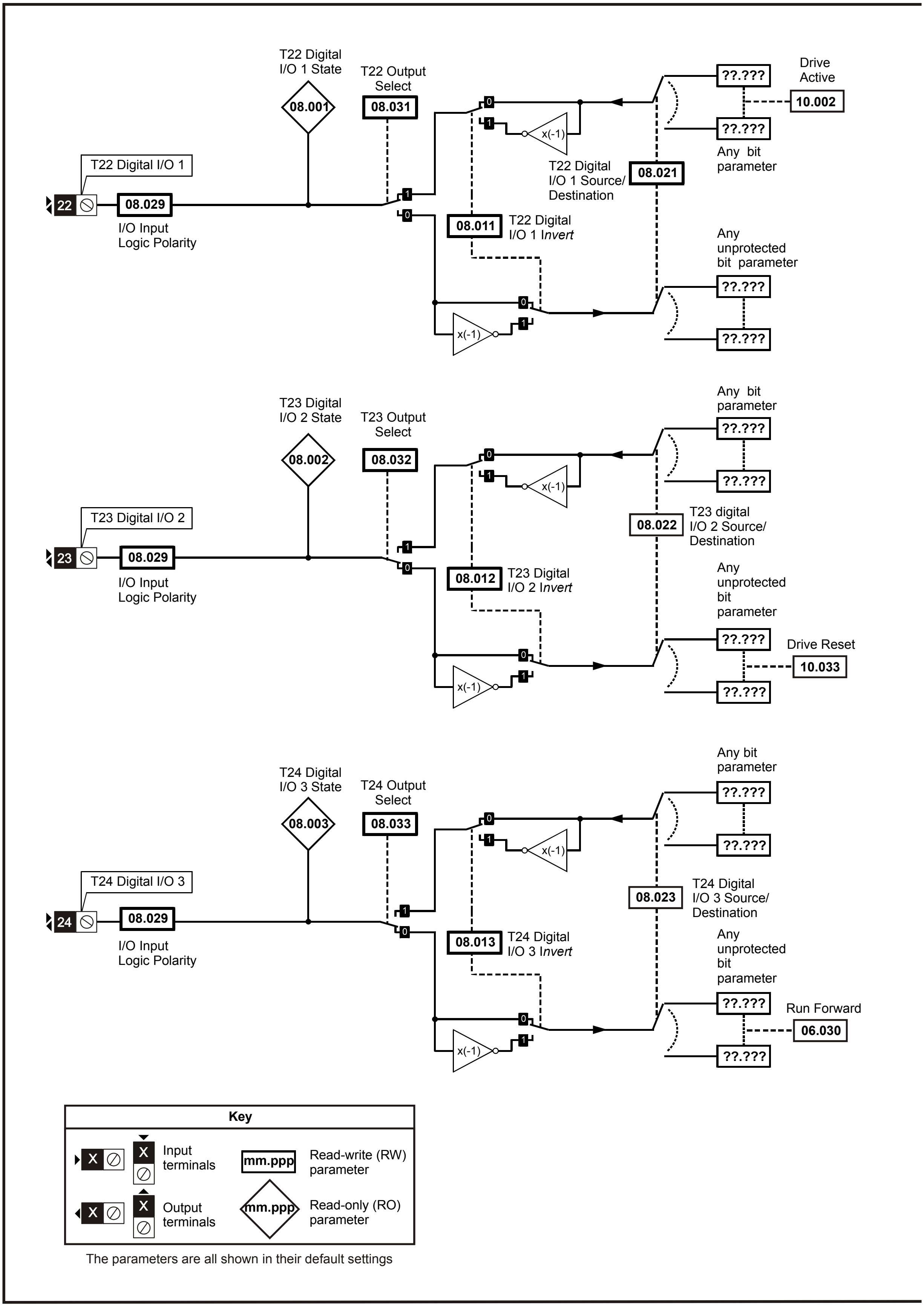
The parameters are all shown in their default settings

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
07.001	Analog Input 1	±100.00 %					RO	Num	ND	NC	PT	FI
07.002	Analog Input 2	±100.00 %					RO	Num	ND	NC	PT	FI
07.004	Monitored Temperature 1	±250 °C					RO	Num	ND	NC	PT	
07.005	Monitored Temperature 2	±250 °C					RO	Num	ND	NC	PT	
07.006	Monitored Temperature 3	±250 °C					RO	Num	ND	NC	PT	
07.007	Analog Input 1 Mode	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
07.008	Analog Input 1 Scaling	0.000 to 10.000		1.000			RW	Num				US
07.009	Analog Input 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
07.010	Analog Input 1 Destination	0.000 to 59.999		1.036			RW	Num	DE		PT	US
07.011	Analog Input 2 Mode	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)		Volt (6)			RW	Txt				US
07.012	Analog Input 2 Scaling	0.000 to 10.000		1.000			RW	Num				US
07.013	Analog Input 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
07.014	Analog Input 2 Destination	0.000 to 59.999		1.037			RW	Num	DE		PT	US
07.019	Analog Output 1 Source	0.000 to 59.999		5.001	3.002		RW	Num			PT	US
07.020	Analog Output 1 Scaling	0.000 to 10.000		1.000			RW	Num				US
07.021	Analog Output 1 Mode	Volts (0), 0-20 mA (1), 20-0 mA (2), 4-20 mA (3), 20-4 mA (4)		Volts (0)			RW	Txt				US
07.022	Analog Output 2 Source	0.000 to 59.999		4.002			RW	Num			PT	US
07.023	Analog Output 2 Scaling	0.000 to 10.000		1.000			RW	Num				US
07.024	Analog Output 2 Mode	Volts (0), 0-20 mA (1), 20-0 mA (2), 4-20 mA (3), 20-4 mA (4)		Volts (0)			RW	Txt				US
07.025	Calibrate Analog Input 1 Full Scale	Off (0) or On (1)		Off (0)			RW	Bit		NC		
07.026	Analog Input 1 Fast Update Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
07.027	Analog Input 1 Fast Update Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
07.028	Analog Input 1 Current Loop Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
07.029	Analog Input 2 Current Loop Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
07.030	Analog Input 1 Offset	±100.00 %		0.00 %			RW	Num				US
07.031	Analog Input 2 Offset	±100.00 %		0.00 %			RW	Num				US
07.033	Power Output	±100.0 %					RO	Num	ND	NC	PT	
07.034	Inverter Temperature	±250 °C					RO	Num	ND	NC	PT	
07.035	Percentage Of d.c. Bus Thermal Trip Level	0 to 100 %					RO	Num	ND	NC	PT	
07.036	Percentage Of Drive Thermal Trip Level	0 to 100 %					RO	Num	ND	NC	PT	
07.037	Temperature Nearest To Trip Level	0 to 29999					RO	Num	ND	NC	PT	
07.038	Temperature Monitor Select 1	0 to 1999		1001			RW	Num				US
07.039	Temperature Monitor Select 2	0 to 1999		1002			RW	Num				US
07.040	Analog Input 1 Minimum	±100.00 %		-100.00 %			RW	Num				US
07.041	Analog Input 2 Minimum	±100.00 %		-100.00 %			RW	Num				US
07.043	Analog Input 1 Maximum	±100.00 %		100.00 %			RW	Num				US
07.044	Analog Input 2 Maximum	±100.00 %		100.00 %			RW	Num				US
07.051	Analog Input 1 Full Scale	0 to 65535					RO	Num	ND	NC	PT	PS
07.052	Temperature Monitor Select 3	0 to 1999		1			RW	Num				US
07.053	Analog Input 1 Thermistor Type	DIN44082 (0), KTY84 (1), PT100 (2), PT1000 (3), PT2000 (4), NI1000 (5)		DIN44082 (0)			RW	Txt				US
07.054	Analog Input 1 Thermistor Feedback	0 to 5000 Ω					RO	Num	ND	NC	PT	
07.055	Analog Input 1 Thermistor Trip Threshold	0 to 5000 Ω		3300 Ω			RW	Num				US
07.056	Analog Input 1 Thermistor Reset Threshold	0 to 5000 Ω		1800 Ω			RW	Num				US
07.057	Analog Input 1 Thermistor Temperature	-50 to 300 °C					RO	Num	ND	NC	PT	
07.058	Analog Input 2 Thermistor Type	DIN44082 (0), KTY84 (1), PT100 (2), PT1000 (3), PT2000 (4), NI1000 (5)		DIN44082 (0)			RW	Txt				US
07.059	Analog Input 2 Thermistor Feedback	0 to 5000 Ω					RO	Num	ND	NC	PT	
07.060	Analog Input 2 Thermistor Trip Threshold	0 to 5000 Ω		3300 Ω			RW	Num				US
07.061	Analog Input 2 Thermistor Reset Threshold	0 to 5000 Ω		1800 Ω			RW	Num				US
07.062	Analog Input 2 Thermistor Temperature	-50 to 300 °C					RO	Num	ND	NC	PT	

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.9 Menu 8: Digital I/O

Figure 11-12 Menu 8 logic diagram



The parameters are all shown in their default settings

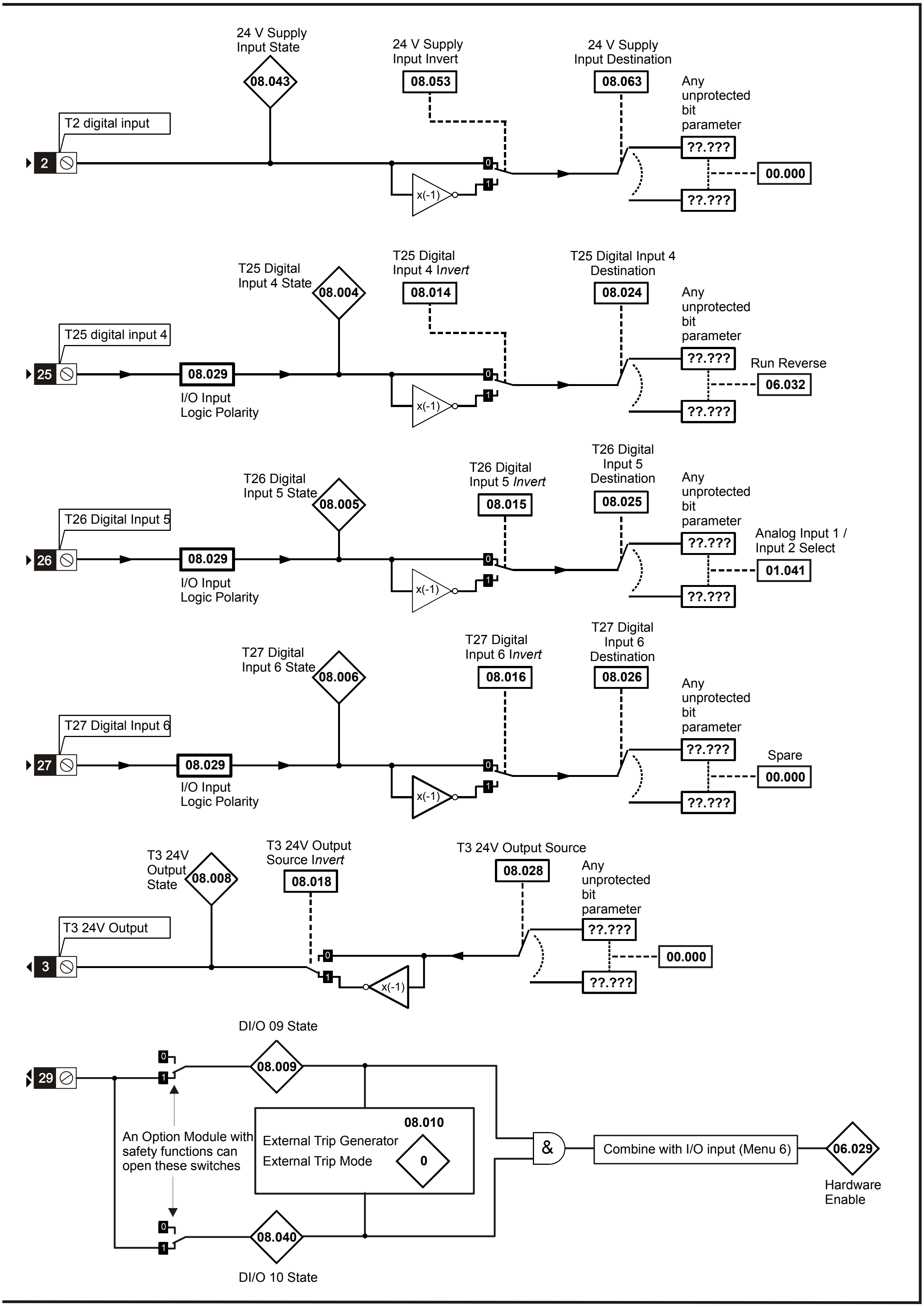

24 V Supply Input State
08.043
24 V Supply Input Invert
08.053
24 V Supply Input Destination
08.063
Any unprotected bit parameter
T2 digital input
2
0
1
x(-1)
??.???
00.000
??.???
T25 Digital Input 4 State
08.004
T25 Digital Input 4 Invert
08.014
T25 Digital Input 4 Destination
08.024
Any unprotected bit parameter
T25 digital input 4
25
08.029
I/O Input Logic Polarity
??.???
Run Reverse
06.032
??.???
T26 Digital Input 5 State
08.005
T26 Digital Input 5 Invert
08.015
T26 Digital Input 5 Destination
08.025
Any unprotected bit parameter
T26 Digital Input 5
26
08.029
I/O Input Logic Polarity
??.???
Analog Input 1 / Input 2 Select
01.041
??.???
T27 Digital Input 6 State
08.006
T27 Digital Input 6 Invert
08.016
T27 Digital Input 6 Destination
08.026
Any unprotected bit parameter
T27 Digital Input 6
27
08.029
I/O Input Logic Polarity
??.???
Spare
00.000
??.???
T3 24V Output State
08.008
T3 24V Output Source Invert
08.018
T3 24V Output Source
08.028
Any unprotected bit parameter
T3 24V Output
3
??.???
00.000
??.???
DI/O 09 State
29
08.009
An Option Module with safety functions can open these switches
08.010
External Trip Generator
External Trip Mode
0
&
Combine with I/O input (Menu 6)
06.029
Hardware Enable
08.040
DI/O 10 State

Figure 11-13 Menu 8 logic (cont)

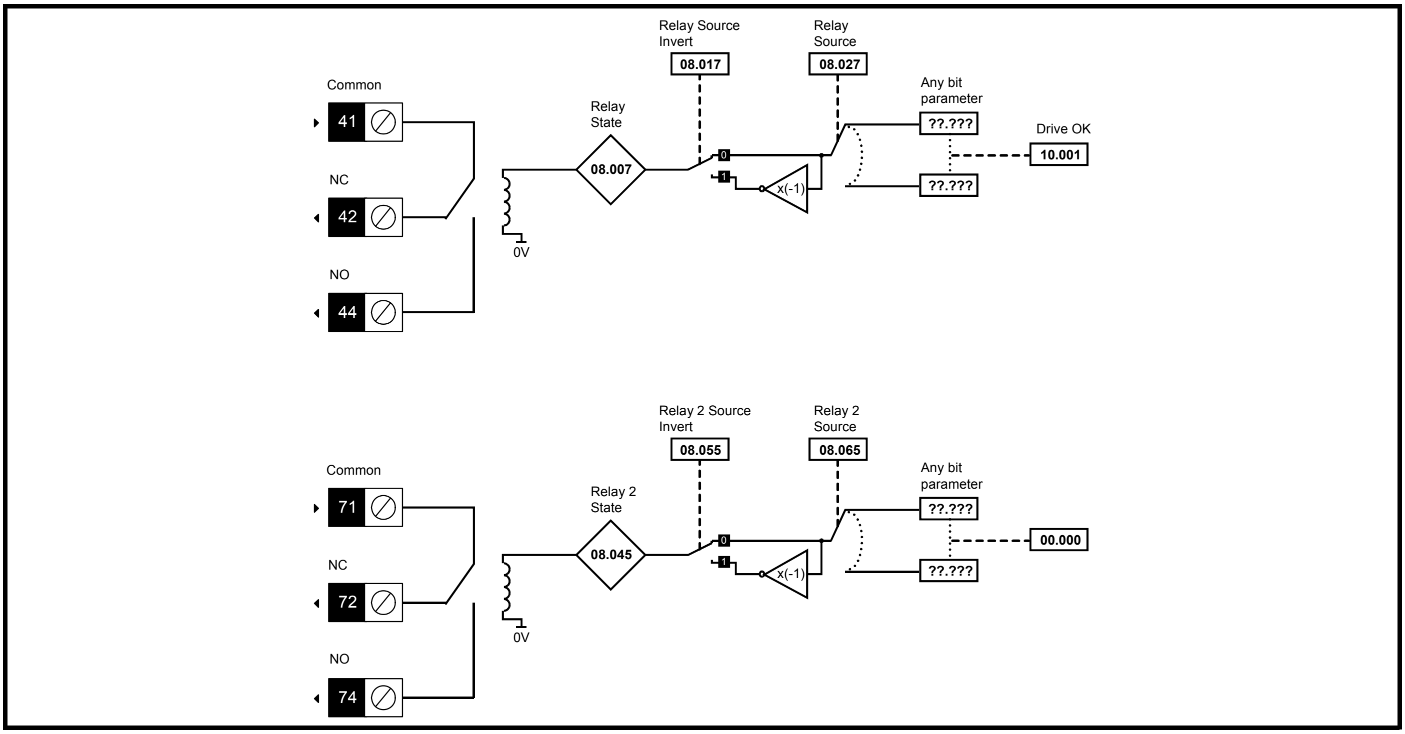
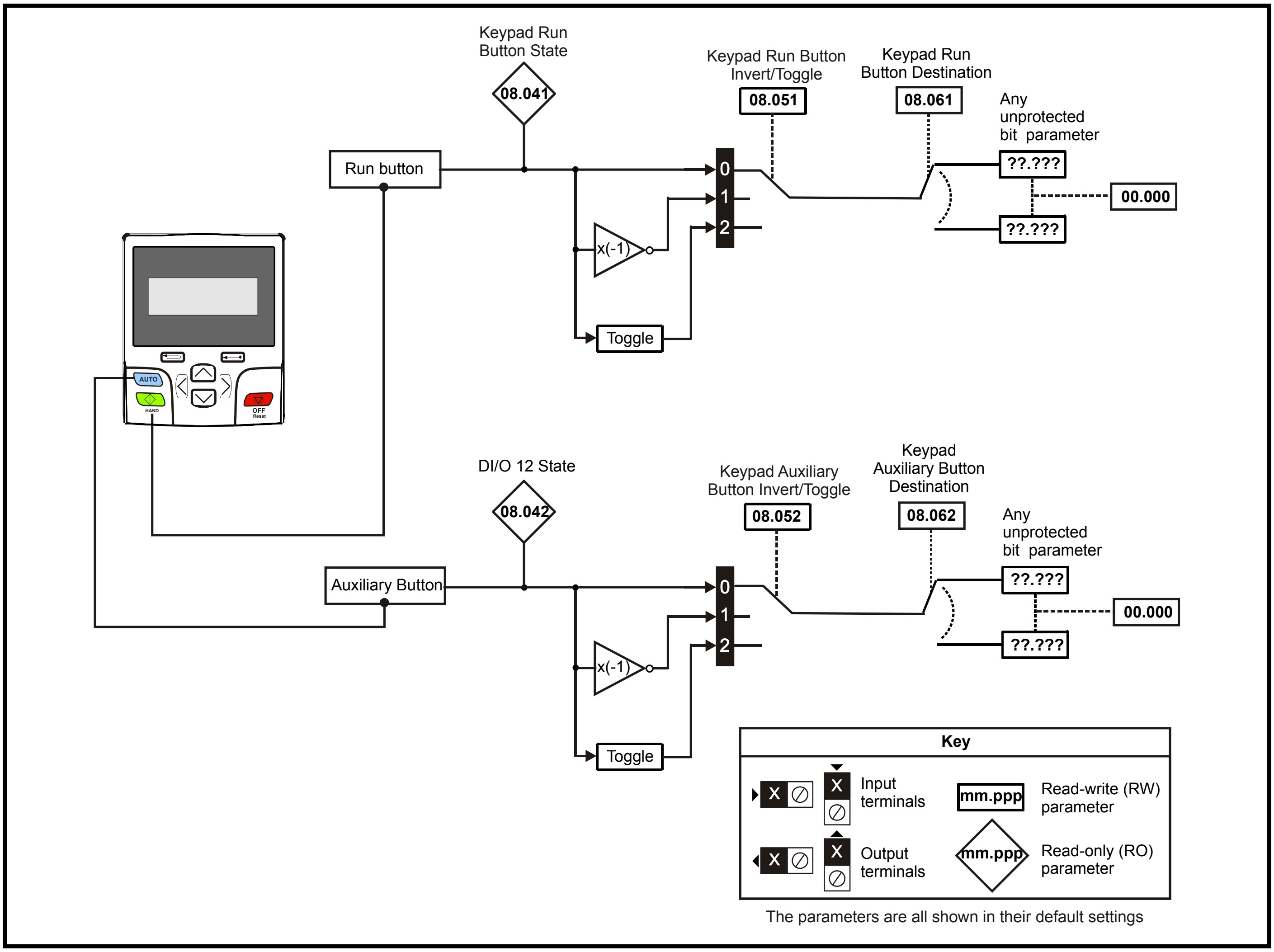


Figure 11-14 Menu 8 logic (cont)



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
08.001	Digital I/O 01 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.002	Digital I/O 02 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.003	Digital I/O 03 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.004	Digital Input 04 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.005	Digital Input 05 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.006	Digital Input 06 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.007	Relay Output State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.008	24V Supply Output State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.009	STO Input 01 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.010	External Trip Mode	Disable (0), STO 1 (1), STO 2 (2), STO 1 OR STO 2 (3)		Disable (0)			RW	Txt				US
08.011	Digital I/O 01 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.012	Digital I/O 02 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.013	Digital I/O 03 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.014	Digital Input 04 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.015	Digital Input 05 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.016	Digital Input 06 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.017	Relay Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.018	24V Supply Output Invert	Not Invert (0) or Invert (1)		Invert (1)			RW	Txt				US
08.020	Digital I/O Read Word	0 to 511					RO	Num	ND	NC	PT	
08.021	Digital I/O 01 Source/Destination	0.000 to 59.999		10.002			RW	Num	DE		PT	US
08.022	Digital I/O 02 Source/Destination	0.000 to 59.999		10.033			RW	Num	DE		PT	US
08.023	Digital I/O 03 Source/Destination	0.000 to 59.999		6.030			RW	Num	DE		PT	US
08.024	Digital Input 04 Destination	0.000 to 59.999		1.054			RW	Num	DE		PT	US
08.025	Digital Input 05 Destination	0.000 to 59.999		1.041			RW	Num	DE		PT	US
08.026	Digital Input 06 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
08.027	Relay Output Source	0.000 to 59.999		10.001			RW	Num			PT	US
08.028	24V Supply Output Source	0.000 to 59.999		0.000			RW	Num			PT	US
08.029	Input Logic Polarity	Negative Logic (0) or Positive Logic (1)		Positive Logic (1)			RW	Txt				US
08.031	Digital I/O 01 Output Select	Off (0) or On (1)		On (1)			RW	Bit				US
08.032	Digital I/O 02 Output Select	Off (0) or On (1)		Off (0)			RW	Bit				US
08.033	Digital I/O 03 Output Select	Off (0) or On (1)					RW	Bit				US
08.040	STO Input 02 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.041	Keypad Run Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.042	Keypad Auxiliary Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.043	24V Supply Input State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.044	Keypad Stop Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.045	Relay 2 Output State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.051	Keypad Run Button Invert/Toggle	Not Invert (0), Invert (1) or Toggle (2)		Not Invert (0)			RW	Txt				US
08.052	Keypad Auxiliary Button Invert/Toggle	Not Invert (0), Invert (1) or Toggle (2)		Not Invert (0)			RW	Txt				US
08.053	24V Supply Input Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.055	Relay 2 Invert	Not Invert (0), Invert (1)		Not Invert (0)			RW	Txt				US
08.061	Keypad Run Button Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
08.062	Keypad Auxiliary Button Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
08.063	24V Supply Input Source	0.000 to 59.999		0.000			RW	Num			PT	US
08.065	Relay 2 Source	0.000 to 59.999		0.000			RW	Num			PT	US
08.071	DI/O Output Enable Register 1	0000000000000000 to 1111111111111111		0000000000000000			RW	Bin			PT	US
08.072	DI/O Input Register 1	0000000000000000 to 1111111111111111					RO	Bin			PT	
08.073	DI/O Output Register 1	0000000000000000 to 1111111111111111		0000000000000000			RW	Bin			PT	

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.10 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 11-15 Menu 9 logic diagram: Programmable logic

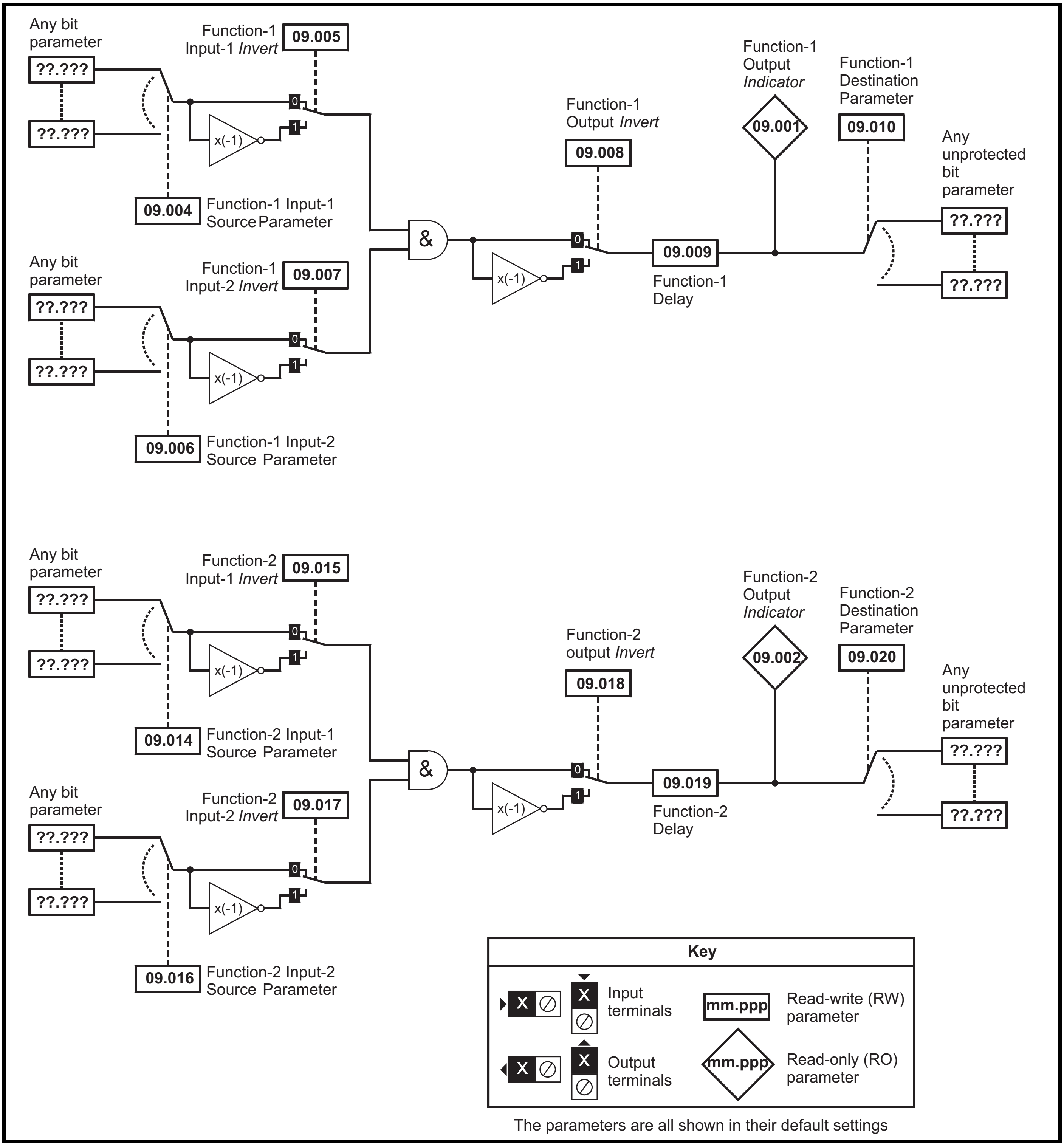
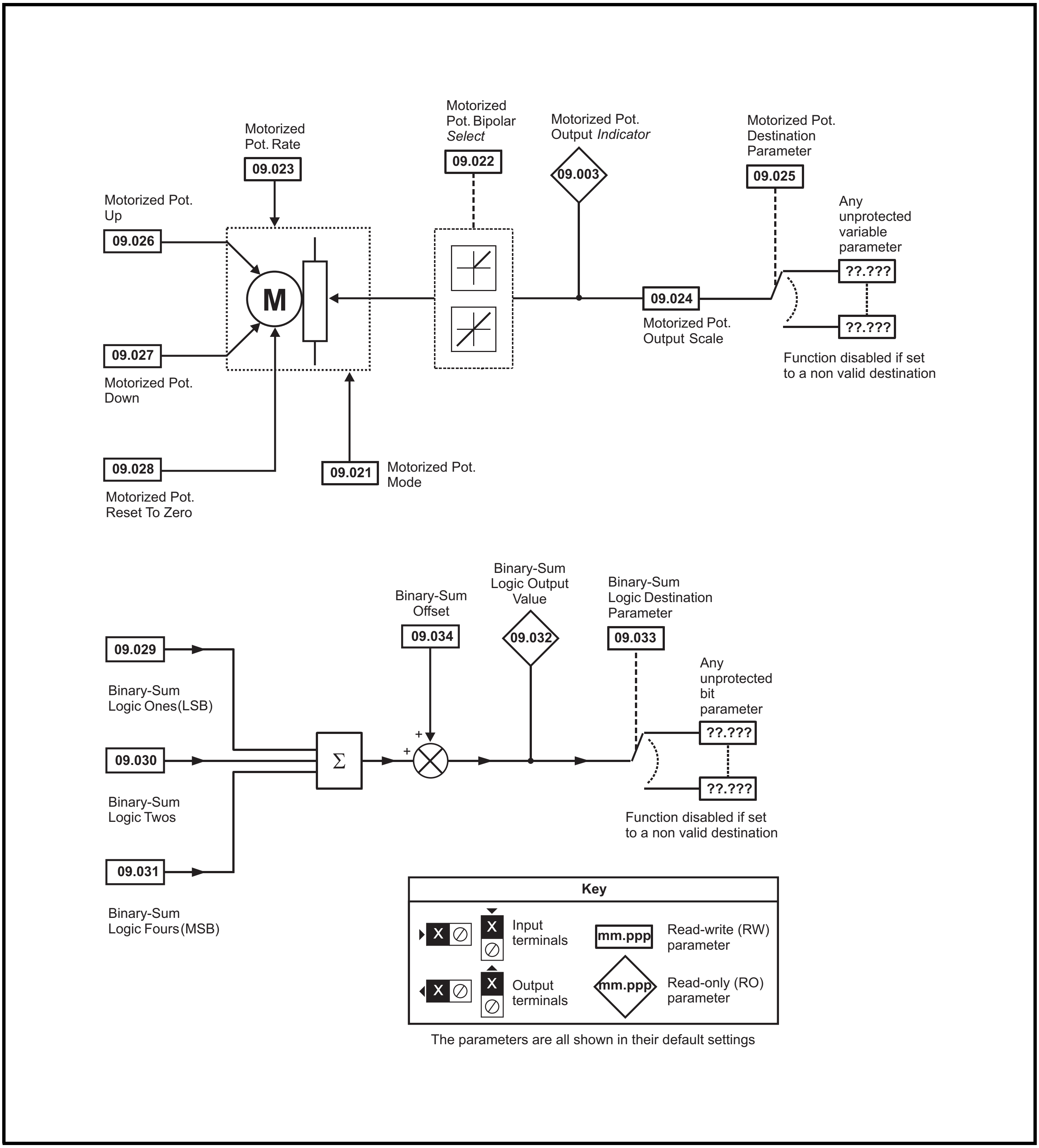
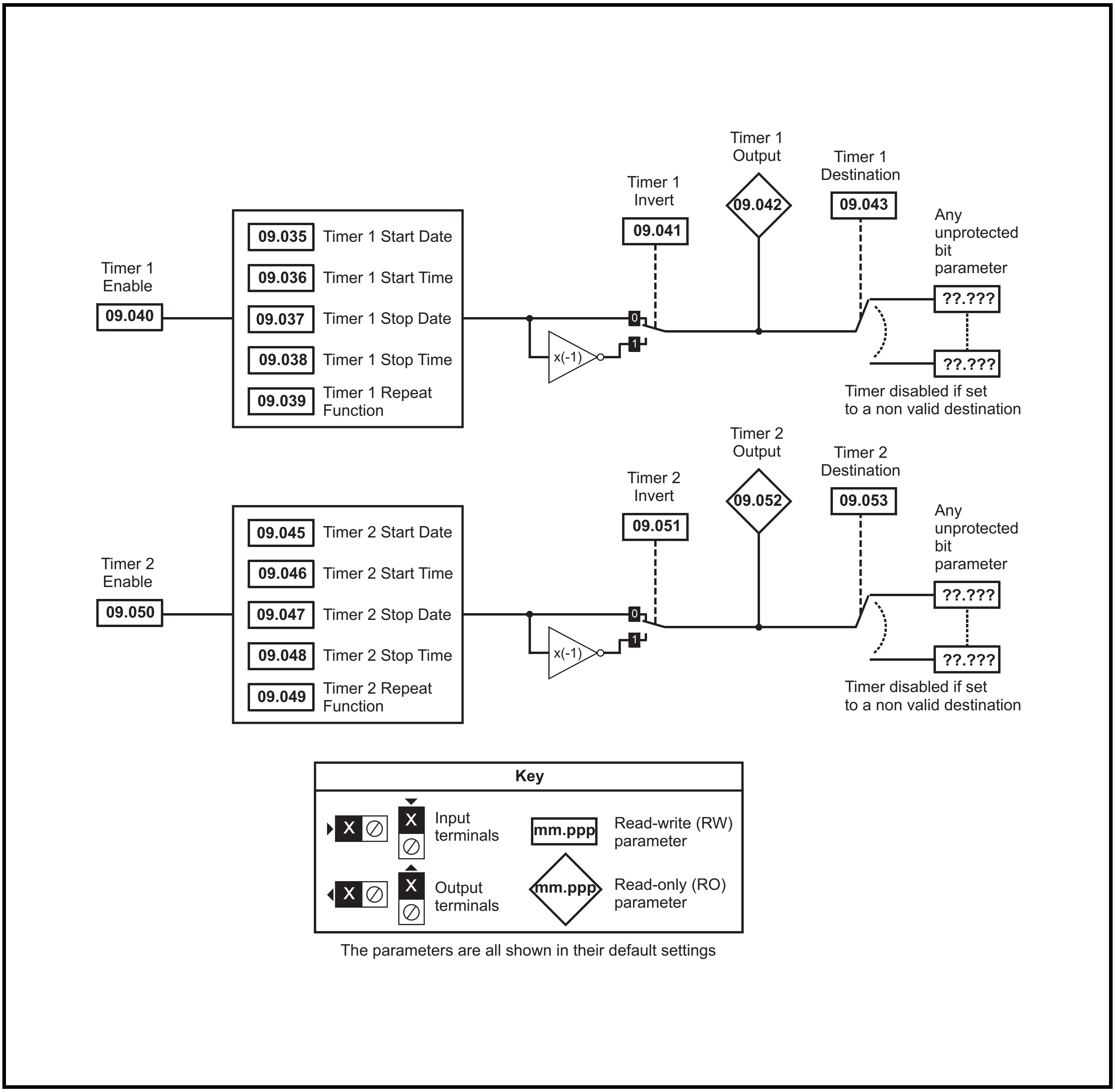


Figure 11-16 Menu 9 logic diagram: Motorized pot and binary sum



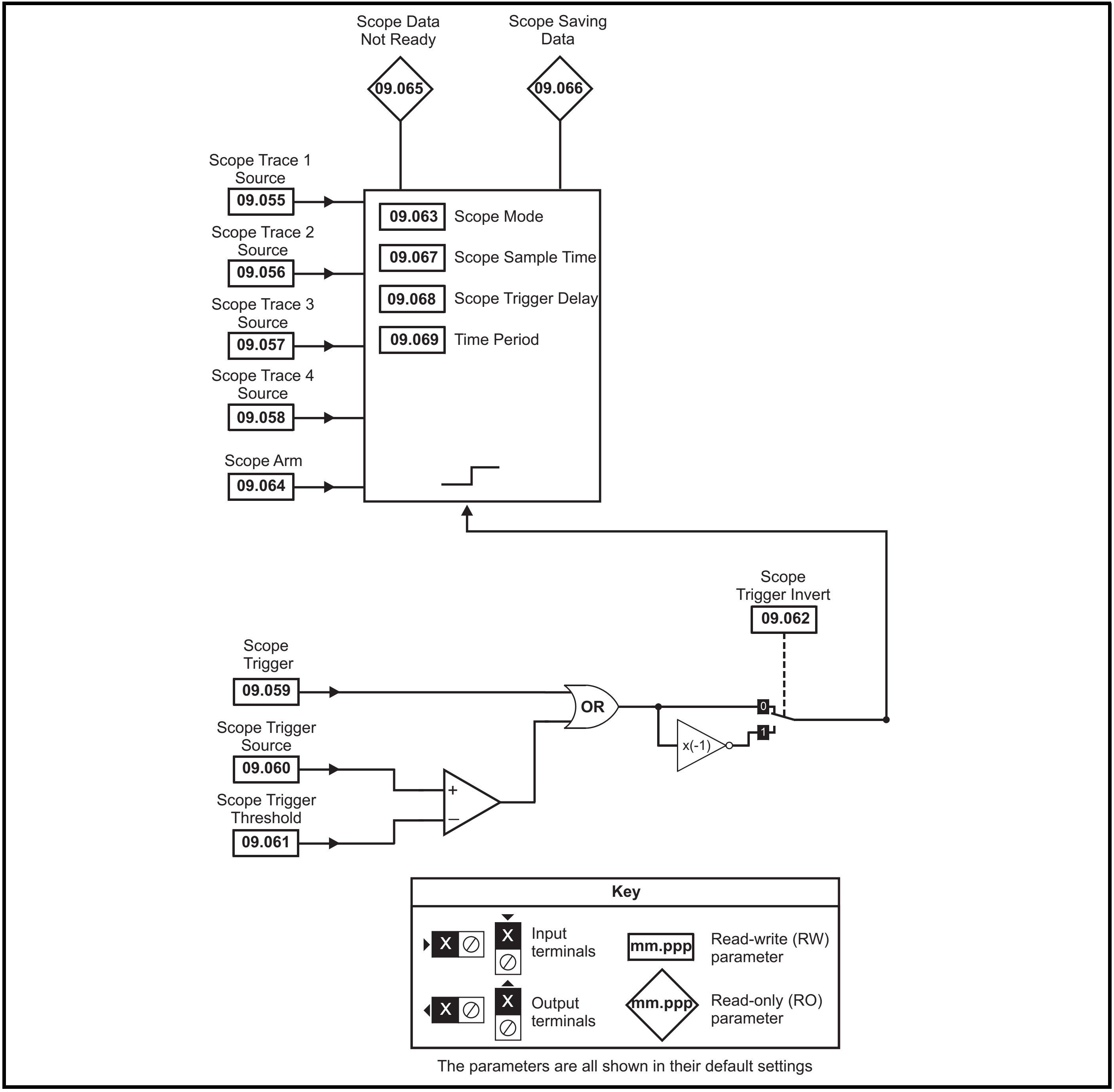
The parameters are all shown in their default settings

Figure 11-17 Menu 9 logic diagram: Timers



The parameters are all shown in their default settings

Figure 11-18 Menu 9 logic diagram: Scope function



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
09.001	Logic Function 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.002	Logic Function 2 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.003	Motorized Pot Output	±100.00 %					RO	Num	ND	NC	PT	PS
09.004	Logic Function 1 Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
09.005	Logic Function 1 Source 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.006	Logic Function 1 Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
09.007	Logic Function 1 Source 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.008	Logic Function 1 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.009	Logic Function 1 Delay	±25.0 s		0.0 s			RW	Num				US
09.010	Logic Function 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.014	Logic Function 2 Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
09.015	Logic Function 2 Source 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.016	Logic Function 2 Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
09.017	Logic Function 2 Source 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.018	Logic Function 2 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.019	Logic Function 2 Delay	±25.0 s		0.0 s			RW	Num				US
09.020	Logic Function 2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.021	Motorized Pot Mode	0 to 4		0			RW	Num				US
09.022	Motorized Pot Bipolar Select	Off (0) or On (1)		Off (0)			RW	Bit				US
09.023	Motorized Pot Rate	0 to 250 s		20 s			RW	Num				US
09.024	Motorized Pot Scaling	0.000 to 4.000		1.000			RW	Num				US
09.025	Motorized Pot Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.026	Motorized Pot Up	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.027	Motorized Pot Down	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.028	Motorized Pot Reset	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.029	Binary Sum Ones	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.030	Binary Sum Twos	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.031	Binary Sum Fours	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.032	Binary Sum Output	0 to 255					RO	Num	ND	NC	PT	
09.033	Binary Sum Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.034	Binary Sum Offset	0 to 248		0			RW	Num				US
09.035	Timer 1 Start Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.036	Timer 1 Start Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.037	Timer 1 Stop Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.038	Timer 1 Stop Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.039	Timer 1 Repeat Function	None (0), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (7)		None (0)			RW	Txt				US
09.040	Timer 1 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
09.041	Timer 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.042	Timer 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.043	Timer 1 Destination	0.000 to 59.999		0.000			RW	DE			PT	US
09.045	Timer 2 Start Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.046	Timer 2 Start Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.047	Timer 2 Stop Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.048	Timer 2 Stop Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.049	Timer 2 Repeat Function	None (0), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (7)		None (0)			RW	Txt				US
09.050	Timer 2 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
09.051	Timer 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.052	Timer 2 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.053	Timer 2 Destination	0.000 to 59.999		0.000			RW	DE			PT	US
09.055	Scope Trace 1 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.056	Scope Trace 2 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.057	Scope Trace 3 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.058	Scope Trace 4 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.059	Scope Trigger	Off (0) or On (1)		Off (0)			RW	Bit				
09.060	Scope Trigger Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.061	Scope Trigger Threshold	-2147483648 to 2147483647		0			RW	Num				US

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
09.062	Scope Trigger Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.063	Scope Mode	Single (0), Normal (1), Auto (2)		Single (0)			RW	Txt				US
09.064	Scope Arm	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.065	Scope Data Not Ready	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.066	Scope Saving Data	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.067	Scope Sample Time	1 to 200		1			RW	Num				US
09.068	Scope Trigger Delay	0 to 100 %		0 %			RW	Num				US
09.069	Scope Time Period	0.00 to 200000.00 ms					RO	Num	ND	NC	PT	
09.070	Scope Auto-save Mode	Disabled (0), Overwrite (1), Keep (2)		Disabled (0)			RW	Txt				US
09.071	Scope Auto-save File Number	0 to 99		0			RO	Num				PS
09.072	Scope Auto-save Reset	Off (0) or On (1)		Off (0)			RW	Bit				
09.073	Scope Auto-save Status	Disabled (0), Active (1), Stopped (2), Failed (3)		Disabled (0)			RO	Txt				PS

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.11 Menu 10: Status and trips

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
10.001	Drive Heathy	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.002	Drive Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.003	Zero Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.004	Running At Or Below Minimum Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.005	Below Set Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.006	At Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.007	Above Set Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.008	Rated Load Reached	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.009	Current Limit Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.010	Regenerating	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.011	Braking IGBT Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.012	Braking Resistor Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.013	Reverse Direction Commanded	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.014	Reverse Direction Running	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.015	Supply Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.016	Under Voltage Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.017	Motor Overload Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.018	Drive Over-temperature Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.019	Drive Warning	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.020	Trip 0	0 to 255					RO	Txt	ND	NC	PT	PS
10.021	Trip 1	0 to 255					RO	Txt	ND	NC	PT	PS
10.022	Trip 2	0 to 255					RO	Txt	ND	NC	PT	PS
10.023	Trip 3	0 to 255					RO	Txt	ND	NC	PT	PS
10.024	Trip 4	0 to 255					RO	Txt	ND	NC	PT	PS
10.025	Trip 5	0 to 255					RO	Txt	ND	NC	PT	PS
10.026	Trip 6	0 to 255					RO	Txt	ND	NC	PT	PS
10.027	Trip 7	0 to 255					RO	Txt	ND	NC	PT	PS
10.028	Trip 8	0 to 255					RO	Txt	ND	NC	PT	PS
10.029	Trip 9	0 to 255					RO	Txt	ND	NC	PT	PS
10.030	Braking Resistor Rated Power	0.000 to 99999.999 kW		See Table 11-5			RW	Num				US
10.031	Braking Resistor Thermal Time Constant	0.000 to 1500.000 s		See Table 11-5			RW	Num				US
10.032	External Trip	Off (0) or On (1)		Off (0)			RW	Bit		NC		
10.033	Drive Reset	Off (0) or On (1)		Off (0)			RW	Bit		NC		
10.034	Number Of Auto-reset Attempts	None (0), 1, 2, 3, 4, 5, Infinite (6)		None (0)			RW	Txt				US
10.035	Auto-reset Delay	0.0 to 600.0 s		1.0 s			RW	Num				US
10.036	Auto-reset Hold Drive Heathy	Off (0) or On (1)		Off (0)			RW	Bit				US
10.037	Action On Trip Detection	00000 to 11111		00000			RW	Bin				US
10.038	User Trip	0 to 255					RW	Num	ND	NC		
10.039	Braking Resistor Thermal Accumulator	0.0 to 100.0 %					RO	Num	ND	NC	PT	
10.040	Status Word	000000000000000 to 111111111111111					RO	Bin	ND	NC	PT	
10.041	Trip 0 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.042	Trip 0 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.043	Trip 1 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.044	Trip 1 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.045	Trip 2 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.046	Trip 2 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.047	Trip 3 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.048	Trip 3 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.049	Trip 4 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.050	Trip 4 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.051	Trip 5 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.052	Trip 5 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.053	Trip 6 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
10.054	Trip 6 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.055	Trip 7 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.056	Trip 7 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.057	Trip 8 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.058	Trip 8 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.059	Trip 9 Date	00-00-00 to 31-12-99					RO	Date	ND	NC	PT	PS
10.060	Trip 9 Time	00:00:00 to 23:59:59					RO	Time	ND	NC	PT	PS
10.061	Braking Resistor Resistance	0.00 to 10000.00 Ω		See Table 11-5			RW	Num				US
10.062	Low Load Detected Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.063	Local Keypad Battery Low	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.064	Remote Keypad Battery Low	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.065	Auto-tune Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.067	Fire Mode Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.068	Hold Drive Heathy On Under Voltage	Off (0) or On (1)		Off (0)			RW	Bit				US
10.069	Additional Status Bits	0000000000 to 1111111111					RO	Bin	ND	NC	PT	
10.070	Trip 0 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.071	Trip 1 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.072	Trip 2 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.073	Trip 3 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.074	Trip 4 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.075	Trip 5 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.076	Trip 6 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.077	Trip 7 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.078	Trip 8 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.079	Trip 9 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.080	Stop Motor	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.081	Phase Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.101	Drive Status	Inhibit (0), Ready (1), Stop (2), Scan (3), Run (4), Supply Loss (5), Deceleration (6), dc Injection (7), Position (8), Trip (9), Active (10), Off (11), Hand (12), Auto (13), Heat (14), Under Voltage (15), Phasing (16)					RO	Txt	ND	NC	PT	
10.102	Trip Reset Source	0 to 1023					RO	Num	ND	NC	PT	PS
10.103	Trip Time Identifier	-2147483648 to 2147483647 ms					RO	Num	ND	NC	PT	
10.104	Active Alarm	None (0), Brake Resistor (1), Motor Overload (2), Ind Overload (3), Drive Overload (4), Auto Tune (5), Limit Switch (6), Fire Mode (7), Low Load (8), Option Slot 1 (9), Option Slot 2 (10), Option Slot 3 (11), Option Slot 4 (12)					RO	Txt	ND	NC	PT	
10.105	Hand Off Auto state	Not Active (0), OFF (1), Hand (2), Auto (3)					RO	Txt	ND	NC	PT	PS
10.106	Potential Drive Damage Conditions	0000 to 1111					RO	Bin	ND	NC	PT	PS

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

Table 11-5 Defaults for Pr 10.030, Pr 10.031 and Pr 10.061

Drive size	Pr 10.030	Pr 10.031	Pr 10.061
3	50 W	3.3 s	75 Ω
4 and 5	100 W	2.0 s	38 Ω
All other ratings and frame sizes	0.000		0.00

11.12 Menu 11: General drive set-up

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
11.018	Status Mode Parameter 1	0.000 to 59.999		0.000			RW	Num			PT	US
11.019	Status Mode Parameter 2	0.000 to 59.999		0.000			RW	Num			PT	US
11.020	Reset Serial Communications	Off (0) or On (1)					RW	Bit	ND	NC		
11.021	Parameter 00.030 Scaling	0.000 to 10.000		1.000			RW	Num				US
11.022	Parameter Displayed At Power-up	0.000 to 0.080		0.001			RW	Num			PT	US
11.023	Serial Address	1 to 255		1			RW	Num				US
11.024	Serial Mode	8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 2 NP (8), 7 1 NP (9), 7 1 EP (10), 7 1 OP (11), 7 2 NP M (12), 7 1 NP M (13), 7 1 EP M (14), 7 1 OP M (15)		8 2 NP (0)			RW	Txt				US
11.025	Serial Baud Rate	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)		19200 (6)			RW	Txt				US
11.026	Minimum Comms Transmit Delay	0 to 250 ms		2 ms			RW	Num				US
11.027	Silent Period	0 to 250 ms		0 ms			RW	Num				US
11.028	Drive Derivative	0 to 255					RO	Num	ND	NC	PT	
11.029	Software Version	00.00.00.00 to 99.99.99.99					RO	Num	ND	NC	PT	
11.030	User Security Code	0 to 2147483647					RW	Num	ND	NC	PT	
11.031	User Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3)		Open-loop (1)	RFC-A (2)	RFC-S (3)	RW	Txt	ND	NC	PT	
11.033	Drive Rated Voltage	200 V (0), 400 V (1), 575 V (2), 690 V (3)					RO	Txt	ND	NC	PT	
11.034	Software Sub-version	0 to 99					RO	Num	ND	NC	PT	
11.035	Number Of Power Modules Test	-1 to 20		-1			RW	Num				US
11.036	NV Media Card File Previously Loaded	0 to 999		0			RO	Num		NC	PT	
11.037	NV Media Card File Number	0 to 999		0			RW	Num				
11.038	NV Media Card File Type	None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6)					RO	Txt	ND	NC	PT	
11.039	NV Media Card File Version	0 to 9999					RO	Num	ND	NC	PT	
11.040	NV Media Card File Checksum	-2147483648 to 2147483647					RO	Num	ND	NC	PT	
11.042	Parameter Cloning	None (0), Read (1), Program (2), Auto (3), Boot (4)		None (0)			RW	Txt		NC		US
11.043	Load Defaults	None (0), Standard (1), US (2)					RW	Txt		NC		
11.044	User Security Status	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	
11.046	Defaults Previously Loaded	0 to 2000					RO	Num	ND	NC	PT	US
11.052	Serial Number LS	000000000 to 999999999					RO	Num	ND	NC	PT	
11.053	Serial Number MS	0 to 999999999					RO	Num	ND	NC	PT	
11.054	Drive Date Code	0 to 65535					RO	Num	ND	NC	PT	
11.056	Option Slot Identifiers	1234 (0), 1243 (1), 1324 (2), 1342 (3), 1423 (4), 1432 (5), 4123 (6), 3124 (7), 4132 (8), 2134 (9), 3142 (10), 2143 (11), 3412 (12), 4312 (13), 2413 (14), 4213 (15), 2314 (16), 3214 (17), 2341 (18), 2431 (19), 3241 (20), 3421 (21), 4231 (22), 4321 (23)		1234 (0)			RW	Txt			PT	
11.060	Maximum Rated Current	0.000 to 99999.999					RO	Num	ND	NC	PT	
11.061	Full Scale Current Kc	0.000 to 99999.999					RO	Num	ND	NC	PT	
11.062	Power Board Software Version Number	0.00 to 99.99					RO	Num	ND	NC	PT	
11.063	Product Type	0 to 255					RO	Num	ND	NC	PT	
11.064	Product Identifier Characters	H300 (1295396912) to (2147483647)		H300			RO	Chr	ND	NC	PT	
11.065	Drive Rating And Configuration	00000000 to 999999999					RO	Num	ND	NC	PT	
11.066	Power Stage Identifier	0 to 255					RO	Num	ND	NC	PT	
11.067	Control Board Identifier	0.000 to 65.535					RO	Num	ND	NC	PT	
11.068	Internal I/O Identifier	0 to 255					RO	Num	ND	NC	PT	
11.069	Position Feedback Interface Identifier	0 to 255					RO	Num	ND	NC	PT	
11.070	Core Parameter Database Version	0.00 to 99.99					RO	Num	ND	NC	PT	
11.071	Number Of Power Modules Detected	0 to 20					RO	Num	ND	NC	PT	US
11.072	NV Media Card Create Special File	0 to 1		0			RW	Num		NC		
11.073	NV Media Card Size	None (0), SMART Card (1), SD Card (2)					RO	Num	ND	NC	PT	
11.075	NV Media Card Read-only Flag	Off (0) or On (1)					RO	Bit	ND	NC	PT	
11.076	NV Media Card Warning Suppression Flag	Off (0) or On (1)					RO	Bit	ND	NC	PT	

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
11.077	NV Media Card File Required Version	0 to 9999					RW	Num	ND	NC	PT	
11.079	Drive Name Characters 1-4	□□□□ (-2147483648) to □□□□ (2147483647)		□□□□ (0)			RW	Chr			PT	US
11.080	Drive Name Characters 5-8	□□□□ (-2147483648) to □□□□ (2147483647)		□□□□ (0)			RW	Chr			PT	US
11.081	Drive Name Characters 9-12	□□□□ (-2147483648) to □□□□ (2147483647)		□□□□ (0)			RW	Chr			PT	US
11.082	Drive Name Characters 13-16	□□□□ (-2147483648) to □□□□ (2147483647)		□□□□ (0)			RW	Chr			PT	US
11.084	Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3)					RO	Txt	ND	NC	PT	US
11.085	Security Status	None (0), Read-only (1), Status-only (2), No Access (3)					RO	Txt	ND	NC	PT	PS
11.086	Menu Access Status	Menu 0 (0) or All Menus (1)					RO	Txt	ND	NC	PT	PS
11.090	Keypad Port Serial Address	1 to16		1			RW	Num				US
11.091	Product Identifier Characters 1	□□□□ (-2147483648) to □□□□ (2147483647)					RO	Chr	ND	NC	PT	
11.092	Product Identifier Characters 2	□□□□ (-2147483648) to □□□□ (2147483647)					RO	Chr	ND	NC	PT	
11.093	Product Identifier Characters 3	□□□□ (-2147483648) to □□□□ (2147483647)					RO	Chr	ND	NC	PT	
11.095	Number Of Rectifiers Detected	0 to 9					RO	Num	ND	NC	PT	
11.096	Number Of Rectifiers Expected	0 to 9		0			RW	Num				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.13 Menu 12: Threshold detectors and variable selectors

Figure 11-19 Menu 12 logic diagram

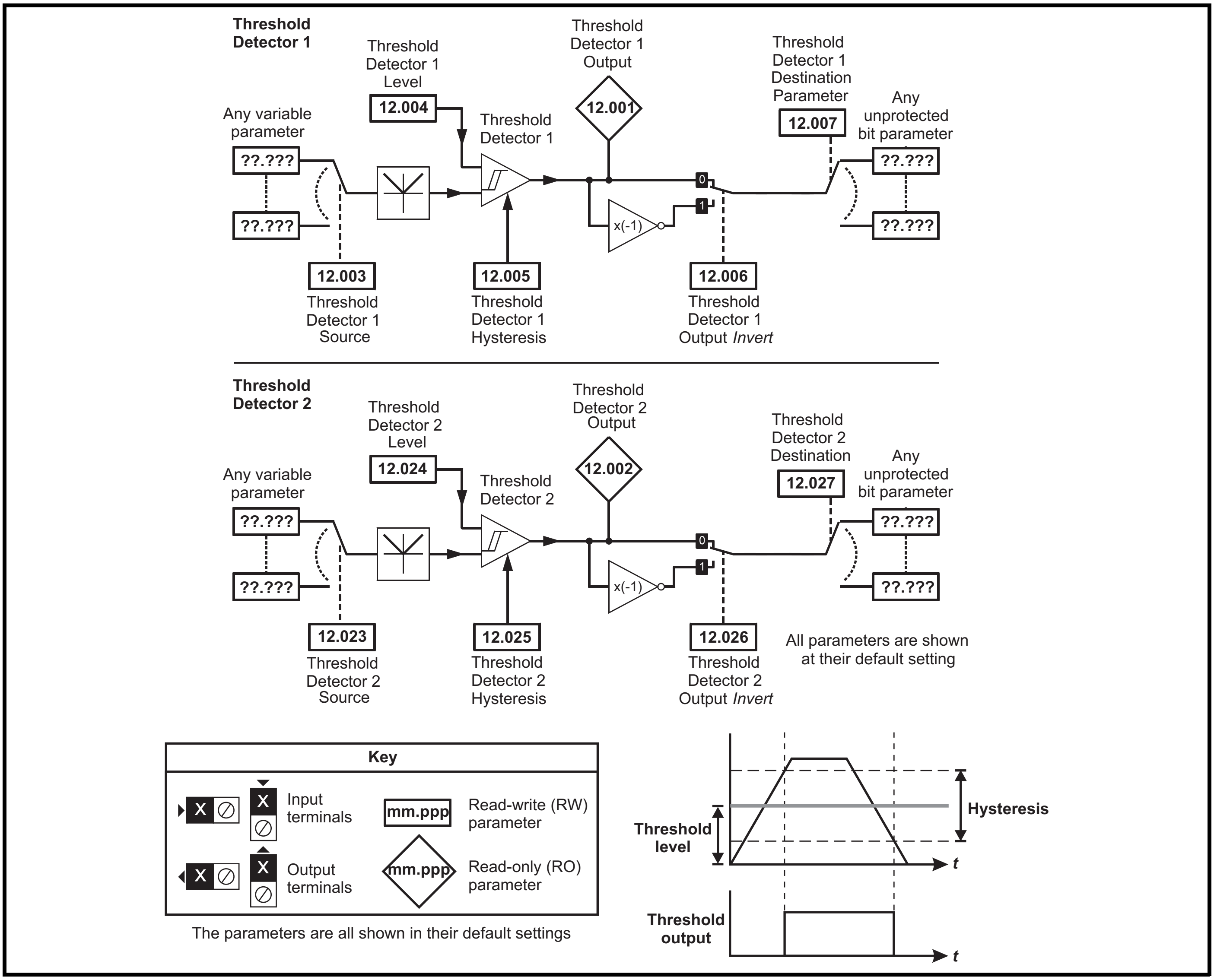
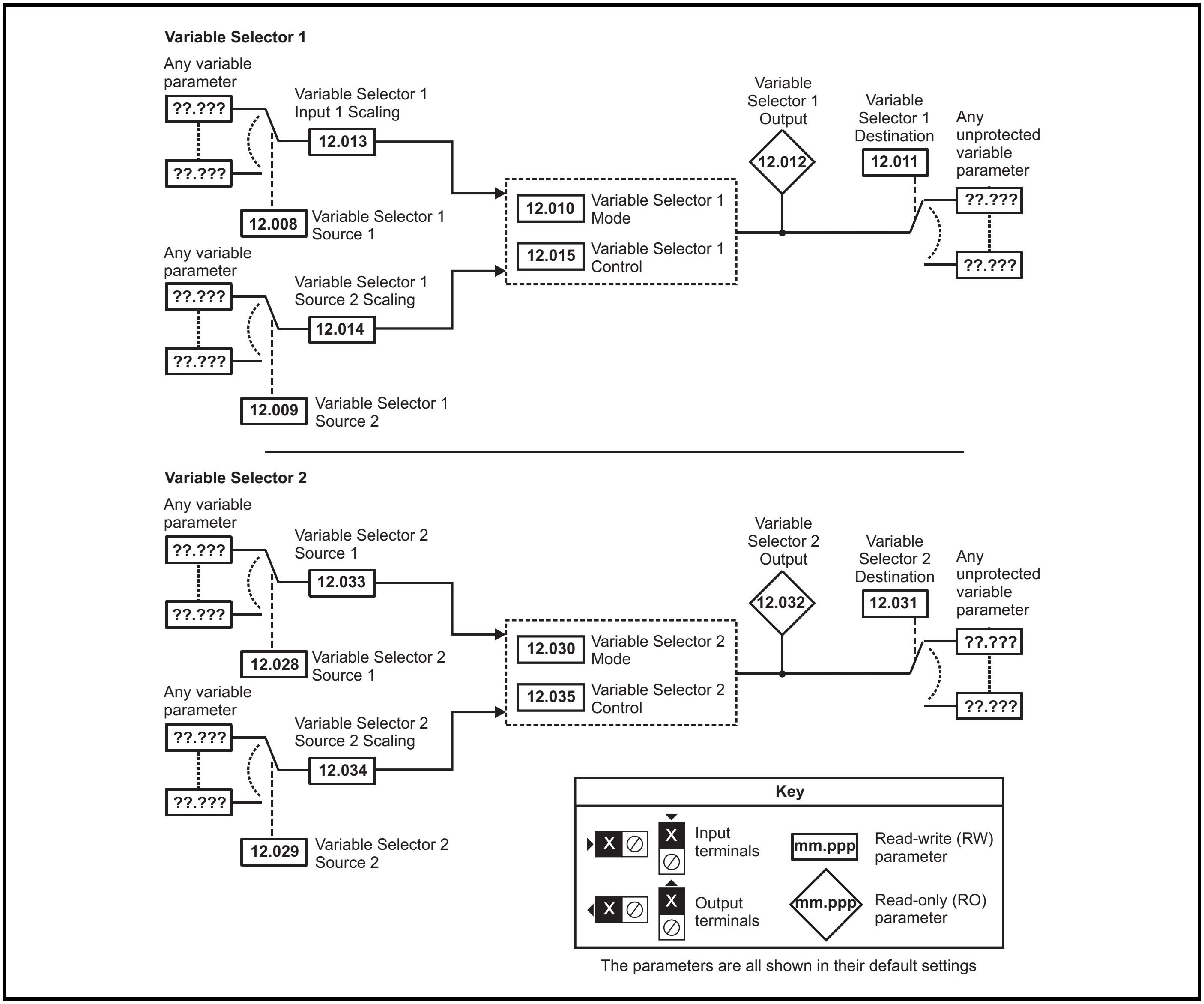


Figure 11-20 Menu 12 logic diagram (continued)

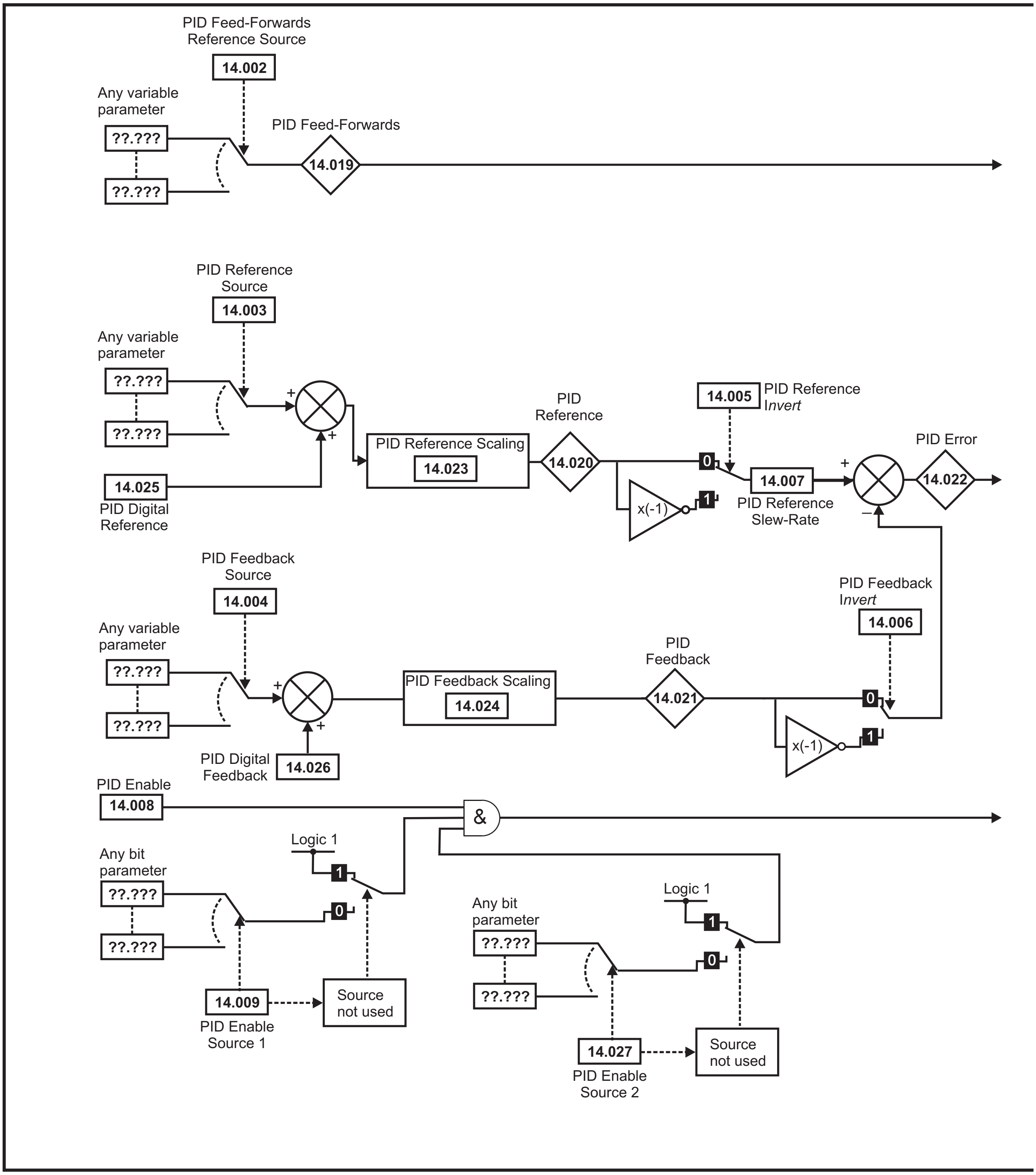


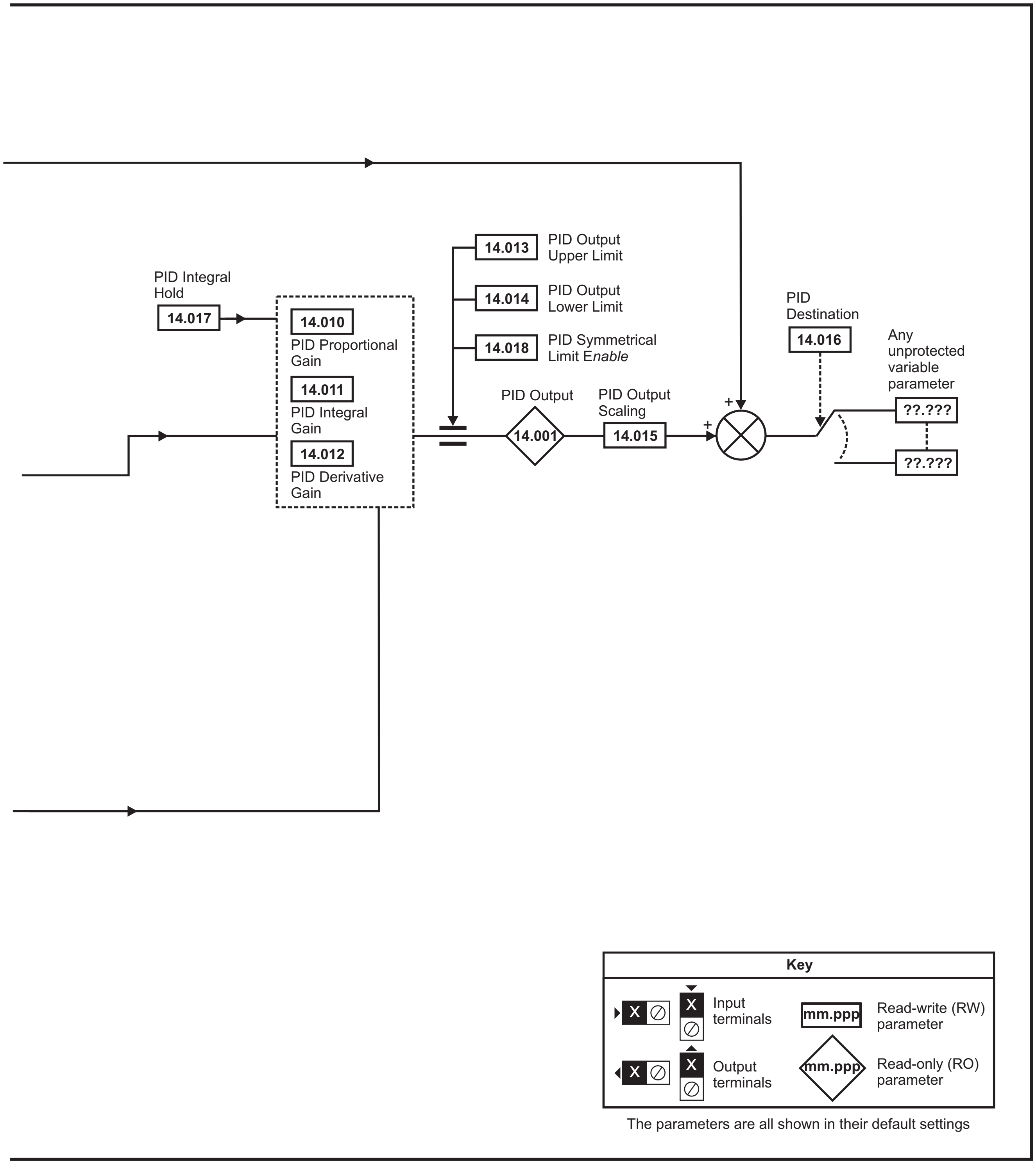
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC- A / S	OL	RFC-A	RFC-S						
12.001	Threshold Detector 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source	0.000 to 59.999		0.000			RW	Num			PT	US
12.004	Threshold Detector 1 Level	0.00 to 100.00 %		0.00 %			RW	Num				US
12.005	Threshold Detector 1 Hysteresis	0.00 to 25.00 %					RW	Num				US
12.006	Threshold Detector 1 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
12.007	Threshold Detector 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.008	Variable Selector 1 Source 1						RW	Num			PT	US
12.009	Variable Selector 1 Source 2						RW	Num			PT	US
12.010	Variable Selector 1 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9), Sectional (10)		Input 1 (0)			RW	Txt				US
12.011	Variable Selector 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.012	Variable Selector 1 Output	±100.00 %					RO	Num	ND	NC	PT	
12.013	Variable Selector 1 Source 1 Scaling	±4.000		1.000			RW	Num				US
12.014	Variable Selector 1 Source 2 Scaling	±4.000		1.000			RW	Num				US
12.015	Variable Selector 1 Control	0.00 to 100.00		0.00			RW	Num				US
12.016	Variable Selector 1 Enable	Off (0) or On (1)		On (1)			RW	Bit				US
12.023	Threshold Detector 2 Source	0.000 to 59.999		0.000			RW	Num			PT	US
12.024	Threshold Detector 2 Level	0.00 to 100.00 %		0.00 %			RW	Num				US
12.025	Threshold Detector 2 Hysteresis	0.00 to 25.00 %					RW	Num				US
12.026	Threshold Detector 2 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
12.027	Threshold Detector 2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.028	Variable Selector 2 Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
12.029	Variable Selector 2 Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
12.030	Variable Selector 2 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9), Sectional (10)		Input 1 (0)			RW	Txt				US
12.031	Variable Selector 2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.032	Variable Selector 2 Output	±100.00 %					RO	Num	ND	NC	PT	
12.033	Variable Selector 2 Source 1 Scaling	±4.000		1.000			RW	Num				US
12.034	Variable Selector 2 Source 2 Scaling	±4.000		1.000			RW	Num				US
12.035	Variable Selector 2 Control	0.00 to 100.00		0.00			RW	Num				US
12.036	Variable Selector 2 Enable	Off (0) or On (1)		On (1)			RW	Bit				US
12.054	External Brake Released Indicator		Off (0) or On (1)		Off (0)		RW	Bit		NC		
12.055	Brake Release Source		Off (0) or On (1)		Off (0)		RW	Bit				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.14 Menu 14: User PID controller

Figure 11-21 Menu 14 Logic diagram





The parameters are all shown in their default settings

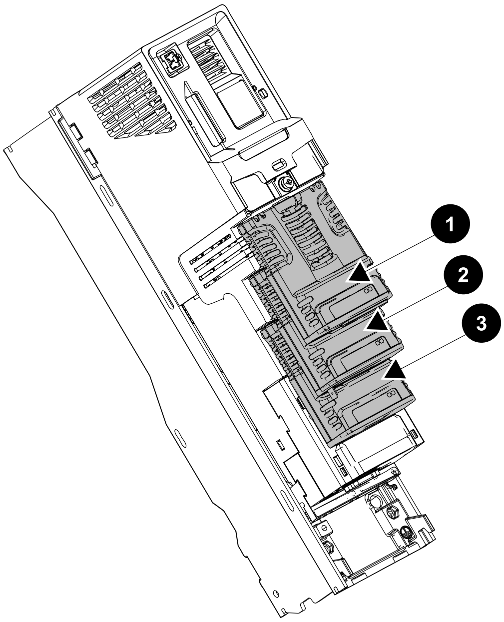
Parameter		Range(⇳)		Default(⇨)			Type					
		Open-Loop	RFC-A / S	Open-Loop	RFC-A	RFC-S						
14.001	PID1 Output	±100.00 %					RO	Num	ND	NC	PT	
14.002	PID1 Feed-forwards Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.003	PID1 Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.004	PID1 Feedback Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.005	PID1 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.006	PID1 Feedback Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.007	PID1 Reference Slew Rate	0.0 to 3200.0 s		0.0 s			RW	Num				US
14.008	PID1 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.009	PID1 Enable Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
14.010	PID1 Proportional Gain	0.000 to 4.000		1.000			RW	Num				US
14.011	PID1 Integral Gain	0.000 to 4.000		0.500			RW	Num				US
14.012	PID1 Differential Gain	0.000 to 4.000		0.000			RW	Num				US
14.013	PID1 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.014	PID1 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.015	PID1 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.016	PID1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.017	PID1 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.018	PID1 Symmetrical Limit Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.019	PID1 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.020	PID1 Reference	±100.00 %					RO	Num	ND	NC	PT	
14.021	PID1 Feedback	±100.00 %					RO	Num	ND	NC	PT	
14.022	PID1 Error	±100.00 %					RO	Num	ND	NC	PT	
14.023	PID1 Reference Scaling	0.000 to 4.000		1.000			RW	Num				US
14.024	PID1 Feedback Scaling	0.000 to 4.000		1.000			RW	Num				US
14.025	PID1 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.026	PID1 Digital Feedback	±100.00 %		0.00 %			RW	Num				US
14.027	PID1 Enable Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
14.028	PID1 Pre-sleep Boost Level	0.00 to 100.00 %		0.00 %			RW	Num				US
14.029	PID1 Maximum Boost Time	0.0 to 250.0 s		0.0 s			RW	Num				US
14.030	PID1 Pre-sleep Boost Level Enable	Off (0) or On (1)					RO	Bit	ND	NC	PT	
14.031	PID2 Output	±100.00 %					RO	Num	ND	NC	PT	
14.032	PID2 Feed-forwards Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.033	PID2 Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.034	PID2 Feedback Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.035	PID2 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.036	PID2 Feedback Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.037	PID2 Reference Slew Rate Limit	0.0 to 3200.0 s		0.0 s			RW	Num				US
14.038	PID2 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.039	PID2 Enable Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
14.040	PID2 Proportional Gain	0.000 to 4.000		1.000			RW	Num				US
14.041	PID2 Integral Gain	0.000 to 4.000		0.500			RW	Num				US
14.042	PID2 Differential Gain	0.000 to 4.000		0.000			RW	Num				US
14.043	PID2 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.044	PID2 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.045	PID2 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.046	PID2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.047	PID2 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.048	PID2 Symmetrical Limit Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.049	PID2 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.050	PID2 Reference	±100.00 %					RO	Num	ND	NC	PT	
14.051	PID2 Feedback	±100.00 %					RO	Num	ND	NC	PT	
14.052	PID2 Error	±100.00 %					RO	Num	ND	NC	PT	
14.053	PID2 Reference Scaling	0.000 to 4.000		1.000			RW	Num				US
14.054	PID2 Feedback Scaling	0.000 to 4.000		1.000			RW	Num				US
14.055	PID2 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.056	PID2 Digital Feedback	±100.00 %		0.00 %			RW	Num				US
14.057	PID2 Enable Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
14.058	PID1 Feedback Output Scaling	0.000 to 4.000		1.000			RW	Num				US

Parameter		**Range(⇳)**		**Default(⇨)**			**Type**					
		Open-Loop	**RFC-A / S**	**Open-Loop**	**RFC-A**	**RFC-S**						
14.059	PID1 Mode Selector	Fbk1 (0), Fbk2 (1), Fbk1 + Fbk2 (2), Min Fbk (3), Max Fbk (4), Av Fbk (5), Min Error (6), Max Error (7)		Fbk1 (0)			RW	Txt				US
14.060	PID1 Feedback Square Root Enable 1	Off (0) or On (1)		Off (0)			RW	Bit				US
14.061	PID2 Feedback Square Root Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.062	PID1 Feedback Square Root Enable 2	Off (0) or On (1)		Off (0)			RW	Bit				US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.15 Menus 15, 16 and 17: Option module set-up

Figure 11-22 Location of option module slots and their corresponding menu numbers



1. Solutions Module Slot 1 - Menu 15
2. Solutions Module Slot 2 - Menu 16
3. Solutions Module Slot 3 - Menu 17

11.15.1 Parameters common to all categories

Parameter		Range(⇳)	Default(⇨)	Type					
mm.001	Module ID	0 to 65535		RO	Num	ND	NC	PT	
mm.002	Software Version	00.00.00.00 to 99.99.99.99		RO	Num	ND	NC	PT	
mm.003	Hardware Version	0.00 to 99.99		RO	Num	ND	NC	PT	
mm.004	Serial Number LS	0 to 99999999		RO	Num	ND	NC	PT	
mm.005	Serial Number MS			RO	Num	ND	NC	PT	
mm.006	Module Status	-2 to 3		RO	Num	ND	NC	PT	
mm.007	Module Reset	Off (0) to On (1)	Off (0)	RW	Bit		NC		

The option module ID indicates the type of module that is installed in the corresponding slot. See the relevant option module user guide for more information regarding the module.

Option module ID	Module	Category
0	No module installed	
209	SI-I/O	Automation (I/O Expansion)
304	SI-Applications Plus	Automation (Applications)
310	MCi210	
311	MCi200	
443	SI-PROFIBUS	Fieldbus
447	SI-DeviceNet	
448	SI-CANopen	
433	SI-Ethernet	
432	SI-PROFINET RT	
434	SI-PROFINET V2	

11.16 Menu 18: Application menu 1

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
18.001	Application Menu 1 Power-down Save Integer	-32768 to 32767		0			RW	Num				PS
18.002 to 18.010	Application Menu 1 Read-only Integer	-32768 to 32767					RO	Num	ND	NC		US
18.011 to 18.030	Application Menu 1 Read-write Integer	-32768 to 32767		0			RW	Num				US
18.031 to 18.050	Application Menu 1 Read-write bit	Off (0) or On (1)		Off (0)			RW	Bit				US
18.051 to 18.054	Application Menu 1 Power-down Save long Integer	-2147483648 to 2147483647		0			RW	Num				PS

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.17 Menu 19: Application menu 2

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
19.001	Application Menu 2 Power-down Save Integer	-32768 to 32767		0			RW	Num				PS
19.002 to 19.010	Application Menu 2 Read-only Integer	-32768 to 32767					RO	Num	ND	NC		US
19.011 to 19.030	Application Menu 2 Read-write Integer	-32768 to 32767		0			RW	Num				US
19.031 to 19.050	Application Menu 2 Read-write bit	Off (0) or On (1)		Off (0)			RW	Bit				US
19.051 to 19.054	Application Menu 2 Power-down Save long Integer	-2147483648 to 2147483647		0			RW	Num				PS

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.18 Menu 20: Application menu 3

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
20.001 to 20.020	Application Menu 3 Read-write Integer	-32768 to 32767		0			RW	Num				
20.021 to 20.040	Application Menu 3 Read-write Long Integer	-2147483648 to 2147483647		0			RW	Num				

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.19 Menu 22: Additional Menu 0 set-up

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
22.001	Parameter 00.001 Set-up	0.000 to 59.999			5.004	3.002		RW	Num			PT	US
22.002	Parameter 00.002 Set-up				5.001			RW	Num			PT	US
22.003	Parameter 00.003 Set-up				4.001			RW	Num			PT	US
22.004	Parameter 00.004 Set-up				5.003			RW	Num			PT	US
22.005	Parameter 00.005 Set-up				11.029			RW	Num			PT	US
22.006	Parameter 00.006 Set-up				0.000			RW	Num			PT	US
22.007	Parameter 00.007 Set-up				0.000			RW	Num			PT	US
22.008	Parameter 00.008 Set-up				0.000			RW	Num			PT	US
22.009	Parameter 00.009 Set-up				0.000			RW	Num			PT	US
22.010	Parameter 00.010 Set-up				1.007			RW	Num			PT	US
22.011	Parameter 00.011 Set-up				1.006			RW	Num			PT	US
22.012	Parameter 00.012 Set-up				2.011			RW	Num			PT	US
22.013	Parameter 00.013 Set-up				2.021			RW	Num			PT	US
22.014	Parameter 00.014 Set-up				5.014	3.010		RW	Num			PT	US
22.015	Parameter 00.015 Set-up				5.013	3.011		RW	Num			PT	US
22.016	Parameter 00.016 Set-up				5.015	3.012		RW	Num			PT	US
22.017	Parameter 00.017 Set-up				5.011			RW	Num			PT	US
22.018	Parameter 00.018 Set-up				5.009			RW	Num			PT	US
22.019	Parameter 00.019 Set-up				5.008			RW	Num			PT	US
22.020	Parameter 00.020 Set-up				5.007			RW	Num			PT	US
22.021	Parameter 00.021 Set-up				5.006		5.033	RW	Num			PT	US
22.022	Parameter 00.022 Set-up				5.018			RW	Num			PT	US
22.023	Parameter 00.023 Set-up				6.009		0.000	RW	Num			PT	US
22.024	Parameter 00.024 Set-up				5.012			RW	Num			PT	US
22.025	Parameter 00.025 Set-up				7.007			RW	Num			PT	US
22.026	Parameter 00.026 Set-up				7.010			RW	Num			PT	US
22.027	Parameter 00.027 Set-up				7.011			RW	Num			PT	US
22.028	Parameter 00.028 Set-up				7.014			RW	Num			PT	US
22.029	Parameter 00.029 Set-up				7.058			RW	Num			PT	US
22.030	Parameter 00.030 Set-up				11.030			RW	Num			PT	US
22.031	Parameter 00.031 Set-up				11.044			RW	Num			PT	US
22.032	Parameter 00.032 Set-up				11.036			RW	Num			PT	US
22.033	Parameter 00.033 Set-up				11.042			RW	Num			PT	US
22.034	Parameter 00.034 Set-up				6.016			RW	Num			PT	US
22.035	Parameter 00.035 Set-up				6.017			RW	Num			PT	US
22.036	Parameter 00.036 Set-up				6.018			RW	Num			PT	US
22.037	Parameter 00.037 Set-up				6.019			RW	Num			PT	US
22.038	Parameter 00.038 Set-up				6.020			RW	Num			PT	US
22.039	Parameter 00.039 Set-up				0.000			RW	Num			PT	US
22.040	Parameter 00.040 Set-up				0.000		5.064	RW	Num			PT	US
22.041	Parameter 00.041 Set-up				0.000		5.071	RW	Num			PT	US
22.042	Parameter 00.042 Set-up				0.000		5.072	RW	Num			PT	US
22.043	Parameter 00.043 Set-up				0.000		5.075	RW	Num			PT	US
22.044	Parameter 00.044 Set-up				0.000		5.077	RW	Num			PT	US
22.045	Parameter 00.045 Set-up				0.000		5.078	RW	Num			PT	US
22.046	Parameter 00.046 Set-up				0.000		5.082	RW	Num			PT	US
22.047	Parameter 00.047 Set-up				0.000		5.084	RW	Num			PT	US
22.048	Parameter 00.048 Set-up				10.034			RW	Num			PT	US
22.049	Parameter 00.049 Set-up				10.035			RW	Num			PT	US
22.050	Parameter 00.050 Set-up				10.020			RW	Num			PT	US
22.051	Parameter 00.051 Set-up				10.021			RW	Num			PT	US
22.052	Parameter 00.052 Set-up				10.022			RW	Num			PT	US
22.053	Parameter 00.053 Set-up				10.023			RW	Num			PT	US
22.054	Parameter 00.054 Set-up				10.024			RW	Num			PT	US
22.055	Parameter 00.055 Set-up				10.025			RW	Num			PT	US
22.056	Parameter 00.056 Set-up				10.026			RW	Num			PT	US
22.057	Parameter 00.057 Set-up				10.027			RW	Num			PT	US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
22.058	Parameter 00.058 Set-up	0.000 to 59.999			10.028			RW	Num			PT	US
22.059	Parameter 00.059 Set-up				10.029			RW	Num			PT	US
22.060	Parameter 00.060 Set-up				10.041			RW	Num			PT	US
22.061	Parameter 00.061 Set-up				10.042			RW	Num			PT	US
22.062	Parameter 00.062 Set-up				10.043			RW	Num			PT	US
22.063	Parameter 00.063 Set-up				10.044			RW	Num			PT	US
22.064	Parameter 00.064 Set-up				10.045			RW	Num			PT	US
22.065	Parameter 00.065 Set-up				10.046			RW	Num			PT	US
22.066	Parameter 00.066 Set-up				10.047			RW	Num			PT	US
22.067	Parameter 00.067 Set-up				10.048			RW	Num			PT	US
22.068	Parameter 00.068 Set-up				10.049			RW	Num			PT	US
22.069	Parameter 00.069 Set-up				10.050			RW	Num			PT	US
22.070	Parameter 00.070 Set-up				10.051			RW	Num			PT	US
22.071	Parameter 00.071 Set-up				10.052			RW	Num			PT	US
22.072	Parameter 00.072 Set-up				10.053			RW	Num			PT	US
22.073	Parameter 00.073 Set-up				10.054			RW	Num			PT	US
22.074	Parameter 00.074 Set-up				10.055			RW	Num			PT	US
22.075	Parameter 00.075 Set-up				10.056			RW	Num			PT	US
22.076	Parameter 00.076 Set-up				10.057			RW	Num			PT	US
22.077	Parameter 00.077 Set-up				10.058			RW	Num			PT	US
22.078	Parameter 00.078 Set-up				10.059			RW	Num			PT	US
22.079	Parameter 00.079 Set-up				10.060			RW	Num			PT	US
22.080	Parameter 00.080 Set-up				0.000			RW	Num			PT	US

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.20 Menu 29: Building Automation Network Setup

Parameter		Range	Default	Type					
29.001	BAN Protocol Selection	Modbus RTU (0), BACnet MSTP (1), Metasys N2 Open (2)	Modbus RTU (0)	RW	Txt				US
29.003	MS/TP Maximum Master MAC Address	0 to 127	127	RW	Num				US
29.004	Device Object Identifier	0 to 4194302	1	RW	Num				US
29.005	Communications Lost Detection Time-Out Period	5 to 60000 s	5 s	RW	Num				US
29.006	Communications Lost Action	0 to 2	0	RW	Num			PT	US
29.010	User Selectable Parameter 1	0.000 to 41.999	0.000	RW	Num			PT	US
29.011	User Selectable Parameter 2	0.000 to 41.999	0.000	RW	Num			PT	US
29.012	User Selectable Parameter 3	0.000 to 41.999	0.000	RW	Num			PT	US
29.013	User Selectable Parameter 4	0.000 to 41.999	0.000	RW	Num			PT	US
29.014	User Selectable Parameter 5	0.000 to 41.999	0.000	RW	Num			PT	US
29.015	User Selectable Parameter 6	0.000 to 41.999	0.000	RW	Num			PT	US
29.016	User Selectable Parameter 7	0.000 to 41.999	0.000	RW	Num			PT	US
29.017	User Selectable Parameter 8	0.000 to 41.999	0.000	RW	Num			PT	US
29.018	User Selectable Parameter 9	0.000 to 41.999	0.000	RW	Num			PT	US
29.019	User Selectable Parameter 10	0.000 to 41.999	0.000	RW	Num			PT	US
29.020	CRC Errors	0 to 65535		RW	Num	ND	NC	PT	
29.021	Token Interval	0.000 to 65.535 s		RO	Num	ND	NC	PT	
29.022	Received Message Counter	0 to 65535		RO	Num	ND	NC	PT	
29.023	Derivative Status	-1 to 3		RO	Num	ND	NC	PT	
29.024	Software Version	0 to 99999999		RO	Num	ND	NC	PT	

RW	Read / Write	RO	Read Only	Bit	Bit Parameter	Txt	Text String	Date	Date Parameter	Time	Time Parameter
Chr	Character Parameter	Bin	Binary Parameter	IP	IP Address	Mac	Mac Address	Ver	Version Number	SMP	Slot, menu, parameter
Num	Number Parameter	DE	Destination	ND	No Default Value	RA	Rating dependant	NC	Non- copyable	PT	Protected
FI	Filtered	US	User Save	PS	Power-Down Save						

12 Technical data

12.1 Drive technical data

12.1.1 Power and current ratings (Derating for switching frequency and temperature)

For a full explanation of Normal Duty refer to Chapter 2.3 *Ratings* on page 12.

Table 12-1 Maximum permissible continuous output current @ 40 °C (104 °F) ambient

Model	Normal Duty								
	Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies						
	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V									
03200066	1.1	1.5	6.6						
03200080	1.5	2.0	8.0						
03200110	2.2	3.0	11						10.2
03200127	3.0	3.0	12.7					12.1	10.2
04200180	4.0	5.0	18						
04200250	5.5	7.5	25					24	22
05200300	7.5	10	30					27.6	23.7
06200500	11	15	50					42.3	24.5
06200580	15	20	58				53	42.3	32.5
07200750	18.5	25	75					74.3	59.7
07200940	22	30	94					74.3	59.7
07201170	30	40	117			114	96	74.3	59.7
08201490	37	50	149				146	125.2	93
08201800	45	60	180			160.2	148.8	126	93
09202160	55	75	216				184	128	93
09202660	75	100	266		258	218	184	128	93
10203250	90	125	325			313	266	194	144
10203600	110	150	360			313	266	194	144
400 V									
03400034	1.1	2.0	3.4						
03400045	1.5	2.0	4.5						
03400062	2.2	3.0	6.2						5.0
03400077	3.0	5.0	7.7					6.2	5.0
03400104	4.0	5.0	10.4					7.6	5.7
03400123	5.5	7.5	12.3				10.5	7.6	5.8
04400185	7.5	10	18.5					14.6	11.1
04400240	11	15	24			21.8	19.2	14.6	11.2
05400300	15	20	30			25.8	22.2	17.1	13.5
06400380	18.5	25	38					31	24.3
06400480	22	30	48				41	31	24.5
06400630	30	40	63		57	48	41	31	24.5
07400790	37	60	79					63	53.6
07400940	45	60	94				80.6	63	53.6
07401120	55	75	112			95.2	80.6	63	53.8
08401550	75	100	155				132	98	77
08401840	90	150	184			169	142	106.7	77

Model	Normal Duty								
	Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies						
	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
09402210	110	150	221			192	159	108	77
09402660	132	200	266	255	231	192	160	109	77
10403200	160	250	320			285	238	173	124
10403610	200	300	361		339	285	238	173	126
11404370	225	350	437		415	336	272		
11404870	250	400	487	460	415	336	272		
11405070	280	400	507	460	415	336	272		
575 V									
05500039	2.2	3.0	3.9						
05500061	4.0	5.0	6.1						
05500100	5.5	7.5	10						
06500120	7.5	10.0	12						
06500170	11.0	15.0	17						14.8
06500220	15.0	20.0	22					20.5	15
06500270	18.5	25.0	27				26.2	20	16
06500340	22.0	30.0	34			31	26.2	20	16.8
06500430	30.0	40.0	43		39.6	31	26.2	20	16.8
07500530	45	50	53			51.8	40.2	27.7	21.2
07500730	55	60	73		71.5	51.8	40.2	27.7	21.2
08500860	75	75	86				73.1	49.7	37.8
08501080	90	100	108			91.8	73.1	49.7	37.8
09501250	110	125	125				101	71	54
09501500	110	150	150			126	100	70	54
10502000	130	200	200		168	126	100	70	54
11502480	185	250	248		220				
11502880	225	300	288	265	220				
11503150	250	350	315	265	220				
690 V									
07600230	18.5	25	23						21.2
07600300	22	30	30					27.9	21.2
07600360	30	40	36					28.1	21.2
07600460	37	50	46				40.5	28.1	21.2
07600520	45	60	52			51.5	40.6	28.1	21.2
07600730	55	75	73		71.5	51.8	40.6	28.1	21.2
08600860	75	100	86				72.2	49.7	37.8
08601080	90	125	108			91.8	72.4	49.7	37.8
09601250	110	150	125				100	71	54
09601550	132	175	155			126	100	71	54
10601720	160	200	172		169	126	100	71	55
10601970	185	250	197			154	114	75	55
11602250	200	250	225		220				
11602750	250	300	275	265	220				
11603050	280	400	305	265	220				

Table 12-2 Maximum permissible continuous output current @ 40 °C (104 °F) ambient with high IP insert installed

<table>
<tr><th rowspan="3">Model</th><th colspan="7">Normal Duty</th></tr>
<tr><th colspan="7">Maximum permissible continuous output current (A) for the following switching frequencies</th></tr>
<tr><th>2 kHz</th><th>3 kHz</th><th>4 kHz</th><th>6 kHz</th><th>8 kHz</th><th>12 kHz</th><th>16 kHz</th></tr>
<tr><td colspan="8">200 V</td></tr>
<tr><td>03200066</td><td colspan="7">6.6</td></tr>
<tr><td>03200080</td><td colspan="7">8.0</td></tr>
<tr><td>03200110</td><td colspan="6">11.0</td><td>9.7</td></tr>
<tr><td>03200127</td><td>12.3</td><td>11.9</td><td>11.1</td><td>10.0</td><td>9.0</td><td>6.4</td><td>4.7</td></tr>
<tr><td>04200180</td><td colspan="3">14.5</td><td>13.5</td><td>12.2</td><td>10.5</td><td>9.6</td></tr>
<tr><td>04200250</td><td colspan="3">14.5</td><td>13.5</td><td>12.2</td><td>10.5</td><td>9.6</td></tr>
<tr><td>05200300</td><td>25.5</td><td>25.2</td><td>24.9</td><td>24.3</td><td>23.7</td><td>22.5</td><td>21.6</td></tr>
<tr><td colspan="8">400 V</td></tr>
<tr><td>03400034</td><td colspan="6">3.4</td><td>3.3</td></tr>
<tr><td>03400045</td><td colspan="3">4.5</td><td>4.4</td><td>4.1</td><td>3.6</td><td>3.3</td></tr>
<tr><td>03400062</td><td>5.1</td><td>5.0</td><td>4.7</td><td>4.4</td><td>4.1</td><td>3.6</td><td>3.3</td></tr>
<tr><td>03400077</td><td colspan="2">7.7</td><td>7.4</td><td>6.7</td><td>6.2</td><td>5.7</td><td>5.0</td></tr>
<tr><td>03400104</td><td colspan="3">8.3</td><td>7.6</td><td>6.9</td><td>6.0</td><td>5.2</td></tr>
<tr><td>03400123</td><td colspan="3">8.3</td><td>7.6</td><td>6.9</td><td>6.0</td><td>5.2</td></tr>
<tr><td>04400185</td><td colspan="5">8.6</td><td>8.4</td><td>6.9</td></tr>
<tr><td>04400240</td><td colspan="5">8.6</td><td>8.4</td><td>6.9</td></tr>
<tr><td>05400300</td><td>17.1</td><td>15.6</td><td>14.4</td><td>12.6</td><td>11.4</td><td>9.6</td><td>8.7</td></tr>
<tr><td colspan="8">575 V</td></tr>
<tr><td>05500039</td><td colspan="7">3.9</td></tr>
<tr><td>05500061</td><td colspan="7">6.1</td></tr>
<tr><td>05500100</td><td colspan="7">10.0</td></tr>
</table>

Table 12-3 Maximum permissible continuous output current @ 50 °C (122 °F)

<table>
<tr><th rowspan="3">Model</th><th colspan="7">Normal Duty</th></tr>
<tr><th colspan="7">Maximum permissible continuous output current (A)
for the following switching frequencies</th></tr>
<tr><th>2 kHz</th><th>3 kHz</th><th>4 kHz</th><th>6 kHz</th><th>8 kHz</th><th>12 kHz</th><th>16 kHz</th></tr>
<tr><td colspan="8">200 V</td></tr>
<tr><td>03200066</td><td colspan="7">6.6</td></tr>
<tr><td>03200080</td><td colspan="7">8.0</td></tr>
<tr><td>03200110</td><td colspan="5">11</td><td>10.5</td><td>9.1</td></tr>
<tr><td>03200127</td><td colspan="2">12.7</td><td>12.6</td><td>12.2</td><td>11.7</td><td>10.5</td><td>9.1</td></tr>
<tr><td>04200180</td><td colspan="7">18</td></tr>
<tr><td>04200250</td><td colspan="6">22.2</td><td>20.2</td></tr>
<tr><td>05200300</td><td colspan="4">30</td><td>29.7</td><td>25.2</td><td>21.6</td></tr>
<tr><td>06200500</td><td colspan="4">50</td><td>49</td><td>38</td><td>30</td></tr>
<tr><td>06200580</td><td colspan="3">58</td><td>56</td><td>49</td><td>38</td><td>30.2</td></tr>
<tr><td>07200750</td><td colspan="5">75</td><td>59.7</td><td>48.8</td></tr>
<tr><td>07200940</td><td colspan="3">94</td><td>92.1</td><td>80</td><td>59.7</td><td>48.9</td></tr>
<tr><td>07201170</td><td colspan="2">117</td><td>112</td><td>92.4</td><td>80</td><td>59.7</td><td>49.1</td></tr>
<tr><td>08201490</td><td colspan="3">149</td><td>147</td><td>133</td><td>113</td><td>84</td></tr>
<tr><td>08201800</td><td colspan="2">180</td><td>167</td><td>148</td><td>133</td><td>113</td><td>84</td></tr>
<tr><td>09202160</td><td colspan="3">216</td><td>197</td><td>168</td><td>117</td><td>84</td></tr>
<tr><td>09202660</td><td>253</td><td>237</td><td>221</td><td>197</td><td>168</td><td>117</td><td>85</td></tr>
<tr><td>10203250</td><td>325</td><td>320</td><td>302</td><td>266</td><td>241</td><td>176</td><td>130</td></tr>
<tr><td>10203600</td><td>346</td><td>320</td><td>302</td><td>266</td><td>241</td><td>176</td><td>130</td></tr>
<tr><td colspan="8">400 V</td></tr>
<tr><td>03400034</td><td colspan="7">3.4</td></tr>
<tr><td>03400045</td><td colspan="7">4.5</td></tr>
<tr><td>03400062</td><td colspan="4">6.2</td><td>5.9</td><td>5.4</td><td>4.4</td></tr>
<tr><td>03400077</td><td>7.6</td><td>7.2</td><td>6.9</td><td>6.4</td><td>5.9</td><td>5.4</td><td>4.4</td></tr>
<tr><td>03400104</td><td colspan="3">10.4</td><td>9.3</td><td>8.5</td><td>6.9</td><td>5.1</td></tr>
<tr><td>03400123</td><td>11.9</td><td>11.2</td><td>10.5</td><td>9.3</td><td>8.5</td><td>6.9</td><td>5.2</td></tr>
<tr><td>04400185</td><td>18</td><td>17.5</td><td>17</td><td>16.3</td><td>15.8</td><td>12.2</td><td>9.3</td></tr>
<tr><td>04400240</td><td>18</td><td>17.5</td><td>17</td><td>16.3</td><td>15.8</td><td>12.2</td><td>9.3</td></tr>
<tr><td>05400300</td><td colspan="3">25.5</td><td>23.6</td><td>20.4</td><td>15.6</td><td>12.3</td></tr>
<tr><td>06400380</td><td colspan="4">38</td><td>37</td><td>28</td><td>21.4</td></tr>
<tr><td>06400480</td><td colspan="3">48</td><td>43</td><td>36.5</td><td>27.4</td><td>21.4</td></tr>
<tr><td>06400630</td><td>63</td><td>58</td><td>52</td><td>43</td><td>37</td><td>28</td><td>21.4</td></tr>
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<tr><td>07400940</td><td colspan="3">94</td><td>86.5</td><td>73.3</td><td>58.3</td><td>49</td></tr>
<tr><td>07401120</td><td colspan="2">112</td><td>109</td><td>87.4</td><td>72.8</td><td>58.3</td><td>49.3</td></tr>
<tr><td>08401550</td><td colspan="3">155</td><td>146</td><td>123</td><td>93</td><td>69</td></tr>
<tr><td>08401840</td><td colspan="2">184</td><td>180</td><td>146</td><td>123</td><td>93.8</td><td>69</td></tr>
<tr><td>09402210</td><td colspan="2">221</td><td>213</td><td>175</td><td>144</td><td>97</td><td>69</td></tr>
<tr><td>09402660</td><td>253</td><td>237</td><td>213</td><td>176</td><td>144</td><td>98</td><td>69</td></tr>
<tr><td>10403200</td><td colspan="2">320</td><td>300</td><td>259</td><td>217</td><td>154</td><td>112</td></tr>
<tr><td>10403610</td><td>343</td><td>321</td><td>300</td><td>260</td><td>217</td><td>155</td><td>112</td></tr>
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<table>
<tr><th rowspan="3">Model</th><th colspan="7">Normal Duty</th></tr>
<tr><th colspan="7">Maximum permissible continuous output current (A)
for the following switching frequencies</th></tr>
<tr><th>2 kHz</th><th>3 kHz</th><th>4 kHz</th><th>6 kHz</th><th>8 kHz</th><th>12 kHz</th><th>16 kHz</th></tr>
<tr><td>11404370</td><td>437</td><td>415</td><td>374</td><td>298</td><td>240</td><td></td><td></td></tr>
<tr><td>11404870</td><td>462</td><td>415</td><td>374</td><td>298</td><td>240</td><td></td><td></td></tr>
<tr><td>11405070</td><td>462</td><td>415</td><td>374</td><td>298</td><td>240</td><td></td><td></td></tr>
<tr><td colspan="8">575 V</td></tr>
<tr><td>05500039</td><td colspan="7">3.9</td></tr>
<tr><td>05500061</td><td colspan="7">6.1</td></tr>
<tr><td>05500100</td><td colspan="7">10</td></tr>
<tr><td>06500120</td><td colspan="7">12</td></tr>
<tr><td>06500170</td><td colspan="6">17</td><td>13.4</td></tr>
<tr><td>06500220</td><td colspan="5">22</td><td>17.8</td><td>13.4</td></tr>
<tr><td>06500270</td><td colspan="4">27</td><td>23.5</td><td>17.8</td><td>15</td></tr>
<tr><td>06500340</td><td colspan="3">34</td><td>28.2</td><td>23.5</td><td>18</td><td>15</td></tr>
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<tr><td>07500530</td><td colspan="3">53</td><td>46.7</td><td>35.8</td><td>24.8</td><td>19</td></tr>
<tr><td>07500730</td><td colspan="2">73</td><td>65</td><td>46.7</td><td>35.8</td><td>24.8</td><td>19</td></tr>
<tr><td>08500860</td><td colspan="3">86</td><td>76.7</td><td>64.5</td><td>44.3</td><td>31.3</td></tr>
<tr><td>08501080</td><td>104</td><td>97.2</td><td>90.7</td><td>76.7</td><td>64.8</td><td>44.3</td><td>31.3</td></tr>
<tr><td>09501250</td><td colspan="3">125</td><td>114</td><td>90</td><td>62</td><td>48</td></tr>
<tr><td>09501500</td><td colspan="3">150</td><td>114</td><td>90</td><td>62</td><td>48</td></tr>
<tr><td>10502000</td><td>200</td><td>184</td><td>154</td><td>114</td><td>90</td><td>62</td><td>48</td></tr>
<tr><td>11502480</td><td colspan="2">226</td><td>198</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11502880</td><td>262</td><td>241</td><td>198</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11503150</td><td>296</td><td>241</td><td>198</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">690 V</td></tr>
<tr><td>07600230</td><td colspan="6">23</td><td>19</td></tr>
<tr><td>07600300</td><td colspan="5">30</td><td>24.8</td><td>19</td></tr>
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<tr><td>07600520</td><td colspan="3">52</td><td>46.7</td><td>35.8</td><td>25</td><td>19</td></tr>
<tr><td>07600730</td><td colspan="2">73</td><td>65</td><td>46.7</td><td>35.8</td><td>25</td><td>19</td></tr>
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<tr><td>08601080</td><td>104</td><td>97.2</td><td>90.7</td><td>76.7</td><td>64.8</td><td>44.3</td><td>31.3</td></tr>
<tr><td>09601250</td><td colspan="3">125</td><td>114</td><td>90</td><td>62</td><td>48</td></tr>
<tr><td>09601550</td><td colspan="2">155</td><td>153</td><td>113</td><td>89</td><td>62</td><td>48</td></tr>
<tr><td>10601720</td><td colspan="2">172</td><td>153</td><td>114</td><td>89</td><td>62</td><td>48</td></tr>
<tr><td>10601970</td><td colspan="2">197</td><td>195</td><td>134</td><td>102</td><td>67</td><td>48</td></tr>
<tr><td>11602250</td><td colspan="2">205</td><td>198</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11602750</td><td>250</td><td>241</td><td>198</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11603050</td><td>296</td><td>241</td><td>198</td><td></td><td></td><td></td><td></td></tr>
</table>

NOTE

55 ° C ratings are available on request.

12.1.2 Power dissipation

Table 12-4 Losses @ 40° C (104° F) ambient

Model	Normal Duty								
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions						
	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V									
03200066	1.1	1.5	88	93	95	99	104	113	122
03200080	1.5	2	95	100	102	107	113	122	133
03200110	2.2	3	117	123	126	133	139	151	146
03200127	3	3	129	136	141	149	158	168	157
04200180	4	5	171	180	187	201	216	244	273
04200250	5.5	7.5	227	239	248	266	284	308	314
05200300	7.5	10	280	291	302	324	344	356	342
06200500	11	15	375	394	413	452	490	480	485
06200580	15	20	442	463	484	528	522	481	486
07200750	18.5	25	533	570	597	650	703	885	894
07200940	22	30	671	718	751	815	881	890	899
07201170	30	40	851	911	951	1004	911	920	929
08201490	37	50	1339	1433	1536	1765	1943	1962	1982
08201800	45	60	1638	1753	1894	1914	1985	2005	2025
09202160 (9A)	55	75	2028	2170	2312	2596	2448	2160	2031
09202660 (9A)	75	100	2585	2754	2822	2623	2448	2156	2034
09202160 (9E)	55	75	1889	2031	2174	2458	2348	2112	2006
09202660 (9E)	75	100	2375	2554	2625	2482	2348	2108	2009
10203250	90	125	2478	2672	2867	3123	2952	2701	2554
10203600	110	150	2802	3016	3230	3126	2957	2706	2554
400 V									
03400034	1.1	1.5	76	80	84	94	103	123	141
03400045	1.5	2	84	88	92	104	115	137	160
03400062	2.2	3	99	104	112	125	139	167	157
03400077	3	5	108	114	122	137	153	149	147
03400104	4	5	138	145	158	186	212	201	197
03400123	5	7.5	155	163	179	209	208	201	200
04400185	7.5	10	214	225	244	283	322	325	310
04400240	11	15	269	283	307	325	329	325	315
05400300	15	20	295	324	353	356	355	359	362
06400380	18.5	25	378	417	456	532	613	652	645
06400480	22	30	469	515	561	657	651	646	650
06400630	30	40	616	656	659	650	646	643	649
07400790	37	50	745	830	907	1062	1218	1230	1242
07400940	45	60	896	999	1088	1264	1241	1253	1266
07401120	55	75	1033	1152	1247	1218	1170	1182	1194
08401550	75	100	1482	1652	1817	2154	2121	2142	2164
08401840	90	125	1798	2004	2191	2333	2279	2302	2325
09402210 (9A)	110	150	2431	2710	2989	3075	2992	2842	2833
09402660 (9A)	132	200	3016	3191	3143	3063	3000	2856	2828
09402210 (9E)	110	150	2286	2565	2844	2966	2917	2807	2815
09402660 (9E)	132	200	2806	2998	2984	2955	2925	2821	2811
10403200	160	250	3210	3582	3954	4148	4034	3939	3843
10403610	200	300	3703	4121	4226	4154	4038	3947	3874
11404370	225	350	4182	4576	4708	4444	4246		
11404870	250	400	4734	4843	4708	4444	4246		
11405070	280	400	4962	4843	4708	4444	4246		

Model	Normal Duty								
	Nominal rating		Drive losses (W) taking into account any current derating for the given conditions						
	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
575 V									
05500039	2.2	3	82	92	102	121	142	183	223
05500061	4	5	120	135	150	180	209	269	328
05500100	5.5	7.5	173	194	215	260	302	388	474
06500120	7.5	10	191	215	239	287	334	430	525
06500170	11	15	253	284	315	376	438	563	569
06500220	15	20	325	362	399	484	569	575	580
06500270	18.5	25	391	448	505	596	682	689	696
06500340	22	30	534	623	712	810	822	830	839
06500430	30	40	675	798	836	813	823	831	840
07500530	45	50	867	1004	1139	1358	1262	1275	1287
07500730	55	60	1078	1248	1375	1209	1122	1133	1145
08500860	75	75	1607	1861	2180	2814	2982	3012	3042
08501080	90	100	2050	2374	2753	2947	2963	2993	3023
09501250 (9A)	110	125	1707	1977	2247	2787	2723	2731	2859
09501500 (9A)	110	150	2087	2410	2734	2810	2692	2697	2859
09501250 (9E)	110	125	1595	1865	2135	2675	2644	2687	2831
09501500 (9E)	110	150	1933	2256	2580	2696	2616	2654	2831
10502000	130	200	2692	3137	2923	2696	2616	2654	2831
11502480	185	250	3391	3999	4097				
11502880	225	300	4004	4296	4097				
11503150	250	350	4439	4296	4097				
690 V									
07600230	18.5	25	363	428	491	617	743	793	970
07600300	22	30	468	551	631	791	952	962	971
07600360	30	40	560	660	754	941	1129	1140	1152
07600460	37	50	725	854	971	1206	1271	1284	1297
07600520	45	60	836	985	1117	1350	1275	1288	1301
07600730	55	75	1059	1248	1375	1209	1122	1133	1145
08600860	75	100	1579	1861	2180	2814	2945	2974	3004
08601080	90	125	2015	2374	2753	2947	2935	2964	2994
09601250 (9A)	110	150	1878	2213	2548	3218	3155	3266	3465
09601550 (9A)	132	175	2384	2797	3211	3232	3155	3267	3474
09601250 (9E)	110	150	1730	2065	2400	3070	3058	3215	3434
09601550 (9E)	132	175	2160	2573	2986	3083	3058	3216	3443
10601720	160	200	2420	2882	3270	3083	3052	3192	3472
10601970	185	250	2614	3132	3649	3667	3495	3633	3993
11602250	200	250	3225	3893	4497				
11602750	250	300	4023	4640	4497				
11603050	280	400	4576	4684	4540				

Table 12-5 Losses @ 40°C (104° F) ambient with high IP insert installed

Model	Normal Duty						
	Drive losses (W) taking into consideration any current derating for the given conditions						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V							
03200066	88	93	95	99	104	113	122
03200080	95	100	102	107	113	122	133
03200110	117	123	126	133	140	158	157
03200127	122	128	124	122	118	98	84
04200180	138	145	151	151	146	142	146
04200250	204	215	205	194	189	187	199
05200300	188	194	201	212	222	240	262
400 V							
03400034	76	80	84	94	103	123	137
03400045	84	88	92	102	105	110	134
03400062	80	84	85	89	92	109	134
03400077	108	114	117	122	135	172	203
03400104	112	118	134	155	173	221	267
03400123	112	118	134	155	173	221	267
04400185	100	105	114	132	153	197	207
04400240	96	101	111	131	152	197	207
05400300	118	118	119	124	132	152	183
575 V							
05500039	32	42	52	71	92	133	173
05500061	70	85	100	130	159	219	278
05500100	123	144	165	210	252	338	424

Table 12-6 Losses @ 50° C (122° F) ambient

Model	Normal Duty						
	Drive losses (W) taking into account any current derating for the given conditions						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V							
03200066	88	93	95	99	104	113	122
03200080	95	100	102	107	113	122	133
03200110	117	123	126	133	139	144	139
03200127	129	136	140	143	147	151	150
04200180	171	180	187	201	216	253	297
04200250	203	214	223	244	265	312	334
05200300	280	291	302	324	341	325	312
06200500	375	394	413	452	480	431	594
06200580	442	463	484	510	483	432	451
07200750	538	570	597	650	703	710	717
07200940	678	718	751	799	750	758	765
07201170	848	898	898	805	751	759	766
08201490	1353	1433	1536	1741	1770	1788	1806
08201800	1640	1737	1740	1759	1771	1789	1807
09202160 (9A)	2028	2170	2312	2354	2256	2010	1910
09202660 (9A)	2431	2405	2368	2358	2245	2015	1922
09202160 (9E)	1889	2031	2174	2240	2172	1970	1889
09202660 (9E)	2241	2239	2223	2243	2161	1975	1900
10203250	2478	2625	2641	2625	2671	2490	2379
10203600	2666	2629	2643	2629	2678	2495	2374
400 V							
03400034	76	80	84	118	103	123	141
03400045	84	88	92	104	115	137	160
03400062	99	104	112	125	132	146	155
03400077	106	106	109	114	117	145	155
03400104	138	145	158	175	194	225	225
03400123	152	152	160	175	194	225	230
04400185	213	213	227	262	300	323	325
04400240	212	212	227	262	300	318	321
05400300	251	275	300	326	326	328	330
06400380	378	417	456	532	597	589	568
06400480	469	515	561	589	580	571	568
06400630	616	604	601	582	583	581	567
07400790	744	830	907	1062	1141	1152	1164
07400940	895	999	1087	1163	1138	1149	1161
07401120	1018	1136	1200	1118	1074	1085	1096
08401550	1480	1652	1815	2016	1970	1990	2010
08401840	1754	1957	2114	1998	1979	1999	2019
09402210 (9A)	2431	2710	2872	2799	2737	2639	2652
09402660 (9A)	2837	2926	2870	2814	2737	2660	2665
09402210 (9E)	2286	2565	2738	2709	2675	2611	2638
09402660 (9E)	2648	2760	2735	2723	2675	2632	2651
10403200	3210	3582	3681	3765	3700	3597	3591

Model	Normal Duty						
	Drive losses (W) taking into account any current derating for the given conditions						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
10403610	3482	3598	3676	3776	3694	3625	3589
11404370	4182	4329	4228	3988	3843		
11404870	4456	4329	4228	3988	3843		
11405070	4456	4329	4228	3988	3843		
575 V							
05500039	82	92	102	121	142	183	223
05500061	120	135	150	180	209	269	328
05500100	173	194	215	260	302	388	474
06500120	191	215	239	287	334	430	525
06500170	253	284	315	376	438	563	515
06500220	325	362	399	482	569	500	519
06500270	391	448	505	596	612	613	652
06500340	534	623	712	737	737	747	749
06500430	675	774	763	734	742	748	750
07500530	936	988	1115	1225	1144	1155	1167
07500730	1161	1225	1228	1098	1030	1040	1051
08500860	1753	1850	2172	2540	2672	2699	2726
08501080	1980	2090	2291	2540	2684	2711	2738
09501250 (9A)	1707	1977	2247	2538	2456	2495	2699
09501500 (9A)	2087	2410	2734	2544	2456	2482	2676
09501250 (9E)	1595	1865	2135	2443	2392	2460	2674
09501500 (9E)	1933	2256	2580	2448	2392	2447	2652
10502000	2692	2841	2654	2448	2392	2447	2652
11502480	3191	3678	3532				
11502880	3965	3678	3532				
11503150	3965	3678	3632				
690 V							
07600230	359	428	491	617	743	750	758
07600300	463	551	631	791	958	968	977
07600360	554	660	754	944	1144	1155	1167
07600460	717	854	965	1206	1144	1155	1167
07600520	814	969	1094	1225	1144	1155	1167
07600730	1029	1225	1228	1098	1030	1040	1051
08600860	1553	1850	2172	2540	2672	2699	2726
08601080	1755	2090	2291	2540	2684	2711	2738
09601250 (9A)	1878	2213	2548	2933	2882	2974	3248
09601550 (9A)	2384	2797	3175	2918	2855	2974	3249
09601250 (9E)	1730	2065	2400	2810	2803	2934	3223
09601550 (9E)	2160	2573	2955	2796	2778	2934	3225
10601720	2420	2882	2947	2805	2789	2932	3229
10601970	2614	3132	3610	3243	3221	3420	3771
11602250	3225	3893	4048				
11602750	4023	4186	4048				
11603050	4421	4230	4091				

Table 12-7 Power losses from the front of the drive when through-panel mounted

Frame size	Power loss
3	≤ 50 W
4	≤ 75 W
5	≤ 100 W
6	≤ 100 W
7	≤ 204 W
8	≤ 347 W
9A/9E	≤ 480 W
10E/11E	≤ 480 W

12.1.3 Supply requirements

AC supply 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.

12.1.4 Line reactors

Input line reactors reduce the risk of damage to the drive resulting from poor phase balance or severe disturbances on the supply network.

Where line reactors are to be used, reactance values of approximately 2 % are recommended. Higher values may be used if necessary, but may result in a loss of drive output (reduced torque at high speed) because of the voltage drop.

For all drive ratings, 2 % line reactors permit drives to be used with a supply unbalance of up to 3.5 % negative phase sequence (equivalent to 5 % voltage imbalance between phases).

Severe disturbances may be caused by the following factors, for example:

- Power factor correction equipment connected close to the drive.
- Large DC drives having no or inadequate line reactors connected to the supply.
- Across the line (DOL) started motor(s) connected to the supply such that when any of these motors are started, the voltage dip exceeds 20 %

Such disturbances may cause excessive peak currents to flow in the input power circuit of the drive. This may cause nuisance tripping, or in extreme cases, failure of the drive.

Drives of low power rating may also be susceptible to disturbance when connected to supplies with a high rated capacity.

Line reactors are particularly recommended for use with the following drive models when one of the above factors exists, or when the supply capacity exceeds 175 kVA:

03200066, 03200080, 03200110, 03200127

03400034, 03400045, 03400062, 03400077

Model sizes 03400104 to 07600730 have an internal DC choke and model sizes 08201490 to 0801080 and frame 9A have internal AC line chokes so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions. Drive sizes 9E,10E and 11E do not have internal input line reactors hence an external input line reactor must be used. For more information refer to section 4.2.3 *Drive model and input line reactor* on page 81.

When required, each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

When required each drive must have its own reactor(s). Three individual reactors or a single three-phase reactor should be used.

Reactor current ratings

The current rating of the line reactors should be as follows:

Continuous current rating:
Not less than the continuous input current rating of the drive

Repetitive peak current rating:
Not less than twice the continuous input current rating of the drive

12.1.5 Motor requirements

No. of phases: 3

Maximum voltage:
200 V drive: 265 V
400 V drive: 530 V
575 V drive: 635 V
690 V drive: 765 V

12.1.6 Temperature, humidity and cooling method

Ambient temperature operating range:
- 20 °C to 55 °C (- 4 °F to 131 °F).
Output current derating must be applied at ambient temperatures >40 °C (104 °F).

Cooling method: Forced convection

Maximum humidity: 95 % non-condensing at 40 °C (104 °F)

12.1.7 Storage

-40 °C (-40 °F) to +55 °C (131 °F) for long term storage, or to +70 °C (158 °F) for short term storage.

Storage time is 2 years.

Electrolytic capacitors in any electronic product have a storage period after which they require reforming or replacing.

The DC bus capacitors have a storage period of 10 years.

The low voltage capacitors on the control supplies typically have a storage period of 2 years and are thus the limiting factor.

Low voltage capacitors cannot be reformed due to their location in the circuit and thus may require replacing if the drive is stored for a period of 2 years or greater without power being applied.

It is therefore recommended that drives are powered up for a minimum of 1 hour after every 2 years of storage.

This process allows the drive to be stored for a further 2 years.

12.1.8 Altitude

Altitude range: 0 to 3,000 m (9,900 ft), subject to the following conditions:

1,000 m to 3,000 m (3,300 ft to 9,900 ft) above sea level: de-rate the maximum output current from the specified figure by 1% per 100 m (330 ft) above 1,000 m (3,300 ft)

For example at 3,000 m (9,900 ft) the output current of the drive would have to be de-rated by 20 %.

12.1.9 IP / UL Rating

The drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) (NEMA 1). However, it is possible to configure the drive to achieve IP65 rating (sizes 3 to 8) or IP55 rating (size 9, 10 and 11) (NEMA 12) at the rear of the heatsink for through-panel mounting (some current derating is required).

In order to achieve the high IP rating at the rear of the heatsink with drive sizes 3,4 and 5 it is necessary to seal a heatsink vent by installing the high IP insert.

The IP rating of a product is a measure of protection against ingress and contact to foreign bodies and water. It is stated as IP XX, where the two digits (XX) indicate the degree of protection provided as shown in Table 12-7 *Power losses from the front of the drive when through-panel mounted* on page 267.

Table 12-8 IP Rating degrees of protection

First digit		Second digit	
Protection against foreign bodies and access to hazardous parts		Protection against ingress of water	
0	Non-protected	0	Non-protected
1	Protected against solid foreign objects of 50 mm ∅ and greater (back of a hand)	1	Protected against vertically falling water drops
2	Protected against solid foreign objects of 12.5mm ∅ and greater (finger)	2	Protected against vertically falling water drops when enclosure tilted up to 15 °
3	Protected against solid foreign objects of 2.5 mm ∅ and greater (tool)	3	Protected against spraying water
4	Protected against solid foreign objects of 1.0mm ∅ and greater (wire)	4	Protected against splashing water
5	Dust-protected (wire)	5	Protected against water jets
6	Dust-tight (wire)	6	Protected against powerful water jets
7	-	7	Protected against the effects of temporary immersion in water
8	-	8	Protected against the effects of continuous immersion in water

Table 12-9 UL enclosure ratings

UL rating	Description
Type 1	Enclosures are intended for indoor use, primarily to provide a degree of protection against limited amounts of falling dirt.
Type 12	Enclosures are intended for indoor use, primarily to provide a degree of protection against dust, falling dirt and dripping non-corrosive liquids.

12.1.10 Corrosive gasses

Concentrations of corrosive gases must not exceed the levels given in:

- Table A2 of EN 50178:1998
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighborhood of industrial sources with chemical emissions.

12.1.11 RoHS compliance

The drive meets EU directive 2011/65/EU for RoHS compliance.

12.1.12 Vibration

Maximum recommended continuous vibration level 0.14 g r.m.s. broad-band 5 to 200 Hz.

NOTE

This is the limit for broad-band (random) vibration. Narrow-band vibration at this level which coincides with a structural resonance could result in premature failure.

Bump Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard:IEC 60068-2-29: Test Eb:
Severity: 18 g, 6 ms, half sine
No. of Bumps: 600 (100 in each direction of each axis)

Random Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard:IEC 60068-2-64: Test Fh:
Severity: 1.0 m^2/s^3 (0.01 g^2/Hz) ASD from 5 to 20 Hz
-3 dB/octave from 20 to 200 Hz
Duration: 30 minutes in each of 3 mutually perpendicular axes.

Sinusoidal Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard: IEC 60068-2-6: Test Fc:
Frequency range: 5 to 500 Hz
Severity: 3.5 mm peak displacement from 5 to 9 Hz
10 m/s^2 peak acceleration from 9 to 200 Hz
15 m/s^2 peak acceleration from 200 to 500 Hz
Sweep rate: 1 octave/minute
Duration: 15 minutes in each of 3 mutually perpendicular axes.

EN 61800-5-1:2007, Section 5.2.6.4. referring to IEC 60068-2-6

Frequency range: 10 to 150 Hz
Amplitude: 10 to 57 Hz at 0.075 mm pk
57 to 150 Hz at 1g p
Sweep rate: 1 octave/minute
Duration: 10 sweep cycles per axis in each of 3 mutually perpendicular axes

12.1.13 Starts per hour

By electronic control: unlimited

By interrupting the AC supply: ≤20 (equally spaced)

12.1.14 Start up time

This is the time taken from the moment of applying power to the drive, to the drive being ready to run the motor:

Sizes 3 to 6 = 2.5 s
Sizes 7 to 11 = 5 s

12.1.15 Output frequency / speed range

In all operating modes (Open loop, RFC-A, RFC-S) the maximum output frequency is limited to 550 Hz.

12.1.16 Accuracy and resolution

Speed:

The absolute frequency and speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100 ppm, and so the absolute frequency/speed accuracy is 100 ppm (0.01 %) of the reference, when a preset speed is used. If an analog input is used the absolute accuracy is further limited by the absolute accuracy of the analog input.

The following data applies to the drive only; it does not include the performance of the source of the control signals.

Open loop resolution:
Preset frequency reference: 0.1 Hz
Precision frequency reference: 0.001 Hz

Closed loop resolution
Preset speed reference: 0.1 rpm
Precision speed reference: 0.001 rpm
Analog input 1: 11 bit plus sign
Analog input 2: 11 bit plus sign

Current:

The resolution of the current feedback is 10 bit plus sign.

Accuracy: typical 2 %
worst case 5 %

12.1.17 Acoustic noise

The heatsink fan generates the majority of the sound pressure level at 1 m produced by the drive. The heatsink fan on all drive sizes are a variable speed fan. The drive controls the speed at which the fan runs based on the temperature of the heatsink and the drive's thermal model system.

Table 12-10 gives the sound pressure level at 1 m produced by the drive for the heatsink fan running at the maximum and minimum speeds.

Table 12-10 Acoustic noise data

Size	Max speed dBA	Min speed dBA
3	62.8	42.9
4	62.6	45.8
5	61.1	41.9
6	65.3	48.2
7	66.8	49.6
8	67.9	49.8
9A/9E/10E	75	52.6
11E	82.5	58

12.1.18 Overall dimensions

H Height including surface mounting brackets
W Width
D Projection forward of panel when surface mounted
F Projection forward of panel when through-panel mounted
R Projection rear of panel when through-panel mounted

Table 12-11 Overall drive dimensions

Size	Dimension				
	H	W	D	F	R
3	382 mm (15.04 in)	83 mm (3.27 in)	200 mm (7.87 in)	134 mm (5.28 in)	67 mm (2.64 in)
4	391 mm (15.39 in)	124 mm (4.88 in)			67 mm (2.64 in)
5	391 mm (15.39 in)	143 mm (5.63 in)	200 mm (7.87 in)	135 mm (5.32 in)	67 mm (2.64 in)
6	391 mm (15.39 in)	210 mm (8.27 in)	227 mm (8.94 in)	131 mm (5.16 in)	96 mm (3.78 in)
7	557 mm (21.93 in)	270 mm (10.63 in)	280 mm (11.02 in)	187 mm (7.36 in)	92 mm (3.62 in)
8	804 mm (31.65 in)	310 mm (12.21 in)	290 mm (11.42 in)	190 mm (7.48 in)	100 mm (3.94 in)
9A	1108 mm (43.61 in)	310 mm (12.21 in)	290 mm (11.42 in)	190 mm (7.48 in)	100 mm (3.94 in)
9E and 10E	1069 mm (42.09 in)	310 mm (12.21 in)	290 mm (11.42 in)	190 mm (7.48 in)	99 mm (3.90 in)
11E	1242 mm (48.9 in)	310 mm (12.21 in)	313 mm (12.32 in)	190 mm (7.48 in)	122 mm (4.8 in)

12.1.19 Weights

Table 12-12 Overall drive weights

Size	Model	kg	lb
3	03400104, 03400123	4.5	9.9
	All other variants	4.0	8.8
4	All variants	6.5	14.30
5		7.4	16.30
6		14	30.90
7		28	61.70
8		52	114.64
9A		66.5	146.6
9E/10E		46	101.40
11E		63	138.9

12.1.20 Input current, fuse and cable size ratings

The input current is affected by the supply voltage and impedance.

Typical input current

The values of typical input current are given to aid calculations for power flow and power loss.

The values of typical input current are stated for a balanced supply.

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 bad balance. 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 Table 12-13.

Table 12-13 Supply fault current used to calculate maximum input currents

Model	Symmetrical fault level (kA)
All	100

WARNING

Fuses

The AC supply to the drive must be installed with suitable protection against overload and short-circuits. Table 12-14 shows the recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

Table 12-14 AC Input current and fuse ratings (200 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
	A	A	A	Nominal A	Maximum A	Class	Nominal A	Maximum A	Class
03200066	8.2	10.4	15.8	16	25	gG	20	25	CC, J or T*
03200080	9.9	12.6	20.9	20					
03200110	14	17	25				25		
03200127	16	20	34	25					
04200180	17	20	30	25	25	gG	25	25	CC, J or T*
04200250	23	28	41	32	32		30	30	
05200300	24	31	52	40	40	gG	40	40	CC, J or T*
06200500	42	48	64	63	63	gG	60	60	CC, J or T*
06200580	49	56	85				60		
07200750	58	67	109	80	80	gG	80	80	CC, J or T*
07200940	73	84	135	100	100		100	100	
07201170	91	105	149	125	125		125	125	
08201490	123	137	213	200	200	gR	200	200	HSJ
08201800	149	166	243				225	225	
09202160	172	205	270	250	250	gR	250	250	HSJ
09202660	228	260	319	315	315		300	300	
10203250	277	305	421	400	400	gR	400	400	HSJ
10203600	333	361	494	450	450		450	450	

Table 12-15 AC Input current and fuse ratings (400 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
	A	A	A	Nominal A	Maximum A	Class	Nominal A	Maximum A	Class
03400034	5	5	7	10	10	gG	10	10	CC, J or T*
03400045	6	7	9						
03400062	8	9	13						
03400077	11	13	21	20	20		20	20	
03400104	12	13	20						
03400123	14	16	25						
04400185	17	19	30	25	25	gG	25	25	CC, J or T*
04400240	22	24	35	32	32		30	30	
05400300	26	29	52	40	40	gG	35	35	CC, J or T*
06400380	32	36	67	63	63	gG	40	60	CC, J or T*
06400480	41	46	80				50		
06400630	54	60	90				60		
07400790	67	74	124	100	100	gG	80	80	CC, J or T*
07400940	80	88	145				100	100	
07401120	96	105	188	125	125		125	125	
08401550	137	155	267	250	250	gR	225	225	HSJ
08401840	164	177	303						
09402210	211	232	306	315	315	gR	300	300	HSJ
09402660	245	267	359				350	350	
10403200	306	332	445	400	400	gR	400	400	HSJ
10403610	370	397	523	450	450		450	450	
11404370	424	449	579	500	500	gR	600	600	HSJ
11404870	455	492	613						
11405070	502	539	752	630	630				

Table 12-16 AC Input current and fuse ratings (575 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
05500039	4	4	7	10	20	gG	10	10	CC, J or T*
05500061	6	7	9						
05500100	9	11	15	20			20	20	
06500120	12	13	22	20	40	gG	20	30	CC, J or T*
06500170	17	19	33	32			25		
06500220	22	24	41	40			30		
06500270	26	29	50	50	63		35	50	
06500340	33	37	63				40		
06500430	41	47	76	63			50		
07500530	41	45	75	50	50	gG	50	50	CC, J or T*
07500730	57	62	94	80	80		80	80	
08500860	74	83	121	125	125	gR	100	100	HSJ
08501080	92	104	165	160	160		150	150	
09501250	145	166	190	150	150	gR	150	150	HSJ
09501500	145	166	221	200	200		175	175	
10502000	177	197	266	250	250	gR	250	250	HSJ
11502480	240	265	327	400	400	gR	400	400	HSJ
11502880	285	310	395						
11503150	313	338	473						

Table 12-17 AC Input current and fuse ratings (690 V)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse rating					
				IEC			UL / USA		
				Nominal	Maximum	Class	Nominal	Maximum	Class
	A	A	A	A	A		A	A	
07600230	18	20	32	25	50	gG	25	50	CC, J or T*
07600300	23	26	41	32			30		
07600360	28	31	49	40			35		
07600460	36	39	65	50			50		
07600520	40	44	75		80			80	
07600730	57	62	92	80			80		
08600860	74	83	121	125	125	gR	100	100	HSJ
08601080	92	104	165	160	160		150	150	
09601250	124	149	194	150	150	gR	150	150	HSJ
09601550	145	171	226	200	200		200	200	
10601720	180	202	268	225	225	gR	250	250	HSJ
10601970	202	225	313	250	250	gR	250	250	
11602250	225	256	379	400	400	gR	400	400	HSJ
11602750	217	302	425						
11603050	298	329	465						

* These fuses are fast acting.

NOTE

Ensure cables used suit local wiring regulations.

CAUTION

The following nominal cable sizes are only a guide. The mounting and grouping of cables affects their current-carrying capacity, in some cases smaller cables may be acceptable but in other cases a larger cable is required to avoid excessive temperature or voltage drop. Refer to local wiring regulations for the correct size of cables.

Table 12-18 Cable ratings (200V)

Model	Cable size (IEC) mm²						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
03200066	1.5	4	B2	1.5	4	B2	14	10	14	10
03200080										
03200110	4			4			12		12	
03200127										
04200180	6	8	B2	6	8	B2	10	8	10	8
04200250	8			8			8		8	
05200300	10	10	B2	10	10	B2	8	8	8	8
06200500	16	25	B2	16	25	B2	4	3	4	3
06200580	25			25			3		3	
07200750	35	70	B2	35	70	B2	2	1/0	2	1/0
07200940							1		1	
07201170	70			70			1/0		1/0	
08201490	95	2 x 70	B2	95	2 x 70	B2	3/0	2 x 1	3/0	2 x 1
08201800	2 x 70			2 x 70			2 x 1		2 x 1	
09202160	2 x 70	2 x 185	B1	2 x 95	2 x 150	B2	2 x 2/0	2 x 500	2 x 2/0	2 x 350
09202660	2 x 95			2 x 120			2 x 4/0		2 x 4/0	
10203250	2 x 120	2 x 185	B1	2 x 120	2 x 150	C	2 x 250	2 x 500	2 x 250	2 x 350
10203600	2 x 150		C	2 x 120			2 x 300		2 x 300	

Table 12-19 Cable ratings (400 V)

Model	Cable size (IEC) mm²						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
03400034	1.5	4	B2	1.5	4	B2	18	10	18	10
03400045							16		16	
03400062							14		14	
03400077	2.5			2.5						
03400104										
03400123							12		12	
04400185	4	6	B2	4	6	B2	10	8	10	8
04400240	6			6			8		8	
05400300	6	6	B2	6	6	B2	8	8	8	8
06400380	10	25	B2	10	25	B2	6	3	6	3
06400480	16			16			4		4	
06400630	25			25			3		3	
07400790	35	70	B2	35	70	B2	1	1/0	1	1/0
07400940	50			50			2		2	
07401120	70			70			1/0		1/0	
08401550	2 x 50	2 x 70	B2	2 x 50	2 x 70	B2	2 x 1	2 x 1/0	2 x 1	2 x 1/0
08401840	2 x 70			2 x 70			2 x 1/0		2 x 1/0	
09402210	2 x 70	2 x 185	B1	2 x 95	2 x 150	B2	2 x 3/0	2 x 500	2 x 2/0	2 x 350
09402660	2 x 95			2 x 120			2 x 4/0		2 x 4/0	
10403200	2 x 120	2 x 185	C	2 x 120	2 x 150	C	2 x 300	2 x 500	2 x 250	2 x 350
10403610	2 x 150			2 x 150			2 x 350		2 x 300	
11404370	4 x 95		C	2 x 185	2 x 185	C	4 x 3/0		2 x 400	
11404870				2 x 240	2 x 240		4 x 4/0			
11405070										

Table 12-20 Cable ratings (575 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
05500039	0.75	1.5	B2	0.75	1.5	B2	16	16	16	16
05500061	1			1			14		14	
05500100	1.5			1.5			14		14	
06500120	2.5	25	B2	2.5	25	B2	14	3	14	3
06500170	4			4			10		10	
06500220	6			6			10		10	
06500270	10			10			8		8	
06500340							6		6	
06500430	16						6		6	
07500530	16	25	B2	16	25	B2	4	3	4	3
07500730	25			25			3		3	
08500860	35	50	B2	35	50	B2	1	1	1	1
08501080	50			50						
09501250	2 x 70	2 x 185	B2	2 x 35	2 x 150	B2	2 x 1	2 x 500	2 x 3	2 x 350
09501500				2 x 50					2 x 1	
10502000	2 x 70	2 x 185	B2	2 x 70	2 x 150	B2	2 x 2/0	2 x 500	2 x 2/0	2 x 350
11502480	2 x 70		C	2 x 70		C	2 x 3/0			
11502880	2 x 95			2 x 95			2 x 4/0			
11503150	2 x 120			2 x 120			2 x 250			

Table 12-21 Cable ratings (690 V)

Model	Cable size (IEC) mm^2						Cable size (UL) AWG			
	Input			Output			Input		Output	
	Nominal	Maximum	Installation method	Nominal	Maximum	Installation method	Nominal	Maximum	Nominal	Maximum
07600230	10	25	B2	10	25	B2	8	3	8	3
07600300							6		6	
07600360							6		6	
07600460	16			16			4		4	
07600520	16			16			4		4	
07600730	25			25			3		3	
08600860	50	70	B2	50	70	B2	2	1/0	2	1/0
08601080	70			70			1/0		1/0	
09601250	2 x 50	2 x 185	B2	2 x 35	2 x 150	B2	2 x 1	2 x 500	2 x 3	2 x 350
09601550	2 x 70			2 x 50			2 x 1/0		2 x 1	
10601720	2 x 70	2 x 185	B2	2 x 70	2 x 150	B2	2 x 2/0	2 x 500	2 x 1/0	2 x 350
10601970	2 x 95						2 x 3/0		2 x 2/0	
11602250	2 x 70		C	2 x 70		C	2 x 3/0			
11602750	2 x 95			2 x 95			2 x 4/0			
11603050							2 x 250			

12.1.21 Protective ground cable ratings

Table 12-22 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 (an additional ground connection is provided on sizes 3, 4 and 5 for this purpose).
> 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

12.1.22 Maximum motor cable lengths

Table 12-23 Maximum motor cable lengths (200 V drives)

<table>
<tr><th colspan="8">200 V Nominal AC supply voltage</th></tr>
<tr><th rowspan="2">Model</th><th colspan="7">Maximum permissible motor cable length for each of the following switching frequencies</th></tr>
<tr><th>2
kHz</th><th>3
kHz</th><th>4
kHz</th><th>6
kHz</th><th>8
kHz</th><th>12
kHz</th><th>16
kHz</th></tr>
<tr><td>03200066</td><td colspan="5">65 m (210 ft)</td><td rowspan="4">50 m (165 ft)</td><td rowspan="4">37 m (120 ft)</td></tr>
<tr><td>03200080</td><td colspan="4">100 m (330 ft)</td><td rowspan="3">75 m (245 ft)</td></tr>
<tr><td>03200110</td><td colspan="3">130 m (425 ft)</td><td rowspan="2">100 m (330 ft)</td></tr>
<tr><td>03200127</td><td colspan="2">200 m (660 ft)</td><td>150 m (490 ft)</td></tr>
<tr><td>04200180</td><td colspan="2" rowspan="2">200 m (660 ft)</td><td rowspan="2">150 m (490 ft)</td><td rowspan="2">100 m (330 ft)</td><td rowspan="2">75 m (245 ft)</td><td rowspan="2">50 m (165 ft)</td><td rowspan="2">37 m (120 ft)</td></tr>
<tr><td>04200250</td></tr>
<tr><td>05200300</td><td colspan="2">200 m (660 ft)</td><td>150 m (490 ft)</td><td>100 m (330 ft)</td><td>75 m (245 ft)</td><td>50 m (165 ft)</td><td>37 m (120 ft)</td></tr>
<tr><td>06200500</td><td colspan="2" rowspan="2">200 m (660 ft)</td><td rowspan="2">150 m (490 ft)</td><td rowspan="2">100 m (330 ft)</td><td rowspan="2">75 m (245 ft)</td><td rowspan="2">50 m (165 ft)</td><td rowspan="2">37 m (120 ft)</td></tr>
<tr><td>06200580</td></tr>
<tr><td>07200750</td><td colspan="2" rowspan="3">250 m (820 ft)</td><td rowspan="3">187 m (614 ft)</td><td rowspan="3">125 m (410 ft)</td><td rowspan="3">93 m (305 ft)</td><td rowspan="3">62 m (203 ft)</td><td rowspan="3">46 m (151 ft)</td></tr>
<tr><td>07200940</td></tr>
<tr><td>07201170</td></tr>
<tr><td>08201490</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>08201800</td></tr>
<tr><td>09202160</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>09202660</td></tr>
<tr><td>10203250</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>10203600</td></tr>
</table>

Table 12-24 Maximum motor cable lengths (400 V drives)

<table>
<tr><th colspan="8">400 V Nominal AC supply voltage</th></tr>
<tr><th rowspan="2">Model</th><th colspan="7">Maximum permissible motor cable length for each of the following switching frequencies</th></tr>
<tr><th>2
kHz</th><th>3
kHz</th><th>4
kHz</th><th>6
kHz</th><th>8
kHz</th><th>12
kHz</th><th>16
kHz</th></tr>
<tr><td>03400034</td><td colspan="5">65 m (210 ft)</td><td rowspan="6">50 m (165 ft)</td><td rowspan="6">37 m (120 ft)</td></tr>
<tr><td>03400045</td><td colspan="4">100 m (330 ft)</td><td rowspan="5">75 m (245 ft)</td></tr>
<tr><td>03400062</td><td colspan="3">130 m (425 ft)</td><td rowspan="4">100 m (330 ft)</td></tr>
<tr><td>03400077</td><td colspan="2" rowspan="3">200 m (660 ft)</td><td rowspan="3">150 m (490 ft)</td></tr>
<tr><td>03400104</td></tr>
<tr><td>03400123</td></tr>
<tr><td>04400185</td><td colspan="2" rowspan="2">200 m (660 ft)</td><td rowspan="2">150 m (490 ft)</td><td rowspan="2">100 m (330 ft)</td><td rowspan="2">75 m (245 ft)</td><td rowspan="2">50 m (165 ft)</td><td rowspan="2">37 m (120 ft)</td></tr>
<tr><td>04400240</td></tr>
<tr><td>05400300</td><td colspan="2">200 m (660 ft)</td><td>150 m (490 ft)</td><td>100 m (330 ft)</td><td>75 m (245 ft)</td><td>50 m (165 ft)</td><td>37 m (120 ft)</td></tr>
<tr><td>06400380</td><td colspan="2" rowspan="3">200 m (660 ft)</td><td rowspan="3">150 m (490 ft)</td><td rowspan="3">100 m (330 ft)</td><td rowspan="3">75 m (245 ft)</td><td rowspan="3">50 m (165 ft)</td><td rowspan="3">37 m (120 ft)</td></tr>
<tr><td>06400480</td></tr>
<tr><td>06400630</td></tr>
<tr><td>07400790</td><td colspan="2" rowspan="3">250 m (820 ft)</td><td rowspan="3">187 m (614 ft)</td><td rowspan="3">125 m (410 ft)</td><td rowspan="3">93 m (305 ft)</td><td rowspan="3">62 m (203 ft)</td><td rowspan="3">46 m (151 ft)</td></tr>
<tr><td>07400940</td></tr>
<tr><td>07401120</td></tr>
<tr><td>08401550</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>08401840</td></tr>
<tr><td>09402210</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>09402660</td></tr>
<tr><td>10403200</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>10403610</td></tr>
<tr><td>11404370</td><td colspan="2" rowspan="3">250 m (820 ft)</td><td rowspan="3">187 m (614 ft)</td><td rowspan="3">125 m (410 ft)</td><td rowspan="3">93 m (305 ft)</td><td></td><td></td></tr>
<tr><td>11404870</td><td></td><td></td></tr>
<tr><td>11405070</td><td></td><td></td></tr>
</table>

Table 12-25 Maximum motor cable lengths (575 V drives)

<table>
<tr><th colspan="8">575 V Nominal AC supply voltage</th></tr>
<tr><th rowspan="2">Model</th><th colspan="7">Maximum permissible motor cable length for each of the following switching frequencies</th></tr>
<tr><th>2
kHz</th><th>3
kHz</th><th>4
kHz</th><th>6
kHz</th><th>8
kHz</th><th>12
kHz</th><th>16
kHz</th></tr>
<tr><td>05500039</td><td colspan="2" rowspan="3">200 m (660 ft)</td><td rowspan="3">150 m (490 ft)</td><td rowspan="3">100 m (330 ft)</td><td rowspan="3">75 m (245 ft)</td><td rowspan="3">50 m (165 ft)</td><td rowspan="3">37 m (120 ft)</td></tr>
<tr><td>05500061</td></tr>
<tr><td>05500100</td></tr>
<tr><td>06500120</td><td colspan="2" rowspan="6">200 m (660 ft)</td><td rowspan="6">150 m (490 ft)</td><td rowspan="6">100 m (330 ft)</td><td rowspan="6">75 m (245 ft)</td><td rowspan="6">50 m (165 ft)</td><td rowspan="6">37 m (120 ft)</td></tr>
<tr><td>06500170</td></tr>
<tr><td>06500220</td></tr>
<tr><td>06500270</td></tr>
<tr><td>06500340</td></tr>
<tr><td>06500430</td></tr>
<tr><td>07500530</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>07500730</td></tr>
<tr><td>08500860</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>08501080</td></tr>
<tr><td>09501250</td><td colspan="2" rowspan="2">250 m (820 ft)</td><td rowspan="2">187 m (614 ft)</td><td rowspan="2">125 m (410 ft)</td><td rowspan="2">93 m (305 ft)</td><td rowspan="2">62 m (203 ft)</td><td rowspan="2">46 m (151 ft)</td></tr>
<tr><td>09501500</td></tr>
<tr><td>10502000</td><td colspan="2">250 m (820 ft)</td><td>187 m (614 ft)</td><td>125 m (410 ft)</td><td>93 m (305 ft)</td><td>62 m (203 ft)</td><td>46 m (151 ft)</td></tr>
<tr><td>11502480</td><td colspan="2" rowspan="3">250 m (820 ft)</td><td rowspan="3">187 m (614 ft)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11502880</td><td></td><td></td><td></td><td></td></tr>
<tr><td>11503150</td><td></td><td></td><td></td><td></td></tr>
</table>

Table 12-26 Maximum motor cable lengths (690 V drives)

690 V Nominal AC supply voltage							
Model	Maximum permissible motor cable length for each of the following switching frequencies						
	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
07600230	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
07600300							
07600360							
07600460							
07600520							
07600730							
08600860	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
08601080							
09601250	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
09601550							
10601720	250 m (820 ft)		187 m (614 ft)	125 m (410 ft)	93 m (305 ft)	62 m (203 ft)	46 m (151 ft)
10601970							
11602250	250 m (820 ft)		187 m (614 ft)				
11602750							
11603050							

- Cable lengths in excess of the specified values may be used only when special techniques are adopted; refer to the supplier of the drive.
- The default switching frequency is 3 kHz for Open-loop and RFC-A and 6 kHz for RFC-S mode.

The maximum cable length is reduced from that shown in Table 12-25 and Table 12-26 if high capacitance or reduced diameter motor cables are used. For further information, refer to section 4.9.2 *High-capacitance / reduced diameter cables* on page 93.

12.1.23 Torque settings

Table 12-27 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 12-28 Drive power terminal data

H300 frame size	AC and motor terminals		DC terminals		Ground terminals	
	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)

Table 12-29 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	11 way control connectors	1.5 mm^2 (16 AWG)
	2 way relay connector	2.5 mm^2 (12 AWG)
3	6 way AC power connector	6 mm^2 (10 AWG)
4		
5	3 way AC power connector 3 way motor connector	8 mm^2 (8 AWG)
6	2 way low voltage power 24 V supply connector	1.5 mm^2 (16 AWG)
7		
8		
9A/9E		
10E/11E		

12.1.24 Electromagnetic compatibility (EMC)

This is a summary of the EMC performance of the drive. For full details, refer to the *EMC Data Sheet* which can be obtained from the supplier of the drive.

Table 12-30 Immunity compliance

Standard	Type of immunity	Test specification	Application	Level
IEC61000-4-2 EN61000-4-2	Electrostatic discharge	6 kV contact discharge 8 kV air discharge	Module enclosure	Level 3 (industrial)
IEC61000-4-3 EN61000-4-3	Radio frequency radiated field	10 V/m prior to modulation 80 - 1000 MHz 80 % AM (1 kHz) modulation	Module enclosure	Level 3 (industrial)
IEC61000-4-4 EN61000-4-4	Fast transient burst	5/50 ns 2 kV transient at 5 kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50 ns 2 kV transient at 5 kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC61000-4-5 EN61000-4-5	Surges	Common mode 4 kV 1.2/50 µs waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2 kV 1.2/50 µs waveshape	AC supply lines: line to line	Level 3
		Lines to ground	Signal ports to ground [1]	Level 2
IEC61000-4-6 EN61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80 MHz 80 % AM (1 kHz) modulation	Control and power lines	Level 3 (industrial)
IEC61000-4-11 EN61000-4-11	Voltage dips and interruptions	-30 % 10 ms +60 % 100 ms -60 % 1 s <-95 % 5 s	AC power ports	
IEC61000-6-1 EN61000-6-1:2007	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
IEC61000-6-2 EN61000-6-2:2005	Generic immunity standard for the industrial environment			Complies
IEC61800-3 EN61800-3:2004	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

[1] See section 4.11.7 *Variations in the EMC wiring* on page 102 for control ports for possible requirements regarding grounding and external surge protection

Emission

The drive contains an in-built filter for basic emission control. An additional optional external filter provides further reduction of emission. The requirements of the following standards are met, depending on the motor cable length and switching frequency.

Table 12-31 Size 3 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	3	4	6	8	12	16
Using internal filter:							
0 – 2	C3			C4			
Using internal filter and ferrite ring (2 turns):							
0 – 10	C3				C4		
10-20	C3			C4			
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-32 Size 3 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	3	4	6	8	12	16
Using internal filter:							
0 – 5	C3			C4			
Using internal filter and ferrite ring (2 turns):							
0 – 10	C3					C4	
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-33 Size 4 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	3	4	6	8	12	16
Using internal filter:							
0 – 2	C3				C4		
Using internal filter and ferrite ring (2 turns):							
0 – 4	C3		C4				
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-34 Size 4 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	3	4	6	8	12	16
Using internal filter:							
0 – 4	C3			C4			
Using internal filter and ferrite ring (2 turns):							
0 – 10	C3		C4				
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-35 Size 5 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	3	4	6	8	12	16
Using internal filter:							
0 – 2	C3		C4				
Using internal filter and ferrite ring (1 turn – no advantage to 2 turns):							
0 – 2	C3					C4	
0 – 5	C3			C4			
0 – 7	C3		C4				
0 – 10	C3	C4					
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-36 Size 5 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 4	C3			C4			
0 – 10	C3	C4					
No advantage to using ferrite ring							
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-37 Size 5 emission compliance (575 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
-	C4						
Using internal filter and ferrite ring (2 turns):							
0 – 4	C3			C4			
0 – 2	C3					C4	
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-38 Size 6 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 2	C3		C4				
Using internal filter and ferrite ring (1 turn – no advantage to 2 turns):							
0 – 2	C3					C4	
0 – 5	C3			C4			
0 – 7	C3		C4				
0 – 10	C3	C4					
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-39 Size 6 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 4	C3			C4			
0 – 10	C3	C4					
No advantage to using ferrite ring							
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-40 Size 6 emission compliance (575 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
-	C4						
Using internal filter and ferrite ring (2 turns):							
0 – 4	C3			C4			
0 – 2	C3					C4	
Using external filter:							
0 – 20	C1	C1	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-41 Size 7 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 100	C4	C4	C4	C4	C4	C4	C4
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-42 Size 7 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 100	C4	C4	C4	C4	C4	C4	C4
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-43 Size 7 emission compliance (575 and 690 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 100	C4	C4	C4	C4	C4	C4	C4
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-44 Size 8 emission compliance (200 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 10	C3	C3	C3	C3	C3	C3	C3
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-45 Size 8 emission compliance (400 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 10	C3	C3	C3	C3	C3	C3	C3
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-46 Size 8 emission compliance (575 V and 690 V drives)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 100	C4	C4	C4	C4	C4	C4	C4
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-47 Size 9E and 10E emission compliance (all voltages)

Motor cable length (m)	Switching Frequency (kHz)						
	2	**3**	**4**	**6**	**8**	**12**	**16**
Using internal filter:							
0 – 100	C3	C3	C3	C3	C3	C3	C3
Using external filter:							
0 – 20	C2	C2	C2	C2	C2	C2	C2
20 – 100	C2	C2	C3	C3	C3	C3	C3

Table 12-48 Size 11 emission compliance (all voltages)

Motor cable length (m)	Switching Frequency (kHz)				
	2	**3**	**4**	**6**	**8**
Using internal filter:					
0 – 50	C3	C3	C3	C3	C3
100	C3	C3	C3	C3	C4
Using external filter:					
20	C2	C2	C2	C2	C2
100	C2	C2	C3	C3	C3

Key (shown in decreasing order of permitted emission level):

E2R	EN 61800-3 second environment, restricted distribution (Additional measures may be required to prevent interference)
E2U	EN 61800-3 second environment, unrestricted distribution
I	Industrial generic standard EN 61000-6-4 EN 61800-3 first environment restricted distribution (The following caution is required by EN 61800-3)

CAUTION

This is a product of the restricted distribution class according to IEC 61800-3. In a residential environment this product may cause radio interference in which case the user may be required to take adequate measures.

R	Residential generic standard EN 61000-6-3 EN 61800-3 first environment unrestricted distribution

EN 61800-3 defines the following:

- The first environment is one that includes residential premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes.
- The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes.
- Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

EN 61800-3:2004+A1:2012

The 2004 revision of the standard uses different terminology to align the requirements of the standard better with the EC EMC Directive.

Power drive systems are categorized C1 to C4:

Category	Definition	Corresponding code used above
C1	Intended for use in the first or second environments	R
C2	Not a plug-in or movable device, and intended for use in the first environment only when installed by a professional, or in the second environment	I
C3	Intended for use in the second environment, not the first environment	E2U
C4	Intended for use in the second environment in a system rated at over 400 A, or in a complex system	E2R

Note that category 4 is more restrictive than E2R, since the rated current of the PDS must exceed 400 A or the supply voltage exceed 1000 V, for the complete PDS.

12.2 Optional external EMC filters

Table 12-49 EMC filter cross reference

Model	CT part number
200 V	
03200066 to 03200127	4200-3230
04200180 to 04200250	4200-0272
05200300	4200-0312
06200500 to 06200580	4200-2300
07200750 to 07201170	4200-1132
08201490 to 08201800	4200-1972
09202160 to 09202660 (9A)	4200-3021
09202160 to 09202660 (9E)	4200-4460
10203250 to 10203600	4200-4460
400 V	
03400034 to 03400123	4200-3480
04400185 to 04400240	4200-0252
05400300	4200-0402
06400380 to 06400630	4200-4800
07400790 to 07401120	4200-1132
08401550 to 08401840	4200-1972
09402210 to 09402660 (9A)	4200-3021
09402210 to 09402660 (9E)	4200-4460
10403200 to 10403610	4200-4460
11404370 to 11405070	4200-0400
575 V	
05500039 to 05500100	4200-0122
06500120 to 06500430	4200-3690
07500530 to 07500730	4200-0672
08500860 to 08501080	4200-1662
09501250 to 09501500 (9A)	4200-1660
09501250 to 09501500 (9E)	4200-2210
10502000	4200-2210
11502480 to 11503150	4200-0690
690 V	
07600230 to 07600730	4200-0672
08600860 to 08601080	4200-1662
09601250 to 09601550 (9A)	4200-1660
09601250 to 09601550 (9E)	4200-2210
10601720 to 10601970	4200-2210
11602250 to 11603050	4200-0690

12.2.1 EMC filter ratings

Table 12-50 Optional external EMC filter details

CT part number	Maximum continuous current		Voltage rating		IP rating	Power dissipation at rated current		Ground leakage		Discharge resistors
	@ 40 °C (104 °F)	@ 50 °C (122 °F)	IEC	UL		@ 40 °C (104 °F)	@ 50 °C (122 °F)	Balanced supply phase-to-phase and phase-to-ground	Worst case	
	A	A	V	V		W	W	mA	mA	MΩ
4200-3230	20	18.5	250	300	20	20	17	2.4	60	1.68
4200-0272	27	24.8	250	300		33	28	6.8	137	
4200-0312	31	28.5	250	300		20	17	2.0	80	
4200-2300	55	51	250	300		41	35	4.2	69	
4200-3480	16	15	528	600		13	11	10.7	151	
4200-0252	25	23	528	600		28	24	11.1	182	
4200-0402	40	36.8	528	600		47	40	18.7	197	
4200-4800	63	58	528	600		54	46	11.2	183	
4200-0122	12	11	760	600						
4200-3690	42	39	760	600		45	39	12	234	

12.2.2 Overall EMC filter dimensions

Table 12-51 Optional external EMC filter dimensions

CT part number	Dimension (mm)						Weight	
	H		W		D			
	mm	inch	mm	inch	mm	inch	kg	lb
4200-3230	426	16.77	83	3.27	41	1.61	1.9	4.20
4200-0272	437	17.20	123	4.84	60	2.36	4.0	8.82
4200-0312	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-2300	434	17.09	210	8.27	60	2.36	6.5	14.30
4200-3480	426	16.77	83	3.27	41	1.61	2.0	4.40
4200-0252	437	17.20	123	4.84	60	2.36	4.1	9.04
4200-0402	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-4800	434	17.09	210	8.27	60	2.36	6.7	14.80
4200-0122	437	17.20	143	5.63	60	2.36	5.5	12.13
4200-3690	434	17.09	210	8.27	60	2.36	7.0	15.40
4200-1132	270	10.63	90	3.54	205	5.9	6.0	13.20
4200-0672	270	10.63	90	3.54	205	5.9	6.2	13.70
4200-1972	300	11.81	120	4.72	170	6.69	9.6	21.10
4200-1662	270	10.63	90	3.54	205	8.07	9.4	20.70
4200-3021	339	13.34	230	9.06	120	4.72	11	24.25
4200-4460	105	4.13	360	14.2	245	9.65	12	26.50
4200-0400	135	5.32	386	15.2	260	10.2	14.7	32.41
4200-1660	360	14.7	245	9.65	105	4.13	5.2	11.46
4200-2210	105	4.13	360	14.2	245	9.65	10.3	22.71
4200-0690	135	5.32	386	15.2	260	10.2	16.75	36.90

12.2.3 EMC filter torque settings

Table 12-52 Optional external EMC Filter terminal data

CT part number	Power connections			Ground connections	
	Bar hole diameter	Max cable size	Max torque	Ground stud size	Max torque
4200-1132	N/A	50 mm^2 (1/0 AWG)	8.0 N m (6.0lb ft)	M10	18 N m (13.3 lb ft)
4200-0672					
4200-1972		95 mm^2 (3/0 AWG)	20 N m (14.8 lb ft)		
4200-1662					
4200-0122		16 mm^2 (6 AWG)	2.3 N m (1.7 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-0252			1.8 N m (1.4 lb ft)		
4200-0272					
4200-0312					
4200-0402					
4200-3230		4 mm^2 (12 AWG)	0.8 N m (0.59 lb ft)	M5	3.0 N m (2.2 lb ft)
4200-3480		4 mm^2 (12 AWG)	0.8 N m (0.59 lb ft)	M5	
4200-2300		16 mm^2 (6 AWG)	2.3 N m (1.70 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-4800					
4200-3690					
4200-3021	10.8 mm	N/A	30 N m (22.1 lb ft)	M10	18 N m (13.3 lb ft)
4200-4460	11 mm				
4200-1660	10.8 mm				
4200-2210	11 mm				
4200-0400	10.5 mm			M12	25 N m (18.4 lb ft)
4200-0690	10.5 mm				

13 Diagnostics

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

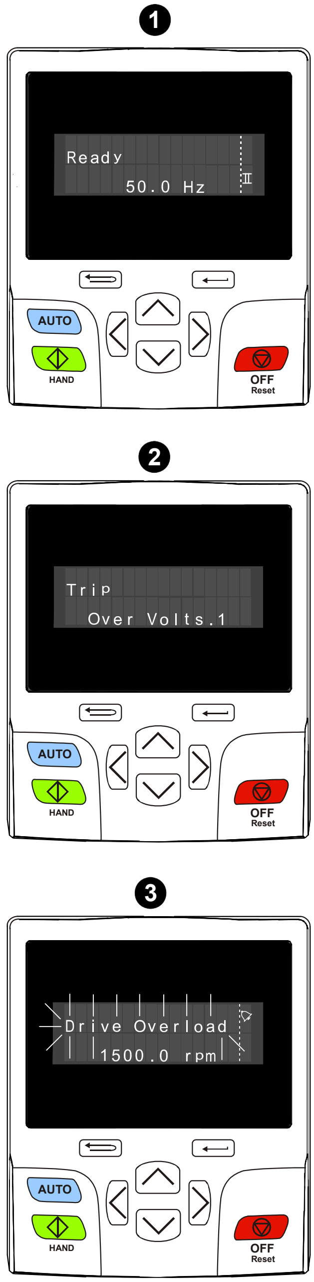
- Trip indications
- Alarm indications
- Status indications

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.

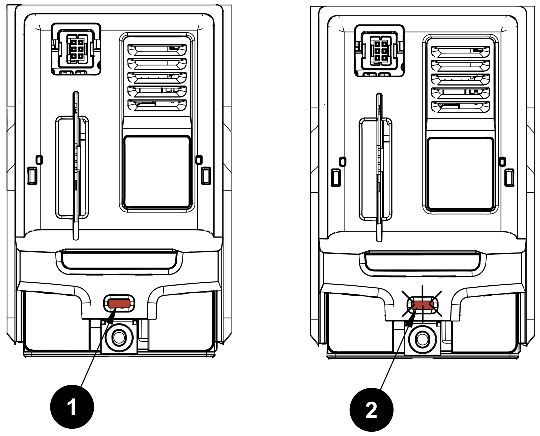
13.1 Status modes (Keypad and LED status)

Figure 13-1 Keypad status modes



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

Figure 13-2 Location of the status LED



1. Non flashing: Normal status
2. Flashing: Trip status

13.2 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.

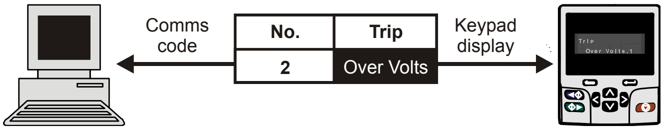
During a trip condition, where a KI-Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip 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-Keypad display will also flash during a trip condition. If a display is not being used, the drive LED Status indicator will flash with 0.5 s duty cycle if the drive has tripped. Refer to Figure 13-2.

Trips are listed alphabetically in Table 13-3 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr **10.001** 'Drive Heathy' using communication protocols. The most recent trip can be read in Pr **10.020** 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 13-4 to identify the specific trip.

Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 13-3 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 13-3.
4. Perform checks detailed under *Diagnosis*.

13.3 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 13-1 is in the form xxyzz and used to identify the source of the trip.

Table 13-1 Trips associated with xxyzz sub-trip number

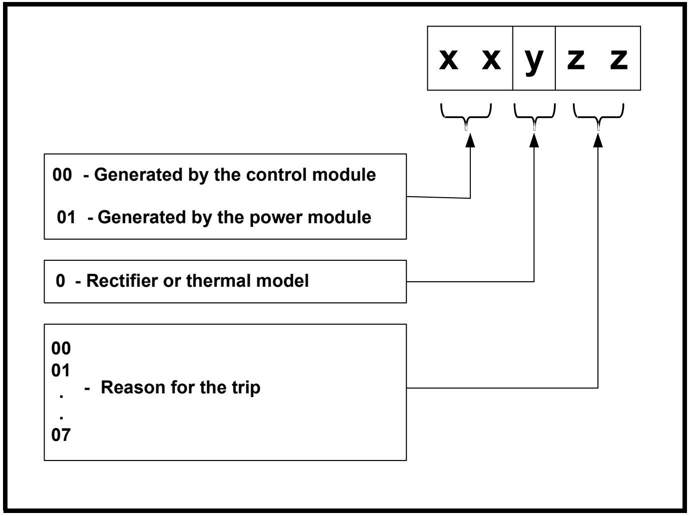
Over Volts	OHt dc bus
OI ac	Phase Loss
OI Brake	Power Comms
PSU	OI Snubber
OHt Inverter	Temp Feedback
OHt Power	Power Data
OHt Control	

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 13-3 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 13-2 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 13-2 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

13.4 Trips, Sub-trip numbers

Table 13-3 Trip indications

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>An Input 1 Loss</td><td>Analog input 1 current loss</td></tr>
<tr><td>28</td><td><i>An Input 1 Loss</i> 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 <i>Analog Input 1 Mode</i> (07.007)
• Current signal is present and greater than 3 mA</td></tr>
<tr><td>An Input 2 Loss</td><td>Analog input 2 current loss</td></tr>
<tr><td>29</td><td><i>An Input 2 Loss</i> 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 <i>Analog Input 2 Mode</i> (07.011)
• Current signal is present and greater than 3 mA</td></tr>
<tr><td>An Output Calib</td><td>Analog output calibration failed</td></tr>
<tr><td>219</td><td>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</td></tr>
<tr><td>App Menu Changed</td><td>Customization table for an application module has changed</td></tr>
<tr><td>217</td><td>The <i>App Menu Changed</i> 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</td></tr>
<tr><td>Autotune 1</td><td>Position feedback did not change or required speed could not be reached</td></tr>
<tr><td>11</td><td>The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The position feedback did not change when position feedback is being used during rotating autotune.</td></tr>
<tr><td>2</td><td>The motor did not reach the required speed during rotating autotune or mechanical load measurement.</td></tr>
</table>
Recommended actions:
• Ensure the motor is free to turn i.e. mechanical brake was released
• Ensure Pr 03.026 is set correctly (or appropriate 2^{nd} motor map parameter)
• Check feedback device wiring is correct
• Check encoder mechanical coupling to the motor</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Autotune 2</td><td>Position feedback direction incorrect</td></tr>
<tr><td>12</td><td>The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The position feedback direction is incorrect when position feedback is being used during a rotating autotune</td></tr>
<tr><td>2</td><td>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.</td></tr>
</table>
Recommended actions:

Check motor cable wiring is correct
Check feedback device wiring is correct
Swap any two motor phases
</td></tr>
<tr><td>Autotune 3</td><td>Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction</td></tr>
<tr><td>13</td><td>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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Measured inertia has exceeded the parameter range during a mechanical load measurement</td></tr>
<tr><td>2</td><td>The commutation signals changed in the wrong direction during a rotating autotune</td></tr>
<tr><td>3</td><td>The mechanical load test has been unable to identify the motor inertia</td></tr>
</table>
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.
</td></tr>
<tr><td>Autotune 7</td><td>Motor number of poles / position feedback resolution set incorrectly</td></tr>
<tr><td>17</td><td>An <i>Autotune 7</i> 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
</td></tr>
<tr><td>Autotune Stopped</td><td>Autotune test stopped before completion</td></tr>
<tr><td>18</td><td>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
</td></tr>
<tr><td>Brake R Too Hot</td><td>Braking resistor overload timed out (I^2t)</td></tr>
<tr><td>19</td><td>The <i>Brake R Too Hot</i> indicates that braking resistor overload has timed out. The value in <i>Braking Resistor Thermal Accumulator</i> (10.039) is calculated using <i>Braking Resistor Rated Power</i> (10.030), <i>Braking Resistor Thermal Time Constant</i> (10.031) and <i>Braking Resistor Resistance</i> (10.061). The <i>Brake R Too Hot</i> trip is initiated when <i>Braking Resistor Thermal Accumulator</i> (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.
</td></tr>
<tr><td>Card Access</td><td>NV Media Card Write fail</td></tr>
<tr><td>185</td><td>The <i>Card Access</i> 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
</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Card Boot</td><td>The Menu 0 parameter modification cannot be saved to the NV Media Card</td></tr>
<tr><td>177</td><td>Menu 0 changes are automatically saved on exiting edit mode.
The <i>Card Boot</i> 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</td></tr>
<tr><td>Card Busy</td><td>NV Media Card cannot be accessed as it is being accessed by an option module</td></tr>
<tr><td>178</td><td>The <i>Card Busy</i> 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</td></tr>
<tr><td>Card Compare</td><td>NV Media Card file/data is different to the one in the drive</td></tr>
<tr><td>188</td><td>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.</td></tr>
<tr><td>Card Data Exists</td><td>NV Media Card data location already contains data</td></tr>
<tr><td>179</td><td>The <i>Card Data Exists</i> 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</td></tr>
<tr><td>Card Drive Mode</td><td>NV Media Card parameter set not compatible with current drive mode</td></tr>
<tr><td>187</td><td>The <i>Card Drive Mode</i> 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</td></tr>
<tr><td>Card Error</td><td>NV Media Card data structure error</td></tr>
<tr><td>182</td><td>The <i>Card Error</i> 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:
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The required folder and file structure is not present</td></tr>
<tr><td>2</td><td>The <000> file is corrupted.</td></tr>
<tr><td>3</td><td>Two or more files in the <MCDF\> folder have the same file identification number.</td></tr>
</table>
Recommended actions:
• Erase all the data block and re-attempt the process
• Ensure the card is located correctly
• Replace the NV Media Card</td></tr>
<tr><td>Card Full</td><td>NV Media Card full</td></tr>
<tr><td>184</td><td>The <i>Card Full</i> 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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>**Card No Data**</td><td>**NV Media Card data not found**</td></tr>
<tr><td>**183**</td><td>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</td></tr>
<tr><td>**Card Option**</td><td>**NV Media Card trip; option modules installed are different between source drive and destination drive**</td></tr>
<tr><td>**180**</td><td>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.</td></tr>
<tr><td>**Card Product**</td><td>**NV Media Card data blocks are not compatible with the drive derivative**</td></tr>
<tr><td>**175**</td><td>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:
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>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).</td></tr>
<tr><td>2</td><td>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.</td></tr>
<tr><td>3</td><td>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).</td></tr>
</table>
Recommended actions:
• Use a different NV Media Card
• This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive</td></tr>
<tr><td>**Card Rating**</td><td>**NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different**</td></tr>
<tr><td>**186**</td><td>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.</td></tr>
<tr><td>**Card Read Only**</td><td>**NV Media Card has the Read Only bit set**</td></tr>
<tr><td>**181**</td><td>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.</td></tr>
<tr><td>**Card Slot**</td><td>**NV Media Card Trip; Option module application program transfer has failed**</td></tr>
<tr><td>**174**</td><td>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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Configuration</td><td>The number of power modules installed is different from the modules expected</td></tr>
<tr><td>111</td><td>The <i>Configuration</i> trip indicates that the <i>Number Of Power Modules Detected</i> (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 <i>Number Of Rectifiers Expected</i> (11.096) is correct.</td></tr>
<tr><td>Control Word</td><td>Trip initiated from the <i>Control Word</i> (06.042)</td></tr>
<tr><td>35</td><td>The <i>Control Word</i> 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 <i>Control Word Enable</i> (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</td></tr>
<tr><td>Current Offset</td><td>Current feedback offset error</td></tr>
<tr><td>225</td><td>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</td></tr>
<tr><td>Data Changing</td><td>Drive parameters are being changed</td></tr>
<tr><td>97</td><td>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. <i>Drive Active</i> (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</td></tr>
<tr><td>Derivative ID</td><td>There is a problem with the identifier associated with derivative image which customizes the drive.</td></tr>
<tr><td>247</td><td>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>
</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Derivative Image</td><td>Derivative Image error</td></tr>
<tr><td>248</td><td>The <i>Derivative Image</i> trip indicates that an error has been detected in the derivative image. The sub-trip number indicates the reason for the trip.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Comments</th></tr>
<tr><td>1 to 52</td><td>An error has been detected in the derivative image, contact the supplier of the drive.</td><td></td></tr>
<tr><td>61</td><td>The option module fitted in slot 1 is not allowed with the derivative image</td><td rowspan="4">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td></tr>
<tr><td>62</td><td>The option module fitted in slot 2 is not allowed with the derivative image</td></tr>
<tr><td>63</td><td>The option module fitted in slot 3 is not allowed with the derivative image</td></tr>
<tr><td>64</td><td>The option module fitted in slot 4 is not allowed with the derivative image</td></tr>
<tr><td>70</td><td>An option module that is required by the derivative image is not fitted in any slot</td><td rowspan="5">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td></tr>
<tr><td>71</td><td>An option module specifically required to be fitted in slot 1 not present</td></tr>
<tr><td>72</td><td>An option module specifically required to be fitted in slot 2 not present</td></tr>
<tr><td>73</td><td>An option module specifically required to be fitted in slot 3 not present</td></tr>
<tr><td>74</td><td>An option module specifically required to be fitted in slot 4 not present</td></tr>
<tr><td>80 to 81</td><td>An error has been detected in the derivative image, contact the supplier of the drive.</td><td></td></tr>
</table>
Recommended action:
Contact the supplier of the drive</td></tr>
<tr><td>Destination</td><td>Two or more parameters are writing to the same destination parameter</td></tr>
<tr><td>199</td><td>The <i>Destination</i> 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</td></tr>
<tr><td>Drive Size</td><td>Power stage recognition: Unrecognized drive size</td></tr>
<tr><td>224</td><td>The <i>Drive Size</i> 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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>**EEPROM Fail**</td><td>**Default parameters have been loaded**</td></tr>
<tr><td>**31**</td><td>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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The most significant digit of the internal parameter database version number has changed</td></tr>
<tr><td>2</td><td>The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded</td></tr>
<tr><td>3</td><td>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</td></tr>
<tr><td>4</td><td>The drive derivative image has changed</td></tr>
<tr><td>5</td><td>The power stage hardware has changed</td></tr>
<tr><td>6</td><td>The internal I/O hardware has changed</td></tr>
<tr><td>7</td><td>The position feedback interface hardware has changed</td></tr>
<tr><td>8</td><td>The control board hardware has changed</td></tr>
<tr><td>9</td><td>The checksum on the non-parameter area of the EEPROM has failed</td></tr>
</table>
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</td></tr>
<tr><td>**Encoder 9**</td><td>**Position feedback is selected from a option module slot which does not have a feedback option module installed**</td></tr>
<tr><td>**197**</td><td>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</td></tr>
<tr><td>**External Trip**</td><td>**An External trip is initiated**</td></tr>
<tr><td>**6**</td><td>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**.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>*External Trip Mode* (08.010) = 1 or 3 and Safe Torque Off input 1 is low</td></tr>
<tr><td>2</td><td>*External Trip Mode* (08.010) = 2 or 3 and Safe Torque Off input 2 is low</td></tr>
<tr><td>3</td><td>*External Trip* (10.032) = 1</td></tr>
</table>
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</td></tr>
<tr><td>**HF01**</td><td>**Data processing error: CPU address error**</td></tr>
<tr><td></td><td>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</td></tr>
</table>

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
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
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
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
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
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

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>HF12</td><td>Data processing error: Main program stack overflow</td></tr>
<tr><td></td><td>The <i>HF12</i> 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.
<table>
<tr><th>Sub-trip</th><th>Stack</th></tr>
<tr><td>1</td><td>Background tasks</td></tr>
<tr><td>2</td><td>Timed tasks</td></tr>
<tr><td>3</td><td>Main system interrupts</td></tr>
</table>
Recommended actions:
Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF13</td><td>Data processing error: Firmware incompatible with hardware</td></tr>
<tr><td></td><td>The <i>HF13</i> 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</td></tr>
<tr><td>HF14</td><td>Data processing error: CPU register bank error</td></tr>
<tr><td></td><td>The <i>HF14</i> 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</td></tr>
<tr><td>HF15</td><td>Data processing error: CPU divide error</td></tr>
<tr><td></td><td>The <i>HF15</i> 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</td></tr>
<tr><td>HF16</td><td>Data processing error: RTOS error</td></tr>
<tr><td></td><td>The <i>HF16</i> 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</td></tr>
<tr><td>HF17</td><td>Data processing error: Clock supplied to the control board is out of specification</td></tr>
<tr><td></td><td>The <i>HF17</i> 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</td></tr>
<tr><td>HF18</td><td>Data processing error: Internal flash memory has failed</td></tr>
<tr><td></td><td>The <i>HF18</i> 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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Option module initialization timed out</td></tr>
<tr><td>2</td><td>Programming error while writing menu in flash</td></tr>
<tr><td>3</td><td>Erase flash block containing setup menus failed</td></tr>
<tr><td>4</td><td>Erase flash block containing application menus failed</td></tr>
<tr><td>5</td><td>Incorrect setup menu CRC contained in flash</td></tr>
<tr><td>6</td><td>Incorrect application menu CRC contained in flash</td></tr>
<tr><td>7</td><td>Incorrect common application menu 18 CRC contained in flash</td></tr>
<tr><td>8</td><td>Incorrect common application menu 19 CRC contained in flash</td></tr>
<tr><td>9</td><td>Incorrect common application menu 20 CRC contained in flash</td></tr>
</table>
Recommended actions:
Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>HF19</td><td>Data processing error: CRC check on the firmware has failed</td></tr>
<tr><td></td><td>The <i>HF19</i> 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</td></tr>
</table>

Trip | **Diagnosis**

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

I/O Overload | **Digital output overload**

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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

Inductance | **This trip occurs in RFC-S mode when the drive has detected that the motor inductances are not suitable.**

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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

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Name Plate</td><td>Electronic nameplate transfer has failed</td></tr>
<tr><td>176</td><td>The <i>Name Plate</i> 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.
<table>
<tr><th>Sub-trip</th><th>Description</th></tr>
<tr><td>1</td><td>Not enough memory space to complete the transfer</td></tr>
<tr><td>2</td><td>Communication with encoder failed</td></tr>
<tr><td>3</td><td>The transfer has failed</td></tr>
<tr><td>4</td><td>The checksum of the stored object has failed</td></tr>
</table>
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, <i>Position Feedback Initialized</i> (03.076).
Verify the encoder wiring.
</td></tr>
<tr><td>OHt Brake</td><td>Braking IGBT over-temperature</td></tr>
<tr><td>101</td><td>The <i>OHt Brake</i> 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
</td></tr>
<tr><td>OHt Control</td><td>Control stage over temperature</td></tr>
<tr><td>23</td><td>This <i>OHt Control</i> trip indicates that a control stage over-temperature has been detected. From the sub-trip ‘xxyzz’, the Thermistor location is identified by ‘zz’.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>01</td><td>Control board thermistor 1 over temperature</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>02</td><td>Control board thermistor 2 over temperature</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>03</td><td>I/O board thermistor over temperature</td></tr>
</table>
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
</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OHt dc bus</td><td>DC bus over temperature</td></tr>
<tr><td>27</td><td>
The <i>OHt dc bus</i> 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 <i>OHt dc bus</i> 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.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>2</td><td>00</td><td>DC bus thermal model gives trip with sub-trip 0</td></tr>
</table>
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:
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>01</td><td>0</td><td>00</td><td>Power stage gives trip with sub-trip 0</td></tr>
</table>
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)

</td></tr>
<tr><td>OHt Inverter</td><td>Inverter over temperature based on thermal model</td></tr>
<tr><td>21</td><td>
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:
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>1</td><td>00</td><td>Inverter thermal model</td></tr>
<tr><td>Control system</td><td>00</td><td>3</td><td>00</td><td>Braking IGBT thermal model</td></tr>
</table>
Recommended actions with sub-trip 100:

Reduce the selected drive switching frequency
Ensure <i>Auto-switching Frequency Change Disable</i> (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.

</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OHt Power</td><td>Power stage over temperature</td></tr>
<tr><td>22</td><td>
<p>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:</p>
<p>Single module type drive:</p>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>zz</td><td>Thermistor location defined by zz in the power board</td></tr>
<tr><td>Power system</td><td>01</td><td>Rectifier number</td><td>zz</td><td>Thermistor location defined by zz in the rectifier</td></tr>
</table>
<p>Multi-module type system:</p>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>01</td><td>U phase power device</td></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>02</td><td>V phase power device</td></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>03</td><td>W phase power device</td></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>04</td><td>Rectifier</td></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>05</td><td>General power system</td></tr>
<tr><td>Power system</td><td>power module number</td><td>0</td><td>00</td><td>Braking IGBT</td></tr>
</table>
<p>Note that the power module that has caused the trip cannot be identified except for the braking IGBT temperature measurement</p>
<p>Recommended actions:</p>

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

</td></tr>
<tr><td>OI ac</td><td>Instantaneous output over current detected</td></tr>
<tr><td>3</td><td>
<p>The instantaneous drive output current has exceeded VM_DRIVE_CURRENT_MAX. This trip cannot be reset until 10 s after the trip was initiated.</p>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td rowspan="2">00</td><td rowspan="2">Instantaneous over-current trip when the measured a.c. current exceeds VM_DRIVE_CURRENT[MAX].</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td></tr>
</table>
<p>Recommended actions:</p>

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)

</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OI Brake</td><td>Braking IGBT over current detected: short circuit protection for the braking IGBT activated</td></tr>
<tr><td>4</td><td>The <i>OI Brake</i> 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 initiated.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>00</td><td>Braking IGBT instantaneous over-current trip</td></tr>
</table>
Recommended actions:
• Check brake resistor wiring
• Check braking resistor value is greater than or equal to the minimum resistance value
• Check braking resistor insulation</td></tr>
<tr><td>OI dc</td><td>Power module over current detected from IGBT on state voltage monitoring</td></tr>
<tr><td>109</td><td>The <i>OI dc</i> 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.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>00</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>00</td></tr>
</table>
Recommended actions:
• Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester
• Replace the drive</td></tr>
<tr><td>OI Snubber</td><td>Snubber over-current detected</td></tr>
<tr><td>92</td><td>The <i>OI Snubber</i> 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.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>01</td><td>Rectifier number*</td><td>00</td><td>Rectifier snubber over-current trip detected.</td></tr>
</table>
* 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</td></tr>
<tr><td>Option Disable</td><td>Option module does not acknowledge during drive mode changeover</td></tr>
<tr><td>215</td><td>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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Out Phase Loss</td><td>Output phase loss detected</td></tr>
<tr><td>98</td><td>The <i>Out Phase Loss</i> 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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>U phase detected as disconnected when drive enabled to run</td></tr>
<tr><td>2</td><td>V phase detected as disconnected when drive enabled to run</td></tr>
<tr><td>3</td><td>W phase detected as disconnected when drive enabled to run</td></tr>
<tr><td>4</td><td>Output phase loss detected when the drive is running</td></tr>
</table>
Recommended action:
• Check motor and drive connections
• To disable the trip set <i>Output Phase Loss Detection Enable</i> (06.059) = 0</td></tr>
<tr><td>Over Speed</td><td>Motor speed has exceeded the over speed threshold</td></tr>
<tr><td>7</td><td>In open loop mode, if the <i>Output Frequency</i> (05.001) exceeds the threshold set in <i>Over Speed Threshold</i> (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 <i>Speed Controller Proportional Gain</i> (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 <i>Over Speed.1</i> trip. This is caused if the speed is allowed to exceed the safe level in RFC-S mode with flux weakening when <i>Enable High Speed Mode</i> (05.022) is set to -1.</td></tr>
<tr><td>Over Volts</td><td>DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds</td></tr>
<tr><td>2</td><td>The <i>Over Volts</i> 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.
<table>
<tr><th>Voltage rating</th><th>VM_DC_VOLTAGE[MAX]</th><th>VM_DC_VOLTAGE_SET[MAX]</th></tr>
<tr><td>200</td><td>415</td><td>410</td></tr>
<tr><td>400</td><td>830</td><td>815</td></tr>
<tr><td>575</td><td>990</td><td>970</td></tr>
<tr><td>690</td><td>1190</td><td>1175</td></tr>
</table>
Sub-trip Identification
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].</td></tr>
</table>
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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Phase Loss</td><td>Supply phase loss</td></tr>
<tr><td>32</td><td>
<p>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 <i>Action On Trip Detection</i> (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.</p>
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>00: Phase loss detected from DC bus ripple</td></tr>
<tr><td>Power system (1)</td><td>Power module number</td><td>Rectifier number (2)</td><td>00: Phase loss detected directly from the supply</td></tr>
</table>
<p>(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 <i>Input Phase Loss Detection Mode</i> (06.047).</p>
<p>(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.</p>
<p>This trip does not occur in regen mode.</p>
<p>Recommended actions:</p>

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

</td></tr>
<tr><td>Phasing error</td><td>This indicates that the phase offset angle is incorrect</td></tr>
<tr><td>198</td><td>
<p>This indicates that the phase offset angle in <i>Position Feedback Phase Angle</i> (03.025) (or <i>M2 Position Feedback Phase Angle</i> (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.</p>
<p>Recommended actions:</p>

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 <i>Position Feedback Phase Angle</i> (03.025).
Spurious Phasing Error trips can sometimes be seen in very dynamic applications. This trip can be disabled by setting <i>Over Speed Threshold</i> (03.008) to a value greater than zero.

<p>If sensorless control is being used this indicates that significant instability has occurred and the motor has accelerated without control.</p>
<p>Recommended actions:</p>

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

</td></tr>
<tr><td>Power Comms</td><td>A Power Comms trip indicates a communications problem within the power system of the drive</td></tr>
<tr><td>90</td><td>
<p>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.</p>
<table>
<tr><th>Type of drive</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control system</td><td>Power module number</td><td>Rectifier number*</td><td>00: Excessive communications errors detected by the rectifier module</td></tr>
</table>
<p>* 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.</p>
<p>Recommended actions:</p>

Hardware fault – Contact the supplier of the drive

</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Power Data</td><td>Power system configuration data error</td></tr>
<tr><td>220</td><td>The <i>Power Data</i> trip indicates that there is an error in the configuration data stored in the power system.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>02</td><td>There is no data table to be uploaded to the control board</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>03</td><td>The power system data table is bigger than the space available in the control pod to store it.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>04</td><td>The size of the table given in the table is incorrect.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>05</td><td>Table CRC error.</td></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>06</td><td>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.</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>00</td><td>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).</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>01</td><td>The power data table that is uploaded to the control system on power up has an error.</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>02</td><td>The power data table used internally by the power module does not match the hardware identification of the power module.</td></tr>
</table>
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Power Down Save</td><td>Power down save error</td></tr>
<tr><td>37</td><td>The <i>Power Down Save</i> 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.</td></tr>
<tr><td>PSU</td><td>Internal power supply fault</td></tr>
<tr><td>5</td><td>The <i>PSU</i> trip indicates that one or more internal power supply rails are outside limits or overloaded.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td>Internal power supply overload</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>Rectifier number*</td><td>Rectifier internal power supply overload</td></tr>
</table>
*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</td></tr>
<tr><td>PSU 24V</td><td>24V internal power supply overload</td></tr>
<tr><td>9</td><td>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</td></tr>
</table>

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. **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 **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
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

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>**SlotX Different**</td><td>**Option module in option slot X has changed**</td></tr>
<tr><td>**204**
209
214</td><td>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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>No module was installed previously</td></tr>
<tr><td>2</td><td>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.</td></tr>
<tr><td>3</td><td>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.</td></tr>
<tr><td>4</td><td>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.</td></tr>
<tr><td>>99</td><td>Shows the identifier of the module previously installed.</td></tr>
</table>
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.**</td></tr>
<tr><td>**SlotX Error**</td><td>**Option module in option slot X has detected a fault**</td></tr>
<tr><td>**202**
207
212</td><td>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</td></tr>
<tr><td>**SlotX HF**</td><td>**Option module X hardware fault**</td></tr>
<tr><td>**200**
205
210</td><td>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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The module category cannot be identified</td></tr>
<tr><td>2</td><td>All the required customized menu table information has not been supplied or the tables supplied are corrupt</td></tr>
<tr><td>3</td><td>There is insufficient memory available to allocate the comms buffers for this module</td></tr>
<tr><td>4</td><td>The module has not indicated that it is running correctly during drive power-up</td></tr>
<tr><td>5</td><td>Module has been removed after power-up or it has stopped working</td></tr>
<tr><td>6</td><td>The module has not indicated that it has stopped accessing drive parameters during a drive mode change</td></tr>
<tr><td>7</td><td>The module has failed to acknowledge that a request has been made to reset the drive processor</td></tr>
<tr><td>8</td><td>The drive failed to correctly read the menu table from the module during drive power up</td></tr>
<tr><td>9</td><td>The drive failed to upload menu tables from the module and timed out (5 s)</td></tr>
<tr><td>10</td><td>Menu table CRC invalid</td></tr>
</table>
Recommended actions:
• Ensure the option module is installed correctly
• Replace the option module
• Replace the drive</td></tr>
<tr><td>**SlotX Not Fitted**</td><td>**Option module in option slot X has been removed**</td></tr>
<tr><td>**203**
208
213</td><td>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**.</td></tr>
<tr><td>**SlotX Watchdog**</td><td>**Option module watchdog function service error**</td></tr>
<tr><td>**201**
206
211</td><td>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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Soft Start</td><td>Soft start relay failed to close, soft start monitor failed</td></tr>
<tr><td>226</td><td>The <i>Soft Start</i> 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</td></tr>
<tr><td>Stored HF</td><td>Hardware trip has occurred during last power down</td></tr>
<tr><td>221</td><td>The <i>Stored HF</i> 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</td></tr>
<tr><td>Sub-array RAM</td><td>RAM allocation error</td></tr>
<tr><td>227</td><td>The <i>Sub-array RAM</i> 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.
<table>
<tr><th>Parameter size</th><th>Value</th></tr>
<tr><td>1 bit</td><td>1000</td></tr>
<tr><td>8 bit</td><td>2000</td></tr>
<tr><td>16 bit</td><td>3000</td></tr>
<tr><td>32 bit</td><td>4000</td></tr>
<tr><td>64 bit</td><td>5000</td></tr>
</table>
<table>
<tr><th>Parameter type</th><th>Value</th></tr>
<tr><td>Volatile</td><td>0</td></tr>
<tr><td>User save</td><td>100</td></tr>
<tr><td>Power-down save</td><td>200</td></tr>
</table>
<table>
<tr><th>Sub-array</th><th>Menus</th><th>Value</th></tr>
<tr><td>Applications menus</td><td>18-20</td><td>1</td></tr>
<tr><td>Derivative image</td><td>29</td><td>2</td></tr>
<tr><td>User program image</td><td>30</td><td>3</td></tr>
<tr><td>Option slot 1 set-up</td><td>15</td><td>4</td></tr>
<tr><td>Option slot 1 applications</td><td>25</td><td>5</td></tr>
<tr><td>Option slot 2 set-up</td><td>16</td><td>6</td></tr>
<tr><td>Option slot 2 applications</td><td>26</td><td>7</td></tr>
<tr><td>Option slot 3 set-up</td><td>17</td><td>8</td></tr>
<tr><td>Option slot 3 applications</td><td>27</td><td>9</td></tr>
</table></td></tr>
<tr><td>Temp Feedback</td><td>Internal thermistor has failed</td></tr>
<tr><td>218</td><td>The <i>Temp Feedback</i> trip indicates that an internal thermistor has failed. The thermistor location can be identified by the sub-trip number.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control board</td><td>00</td><td>00</td><td>01: Control board thermistor 1
02: Control board thermistor 2
03: I/O board thermistor</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>Zero for temperature feedback provided via power system comms.21, 22 and 23 for direct ELV temperature feedback.</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>Rectifier number*</td><td>Always zero</td></tr>
</table>
* 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</td></tr>
<tr><td>Th Brake Res</td><td>Brake resistor over temperature</td></tr>
<tr><td>10</td><td>The <i>Th Brake Res</i> 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 <i>On Trip Detection</i> (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</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Th Short Circuit</td><td>Motor thermistor short circuit</td></tr>
<tr><td>25</td><td>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.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>3</td><td><i>Analog Input 3 Mode</i> (07.015) = 7 and the resistance of the thermistor connected to analog input 3 is less than 50 Ω.</td></tr>
<tr><td>4</td><td><i>P1 Thermistor Short Circuit Detect</i> (03.123) = 1 and the resistance of the thermistor connected to the drive P1 position feedback interface is less than 50 Ω.</td></tr>
</table>
Recommended actions:
• Check thermistor continuity
• Replace motor / motor thermistor</td></tr>
<tr><td>Thermistor</td><td>Motor thermistor over-temperature</td></tr>
<tr><td>24</td><td>The <i>Thermistor</i> 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
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>3</td><td>Trip initiated from analog input 3</td></tr>
<tr><td>4</td><td>Trip initiated from P1 position feedback interface</td></tr>
</table>
Recommended actions:
• Check motor temperature
• Check threshold level (07.048)
• Check thermistor continuity</td></tr>
<tr><td>Undefined</td><td>Drive has tripped and the cause of the trip is Undefined</td></tr>
<tr><td>110</td><td>The <i>Undefined</i> 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</td></tr>
<tr><td>User 24V</td><td>User 24 V supply is not present on control terminals (1,2)</td></tr>
<tr><td>91</td><td>A <i>User 24 V</i> trip is initiated, if <i>User Supply Select</i> (Pr 06.072) is set to 1 or <i>Low Under Voltage Threshold Select</i> (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)</td></tr>
</table>

Trip	Diagnosis
User Program	**On board user program error**
249	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	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	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	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

Trip	Diagnosis
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.

Table 13-4 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 13-5 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 a 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	

13.5 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.

13.6 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 13-6 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.

13.7 Status indications

Table 13-7 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 13-8 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		

13.8 Programming error indications

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

Table 13-9 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.

13.9 Displaying the trip history

The drive retains a log of the last ten trips that have occurred. *Trip 0* (10.020) to *Trip 9* (10.029) store the most recent 10 trips that have occurred where *Trip 0* (10.020) is the most recent and *Trip 9* (10.029) is the oldest. When a new trip occurs it is written to *Trip 0* (10.020) 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* (10.041) to *Trip 9 Time* (10.060). The date and time are taken from *Date* (06.016) and *Time* (06.017). The date / time source can be selected with *Date / Time Selector* (06.019). 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 **10.020** and Pr **10.029** inclusive is read by serial communication, then the trip number in Table 13-3 is the value transmitted.

NOTE

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

13.10 Behaviour 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**.

14 UL listing information

14.1 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.

14.2 Option modules, kits and accessories

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

14.3 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.

14.4 Mounting

Drives can be mounted directly onto a vertical surface. This is known as 'surface' or 'standard' mounting. Refer to section 3.5.1 *Surface mounting* on page 33 for further information.

Drives can be installed side by side with recommended spacing between them. This is known as 'bookcase' mounting. Refer to section 3.6 *Enclosure for standard drives* on page 47 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 Emerson Industrial Automation.

Some drives may be through-hole mounted. Mounting brackets and sealing kits are available from Emerson Industrial Automation. Refer to section 3.5.2 *Through-panel mounting* on page 40 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.

14.5 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 section 12.1.1 *Power and current ratings (Derating for switching frequency and temperature)* on page 257.

14.6 Electrical Installation

TERMINAL TORQUE

Terminals must be tightened to the rated torque as specified in the Installation Instructions. Refer to section 3.12.2 *Terminal sizes and torque settings* on page 65 for further information.

WIRING TERMINALS

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

UL Listed closed-loop connectors sized according to the field wiring shall be used for all field wiring connections. Refer to section 3.12.2 *Terminal sizes and torque settings* on page 65 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 12.1.20 *Input current, fuse and cable size ratings* on page 269

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".

14.7 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 158. 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.

14.8 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.

14.9 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.

14.10 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.

14.11 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 Emerson Industrial Automation.

Alternatively, the inverters may be supplied by converters from the *HVAC Drive-H300* range manufactured by Emerson 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 Emerson Industrial Automation for further details.

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