



Nidec

All for dreams

User Guide

HVAC Drive H300 Standard and High IP

Model sizes 3-12

Universal Variable Speed AC drive for induction and permanent magnet motors



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Issue: 5

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Compliance Information

Manufacturer: Nidec Control Techniques Limited ("we", "our")

Registered office: The Gro, Newtown, Powys, SY16 3BE United Kingdom

Registered in: England and Wales, company registration number 01236886

Manufacturer's EU Authorised Representative: Nidec Netherlands B.V., Kubus 155, 3364 DG Slidrecht, the Netherlands, registered at the Dutch Trade Register under number 33213151; Tel. +31 (0)184 420 555, info.nl@mail.nidec.com

Original instructions

With reference to the UK Supply of Machinery (Safety) Regulations 2008 and the EU Machinery Directive 2006/42/EC, the English version of this Manual constitutes the original instructions. Manuals published in other languages are translations of the original instructions and the English language version of this Manual prevails over any other language version in the event of inconsistency.

Documentation and user software tools

Manuals, datasheets and software that we make available to users of our products can be downloaded from: <http://www.drive-setup.com>

Warranty and liability

The contents of this Manual are presented for information purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the designs, specifications or performance of our products at any time without notice. For full details of the warranty terms applicable to the product, contact the supplier of the product.

In no event and under no circumstances shall we be liable for damages and failures due to misuse, abuse, improper installation, or abnormal conditions of temperature, dust, or corrosion, or failures due to operation outside the published ratings for the product, nor shall we be liable for consequential and incidental damages of any kind.

Environmental management

We operate an Environmental Management System which complies with the requirements of ISO 14001:2015. Further information on our Environmental Statement can be found at: <http://www.drive-setup.com/environment>.

Restriction and control of hazardous substances

The products covered by this Manual comply with the following legislation and regulations on the restriction and control of hazardous substances:

UK Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

UK REACH etc. (Amendment etc.) (EU Exit) Regulations 2020, European Union REACH Regulation EC 1907/2006

EU restriction of the Use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) - Directive 2011/65/EU

EC Regulation 1907/2006 on the Registration, Evaluation, authorisation, and restriction of Chemicals (REACH)

Chinese Administrative Measures for Restriction of Hazardous Substances in Electrical and Electronic Products 2016/07/01

U.S. Environmental Protection Agency ("EPA") regulations under the Toxic Substances Control Act ("TSCA")

MEPC 68/21 / Add.1, Annex 17, Resolution MEPC.269(68) 2015 Guidelines for the development of the inventory of hazardous materials

The products covered by this Manual do not contain asbestos.

Further information on REACH and RoHS can be found at: <http://www.drive-setup.com/environment>.

Conflict minerals

With reference to the Conflict Minerals (Compliance) (Northern Ireland) (EU Exit) Regulations 2020, the U.S. Dodd-Frank Wall Street Reform and Consumer Protection Act and Regulation (EU) 2017/821 of the European Parliament and of the European Council:

We have implemented due diligence measures for responsible sourcing, we conduct conflict minerals surveys of relevant suppliers, we continually review due diligence information received from suppliers against company expectations and our review process includes corrective action management. We are not required to file an annual conflict minerals disclosure. Nidec Control Techniques Limited is not an issuer as defined by the U.S. SEC.

Disposal and recycling (WEEE)



The products covered by this Manual fall within the scope of the UK Waste Electrical and Electronic Equipment Regulations 2013, EU Directive 2012/19/EU amended by EU Directive 2018/849 (EU) on Waste Electrical and Electronic Equipment (WEEE).

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

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

Copyright and trade marks

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How to use this guide

This user guide provides complete information for installing the drive.

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

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 the table of contents overleaf.

| | 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 | | | ● | ● | |
| 9 NV media card operation | | | ● | ● | |
| 10 Building automation | | | ● | ● | |
| 11 Advanced parameters | | | ● | ● | |
| 12 Technical data | | ● | ● | ● | |
| 13 Diagnostics | | | | | ● |
| 14 UL listing information | | | ● | ● | |

UK Declaration of Conformity

1. Product range

Unidrive-M, Commander, Digitax HD and derivative products, variable speed AC motor drives

2. Name and address of the manufacturer

Nidec Control Techniques Ltd
The Gro
Newtown
Powys
SY16 3BE
UK

3. Responsibility

This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

| Model number | Interpretation | Nomenclature aaaa - bbc ddddde |
|--------------|----------------|--|
| aaaa | Basic series | C200, C300, M100, M101, M200, M201, M300, M400, M600, M700, M701, M702, M708, M709, M750, M751, M752, M753, M754, M880, M881, M882, M888, M889, E200, E300, F300, F600, H300, HS30, HS70, HS71, HS72, M000, RECT |
| bb | Frame size | 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12 |
| c | Voltage rating | 1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V |
| dddd | Current rating | Example 01000 = 100 A |
| e | Drive format | A = 6P Rectifier + Inverter with internal choke, D = Inverter, E = 6P Rectifier + Inverter, T = 12P Rectifier + Inverter |

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

5. Declaration

The object of the declaration is in conformity with the relevant Union harmonization legislation:

| UK Regulations |
|--|
| Electrical Equipment (Safety) Regulations 2016 |
| Electromagnetic Compatibility Regulations 2016 |
| The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012 |
| The Ecodesign for Energy-Related Products Regulations 2021 No. 745 |

6. References to the relevant designated British standards

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

| | |
|---------------------------------|---|
| BS EN 61800-5-1:2007 + A11:2021 | Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy |
| BS EN 61800-3: 2004 + A1: 2012 | Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods |
| BS EN 61000-6-2: 2005 | Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments |
| BS EN 61000-6-4: 2007+ A1: 2011 | Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments |
| BS EN 61000-3-2:2014 | Electromagnetic compatibility (EMC) - Part 3-2: Limits for harmonic current emissions (equipment input current ≥ 16 A per phase) |
| BS 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 |

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

7. Responsible person



Jon Holman-White
Vice President of Research and Development
Nidec Control Techniques Ltd
Date: 28th June 2021
Newtown, Powys, UK.

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 product or system complies with all the relevant laws in the country where it is to be used.

1-000-022-213 Rev.00.19

EU Declaration of Conformity - Machinery Directive

1. Product model

Unidrive-M and derivative products incorporating a Safe Torque Off (STO) function used as a safety component of a machine.

Only the Safe Torque Off function may be used as a safety component of a machine.

2. Name and address of the manufacturer and authorised representative

Manufacturer:
Nidec Control Techniques Ltd
The Gro
Newtown
Powys
UK
SY16 3BE

Authorised representative:
Nidec Netherlands B.V.
Kubus 155
3364 DG Sliedrecht
Netherlands.

3. Responsibility

This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

| Model number | Interpretation | Nomenclature aaaa - bbc ddddde |
|--------------|----------------|---|
| aaaa | Basic series | M600, M700, M701, M702, M708, M709, M750, M751, M753, M754, F300, F600, H300, E200, E300, HS70, HS71, HS72 |
| bb | Frame size | 03, 04, 05, 06, 07, 08, 09, 10, 11, 12 |
| c | Voltage rating | 1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V |
| dddd | 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.

5. Declaration

The object of the declaration is in conformity with the relevant Union harmonization legislation:

Machinery Directive (2006/42/EC)

Electromagnetic Compatibility Directive (2014/30/EU)

Type examination has been carried out by the following notified body:

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

Notified body identification number: 0035

EC type-examination certificate number: 01/205/5270.02/17 dated 2017-08-28

6. References to the relevant harmonised standards used

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

| | |
|--|---|
| EN 61800-5-1:2016 | Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional |
| EN 61800-5-1:2016 (in extracts) | 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 ISO 13849-1:2015 | Safety of Machinery, Safety-related parts of control systems, General principles for design |
| EN 62061:2005 + AC: 2010 + A1: 2013 + A2: 2015 | Safety of machinery, Functional safety of safety related electrical, electronic and programmable electronic control systems |
| EN 61508 Parts 1 - 7:2010 | Functional safety of electrical/ electronic/programmable electronic safety-related systems |

7. Signed for and on behalf of:

Person authorised to complete the technical file:

Authorised representative (see details above)



DoC authorised by:

Jon Holman-White, Vice President, Research and Development

Date:

1st January 2021, 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 power drive system (PDS).

It is the responsibility of the installer to ensure that the design of the system and machine, including its safety-related control system, is carried out in accordance with the requirements of the Machinery Directive and any other relevant legislation.

The use of a safety component does not ensure the safety of the machine.

Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters.

The drive must be installed only by professional installers who are familiar with requirements for safety and EMC.

The assembler is responsible for ensuring that the final product or system complies with all relevant laws in the country where it is to be used. For more information regarding Safe Torque Off, refer to the Product Documentation.

EU Declaration of Conformity

1. Product range

Unidrive-M, Commander, Digitax HD and derivative products, variable speed AC motor drives

2. Name and address of the manufacturer and authorised representative

Manufacturer
Nidec Control Techniques Ltd
The Gro
Newtown
Powys
UK
SY16 3BE

Authorised representative:
Nidec Netherlands B.V.
Kubus 155
3364 DG Sliedrecht
Netherlands.

3. Responsibility

This declaration is issued under the sole responsibility of the manufacturer.

4. Object of the declaration

| Model number | Interpretation | Model Number nomenclature aaaa - bbc ddddde |
|--------------|----------------|--|
| aaaa | Basic series | C200, C300, M100, M101, M200, M201, M300, M400, M600, M700, M701, M702, M708, M709, M750, M751, M752, M753, M754, M880, M881, M882, M888, M889, E200, E300, F300, F600, H300, HS30, HS70, HS71, HS72, M000, RECT |
| bb | Frame size | 01, 02, 03, 04, 05, 06, 07, 08, 09, 10, 11, 12 |
| c | Voltage rating | 1 = 100 V, 2 = 200 V, 4 = 400 V, 5 = 575 V, 6 = 690 V |
| dddd | Current rating | Example 01000 = 100 A |
| e | Drive format | A = 6P Rectifier + Inverter with internal choke, D = Inverter, E = 6P Rectifier + Inverter, T = 12P Rectifier + Inverter |

5. Declaration

The object of the declaration is in conformity with the relevant European Union harmonisation legislation.

Low Voltage Directive (2014/35/EU)

Electromagnetic Compatibility Directive (2014/30/EU)

Restriction of Hazardous Substances Directive (2011/65/EU)

Regulation 2019/1781 of directive 2009/125/EC (Energy related products).

6. References to the relevant harmonised EN standard

The variable speed drive products listed above have been designed and manufactured in accordance with the following European harmonised 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 |

6. Responsible person



Jon Holman-White

Vice President, Research and Development

Nidec Control Techniques Ltd

Date: 8th February 2021

Newtown, Powys, UK.


IMPORTANT NOTE

These products are Basic Drive Modules, intended to be used with motors, controllers, electrical protection components and other equipment to form Power Drive Systems. Compliance with safety and EMC regulations depends upon installing and configuring the drive modules correctly.

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Safety information and Installation instructions supplied with the drive. The installer is responsible for ensuring that the Power Drive System complies with all applicable laws in the country where it is to be used.


1 Safety information

1.1 Warnings, Cautions and Notes



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

WARNING



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

CAUTION

NOTE

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

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

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

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

Drives and controllers are intended as components for professional incorporation into complete systems. If installed incorrectly they may present a safety hazard. The drive uses high voltages and currents, carries a high level of stored electrical energy, and is used to control equipment which can cause injury. Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning/start-up and maintenance must be carried out by personnel who have the necessary training and competence. They must read this safety information and this guide carefully.

1.3 Responsibility

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

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

1.4 Compliance with regulations

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

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

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

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

The voltages used in the drive can cause severe electrical shock and/or burns, and could be lethal. Extreme care is necessary at all times when working with or adjacent to the drive. Hazardous voltage may be present in any of the following locations:

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

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

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

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

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

1.6 Stored electrical charge

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

1.7 Mechanical hazards

Careful consideration must be given to the functions of the drive or controller which might result in a hazard, either through their intended behaviour or through incorrect operation due to a fault. In any application where a malfunction of the drive or its control system could lead to or allow damage, loss or injury, a risk analysis must be carried out, and where necessary, further measures taken to reduce the risk - for example, an over-speed protection device in case of failure of the speed control, or a fail-safe mechanical brake in case of loss of motor braking.

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

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

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

1.8 Access to equipment

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

1.9 Environmental limits

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

1.10 Hazardous environments

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

1.11 Motor

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

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

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

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

1.12 Mechanical brake control

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

1.13 Adjusting parameters

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

1.14 Electromagnetic compatibility (EMC)

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

2 Product information

2.1 Drive firmware version

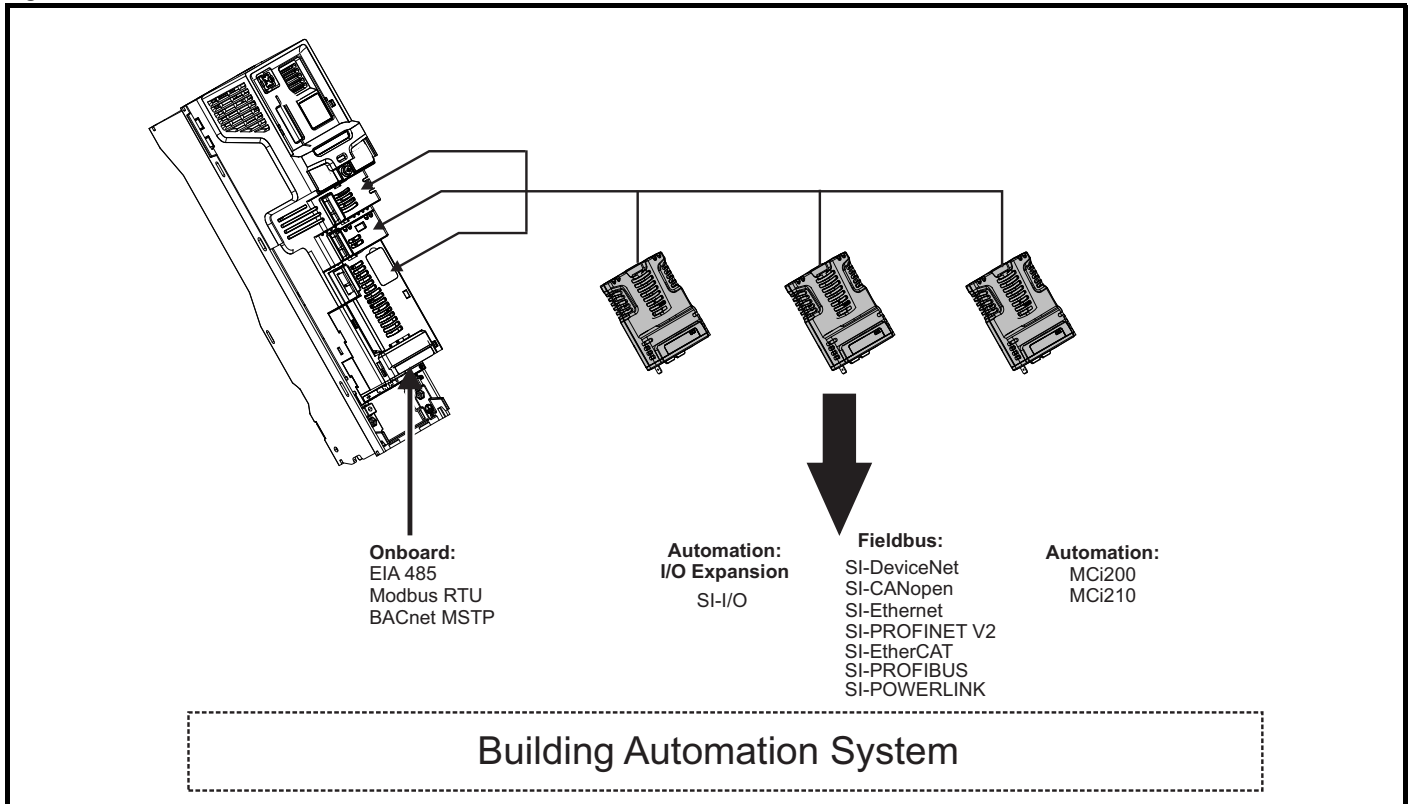
This product is supplied with the latest firmware version. If this drive is to be connected to an existing system or machine, all drive firmware versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from an Nidec 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 **00.005** {11.029}.

2.2 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 or BACnet MSTP.

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.

2.4 Ratings

Normal Duty

The H300 is optimized 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.

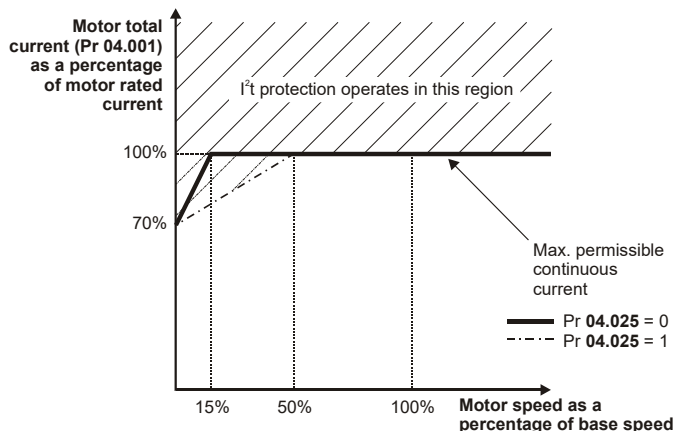
NOTE

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 273.

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 High IP 200 V drive ratings (200 V to 240 V ±10 %)

| Frame size | High IP Model | Normal Duty | | | |
|------------|--------------------------|-----------------------------------|------------------------|----------------------|--------------|
| | | Maximum continuous output current | Nominal power at 230 V | Motor power at 230 V | Peak current |
| | | A | kW | hp | A |
| 3 | H300-03200066A10100AB653 | 6.6 | 1.1 | 1.5 | 7.2 |
| | H300-03200080A10100AB653 | 8 | 1.5 | 2 | 8.8 |
| | H300-03200110A10100AB653 | 11 | 2.2 | 3 | 12.1 |
| | H300-03200127A10100AB653 | 12.7 | 3 | 3 | 13.9 |
| 4 | H300-04200180A10100AB653 | 18 | 4 | 5 | 19.8 |
| | H300-04200240A10100AB653 | 24 | 5.5 | 7.5 | 27.5 |
| | H300-04200250A10100AB653 | 25 | 5.5 | 7.5 | 27.5 |
| 5 | H300-0500300A10100AB653 | 30 | 7.5 | 10 | 33 |
| 6 | H300-06200500A10100AB653 | 50 | 11 | 15 | 55 |

Table 2-3 400 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 |
| Frame size 12 | 12404800 | 608 | 315 | 500 | 668 |
| | 12405660 | 660 | 355 | 550 | 726 |
| | 12406660 | 755 | 400 | 650 | 830.5 |
| | 12407200 | 865 | 500 | 700 | 951.5 |

* 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 273.

Table 2-4 400 V drive input current, fuse rating and cable size

| Model | Maximum continuous input current | Fuse (6 per drive) | | | | Nominal cable size (European) mm ² | | | | Nominal cable size (USA) | | |
|-----------|----------------------------------|--------------------|-------|--------|-------|---|-----------------|-----------------|-----------------------------|--|--|--------------------------------------|
| | | IEC | | UL/USA | | Input 6 pulse | Input 12 pulse | Output | Cable type (input & output) | Input 6 pulse | Input 12 pulse | Output |
| | | Nom | Class | Nom | Class | | | | | | | |
| | | 3 ph | A | A | A | mm ² | mm ² | mm ² | kcmil | kcmil | kcmil | |
| 12404800T | 720 | 550 | aR | 400 | gR | 4 x 120 | 2 x 120 | 3 x 150 | XLPE/EPR | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 1/0 AWG (53.5 mm ²) |
| 12405660T | 777 | 550 | | 450 | | 4 x 150 | 2 x 150 | 4 x 120 | | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 2/0 AWG (67.4 mm ²) |
| 12406600T | 845 | 550 | | 500 | | 4 x 150 | 2 x 150 | 3 x 185 | | 4 x 4/0 AWG (107.2 mm ²) | 2 x 4/0 AWG (107.2 mm ²) | 4 x 3/0 AWG (85 mm ²) |
| 12407200T | 995 | 550 | | 550 | | 4 x 185 | 2 x 185 | 4 x 185 | | 4 x 250 Kcmil (127.2 mm ²) | 2 x 250 Kcmil (127.2 mm ²) | 4 x 4/0 AWG (107.2 mm ²) |

Table 2-5 High IP 400 V drive ratings (380 V to 480 V ±10 %)

| Frame size | H300 High IP Model | Normal Duty | | | |
|------------|--------------------------|-----------------------------------|------------------------|----------------------|--------------|
| | | Maximum continuous output current | Nominal power at 400 V | Motor power at 460 V | Peak current |
| | | A | kW | hp | A |
| 3 | H300-03400034A10100AB653 | 3.4 | 1.1 | 1.5 | 3.7 |
| | H300-03400045A10100AB653 | 4.5 | 1.5 | 2.0 | 4.9 |
| | H300-03400062A10100AB653 | 6.2 | 2.2 | 3.0 | 6.8 |
| | H300-03400077A10100AB653 | 7.7 | 3.0 | 5.0 | 8.4 |
| | H300-03400104A10100AB653 | 10.4 | 4.0 | 5.0 | 11.4 |
| | H300-03400123A10100AB653 | 12.3 | 5.5 | 7.5 | 13.5 |
| 4 | H300-04400185A10100AB653 | 18.5 | 7.5 | 10.0 | 20.3 |
| | H300-04400240A10100AB653 | 24.0 | 11.0 | 15.0 | 26.4 |
| 5 | H300-05400300A10100AB653 | 30.0 | 15.0 | 20.0 | 33.0 |
| | H300-05400310A10100AB653 | 31.0 | 15.0 | 20.0 | 33.0 |
| 6 | H300-06400380A10100AB653 | 38.0 | 18.5 | 25.0 | 41.8 |
| | H300-06400480A10100AB653 | 48.0 | 22 | 30.0 | 52.8 |

Table 2-6 575 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 273.

Table 2-7 High IP 575 V drive ratings (500 V to 575 V ±10 %)

| Frame size | H300 Drive High IP Model | Normal Duty | | | |
|------------|--------------------------|-----------------------------------|------------------------|----------------------|--------------|
| | | Maximum continuous output current | Nominal power at 575 V | Motor power at 575 V | Peak current |
| | | A | kW | hp | A |
| 5 | H300-05500039A10100AB653 | 3.9 | 2.2 | 3 | 4.3 |
| | H300-05500061A10100AB653 | 6.1 | 4 | 5 | 6.7 |
| | H300-05500100A10100AB653 | 10 | 5.5 | 7.5 | 11 |
| 6 | H300-06500120A10100AB653 | 12 | 7.5 | 10 | 13.2 |
| | H300-06500170A10100AB653 | 17 | 11 | 15 | 18.7 |
| | H300-06500220A10100AB653 | 22 | 15 | 20 | 24.2 |
| | H300-06500270A10100AB653 | 27 | 18.5 | 25 | 29.7 |
| | H300-06500340A10100AB653 | 34 | 22 | 30 | 37.4 |

Table 2-8 690 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 273.

2.4.1 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 2-9 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.

2.5 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)

2.5.1 Open loop mode

The drive applies power to the motor at frequencies varied by the user. The motor speed is a result of the output frequency of the drive and slip due to the mechanical load. The drive can improve the speed control of the motor by applying slip compensation. The performance at low speed depends on whether V/F mode or open loop vector mode is selected.

Open loop vector mode

The voltage applied to the motor is directly proportional to the frequency except at low speed where the drive uses motor parameters to apply the correct voltage to keep the flux constant under varying load conditions.

Typically 100 % torque is available down to 1 Hz 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.

2.5.2 RFC-A Sensorless

Rotor Flux Control 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.

2.5.3 RFC- S Sensorless

Rotor Flux Control for Synchronous (permanent magnet brushless) motors (**RFC-S**) provides closed loop control without a position feedback device.

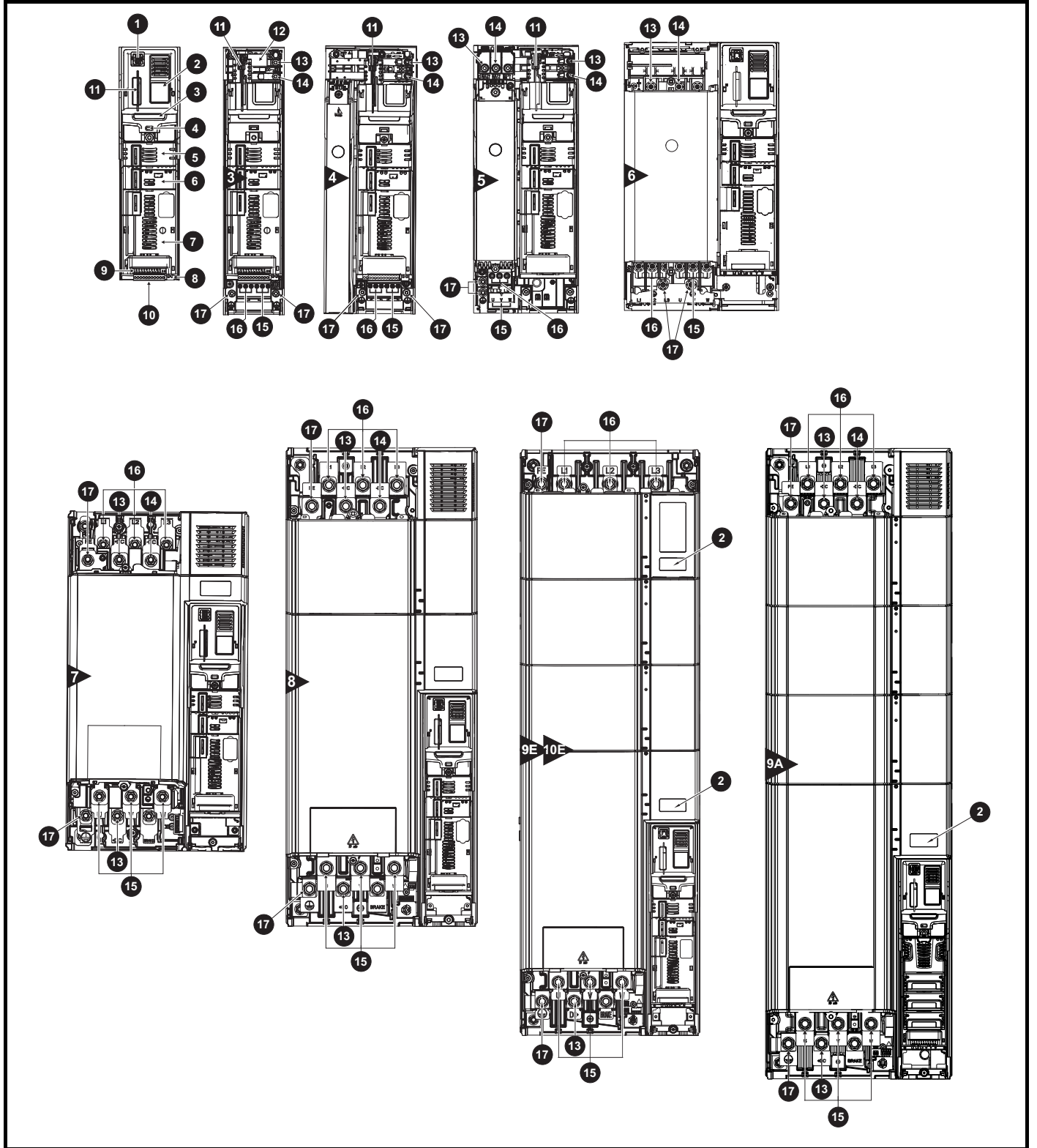
For use with permanent magnet brushless motors without a feedback device installed.

Flux control is not required because the motor is self excited by the permanent magnets which form part of the rotor.

Full torque is available all the way down to zero speed, with salient motors.

2.6 Drive features

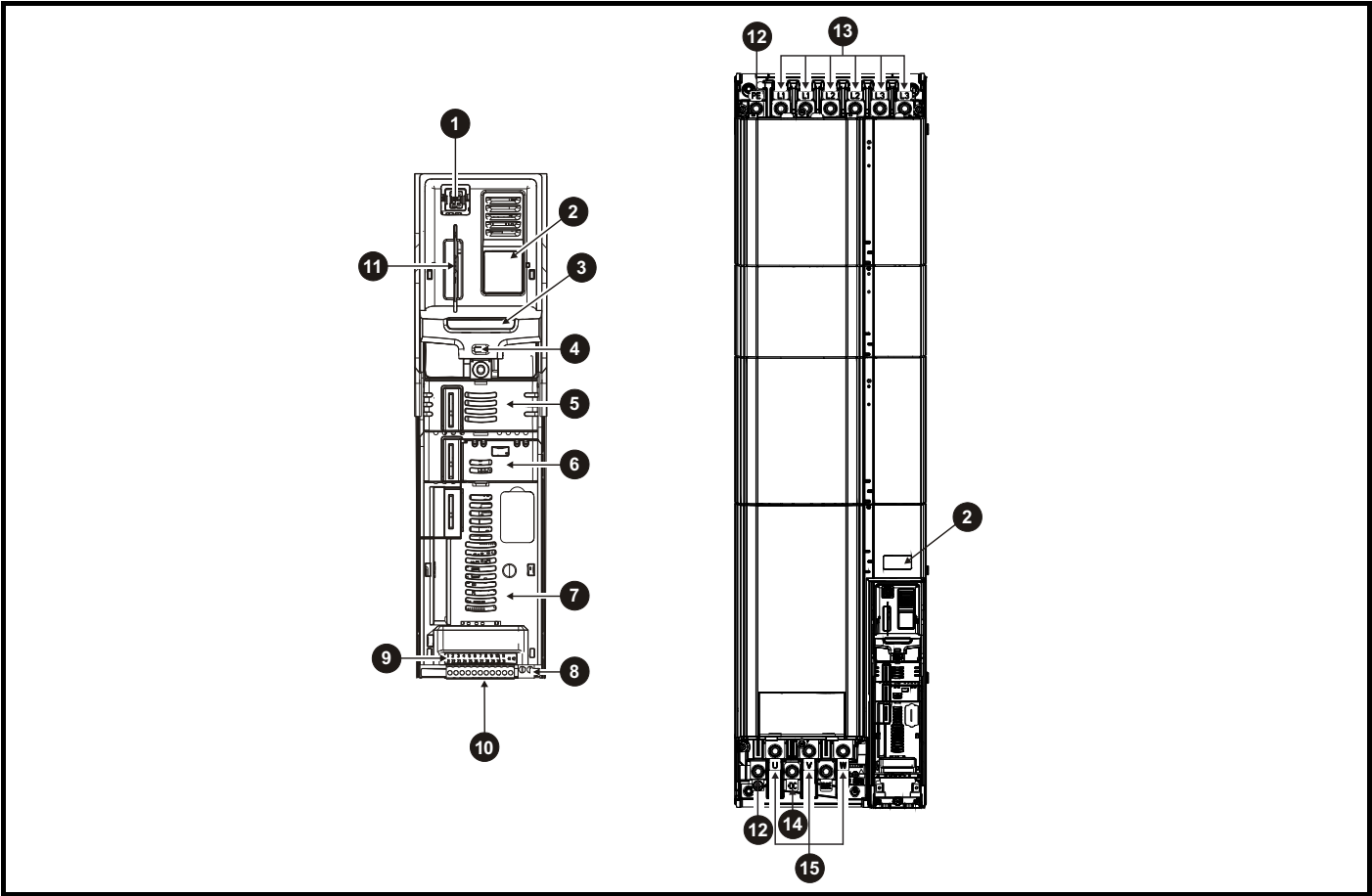
Figure 2-3 Features of the drive (size 3 to 10)



Key

- | | | | |
|-------------------------|-------------------------|-------------------------|---------------------------|
| 1. Keypad connection | 6. Option module slot 2 | 11. NV media card slot | 16. AC supply connections |
| 2. Rating label | 7. Option module slot 3 | 12. Internal EMC filter | 17. Ground connections |
| 3. Identification label | 8. Relay connections | 13. DC bus + | |
| 4. Status LED | 9. Control connections | 14. DC bus - | |
| 5. Option module slot 1 | 10. Communications port | 15. Motor connections | |

Figure 2-4 Features of the drive (size 11E)



Key

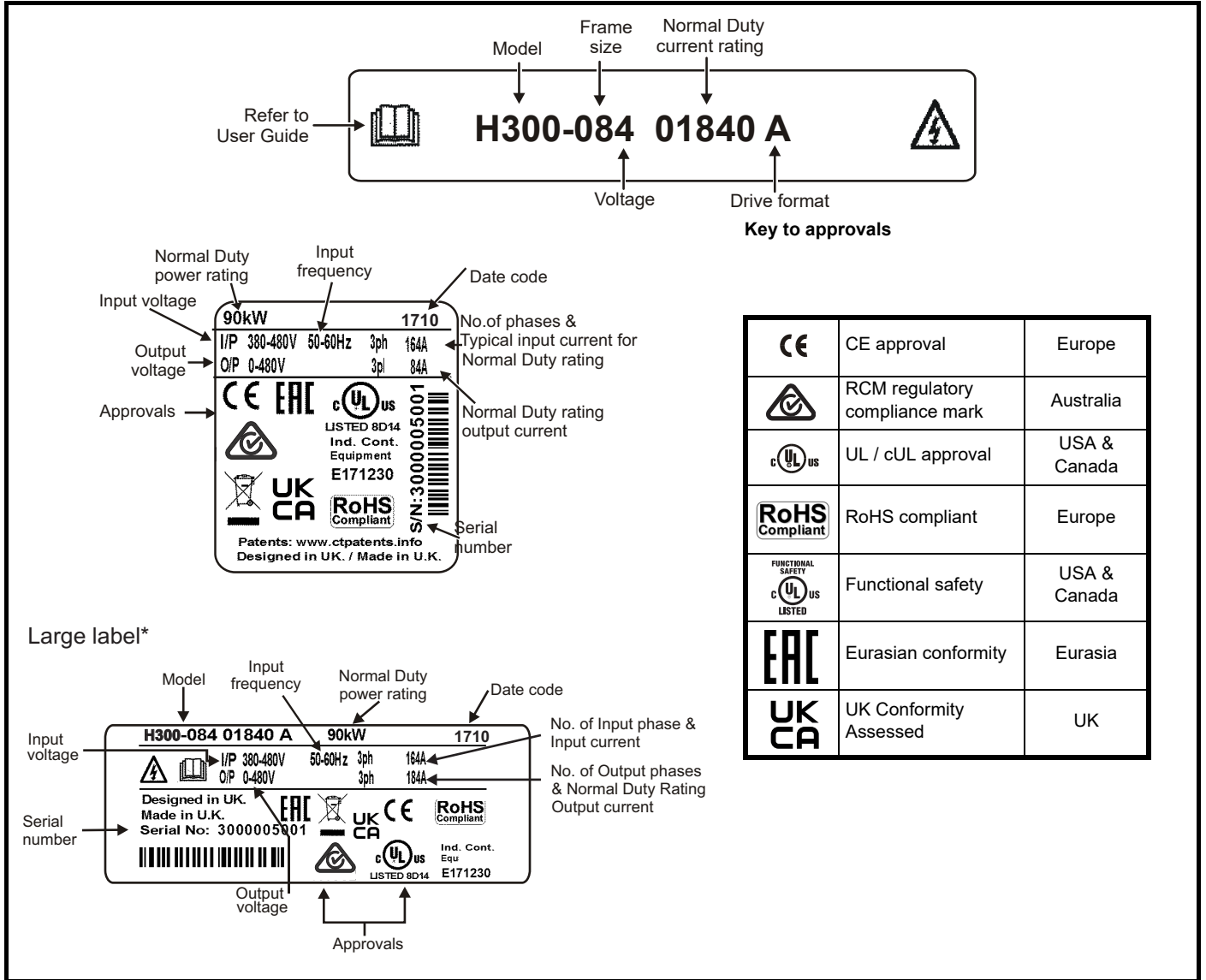
- | | | | |
|-------------------------|-------------------------|-------------------------|----------------------------|
| 1. Keypad connection | 5. Option module slot 1 | 9. Control connections | 13. AC supply connections* |
| 2. Rating label | 6. Option module slot 2 | 10. Communications port | 14.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

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

2.7 Nameplate description

See Figure 2-3 for location of rating labels.

Figure 2-5 Typical drive rating labels



* This label is only applicable to Size 7 and above.

Refer to Figure 2-2 *Model number* on page 15 for further information relating to the labels.

NOTE

Date code format

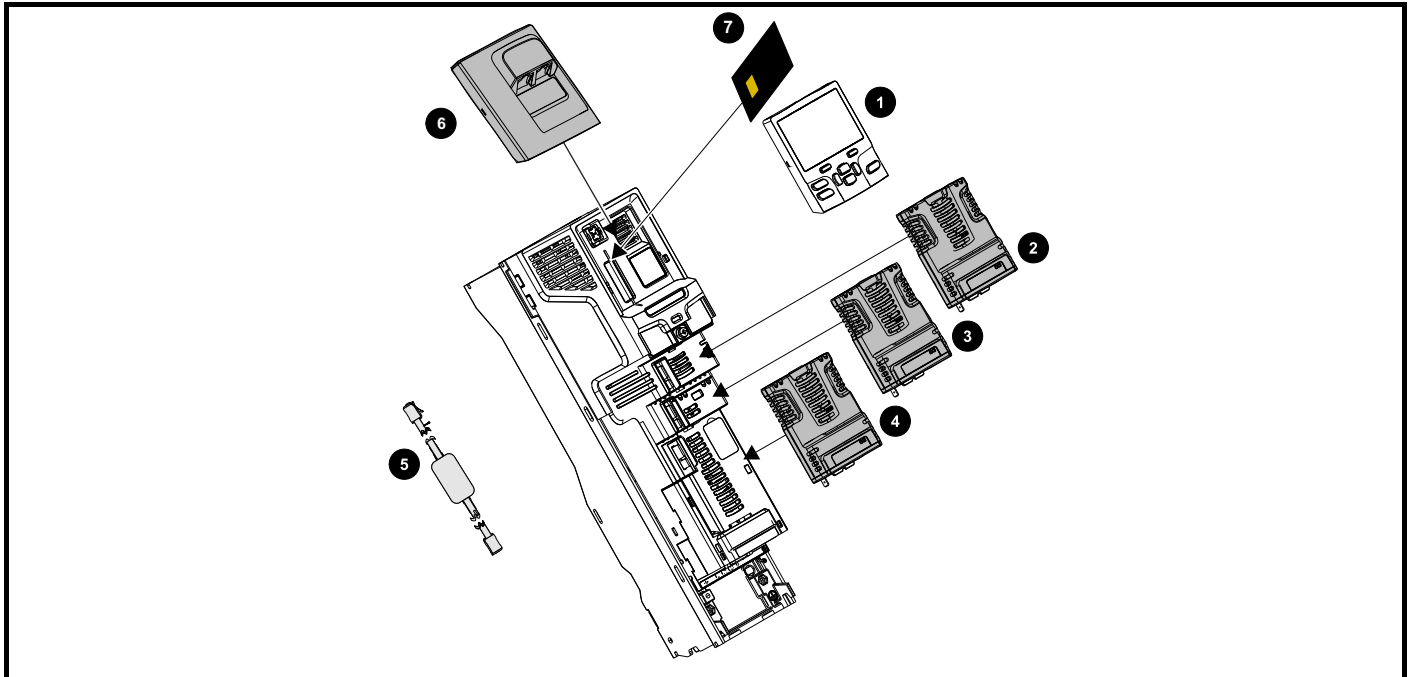
The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built.

Example:

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

2.8 Options

Figure 2-6 Options available with the drive



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

* 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 187



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 2-10 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 |
| |  | Brown Red | SI-EtherCAT | EtherCAT option EtherCAT adapter for communications with the drive |
| |  | Pale Blue | SI-POWERLINK | POWERLINK 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: <ul style="list-style-type: none"> 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 2-11 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 2-12 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 |

2.9 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 2-13.

Table 2-13 Parts supplied with the drive (size 3 to 8)






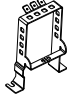






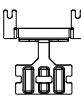
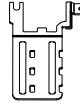
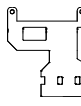




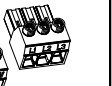

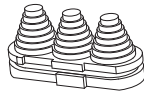
| Description | Size 3 | Size 4 | Size 5 | Size 6 | Size 7 | Size 8 |
|--|--|--|--|--|--|--|
| Control connectors 1 to 9 and 21 to 29 | | | |  x 1 |  x 1 | |
| Relay connector | | | |  x 1 |  x 1 | |
| 24 V power supply connector | | | | |  x 1 | |
| Grounding bracket | | | |  x 1 | | |
| Surface mounting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

Table 2-14 Parts supplied with the drive (size 9A, 9E, 10E and 11E)








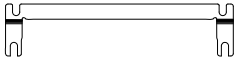
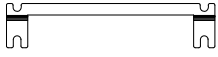

| Description | Size 9A / 9E | Size 10E | Size 11E |
|---|--|---|--|
| Control connectors 1 to 9 and 21 to 29 | |  x 1 |  x 1 |
| Relay connector | |  x 1 |  x 1 |
| 24 V power supply connectors | |  x 1 |  x 1 |
| Grounding bracket | |  x 1 | |
| Surface mounting brackets |  x 2 | |  x 2  x 1 |

Table 2-15 Parts supplied with the High IP Drive

| Description | Size 3 | Size 4 | Size 5 | Size 6 |
|-------------|-----------|-----------|-----------|-----------|
| Kit bag | 3470-0201 | 3470-0200 | 3470-0203 | 3470-0205 |
| | 3470-0202 | 3470-0199 | 3470-0204 | 3470-0198 |

NOTE


For Frame 12 Drives please consult the Power Module Frame 12 Installation Guide.


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 | <p>Follow the instructions</p> <p>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.</p> |
|--|---|

| | |
|--|--|
|  WARNING | <p>Competence of the installer</p> <p>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.</p> |
|--|--|

| | |
|--|---|
|  WARNING | <p>Enclosure</p> <p>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.</p> |
|--|---|

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 63.

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 59.

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 87.

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.

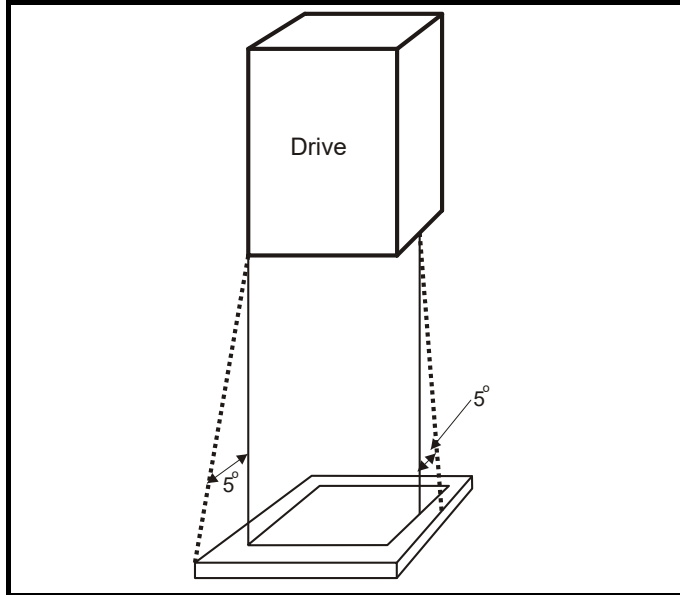
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

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.

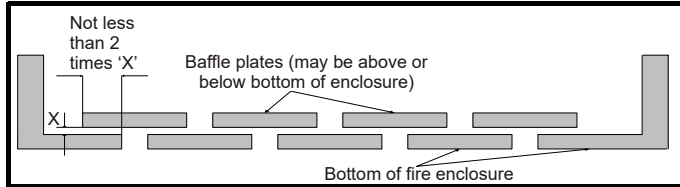
The location and size of the bottom shall cover the area shown in Figure 3-1. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

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 115.*

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



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.

WARNING

3.3.1 Removing the terminal covers

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

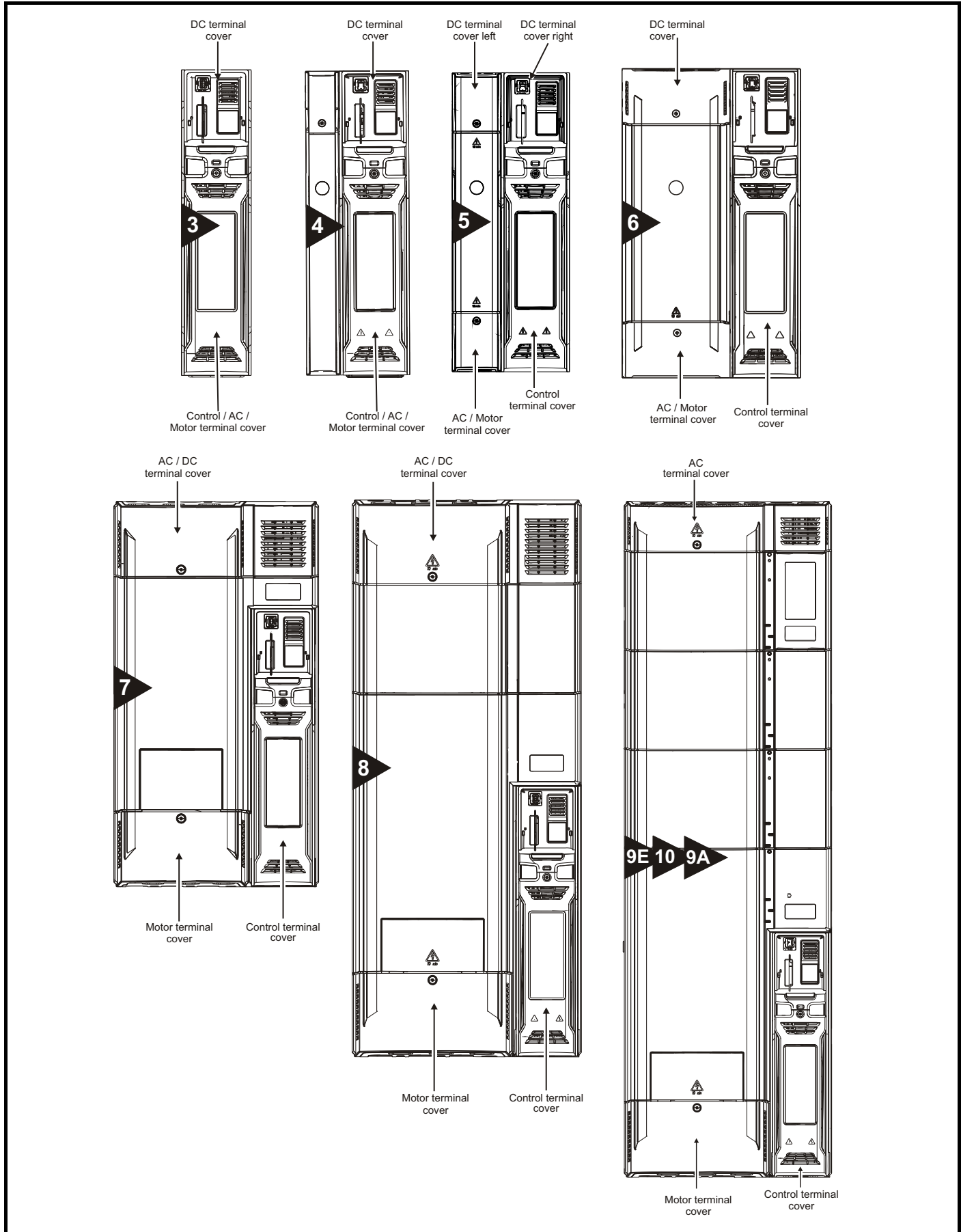


Figure 3-4 Location and identification of terminal covers (size 11)

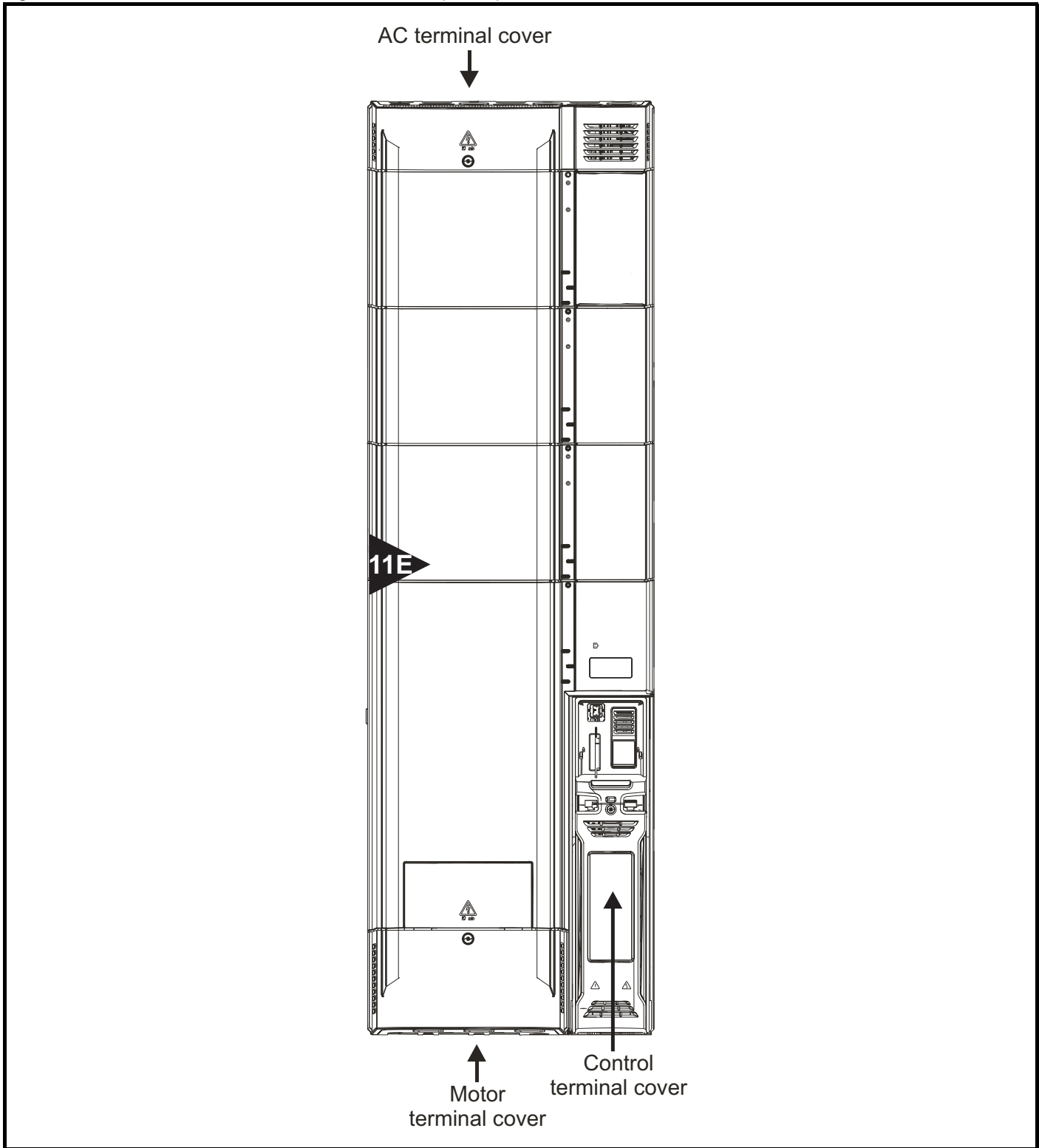
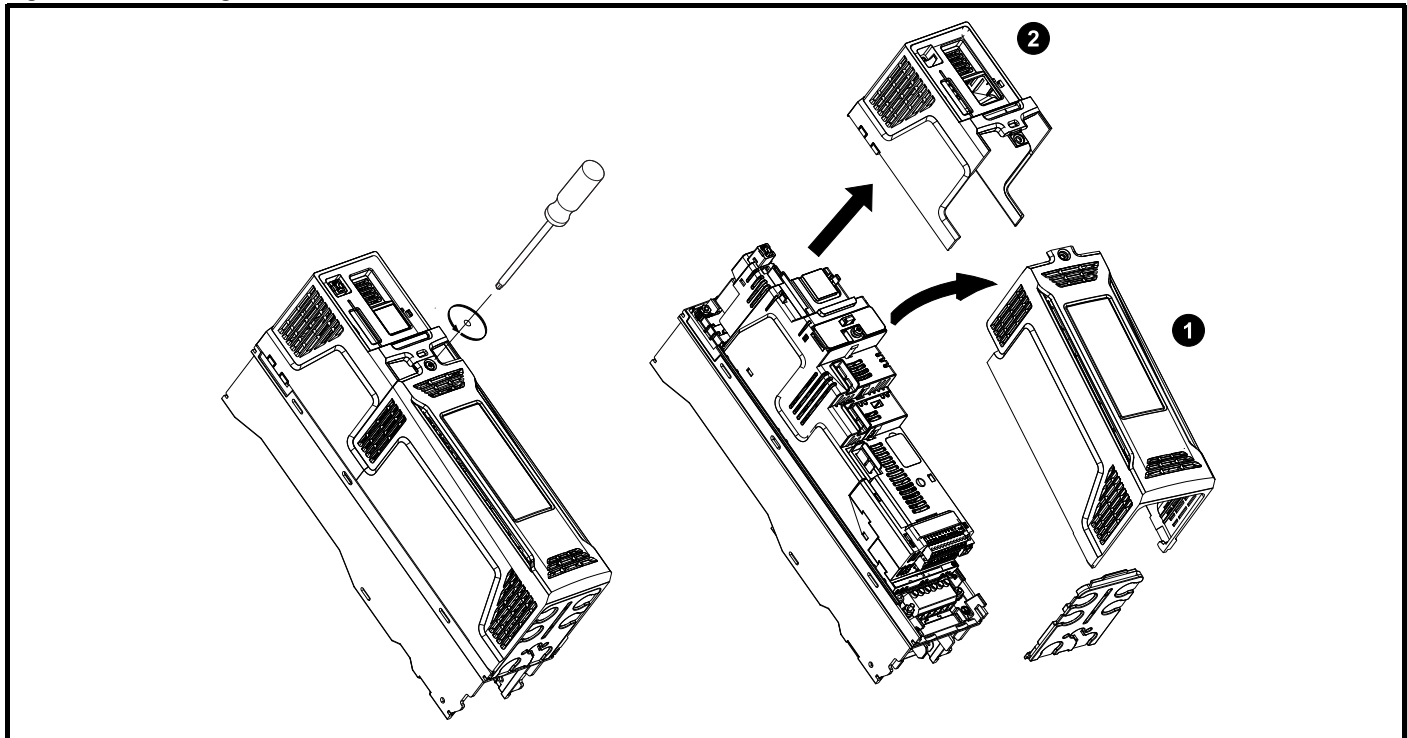


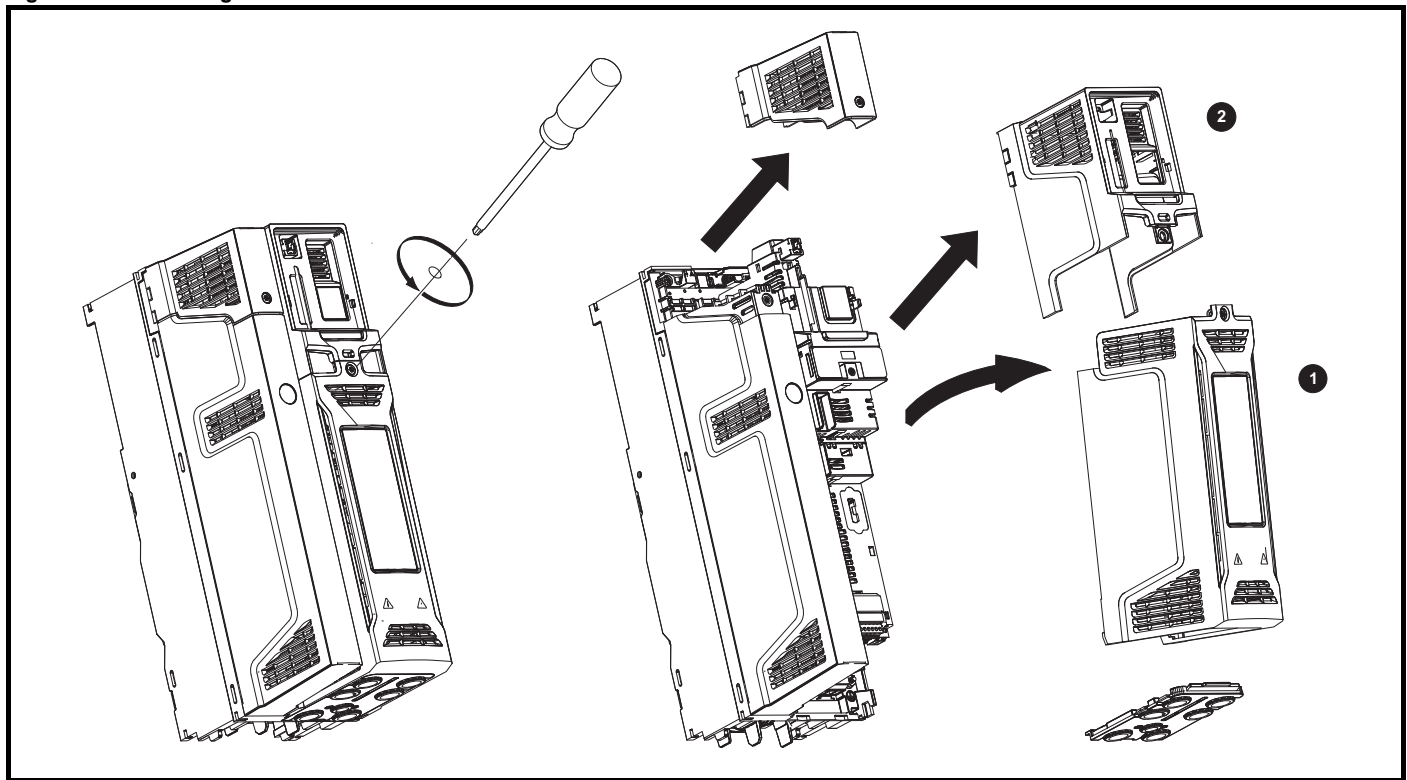
Figure 3-5 Removing the size 3 terminal covers



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 Nm (8.4 lb in).

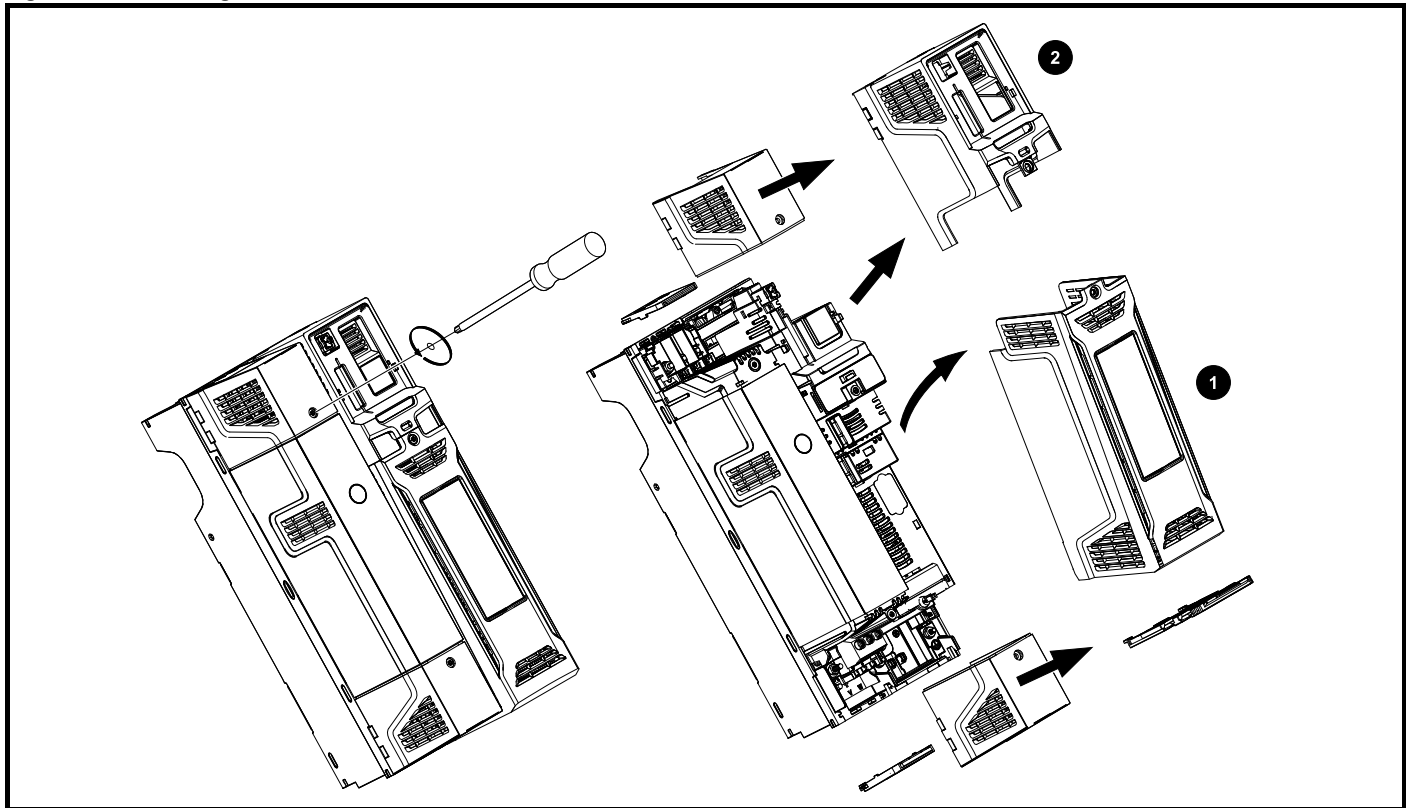
Figure 3-6 Removing the size 4 terminal covers



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 Nm (8.4 lb in).

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 Nm (8.4 lb in).

Figure 3-8 Removing the size 6 terminal covers

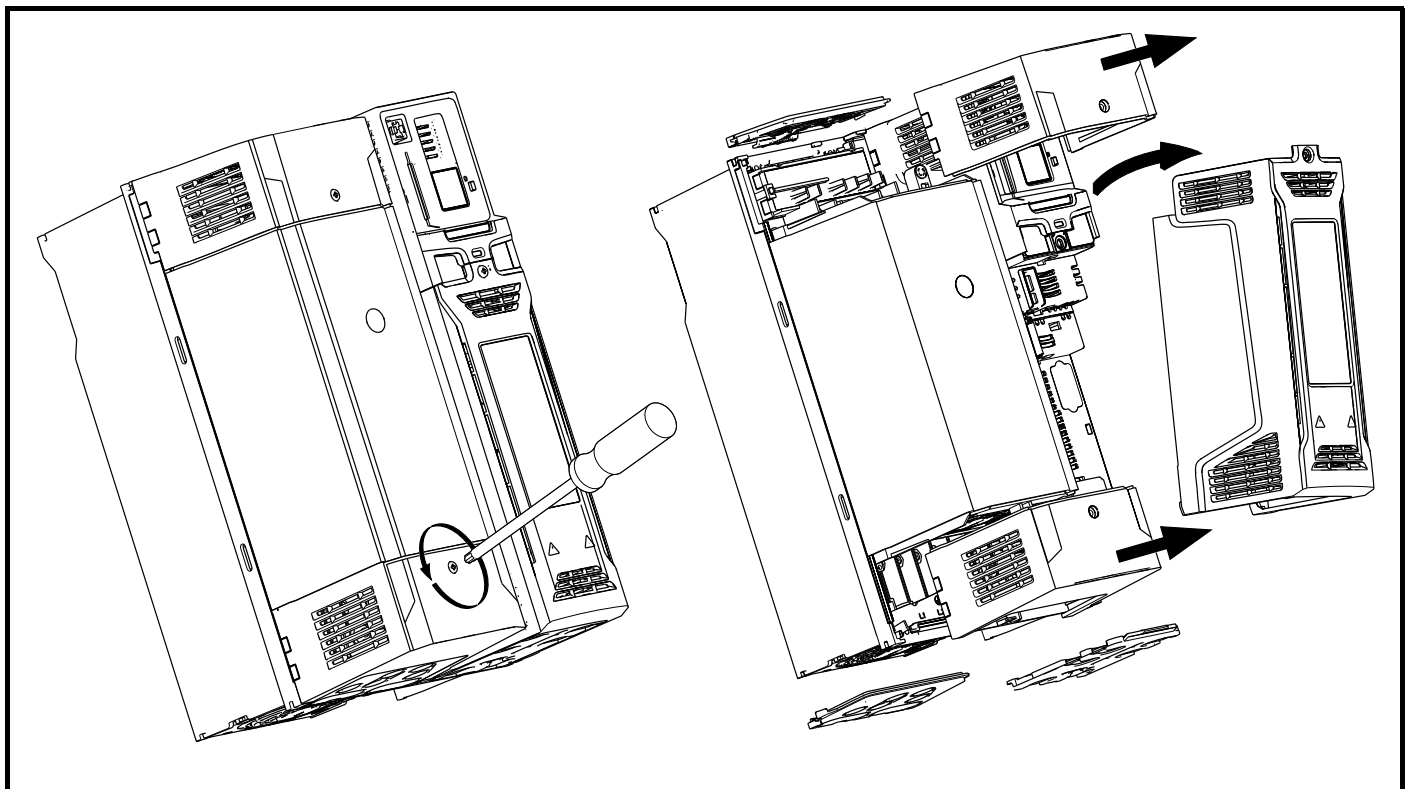
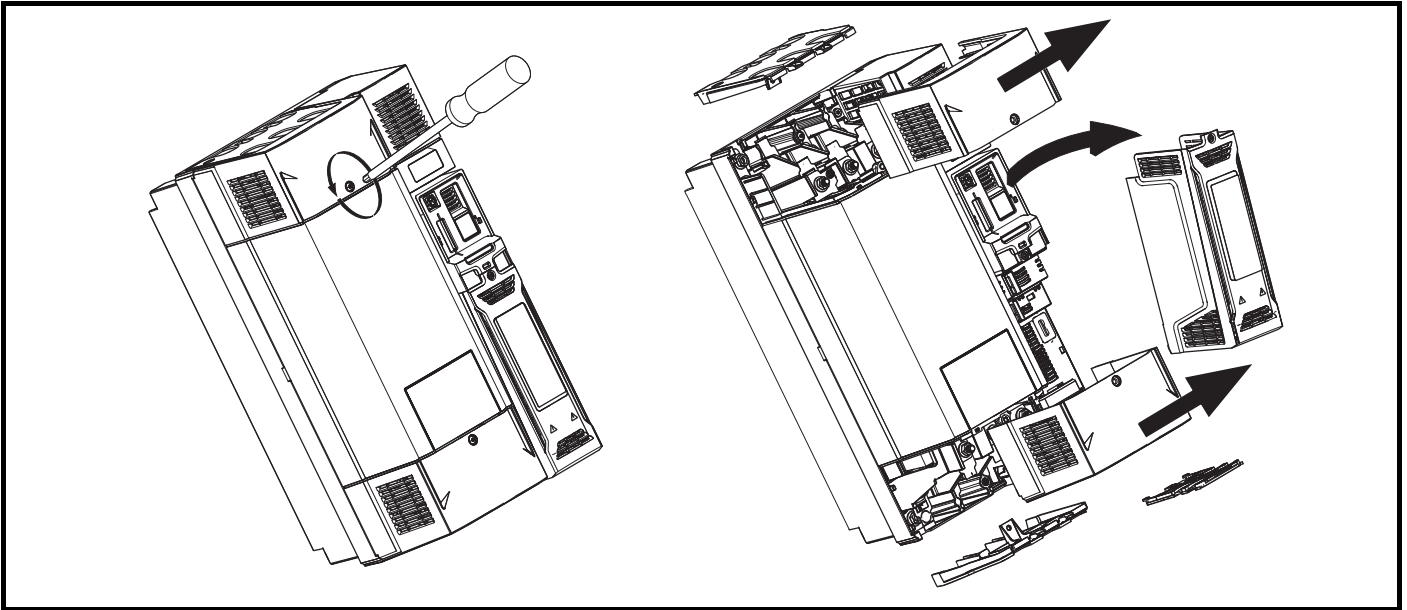
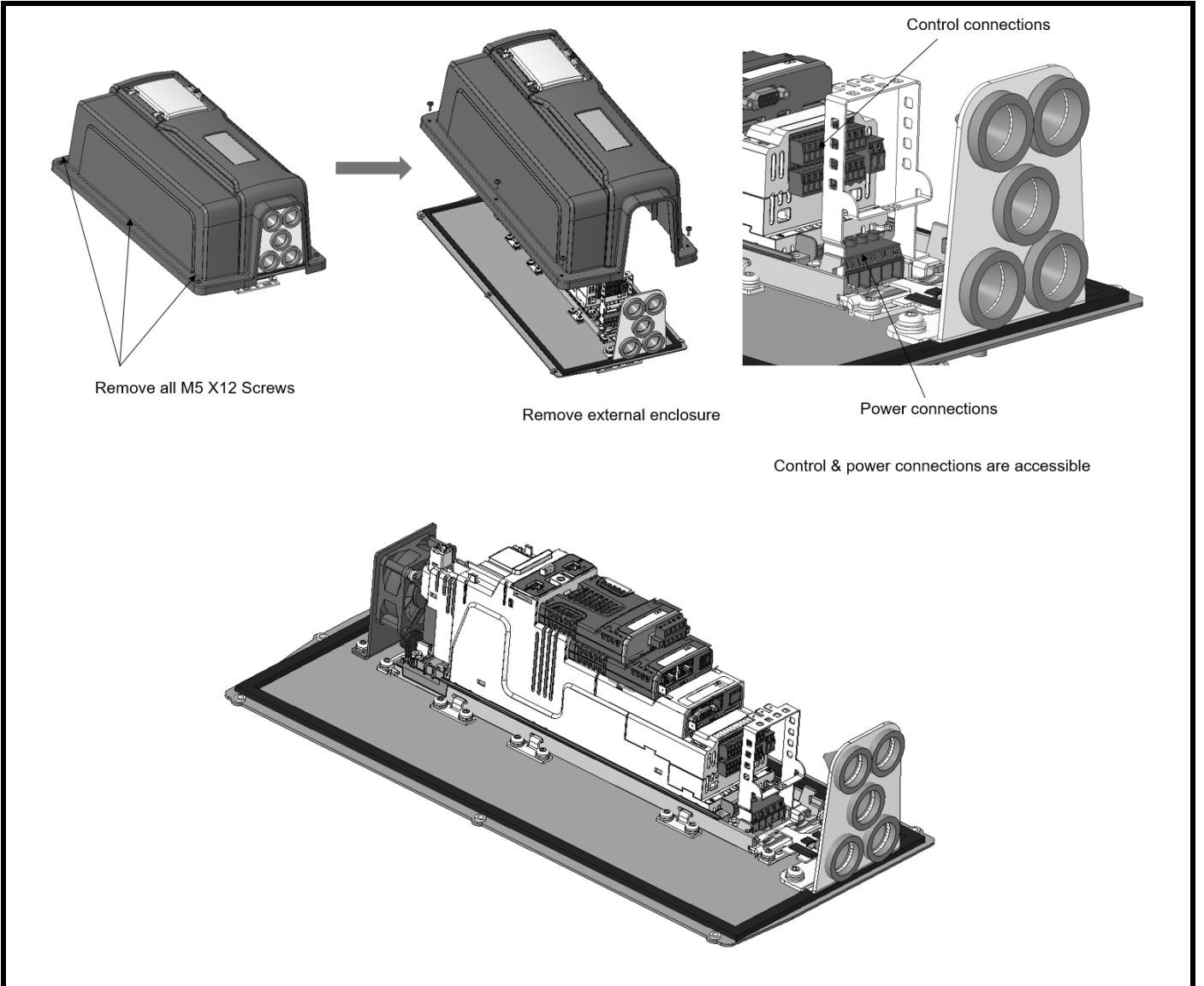


Figure 3-9 Removing the size 7 to 11 terminal covers (size 7 shown)



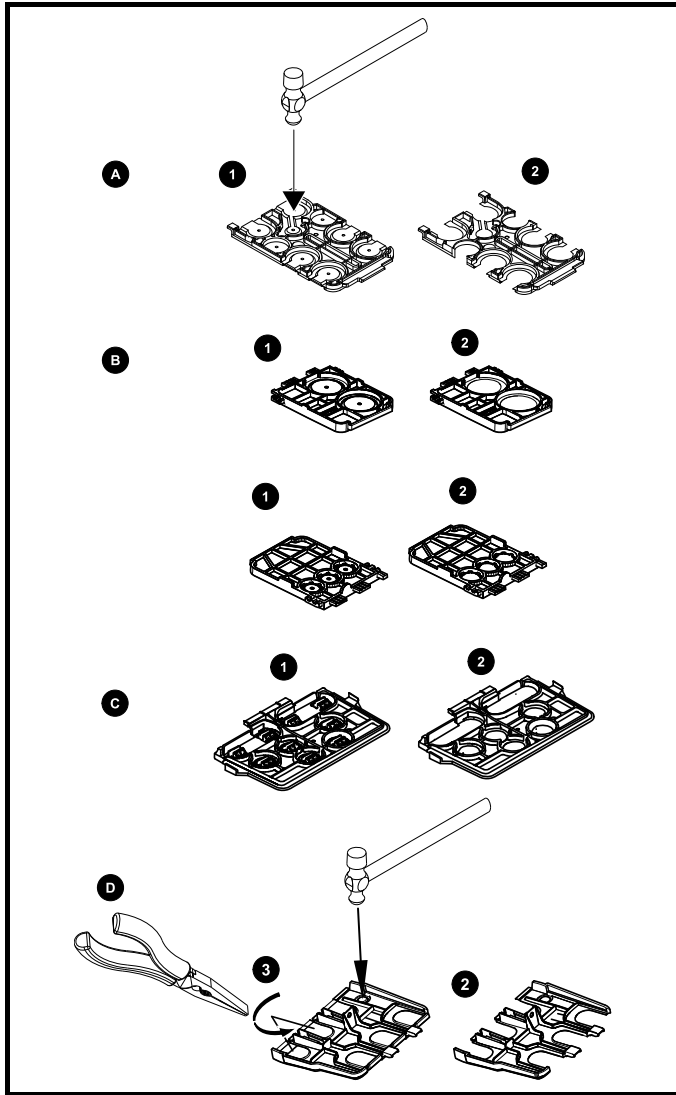
When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 Nm (8.4 lb in).

Figure 3-10 High IP Access to control and power terminals



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

Figure 3-11 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.

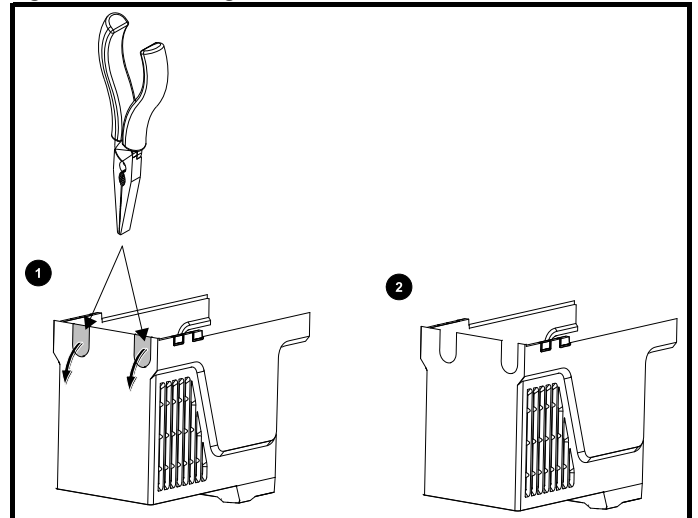
Grommet kits are available for size 7 to 10 finger guards. For size 8 to 10, two versions are available allowing for either single or double cable entries.

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 3-12 Removing the size 3 and 4 DC terminal cover break-outs



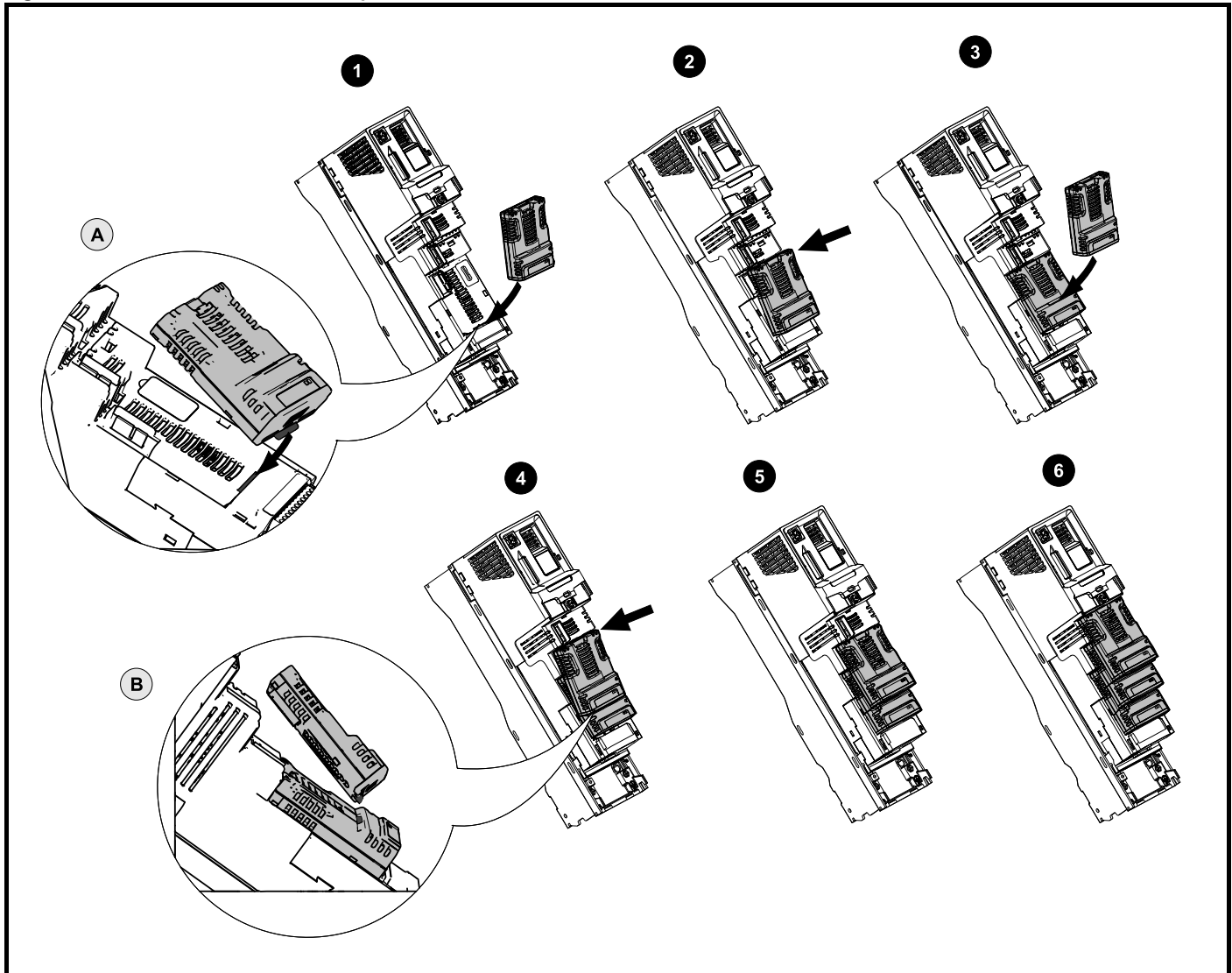
Grasp the DC terminal cover break-outs with pliers as shown (1) and pull down in the direction shown to remove. Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed. Use the DC terminal cover grommets supplied in the accessory box (Table 2-13 on page 28) to maintain the seal at the top of the drive.

3.4 Installing / removing option modules and keypads



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

Figure 3-13 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 22 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

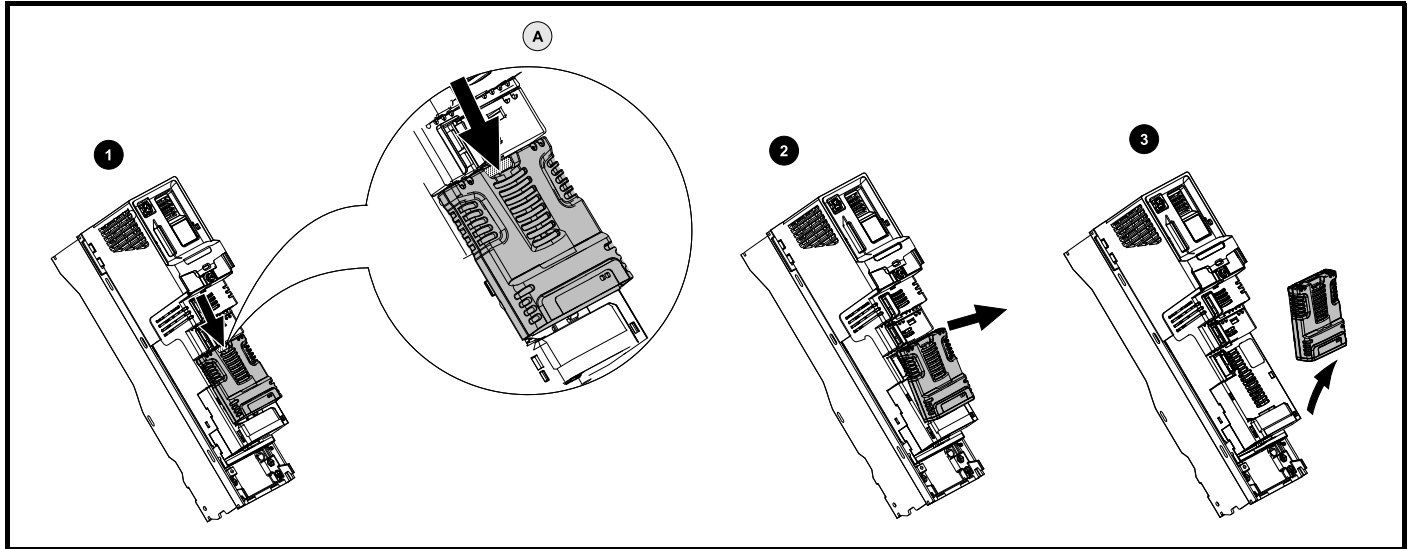
- Move the option module in direction shown (3).
- Align and insert the option module tab in to the slot provided on the already installed option module (4), this is highlighted in the detailed view (B).
- Press down on the option module until it clicks into place. Image (5) shows two option modules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

Installing the third option module

- Repeat the above process.

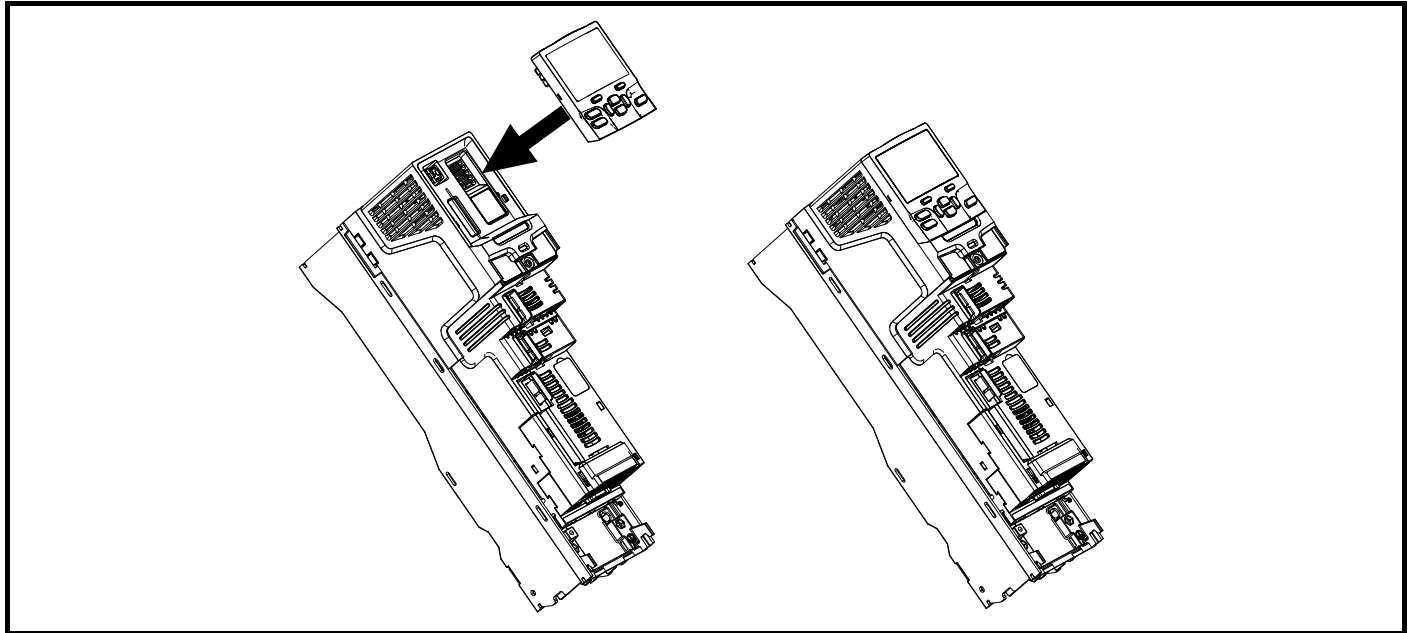
The drive has the facility for all three option module slots to be used at the same time, image (6) shows the three option modules installed.

Figure 3-14 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 3-15 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 |



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.



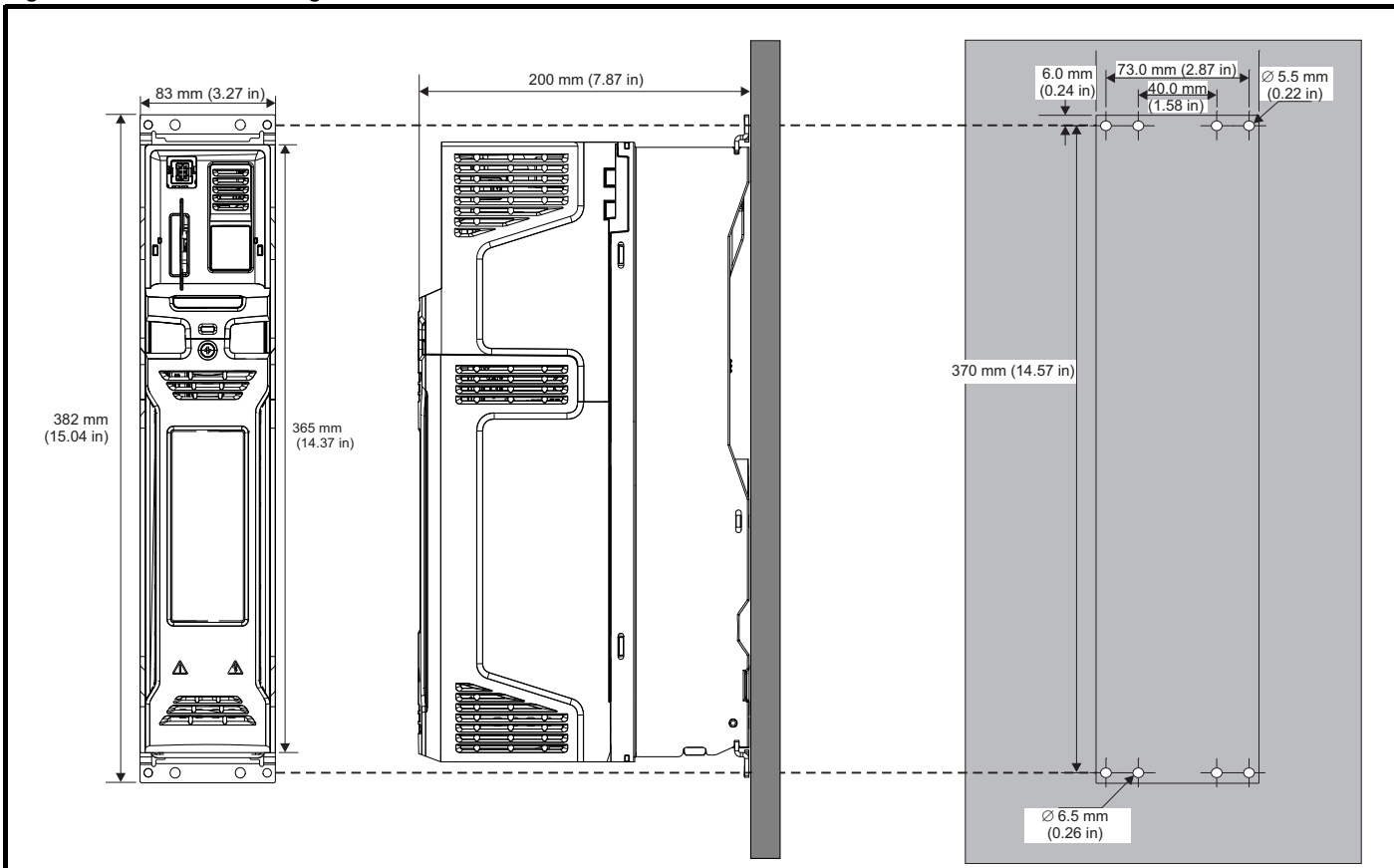
Many of the drives in this product range weigh in excess of 15 kg (33 lb). Use appropriate safeguards when lifting these models. A full list of drive weights can be found in section 12.1.19 *Weights* on page 286.

NOTE

For size 12 drives please refer to Unidrive M Power Module Frame 12 Installation Guide for information.

3.5.1 Surface mounting

Figure 3-16 Surface mounting the size 3 drive

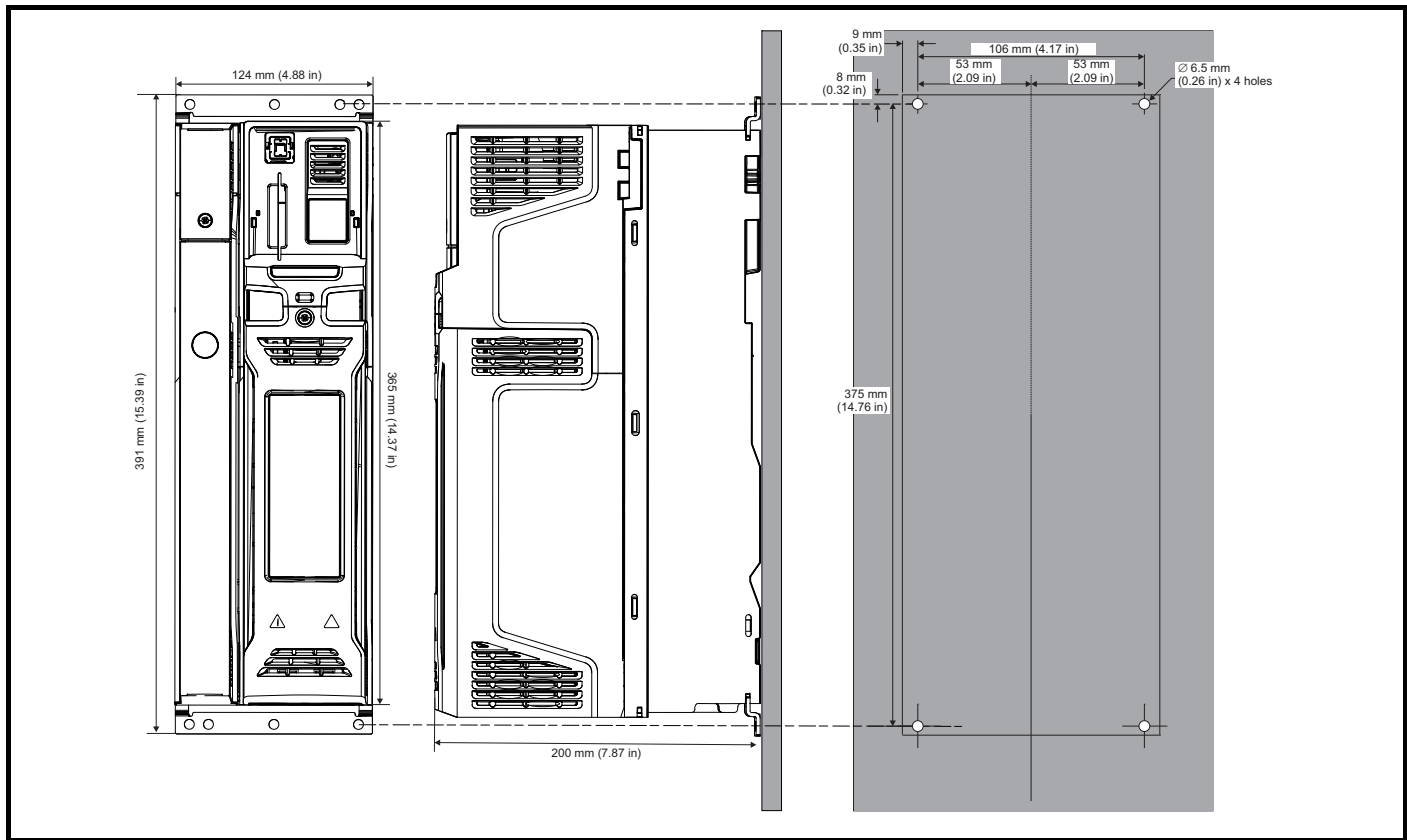


NOTE

| | | | | | | | | | | | | | |
|--------------------|---------------------|--------------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|--------------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|

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.

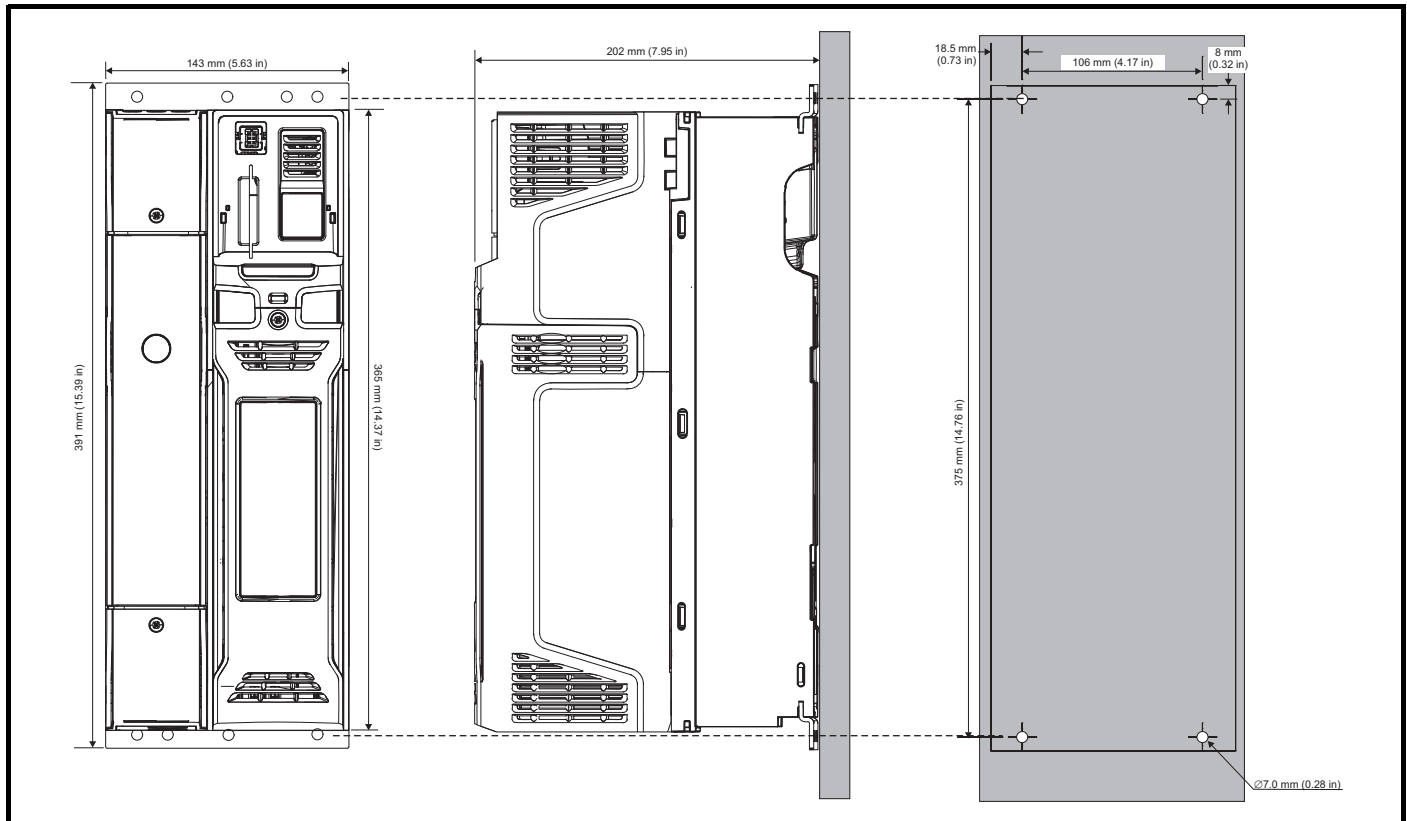
Figure 3-17 Surface mounting the size 4 drive



NOTE

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

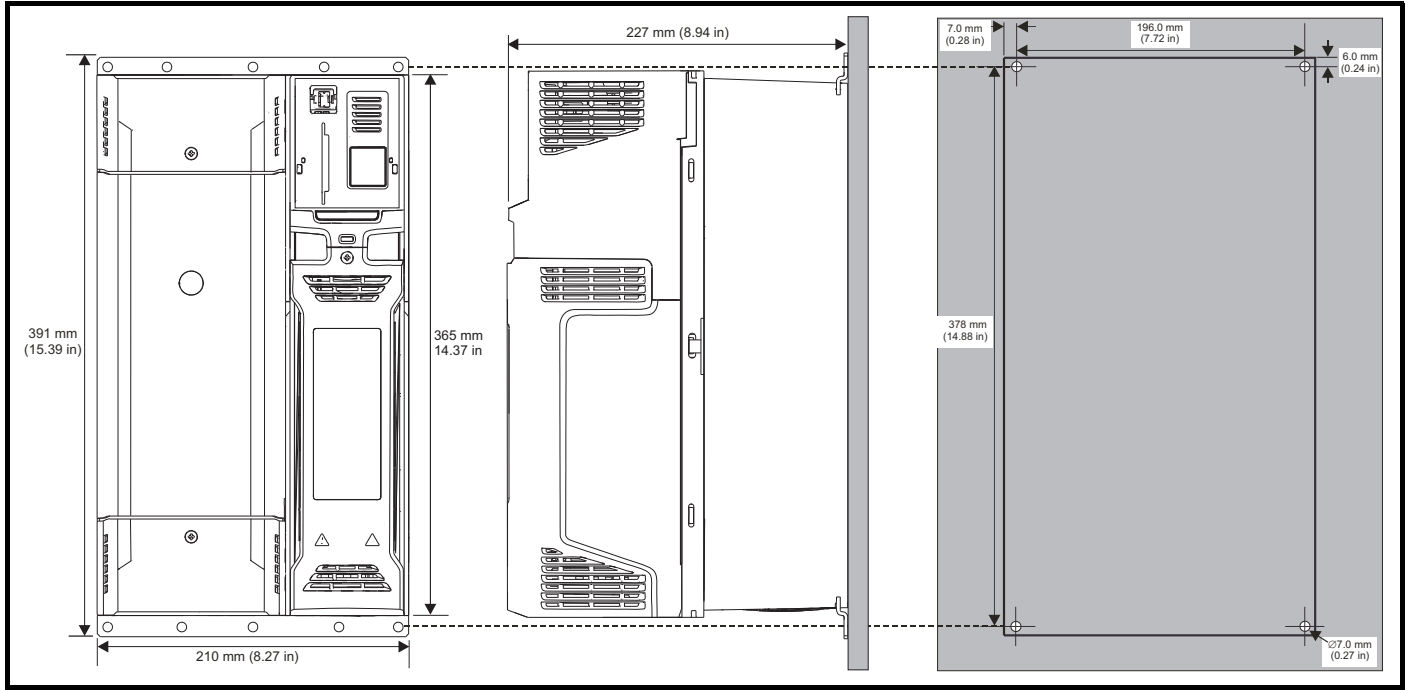
Figure 3-18 Surface mounting the size 5 drive



NOTE

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

Figure 3-19 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 3-20 Surface mounting the size 7 drive

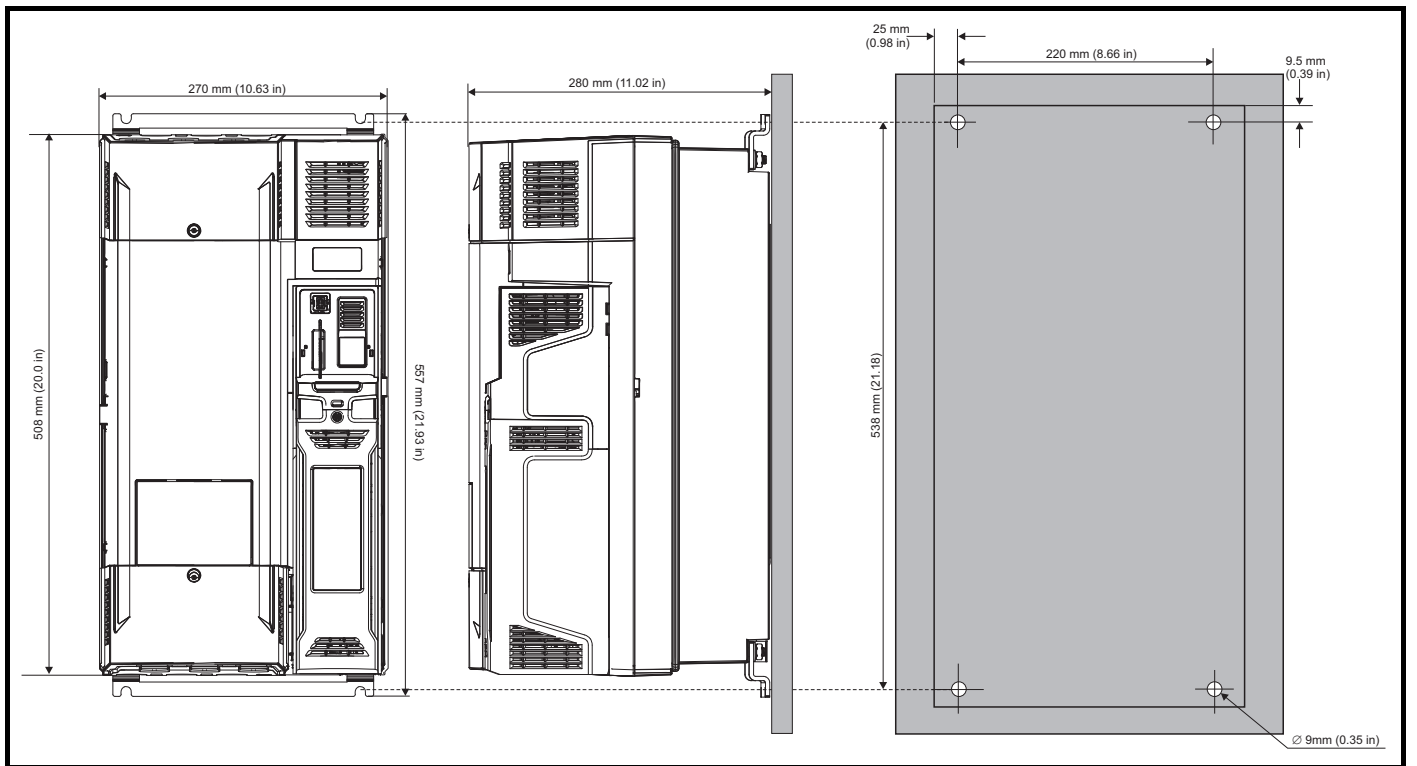


Figure 3-21 Surface mounting the size 8 drive

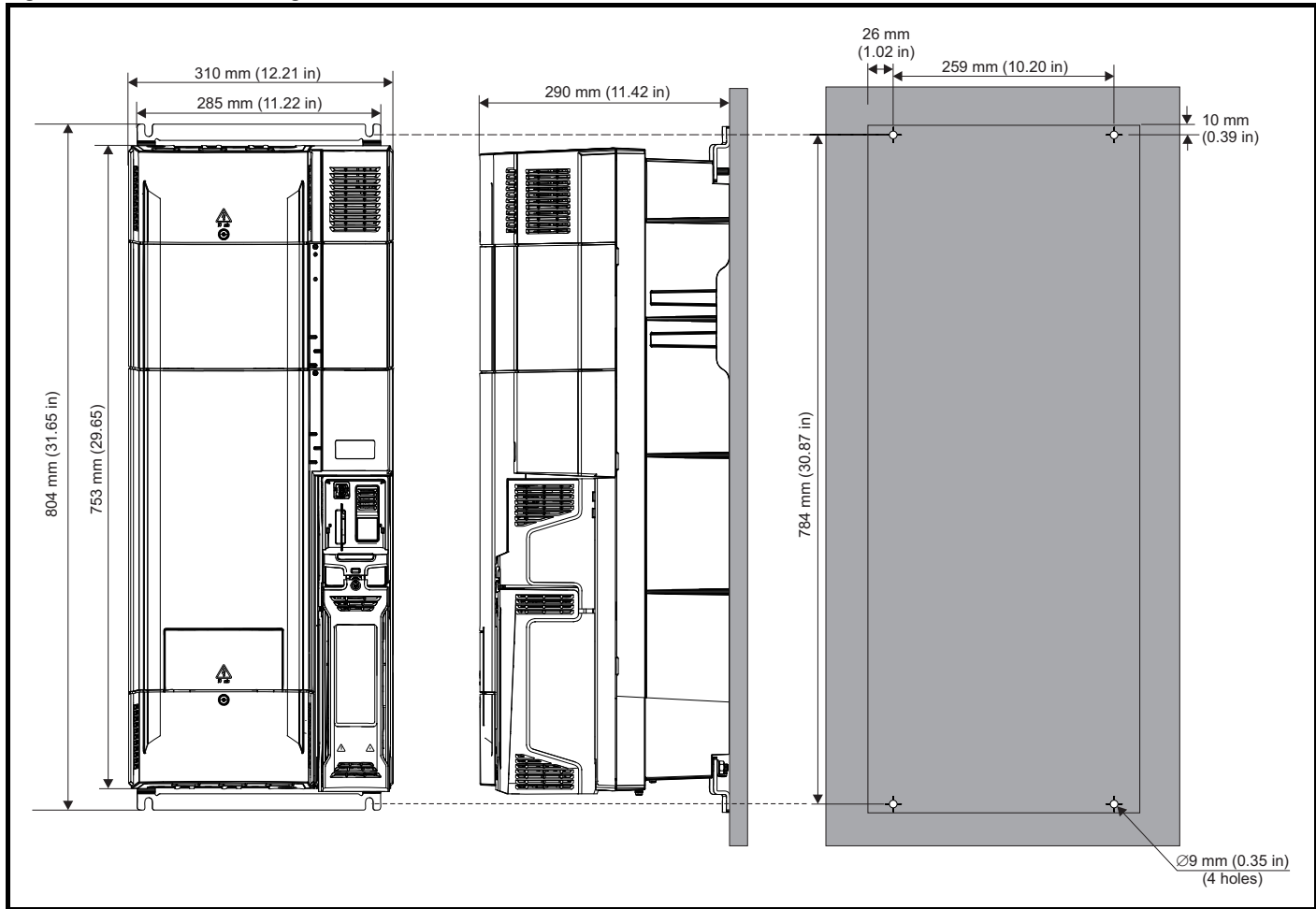


Figure 3-22 Surface mounting the size 9A

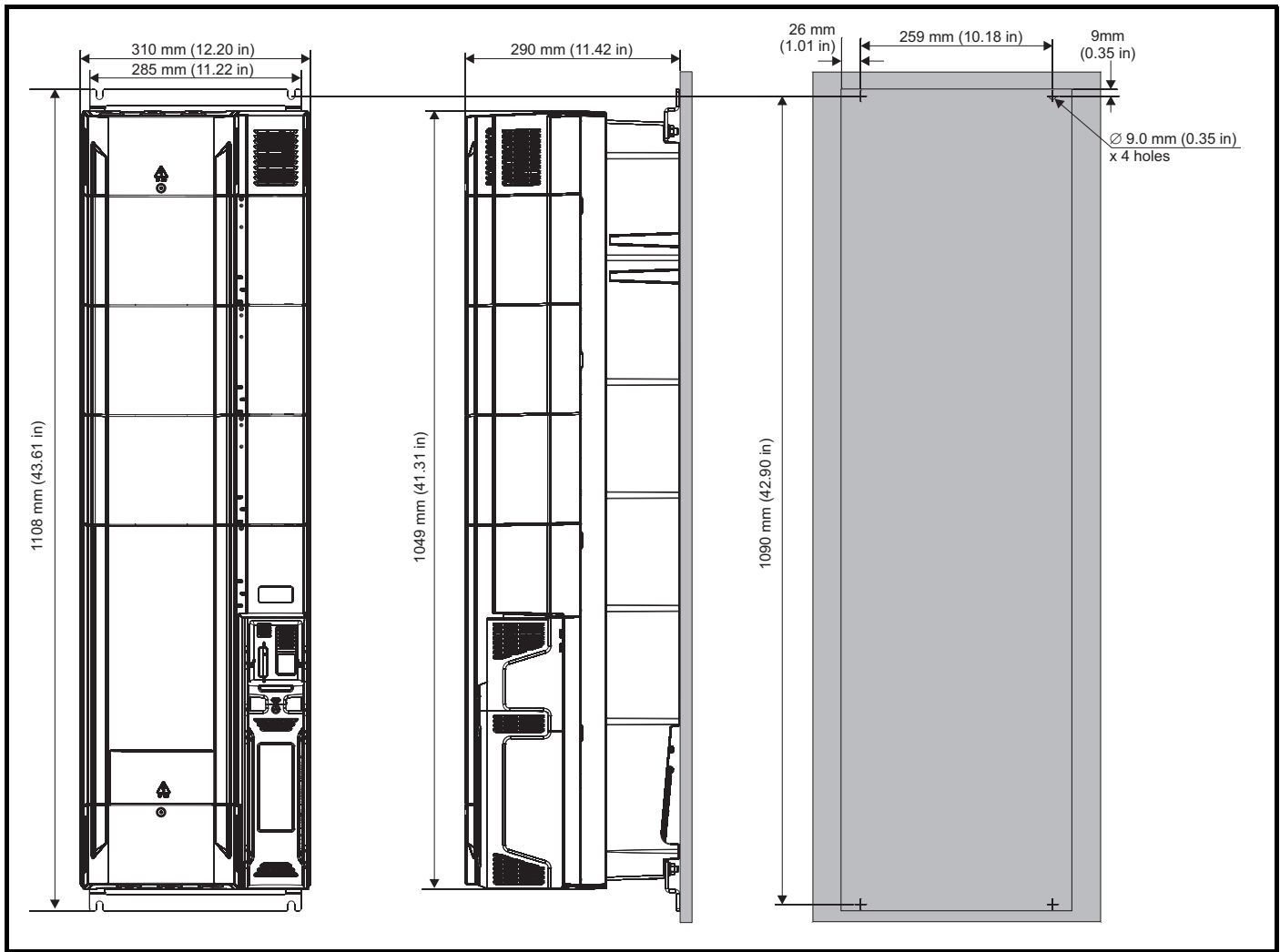


Figure 3-23 Surface mounting the size 9E and 10E

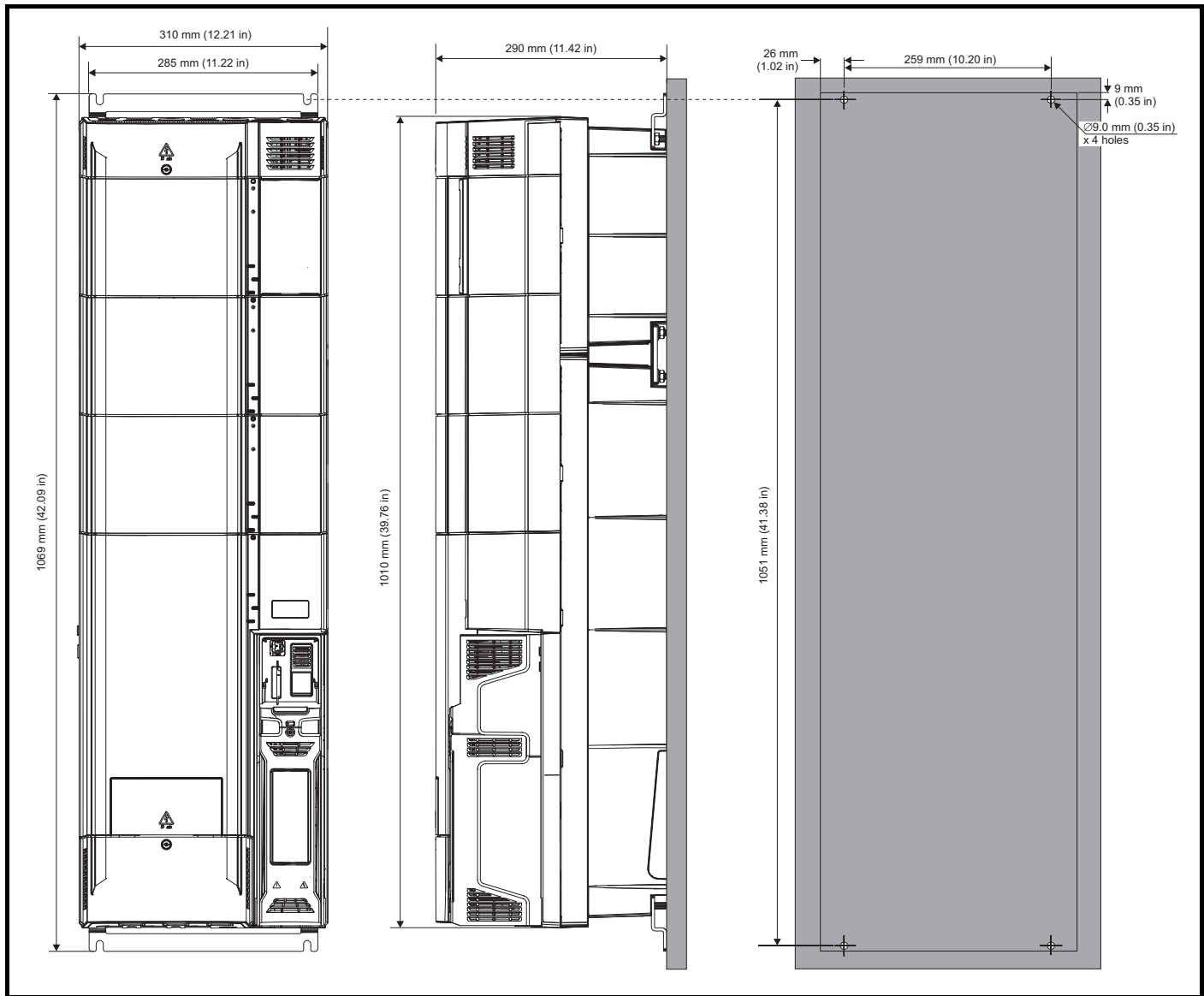


Figure 3-24 Surface mounting the size 11E

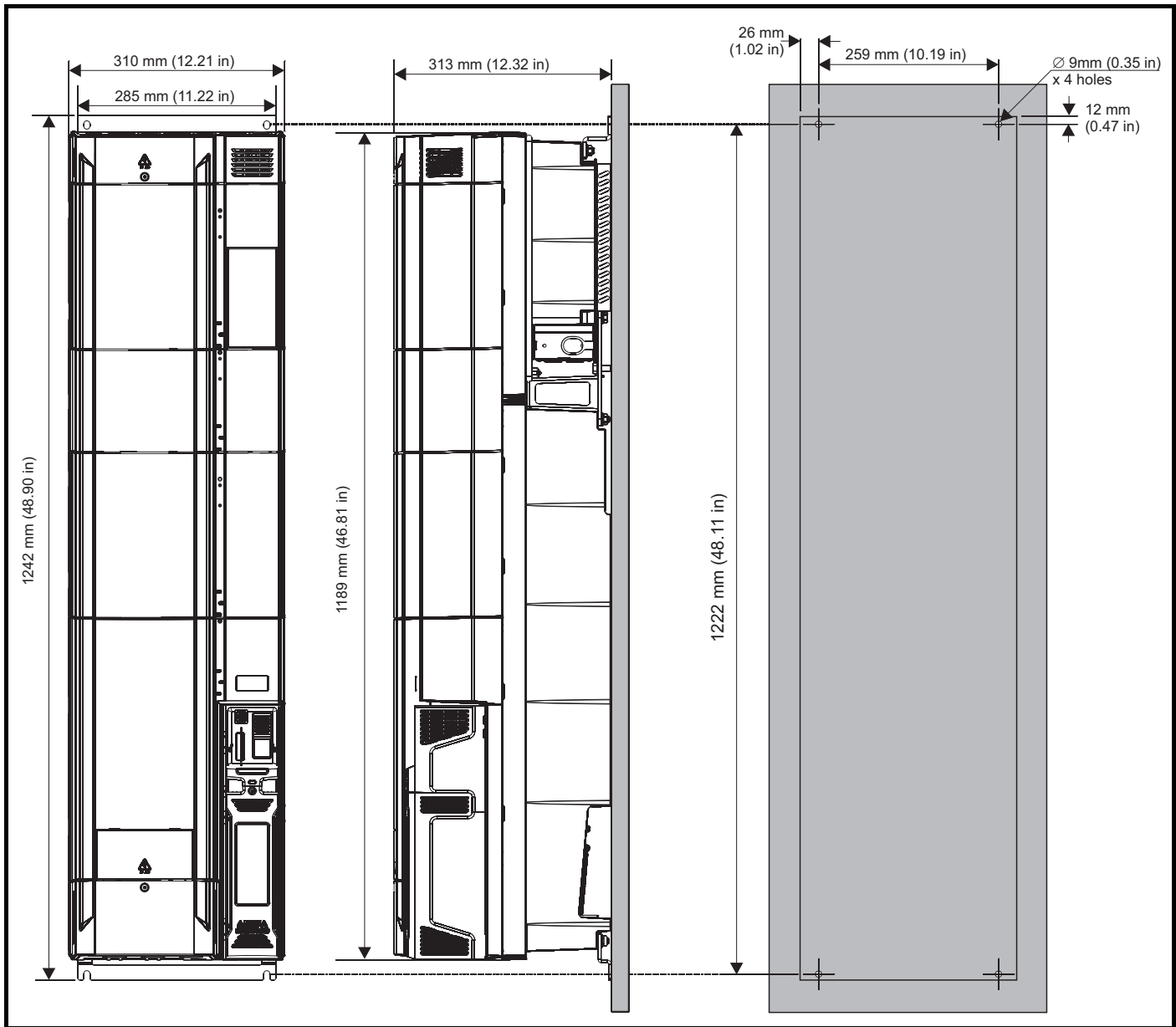
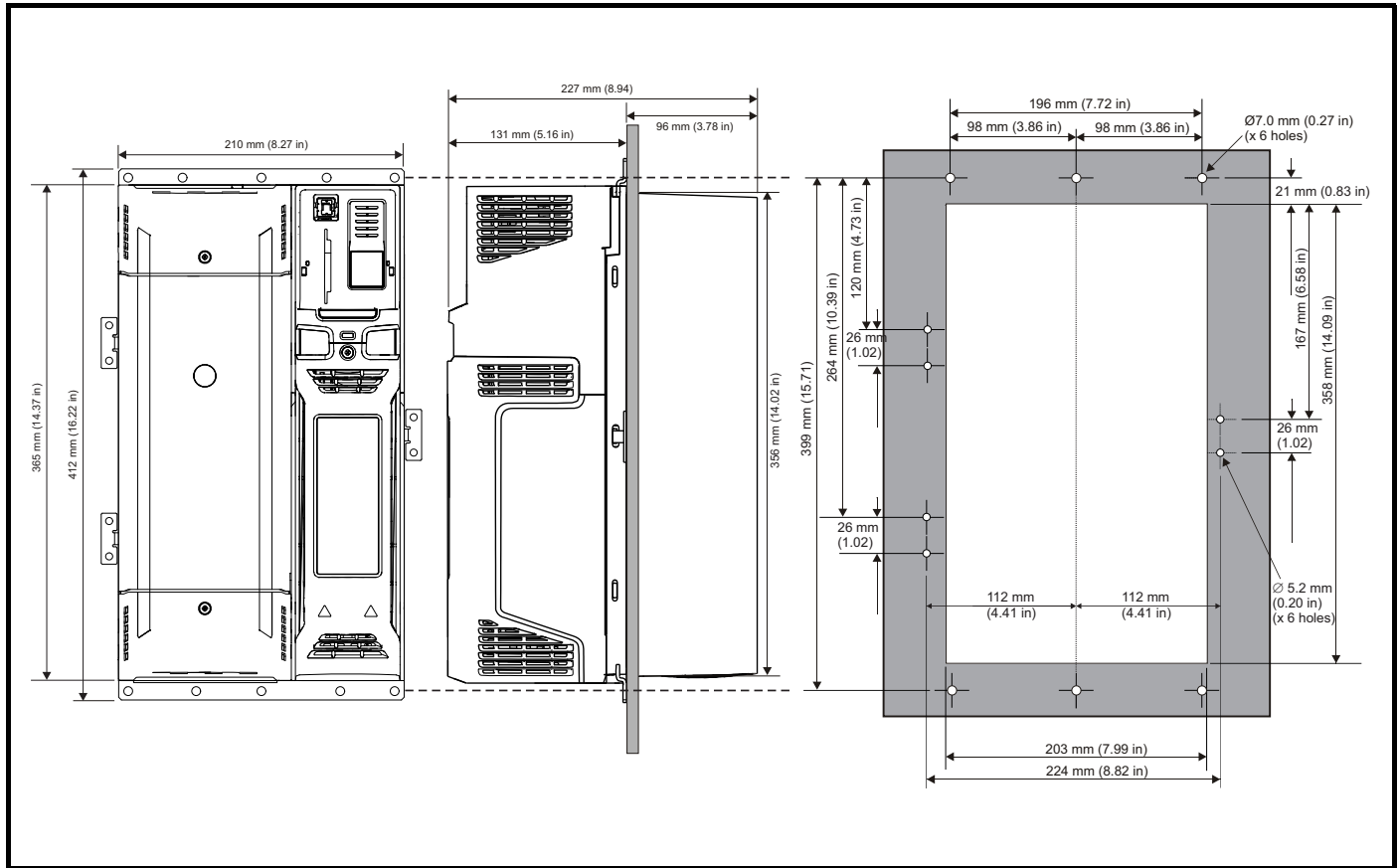


Figure 3-28 Through panel mounting the size 6 drive



NOTE

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

Figure 3-29 Through panel mounting the size 7 drive

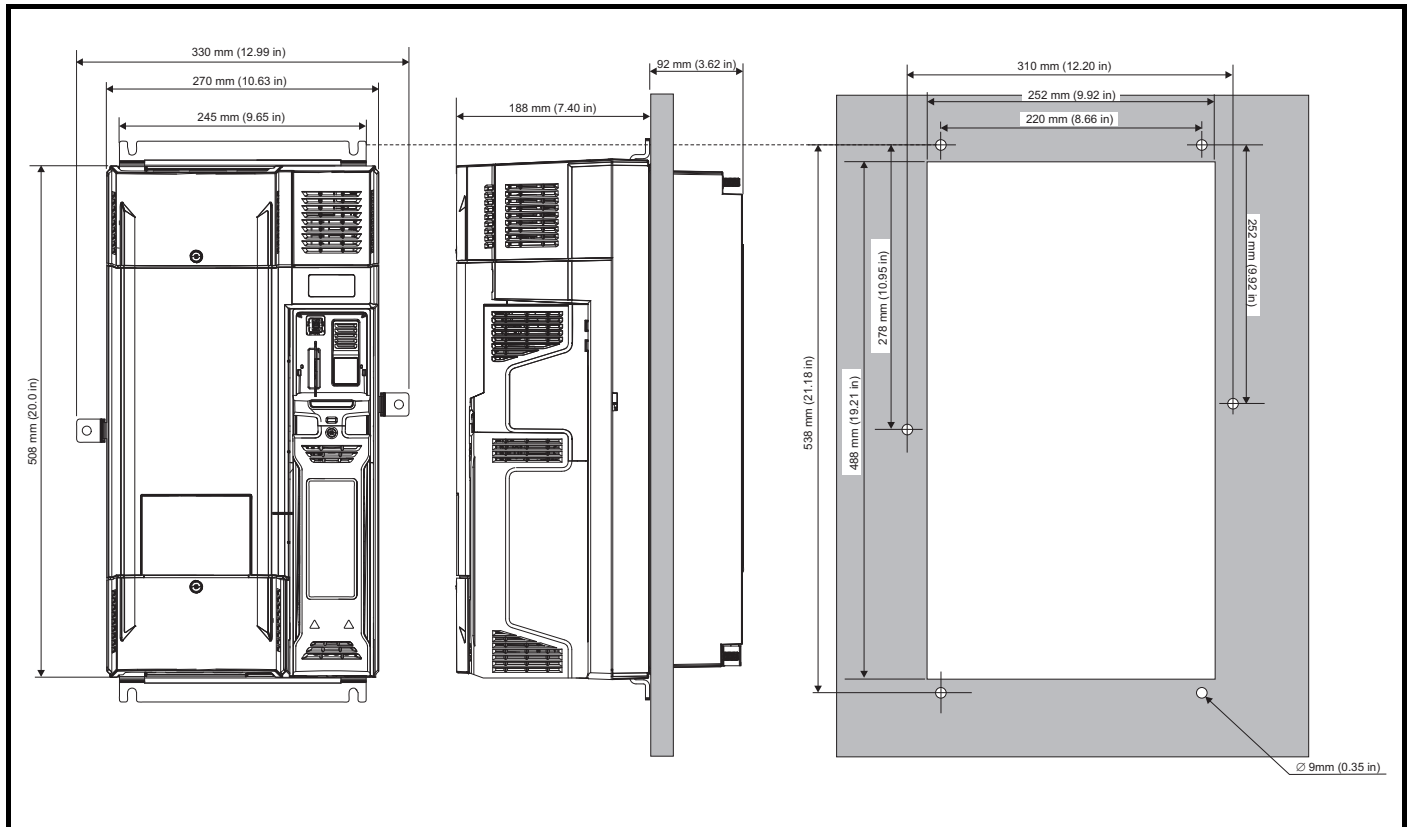


Figure 3-30 Through panel mounting the size 8 drive

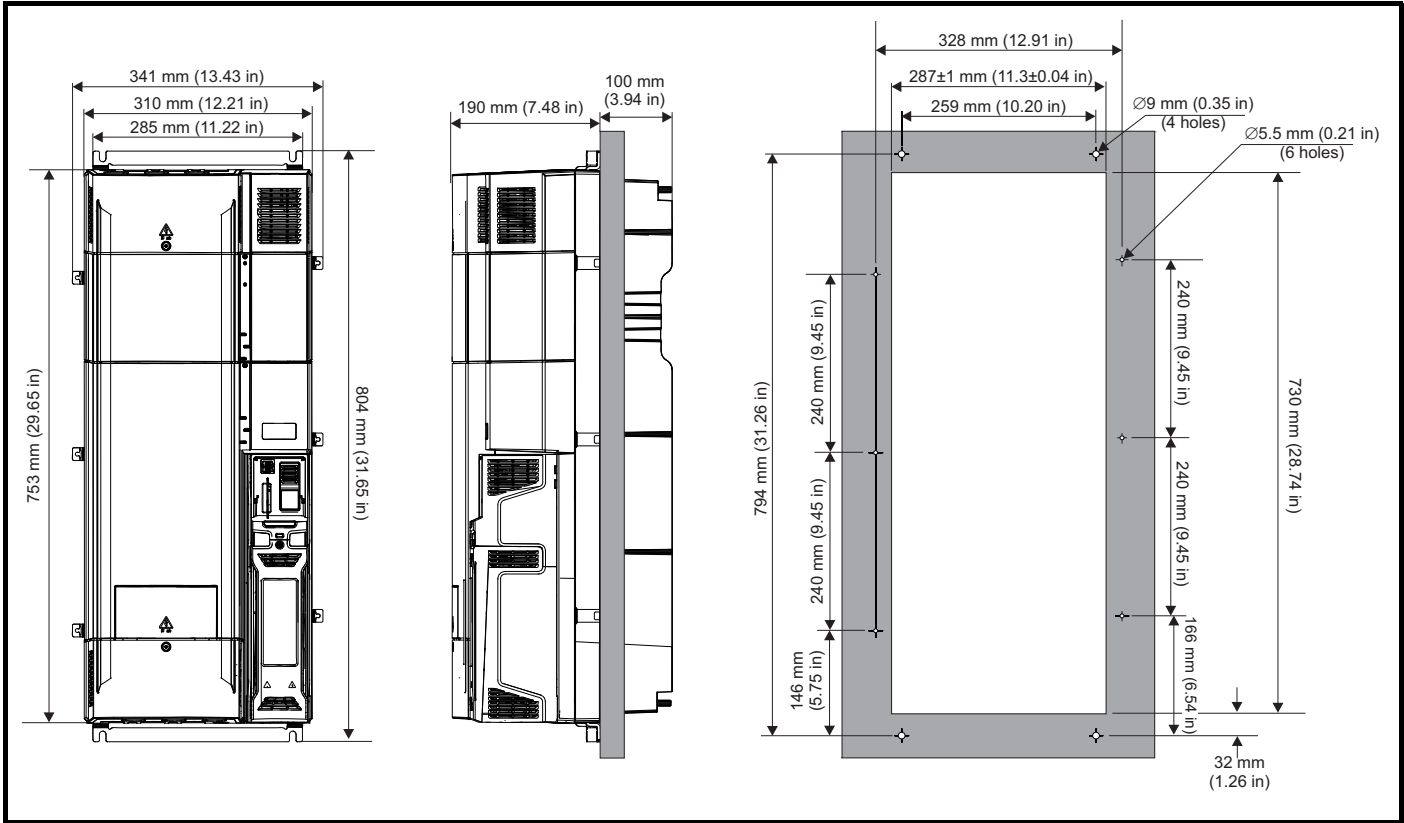


Figure 3-31 Through panel mount detail for size 9A

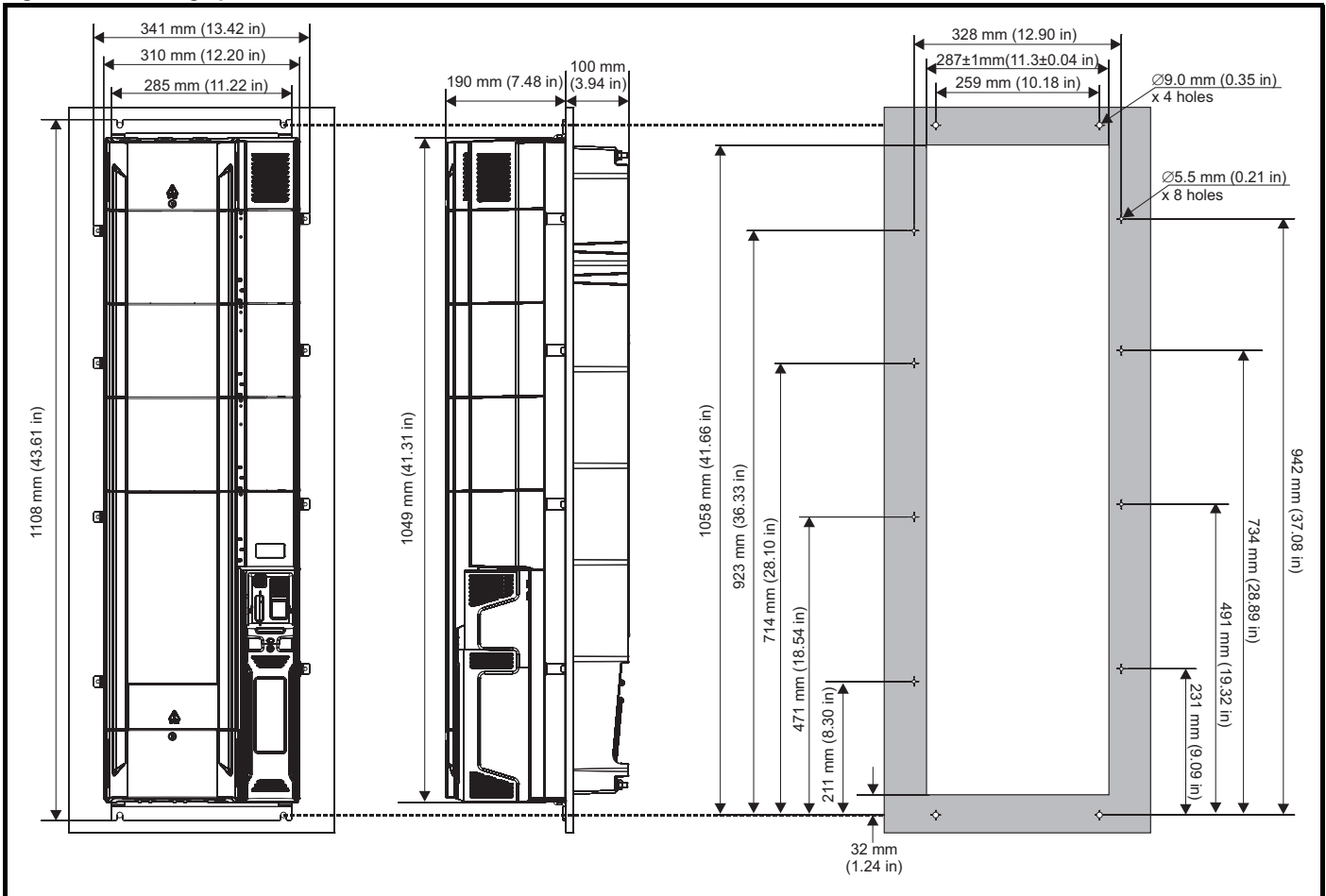


Figure 3-33 Through panel mounting the size 11E

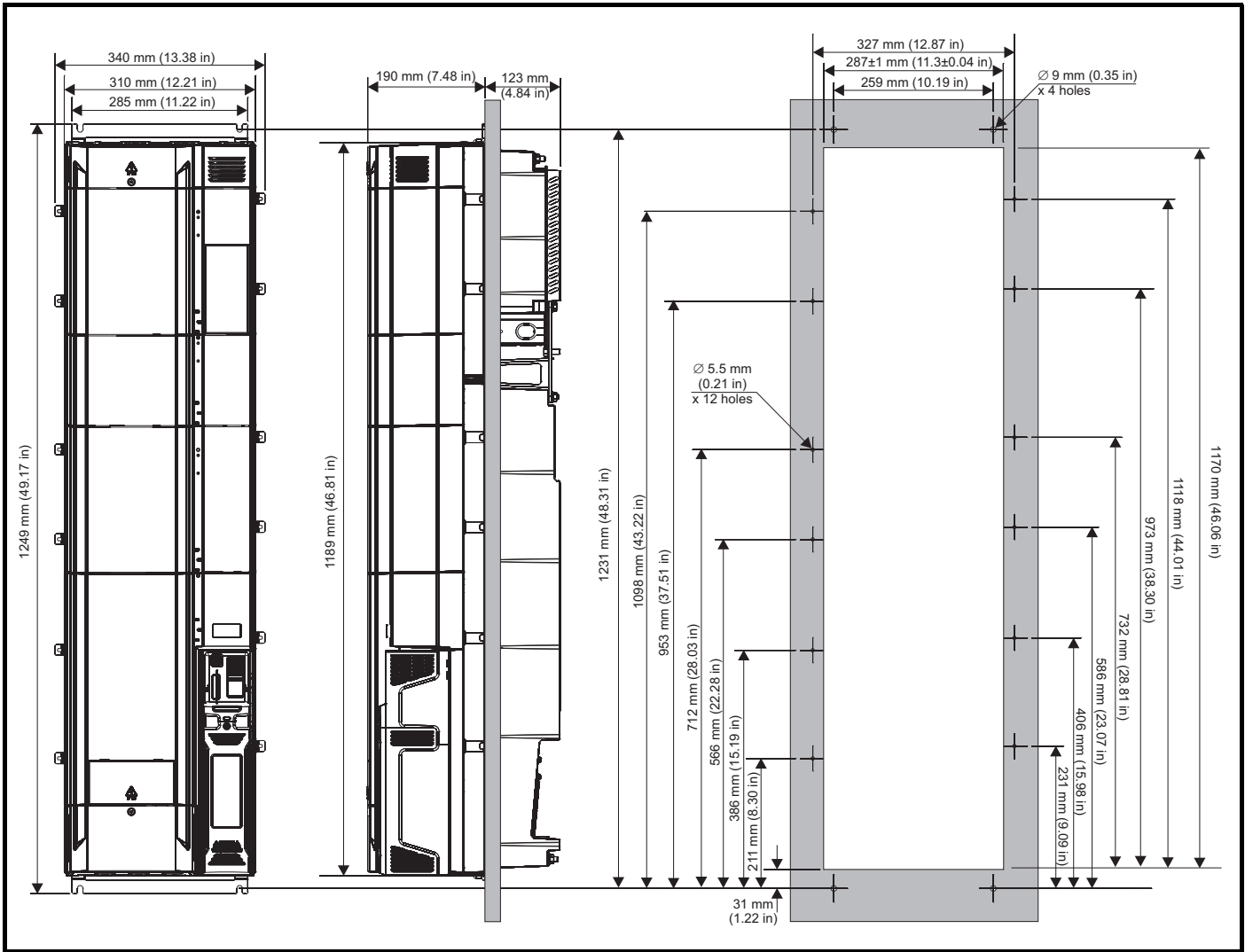


Figure 3-34 Size 3 High IP Drive and Mounting Hole Dimensions

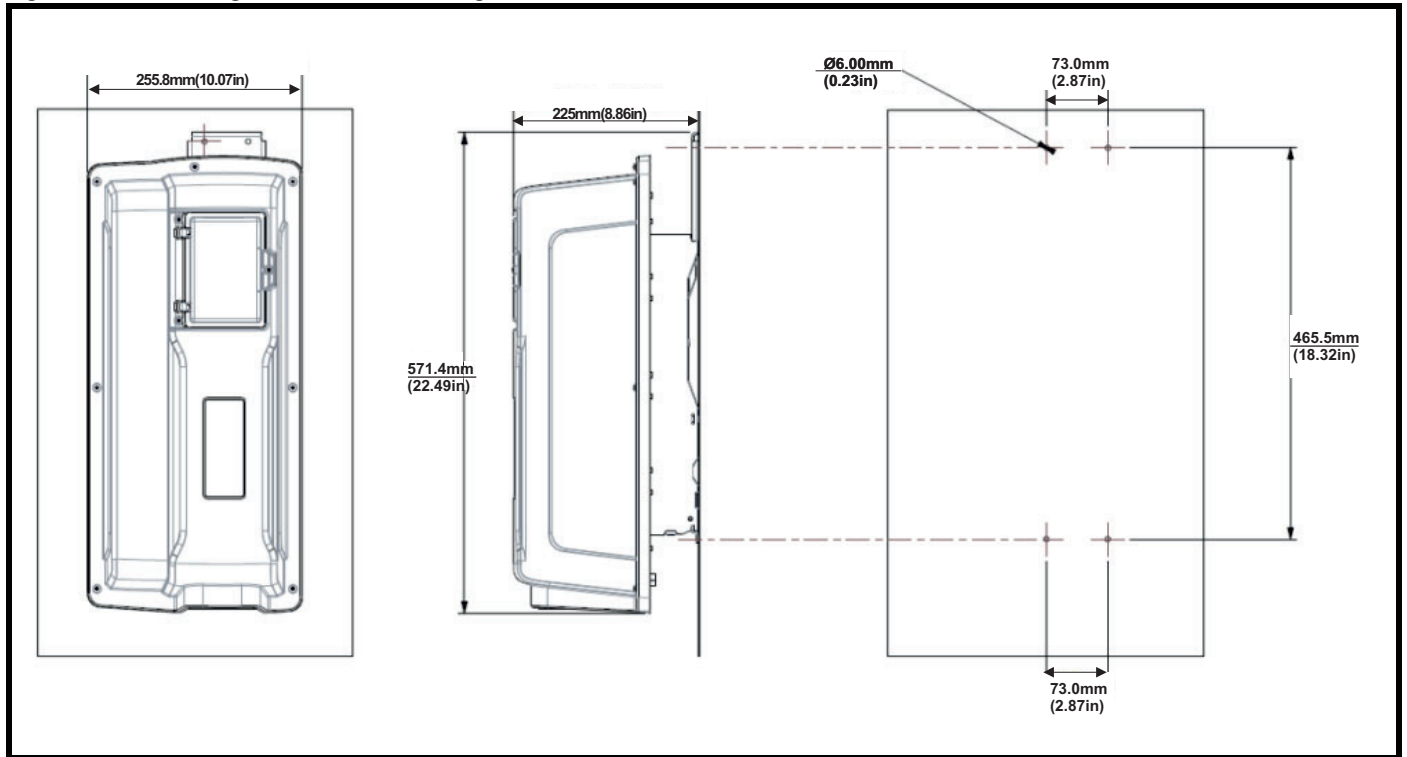


Figure 3-35 Size 4 High IP Drive and Mounting Hole Dimensions

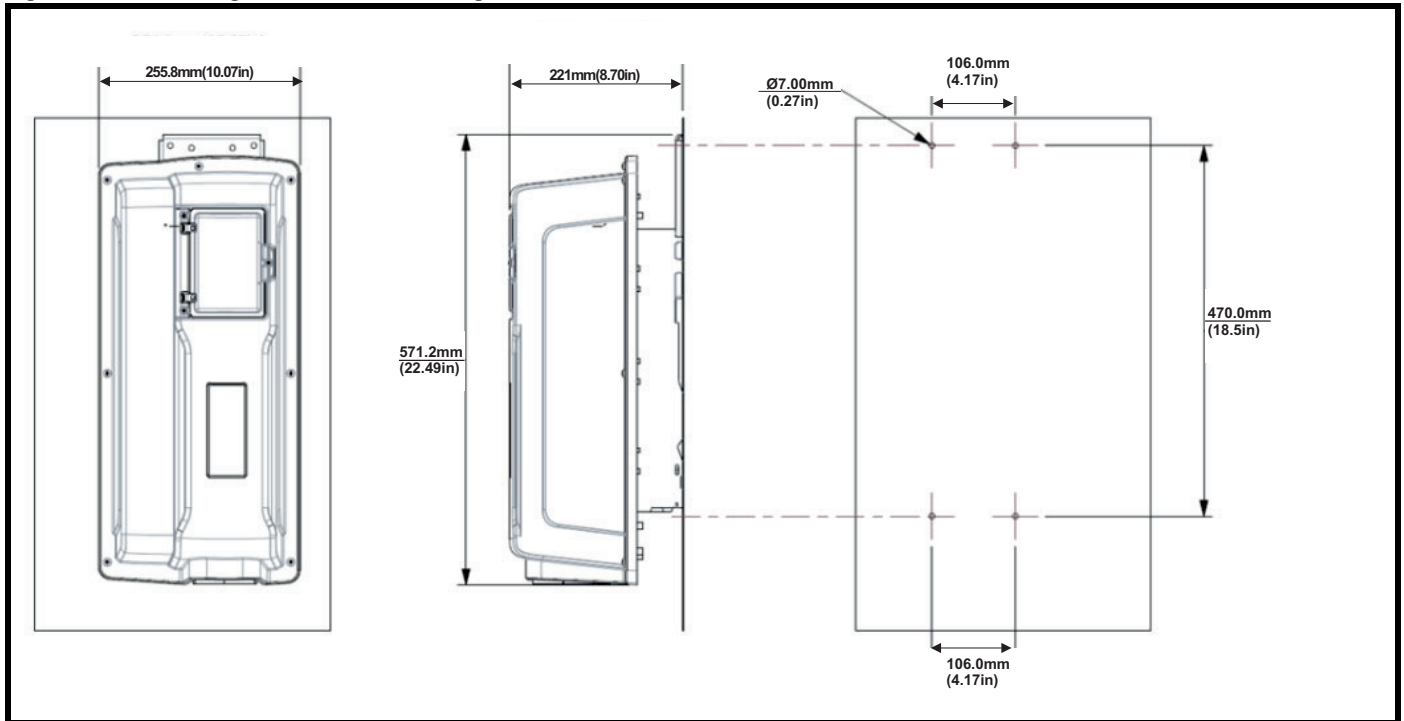


Figure 3-36 Size 5 High IP Drive and Mounting Hole Dimensions

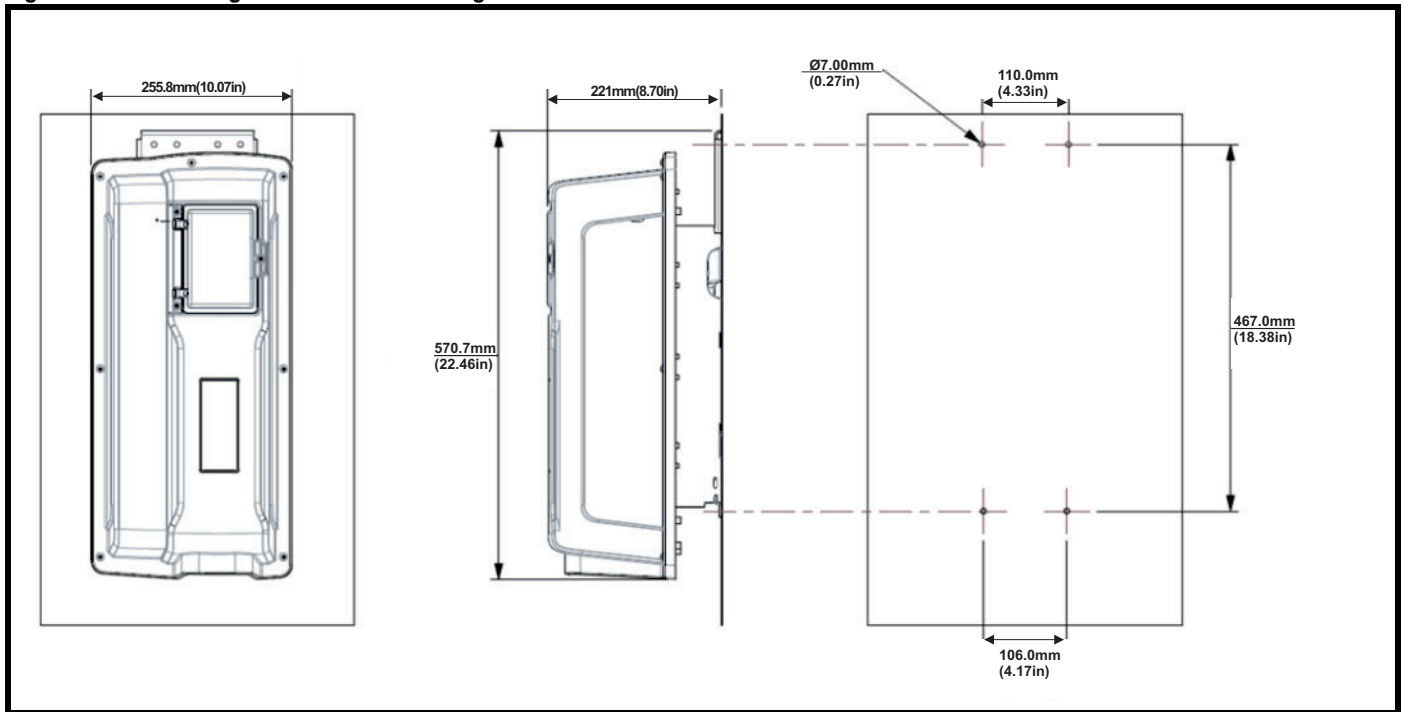
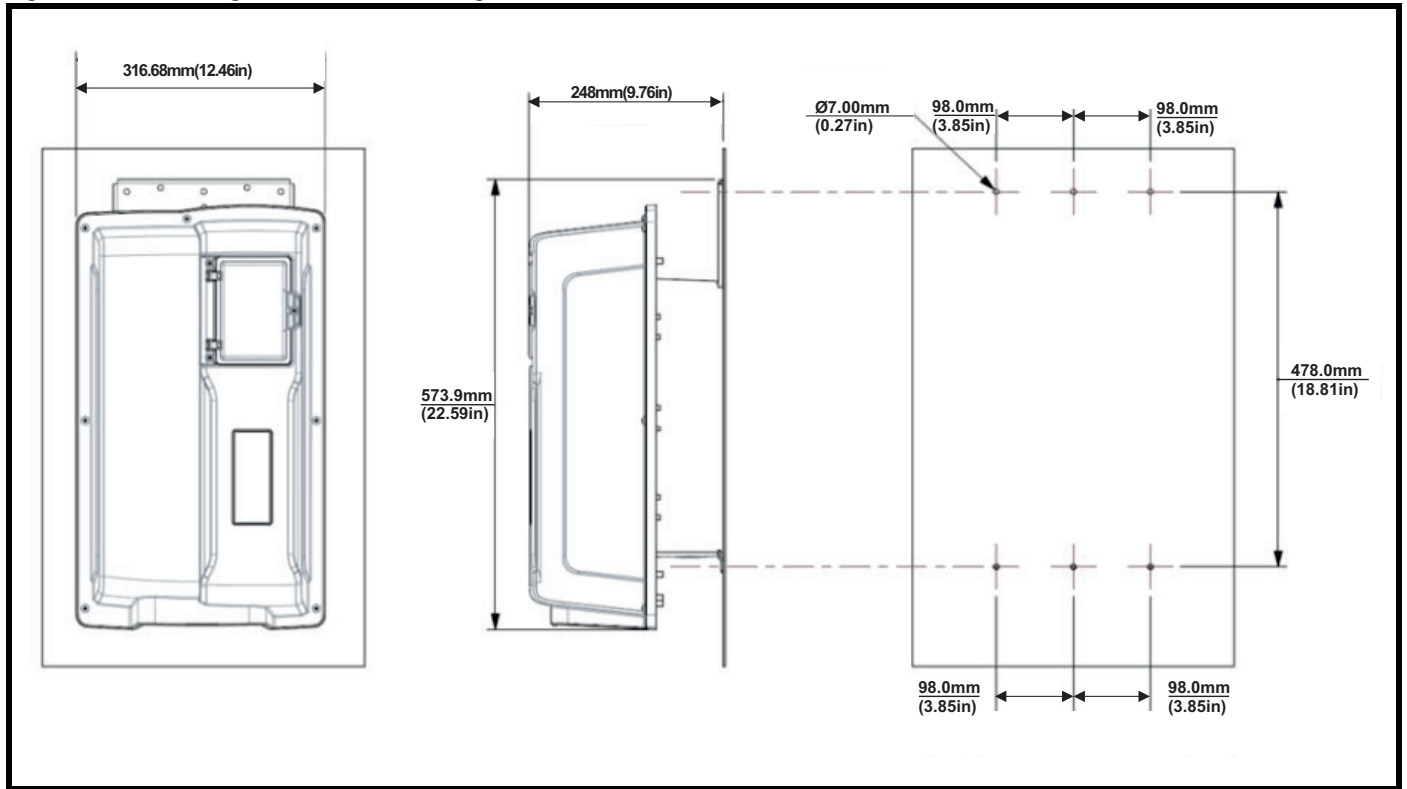
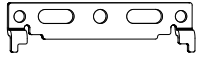


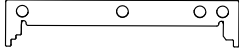


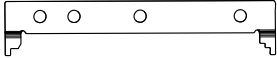


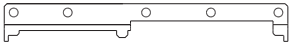


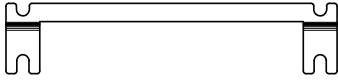
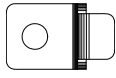

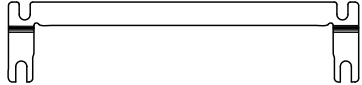


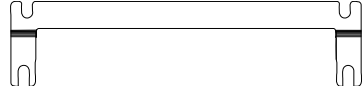




Figure 3-37 Size 6 High IP Drive and Mounting Hole Dimensions



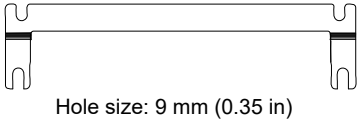

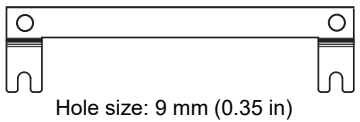

3.5.3 Mounting brackets

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 3-38 Recommended spacing between the drives

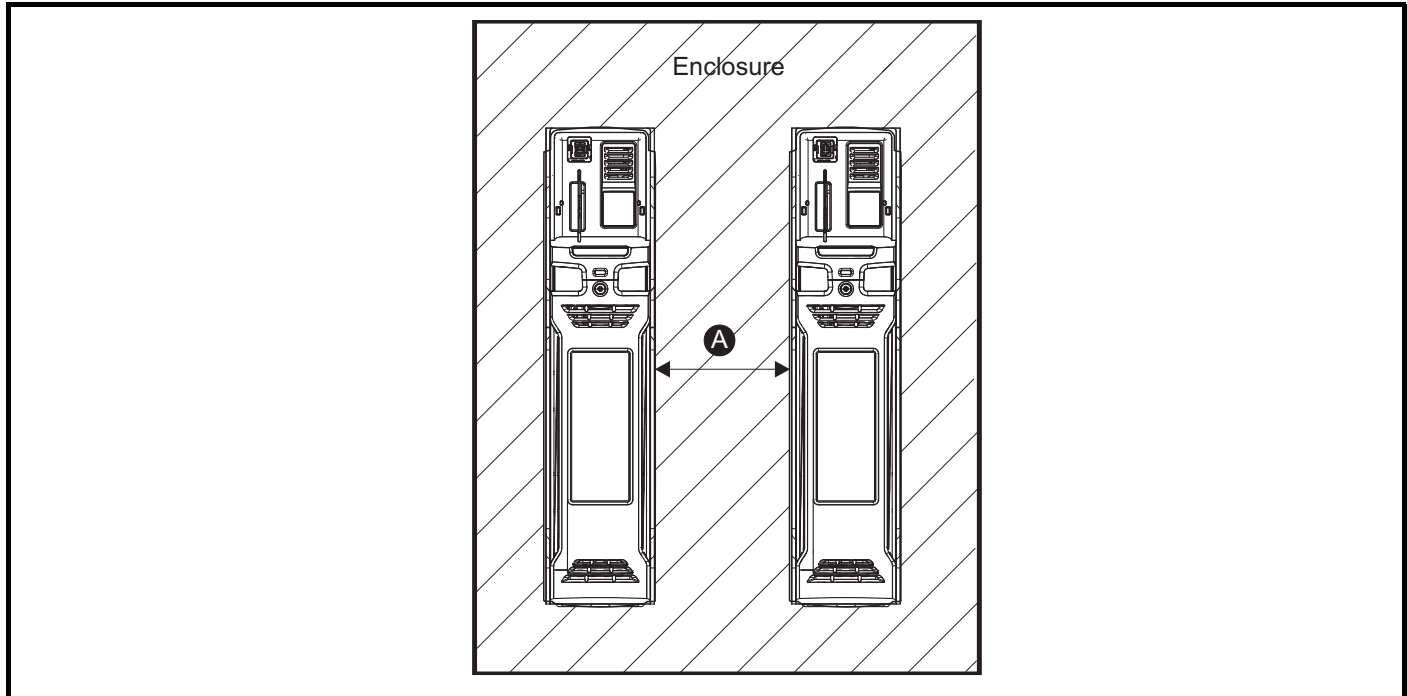


Table 3-4 Spacing required between the drives (without high IP bung)

| 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 277.

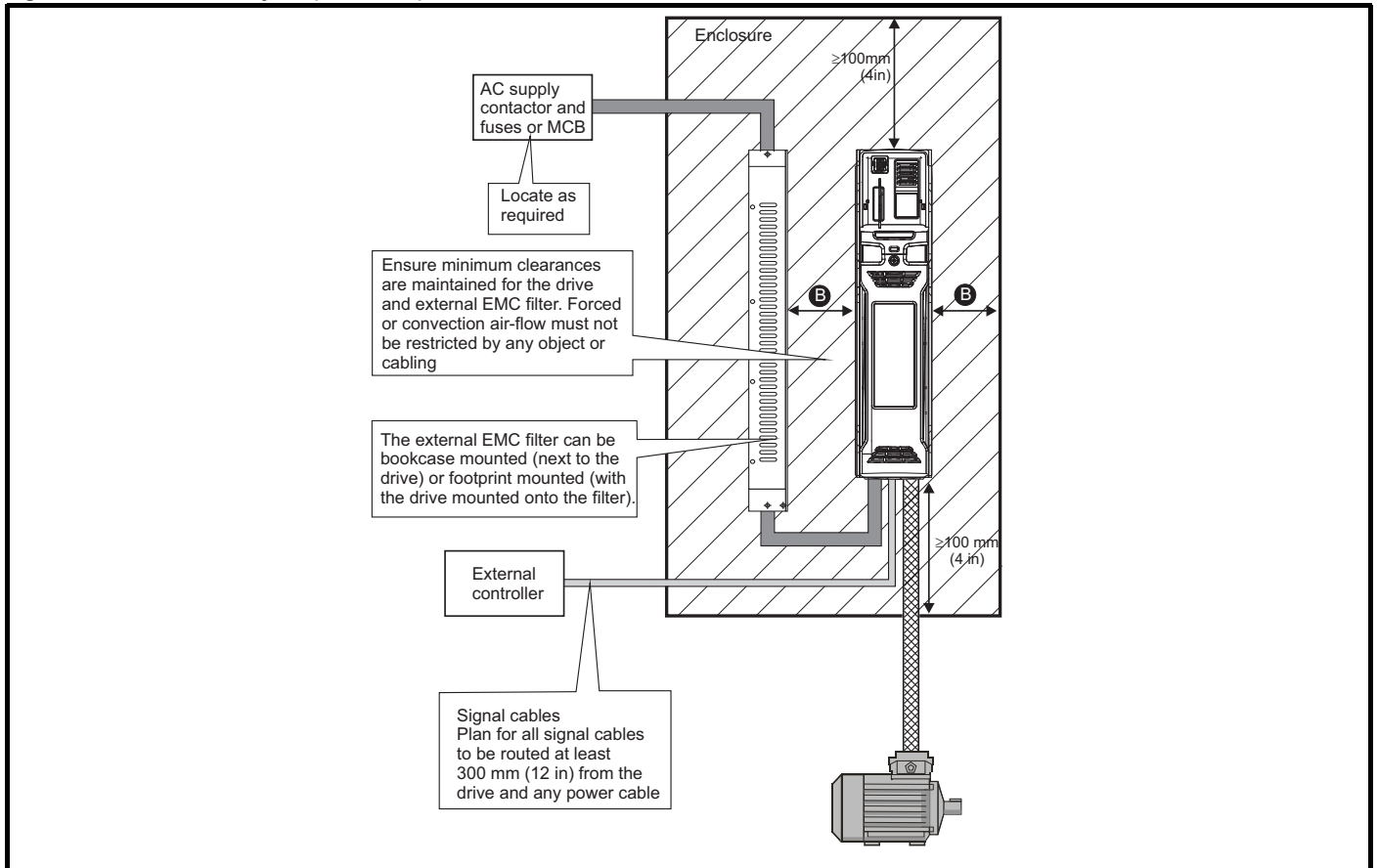
NOTE

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 3-39 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 3-40 Enclosure layout (size 9 to 11)

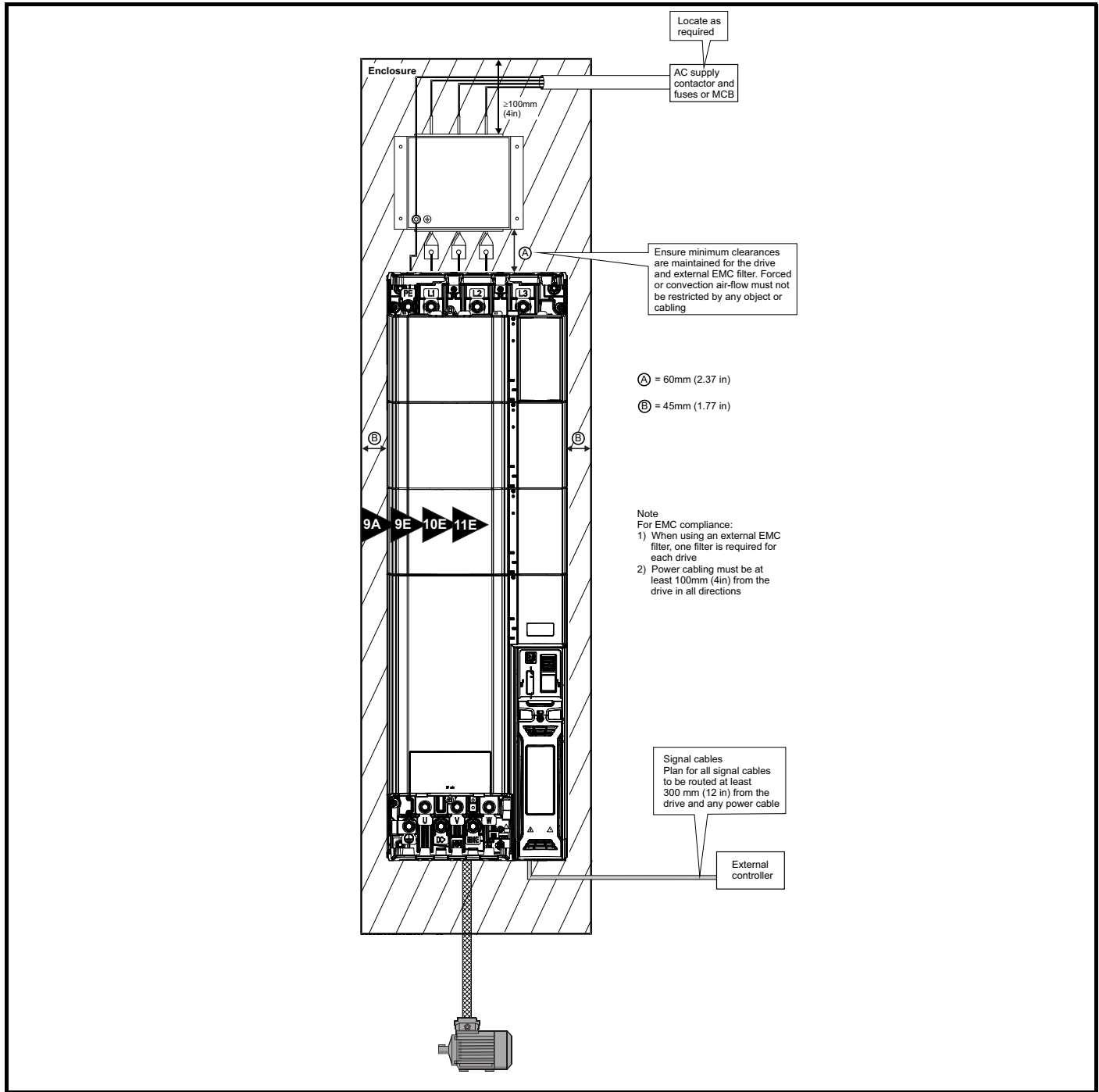


Table 3-6 Spacing required between drive / enclosure and drive (size 9 to 11)

| 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 279 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 299 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 $^{\circ}C$ <i>outside</i> the enclosure |
| T_{int} | Maximum permissible temperature in $^{\circ}C$ <i>inside</i> the enclosure |
| P | Power in Watts dissipated by <i>all</i> heat sources in the enclosure |
| k | Heat transmission coefficient of the enclosure material in $W/m^2/^{\circ}C$ |

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: $40^{\circ}C$
- Maximum ambient temperature outside the enclosure: $30^{\circ}C$

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: $2 \times (187 + 9.2) = 392.4 W$

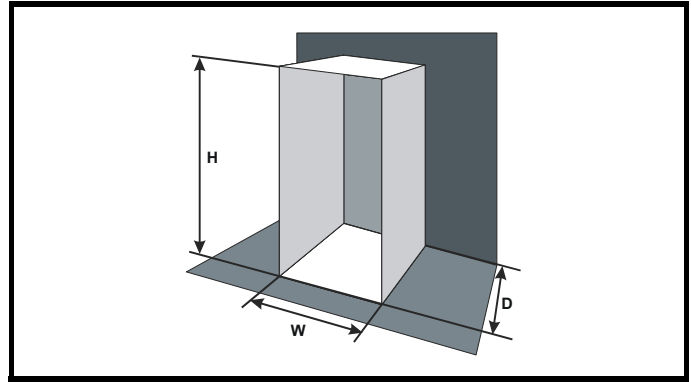
NOTE

Power dissipation for the drives and the external EMC filters can be obtained from Chapter 12 *Technical data* on page 273.

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

The value of $5.5 W/m^2/^{\circ}C$ 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 3-41 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

| | |
|-----------|---------------|
| T_{int} | $40^{\circ}C$ |
| T_{ext} | $30^{\circ}C$ |
| k | 5.5 |
| P | 392.4 W |

The minimum required heat conducting area is then:

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

$$= 7.135 m^2 (77.8 ft^2) \quad (1 m^2 = 10.9 ft^2)$$

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 $D = 0.6m$, 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 $^{\circ}C$ <i>outside</i> the enclosure |
| T_{int} | Maximum permissible temperature in $^{\circ}C$ <i>inside</i> the enclosure |
| P | Power in Watts dissipated by <i>all</i> heat sources in the enclosure |
| k | Ratio of $\frac{P_o}{P_i}$ |

Where:

P_o 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: $3 \times (101 + 6.9) = 323.7 \text{ W}$

Insert the following values:

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

Then:

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

$$= 126.2 \text{ m}^3/\text{hr} \text{ (74.5 ft}^3/\text{min)} \quad (1 \text{ m}^3/\text{hr} = 0.59 \text{ ft}^3/\text{min)}$$

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

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 273.

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 79 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

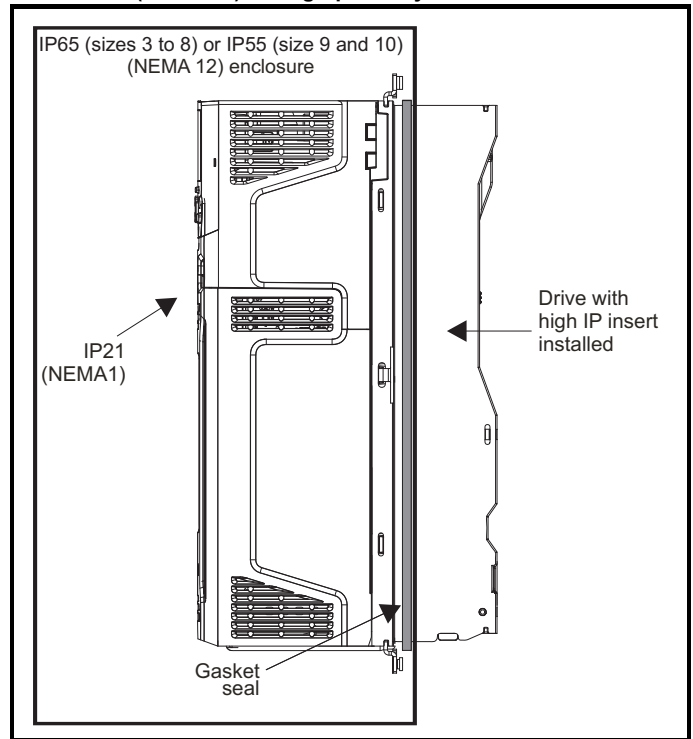
An explanation of environmental protection rating is provided in section 12.1.9 *IP / UL Rating*.

The standard drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) (NEMA 1). The high IP drive is rated at IP65. However, it is possible to configure the standard 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 273.

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.

There is also an alternative solution to provide IP65 rating for frame sizes 3 to 6 using a sealed cover when through panel mounting is not appropriate or if the drive is to be used outside of a control panel as shown on page 51.

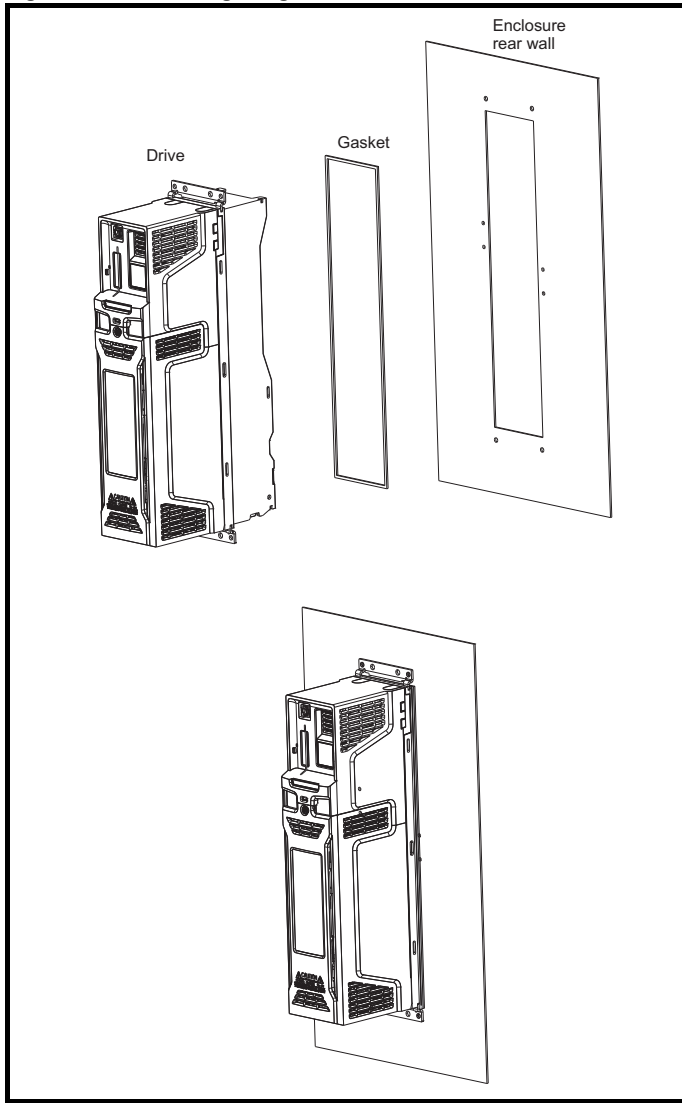
Figure 3-42 Example of IP65 (sizes 3 to 8) or IP55 (size 9 and 10) (NEMA 12) through-panel layout



The main gasket should be installed as shown in Figure 3-43.

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 3-45, Figure 3-46 and Figure 3-47.

Figure 3-43 Installing the gasket



To seal the space between the drive and the backplate, use two sealing brackets as shown in Figure 3-44.

Figure 3-44 Through panel mounting

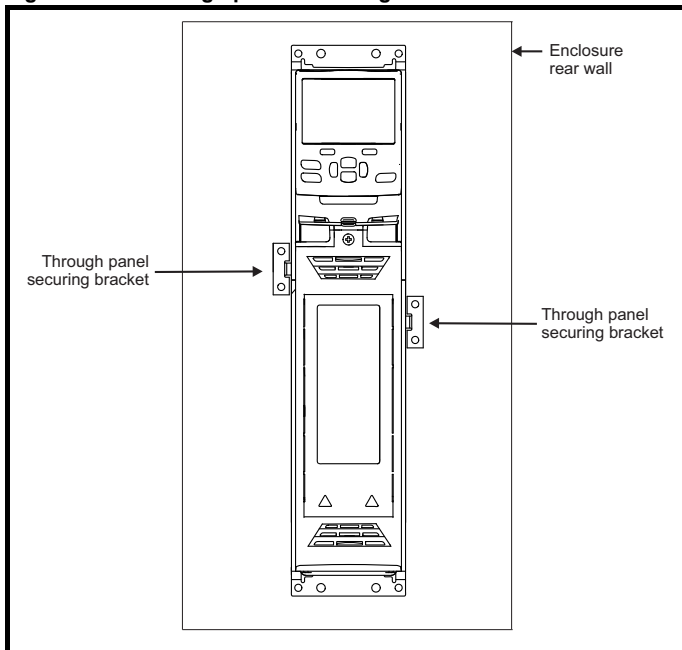
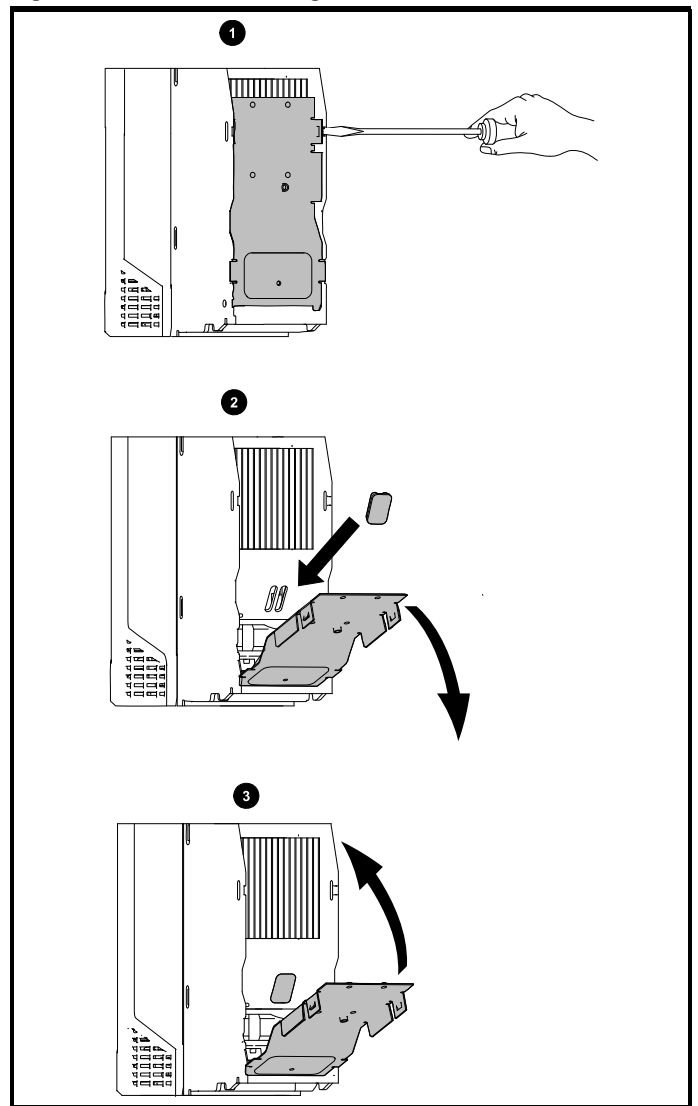


Figure 3-45 Installation of high IP insert for size 3

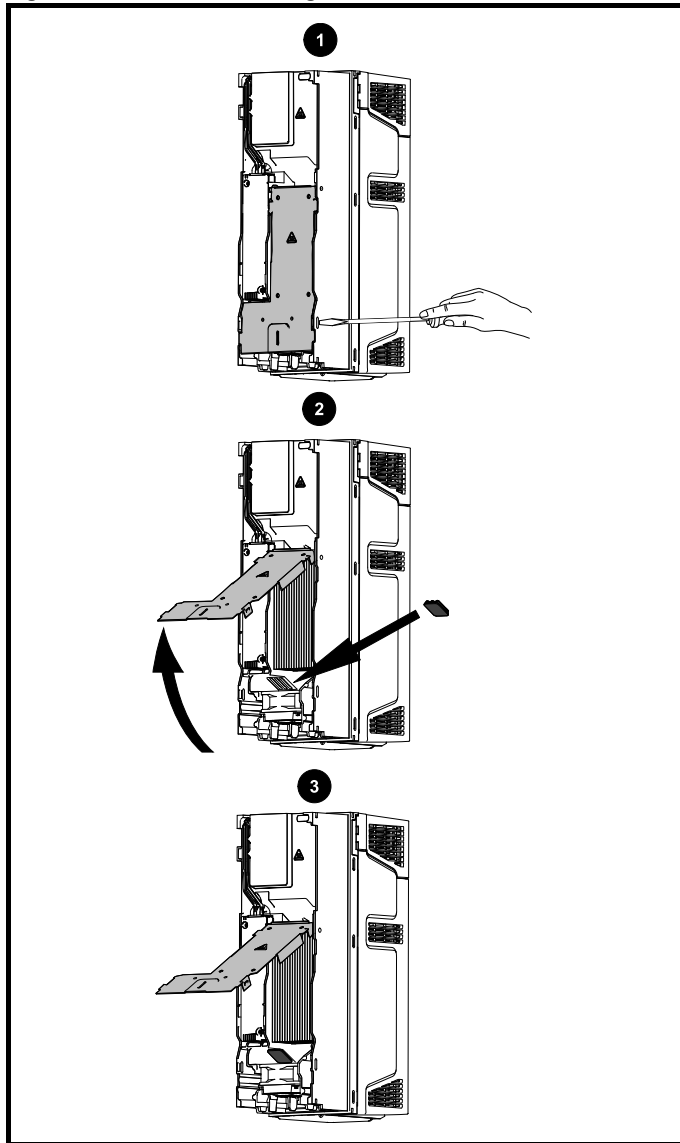


1. To install the high IP insert, firstly place a flat head screwdriver into the slot highlighted (1).
2. Pull the hinged baffle down to expose the ventilation hole, install the high IP insert into the ventilation hole in the heatsink (2). Ensure the high IP insert is securely installed by firmly pressing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

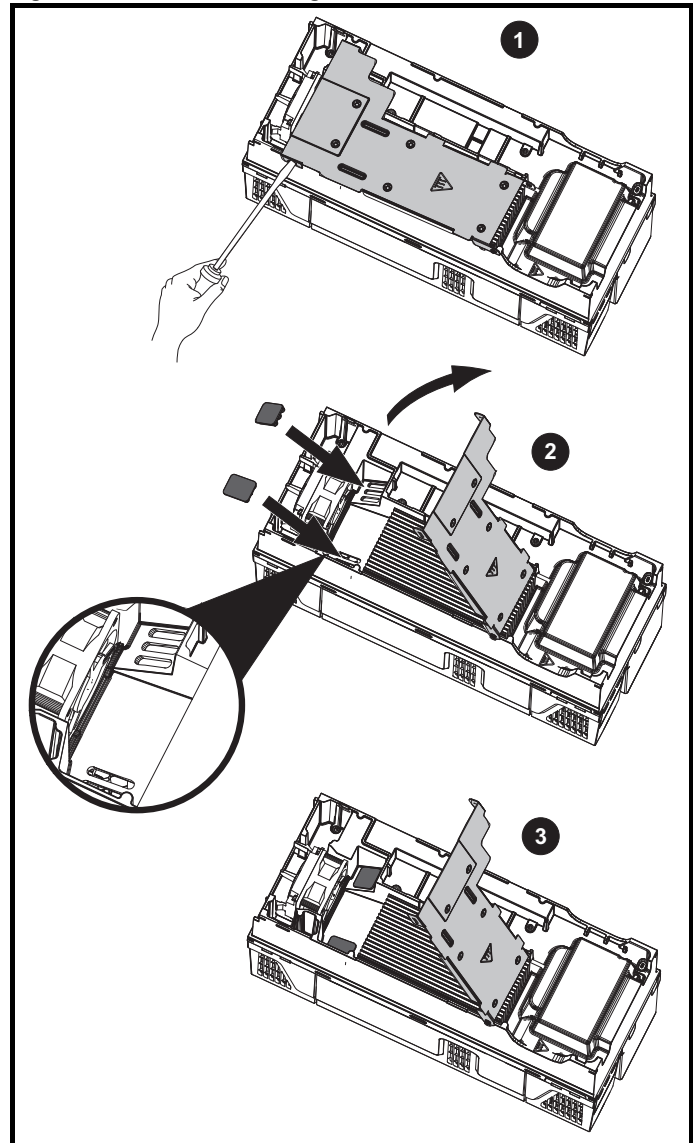
Figure 3-46 Installation of high IP insert for size 4



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 3-47 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

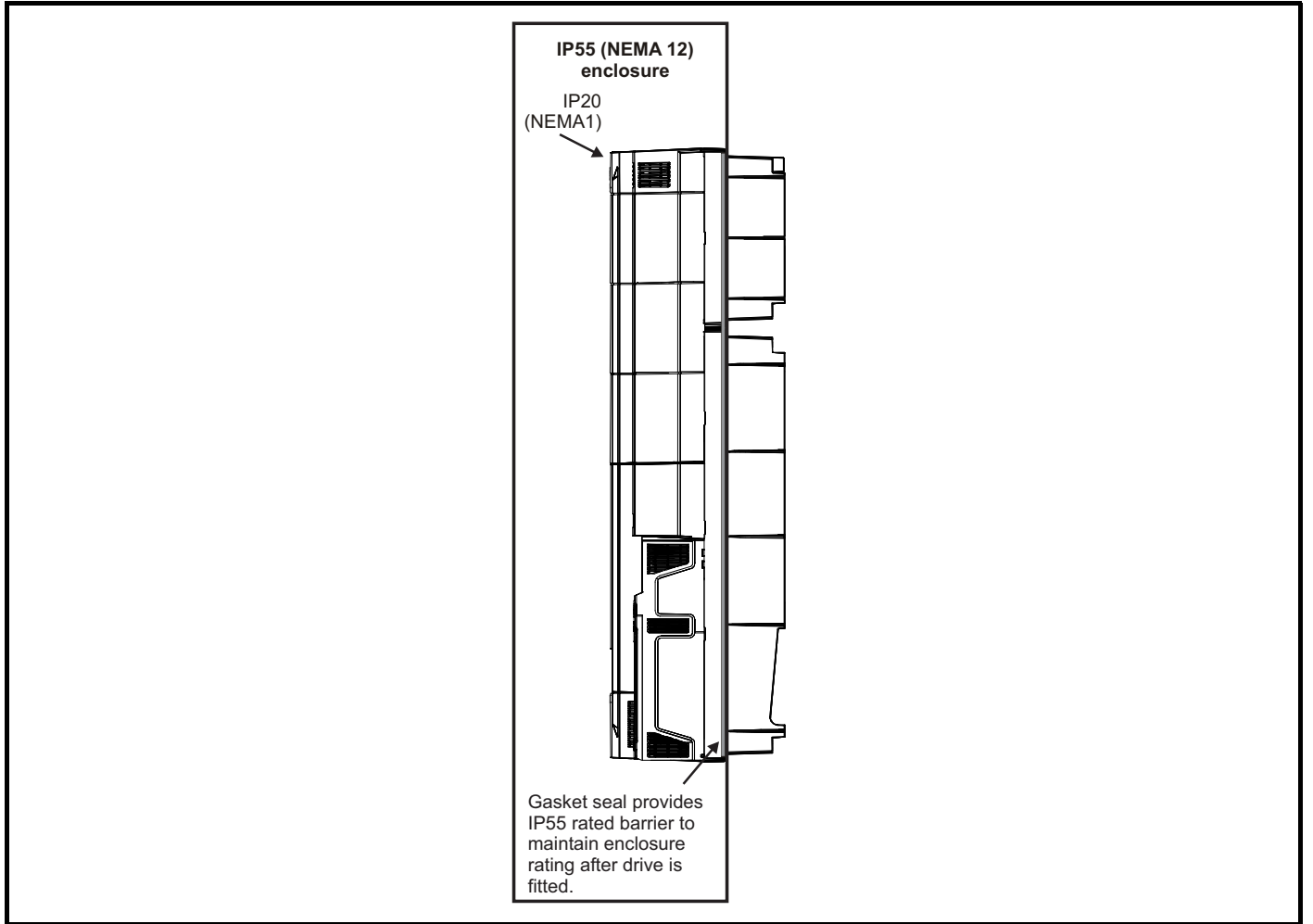
| Environment | High IP insert | Comments |
|-----------------------------|----------------|------------------------------|
| Clean | Not installed | |
| Dry, dusty (non-conductive) | Installed | Regular cleaning recommended |
| Dry, dusty (conductive) | Installed | |
| IP65 compliance | Installed |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

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 273.

Failure to do so may result in nuisance tripping.

Figure 3-48 Example of IP55 (NEMA 12) size 9 to 11 through-panel layout



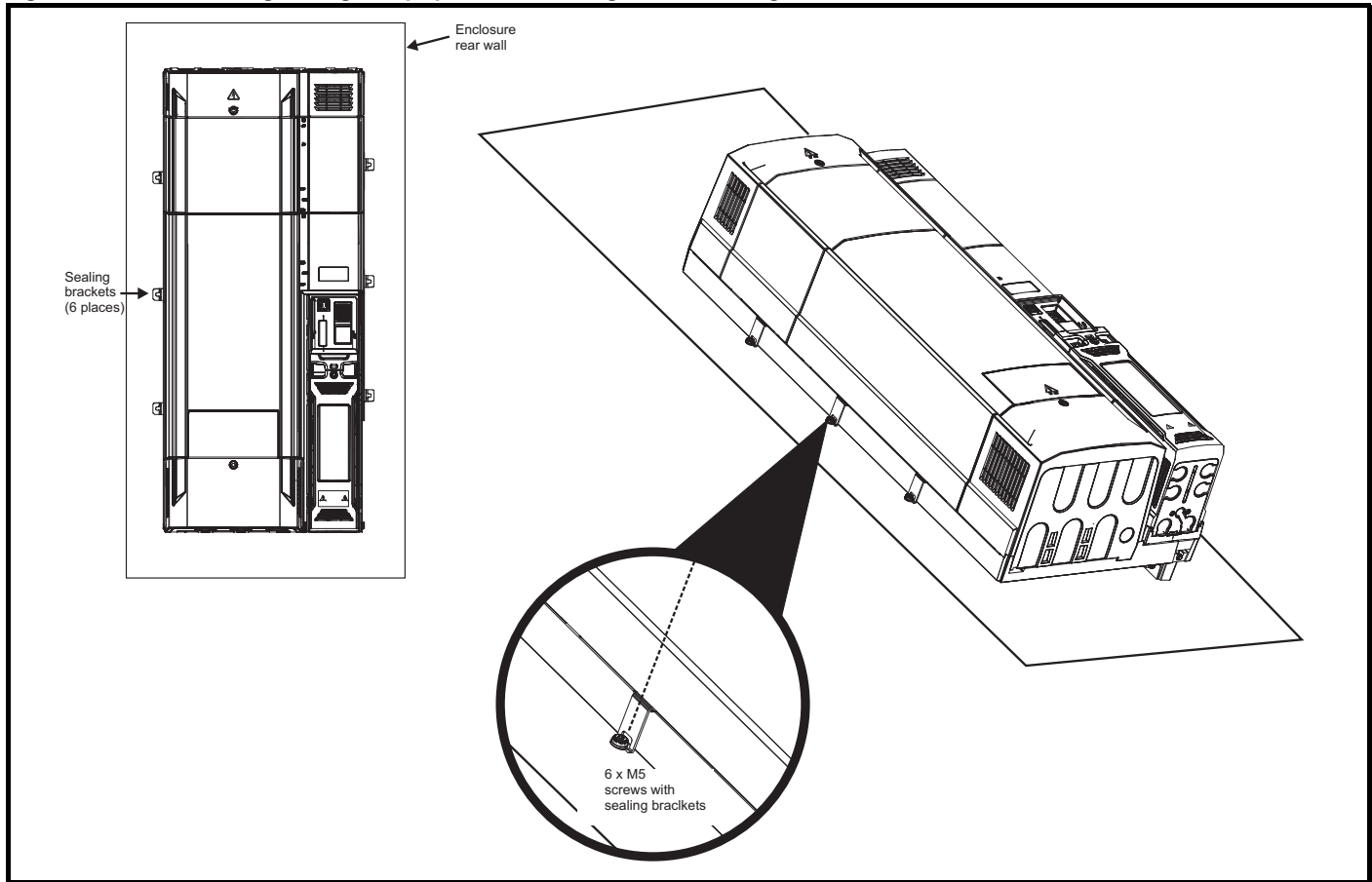
The main gasket should be installed as shown in Figure 3-43. Any screws / bolts that are used for mounting should be installed with M8 flat nylon washers to maintain a seal around the screw hole.

See Figure 3-49 on page 67, 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 3-49 View showing sealing clamps provided in through hole mounting kit



NOTE

For detailed information regarding IP55 (NEMA 12) Through Panel Mounting see Figure 3-31 *Through panel mount detail for size 9A* on page 52, Figure 3-32 *Through-panel mounting the size 9E and 10E* on page 53 and Figure 3.5.3 *Mounting brackets* on page 58.

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 EMC filter 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 |

NOTE

For size 12 drives please refer to Unidrive M Power Module Frame 12 Installation Guide for information.

The external EMC filters for sizes 0 to 6 can be footprint mounted or bookcase mounted as shown in Figure 3-50 and Figure 3-51. The external EMC filters for sizes 7 to 11, are designed to be mounted above the drive as shown in Figure 3-52.

Mount the external EMC filter following the guidelines in section 4.11.6 *Compliance with generic emission standards* on page 121.

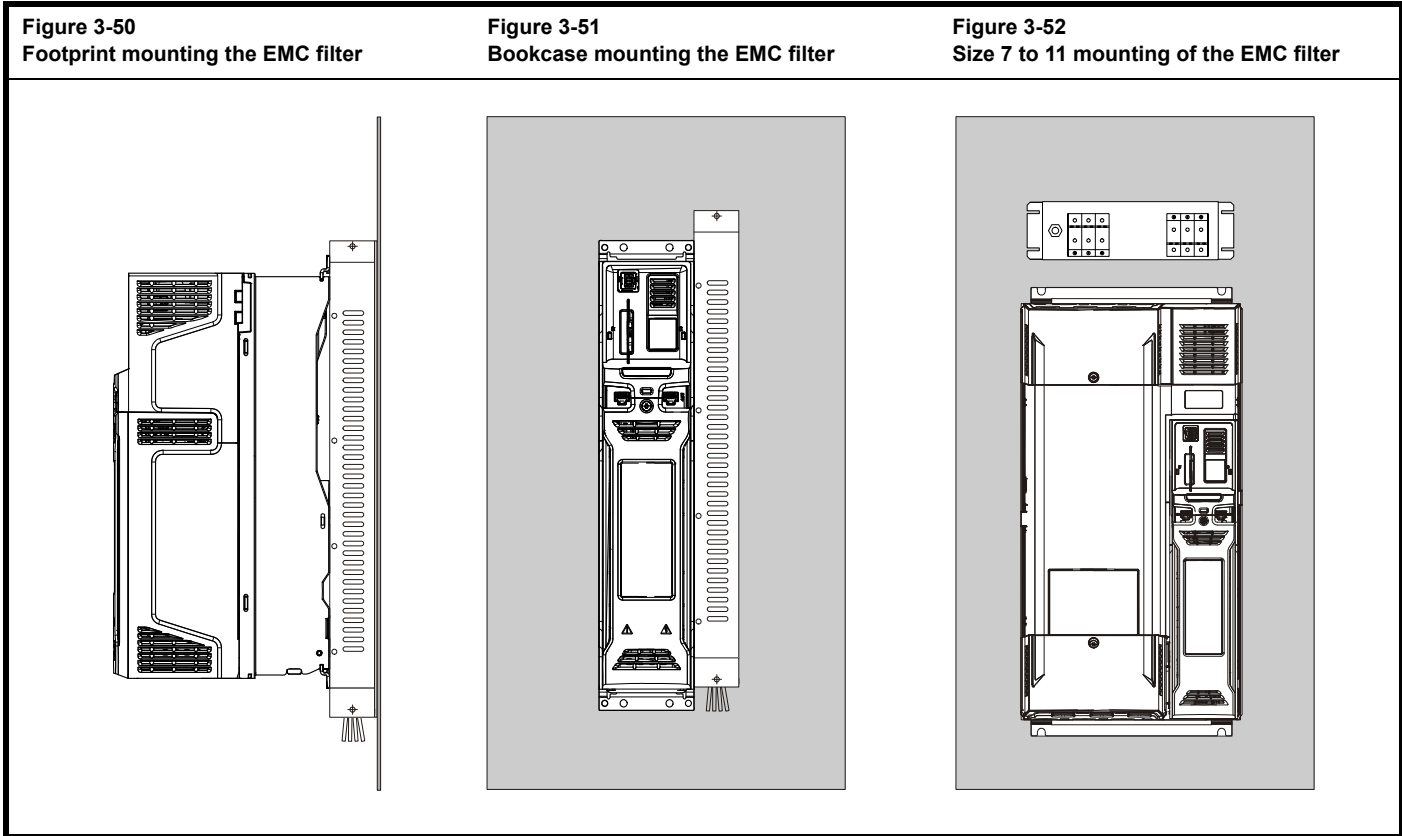
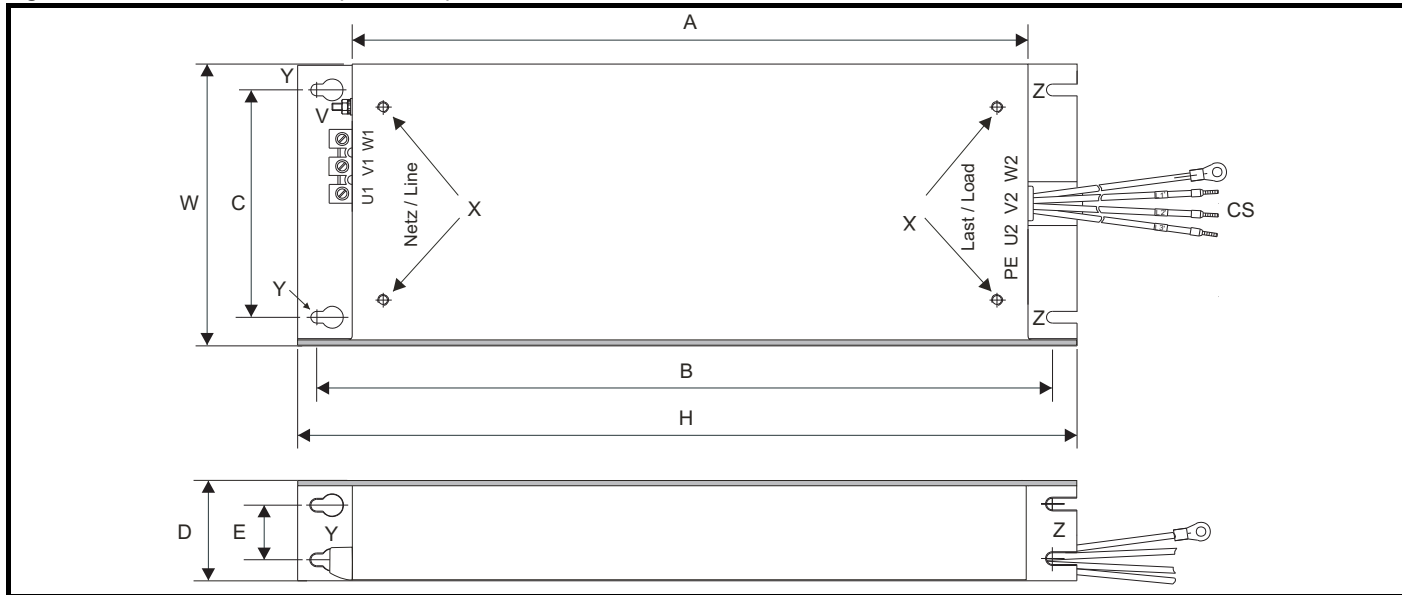


Figure 3-53 External EMC filter (size 3 to 6)



- 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 | 414 mm | 56 mm | 41 mm | | 426 mm | 83 mm | M5 | M5 | 5.5 mm | 5.5 mm | 2.5 mm ² |
| 4200-3480 | (15.12 in) | (16.30 in) | (2.21 in) | (1.61 in) | | (16.77 in) | (3.27 in) | | | (0.22 in) | (0.22 in) | (14 AWG) |

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 | 425 mm | 100 mm | 60 mm | 33 mm | 437 mm | 123 mm | M6 | M6 | 6.5 mm | 6.5 mm | 6 mm ² |
| 4200-0252 | (15.55 in) | (16.73 in) | (3.94 in) | (2.36 in) | (1.30 in) | (17.2 in) | (4.84 in) | | | (0.26 in) | (0.26 in) | (10 AWG) |

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 | 425 mm | 106 mm | 60 mm | 33 mm | 437 mm | 143 mm | M6 | M6 | 6.5 mm | 6.5 mm | 10 mm ² |
| 4200-0402 | | | | | | | | | | | | (8 AWG) |
| 4200-0122 | | | | | | | | | | | | 2.5 mm ² |
| | (15.55 in) | (16.73 in) | (4.17 in) | (2.36 in) | (1.30 in) | (17.2 in) | (5.63 in) | | | (0.26 in) | (0.26 in) | (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 | 420 mm | 180 mm | 60 mm | 33 mm | 434 mm | 210 mm | M6 | M6 | 6.5 mm | 6.5 mm | 16 mm ² |
| 4200-4800 | | | | | | | | | | | | (6 AWG) |
| 4200-3690 | | | | | | | | | | | | |
| | (15.43 in) | (16.54 in) | (7.09 in) | (2.36 in) | (1.30 in) | (17.09 in) | (8.27 in) | | | (0.26 in) | (0.26 in) | |

Figure 3-54 External EMC filter (size 7 to 8)

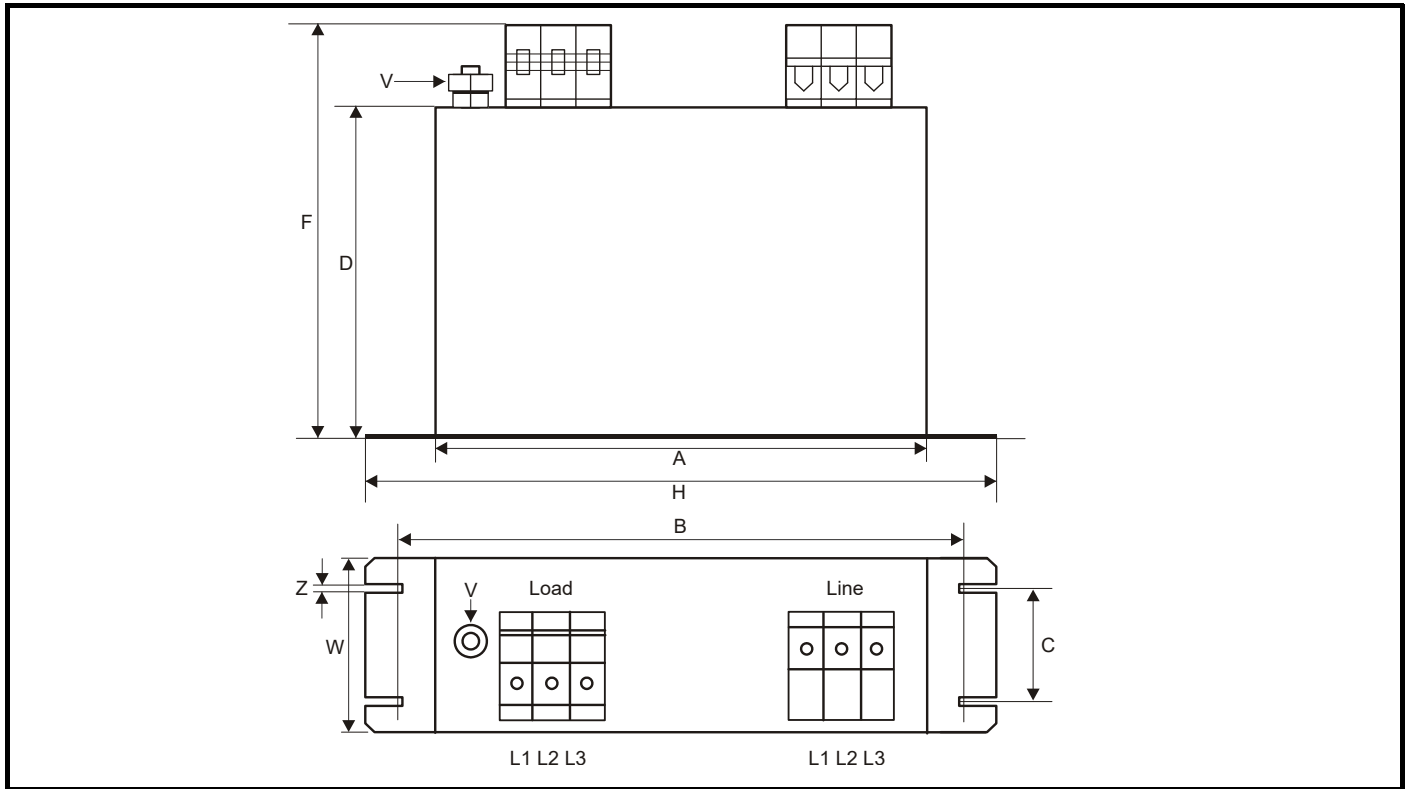


Table 3-14 Size 7 external EMC filter dimensions

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

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 | 275 mm | 85 mm | 170 mm | | 249 mm | 300 mm | 120 mm | M10 | | | 6.5 mm |
| 4200-1662 | (10.24 in) | (10.83 in) | (3.35 in) | (6.69 in) | | (9.79 in) | (11.81 in) | (4.72 in) | | | | (0.26 in) |

Figure 3-55 External EMC filter (size 9A)

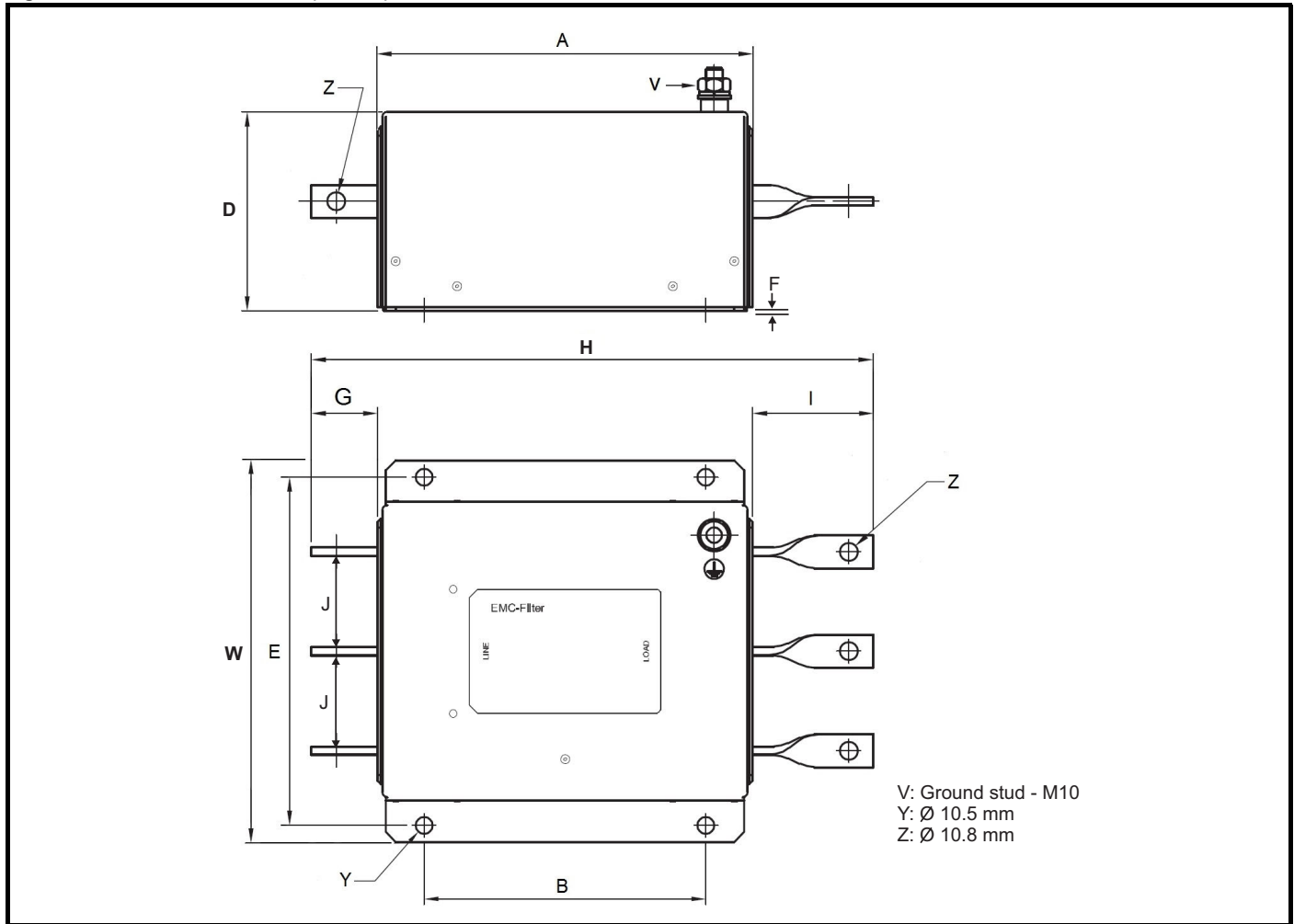


Table 3-16 Size 9A external EMC filter dimensions

| 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 3-56 External EMC filter (size 9E and 10)

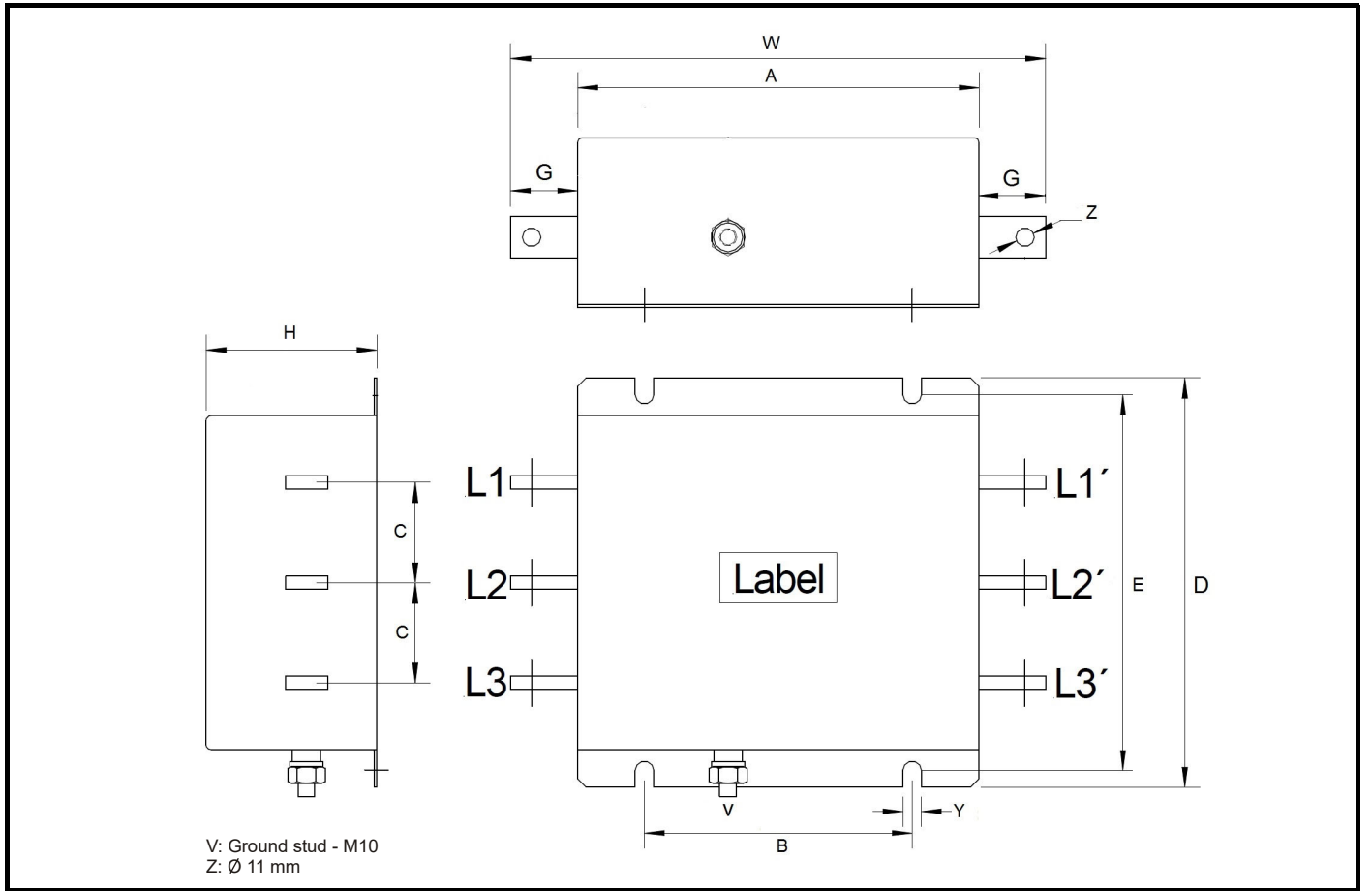


Table 3-17 Size 9E and 10E external EMC filter dimensions

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

Figure 3-57 External EMC filter (size 11)

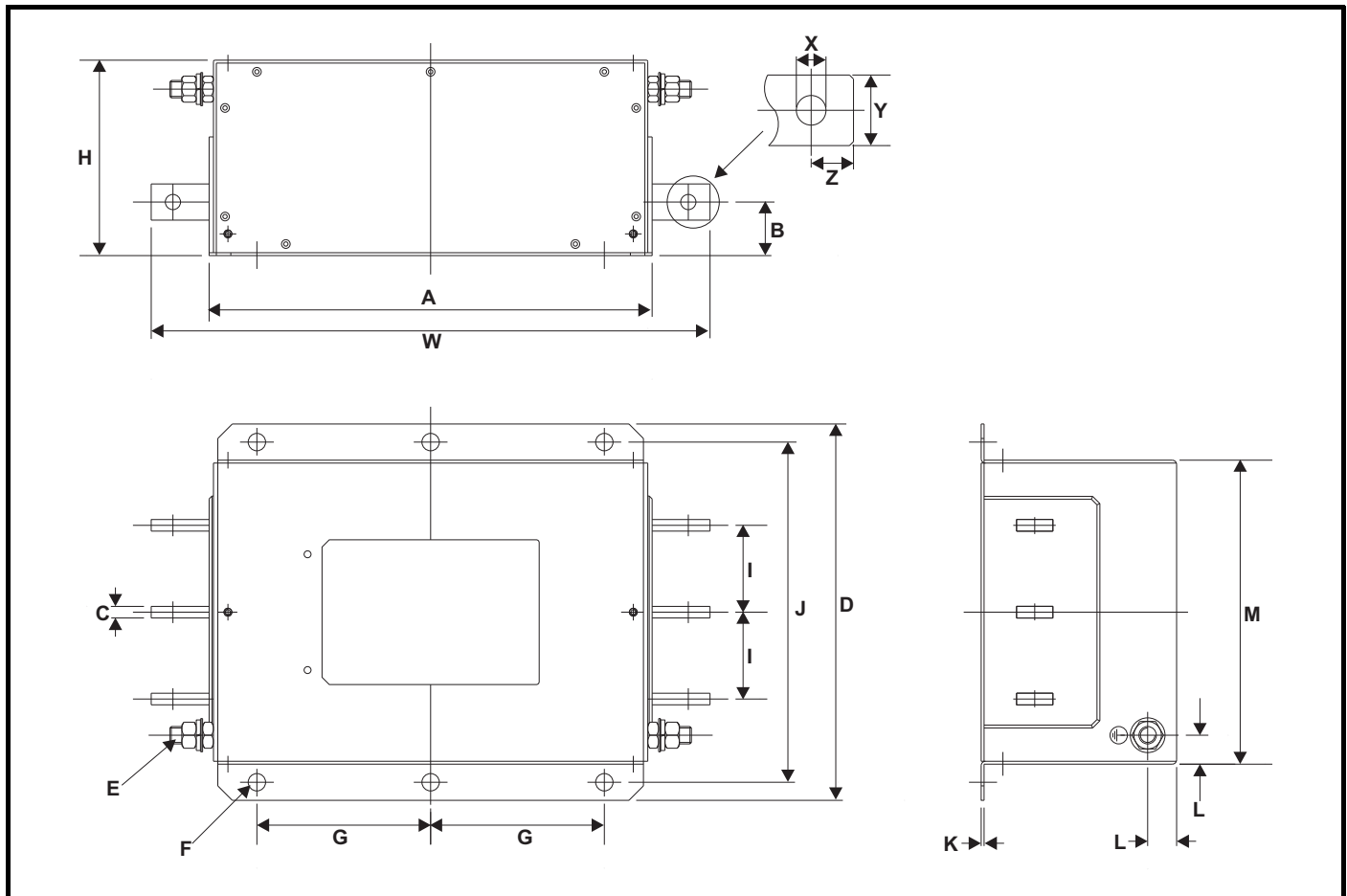


Table 3-18 Size 11 external EMC filter dimensions

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

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

Figure 3-58 Input line reactor (INLX0X) for size 9 and 10

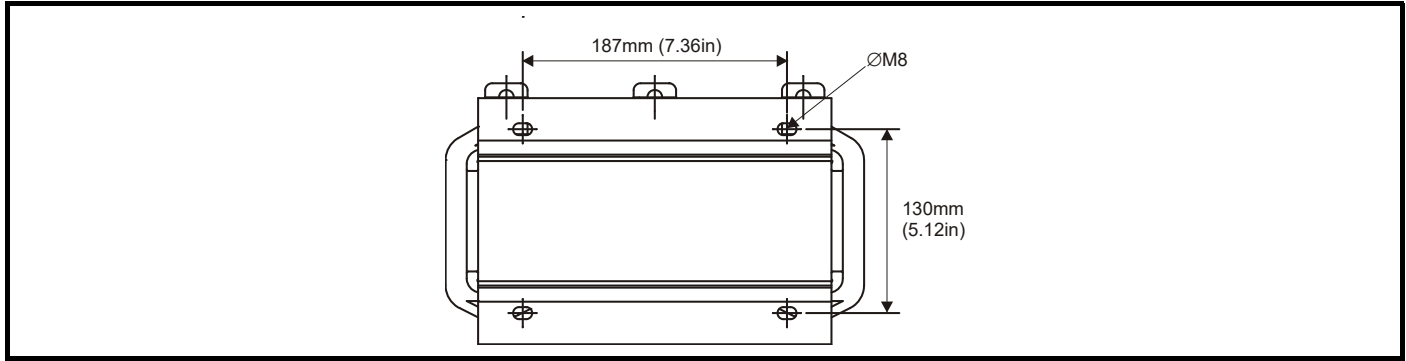
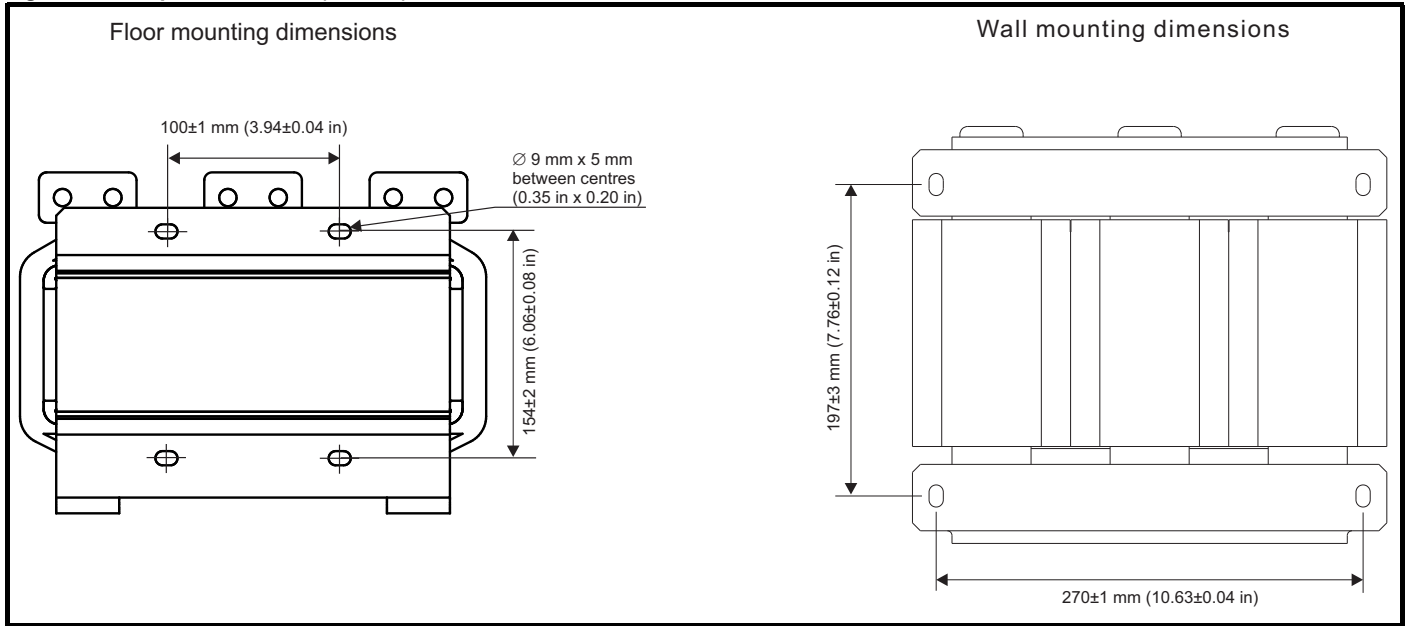


Figure 3-59 Input line reactor (INLX0X) for size 11

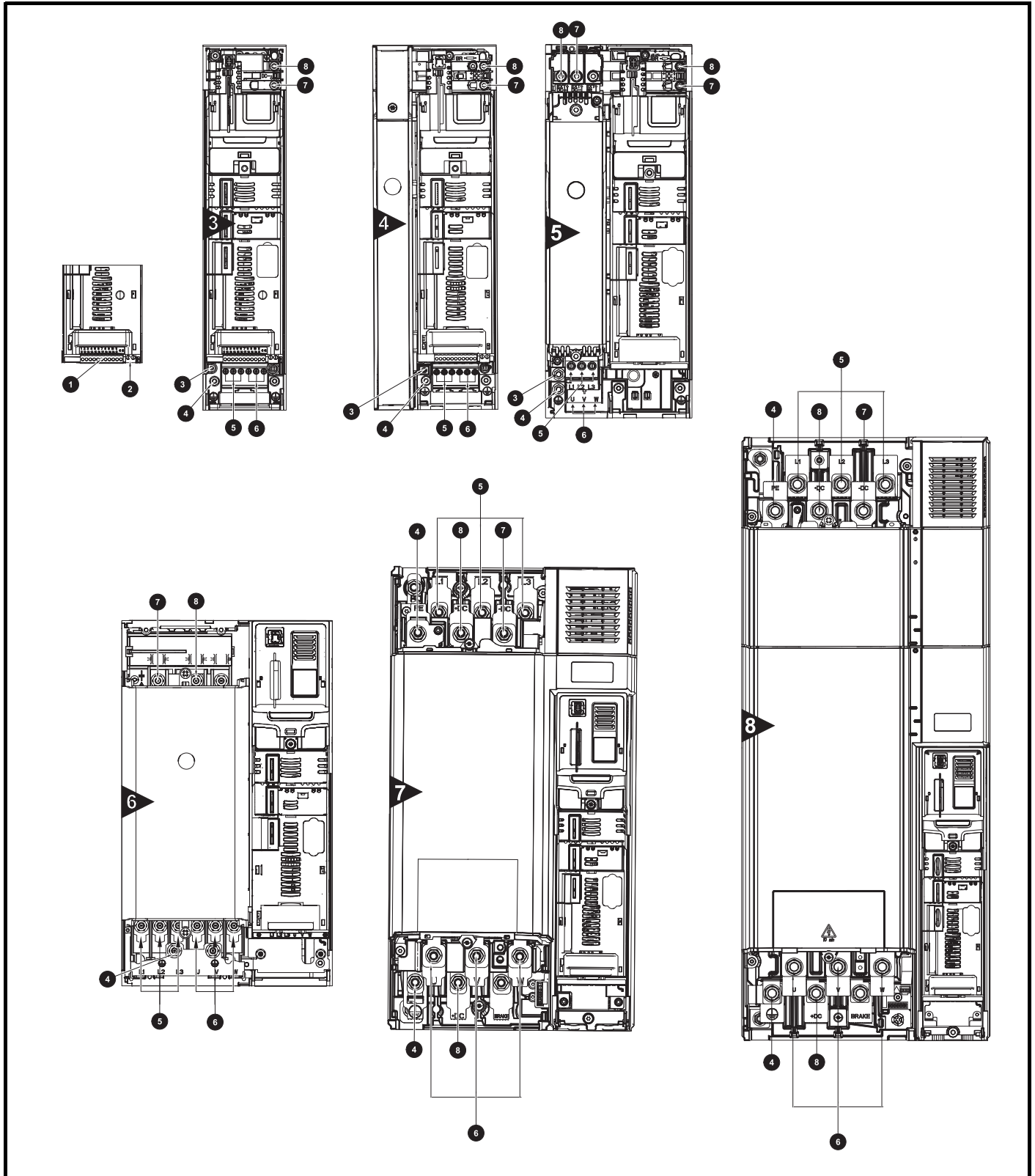


For overall dimensions and other details, refer to Chapter 4.2.3 *Drive model and input line reactor* on page 98.

3.12 Electrical terminals

3.12.1 Location of the power and ground terminals

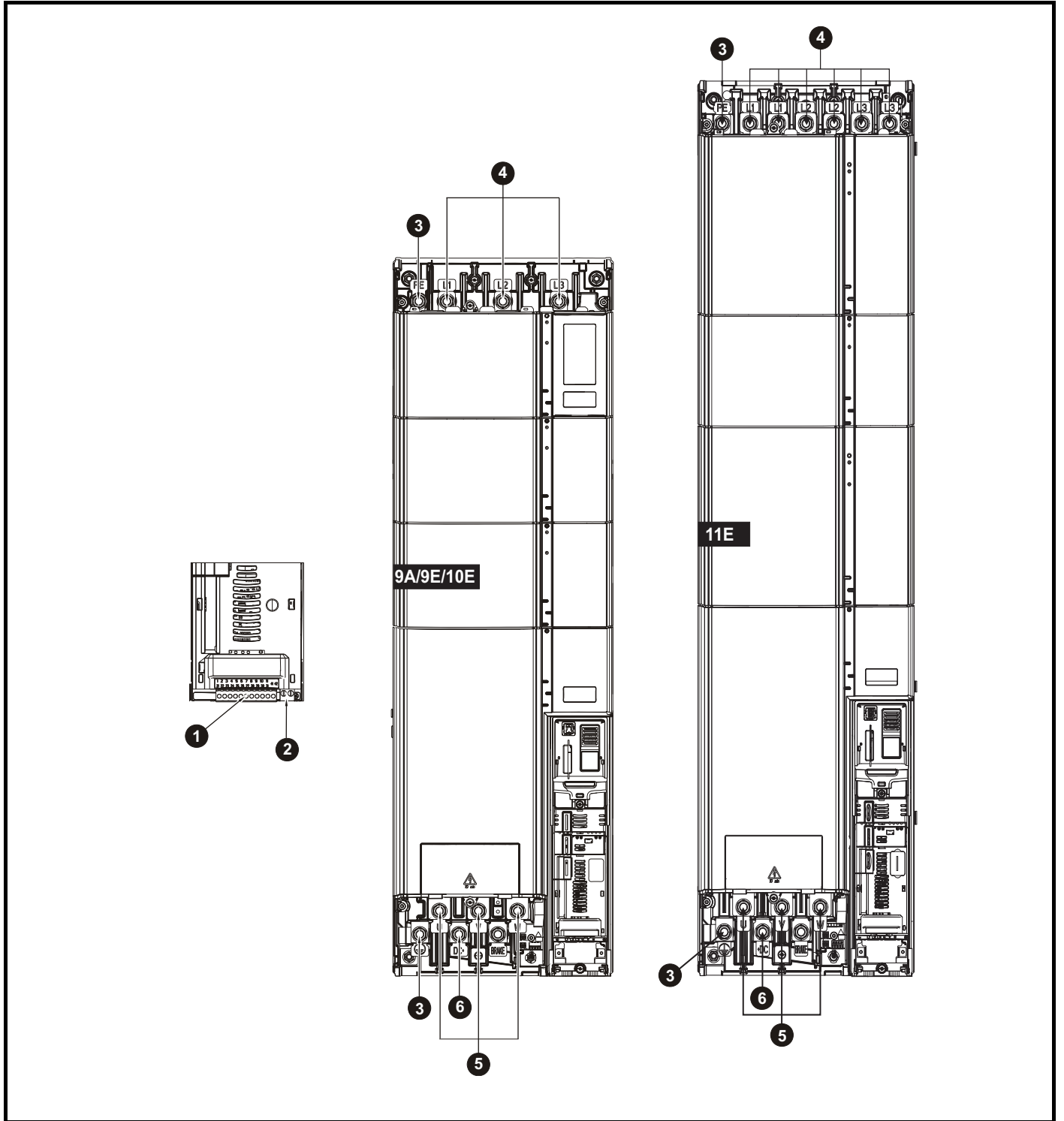
Figure 3-60 Locations of the power and ground terminals (size 3 to 8)



Key

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

Figure 3-61 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



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

| 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 Nm (6 lb in) | 0.8 Nm (7.2 lb in) | 2.0 Nm (16.8 lb in) | 2.5 Nm (21.6 lb in) | 2.0 Nm (16.8 lb in) | 2.5 Nm (21.6 lb in) |
| 5 | Plug-in terminal block | | T20 Torx (M4) / M4 Nut (7 mm AF) | | M5 Nut (8 mm AF) | |
| | 1.5 Nm (13.2 lb in) | 1.8 Nm (15.6 lb in) | 1.5 Nm (13.2 lb in) | 2.5 Nm (21.6 lb in) | 2.0 Nm (18 lb in) | 5.0 Nm (44.4 lb in) |
| 6 | | | M6 Nut (10 mm AF) | | | |
| | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) |
| 7 | M8 Nut (13 mm AF) | | M8 Nut (13 mm AF) | | M8 Nut (13 mm AF) | |
| | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) |
| 8 to 11 | M10 Nut (17 mm AF) | | M10 Nut (17 mm AF) | | M10 Nut (17 mm AF) | |
| | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) |

Table 3-20 Drive control and relay terminal data

| Model | Connection type | Torque settings |
|----------|------------------------|---------------------|
| All | Plug-in terminal block | 2.0 Nm (17.7 lb in) |
| Frame 12 | | 0.5 Nm (4.4 lb in) |

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 Nm (72 lb in) | M10 | 18 Nm (159.6 lb in) |
| 4200-0672 | | | | | |
| 4200-1972 | | 95 mm ² (3/0 AWG) | 20 Nm (177.6 lb in) | | |
| 4200-1662 | | | | | |
| 4200-0122 | | 16 mm ² (6 AWG) | 2.3 Nm (20.4 lb in) | M6 | 4.8 Nm (33.6 lb in) |
| 4200-0252 | | | | | |
| 4200-0272 | | | | | |
| 4200-0312 | | | | | |
| 4200-0402 | | | | | |
| 4200-3230 | | 4 mm ² (12 AWG) | 0.8 Nm (7.08 lb in) | M5 | 3.0 Nm (26.4 lb in) |
| 4200-3480 | | 4 mm ² (12 AWG) | 0.8 Nm (7.08 lb in) | M5 | |
| 4200-2300 | | 16 mm ² (6 AWG) | 2.3 Nm (20.4 lb in) | M6 | 4.8 Nm (33.6 lb in) |
| 4200-4800 | | | | | |
| 4200-3690 | | | | | |
| 4200-3021 | 10.8 mm | N/A | 30 Nm (265.2 lb in) | M10 | 18 Nm (159.9 lb in) |
| 4200-4460 | 11 mm | | | | |
| 4200-1660 | 10.8 mm | | | | |
| 4200-2210 | 11 mm | | | | |
| 4200-0400 | 10.5 mm | | | | |
| 4200-0690 | 10.5 mm | | | M12 | 25 Nm (220.8 lb in) |

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 3-62 Keypad (rear view)

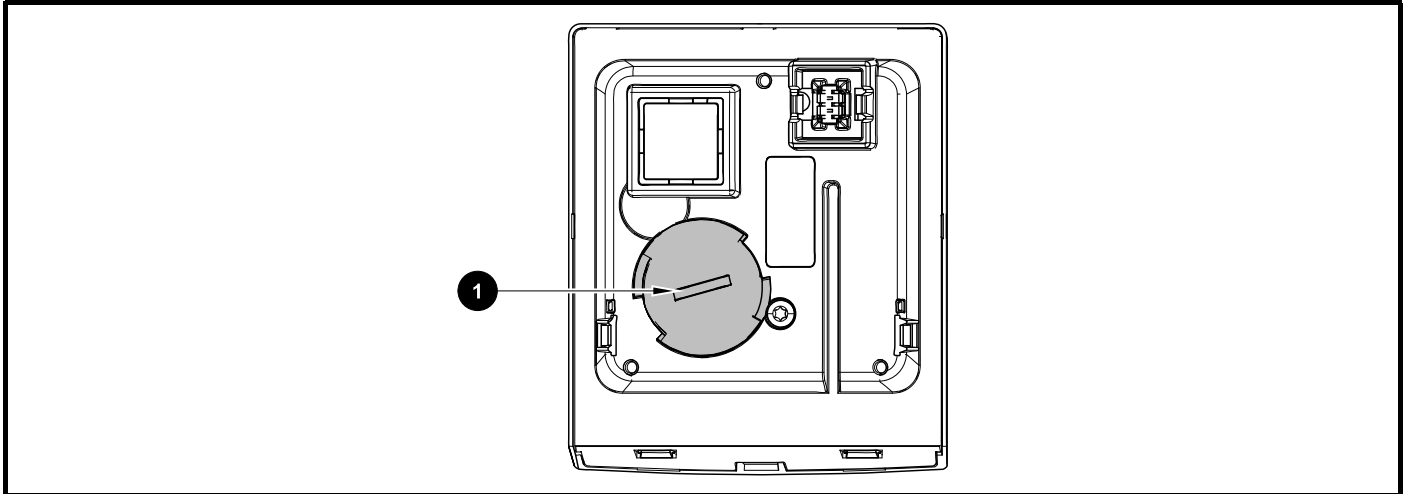


Figure 3-62 above illustrates a rear view of the keypad (KI-HOA Keypad RTC and HOA Keypad RTC).

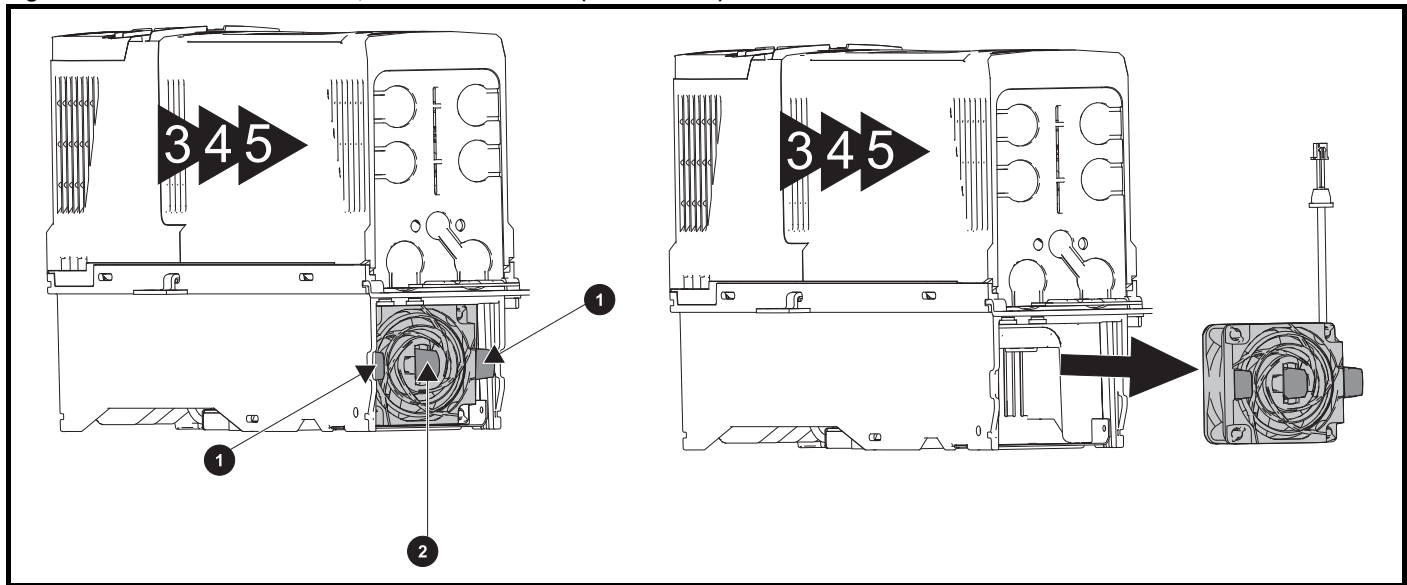
1. To remove the battery cover insert a flat head screwdriver into the slot as shown (1), push and turn anti-clockwise until the battery cover is released.
2. Replace the battery (the battery type is: CR2032).
3. Reverse point 1 above to replace battery cover.

NOTE

Ensure the battery is disposed of correctly.

3.13.2 Size 3 to 5 heatsink fan removal procedure

Figure 3-63 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 |

Figure 3-64 Removal of the High IP size 3, 4 and 5 heatsink fan

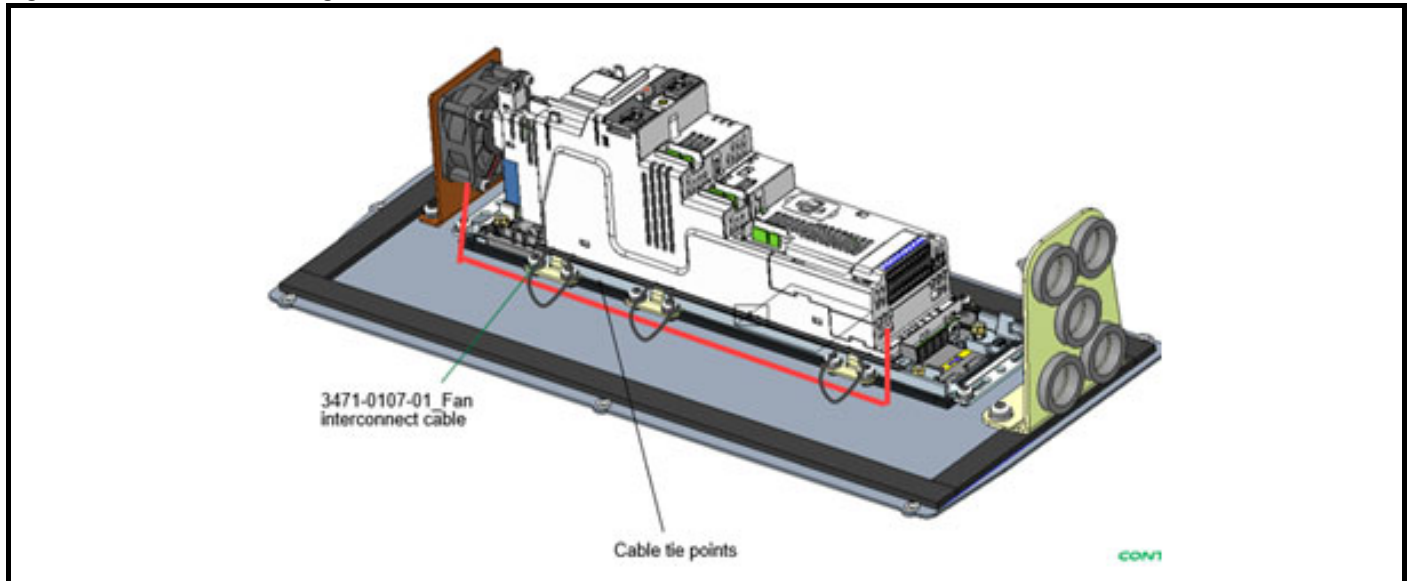
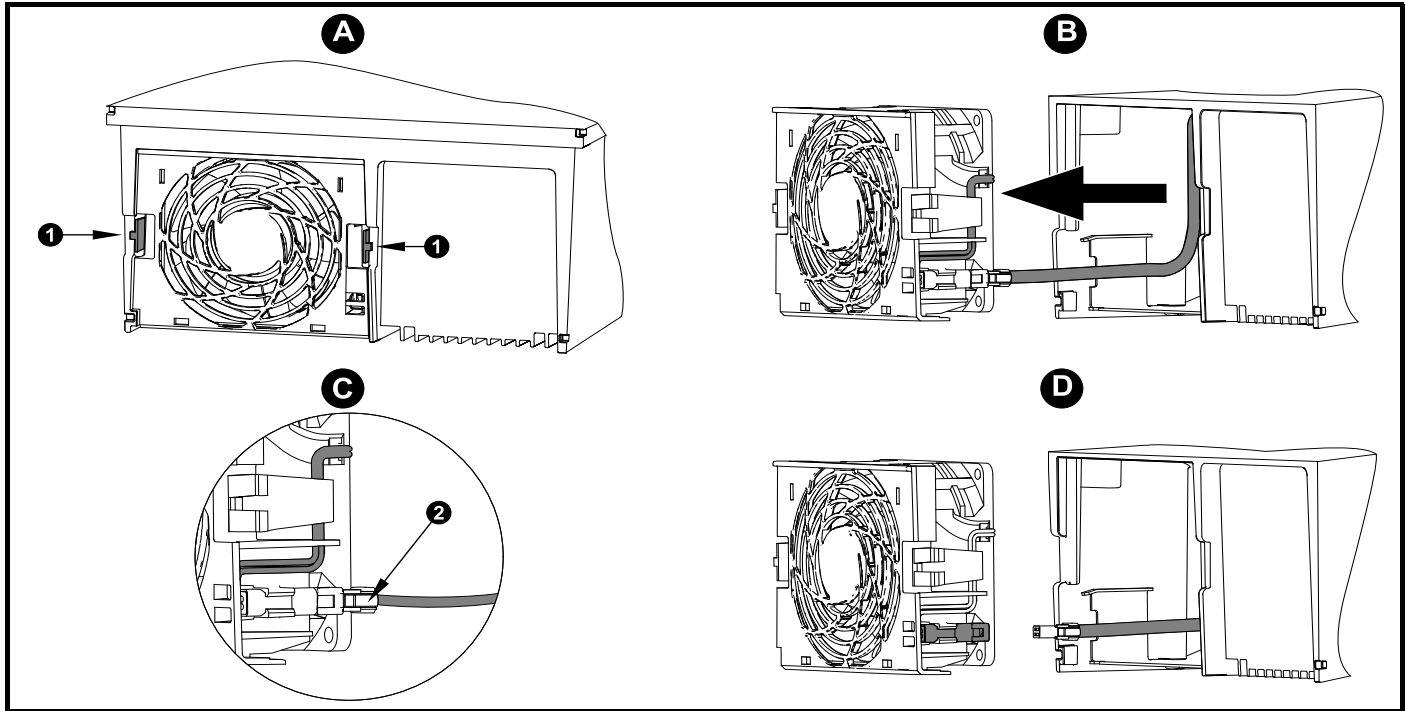


Table 3-24 Size 3 to 5 High IP heatsink fan part numbers

| Model | Heatsink fan part number |
|-------------|--------------------------|
| Size 3 to 5 | 3251-0245 |

3.13.3 Size 6 heatsink fan removal procedure

Figure 3-65 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.

Figure 3-66 Removal of the High IP size 6 heatsink fan

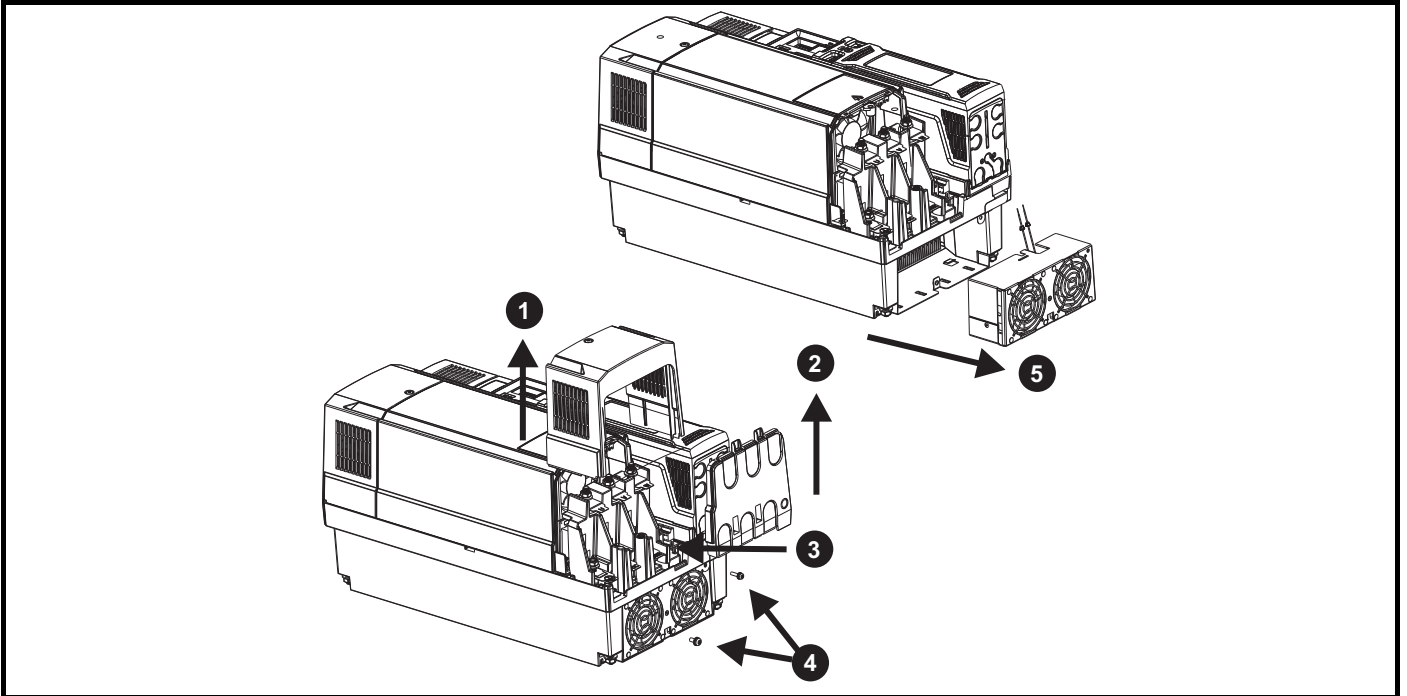


Table 3-25 Size 6 heatsink fan part number (Std and High IP)

| Model | Heatsink fan part number |
|--------|--------------------------|
| Size 6 | 3251-0030 |

3.13.4 Size 7 heatsink fan replacement

Figure 3-67 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

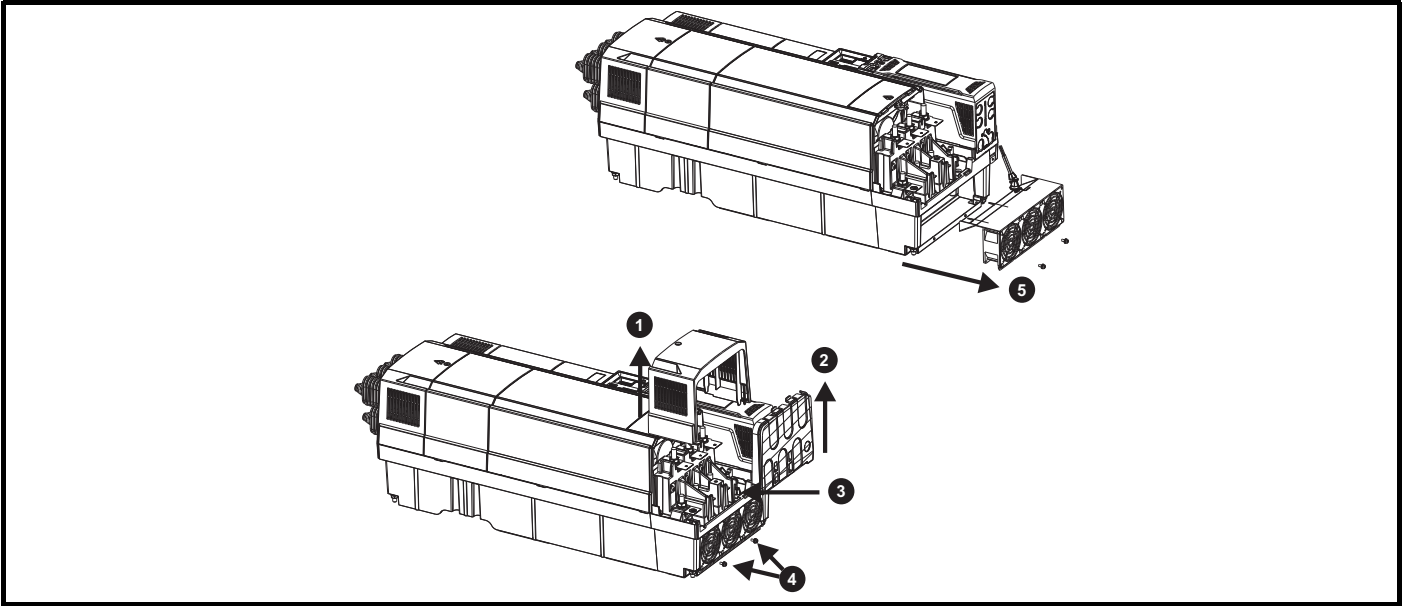
After fan(s) have been replaced, reverse the above steps to refit.

Table 3-26 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 3-68 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

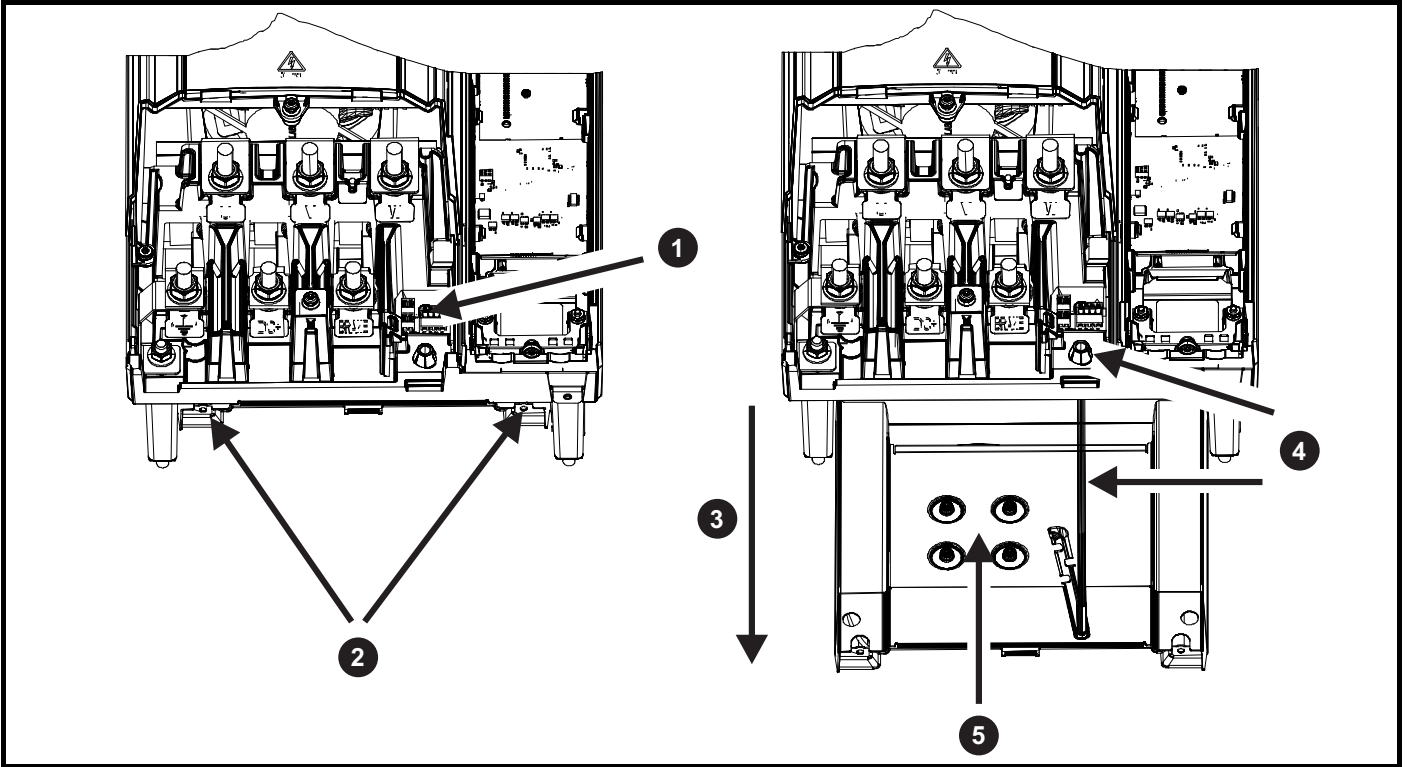
After fan(s) have been replaced, reverse the above steps to refit.

Table 3-27 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 3-69 Size 9 to 11 Heatsink fan replacement



Heatsink fan removal procedure

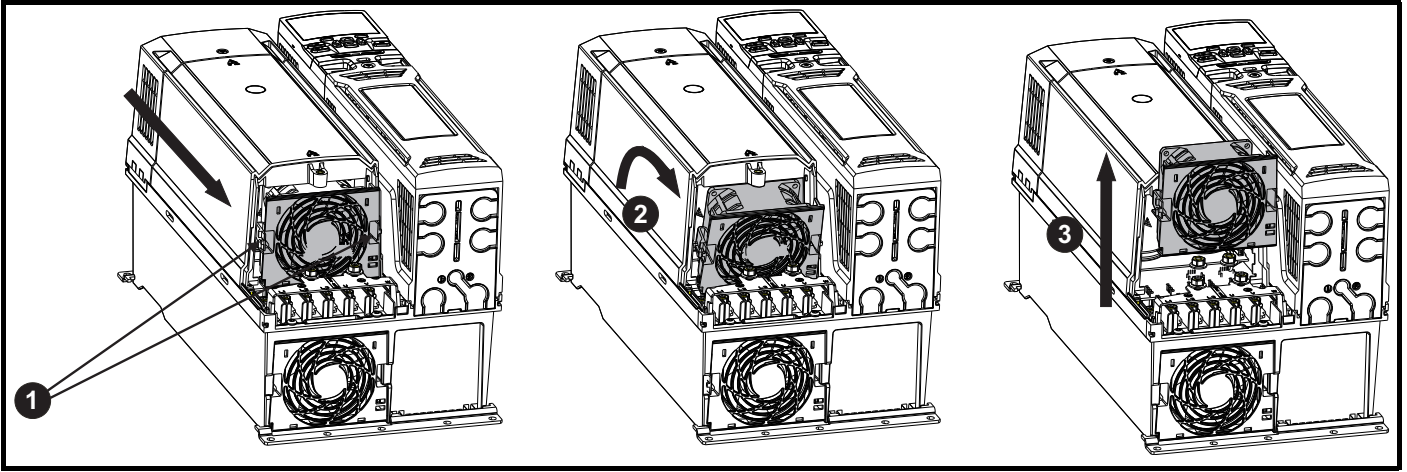
- 1) Using a flat screwdriver remove the fan wires from the fan connector (making a note of the order).
 - 2) Using a T20 Torque driver remove the two screws that retain the heatsink fan housing
 - 3) Withdraw the heatsink fan housing from the drive in the direction shown
 - 4) Pull the fan cable through 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 3-28 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 3-70 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.

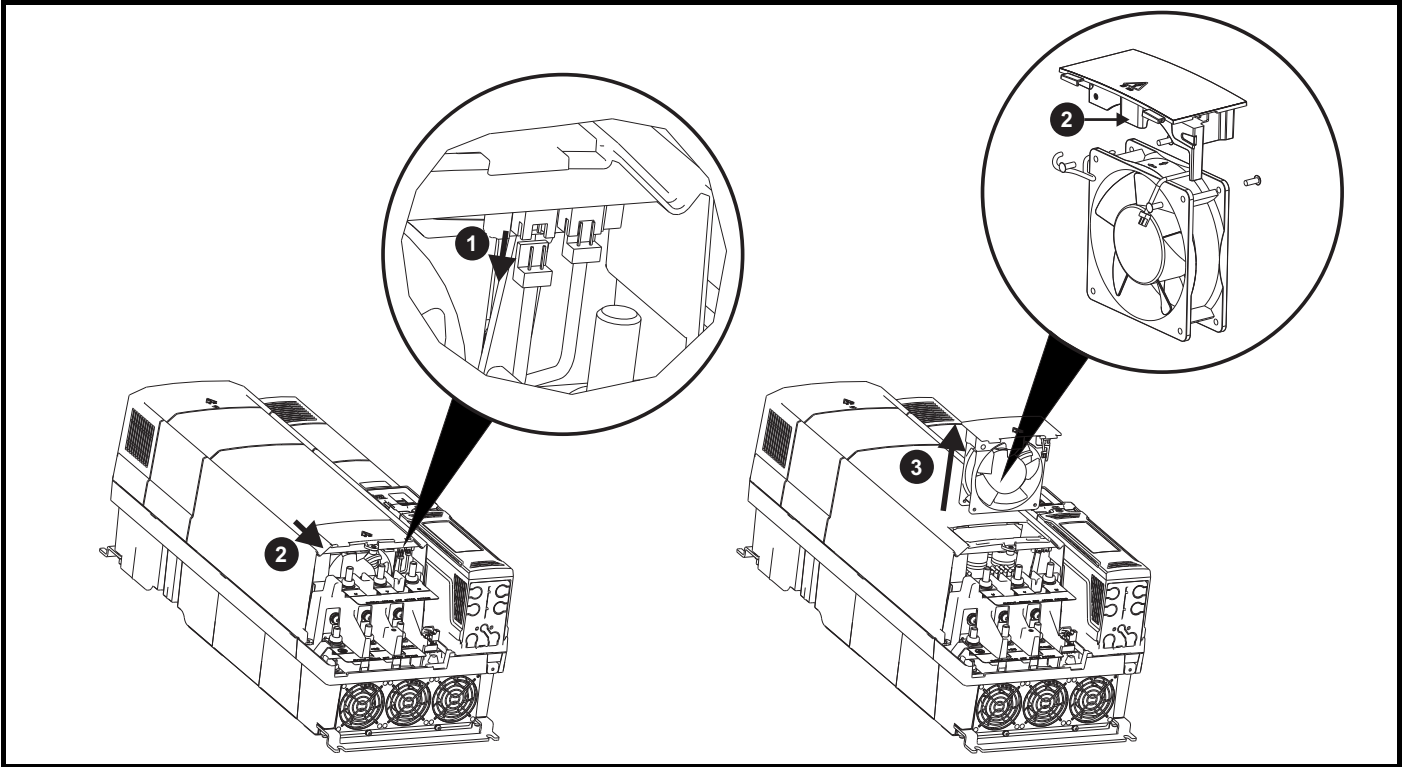
Replace the fan by reversing the above instructions.

Table 3-29 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 3-71 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

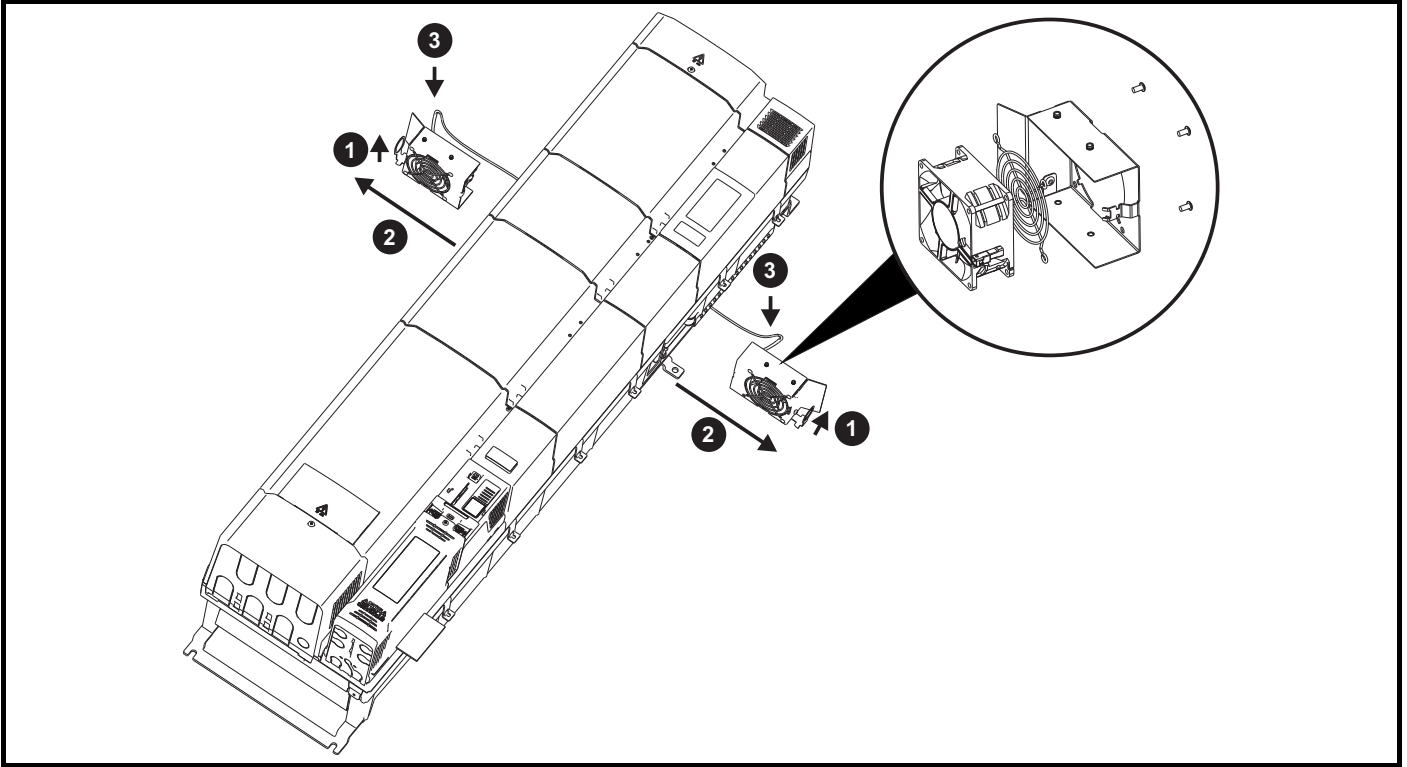
After fan has been replaced, reverse the above steps to refit.

Table 3-30 Size 7 to 11 Auxiliary (capacitor 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 |

3.13.9 Size 11E rectifier fan replacement

Figure 3-72 Size 11E rectifier fan replacement



Size 11E rectifier fan removal procedure

- 1) Lift the ring eye provided
- 2) Pull the fan housing in the direction shown
- 3) Disconnect the fan wiring at the connector shown

After fans have been replaced, reverse the above steps to refit the fan housing in the rectifier (making sure the fan housing aligns correctly in the slots top and bottom).

Table 3-31 Size 11E rectifier fan part number

| Drive model | Rectifier fan part number |
|--------------------|---------------------------|
| Size 11E rectifier | 3251-0030 |

For the IP65 version, frame 3 there is an addition fan inside the drive cover. The part number for this fan is 3251-0029-00 and can be accessed as shown on page 54.

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



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.



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.



STOP function

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



Safe Torque Off function

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



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.



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).



Permanent magnet motors

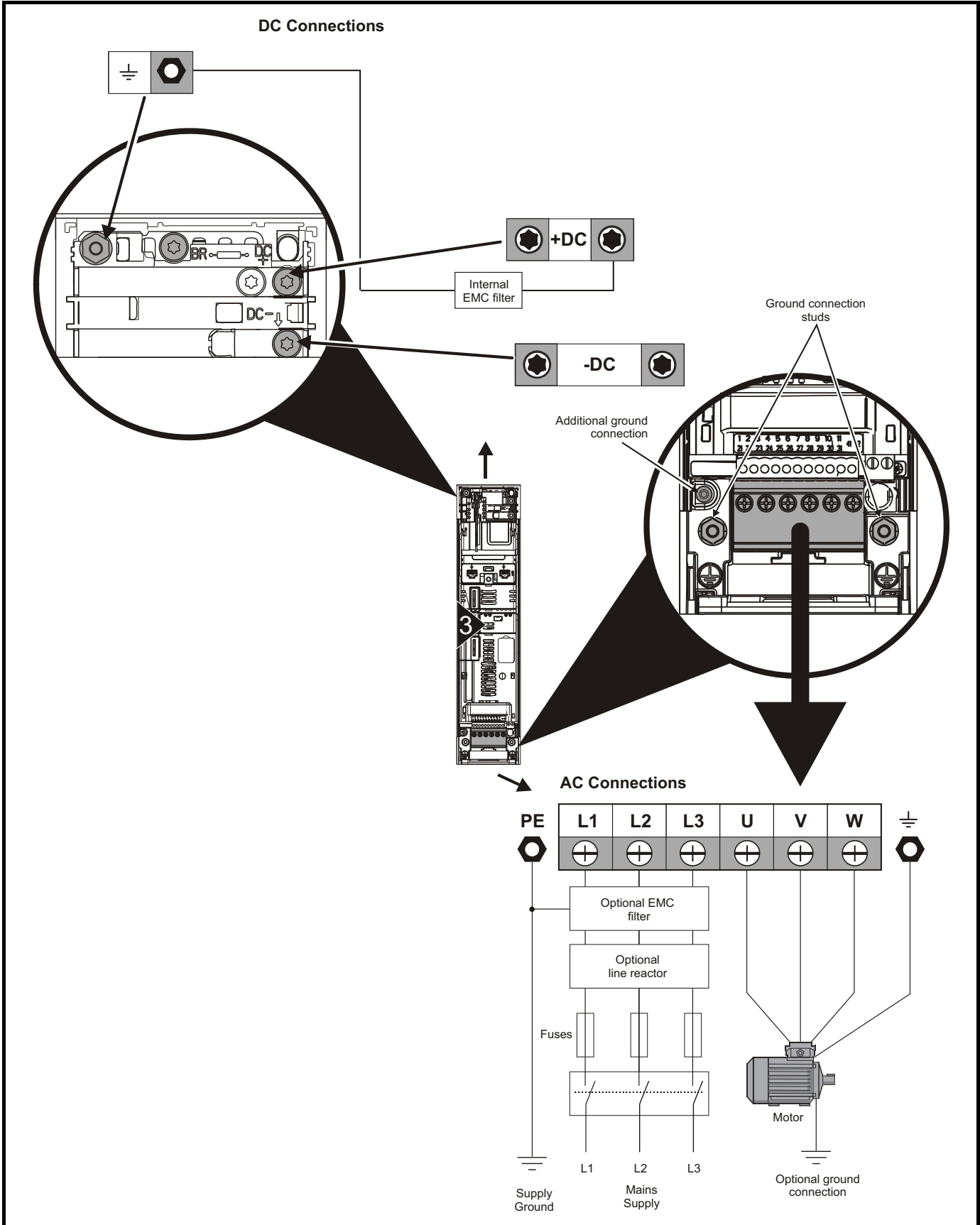
Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.

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

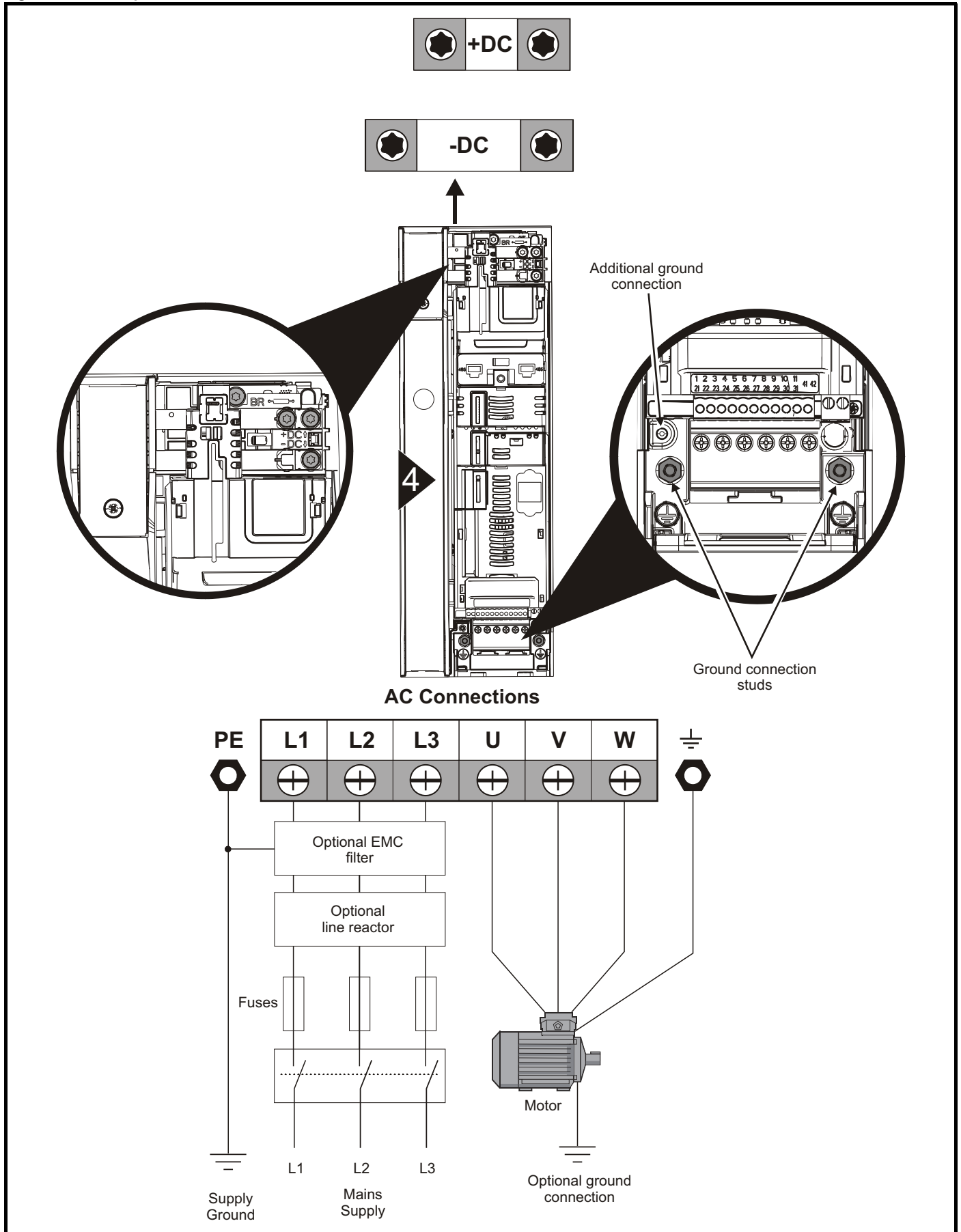
4.1.1 AC and DC connections

Figure 4-1 Size 3 power connections



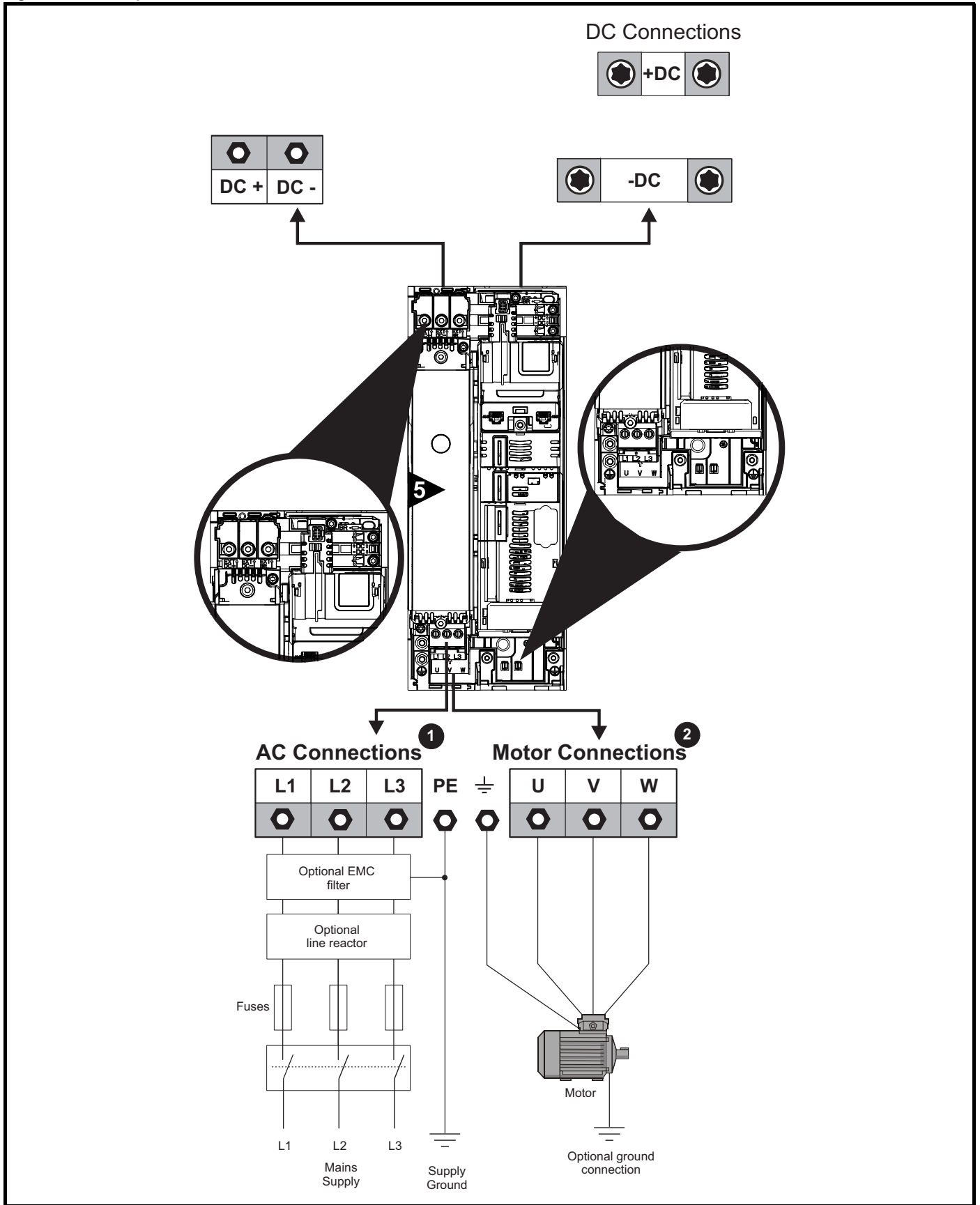
See Figure 4-9 for further information on ground connections.

Figure 4-2 Size 4 power connections



See Figure 4-9 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 4-10 for further information on ground connections.

Figure 4-4 Size 6 power connections

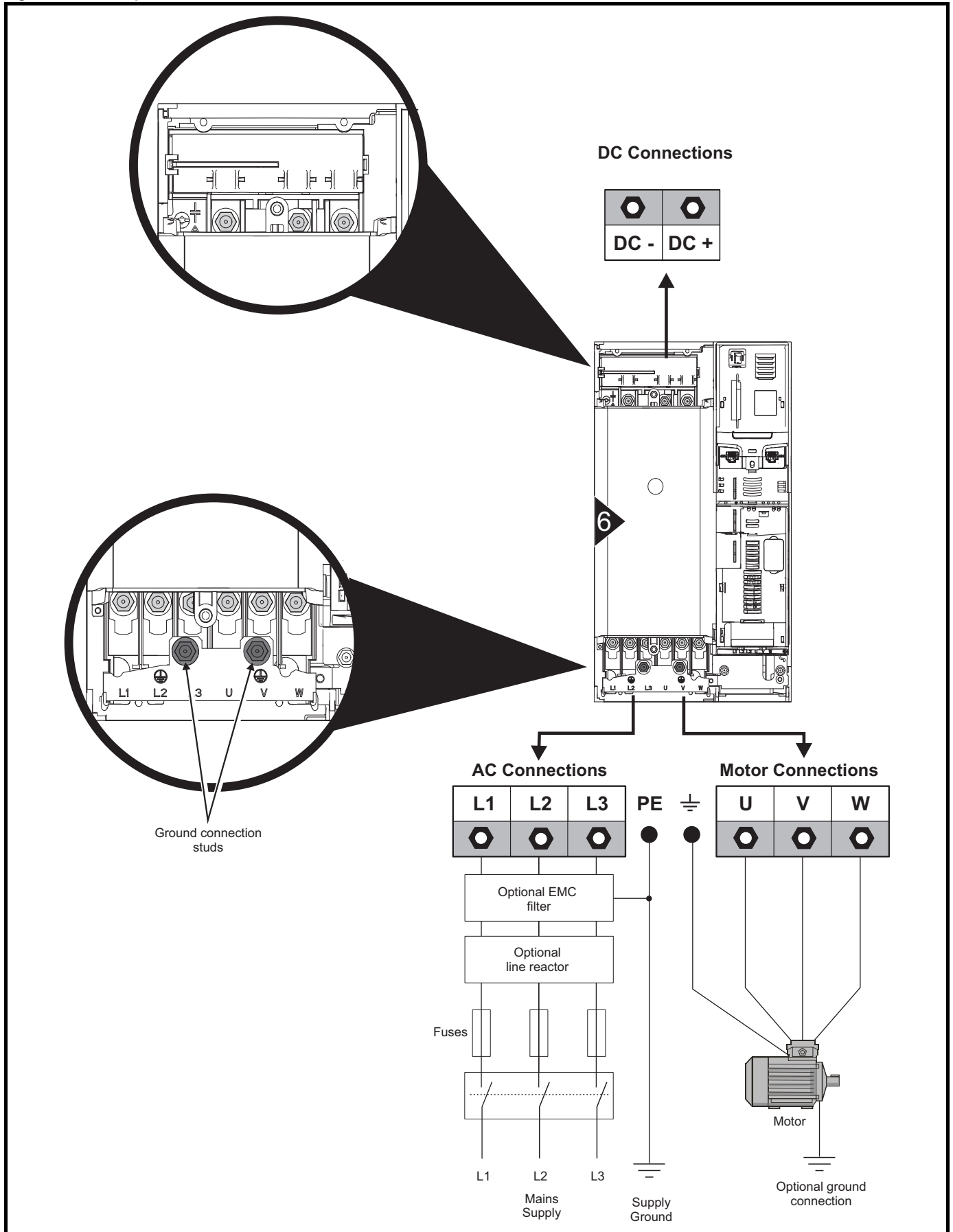


Figure 4-5 Size 7 and 8 power connections (Size 7 shown)

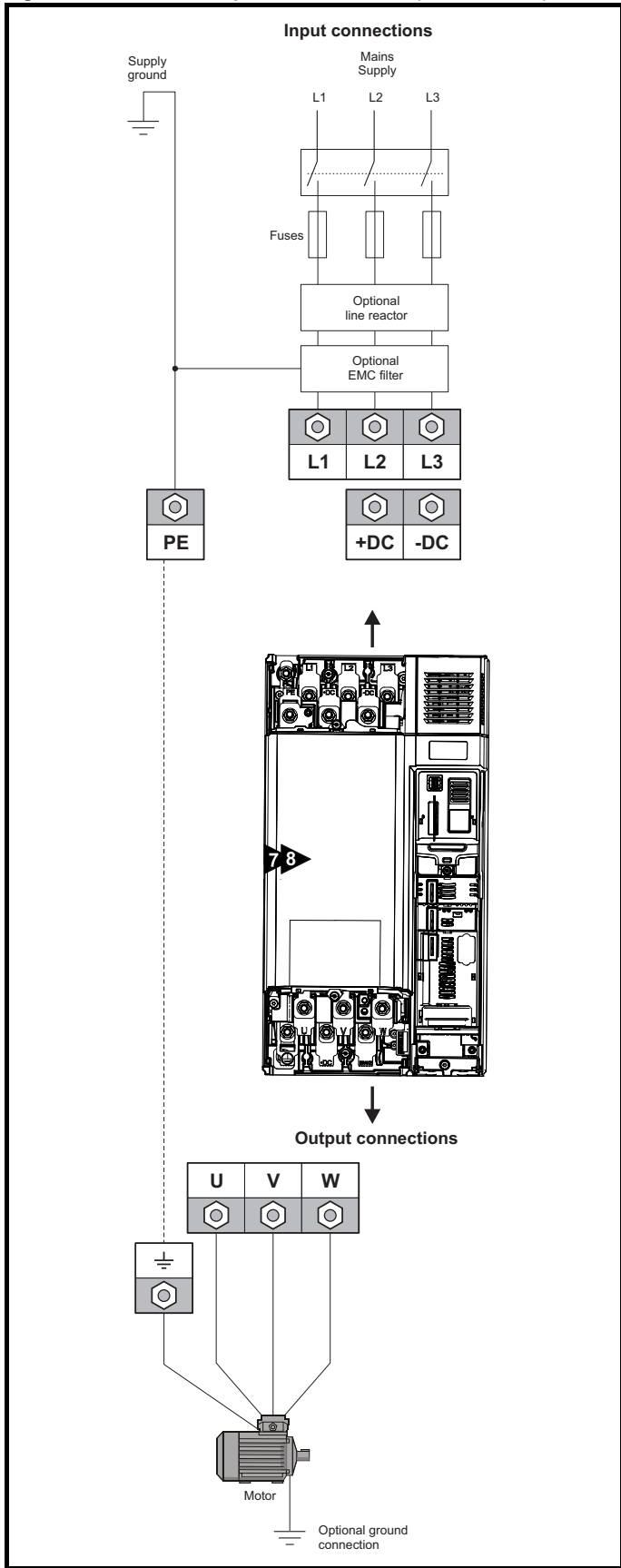


Figure 4-6 Size 9A Power and Ground Connections

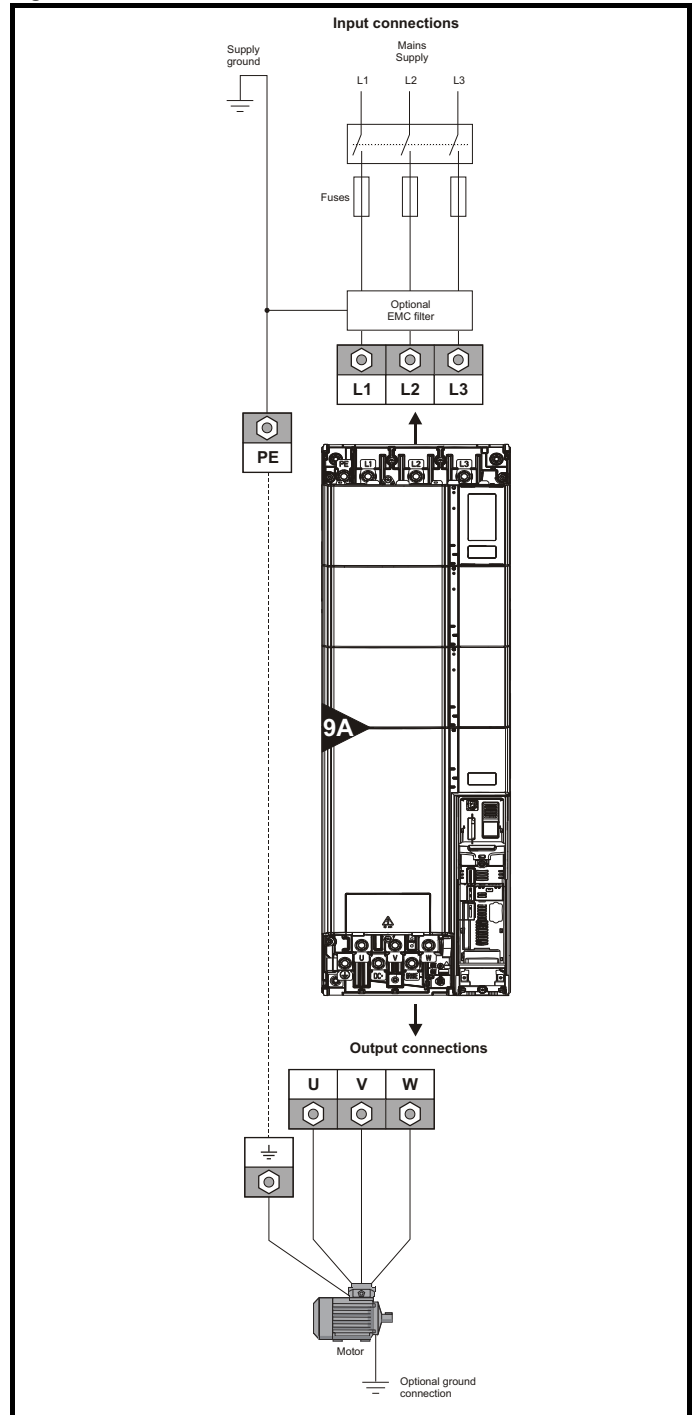
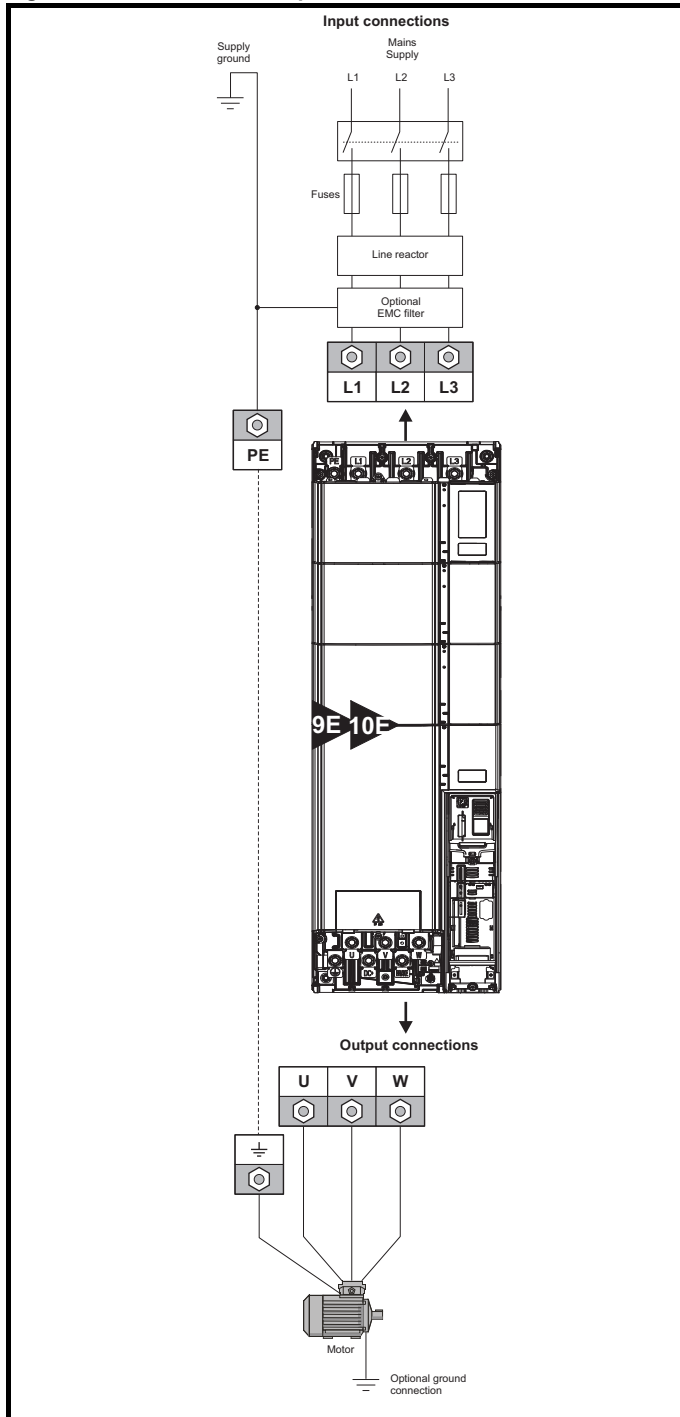
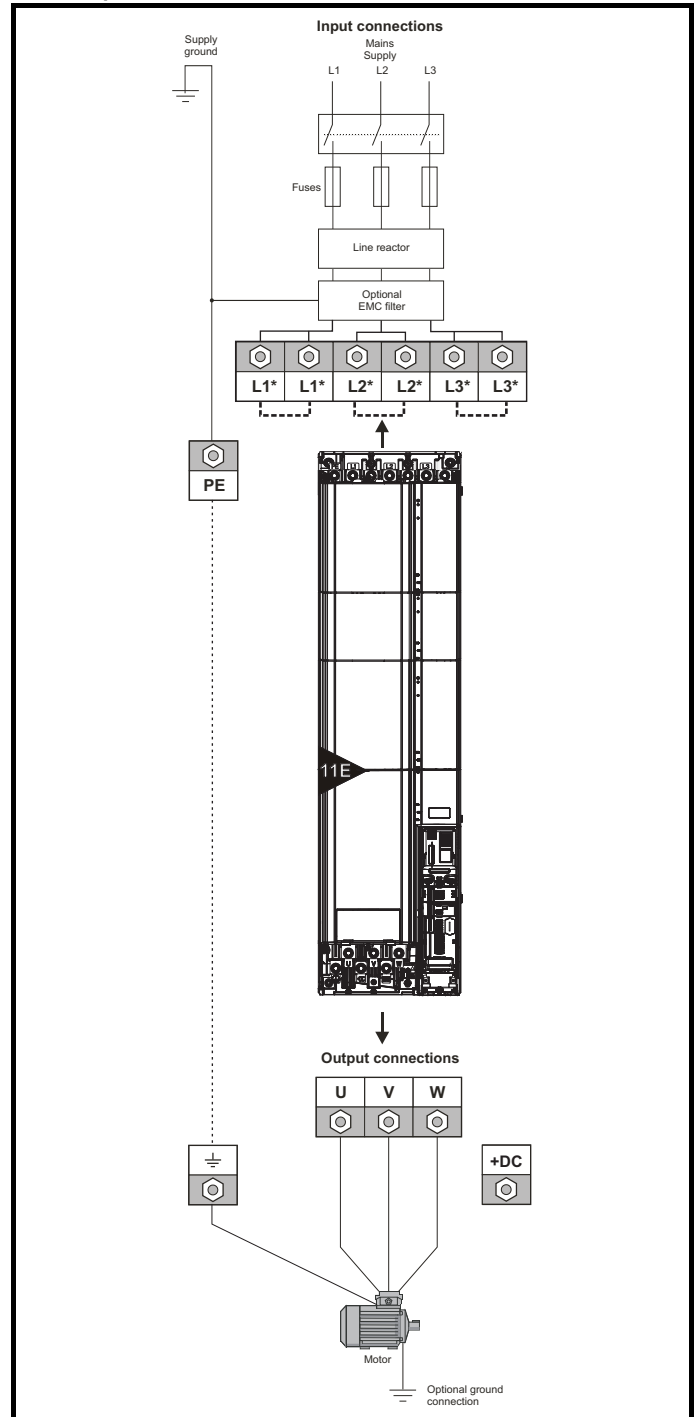


Figure 4-7 Size 9E and 10E power connections

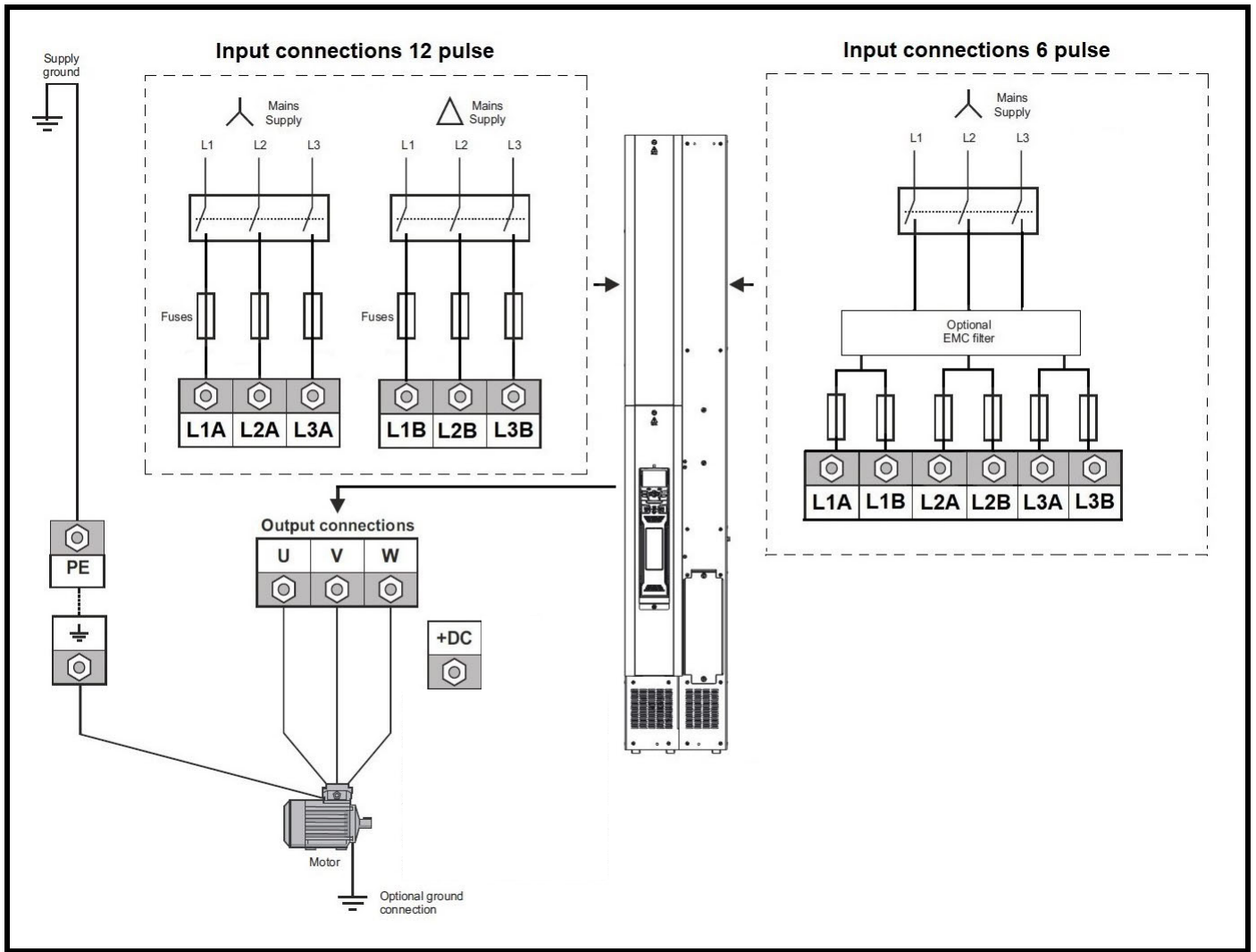


Size 11E power connections



WARNING A separate line reactor (INLXXX) of at least the value shown in Table 4-14 and Table on page 98 must be used with size 9E, 10E and 11E. Failure to provide sufficient reactance could damage or reduce the service life of the drive.

Figure 4-8 Power Module Frame 12 power connections



4.1.2 Ground connections

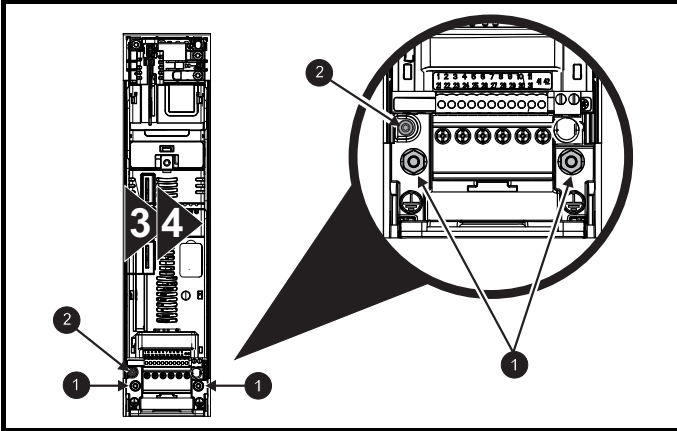


Electrochemical corrosion of grounding terminals
 Ensure that grounding terminals are protected against corrosion i.e. as could be caused by condensation.

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 4-9 for additional ground connection.

Figure 4-9 Size 3 and 4 ground connections

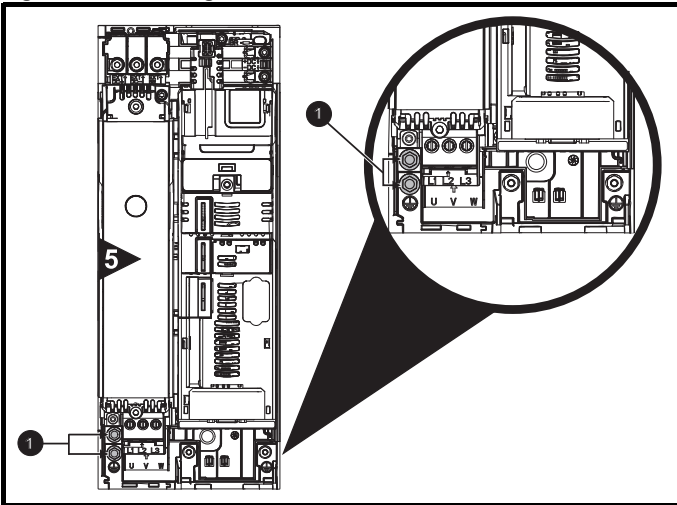


1. Ground connection studs.
2. Additional ground connection.

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 4-10 for additional ground connection.

Figure 4-10 Size 5 ground connections

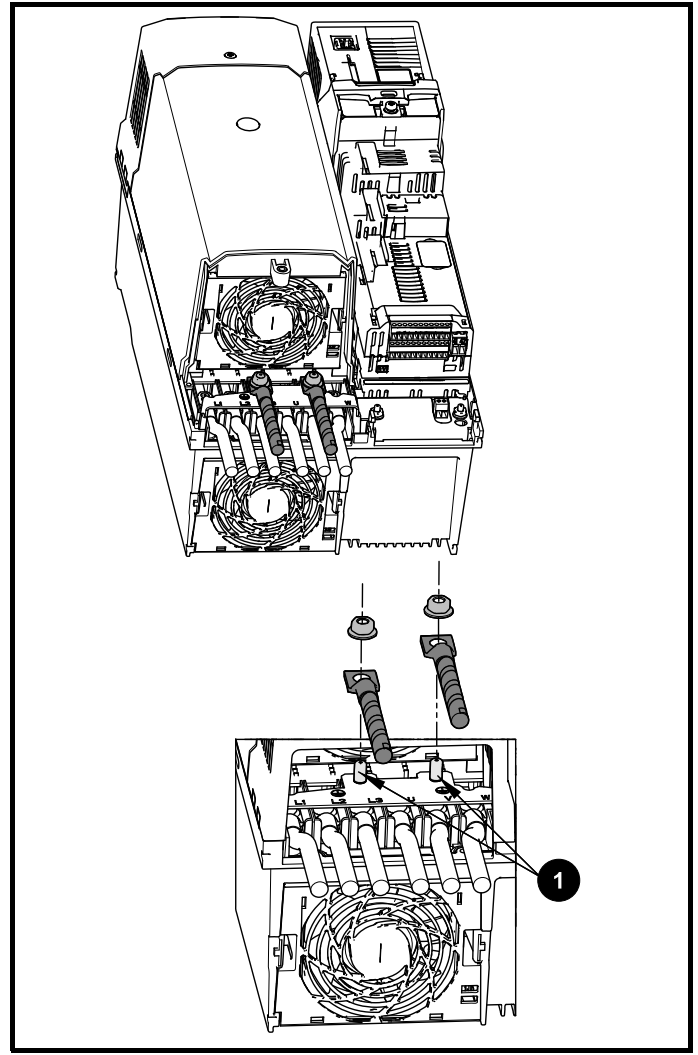


1. Ground connection studs.

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 4-11 below.

Figure 4-11 Size 6 ground connections



1. Ground connection studs

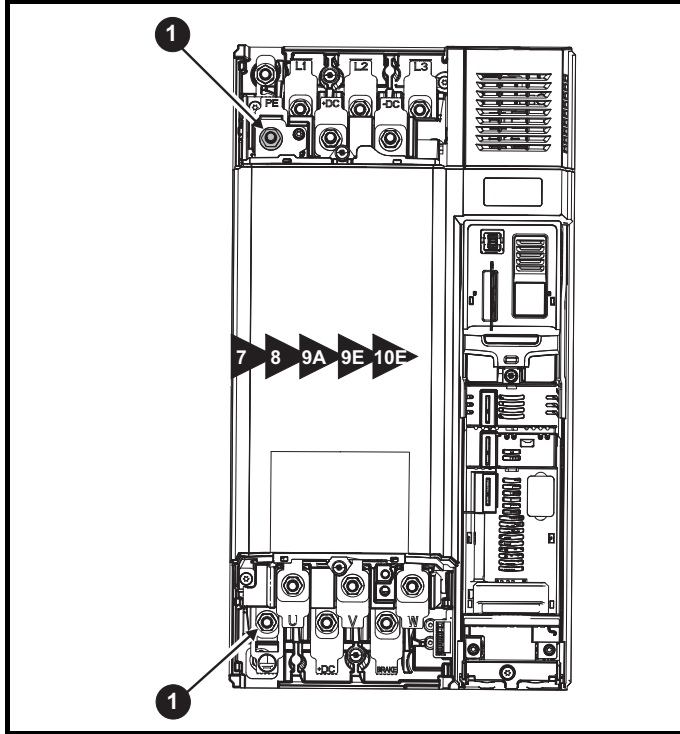
Size 7

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 4-12 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 4-13 Size 11E ground connections

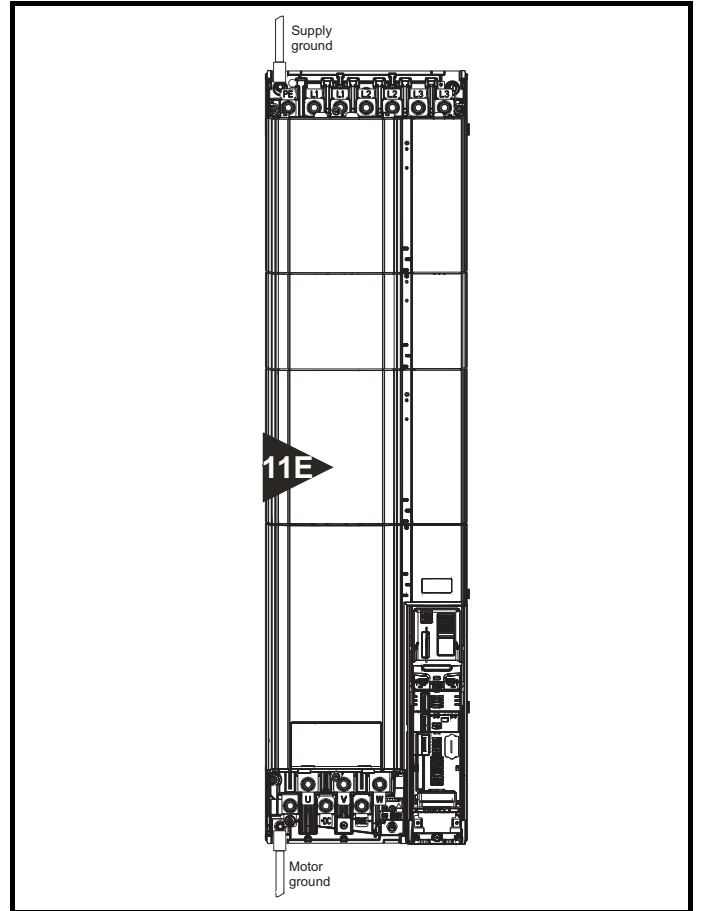


Table 4-1 Protective ground cable ratings

| Input phase conductor size | Minimum ground conductor size |
|--|--|
| $\leq 10 \text{ mm}^2$ | 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). |
| $> 10 \text{ mm}^2$ and $\leq 16 \text{ mm}^2$ | The same cross-sectional area as the input phase conductor |
| $> 16 \text{ mm}^2$ and $\leq 35 \text{ mm}^2$ | 16 mm^2 |
| $> 35 \text{ mm}^2$ | 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 $\pm 10\%$
- 400 V drive: 380 V to 480 V $\pm 10\%$
- 575 V drive: 500 V to 575 V $\pm 10\%$
- 690 V drive: 500 V to 690 V $\pm 10\%$

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.



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 118. 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 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 98.

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



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 |
| 4 | 03400123 | INL 4003 | 4401-0151 |
| | 04200180 | INL 2002 | 4401-0144 |
| | 04200250 | INL 2003 | 4401-0145 |
| | 04400185 | INL 4004 | 4401-0152 |
| 5 | 04400240 | INL 4005 | 4401-0153 |
| | 05200300 | INL 2008 | 4401-0226 |
| | 05400300 | INL 4013 | 4401-0236 |
| | 05500039 | INL 5007 | 4401-0242 |
| 6 | 05500061 | INL 5008 | 4401-0243 |
| | 05500100 | INL 5009 | 4401-0244 |
| | 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 |
| 7 | 06500340 | INL 5005 | 4401-0161 |
| | 06500430 | INL 5006 | 4401-0223 |
| | 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 |
| 8 | 07600460 | INL 6004 | 4401-0251 |
| | 07600520 | INL 6005 | 4401-0252 |
| | 07600730 | INL 6006 | 4401-0253 |
| | 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 |
| 9E | 08501080 | INL 5012 | 4401-0247 |
| | 08600860 | INL 6007 | 4401-0254 |
| 10E | 08601080 | INL 6008 | 4401-0255 |
| | 09202160, 09202660, 09402210, 09402660 | INL 401 | 4401-0181 |
| 11E | 09501250, 09501500, 09601720, 09601970 | INL 601 | 4401-0183 |
| | 10203250, 10203600, 10403200, 10403610 | INL 402 | 4401-0182 |
| 11E | 10502000, 10601720, 10601970 | INL 602 | 4401-0184 |
| | 11404370 | INL 403L** | 4401-0274 |
| | 11404370, 11404870, 11405070 | INL 403* | 4401-0259 |
| | 11502480, 11502880, 11503150, 11602250, 11602750, 11603050 | INL 603* | 4401-0261 |

* Natural cooling.

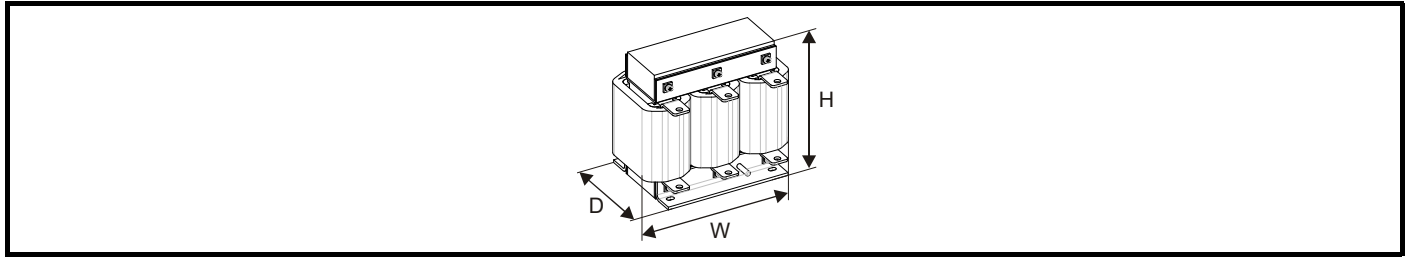
** May represent a more economic solution when operating below 420 A.

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 4-14 Input line reactor dimensions



4.2.4 Input inductor calculation

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

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

Where:

I = drive rated input current (A)

L = inductance (H)

f = supply frequency (Hz)

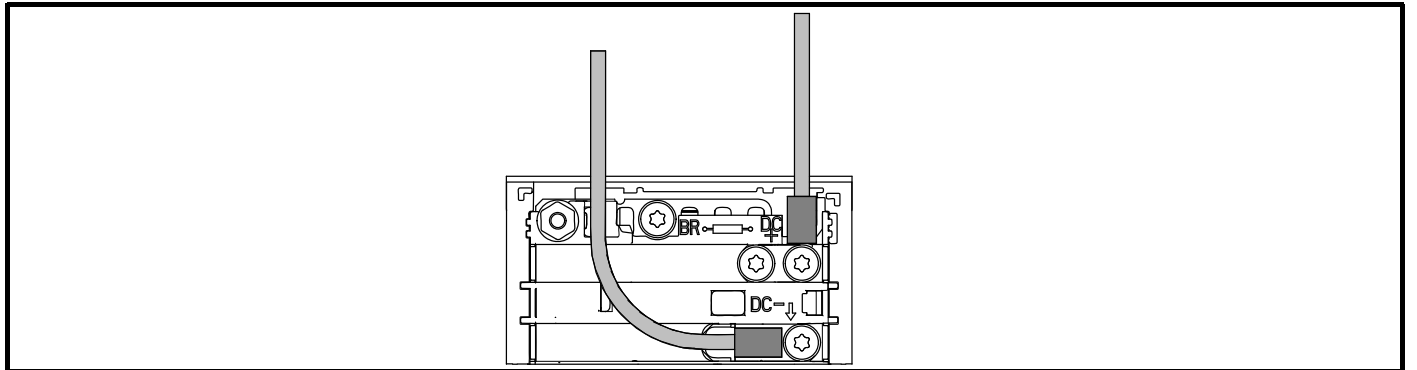
V = voltage between lines

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 75 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 4-15 below shows DC supply connections and cable routing.

Figure 4-15 DC supply connections (size 3 shown)



NOTE

The Internal EMC filter and plastics have been removed from the above Figure 4-15 to demonstrate the routing of the DC cables.

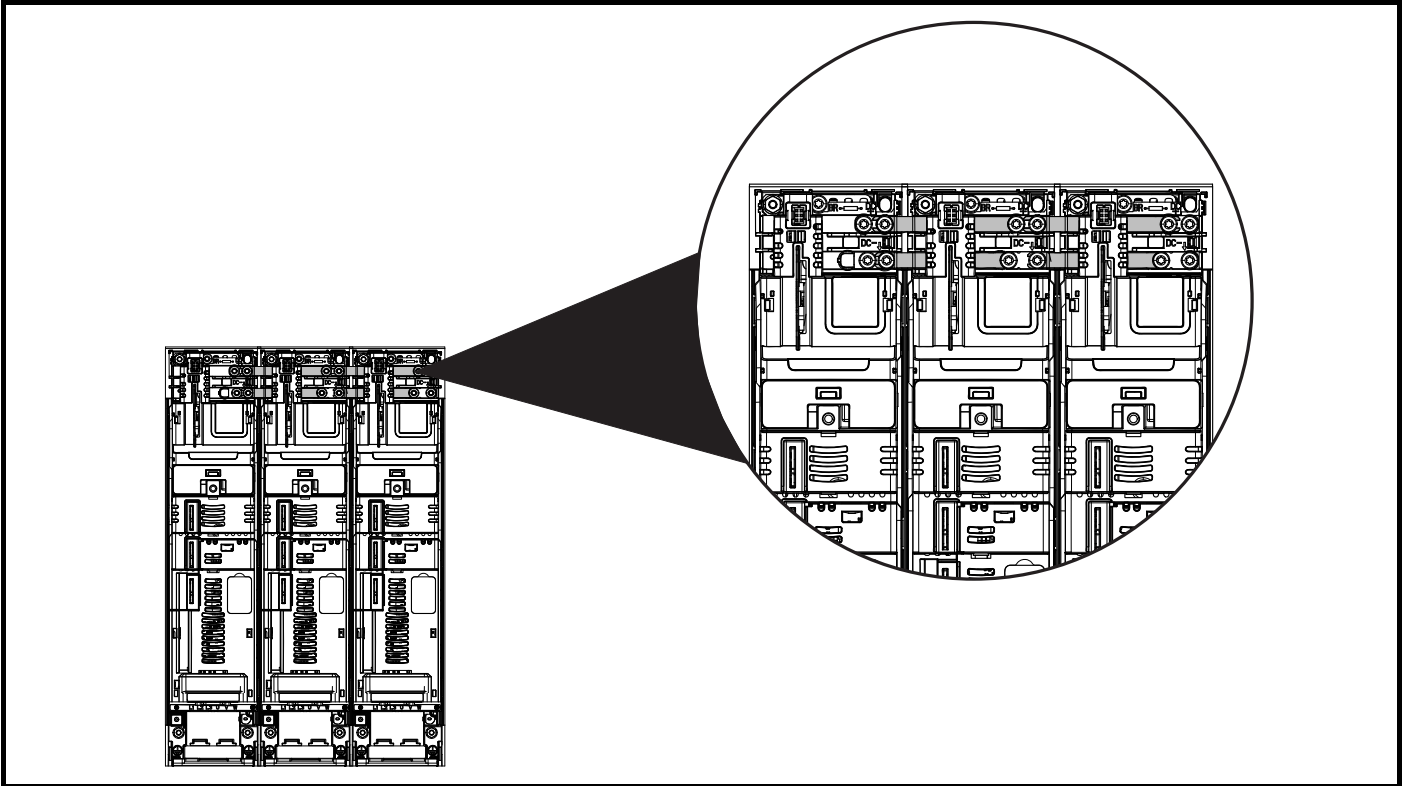
4.4 DC bus paralleling

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 4-16 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 modules 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 4-17 *Location of the 24 Vdc power supply connection on size 6* on page 102.

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:

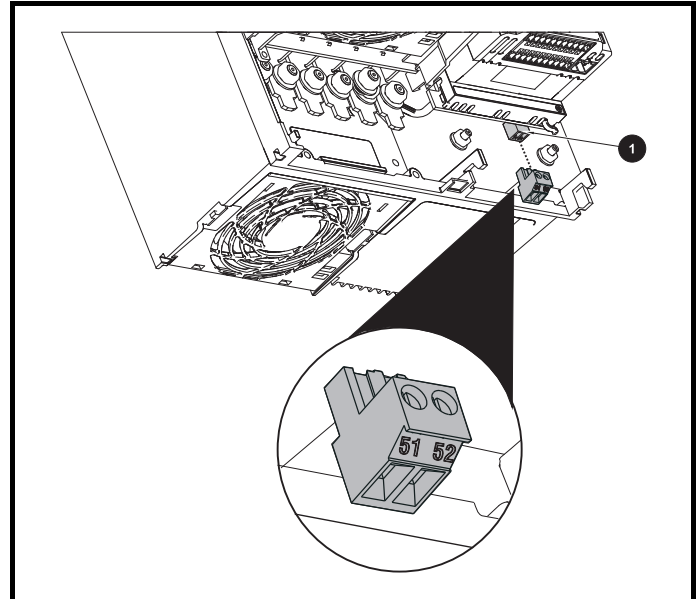
| | |
|--|------------------|
| 1 | 0V common |
| 2 | +24 Vdc |
| Nominal operating voltage | 24.0 Vdc |
| Minimum continuous operating voltage | 19.2 V |
| Maximum continuous operating voltage | 28.0 V |
| Minimum start up voltage | 21.6 V |
| Maximum power supply requirement at 24 V | 40 W |
| Recommended 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 4-17 Location of the 24 Vdc power supply connection on size 6



1. 24 Vdc power supply connection

Figure 4-18 Location of the 24 Vdc power supply connection on size 7

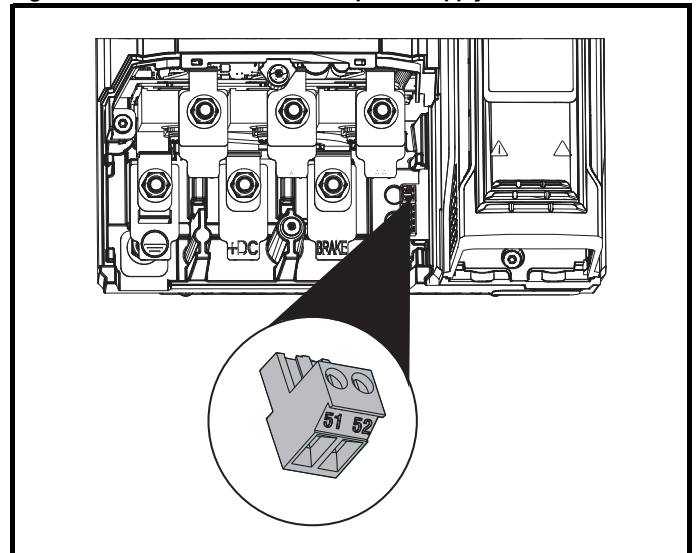


Figure 4-19 Location of the 24 Vdc power supply connection on size 8 to 11

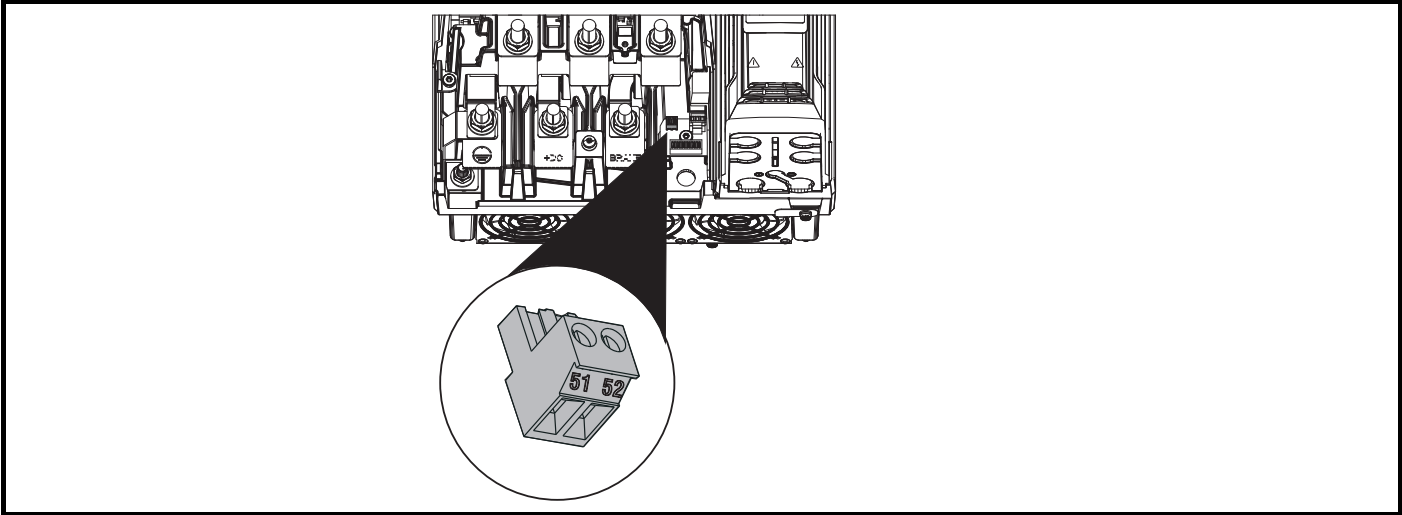
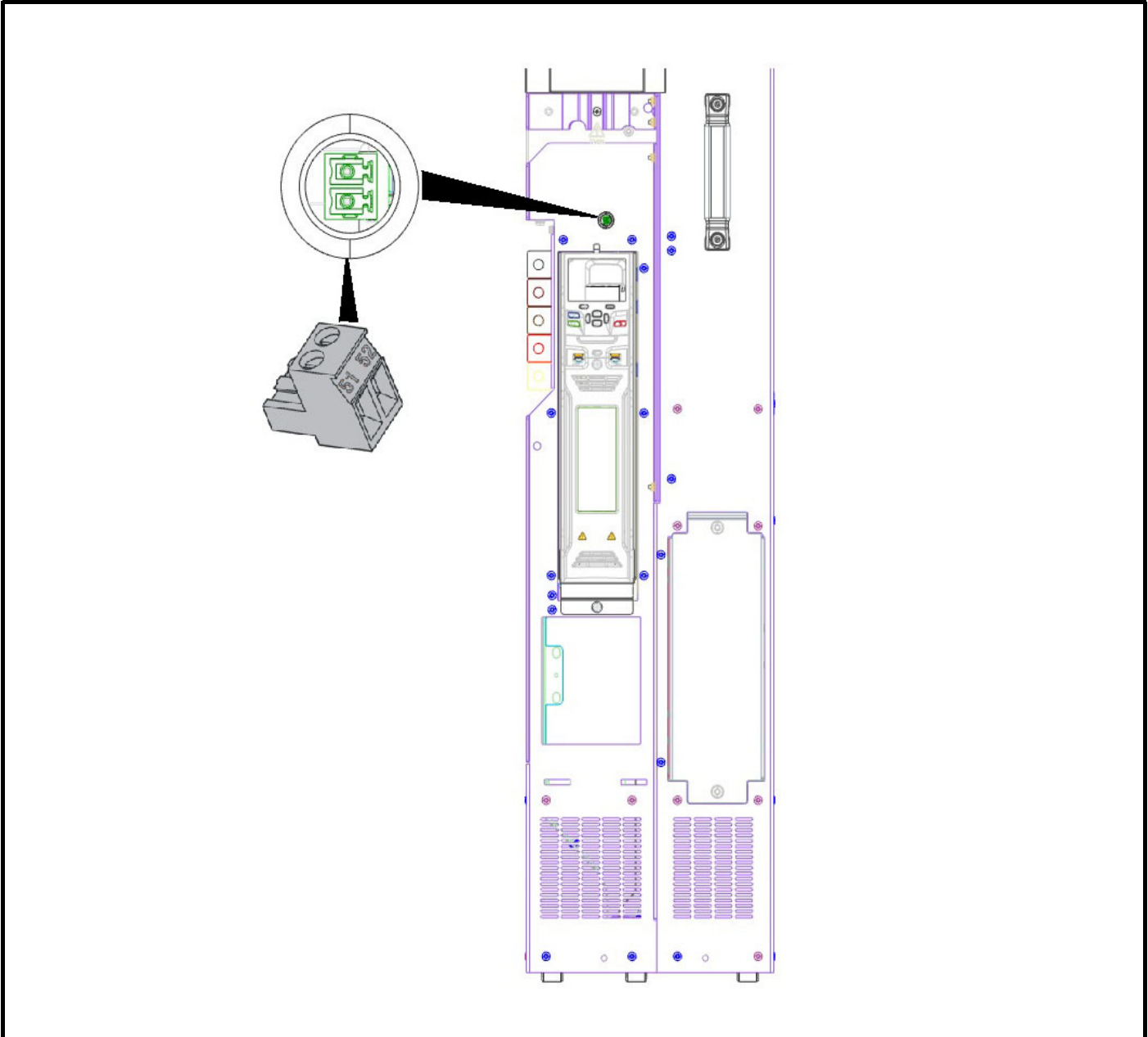


Figure 4-20 Location of the 24 Vdc power supply connection on size 12



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 12

| | |
|---------------------------------------|----------------------|
| 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 |

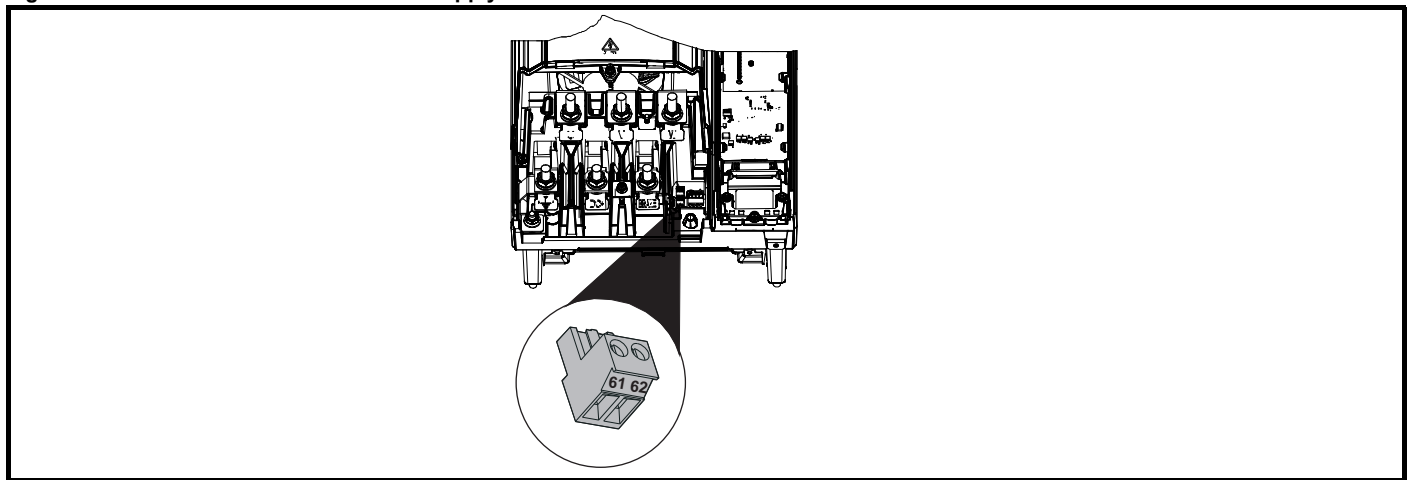
NOTE

Size 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 Unidrive M 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 4-21 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 4-20 *Location of the 24 Vdc power supply connection on size 12* on page 103 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 |



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 A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|
| | | | | IEC | | | UL / USA | | |
| | | | | 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 | 25 | gG | 25 | 25 | CC, J or T* |
| 04200180 | 17 | 20 | 30 | 25 | | | | | |
| 04200250 | 23 | 28 | 41 | 32 | 32 | gG | 30 | 30 | CC, J or T* |
| 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 | | | | |
| 07201170 | 91 | 105 | 149 | 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 | | | | |
| 10203250 | 277 | 305 | 421 | 400 | 400 | gR | 400 | 400 | HSJ |
| 10203600 | 333 | 361 | 494 | 450 | 450 | | | | |

* These fuses are fast acting.

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

| Model | Typical input current A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|
| | | | | IEC | | | UL / USA | | |
| | | | | 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 | gG | 20 | 20 | CC, J or T* |
| 03400104 | 12 | | 20 | | | | | | |
| 03400123 | 14 | | 25 | | | | | | |
| 04400185 | 17 | 19 | 30 | 25 | 25 | gG | 25 | 25 | CC, J or T* |
| 04400240 | 22 | 24 | 35 | 32 | 32 | | | | |
| 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 | |
| 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 | | | | |
| 11404370 | 424 | 449 | 579 | 500 | 500 | gR | 600 | 600 | HSJ |
| 11404870 | 455 | 492 | 613 | | | | | | |
| 11405070 | 502 | 539 | 752 | | | | | | |

* These fuses are fast acting.

Table 4-9 400 V drive input current, fuse rating and cable size

| Model | Maximum continuous input current | Fuse (6 per drive) | | | | Nominal cable size (European) mm ² | | | | Nominal cable size (USA) | | |
|-----------|----------------------------------|--------------------|-----|--------|-----|---|-----------------|-----------------|--|--------------------------|--|--------------------------------------|
| | | IEC | | UL/USA | | Input 6 pulse | Input 12 pulse | Output | Cable type (input & output) | Input 6 pulse | Input 12 pulse | Output |
| | | 3 ph | Nom | Class | Nom | | | | | | | |
| | | A | A | | A | s | mm ² | mm ² | | mm ² | kcmil | kcmil |
| 12404800T | 720 | 550 | aR | 400 | gR | 4 x 120 | 2 x 120 | 3 x 150 | | XLPE/EPR | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) |
| 12405660T | 777 | 550 | | 450 | | 4 x 150 | 2 x 150 | 4 x 120 | 4 x 3/0 AWG (85 mm ²) | | 2 x 3/0 AWG (85 mm ²) | 4 x 2/0 AWG (67.4 mm ²) |
| 12406600T | 845 | 550 | | 500 | | 4 x 150 | 2 x 150 | 3 x 185 | 4 x 4/0 AWG (107.2 mm ²) | | 2 x 4/0 AWG (107.2 mm ²) | 4 x 3/0 AWG (85 mm ²) |
| 12407200T | 995 | 550 | | 550 | | 4 x 185 | 2 x 185 | 4 x 185 | 4 x 250 Kcmil (127.2 mm ²) | | 2 x 250 Kcmil (127.2 mm ²) | 4 x 4/0 AWG (107.2 mm ²) |

Table 4-10 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 | A | A | Class | |
| 05500039 | 4 | 4 | 7 | 10 | 20 | gG | 10 | 10 | CC, J or T* | |
| 05500061 | 6 | 7 | 9 | | | | 20 | 20 | | |
| 05500100 | 9 | 11 | 15 | | | | 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 | gG | 35 | 50 | CC, J or T* | |
| 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 4-11 575 V drive input current, fuse rating and cable size

| Model | Maximum continuous input current | Fuse (6 per drive) | | | | Nominal cable size (European) mm ² | | | | Nominal cable size (USA) | | |
|-----------|----------------------------------|--------------------|-----|--------|-----|---|-----------------|-----------------|-----------------------------|--|--|--------------------------------------|
| | | IEC | | UL/USA | | Input 6 pulse | Input 12 pulse | Output | Cable type (input & output) | Input 6 pulse | Input 12 pulse | Output |
| | | 3 ph | Nom | Class | Nom | | | | | | | |
| | | A | A | | A | A | mm ² | mm ² | mm ² | kcmil | kcmil | kcmil |
| 12503150T | 555 | 400 | aR | 315 | gR | 2 x 150 | 1 x 150 | 1 x 185 | XLPE/EPR | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 1/0 AWG (53.5 mm ²) |
| 12503600T | 625 | 400 | | 315 | | 3 x 150 | 1 x 240 | 1 x 240 | | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 2/0 AWG (67.4 mm ²) |
| 12504100T | 703 | 400 | | 350 | | 2 x 185 | 1 x 185 | 2 x 120 | | 4 x 4/0 AWG (107.2 mm ²) | 2 x 4/0 AWG (107.2 mm ²) | 4 x 3/0 AWG (85 mm ²) |
| 12504600T | 781 | 400 | | 400 | | 2 x 240 | 1 x 240 | 2 x 150 | | 4 x 250 Kcmil (127.2 mm ²) | 2 x 250 Kcmil (127.2 mm ²) | 4 x 4/0 AWG (107.2 mm ²) |

Table 4-12 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 | |
| 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 | gR | 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 | | 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.

Table 4-13 690 V drive input current, fuse rating and cable size

| Model | Maximum continuous input current | Fuse (6 per drive) | | | | Nominal cable size (European) mm ² | | | | Nominal cable size (USA) | | |
|-----------|----------------------------------|--------------------|-----|--------|-----|---|-----------------|-----------------|-----------------------------|--|--|--------------------------------------|
| | | IEC | | UL/USA | | Input 6 pulse | Input 12 pulse | Output | Cable type (input & output) | Input 6 pulse | Input 12 pulse | Output |
| | | 3 ph | Nom | Class | Nom | | | | | | | |
| | | A | A | | A | A | mm ² | mm ² | mm ² | kcmil | kcmil | kcmil |
| 12603150T | 555 | 400 | aR | 315 | gR | 2 x 150 | 1 x 150 | 1 x 185 | XLPE/EPR | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 1/0 AWG (53.5 mm ²) |
| 12603600T | 625 | 400 | | 315 | | 3 x 150 | 1 x 240 | 1 x 240 | | 4 x 3/0 AWG (85 mm ²) | 2 x 3/0 AWG (85 mm ²) | 4 x 2/0 AWG (67.4 mm ²) |
| 12604100T | 703 | 400 | | 350 | | 2 x 185 | 1 x 185 | 2 x 120 | | 4 x 4/0 AWG (107.2 mm ²) | 2 x 4/0 AWG (107.2 mm ²) | 4 x 3/0 AWG (85 mm ²) |
| 12604600T | 781 | 400 | | 400 | | 2 x 240 | 1 x 240 | 2 x 150 | | 4 x 250 Kcmil (127.2 mm ²) | 2 x 250 Kcmil (127.2 mm ²) | 4 x 4/0 AWG (107.2 mm ²) |

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 4-14 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 | | | | 4 | | | 12 | | | |
| 03200110 | 4 | 8 | B2 | 4 | 8 | B2 | 10 | 8 | 10 | 8 |
| 03200127 | | | | 8 | | | 8 | | | |
| 04200180 | 6 | 8 | B2 | 6 | 8 | B2 | 10 | 8 | 10 | 8 |
| 04200250 | 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 | | | 3 | | | 3 | | | |
| 07200750 | 35 | 70 | B2 | 35 | 70 | B2 | 2 | 1/0 | 2 | 1/0 |
| 07200940 | | | | 1 | | | 1 | | | |
| 07201170 | | | | 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 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 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 4-15 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 | | | | 2.5 | | | 14 | | 14 | |
| 03400077 | | | | | | | 12 | | 12 | |
| 03400104 | 4 | 6 | B2 | 4 | 6 | B2 | 10 | 8 | 10 | 8 |
| 03400123 | | | | 6 | | | 8 | | | |
| 04400185 | 4 | 6 | B2 | 4 | 6 | B2 | 10 | 8 | 10 | 8 |
| 04400240 | 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 | | | 4 | | | 4 | | | |
| 06400630 | 25 | | | 3 | | | 3 | | | |
| 07400790 | 35 | 70 | B2 | 35 | 70 | B2 | 1 | 1/0 | 1 | 1/0 |
| 07400940 | 50 | | | 2 | | | 2 | | | |
| 07401120 | 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 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 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 | 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 | | | | 2 x 240 | 2 x 240 | | | | | |

Table 4-16 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 | |
| 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 | | | 1 | | 1 | |
| 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 4-17 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 | | | | 4 | | | 4 | | | |
| 07600520 | | | | 4 | | | 4 | | | |
| 07600730 | | | | 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 4-13 *Size 11E ground connections* on page 96.


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 overheating 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 4-18 to section 4-21.

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 4-18 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) | | | | | | |
| 03200080 | 100 m (330 ft) | | | | | | |
| 03200110 | 130 m (425 ft) | | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 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 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 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 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 07201170 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |

Table 4-19 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) | | | | | | |
| 03400045 | 100 m (330 ft) | | | | | | |
| 03400062 | 130 m (425 ft) | | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 03400077 | 200 m (660 ft) | | 150 m (490 ft) | | | | |
| 03400104 | 200 m (660 ft) | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 03400123 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 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 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 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 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 06400630 | | 150 m (490 ft) | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 07401120 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 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 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | 62 m (203 ft) | 46 m (151 ft) |
| 11404370 | 250 m (820 ft) | 187 m (614 ft) | 125 m (410 ft) | 93 m (305 ft) | | | |
| 11404870 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | | |
| 11405070 | | 187 m (614 ft) | | 125 m (410 ft) | 93 m (305 ft) | | |

For Frame 12 Drives consult with the Unidrive M Power Module Frame 12 Power Installation Guide.

Table 4-20 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 4-21 Maximum motor cable lengths (690 V drives)

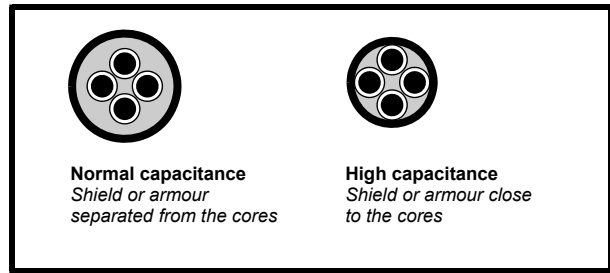
| 690 V Nominal AC supply voltage | | | | | | | |
|---------------------------------|--|-------------------|-------------------|------------------|------------------|------------------|--------|
| Model | Maximum permissible motor cable length for each of the following switching frequencies | | | | | | |
| | 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 4-22 shows how to identify the two types).

Figure 4-22 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 113 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 4-23 and Figure 4-24. The maximum motor cable lengths specified in section 4.9.1 *Cable types and lengths* on page 112 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 Δ connection, a sinusoidal filter or an output inductor must be connected as shown in Figure 4-24, even when the cable lengths are less than the maximum permissible. For details of inductor sizes refer to the supplier of the drive.

Figure 4-23 Preferred chain connection for multiple motors

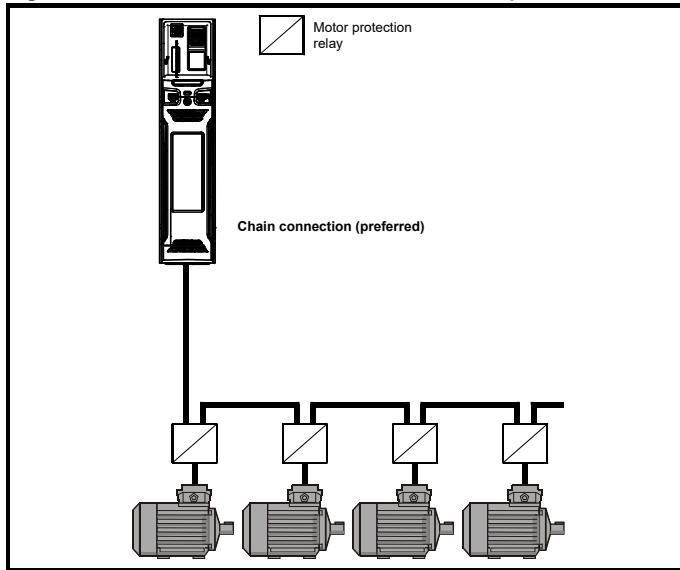
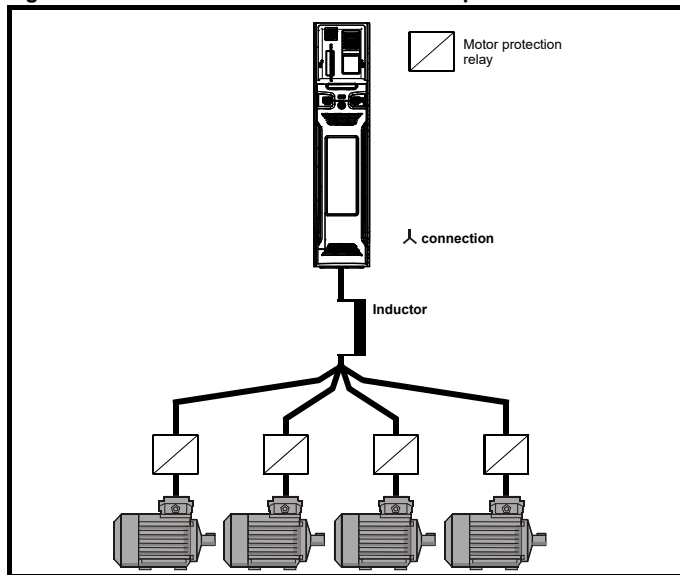


Figure 4-24 Alternative connection for multiple motors



4.9.5 Δ / Δ motor operation

The voltage rating for Δ 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 Δ for 400 V operation or Δ for 230 V operation, however, variations on this are common e.g. Δ 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 130.

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 118.

With internal filter installed:

Size 3 to 5: 28 mA* AC at 400 V 50 Hz
30 μ A DC with a 600 V DC bus (10 M Ω)

Size 7 to 11: 56 mA* AC at 400 V 50 Hz
18 μ A DC with a 600 V DC bus (33 M Ω)

Size 12: 18 mA* AC at 400 V 50 Hz with internal filter in circuit

* Proportional to the supply voltage and frequency.

With internal filter removed:**

<1 mA
Size 12: <63 mA

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



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



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 273 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 124 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 273

The correct external EMC filter must be used and all of the guidelines in section 4.11.4 *General requirements for EMC* on page 120 and section 4.11.6 *Compliance with generic emission standards* on page 121 must be followed.

Table 4-22 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 |

| Model | CT part number |
|---------------------------|----------------|
| 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 |

 **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.

WARNING

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.

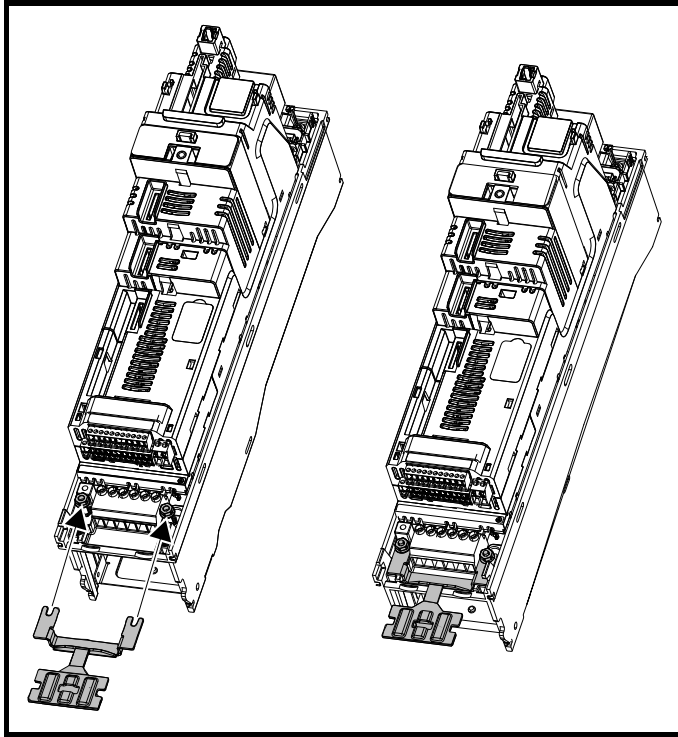
4.11.1 Grounding hardware

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 clamps¹ (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).

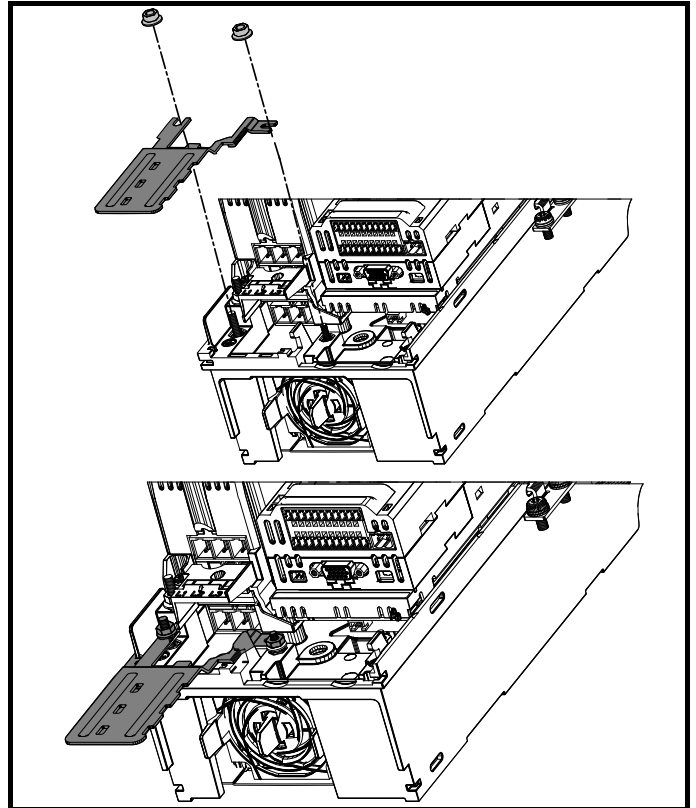
- See Figure 4-25, Figure 4-26 and Figure 4-27 for details on installing the grounding clamp.
- See Figure 4-28 for details on installing the grounding bracket.

Figure 4-25 Installation of grounding clamp (size 3 and 4)



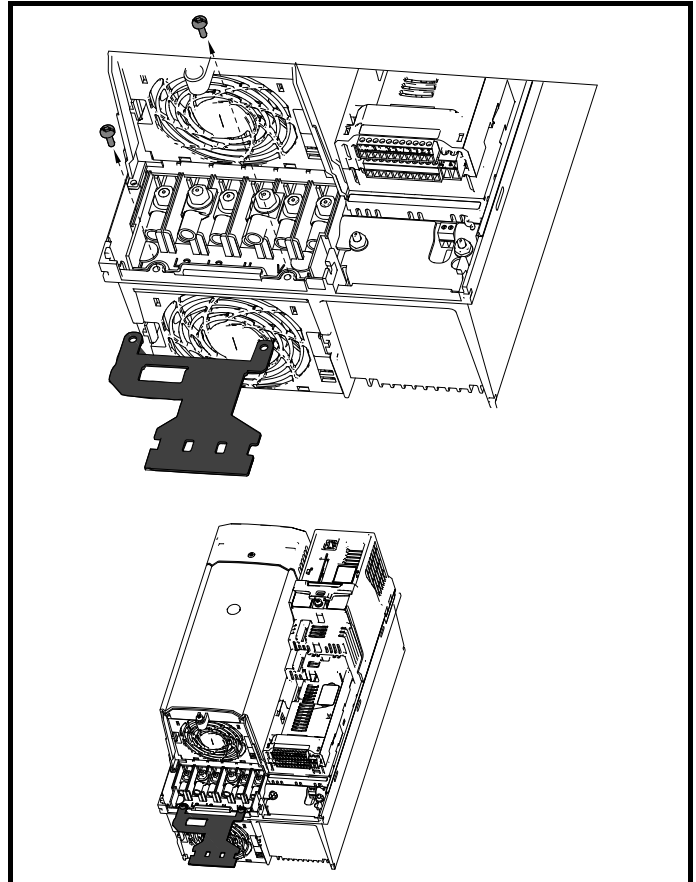
Loosen the ground connection nuts and slide the grounding clamp in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 Nm (17.64 lb in).

Figure 4-26 Installation of grounding clamp (size 5)



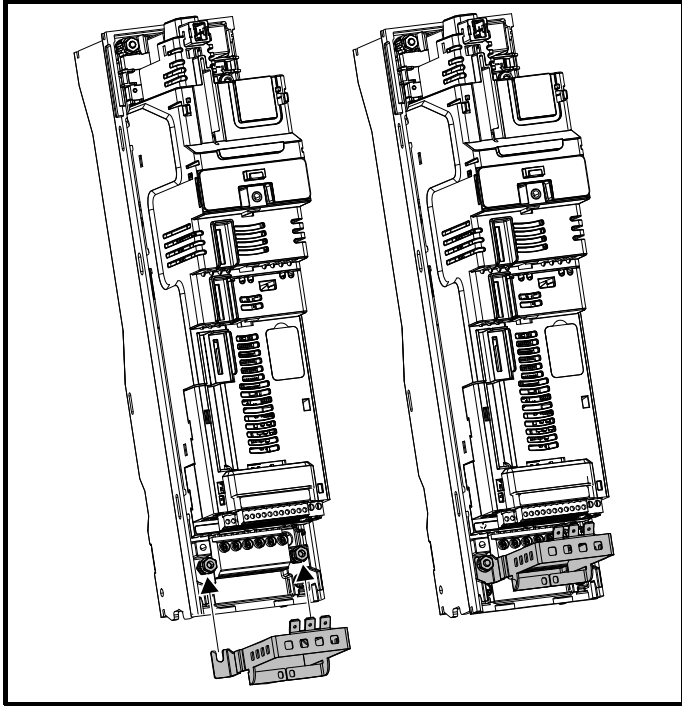
Loosen the ground connection nuts and slide the grounding clamp down onto the pillars in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 Nm (17.64 lb in).

Figure 4-27 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 Nm (17.64 lb in).

Figure 4-28 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 Nm (17.64 lb in).



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.



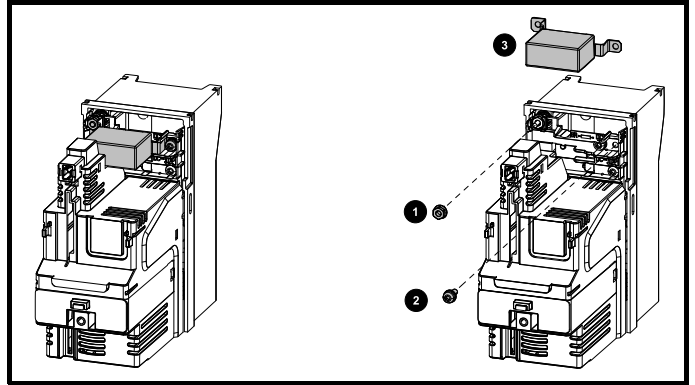
WARNING If the drive is used with ungrounded (IT) supplies, the internal EMC filter must be removed unless additional motor ground fault protection is installed. For instructions on removal refer to section 4.11.2. For details of ground fault protection contact the supplier of the drive.

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 121 and section 12.1.24 *Electromagnetic compatibility (EMC)* on page 295. 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.

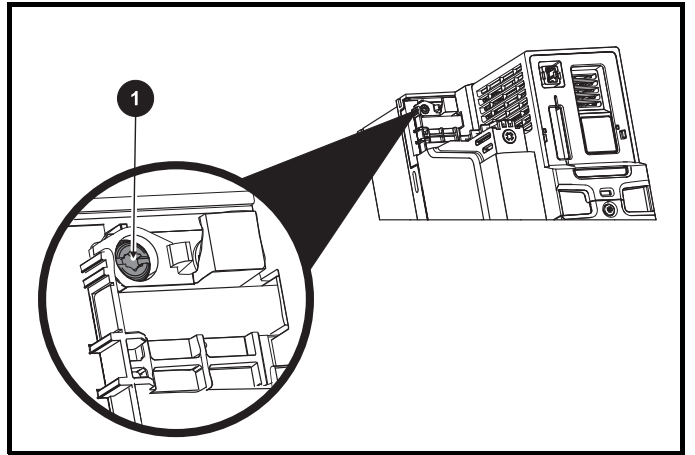
Figure 4-29 Removal of the size 3 internal EMC filter



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

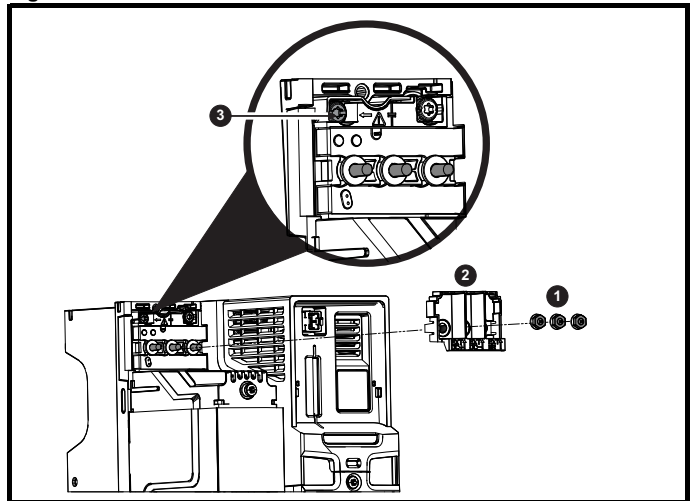
Lift away from the securing points and rotate away from the drive. Ensure the screw and nut are replaced and re-tightened with a maximum torque of 2 Nm (17.64 lb in).

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



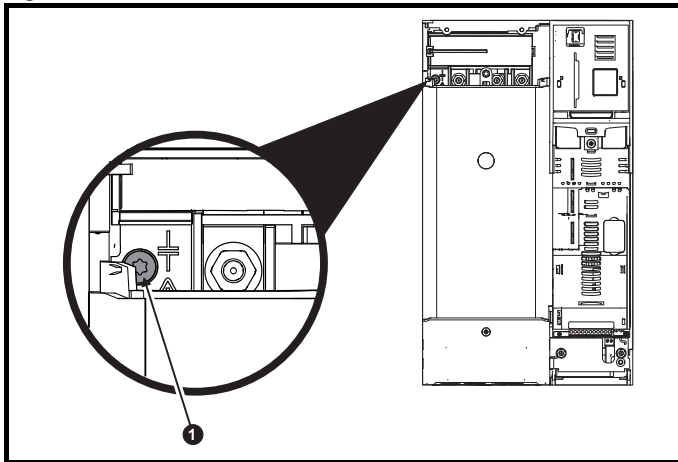
To electrically disconnect the Internal EMC filter, remove the screw as highlighted above (1).

Figure 4-31 Removal of the size 5 internal EMC filter



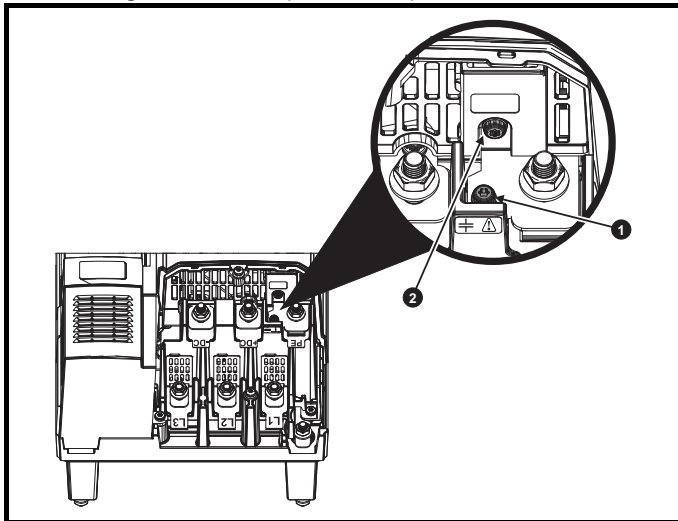
Remove the three M4 terminal nuts (1). Lift away the cover (2) to expose the M4 Torx internal EMC filter removal screw. Finally remove the M4 Torx internal EMC filter removal screw (3) to electrically disconnect the internal EMC filter.

Figure 4-32 Removal of the size 6 internal EMC filter



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

Figure 4-33 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

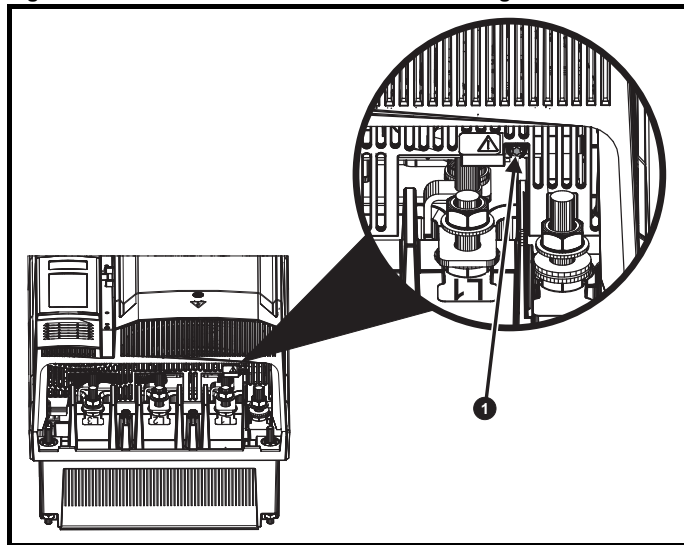
The Internal EMC filter on size 9E, 10E and 11E cannot be removed.

4.11.3 Line to ground varistors



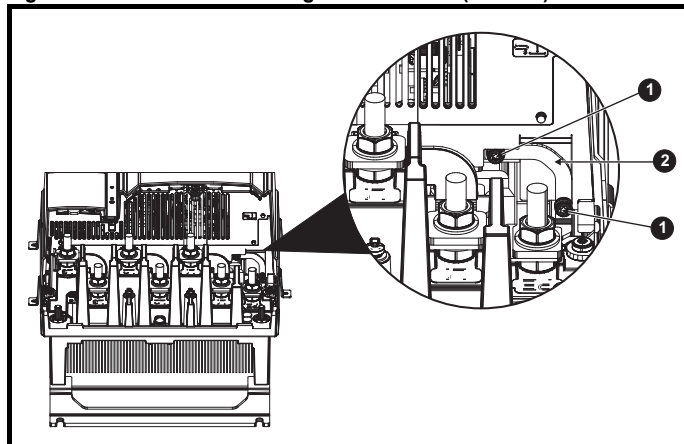
The line to ground varistors should only be removed in special circumstances such as ungrounded supplies with more than one source, for example on ships. Where the line to ground varistors are removed, ensure that line to ground transients are limited to values of category II. This is to ensure that 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 4-34 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 4-35 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.

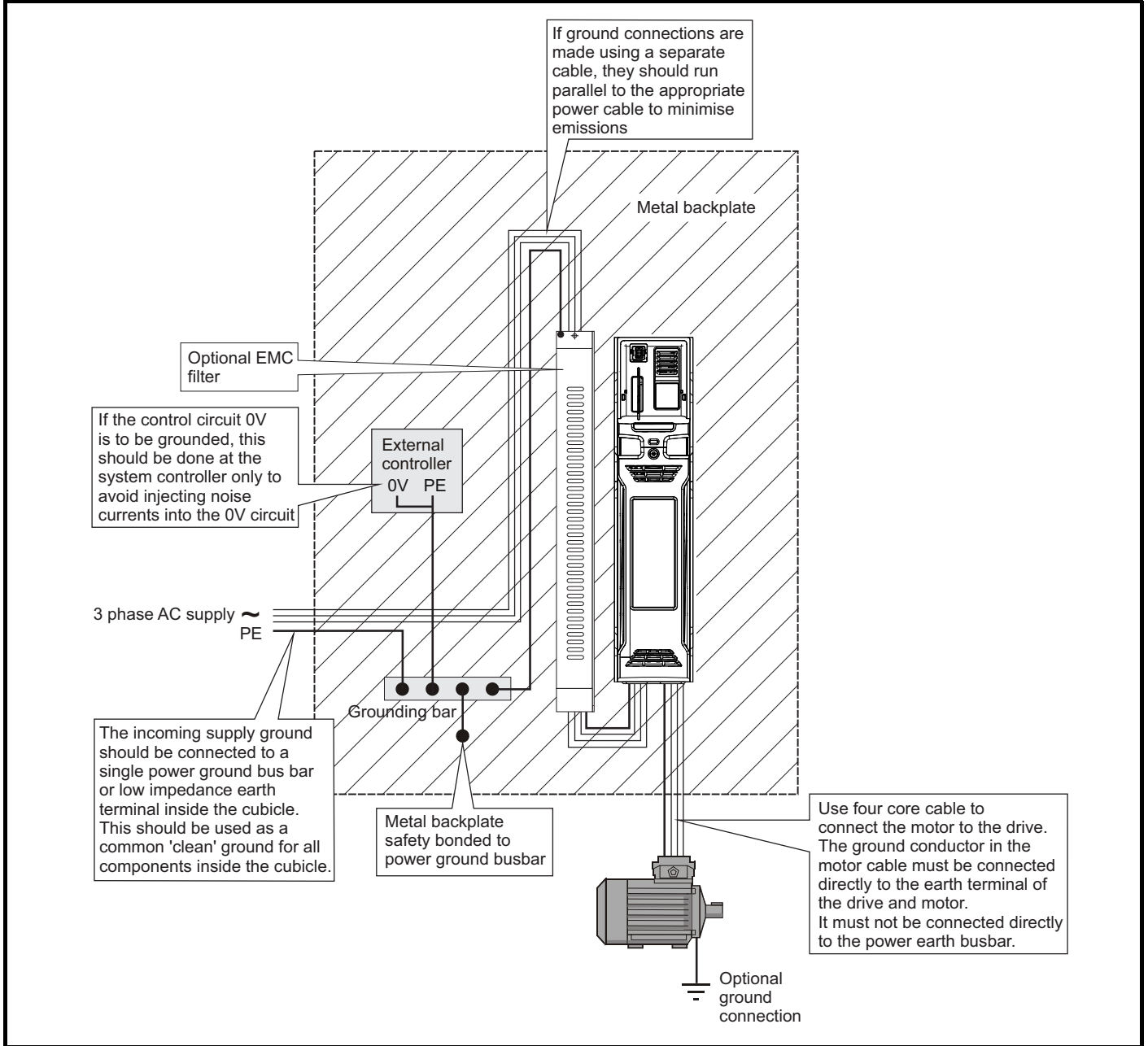
4.11.4 General requirements for EMC

Ground (earth) connections

The grounding arrangements should be in accordance with Figure 4-36, which shows a single drive on a back-plate with or without an additional enclosure.

Figure 4-36 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 121.

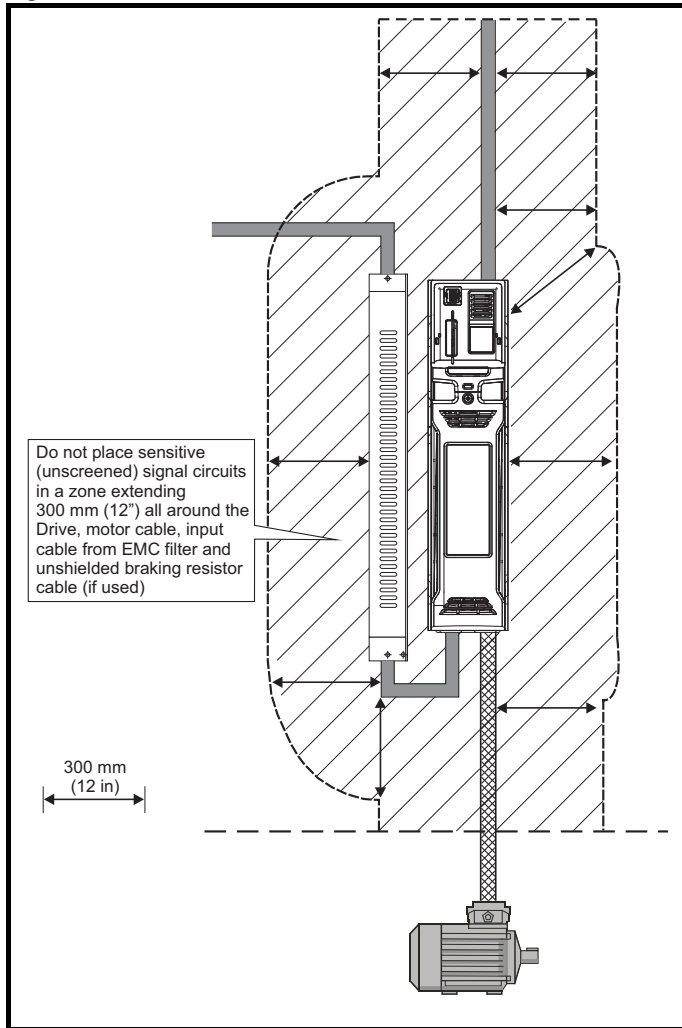
Figure 4-36 General EMC enclosure layout showing ground connections



Cable layout

Figure 4-37 indicates the clearances which should be observed around the drive and related 'noisy' power cables by all sensitive control signals / equipment.

Figure 4-37 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 121. An external EMC filter will always be required.



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 120.



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 295 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 4-38 and Figure 4-41. Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-38 Supply and ground cable clearance (sizes 3 to 6)

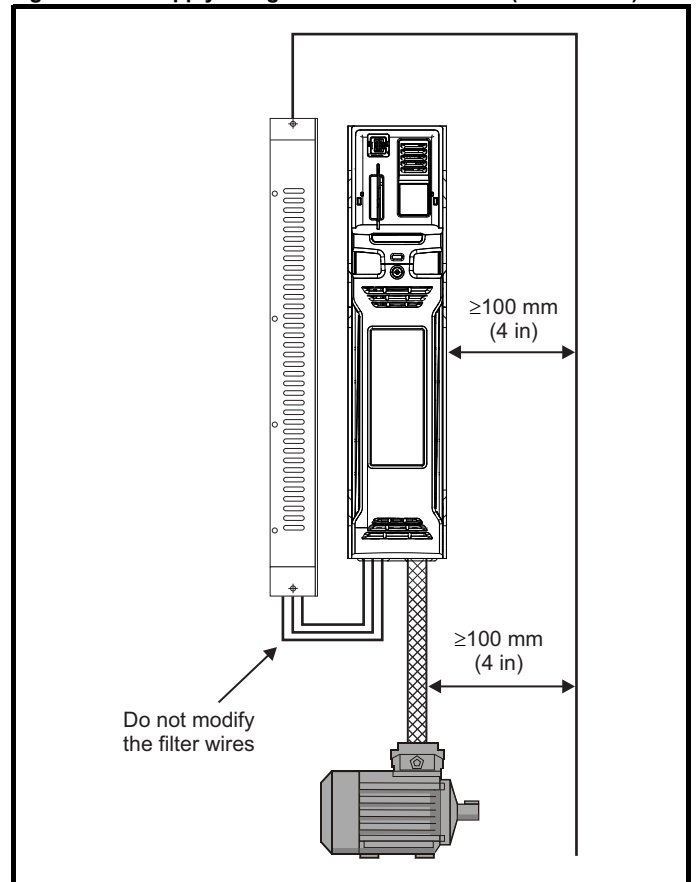
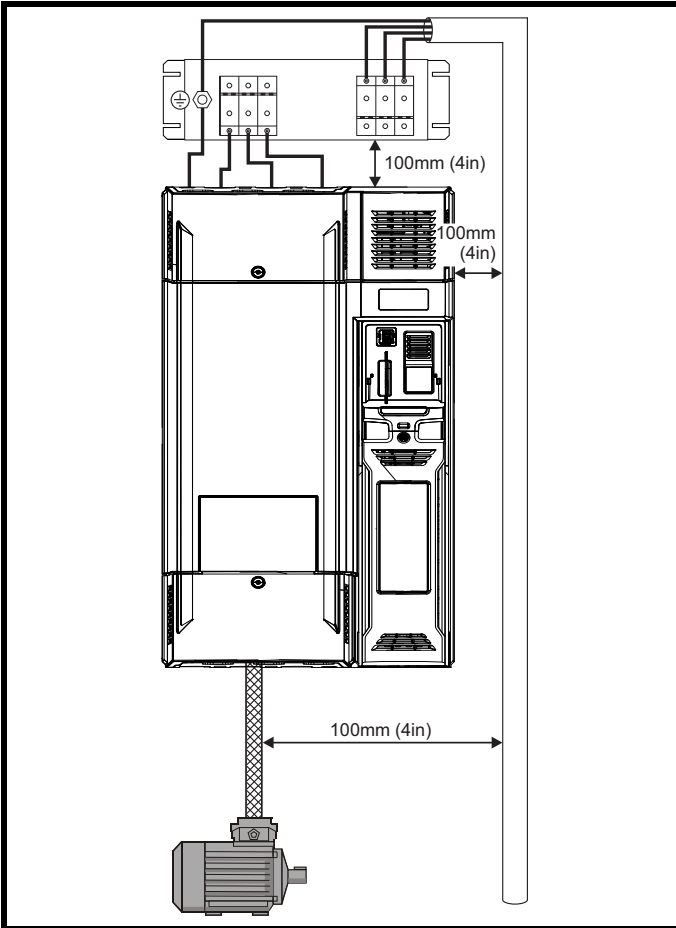
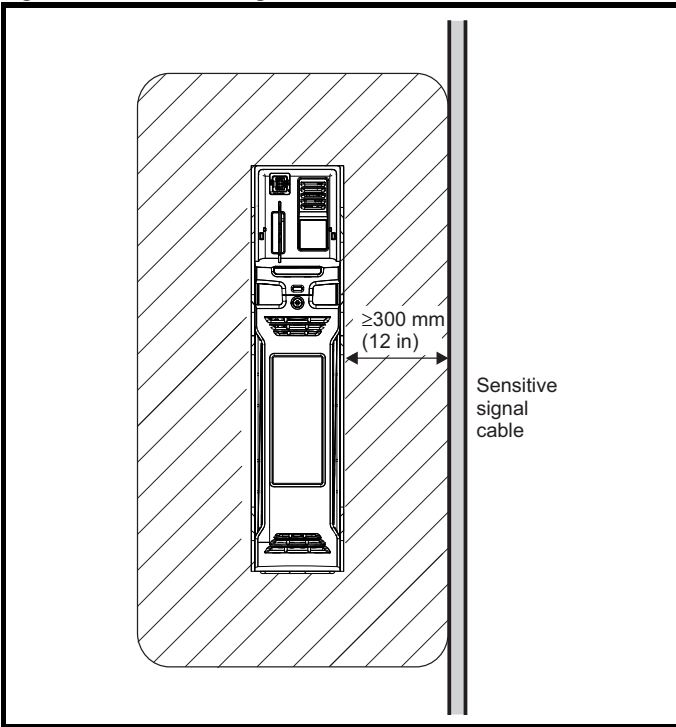


Figure 4-39 Supply and ground cable clearance (size 7 onwards)



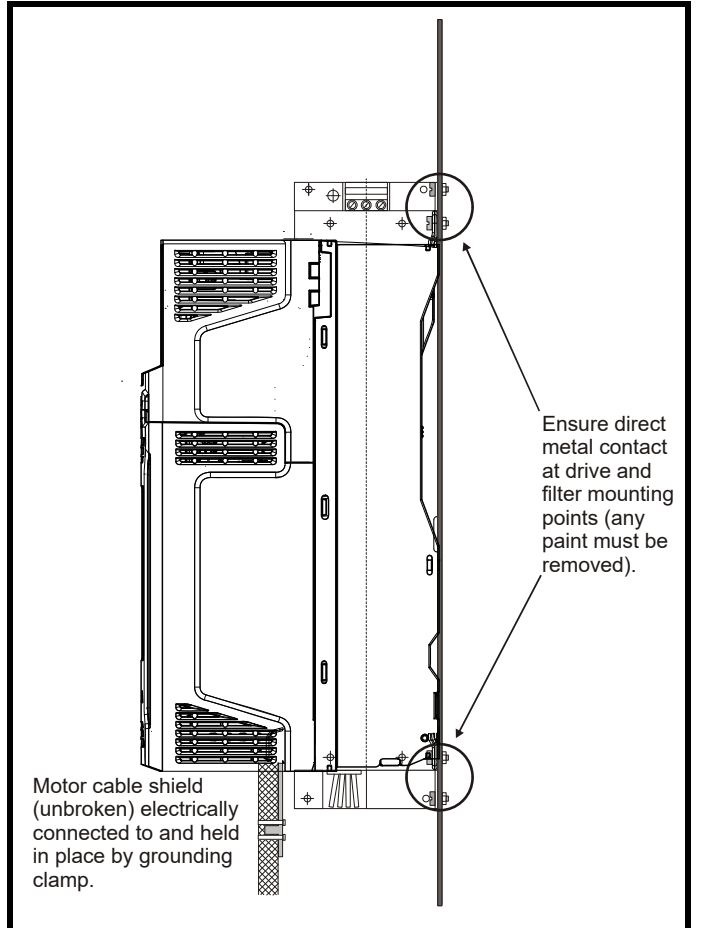
Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-40 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 4-41 Grounding the drive, motor cable shield and filter

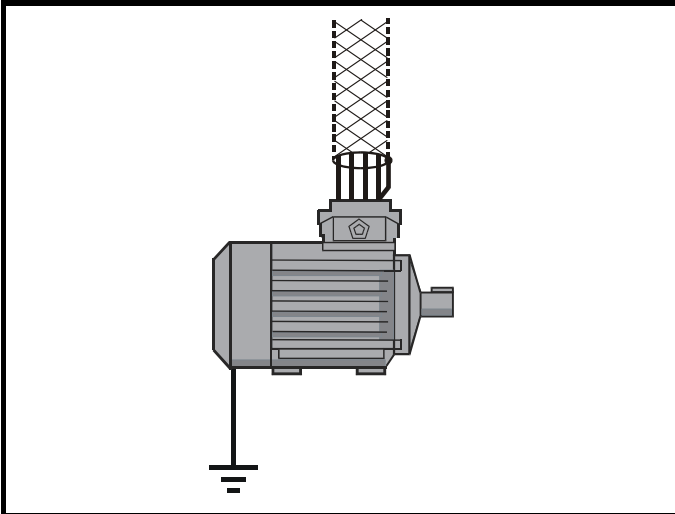


Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long.

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 4-42 Grounding the motor cable shield

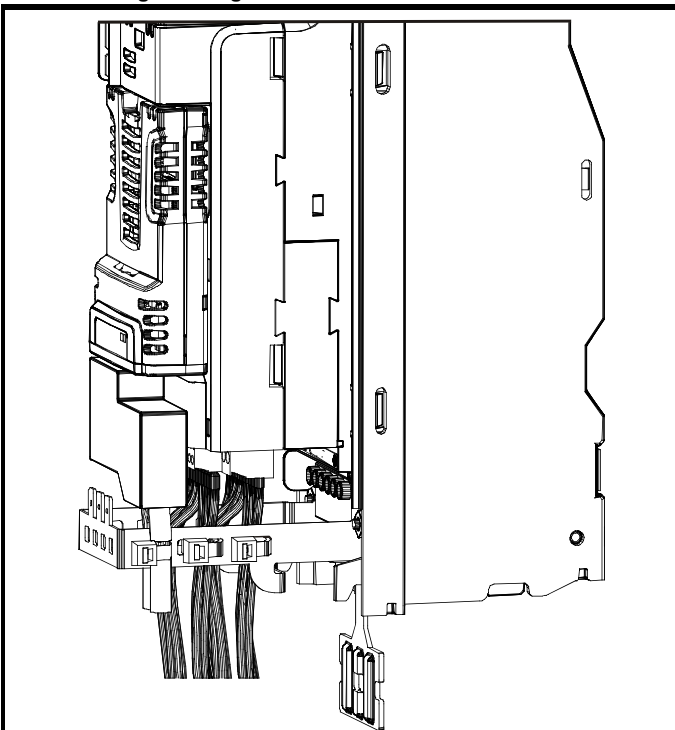


Unshielded wiring to the optional braking resistor(s) may be used provided the wiring runs internally to the enclosure.

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 4-43. 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 4-43 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:

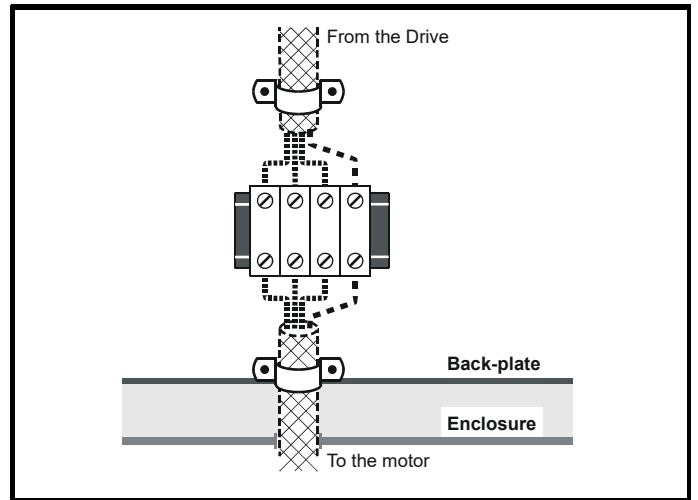
- Connecting the motor cable to a terminal block in the drive enclosure
- Installing a motor isolator / disconnect switch for safety when work is done on the motor

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 4-44 Connecting the motor cable to a terminal block in the enclosure



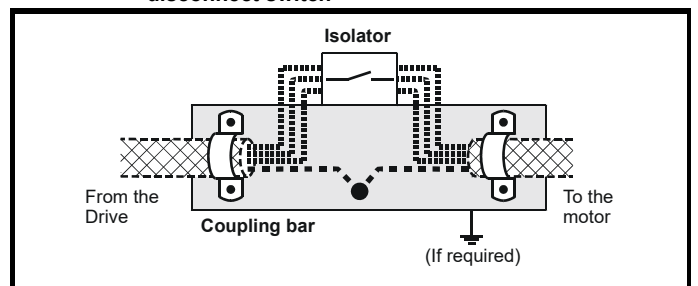
Using a motor isolator / disconnect-switch

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 4-45 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 mm², 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 4-46 and Figure 4-47.

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 4-46 Surge suppression for digital and unipolar inputs and outputs

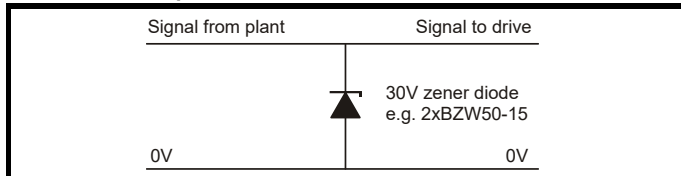
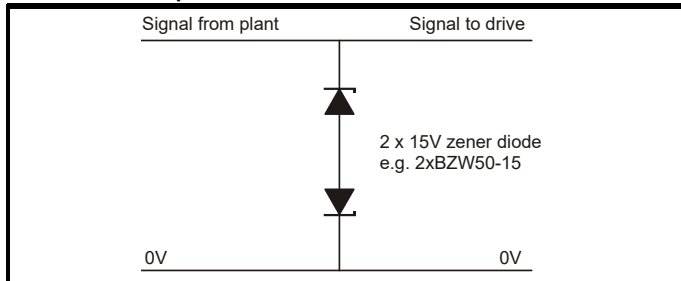


Figure 4-47 Surge suppression for analog and bipolar inputs and outputs



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 or BACnet MSTP protocols. See Table 4-23 for the connection details.

Figure 4-48 Location of the comms connector

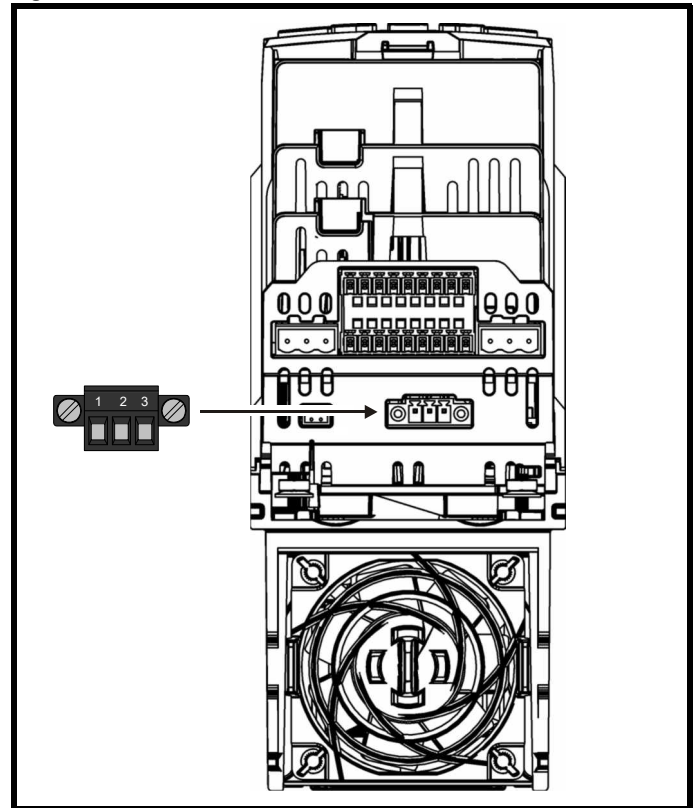


Table 4-23 Serial communication port pin-outs

| 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 may be 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.

USB/EIA-232 to EIA-485 Communications

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

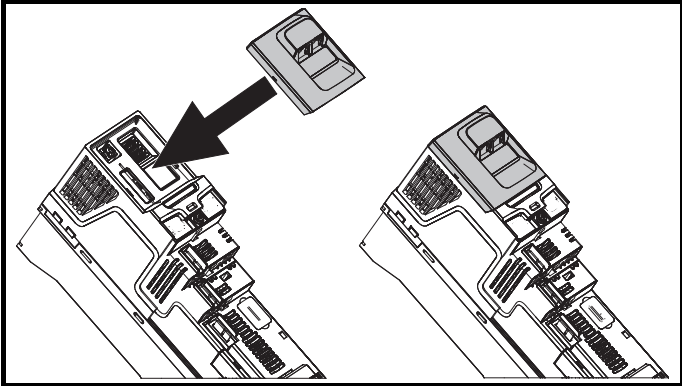
To gain access to the drive parameters (including connection to Connect), a KI-485 Adaptor should be installed as shown in Figure 4-49 and used in conjunction with a suitable USB to EIA-485 isolated

converter. A suitable isolated converter is available from Control Techniques:

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

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

Figure 4-49 KI-485 Adaptor Installation



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

To remove, reverse the installation instructions.

NOTE

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

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

4.13 Control connections

4.13.1 General

Table 4-24 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.

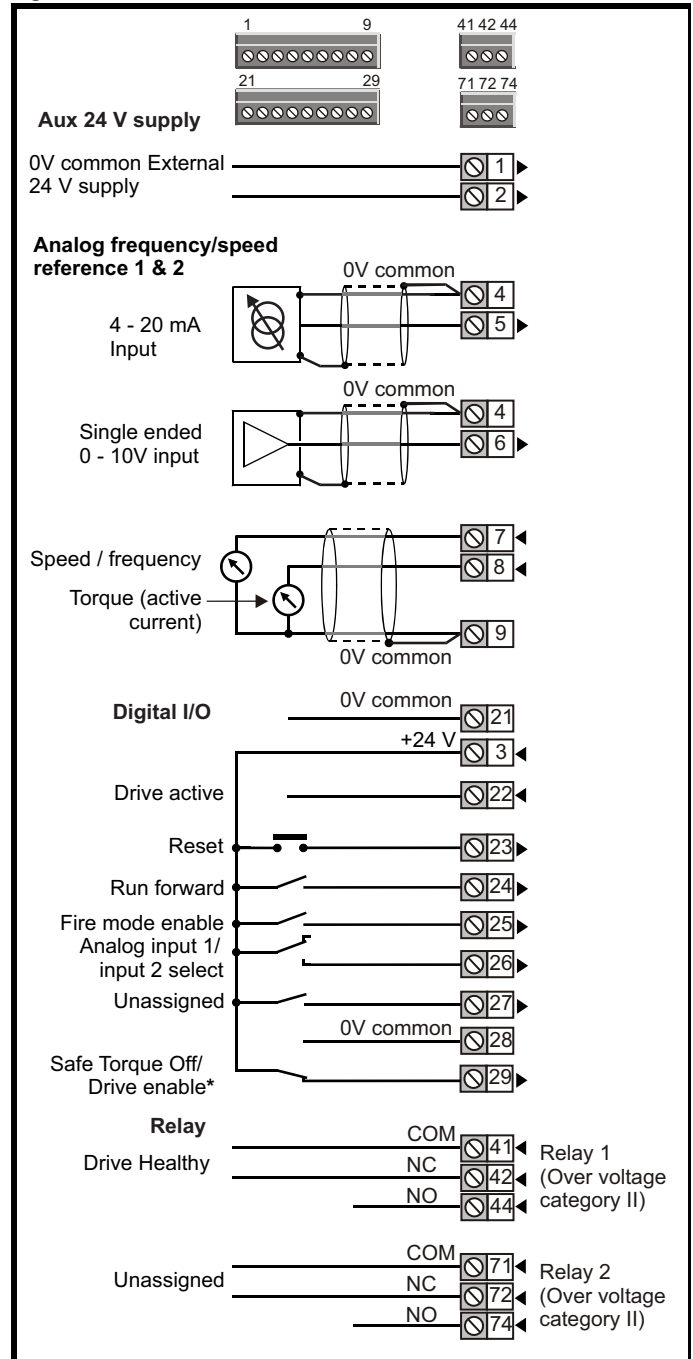
NOTE

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 4-50 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 $\pm 5\%$, 20 to 0 mA $\pm 5\%$, 4 to 20 mA $\pm 5\%$, 20 to 4 mA $\pm 5\%$ |
| Maximum offset | 250 μ A |
| Absolute maximum voltage (reverse bias) | ± 36 V relative to 0V |
| Absolute maximum current | ± 30 mA |
| Equivalent input resistance | $\leq 300 \Omega$ |
| Operating in voltage mode (Default for terminal 6) | |
| Full scale voltage range | ± 10 V $\pm 2\%$ |
| 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 μ s 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 $\pm 2\%$ |
| 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 $\Omega \pm 40\%$ |
| 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 | >8 mA @15 V (similar to IEC 61131-2, type 1 except the maximum current can be up to 20 mA) Effective input capacitance: 20 nF |
| Low state maximum current for disable to SIL3 and PL e | 0.5 mA |
| Response time | Nominal: 8 ms Maximum: 20 ms |
| <p>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.</p> | |

Refer to section 4.15 *Safe Torque Off (STO)* on page 130 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 |

NOTE

With the H300, high IP units there is maximum of 46 mA (24 V) available for user option modules.

This will not affect the use of most of the option modules, however, when using the digital outputs of SI-IO modules or when supplying the power to an encoder connected to an SI-Encoder or SI-Universal Encoder will require an external 24 V power supply to be used if the total current required exceeds 46 mA.

| | |
|--------------------------------------|------------------------------|
| 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 4-17 to Figure 4-19 on page 103 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 4-25 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 | |

| Type | Value | Percentage of SIL 3 allowance |
|---|----------------------------|-------------------------------|
| 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

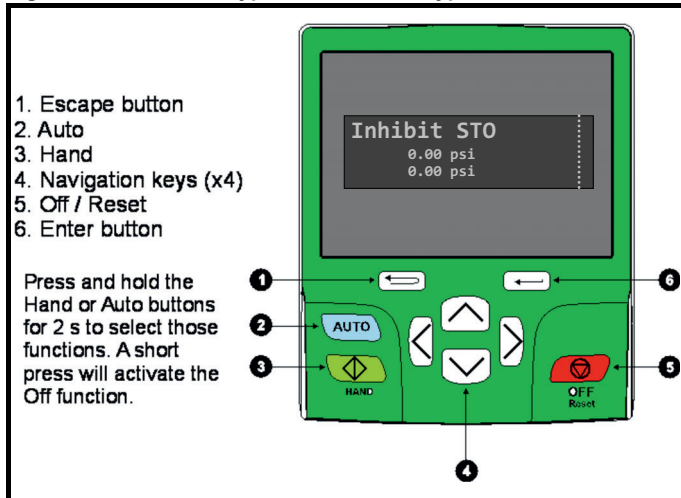
The KI-HOA keypad RTC can only be mounted on the drive. The HOA keypad RTC can be mounted on the drive or remotely mounted.

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




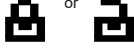


The red stop  button is also used to reset the drive.

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 |
|  | 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 78 for information on battery replacement.

Figure 5-2 *Display modes* on page 133, 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  - 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
- 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 1.014.

Hand

The speed/frequency reference Pr 1.014 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.

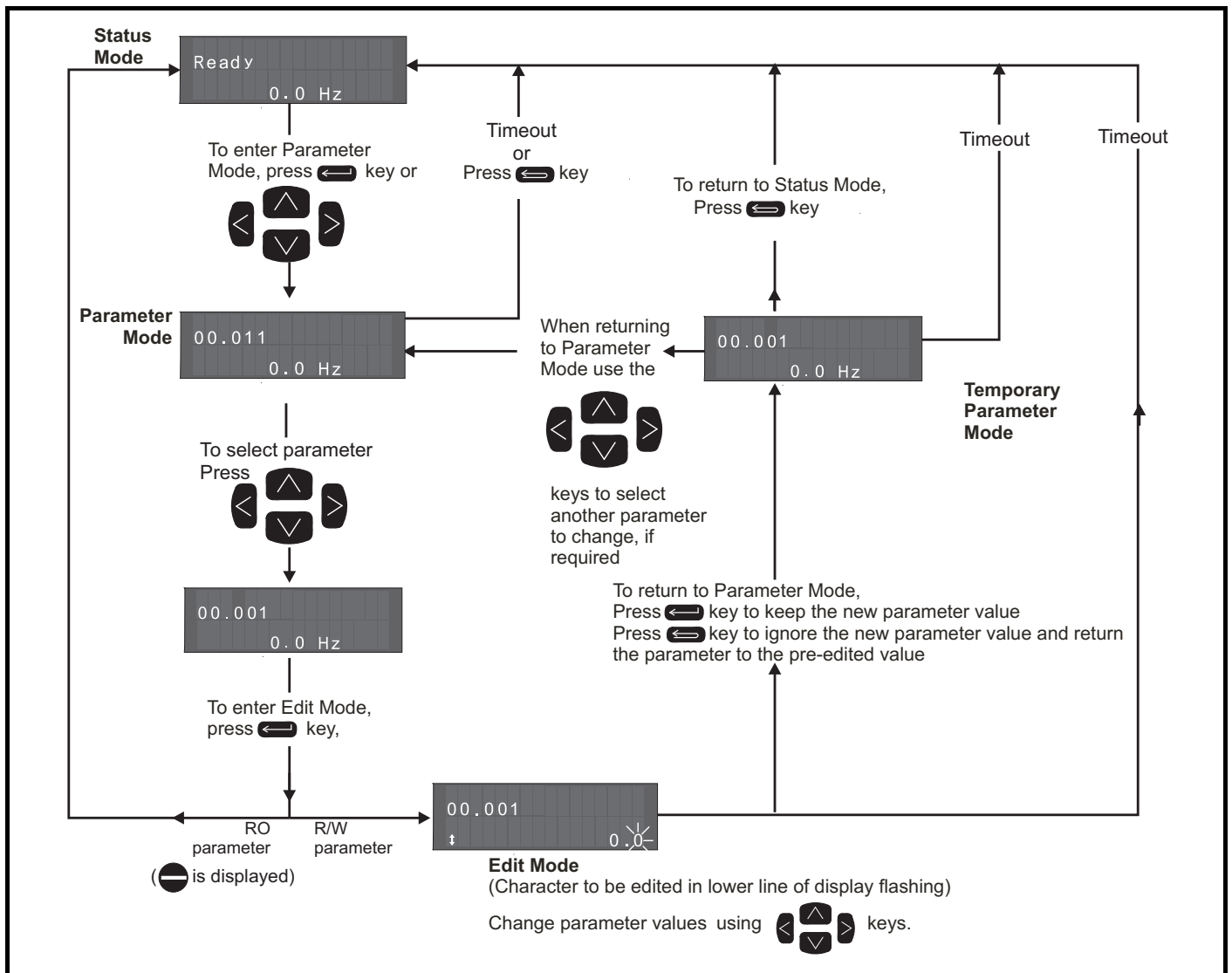
When Hand is selected from Auto, Pr 1.017 will be set to the value of the *Pre-ramp reference* (Pr 1.003) on mode transition, so the current motor speed is maintained.

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 1.014) 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 138.

5.2.3 Quick access mode

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


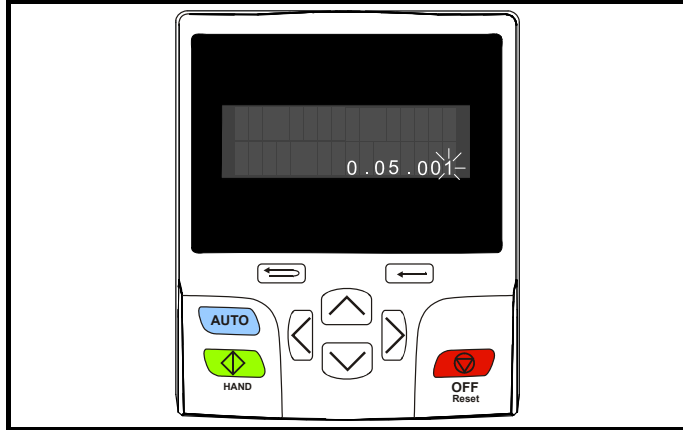




To enter the quick access mode, press and hold the  Enter button on the keypad while in 'parameter mode'.

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':





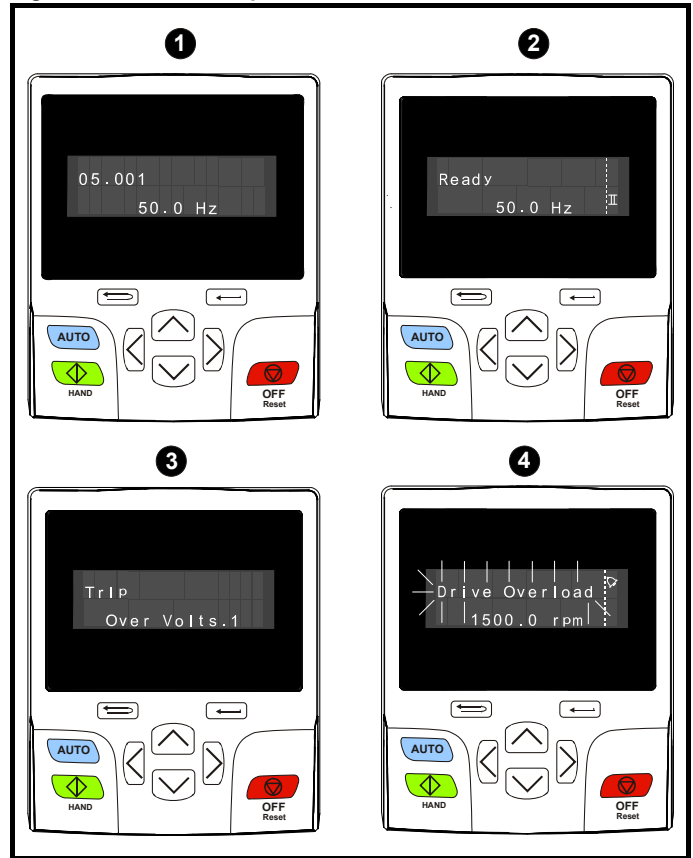
- If the  up and down  keypad buttons are pressed together, then the parameter value of the parameter being edited will be set to 0.
- If the  left and right  keypad buttons are pressed together, the least significant digit (furthest right) will be selected on the keypad display for editing.

Figure 5-4 Mode examples



1. Parameter view mode: Read write or Read only

2. Status mode: Drive Healthy 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 303.

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.



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

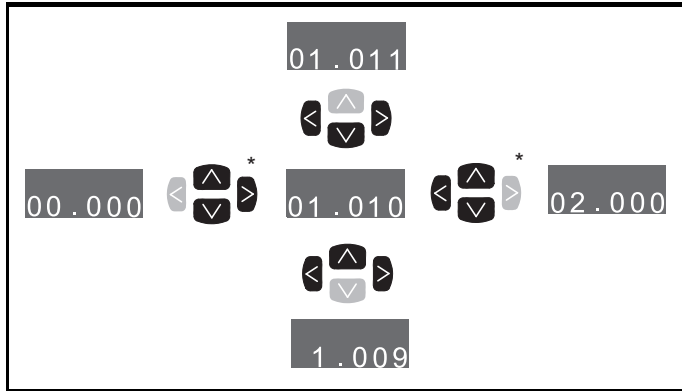
For new parameter-values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *Saving parameters* on page 137.

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 138

Figure 5-5 Parameter navigation



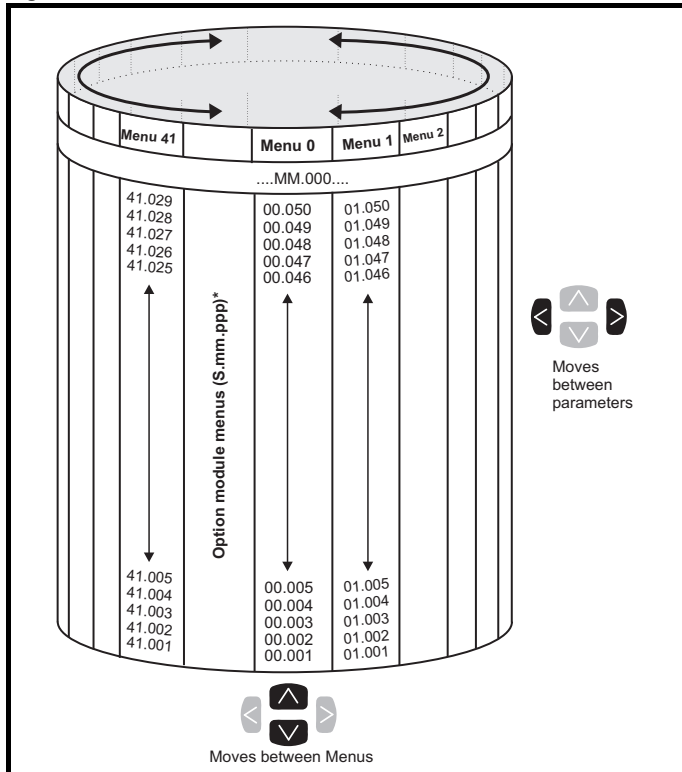
* Can only be used to move between menus if all menus have been enabled (Pr 00.031). Refer to section 5.9 *Parameter access level and security* on page 138.

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 menu and parameter.

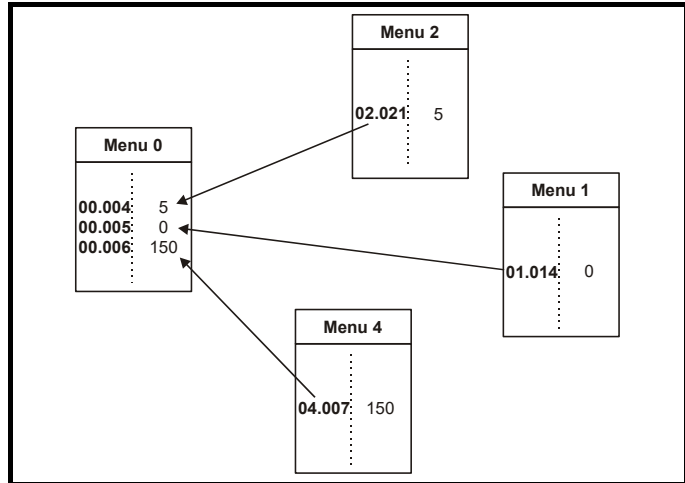
5.4 Menu 0

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 141.

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 <i>Enable Conditions</i> (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 | <i>Motor Protection Accumulator</i> (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. <i>Percentage Of Drive Thermal Trip Level</i> (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

| First row string | Second row string | Status |
|--|-----------------------|-------------------------------------|
| Booting | Parameters | Parameters are being loaded |
| Drive parameters are being loaded from a NV Media Card | | |
| 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 | | |

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:

| 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.

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 138 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 138 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 4-48 *Location of the comms connector* on page 124. It allows communication to other devices via three building automation network protocols (Modbus RTU and BACnet MSTP).

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 124 for connection and isolation details). The communications port applies a 2 unit load to the communications network.

USB/EIA-232 to EIA-485 Communications

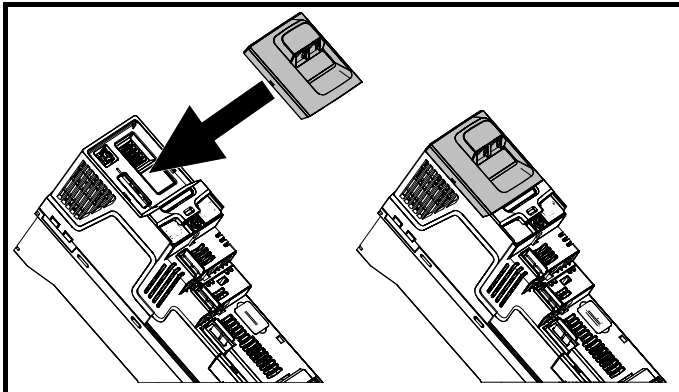
An external USB/EIA-232 hardware interface such as a PC cannot be used directly with the 2-wire EIA-485 interface of the drive.

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 mm² (AWG 26) or larger are used and the cable shield should be connected to the grounded panel / cubicle at the keypad end of the cable.

Figure 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.

| Serial communications set-up parameters | | | | | | |
|--|---|------------------|---------------|----------------------|---|---|
| <i>Serial Mode</i> (11.024) {00.035} | Data Bits | Stop Bits | Parity | Register Mode | Pr 11.024 | 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. |
| | 8 | 2 | NP | Standard | 0 | |
| | 8 | 1 | NP | Standard | 1 | |
| | 8 | 1 | EP | Standard | 2 | |
| | 8 | 1 | OP | Standard | 3 | |
| | 8 | 2 | NP | Modified | 4 | |
| | 8 | 1 | NP | Modified | 5 | |
| | 8 | 1 | EP | Modified | 6 | |
| | 8 | 1 | OP | Modified | 7 | |
| | 7 | 2 | NP | Standard | 8 | |
| | 7 | 1 | NP | Standard | 9 | |
| | 7 | 1 | EP | Standard | 10 | |
| | 7 | 1 | OP | Standard | 11 | |
| | 7 | 2 | NP | Modified | 12 | |
| | 7 | 1 | NP | Modified | 13 | |
| 7 | 1 | EP | Modified | 14 | | |
| 7 | 1 | OP | Modified | 15 | | |
| <i>Serial Baud Rate</i> (11.025) {00.036} | 300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600(8), 76800(9), 115200 (10) | | | | 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. | |
| <i>Serial Address</i> (11.023) {00.037} | 1 to 247 | | | | This parameter defines the serial address and an addresses between 1 and 247 are permitted. | |

See Chapter 10 *Building Automation on page 192* 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 | | | |

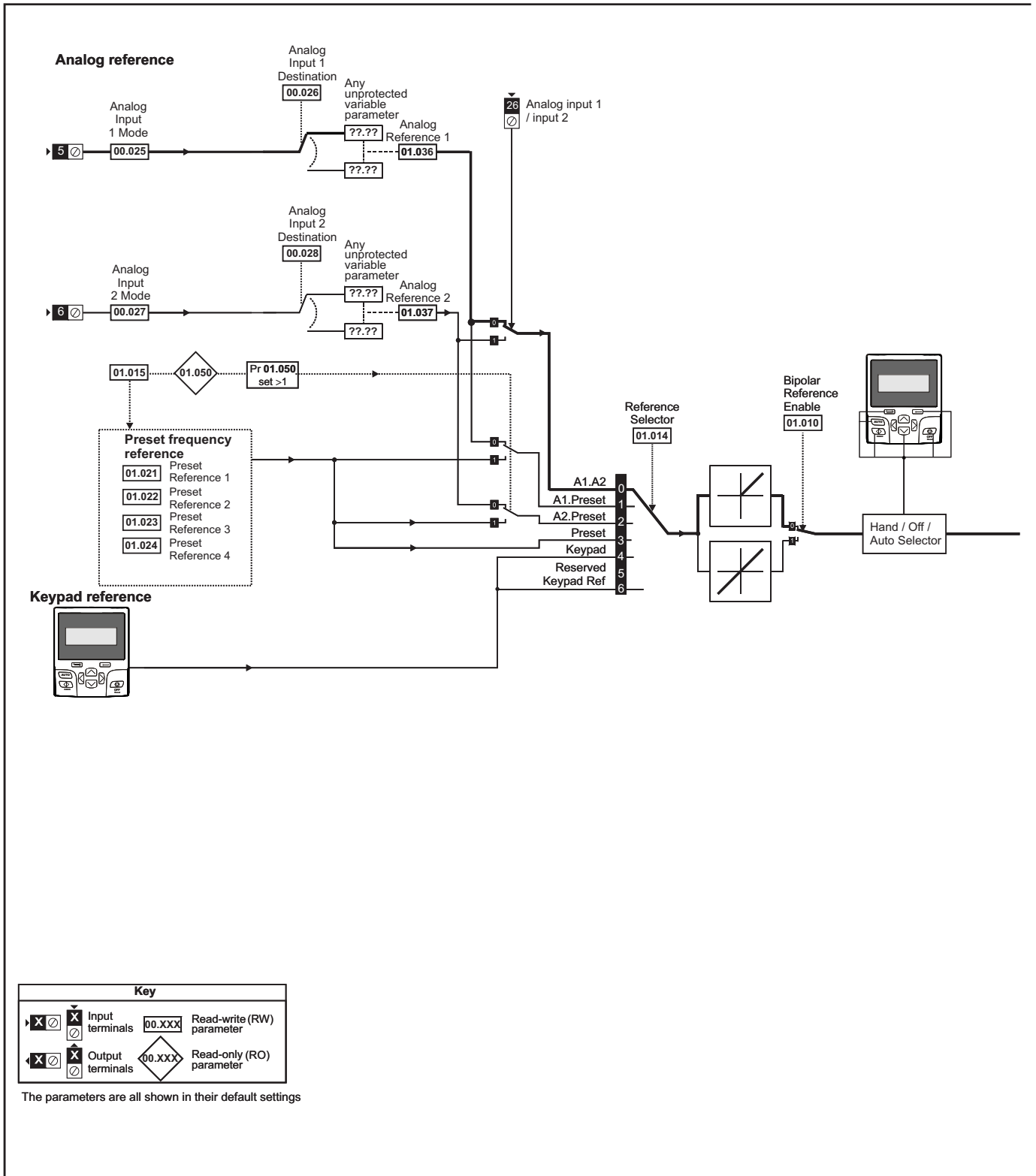
| Parameter | Range | | | Default | | | Type | | | | | | | |
|-----------|--|----------|--|---------|---|------------------|------|-----------------|----|------|----|----|----|----|
| | OL | RFC-A | RFC-S | OL | RFC-A | RFC-S | | | | | | | | |
| 00.025 | Analog Input 1 Mode | {07.007} | 4-20 mA Low (-4), 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 |

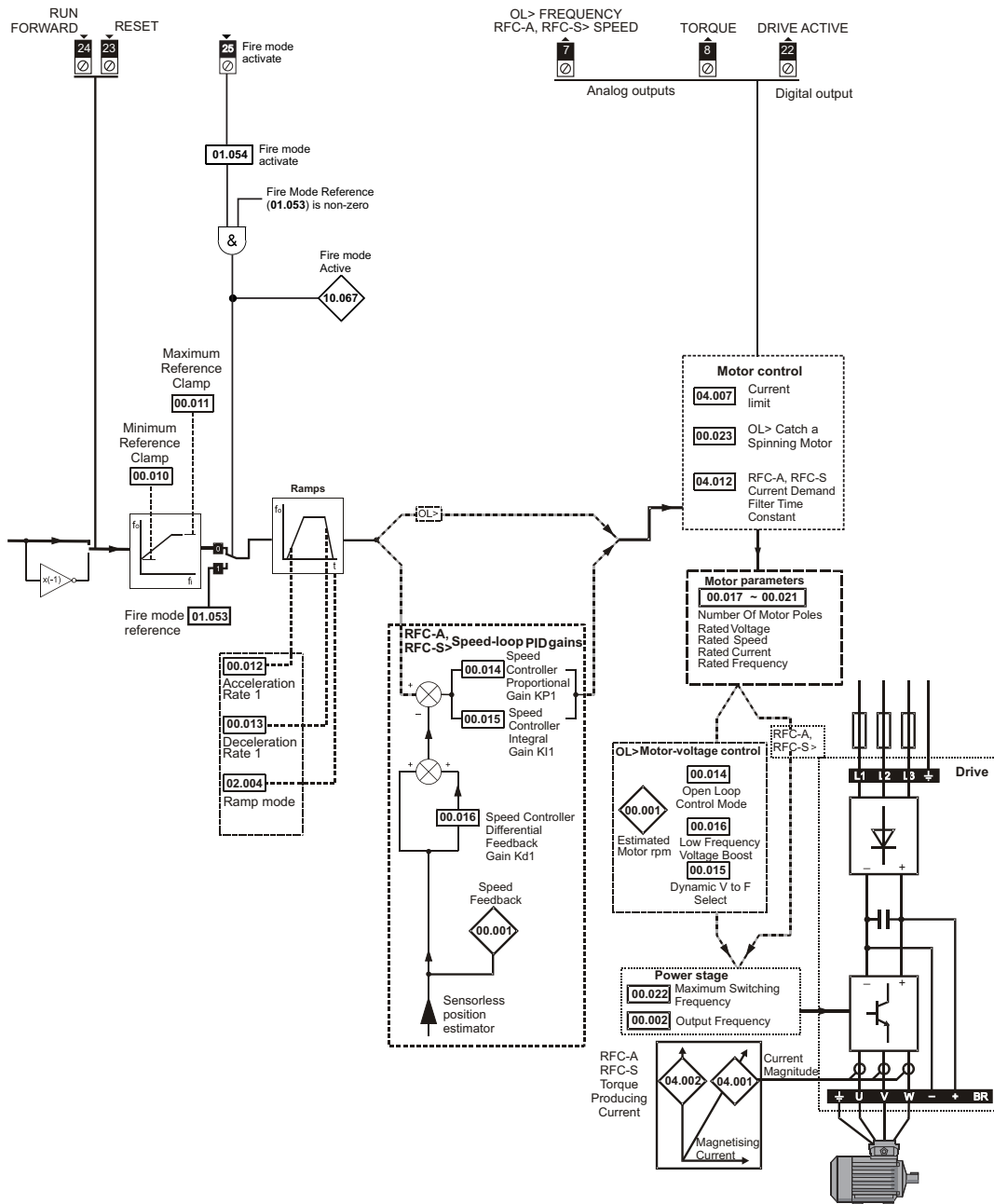
| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|

| Parameter | Range | | | Default | | | Type | | | | | | |
|-----------|-------------|----------|----------------------|---------|-------|-------|------|------|------|----|----|----|----|
| | OL | RFC-A | RFC-S | OL | RFC-A | RFC-S | RO | Time | ND | NC | PT | PS | |
| 00.063 | Trip 1 Time | {10.044} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.064 | Trip 2 Date | {10.045} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.065 | Trip 2 Time | {10.046} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.066 | Trip 3 Date | {10.047} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.067 | Trip 3 Time | {10.048} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.068 | Trip 4 Date | {10.049} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.069 | Trip 4 Time | {10.050} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.070 | Trip 5 Date | {10.051} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.071 | Trip 5 Time | {10.052} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.072 | Trip 6 Date | {10.053} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.073 | Trip 6 Time | {10.054} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.074 | Trip 7 Date | {10.055} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.075 | Trip 7 Time | {10.056} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.076 | Trip 8 Date | {10.057} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.077 | Trip 8 Time | {10.058} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |
| 00.078 | Trip 9 Date | {10.059} | 00-00-00 to 31-12-99 | | | | | RO | Date | ND | NC | PT | PS |
| 00.079 | Trip 9 Time | {10.060} | 00:00:00 to 23:59:59 | | | | | RO | Time | ND | NC | PT | PS |

| | | | | | | | | | | | | | |
|----|------------------|-----|-------------|------|---------------------|------|------------------|-----|-------------|-----|------------------|----|-------------|
| 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





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 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 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 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 <i>Under Voltage Active</i> (Pr 10.016) is not active and <i>Low Under Voltage Threshold Select</i> 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. On Board user program, not supported on H300 |
| 6yyy* | NV media card: Load the drive parameters from parameter 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 |
| 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 187 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 | ↕ | VM_SPEED rpm | ⇒ | | |
| RFC-S | | | | | |

RFC-A / RFC-S

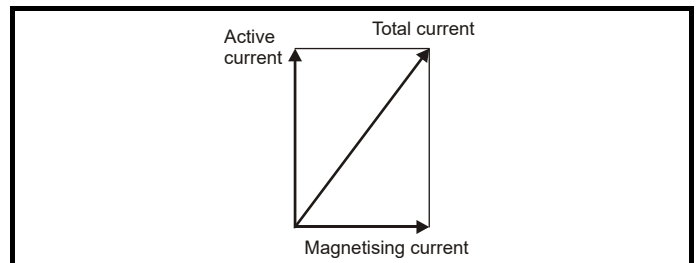
Pr **00.001 (03.002)** indicates the value of the motor speed which is obtained from the speed feedback.

| 00.002 {05.001} | Output Frequency | | | | |
|-----------------|------------------|----------------------|----|----|----|
| RO | Num | ND | NC | PT | FI |
| OL | ↕ | VM_SPEED_FREQ_REF Hz | ⇒ | | |
| RFC-A | | ±2000.0 Hz | ⇒ | | |
| RFC-S | | | | | |

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 | ↕ | 0.000 to VM_DRIVE_CURRENT_UNIPOLAR A | ⇒ | | |
| RFC-A | | | | | |
| RFC-S | | | | | |

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 | ↕ | VM_POWER kW | ⇒ | | |
| RFC-A | | | | | |
| RFC-S | | | | | |

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 | |
|----------------------------------|---------------|
| RW | Num |
| OL | |
| RFC-A | 0 to 99999999 |
| 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 |
| OL | 0.0 Hz |
| RFC-A | VM_NEGATIVE_REF_CLAMP1 Hz / rpm |
| RFC-S | 0.0 rpm |

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 |
| OL | 50Hz default: 50.0 Hz 60Hz default: 60.0 Hz |
| RFC-A | VM_POSITIVE_REF_CLAMP1 Hz / rpm |
| RFC-S | 50Hz default: 1500.0 rpm 60Hz default: 1800.0 rpm |

(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 182.

6.3.5 Ramps

| 00.012 {02.011} Acceleration Rate 1 | |
|-------------------------------------|------------------------|
| RW | Num |
| OL | 0.0 to VM_ACCEL_RATE |
| RFC-A | 0.000 to VM_ACCEL_RATE |
| 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 |
| OL | 0.0 to VM_ACCEL_RATE |
| RFC-A | 0.000 to VM_ACCEL_RATE |
| 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 |
| OL | Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Current 1P (6) |

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 171.

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

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 228 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to section 8 *Optimization* on page 171.

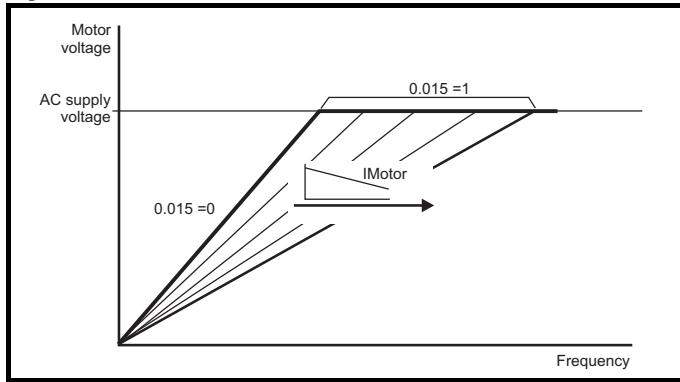
| 00.015 {05.013} Dynamic V to F Select | |
|---------------------------------------|-------------------|
| RW | Bit |
| OL | Off (0) or On (1) |

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



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 |
| OL | 200 V drive: 230 V |
| RFC-A | ±VM_AC_VOLTAGE_SET ⇒ 50Hz default 400 V drive: 400 V |
| RFC-S | ⇒ 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.

| 00.015 {03.011} Speed Controller Integral Feedback Gain Ki 1 | |
|--|--|
| RW | Num |
| RFC-A | 0.00 to 655.35 s ² /rad ⇒ 0.10s ² /rad |
| RFC-S | ⇒ |

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 228 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to section 8 *Optimization* on page 171.

| 00.019 {05.008} Rated Speed | |
|-----------------------------|---|
| RW | Num |
| 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.

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

6.3.7 Motor parameters

| 00.017 {05.011} Number Of Motor Poles | |
|---------------------------------------|--|
| RW | Num |
| OL | Automatic (0) to 480 Poles (240) ⇒ Automatic (0) |
| RFC-A | ⇒ |
| 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-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 174).

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 181 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 $\frac{2}{3}$, 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) $\times \frac{2}{3}$, 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 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).

| 00.025 {07.707} Analog Input 1 Mode | | RW | Txt | | | | | | US |
|-------------------------------------|--|----|--|--|--|--|--|--|-------------|
| OL | | | 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) | | | | | | |
| RFC-A | | | | | | | | | |
| RFC-S | | | | | | | | | 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 | | | 00.000 to 59.999 | | | | | | 01.036 |
| RFC-S | | | | | | | | | |

Pr 00.026 sets the destination of analog input 1

| 00.027 {07.011} Analog Input 2 Mode | | RW | Txt | | | | | | US |
|-------------------------------------|--|----|-----|--|--|--|--|--|----|
| OL | 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) | | | | | | | | |
| RFC-A | | | | | | | | | |
| RFC-S | | ⇕ | | | | | | | |

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 | 00.000 to 59.999 | | | | | | | |
| RFC-A | | ⇕ | | | | | | 01.036 |
| RFC-S | | | | | | | | |

Pr 00.028 sets the destination of analog input 2

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

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 | 0 to 2147483647 | | | | | | | | |
| RFC-A | | ⇕ | | | | | | 0 | |
| RFC-S | | | | | | | | | |

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 138.

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

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 | 0 to 999 | | | | | | | | |
| RFC-A | | ⇕ | | | | | | 0 | |
| RFC-S | | | | | | | | | |

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 | None (0), Read (1), Program (2), Auto (3), Boot (4) | ⇒ | None (0) |
| RFC-A | | | |
| RFC-S | | | |

* 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 187.

| 00.034 {06.016} | | Date | |
|-----------------|----------------------|------|----|
| RW | Date | ND | NC |
| OL | 00-00-00 to 31-12-99 | ⇒ | |
| RFC-A | | | |
| RFC-S | | | |

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 an 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.

$$\text{Value} = (\text{day}[1..31] \times 10000) + (\text{month}[1..12] \times 100) + \text{year}[0..99]$$

| 00.035 {06.017} | | Time | |
|-----------------|----------------------|------|----|
| RW | Time | ND | NC |
| OL | 00:00:00 to 23:59:59 | ⇒ | |
| RFC-A | | | |
| RFC-S | | | |

See Date (**00.034**)

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

See Date (**00.034**)

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

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 | | Std (0) or US (1) | US (1) |
| RFC-A | ⇕ | | |
| RFC-S | ⇕ | | |

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 $L_q/L_d < 1.1$ 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 inertia, 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 arbitrary 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 $L_q/L_d = 1.1$. 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 | | | | RA | | | | | US | | |
| OL | ⇕ | | | | | ⇒ | | | | | | |
| RFC-A | | | | | | | | | | | | |
| RFC-S | ⇕ | 0 to 200 % | | | | ⇒ | 100 % | | | | | |

Maximum test current level used for I_q 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 I_q . 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 L_q is likely to vary significantly with I_q 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 L_q will not be affected by the level of I_q , 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 I_q .

| 00.044 {05.077} Phase Offset At Iq Test Current | | | | | | | | | | | | |
|---|-----|------------------|--|--|----|---|------|--|--|----|--|--|
| RW | Num | | | | RA | | | | | US | | |
| OL | ⇕ | | | | | ⇒ | | | | | | |
| RFC-A | | | | | | | | | | | | |
| RFC-S | ⇕ | $\pm 90.0^\circ$ | | | | ⇒ | 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 I_q 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 I_q 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 I_q . 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 L_q with changes in I_q .

| 00.046 {05.082} Id Test Current For Inductance Measurement | | | | | | | | | | | | |
|--|-----|-------------|--|--|----|---|--------|--|--|----|--|--|
| RW | Num | | | | RA | | | | | US | | |
| OL | ⇕ | | | | | ⇒ | | | | | | |
| RFC-A | | | | | | | | | | | | |
| RFC-S | ⇕ | -100 to 0 % | | | | ⇒ | - 50 % | | | | | |

Minimum test current level used for I_d 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 L_q used in the control algorithms as I_d 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 L_q with I_d .

| 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 L_q with changes in I_d .

| | | | | | | | | | | | | |
|--|-----|---|--|--|--|--|---|-------|--|--|--|----|
| 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 301. 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 171.




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 138). 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 163.

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 |

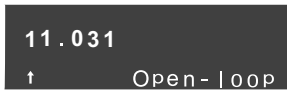

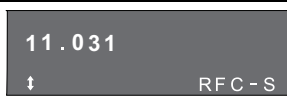
7.2 Changing the operating mode

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:

- 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
- Change the setting of Pr **00.030** to L2 to allow access to Pr **11.031**
- Change the setting of Pr **11.031** as follows:

| Pr 11.031 setting | | Operating mode |
|--|---|----------------|
|  | 1 | Open-loop |
|  | 2 | RFC-A |
|  | 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)

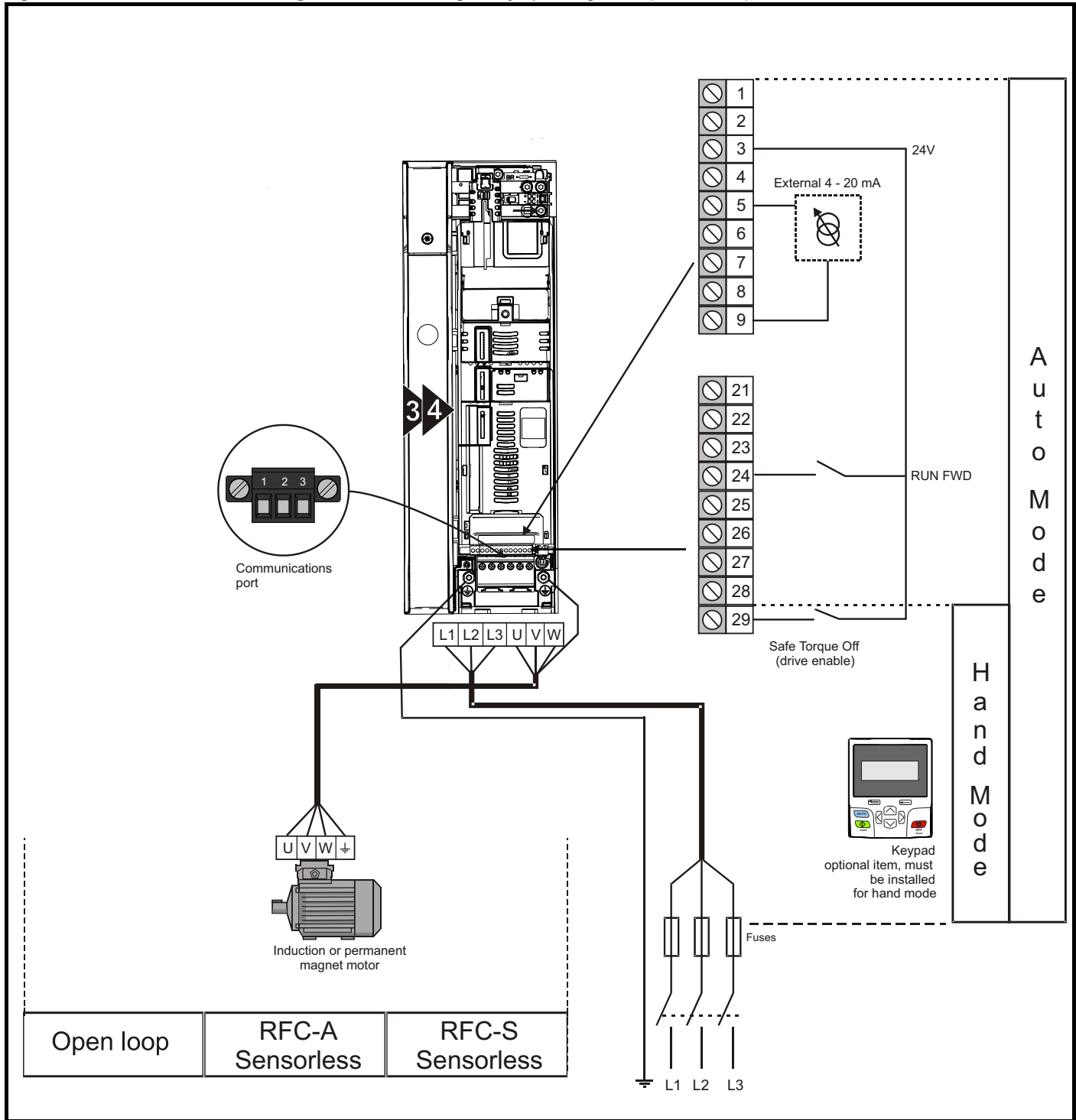


Figure 7-2 Minimum connections to get the motor running in any operating mode (size 5)

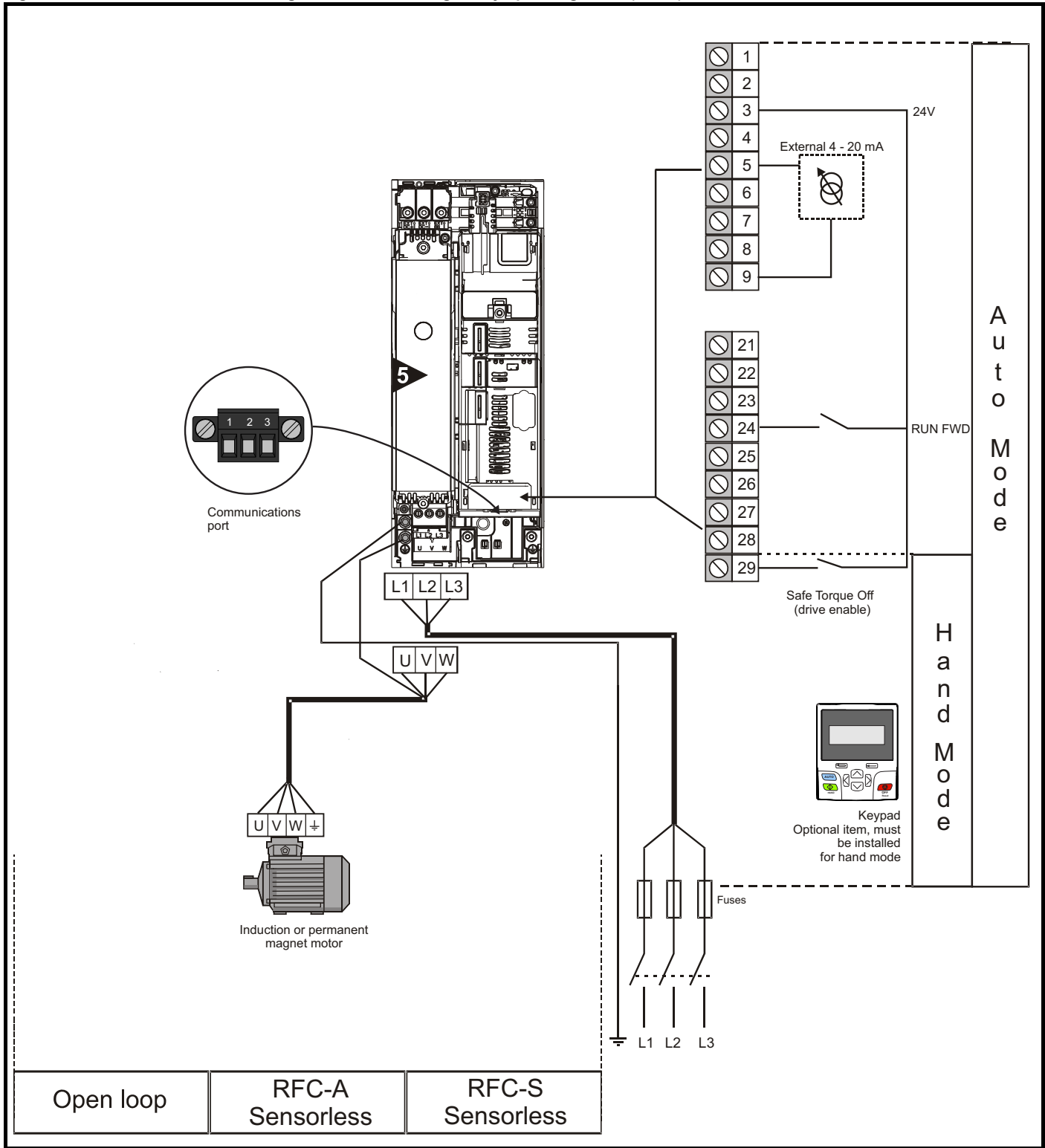


Figure 7-3 Minimum connections to get the motor running in any operating mode (size 6)

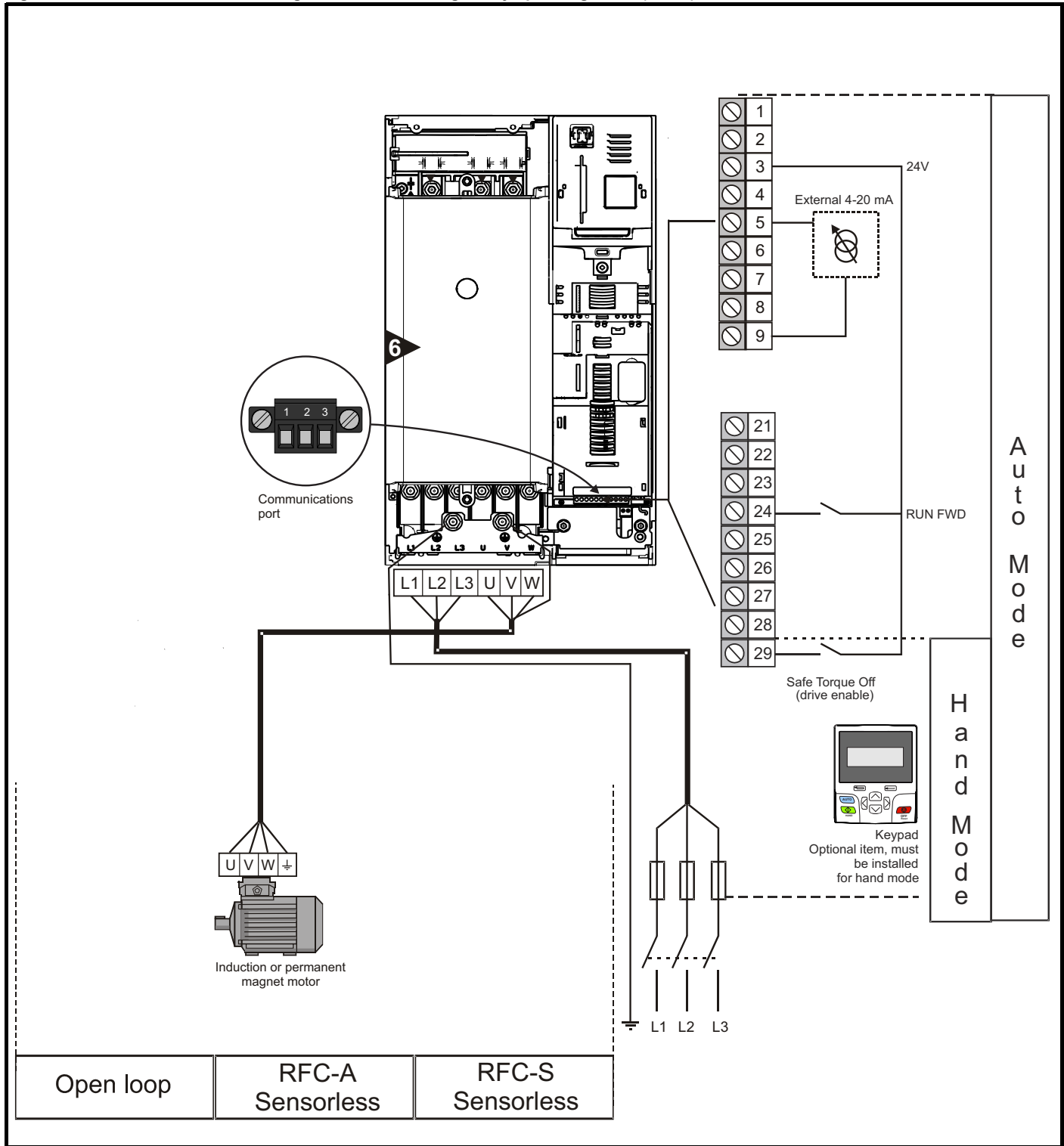
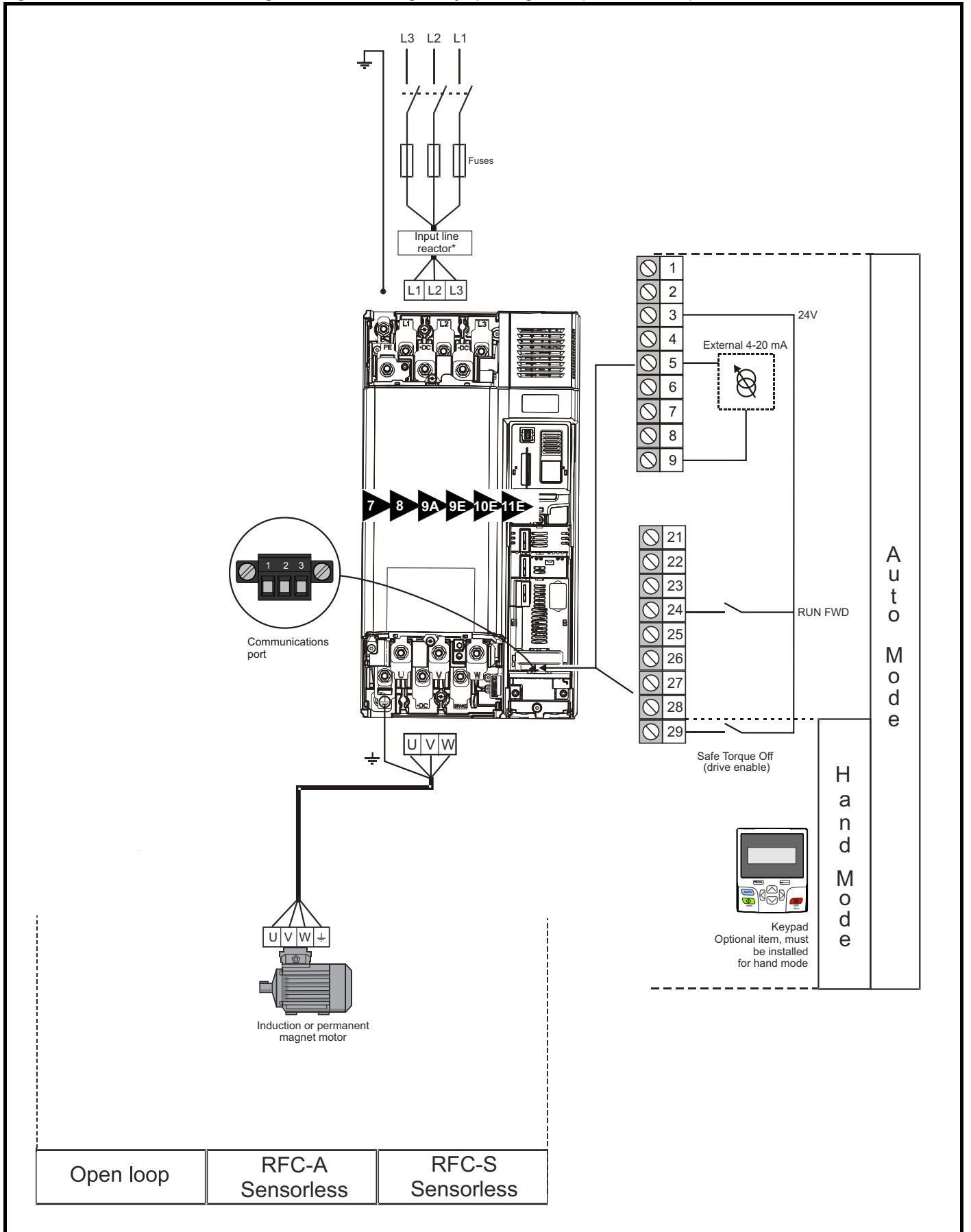




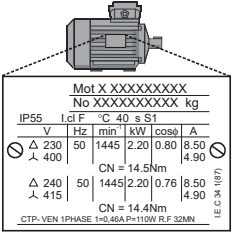
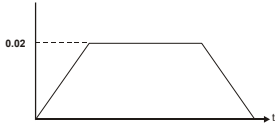
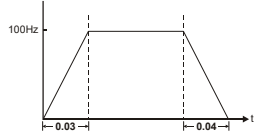
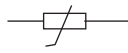

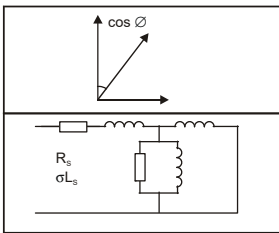


Figure 7-4 Minimum connections to get the motor running in any operating mode (size 7 onwards)



* Required for size 9E and 10.

7.3 Quick start commissioning / start-up

7.3.1 Open loop

| Action | Detail | |
|---------------------------------------|---|---|
| Before power-up | Ensure: <ul style="list-style-type: none"> 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 <i>Changing the operating mode</i> on page 137. Ensure: <ul style="list-style-type: none"> Drive displays 'Inhibit' If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 301. |  |
| Enter motor nameplate details | Enter: <ul style="list-style-type: none"> 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 Δ or λ connection |  |
| Set maximum frequency | Enter: <ul style="list-style-type: none"> Maximum frequency in Pr 00.011 (Hz) |  |
| Set acceleration / deceleration rates | Enter: <ul style="list-style-type: none"> 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 | <p>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.</p> <div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;">  <p>WARNING A rotating autotune will cause the motor to accelerate up to $\frac{2}{3}$ 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.</p> </div> <ul style="list-style-type: none"> 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 $\frac{2}{3}$ base speed in the direction selected. The rotating autotune measures the power factor of the motor. <p>To perform an autotune:</p> <ul style="list-style-type: none"> 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. <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 301.</p> <ul style="list-style-type: none"> 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 |  |



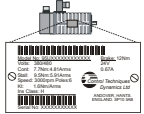
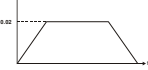
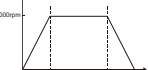
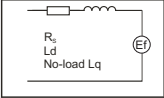


7.3.2 RFC - A Sensorless

Induction motor without position feedback

| Action | Detail | |
|---------------------------------------|--|--|
| Before power-up | Ensure: <ul style="list-style-type: none"> 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 <i>Changing the operating mode</i> on page 137, otherwise restore parameter defaults (See section 5.8 <i>Restoring parameter defaults</i> on page 138). Ensure: <ul style="list-style-type: none"> Drive displays 'Inhibit' If the drive trips, see <i>Chapter 13 Diagnostics</i> on page 301. | |
| Enter motor nameplate details | Enter: <ul style="list-style-type: none"> 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 Δ or Y connection | |
| Set maximum speed | Enter: <ul style="list-style-type: none"> Maximum speed in Pr 00.011 (rpm) | |
| Set acceleration / deceleration rates | Enter: <ul style="list-style-type: none"> Acceleration rate in Pr 00.012 (s to Pr 1.006) Deceleration rate in Pr 00.013 (s from Pr 1.006) | |
| Autotune | <p>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.</p> <p>NOTE It is highly recommended that a rotating autotune is performed (Pr 00.024 set to 2).</p> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>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.</p> </div> <ul style="list-style-type: none"> 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. <p>To perform an autotune:</p> <ul style="list-style-type: none"> 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. <p>If the drive trips, see <i>Chapter 13 Diagnostics</i> on page 301.</p> <ul style="list-style-type: none"> 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 | |
| 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: <ul style="list-style-type: none"> 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 <i>Changing the operating mode</i> on page 137, otherwise restore parameter defaults (see Chapter 5.8 <i>Restoring parameter defaults</i> on page 138). Ensure: <ul style="list-style-type: none"> Drive displays 'inhibit' If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 301. |  |
| Enter motor nameplate details | Enter: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> Maximum speed in Pr 00.002 (rpm) |  |
| Set acceleration / deceleration rates | Enter: <ul style="list-style-type: none"> 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. <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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 <i>Diagnostics</i> on page 301. <ul style="list-style-type: none"> 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).

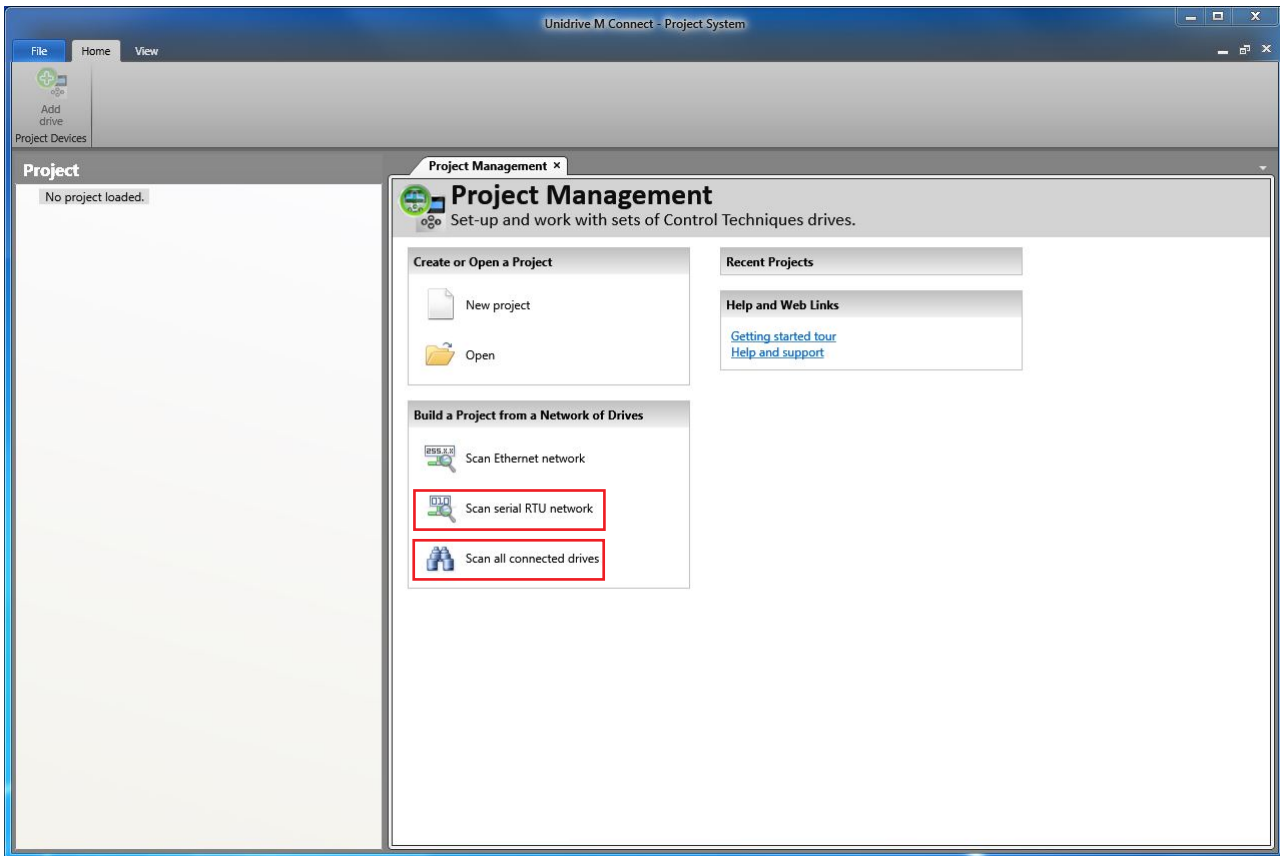
HVAC Drive Connect system requirements

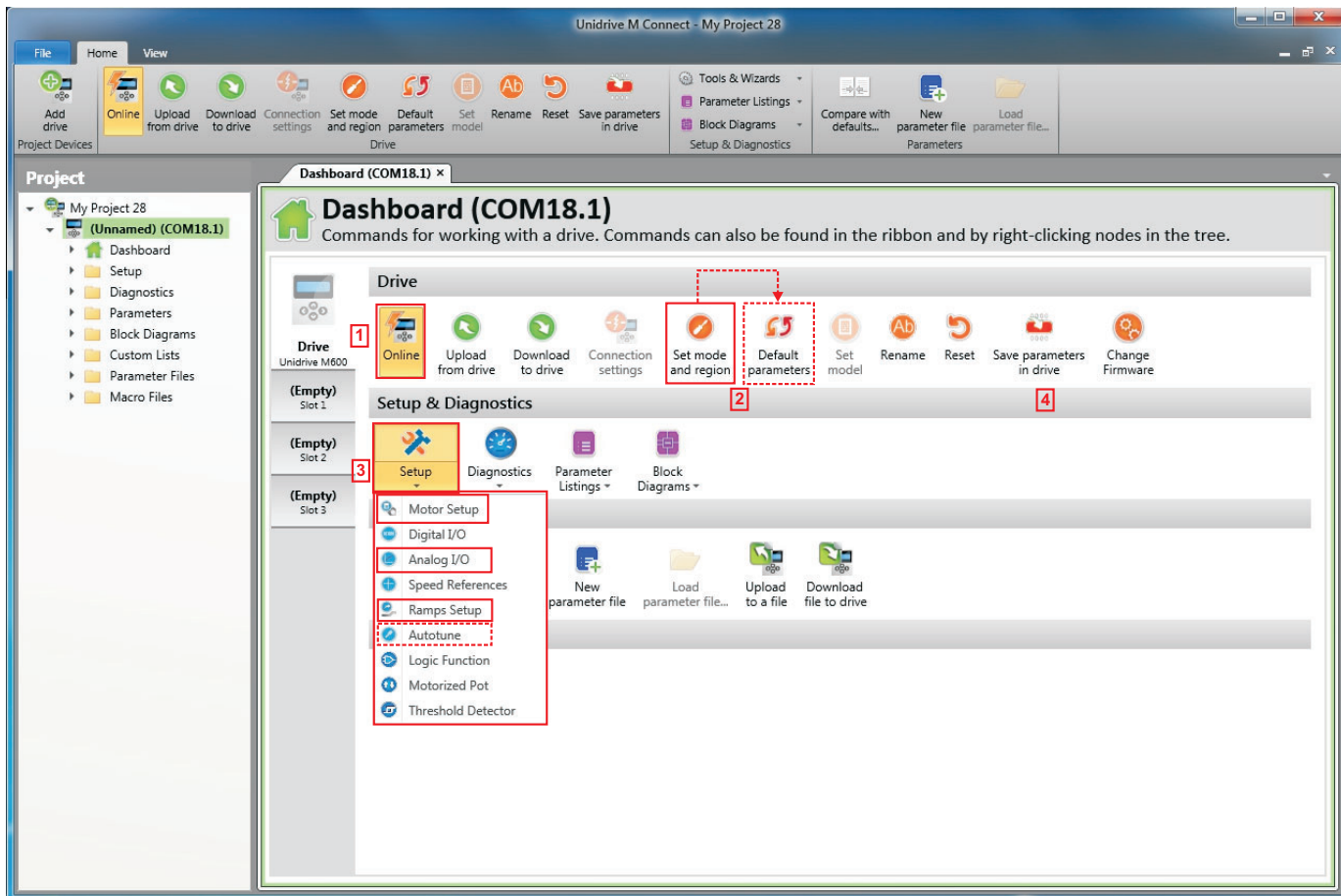
- Windows 10, Windows 8, Windows 7 SP1
- Minimum of 1280 x 1024 screen resolution with 256 colours
- Microsoft.Net Frameworks 4.0 (this is provided in the downloaded file)
- Note that you must have administrator rights to install HVAC Drive Connect

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):

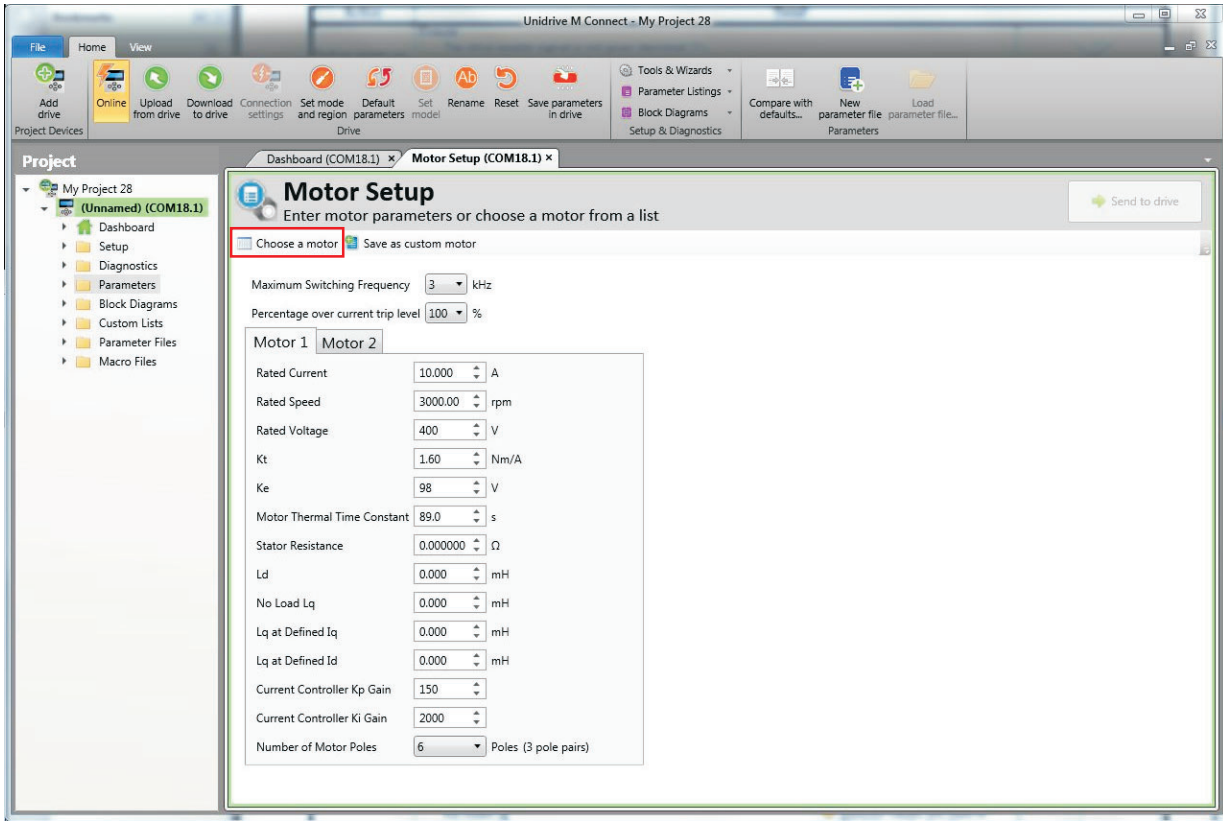
| Action | Detail |
|-------------|---|
| Motor Setup | HVAC Drive Connect contains a database for induction motors and permanent magnet motors. Provision is also made to enter motor nameplate data. The next section describes the use of the motor database for a Leroy Somer LSRPM motor used in RFC-S Sensorless 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.

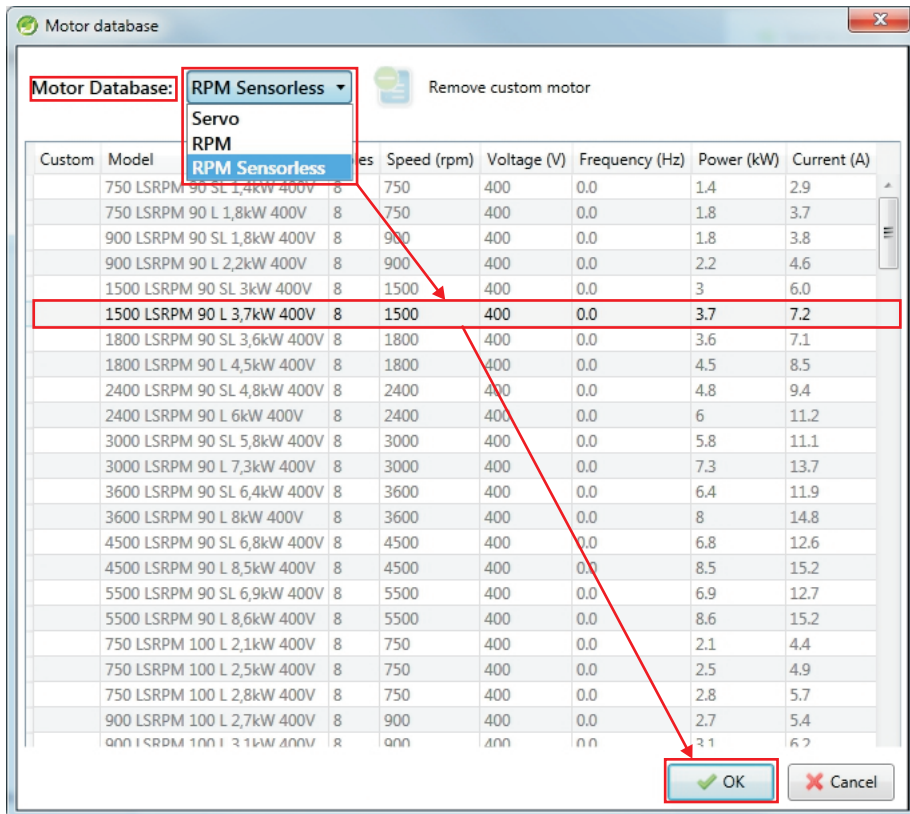
Select 'Motor Setup' from the 'Dashboard'.

On the 'Motor Setup' screen, select 'Choose a motor'.

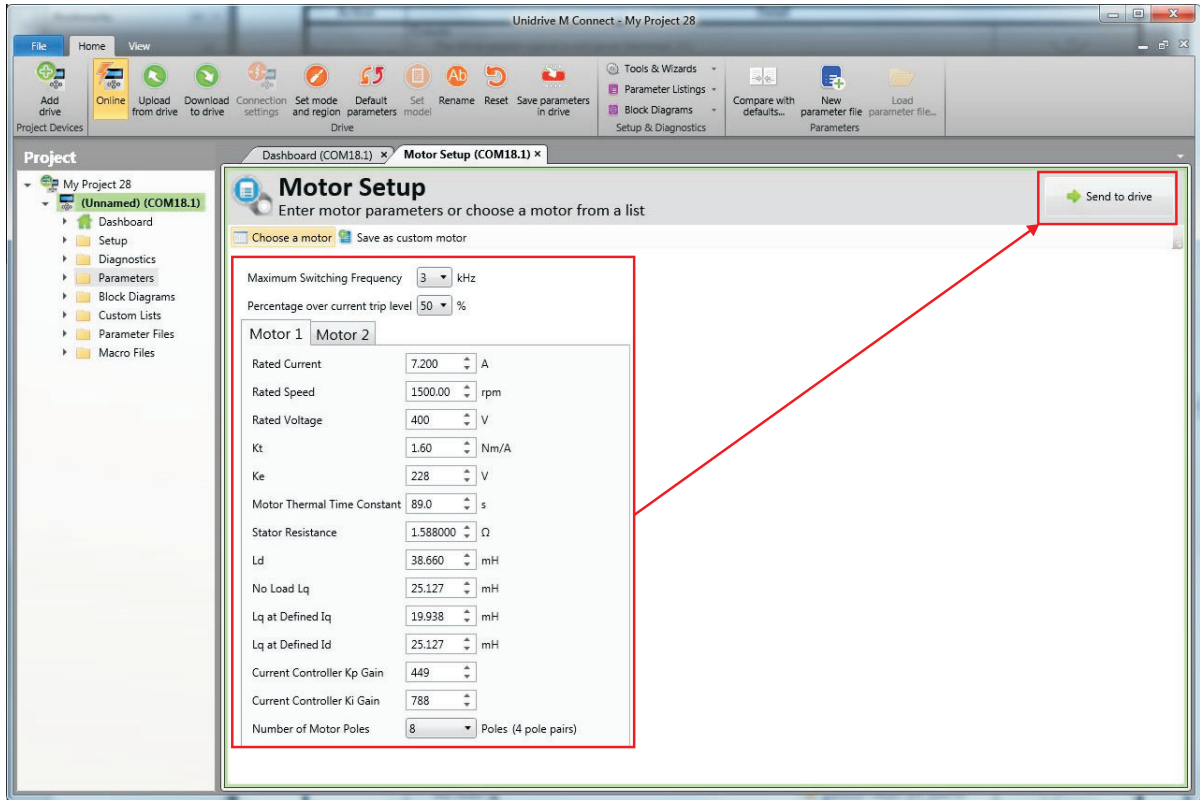


Select the required motor database:

Select the required motor from the list and click 'OK'.



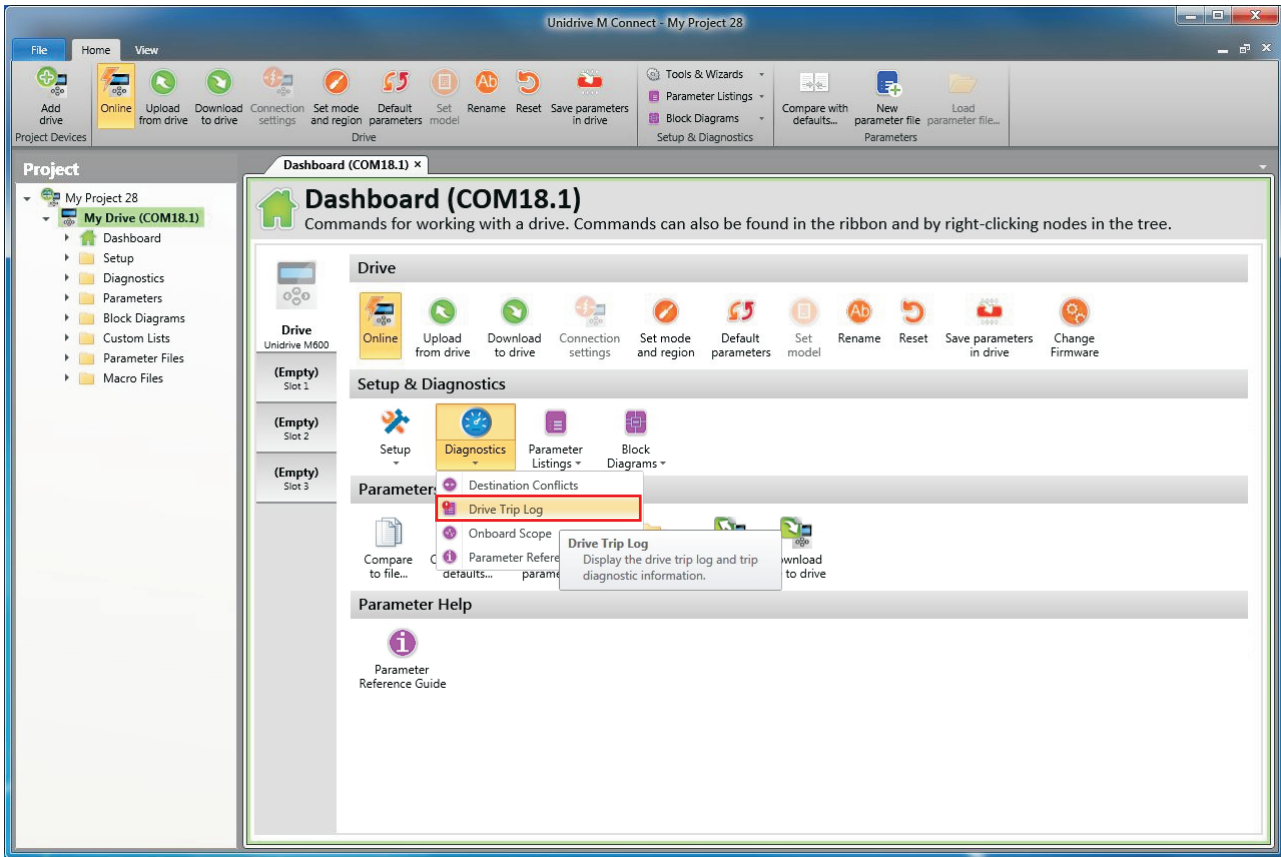
The data for the selected motor is displayed on the 'Motor Setup' screen. Click 'Send to drive' to set the associated parameters.



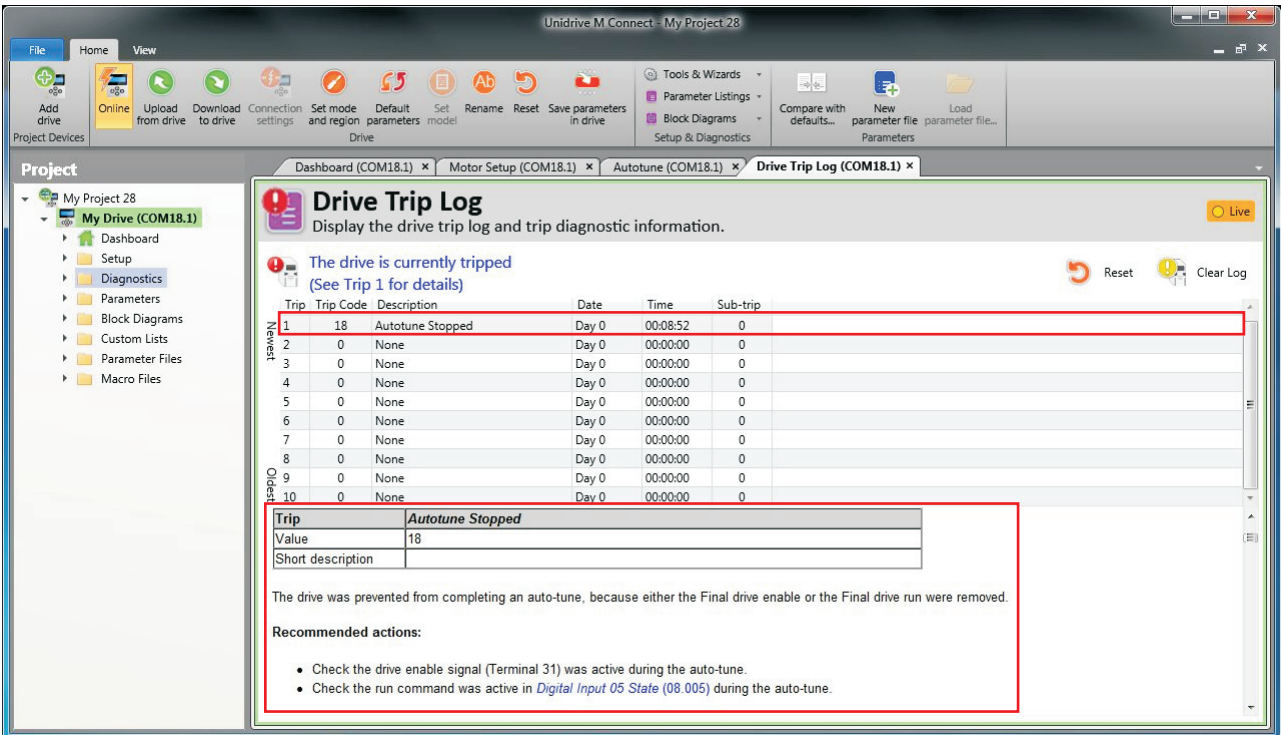
7.5 Diagnostics

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

Select 'Drive Trip Log' from the 'Dashboard'.



The drive trip log shows the trip responsible for stopping the autotune and a description of the trip.



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 |
| <ul style="list-style-type: none"> 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 <i>Switching frequency</i> on page 181, for more information). Motor thermal overload protection (see section 8.2 <i>Motor thermal protection</i> on page 180, for more information) Vector mode voltage control (see <i>Open Loop Control Mode</i> (00.014), later in this table) Slip compensation (see <i>Enable Slip Compensation</i> (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 |
| <p>The <i>Rated Voltage</i> (00.018) and the <i>Rated Frequency</i> (00.021) are used to define the voltage to frequency characteristic applied to the motor (see <i>Open Loop Control Mode</i> (00.014), later in this table). The <i>Rated Frequency</i> (00.021) is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see <i>Rated Speed</i> (00.019), later in this table).</p> | |
| | |
| 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 |
| <p>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.</p> $\text{Rated slip (Hz)} = \text{Motor rated frequency} - (\text{Number of pole pairs} \times [\text{Motor rated speed} / 60]) = \mathbf{00.021} = \left(\frac{\mathbf{00.017}}{2} \times \frac{\mathbf{00.019}}{60} \right)$ <p>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.</p> <p>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.</p> $\text{Number of poles} = 120 \times (\text{Rated Frequency} (00.021) / \text{Rated Speed} (\mathbf{00.019})) \text{ rounded to the nearest even number.}$ | |
| Pr 05.010 Rated Power Factor | Defines the angle between the motor voltage and current |
| <p>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 <i>Rated Current</i> (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).</p> | |

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) $\times \frac{2}{3}$, 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

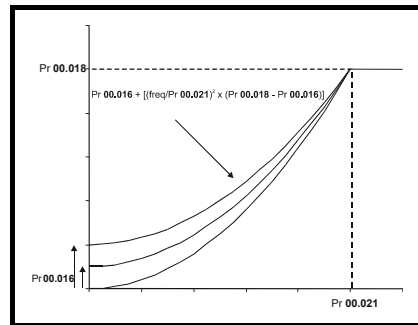
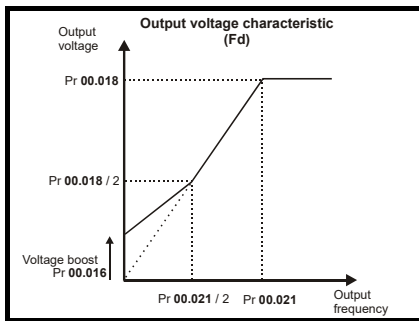
Neither the stator resistance nor the voltage offset are used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **00.016**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed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

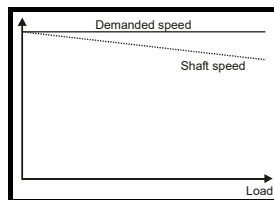
Pr 00.014 {05.014} Open Loop Control Mode (cont)

For both these modes, at low frequencies (from 0Hz to $\frac{1}{2}$ 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 |
| <p>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:</p> <ul style="list-style-type: none"> • Motor thermal overload protection (see section 8.2 <i>Motor thermal protection</i> on page 180, 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 |
| <p>The <i>Rated Voltage</i> (00.018) and the <i>Rated Frequency</i> (00.021) are used to define the voltage to frequency characteristic applied to the motor (see <i>Open Loop Control Mode</i> (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 <i>Rated Speed</i> (00.019), later in this table).</p> | |
| <p>The graph, titled 'Output voltage characteristic', plots Output voltage on the vertical axis against Output frequency on the horizontal axis. A solid line starts at the origin (0,0) and rises linearly to a point where the frequency is Pr 00.021 and the voltage is Pr 00.018. From this point, the line becomes horizontal, indicating constant voltage. A dashed line from the origin passes through a point where the frequency is Pr 00.021 / 2 and the voltage is Pr 00.018 / 2, showing that the relationship is linear up to the rated frequency.</p> | |
| 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 |
| <p>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:</p> <ul style="list-style-type: none"> • 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 <p>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 <i>Motor Parameter Adaptive Control</i> (05.016), later in this table).</p> <p>When Pr 00.017 is set to 'Automatic', the number of motor poles is automatically calculated from the motor <i>Rated Frequency</i> (00.021), and the motor <i>Rated Speed</i> (00.019).</p> <p>Number of poles = $120 \times (\text{Motor Rated Frequency (00.021)} / \text{Motor Rated Speed (00.019)})$ rounded to the nearest even number.</p> | |
| Pr 05.010 Rated Power Factor | Defines the angle between the motor voltage and current |
| <p>The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. If the <i>Stator Inductance</i> (05.025) is set to zero then the power factor is used in conjunction with the motor <i>Rated Current</i> (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 <i>Autotune</i> (Pr 00.024), later in this table).</p> | |

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}

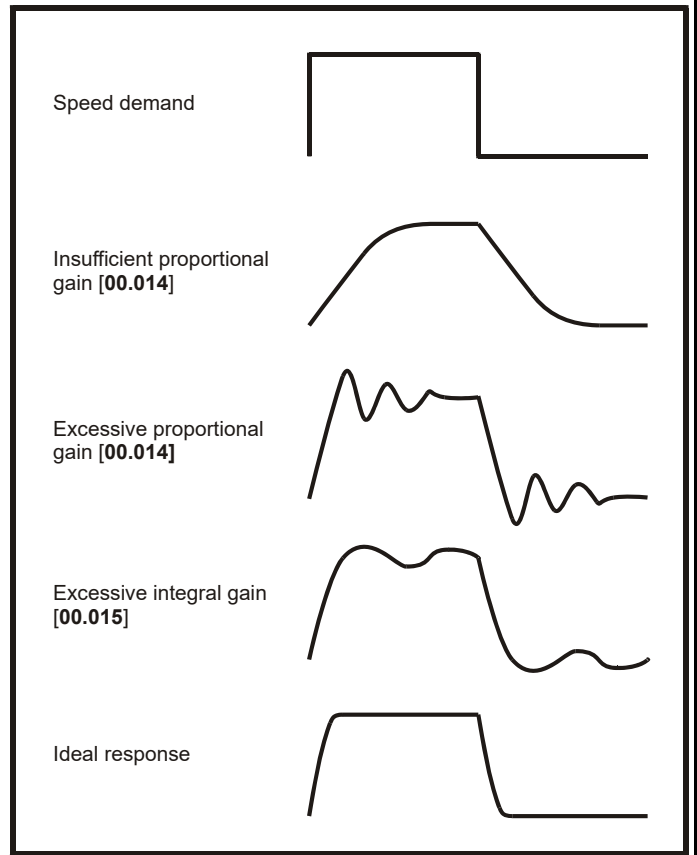
If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, 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 180, 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 $L_q/L_d = 1.1$. Even if a motor has a larger ratio on no load, this ratio normally reduces as the q axis current is increased from zero. *Low Speed Sensorless Mode Current* (05.071) should be set at a level that is lower than the point where the inductance ratio falls to 1.1. The value of this parameter is used to define the drive current limits when signal injection is active and prevent loss of control of the motor.

(1) Non-salient mode

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

(2) Current

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

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

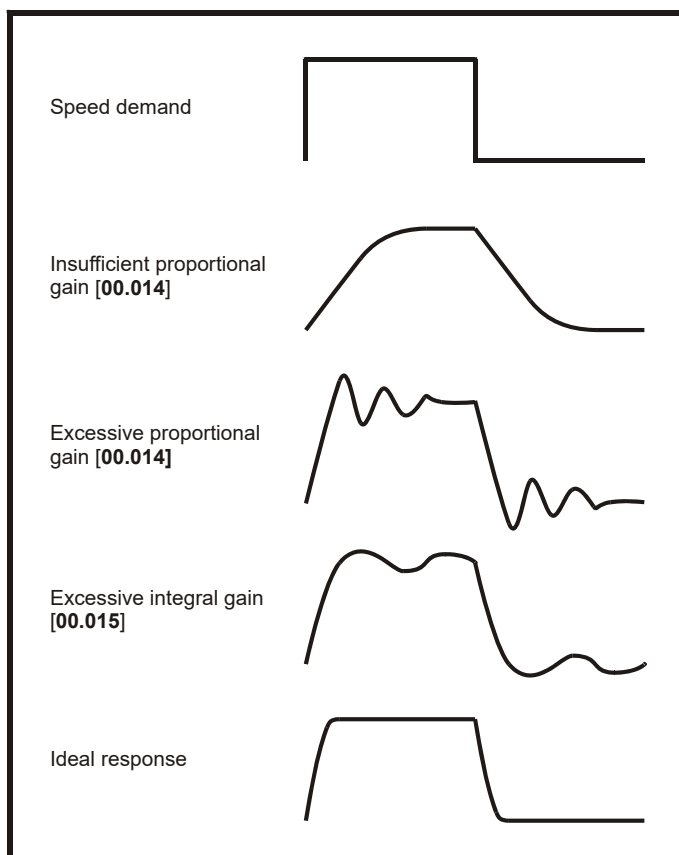
If the proportional gain has a value and the integral gain is set to zero the controller will only have a proportional term, and there must be a speed error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual speeds. This effect, 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:

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

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

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:

$$\text{Pr } \mathbf{04.019} = \text{Percentage Losses} \times [(1 - K_2) (1 - e^{-t/\tau_1}) + K_2 (1 - e^{-t/\tau_2})]$$

Where:

T = *Motor Protection Accumulator* (04.019)

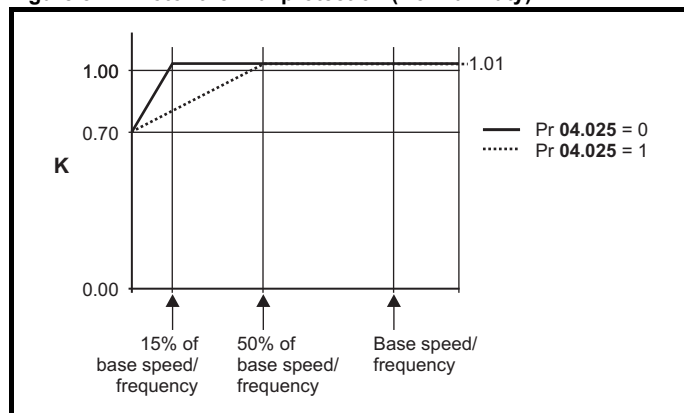
K₂ = *Motor Thermal Time Constant 2 Scaling* (04.038) / 100 %

τ₁ = *Motor Thermal Time Constant 1* (04.015)

τ₂ = *Motor Thermal Time Constant 2* (04.037)

K₁ = 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 the 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 273.
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 | |

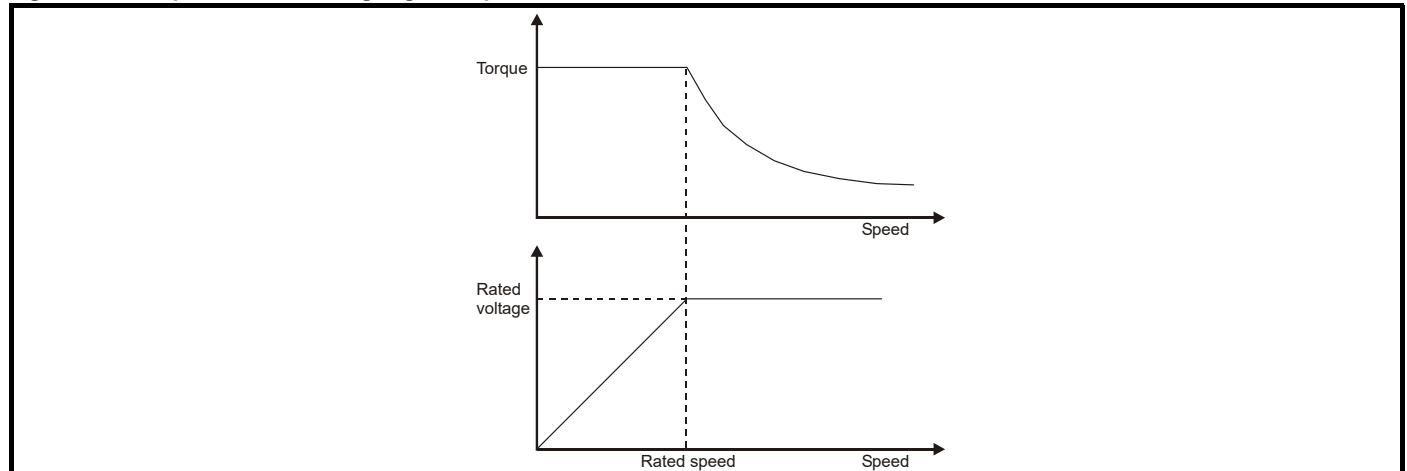
8.4 High speed operation

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 | $400 \times 1000 / (K_e \times \sqrt{2})$ | $400 / \sqrt{2}$ |
| 400 | $800 \times 1000 / (K_e \times \sqrt{2})$ | $800 / \sqrt{2}$ |
| 575 | $955 \times 1000 / (K_e \times \sqrt{2})$ | $955 / \sqrt{2}$ |
| 690 | $1145 \times 1000 / (K_e \times \sqrt{2})$ | $1145 / \sqrt{2}$ |

K_e 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 (K_e) of the motor. K_e 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 138). 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 | | ⇒ | | 0.0 Hz | | | | | |
| RFC | | Hz/rpm | | | | 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 | | | | | | | | | | | | |
| RW | 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:

$$\text{Output} = \text{Error} \times [\text{Kp} + \text{Ki}/\text{s} + \text{Kds}/(0.064\text{s} + 1)]$$

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 | | | |

| | | | | | | | | | |
|---------------|-------------------------------|--|--|--|---|-------|--|----|--|
| 14.024 | PID 1 feedback scaling | | | | | | | | |
| 14.054 | PID 2 feedback 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 | | | |

| | | | | | | | | | |
|---------------|--------------------------------|--|--|--|---|------|--|--|--|
| 14.025 | PID 1 digital reference | | | | | | | | |
| 14.055 | PID 2 digital reference | | | | | | | | |
| RW | Bi | | | | | NC | | | |
| ⇅ | ±100.00 % | | | | ⇒ | 0.00 | | | |

| | | | | | | | | | |
|---------------|------------------------------|--|--|--|---|---------|--|----|--|
| 14.017 | PID 1 integrator hold | | | | | | | | |
| 14.047 | PID 2 integrator hold | | | | | | | | |
| RW | Bit | | | | | NC | | US | |
| ⇅ | OFF (0) or On (1) | | | | ⇒ | OFF (0) | | | |

| | | | | | | | | | |
|---------------|-------------------------------|--|--|--|---|------|--|--|--|
| 14.026 | PID 1 digital feedback | | | | | | | | |
| 14.055 | PID 2 digital feedback | | | | | | | | |
| RW | Bi | | | | | NC | | | |
| ⇅ | ±100.00 % | | | | ⇒ | 0.00 | | | |

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.

| | | | | | | | | | |
|---------------|---|--|--|--|---|------|----|--|--|
| 14.027 | PID 1 optional enable source parameter 2 | | | | | | | | |
| RW | Uni | | | | | PT | US | | |
| ⇅ | 0.00 to 50.99 | | | | ⇒ | 0.00 | | | |

| | | | | | | | | | |
|---------------|---------------------------------------|--|--|--|---|---------|--|----|--|
| 14.018 | PID 1 symmetrical limit enable | | | | | | | | |
| 14.048 | PID 2 symmetrical limit enable | | | | | | | | |
| RW | Bit | | | | | | | US | |
| ⇅ | OFF (0) or On (1) | | | | ⇒ | OFF (0) | | | |

| | | | | | | | | | |
|---------------|------------------------------------|--|--|--|---|------|--|----|--|
| 14.028 | PID 1 pre-sleep boost level | | | | | | | | |
| RW | Uni | | | | | | | US | |
| ⇅ | 0.00 to 100.00 % | | | | ⇒ | 0.00 | | | |

| | | | | | | | | | |
|---------------|-----------------------------|--|--|--|---|----|----|----|--|
| 14.019 | PID 1 main reference | | | | | | | | |
| 14.049 | PID 2 main reference | | | | | | | | |
| RO | Bi | | | | | NC | PT | US | |
| ⇅ | ±100.00 % | | | | ⇒ | | | | |

| | | | | | | | | | |
|---------------|---------------------------|--|--|--|---|-----|--|----|--|
| 14.029 | Maximum boost time | | | | | | | | |
| RW | Uni | | | | | | | US | |
| ⇅ | 0.0 to 250.0 s | | | | ⇒ | 0.0 | | | |

| | | | | | | | | | |
|---------------|------------------------|--|--|--|---|----|----|----|--|
| 14.020 | PID 1 reference | | | | | | | | |
| 14.050 | PID 2 reference | | | | | | | | |
| RO | Bi | | | | | NC | PT | US | |
| ⇅ | ±100.00 % | | | | ⇒ | | | | |

| | | | | | | | | | |
|---------------|---|--|--|--|---|----|----|--|--|
| 14.030 | PID 1 pre-sleep boost level enable | | | | | | | | |
| RO | Bit | | | | | NC | PT | | |
| ⇅ | OFF (0) or On (1) | | | | ⇒ | | | | |

| | | | | | | | | | |
|---------------|-----------------------|--|--|--|---|----|----|----|--|
| 14.021 | PID 1 feedback | | | | | | | | |
| 14.051 | PID 2 feedback | | | | | | | | |
| RO | Bi | | | | | NC | PT | US | |
| ⇅ | ±100.00 % | | | | ⇒ | | | | |

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.

| | | | | | | | | | |
|---------------|--------------------|--|--|--|---|----|----|----|--|
| 14.022 | PID 1 error | | | | | | | | |
| 14.052 | PID 2 error | | | | | | | | |
| RO | Bi | | | | | NC | PT | US | |
| ⇅ | ±100.00 % | | | | ⇒ | | | | |

| | | | | | | | | | |
|---------------|---------------------|--|--|--|---|---|--|----|--|
| 14.038 | PID 2 enable | | | | | | | | |
| RW | Uni | | | | | | | US | |
| ⇅ | 0 to 2 | | | | ⇒ | 0 | | | |

| | | | | | | | | | |
|---------------|--------------------------------|--|--|--|---|-------|--|----|--|
| 14.023 | PID 1 reference scaling | | | | | | | | |
| 14.053 | PID 2 reference scaling | | | | | | | | |
| RW | Uni | | | | | | | US | |
| ⇅ | 0.000 to 4.000 | | | | ⇒ | 1.000 | | | |

| 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.

$$\text{Square root function output} = \text{Sign}(\text{Feedback}) \times 100.00\% \times \sqrt{|\text{Feedback}| / 100.00\%}$$

where Sign(Feedback) is 1 if the feedback is positive or -1 if 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 |

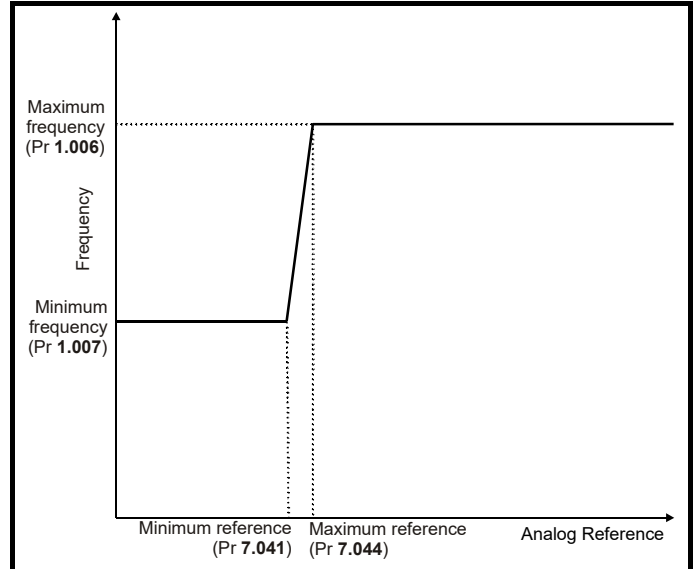
Dual setpoint, dual feedback (Pr 14.059 = 6 to 7)

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:

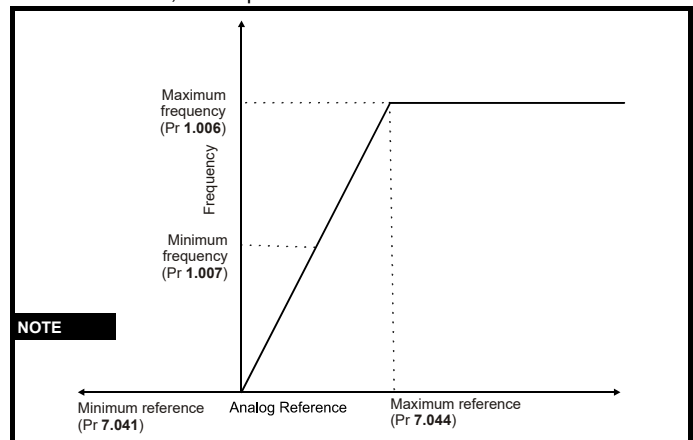
- Output frequency = 20 Hz when analog reference < 25%,
- Output frequency = 60 Hz when analog reference > 75%,
- Output frequency = linear ramp between 20 and 60 Hz when analog reference is between 25 and 75 %, then the parameters should be set as follows:
 - Pr 1.006 = 60
 - Pr 1.007 = 20
 - Pr 7.041 = 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.



NOTE

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

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".

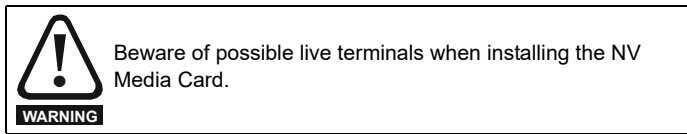
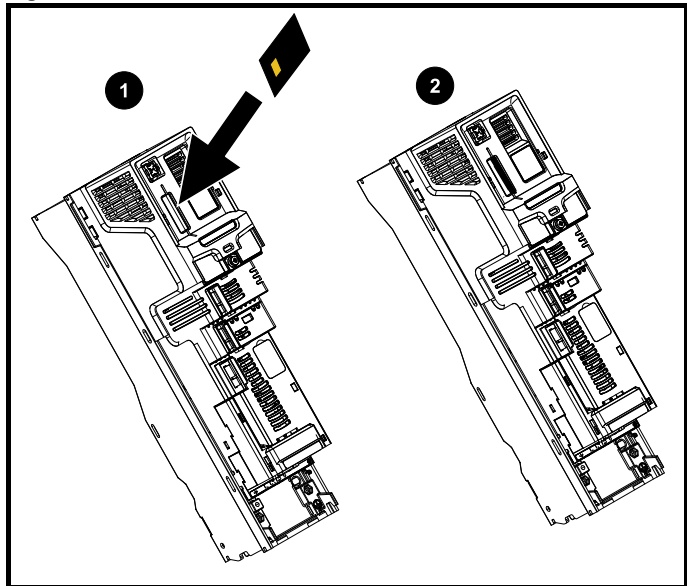


Figure 9-1 Installation of the NV Media Card



1. Installing the NV Media Card
2. NV Media Card installed

| NV Media Card | Part number |
|--|----------------|
| SD Card Adaptor (memory card not included) | 82400000016400 |
| 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 NV Media Card

NOTE
Overwrites any data already in data block 1

Pr 00.033 = Program +

Drive automatically writes to the NV Media Card when a parameter save is performed

Auto Save

Pr 00.033 = Auto +

Drive boots from the NV Media Card on power up and automatically writes to the NV Media Card when a parameter save is performed

Boot

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 189.

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. On Board user program not supported on H300 | ✓ | ✓ |
| 6yyy | Load the drive parameters from parameter file yyy | ✓ | ✓ |
| 7yyy | Erase file yyy. | ✓ | ✓ |
| 8yyy | Compare the data in the drive with file yyy. If the files are the same then <i>Pr mm.000 (mm.000)</i> 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 | ⇕ | | 0 to 999 | ⇒ | 0 |
| RFC-S | | | | | |

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 | NC | PT |
|----------------------------------|---|----|----------|----|----|
| OL | | | | | |
| RFC-A | ⇕ | | 0 to 999 | ⇒ | 0 |
| RFC-S | | | | | |

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 | ⇕ | | None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6) | ⇒ | | |
| RFC-S | | | | | | |

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 | ⇕ | | 0 to 9999 | ⇒ | | |
| RFC-S | | | | | | |

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 | ⇕ | | --2147483648 to 2147483647 | ⇒ | | |
| RFC-S | | | | | | |

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 | ⇕ | | None (0), Read (1), Program (2), Auto (3), Boot (4) | ⇒ | None (0) |
| RFC-S | | | | | |

* 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 | ⇕ | | 0 to 1 | ⇒ 0 |
| RFC-S | | | | |

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 | ⇕ | | None (0), SMART Card (1), SD Card (2) | ⇒ | | |
| RFC-S | | | | | | |

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 | ⇕ | | Off (0) or On (1) | ⇒ | | |
| RFC-S | | | | | | |

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 | | | | | | | | | | | | | |
| RFC-A | ⇕ | Off (0) or On (1) | | | ⇒ | | | | | | | | |
| 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 | | | | | | | | | | | | | |
| RFC-A | ⇕ | 0 to 9999 | | | ⇒ | | | | | | | | |
| 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 301 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

As standard the H300 Drive is provided with a 2 wire EIA-485 interface located beneath the control terminals (see Figure 10-1). All two protocols use this communication interface.

Figure 10-1 Location of the comms connector

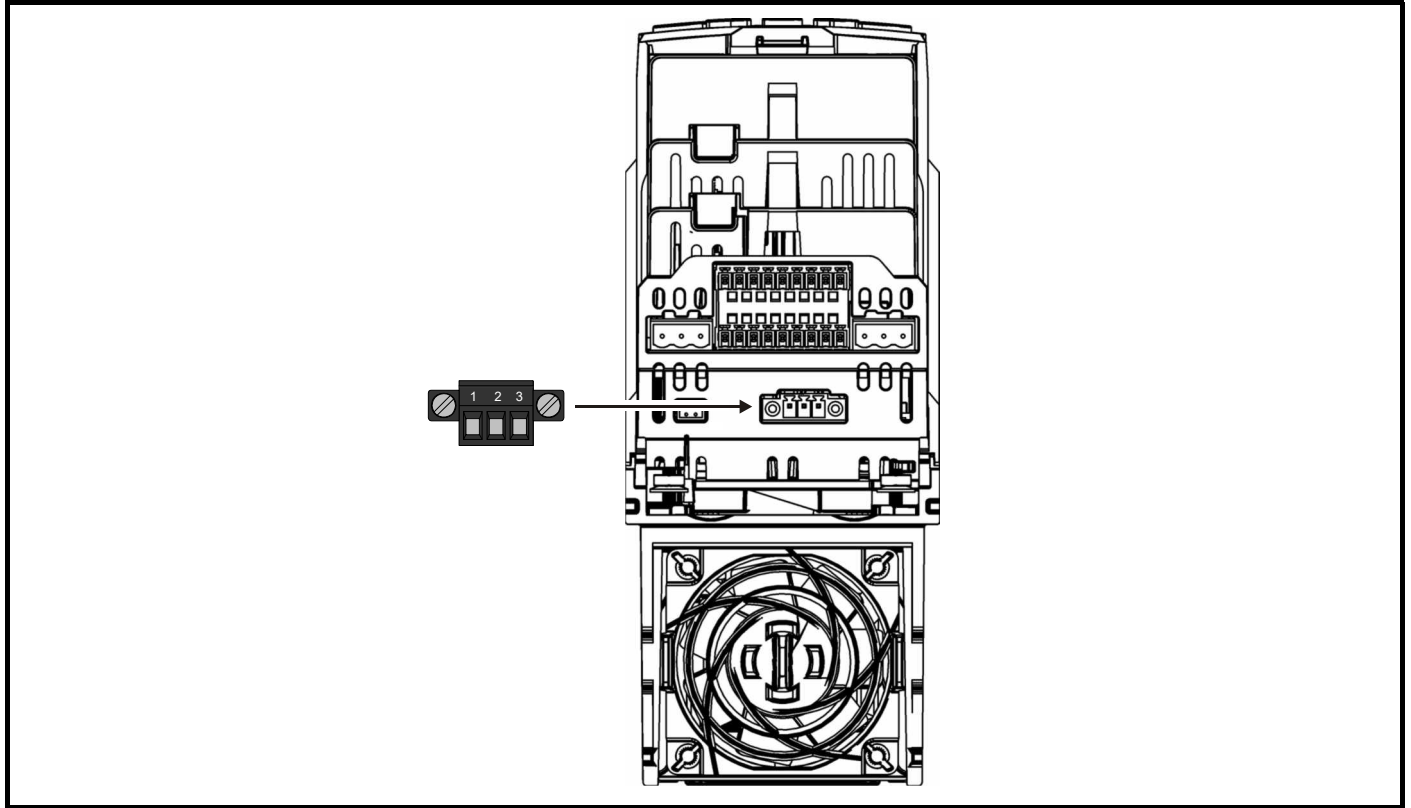


Table 10-1 Serial communication port pin-outs

| 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

| Protocol | Master / Slave | Allowable MAC Address Values | | |
|------------|----------------|------------------------------|---------|-----------|
| | | Minimum | Maximum | Broadcast |
| Modbus RTU | Slave | 1 | 247 | 0 |
| BACnet* | Master | 0 | 127 | 255 |

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. BACnet module act as a Master on the Data Link Layer over MS/TP.

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. BACnet module only supports 9600, 19200 and 38400 baud rates

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 |

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.

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

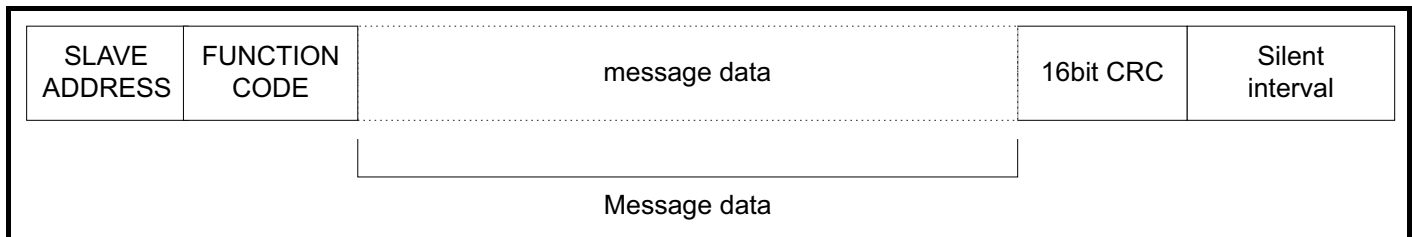
Physical layer

| 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

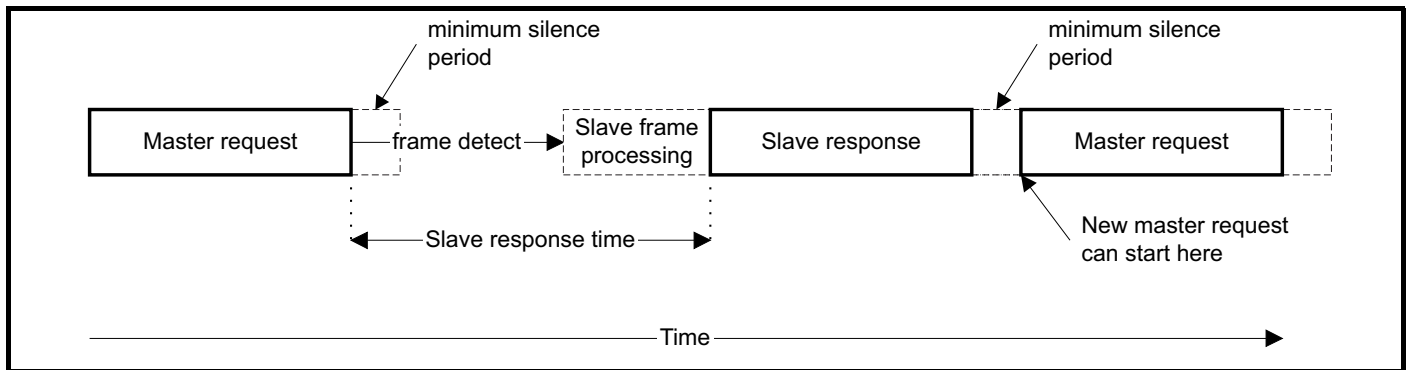


The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without 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 than 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 199 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 |

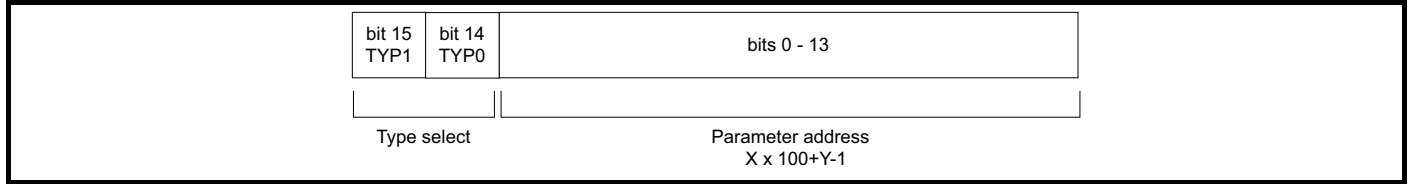
10.3.7 Extended data types

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 |
| 3 | 0xE4 | $(16384 + 2021 - 1) = 18404 = 0x47E4$ |
| 4 | 0x00 | Number of 16bit registers to read |
| 5 | 0x08 | Pr 20.021 through Pr 20.024 is 4x32 bit registers = 8x16 bit registers |
| 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 $x^{16} + x^{15} + x^2 + 1$. 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

This section describes the support for BACnet MS/TP Master device.

H300 BACnet derivative support "BACnet-Application Specific Controller (B-ASC)" profile and it is compliance to BACnet protocol Version 1 Revision15.

H300 BACnet drive act as Master on Data Link Layer over MS/TP for data communication. Device supports three standard Baud rate **9600, 19200, 38400**.

10.4.1 BACnet Interoperability Building Blocks (BIBBs)

The BACnet Interoperability Building Blocks (BIBBs) are collections of one or more BACnet services. They are prescribed in terms of an "A" and a "B" device. Both of these devices are nodes on a BACnet network.

Here "A" node will act as the user of data (Client) and "B" node will be the provider of this data.

HVAC H300 device support following BIBBs

10.4.2 Data Sharing Services: These BIBBs prescribe the BACnet capabilities required to interoperable perform the data sharing functions.

- Data Sharing-ReadProperty-B (DS-RP-B)**

The B device is a provider of data to device A.

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| Read Property | | X |

This property has the following three fields

| Object ID | Property | ArrayIndex |
|-----------|----------|------------|
|-----------|----------|------------|

'ArrayIndex' field is required while reading an 'Array' property.

- Date Sharing-WriteProperty-B(DS-RW-B)**

The B device allows a value to be changed by device A.

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| Write Property | | X |

This property has the following five fields

| Object ID | Property | ArrayIndex | Value | Priority |
|-----------|----------|------------|-------|----------|
|-----------|----------|------------|-------|----------|

'ArrayIndex' is required while writing an 'Array' property.

'Priority' is required while writing to 'Commandable' property.

10.4.3 Device and Network Management Services: These BIBBs prescribe the BACnet capabilities required to interoperable perform the Device Management and Network Management functions.

- Device Management-Dynamic Device Building-B (DM-DDB-B)**

The B device provides information about its device attributes and responds to requests to identify itself. This is an unconfirmed service.

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| Who-Is | | X |
| I-Am | X | |

Structure of Who-Is service is as below; Both the fields are optional

| Low Limit | High Limit |
|-----------|------------|
|-----------|------------|

- Device Management-Dynamic Object Building-B (DM-DOB-B)**

The B device provides address information about its objects upon request. This is an unconfirmed service.

| BACnet Service | Initiate | Execute |
|----------------|----------|---------|
| Who-Has | | X |
| I-Have | X | |

Structure of 'Who-Has' service primitive is as below. The limit fields are optional.

| Low Limit | High Limit | Object ID | Object Name |
|-----------|------------|-----------|-------------|
|-----------|------------|-----------|-------------|

Refer the 'H300 BACnet Objects list with ID and Name' table below.

10.4.4 Device Management-Reinitialize Device-B (DM-RD-B)

The B device performs reinitialization requests from the A device. The optional password field shall be ignored.

| BACnet Service | Initiate | Execute |
|---------------------|----------|---------|
| Reinitialize Device | | X |

Structure of 'ReinitializeDevice' service primitive is as below.

The password field is an optional.

| State | Password |
|-------|----------|
| | |

H300 BACnet Drive supports the following two states.

- 'Cold Start' (Reboot itself).
- 'Warm Start' (Reset itself to some predefined initial state).

Password field is an optional hence ignored.

10.4.5 Device Management-TimeSynchronization-B (DM-RD-B)

The B device interprets time synchronization messages from the A device. This service may be broadcast, multicast, or addressed to a single recipient.

| BACnet Service | Initiate | Execute |
|---------------------|----------|---------|
| TimeSynchronization | | X |

Structure of 'TimeSynchronization' service primitive is as below.

| Date | Time |
|------|------|
| | |

Valid 'Date' range: Minimum: January 1, 2012; Maximum: December 31, 2079.

10.4.6 Device Management-DeviceCommunicationControl-B (DM-DCC-B)

The B device instructed to stop initiating and optionally stop responding to all APDUs (except DeviceCommunicationControl or, if supported, ReinitializeDevice). This is confirmed service request.

| BACnet Service | Initiate | Execute |
|----------------------------|----------|---------|
| DeviceCommunicationControl | | X |

Structure of 'DeviceCommunicationControl' service primitive is as below'

| Time | Enable/Disable | Password |
|------|----------------|----------|
| | | |

'Password' field is an optional hence ignored.

Only 'indefinite' time duration is supported therefore 'Time' field must be kept 'blank' and communication must be re-enabled by a 'DeviceCommunicationControl' or 'ReinitializeDevice' service.

10.4.7 Object/Property Support Matrix

The following table summarizes the Object Types / Properties supported:

| Property | Object Type | | | | | | |
|-------------------------------|-------------|--------------|---------------|--------------|--------------|---------------|--------------|
| | Device | Analog Input | Analog Output | Analog Value | Binary Input | Binary Output | Binary Value |
| Object Identifier | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Object Name | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Object Type | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Property List | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| System Status | ✓ | | | | | | |
| Vendor Name | ✓ | | | | | | |
| Vendor Identifier | ✓ | | | | | | |
| Model Name | ✓ | | | | | | |
| Firmware Revision | ✓ | | | | | | |
| Application Software Revision | ✓ | | | | | | |
| Protocol Version | ✓ | | | | | | |
| Protocol Revision | ✓ | | | | | | |
| Services Supported | ✓ | | | | | | |
| Object Types Supported | ✓ | | | | | | |
| Object List | ✓ | | | | | | |

| Property | Object Type | | | | | | |
|------------------------|-------------|--------------|---------------|--------------|--------------|---------------|--------------|
| | Device | Analog Input | Analog Output | Analog Value | Binary Input | Binary Output | Binary Value |
| Max APDU Length | ✓ | | | | | | |
| Segmentation Support | ✓ | | | | | | |
| Local Date | ✓ | | | | | | |
| Local Time | ✓ | | | | | | |
| APDU Timeout | ✓ | | | | | | |
| Number APDU Retries | ✓ | | | | | | |
| Max Master | ✓ | | | | | | |
| Max Info Frames | ✓ | | | | | | |
| Device Address Binding | ✓ | | | | | | |
| Database Revision | ✓ | | | | | | |
| Present Value | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Status Flags | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Event State | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Reliability | | ✓ | | ✓** | | | |
| Out-of-Service | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Units | | ✓ | ✓ | ✓ | | | |
| Priority Array | | | ✓* | ✓* | | ✓* | ✓* |
| Relinquish Default | | | ✓* | ✓* | | ✓* | ✓* |
| Polarity | | | | | ✓*** | ✓*** | |

* These properties are for commandable objects only.

** Not all the AV objects have this property.

*** Polarities are changed by the drive parameters. For BACnet they are read-only.

10.4.8 Detailed BACnet Objects

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. |

Device Object

| Device Object Properties |
|-------------------------------|
| Object Identifier |
| Object Name |
| Object Type |
| Property List |
| System Status |
| Vendor Name |
| Vendor Identifier |
| Model Name |
| Firmware Revision |
| Application Software Revision |
| Protocol Version |
| Protocol Revision |
| Services Supported |
| Object Types Supported |
| Object List |
| Max APDU Length |
| Segmentation Support |
| Local Date |
| Local Time |
| APDU Timeout |
| Number APDU Retries |
| Max Master |
| Max Info Frames |
| Device Address Binding |
| Database Revision |

Analog Input Objects

| Instance ID | Object Name | Description | Units | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|-------------------------|---------|--|
| 1 | #AI_01 Drive Analog IP1 | Analog Input 1 on Drive | Percent | R |
| 2 | #AI_02 Drive Analog IP2 | Analog Input 2 on Drive | Percent | R |

Analog Output Objects

| Instance ID | Object Name | Description | Units | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|--------------------------|---------|--|
| 1 | #AO_01 Drive Analog OP1 | Analog Output 1 on Drive | Percent | C |
| 2 | #AO_02 Drive Analog OP2 | Analog Output 2 on Drive | Percent | C |

Analog Value Objects

| Instance ID | Object Name | Description | Units | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|---|----------|--|
| 4 | #AV_04 Speed Ref | The required output frequency/speed reference | Hertz | C |
| 5 | #AV_05 Max Speed Ref | The maximum reference clamp value | Hertz | W |
| 6 | #AV_06 Output Current | Motor output current magnitude | Amperes | R |
| 7 | #AV_07 Output Torque | Motor output torque as a percent of full load | Percent | R |
| 8 | #AV_08 Output Frequency | Drive output frequency | Hertz | R |
| 9 | #AV_09 Output Speed | Motor Speed | RPM | R |
| 10 | #AV_10 Output Power | Drive Output Power | kW | R |
| 11 | #AV_11 Drive Status Wd | Drive Status Word | No Units | R |
| 12 | #AV_12 User Trip Param | User trip | No Units | W |
| 13 | #AV_13 Last Trip | Last Drive Trip | No Units | R |
| 14 | #AV_14 Filtr Change(dt) | Time between filter changes | Hours | W |
| 15 | #AV_15 Nxt Filtr ChTime | Time before filter change due | Hours | R |
| 16 | #AV_16 Enrgy Meter(MWh) | Energy meter (MWh) | MWh | R |
| 17 | #AV_17 Enrgy Meter(kWh) | Energy meter (kWh) | kWh | R |
| 18 | #AV_18 PID1 Dig Ref | Digital reference for PID 1 | Percent | C |
| 19 | #AV_19 PID1 Dig Fback | Digital feedback for PID 1 | Percent | C |
| 20 | #AV_20 PID1 Ref | Sum of all reference inputs to PID 1 | Percent | R |
| 21 | #AV_21 PID1 Fback | Sum of all feedback inputs to PID 1 | Percent | R |
| 22 | #AV_22 PID1 Output | The output from PID 1 | Percent | R |
| 23 | #AV_23 PID2 Dig Ref | Digital reference for PID 2 | Percent | C |
| 24 | #AV_24 PID2 Dig Fback | Digital feedback for PID 2 | Percent | C |
| 25 | #AV_25 PID2 Ref | Sum of all reference inputs to PID 2 | Percent | R |
| 26 | #AV_26 PID2 Fback | Sum of all feedback inputs to PID 2 | Percent | R |
| 27 | #AV_27 PID2 Output | The output from PID 2 | Percent | R |
| 28 | #AV_28 User Sel 29.010 | User selectable parameter 1 | No Units | R/W |
| 29 | #AV_29 User Sel 29.011 | User selectable parameter 2 | No Units | R/W |
| 30 | #AV_30 User Sel 29.012 | User selectable parameter 3 | No Units | R/W |
| 31 | #AV_31 User Sel 29.013 | User selectable parameter 4 | No Units | R/W |
| 32 | #AV_32 User Sel 29.014 | User selectable parameter 5 | No Units | R/W |
| 33 | #AV_33 User Sel 29.015 | User selectable parameter 6 | No Units | R/W |
| 34 | #AV_34 User Sel 29.016 | User selectable parameter 7 | No Units | R/W |
| 35 | #AV_35 User Sel 29.017 | User selectable parameter 8 | No Units | R/W |
| 36 | #AV_36 User Sel 29.018 | User selectable parameter 9 | No Units | R/W |
| 37 | #AV_37 User Sel 29.019 | User selectable parameter 10 | No Units | R/W |

NOTE

Analog Value 28 to 37 are the objects where any drive parameter can be mapped and controlled using BACnet communication. The Access control for that object will be as per the drive parameters access.

Binary Input Objects

| Instance ID | Object Name | Description | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|---|--|
| 1 | #BI_01 Drive Binary IP1 | Digital Input 1 on Drive (bi-directional) | R |
| 2 | #BI_02 Drive Binary IP2 | Digital Input 2 on Drive (bi-directional) | R |
| 3 | #BI_03 Drive Binary IP3 | Digital Input 3 on Drive (bi-directional) | R |
| 4 | #BI_04 Drive Binary IP4 | Digital Input 4 on Drive | R |
| 5 | #BI_05 Drive Binary IP5 | Digital Input 5 on Drive | R |
| 6 | #BI_06 Drive Binary IP6 | Digital Input 6 on Drive | R |
| 7 | #BI_07 Drive Binary IP7 | Drive enable input | R |

Binary Output Objects

| Instance ID | Object Name | Description | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|--|--|
| 1 | #BO_01 Drive Binary OP1 | Digital Output 1 on Drive (bi-directional) | C |
| 2 | #BO_02 Drive Binary OP2 | Digital Output 2 on Drive (bi-directional) | C |
| 3 | #BO_03 Drive Binary OP3 | Digital Output 2 on Drive (bi-directional) | C |
| 4 | #BO_04 Drive Binary OP4 | 24V Output | C |
| 5 | #BO_05 Drive Binary RI1 | Drive Relay 1 | C |
| 6 | #BO_06 Drive Binary RI2 | Drive Relay 2 | C |

NOTE

Binary Input and Output objects 1 to 3 are bi-directional points - They can be either Input or Output at a time.

Binary Value Objects

| Instance ID | Object Name | Description | Access R=Read, W=Read/Write, C=Commandable |
|-------------|-------------------------|--|--|
| 1 | #BV_01 Reset Enrgy Metr | Digital Output 1 on Drive (bi-directional) | W |
| 2 | #BV_02 Filtr Change Rqd | Digital Output 2 on Drive (bi-directional) | W* |
| 3 | #BV_03 Drive Run Fwrd | Digital Output 2 on Drive (bi-directional) | C |
| 4 | #BV_04 Drive Healthy | 24V Output | R |
| 5 | #BV_05 Drive Warning | Drive Relay 1 | R |
| 6 | #BV_06 Drive Reset | Drive Relay 2 | W** |

* Can only be set to INACTIVE.


** Can only be set to ACTIVE from INACTIVE.

NOTE

The object instantiation in H300 drive is STATIC. i.e. No object can be created or deleted at runtime.

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*.



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*.

WARNING

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 | <p>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.</p> <p>The maximum frequency/speed is taken from <i>Maximum Reference Clamp</i> (01.006) if <i>Select Motor 2 Parameters</i> (11.045) = 0, or <i>M2 Maximum Reference Clamp</i> (21.001) if <i>Select Motor 2 Parameters</i> (11.045) = 1.</p> <p>Open-loop mode VM_ACCEL_RATE[MIN] = 0.0</p> <p>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</p> <p>RFC-A, RFC-S modes VM_ACCEL_RATE[MIN] = 0.000</p> <p>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</p> | |

| VM_DC_VOLTAGE | | Range applied to parameters showing DC voltage |
|----------------------|---|--|
| Units | V | |
| Range of [MIN] | 0 | |
| Range of [MAX] | 0 to 1190 | |
| Definition | <p>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</p> <p>VM_DC_VOLTAGE[MIN] = 0</p> | |

| VM_DC_VOLTAGE_SET | | Range applied to DC voltage reference parameters |
|--------------------------|--|--|
| Units | V | |
| Range of [MIN] | 0 | |
| Range of [MAX] | 0 to 1150 | |
| Definition | <p>VM_DC_VOLTAGE_SET[MAX] is drive voltage rating NV dependent. See Table 11-4</p> <p>VM_DC_VOLTAGE_SET[MIN] = 0</p> | |

| 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 | <p>VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) or Kc value for the drive and is given by <i>Full Scale Current Kc</i> (11.061).</p> <p>VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]</p> | |

| 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 | <p>VM_DRIVE_CURRENT_UNIPOLAR[MAX] = VM_DRIVE_CURRENT[MAX]</p> <p>VM_DRIVE_CURRENT_UNIPOLAR[MIN] = 0.000</p> | |

| 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 | <p>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</p> <p>VM_HIGH_DC_VOLTAGE[MIN] = 0</p> | |

| VM_LOW_UNDER_VOLTS | | Range applied the low under-voltage threshold |
|---------------------------|---|---|
| Units | V | |
| Range of [MIN] | 24 | |
| Range of [MAX] | 24 to 1150 | |
| Definition | <p>If <i>Back-up Mode Enable</i> (06.068) = 0: VM_LOW_UNDER_VOLTS[MAX] = VM_STD_UNDER_VOLTS[MIN] If <i>Back-up Mode Enable</i> (06.068) = 1: VM_LOW_UNDER_VOLTS[MAX] = VM_STD_UNDER_VOLTS[MIN] / 1.1.</p> <p>VM_LOW_UNDER_VOLTS[MIN] = 24.</p> | |

| 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] = <i>Maximum Switching Frequency</i> (05.018) VM_MIN_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes | |

| 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] = $(I_{Tlimit} / I_{Trated}) \times 100 \%$ Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ $I_{Mrated} = Pr \ 05.007 \sin \phi$ $I_{Trated} = Pr \ 05.007 \times \cos \phi$ $\cos \phi = Pr \ 05.010$ 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] = $(I_{Tlimit} / I_{Trated}) \times 100 \%$ Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ $I_{Mrated} = Pr \ 05.007 \times \sin \phi_1$ $I_{Trated} = Pr \ 05.007 \times \cos \phi_1$ $\phi_1 = \cos^{-1}(Pr \ 05.010) + \phi_2$. ϕ_1 is calculated during an autotune. See the variable minimum / maximum calculations in the <i>Parameter Reference Guide</i> 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 VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{MaxRef} / Pr \ 05.007) \times 100 \%$ 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). | |

| VM_NEGATIVE_REF_CLAMP1 VM_NEGATIVE_REF_CLAMP2 | | Limits applied to the negative frequency or speed clamp | | | | | | | | | | | | | | | | | | |
|--|--|---|-----------------------------------|-----------------------------|-----------------------------|---|---|-----|-----------|---|---|-----|-----|---|---|-----------------------------|-----|--|--|--|
| 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 | <table border="1"> <thead> <tr> <th>Negative Reference Clamp Enable (01.008)</th> <th>Bipolar Reference Enable (01.010)</th> <th>VM_NEGATIVE_REF_CLAMP1[MIN]</th> <th>VM_NEGATIVE_REF_CLAMP1[MAX]</th> </tr> </thead> <tbody> <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> </tbody> </table> | Negative Reference Clamp Enable (01.008) | Bipolar Reference Enable (01.010) | VM_NEGATIVE_REF_CLAMP1[MIN] | VM_NEGATIVE_REF_CLAMP1[MAX] | 0 | 0 | 0.0 | Pr 01.006 | 0 | 1 | 0.0 | 0.0 | 1 | X | -VM_POSITIVE_REF_CLAMP[MAX] | 0.0 | | | |
| Negative Reference Clamp Enable (01.008) | Bipolar Reference Enable (01.010) | VM_NEGATIVE_REF_CLAMP1[MIN] | VM_NEGATIVE_REF_CLAMP1[MAX] | | | | | | | | | | | | | | | | | |
| 0 | 0 | 0.0 | Pr 01.006 | | | | | | | | | | | | | | | | | |
| 0 | 1 | 0.0 | 0.0 | | | | | | | | | | | | | | | | | |
| 1 | X | -VM_POSITIVE_REF_CLAMP[MAX] | 0.0 | | | | | | | | | | | | | | | | | |

| VM_POSITIVE_REF_CLAMP1 VM_POSITIVE_REF_CLAMP2 | | Limits applied to the positive frequency or speed reference clamp | | | | | | | | | | |
|--|--|--|-----------------|-----------------------------|-----------------|--|-------------------------------|--|--|--|------------------|---------------------|
| 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: 550.0 RFC-A, RFC-S: 0.0 to 50000.0 | | | | | | | | | | | |
| Definition | <p>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.</p> <table border="1"> <thead> <tr> <th>Feedback device</th> <th>VM_POSITIVE_REF_CLAMP1[MAX]</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>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.</p> | | Feedback device | VM_POSITIVE_REF_CLAMP1[MAX] | AB, AB Servo | (500 kHz x 60 / rotary lines per revolution) rpm (500 kHz / linear line pitch in mm) mm/s | FD, FR, FD Servo, FR Servo | (500 kHz x 60 / rotary lines per revolution)/2 rpm (500 kHz / linear line pitch in mm)/2 mm/s | SC, SC Hiper, SC EnDat, SC SSI, SC Servo | (500 kHz x 60 / sine waves per revolution) rpm (500 kHz x linear line pitch in mm) mm/s | Any other device | 50000.0 rpm or mm/s |
| | Feedback device | VM_POSITIVE_REF_CLAMP1[MAX] | | | | | | | | | | |
| | AB, AB Servo | (500 kHz x 60 / rotary lines per revolution) rpm (500 kHz / linear line pitch in mm) mm/s | | | | | | | | | | |
| | FD, FR, FD Servo, FR Servo | (500 kHz x 60 / rotary lines per revolution)/2 rpm (500 kHz / linear line pitch in mm)/2 mm/s | | | | | | | | | | |
| | SC, SC Hiper, SC EnDat, SC SSI, SC Servo | (500 kHz x 60 / sine waves per revolution) rpm (500 kHz x linear line pitch in mm) mm/s | | | | | | | | | | |
| | Any other device | 50000.0 rpm or mm/s | | | | | | | | | | |

| 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 | <p>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.</p> <p>$VM_POWER[MAX] = \sqrt{3} \times VM_AC_VOLTAGE[MAX] \times VM_DRIVE_CURRENT[MAX] / 1000$</p> <p>$VM_POWER[MIN] = -VM_POWER[MAX]$</p> | |

| 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 | <p>VM_RATED_CURRENT [MAX] = <i>Maximum Rated Current</i> (11.060) and is dependent on the drive rating. This is the Normal Duty rating of the drive.</p> <p>VM_RATED_CURRENT [MIN] = 0.00</p> | |

| 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 | <p>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.</p> <p>$VM_SPEED[MAX] = 2 \times VM_SPEED_FREQ_REF[MAX]$</p> <p>$VM_SPEED[MIN] = 2 \times VM_SPEED_FREQ_REF[MIN]$</p> | |

| VM_SPEED_FREQ_KEYPAD_REF | | Range applied Keypad Control Mode Reference (01.017) | |
|---------------------------------|---|--|--|
| Units | Open-loop: Hz RFC-A, RFC-S: rpm or mm/s | | |
| Range of [MIN] | Open-loop: -550.0 to 550.0 RFC-A, RFC-S: -50000.0 to 50000.0 | | |
| Range of [MAX] | Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0 | | |
| Definition | <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> | | |
| | Negative Reference Clamp Enable (01.008) | Bipolar Reference Enable (01.010) | VM_SPEED_FREQ_USER_REFS[MIN] |
| | 0 | 0 | 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) |
| | 0 | 1 | $-VM_SPEED_FREQ_REF[MAX]$ |
| | 1 | 0 | 0.0 |
| 1 | 1 | $-VM_SPEED_FREQ_REF[MAX]$ | |

| 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. | | |
| | 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[MIN] = -VM_SPEED_FREQ_REF[MAX]. | | | |

| 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 | <p>VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX]</p> <p>VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 11-4</p> | |

| | | |
|-------------------------------|---|---|
| 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 | <p>VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent</p> <p>VM_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes</p> | |

| VM_TORQUE_CURRENT | | Range applied to torque and torque producing current parameters | | | | | | |
|------------------------------------|---|---|------------------------------------|-------------------------|---|------------------------------|---|------------------------------|
| Units | % | | | | | | | |
| Range of [MIN] | -1000.0 to 0.0 | | | | | | | |
| Range of [MAX] | 0.0 to 1000.0 | | | | | | | |
| Definition | <table border="1"> <thead> <tr> <th>Select Motor 2 Parameters (11.045)</th> <th>VM_TORQUE_CURRENT [MAX]</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>VM_MOTOR1_CURRENT_LIMIT[MAX]</td> </tr> <tr> <td>1</td> <td>VM_MOTOR2_CURRENT_LIMIT[MAX]</td> </tr> </tbody> </table> <p>VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]</p> | | Select Motor 2 Parameters (11.045) | VM_TORQUE_CURRENT [MAX] | 0 | VM_MOTOR1_CURRENT_LIMIT[MAX] | 1 | VM_MOTOR2_CURRENT_LIMIT[MAX] |
| 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_UNIPOLAR | | Unipolar version of VM_TORQUE_CURRENT |
| Units | % | |
| Range of [MIN] | 0.0 | |
| Range of [MAX] | 0.0 to 1000.0 | |
| Definition | <p>VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX]</p> <p>VM_TORQUE_CURRENT_UNIPOLAR[MIN] = 0.0</p> <p><i>User Current Maximum Scaling (04.024)</i> defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to <i>Percentage Load (04.020)</i>, <i>Torque Reference (04.008)</i> and <i>Torque Offset (04.009)</i>. 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.</p> <p>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.</p> | |

| 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 | <p>VM_USER_CURRENT[MAX] = <i>User Current Maximum Scaling</i> (04.024)</p> <p>VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX]</p> <p><i>User Current Maximum Scaling</i> (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to <i>Percentage Load</i> (04.020), <i>Torque Reference</i> (04.008) and <i>Torque Offset</i> (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.</p> <p>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.</p> | |

| 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 | <p>VM_USER_CURRENT_HIGH_RES[MAX] = <i>User Current Maximum Scaling</i> (04.024) with an additional decimal place</p> <p>VM_USER_CURRENT_HIGH_RES[MIN] = -VM_USER_CURRENT_HIGH_RES[MAX]</p> <p><i>User Current Maximum Scaling</i> (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to <i>Percentage Load</i> (04.020), <i>Torque Reference</i> (04.008) and <i>Torque Offset</i> (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.</p> <p>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.</p> | |

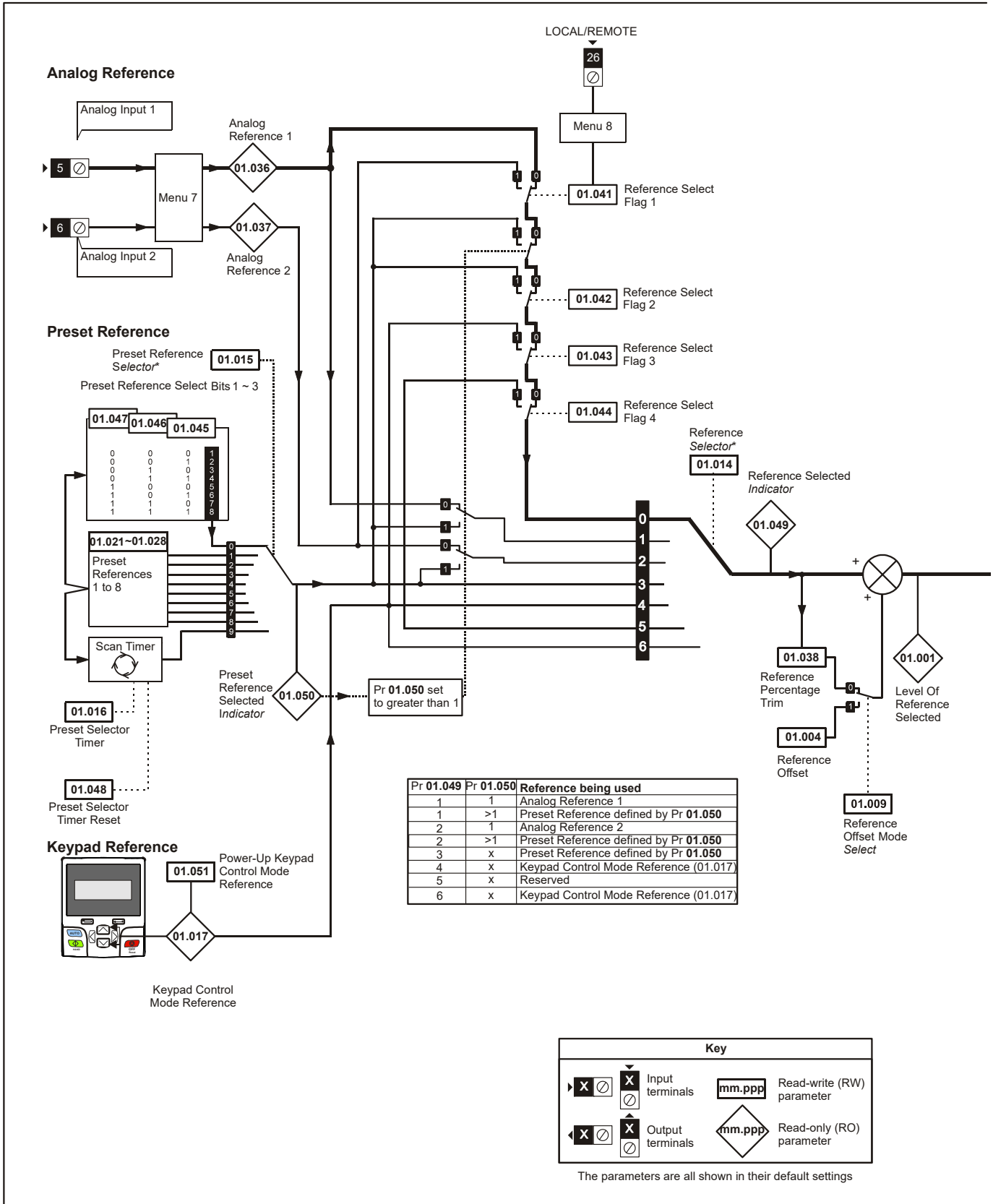
Table 11-4 Voltage ratings dependant values

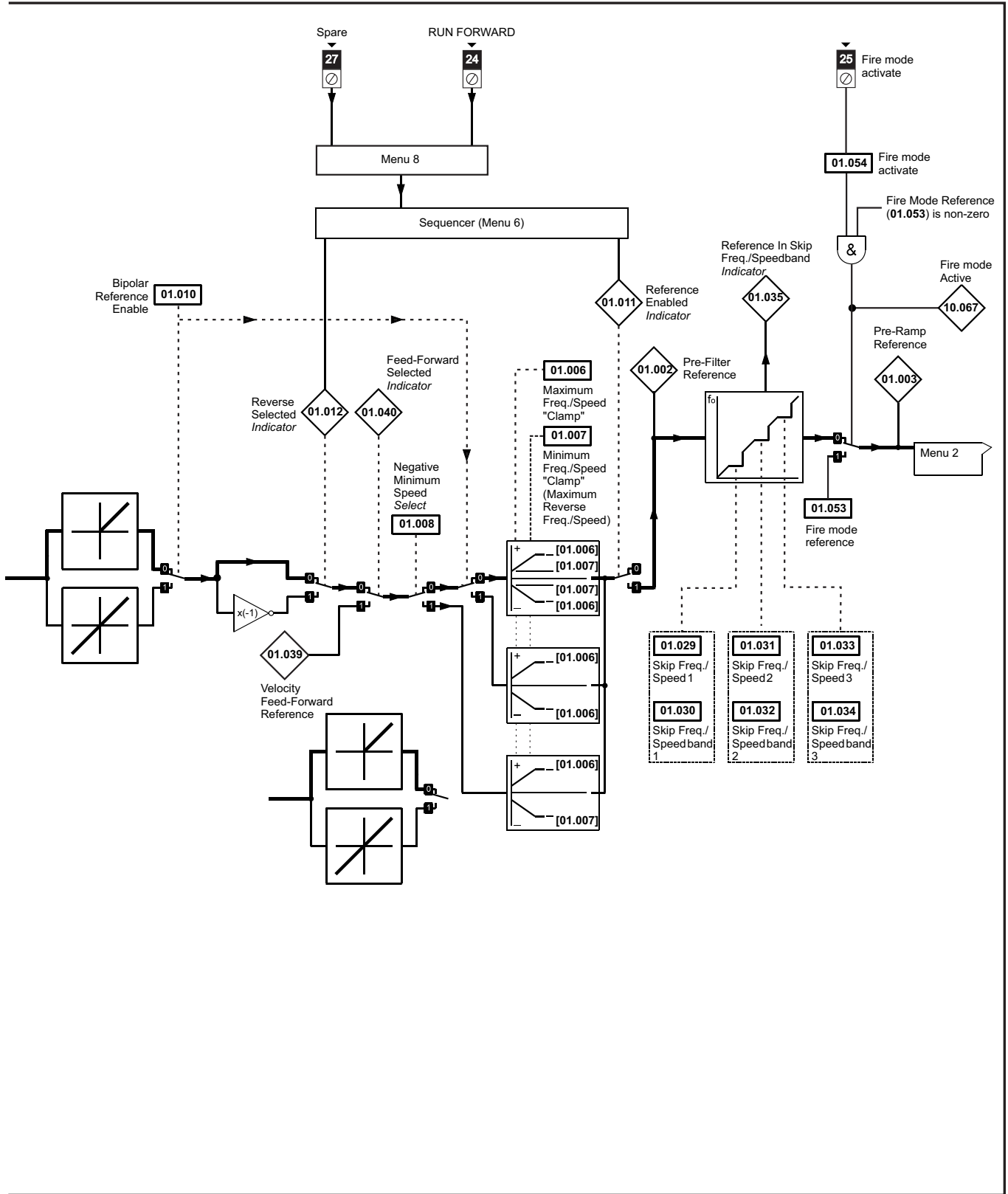
| Variable min/max | Voltage level (V) | | | |
|---------------------------|-------------------|-------|-------|-------|
| | 200 V | 400 V | 575 V | 690 V |
| VM_DC_VOLTAGE_SET[MAX] | 400 | 800 | 955 | 1150 |
| VM_DC_VOLTAGE[MAX] | 415 | 830 | 990 | 1190 |
| VM_AC_VOLTAGE_SET[MAX] | 265 | 530 | 635 | 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|

11.2 Menu 1: Frequency / speed reference

Figure 11-1 Menu 1 logic diagram





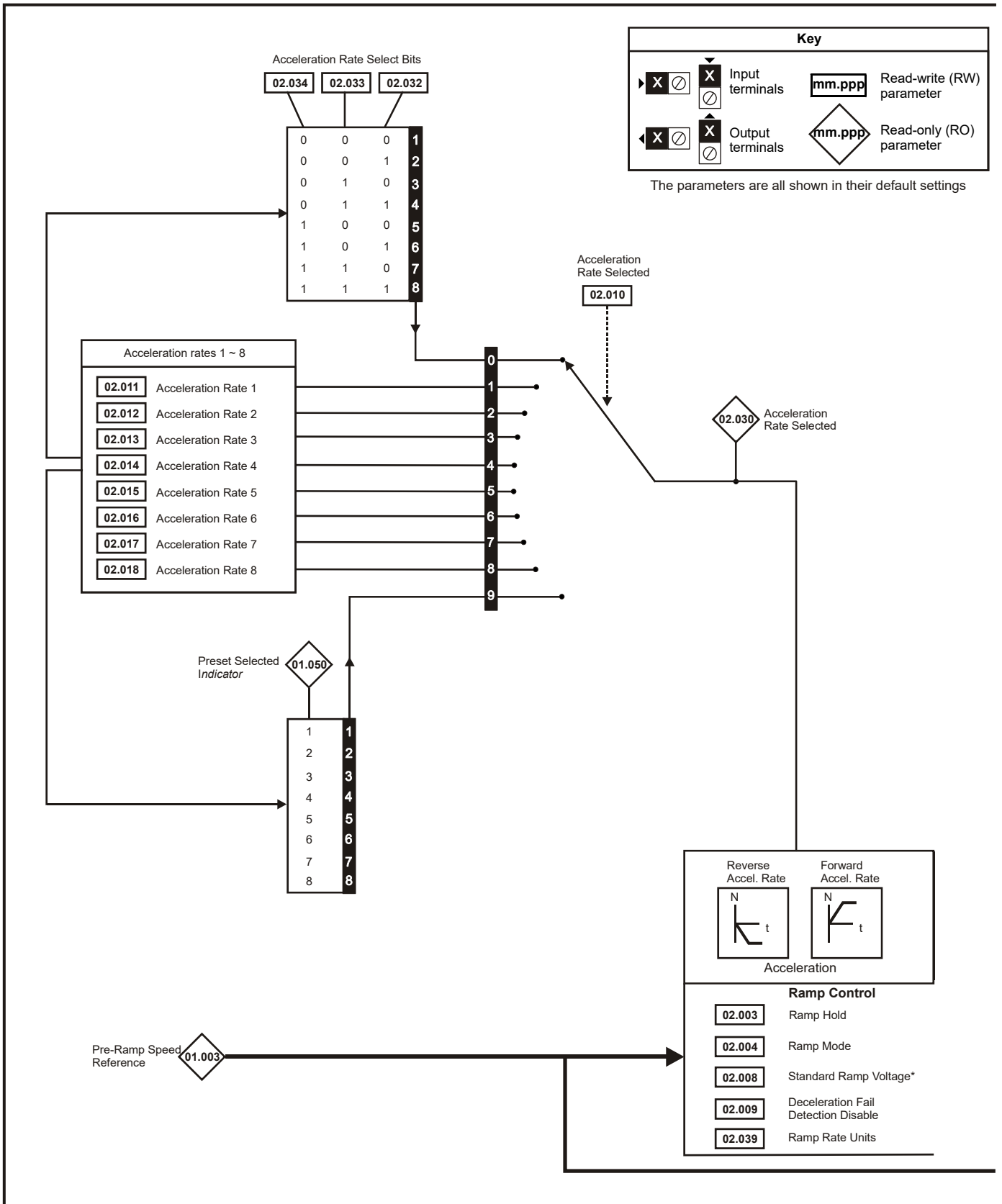
| Parameter | Range(↕) | | Default(⇔) | | | Type | | | | | | | | | | |
|-----------|--|--|------------------------------|--------------------------|------------------------------|--------|--|--|--|----|-----|-----|----|----|----|----|
| | OL | RFC-A / S | OL | RFC-A | RFC-S | | | | | | | | | | | |
| 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 Band 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 | | |

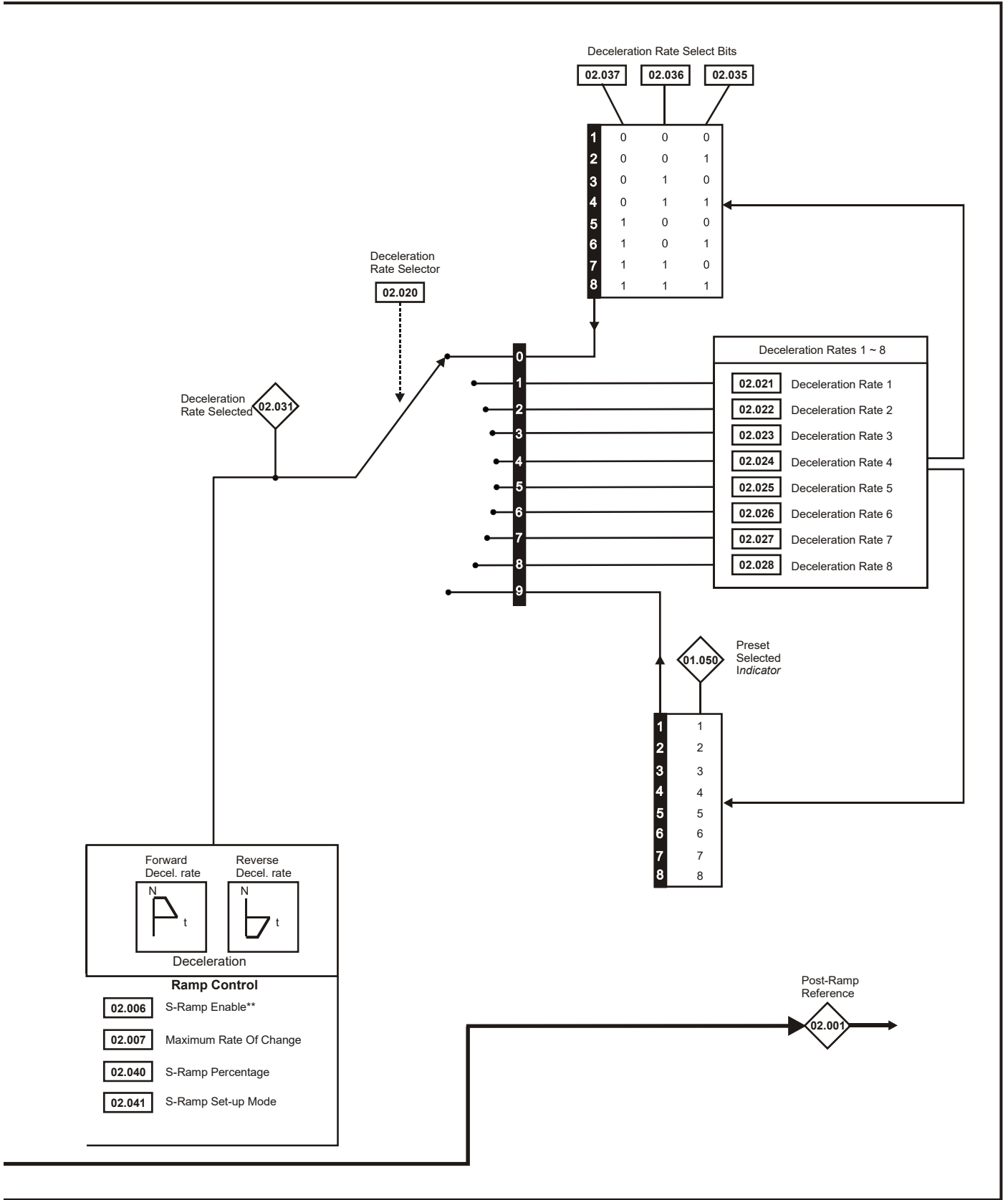
| | | | | | | | | | | | | | |
|----|------------------|----|------------|-----|---------------------|-----|------------------|-----|-------------|-----|------------------|----|-------------|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|

11.3 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram





| 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

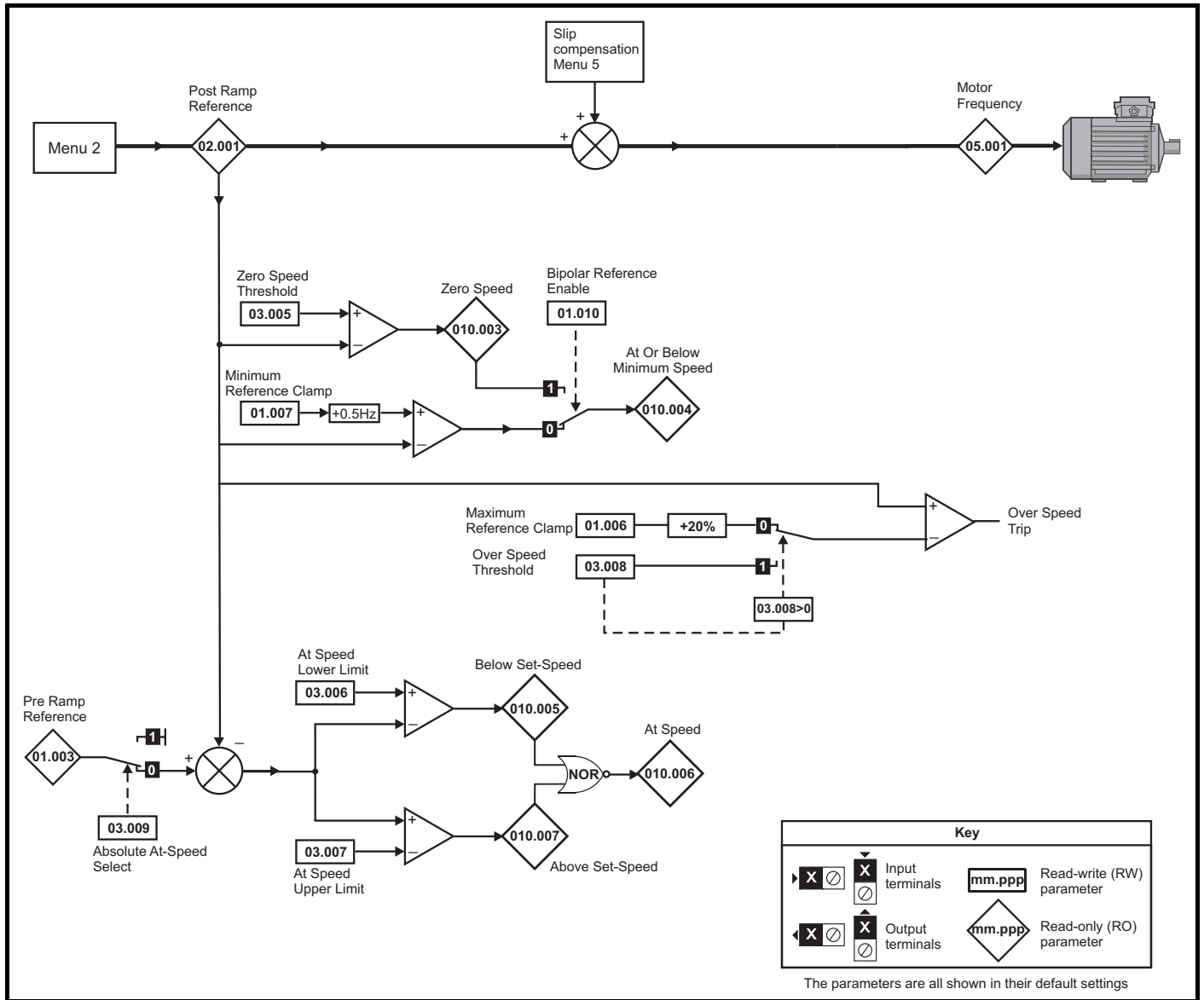
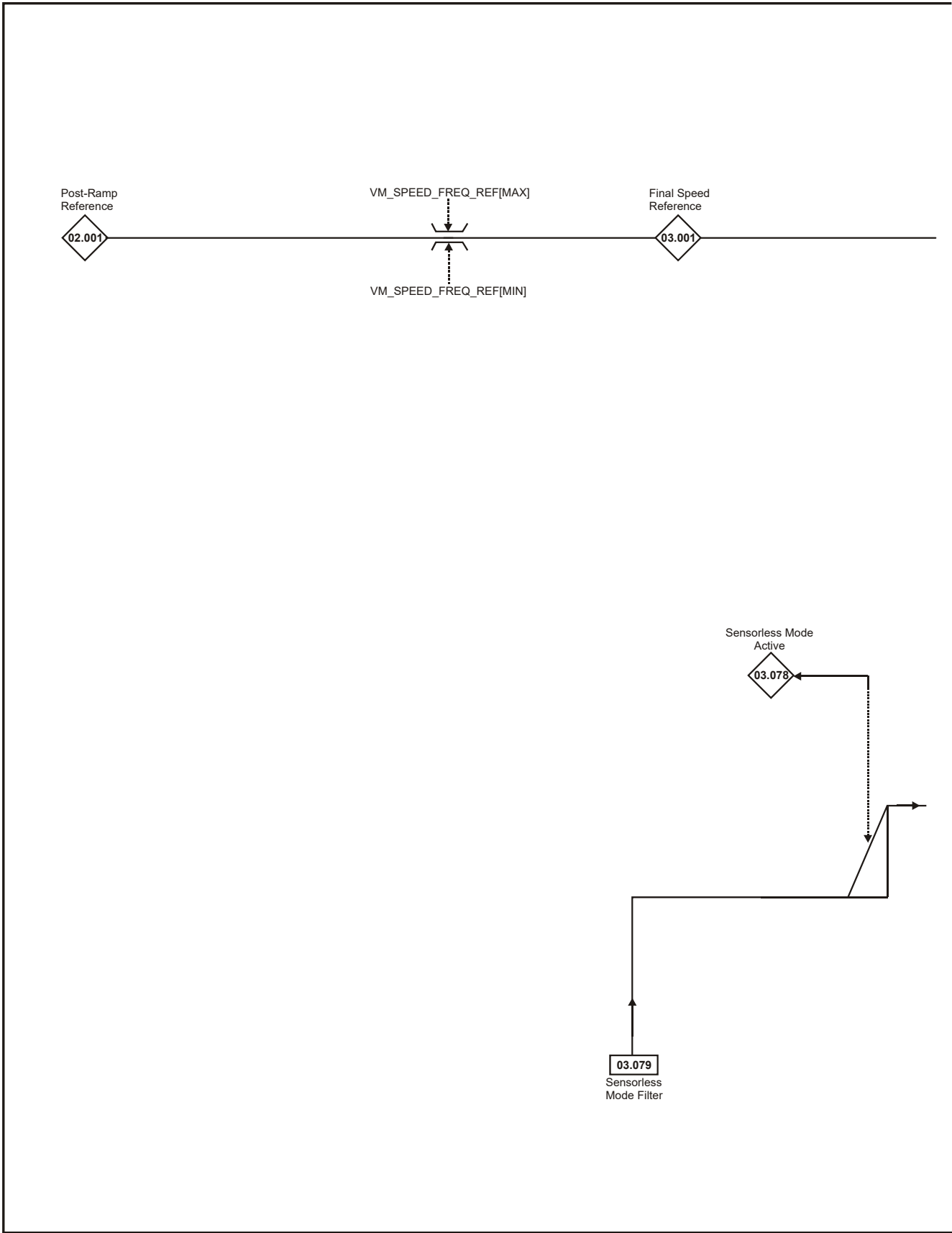
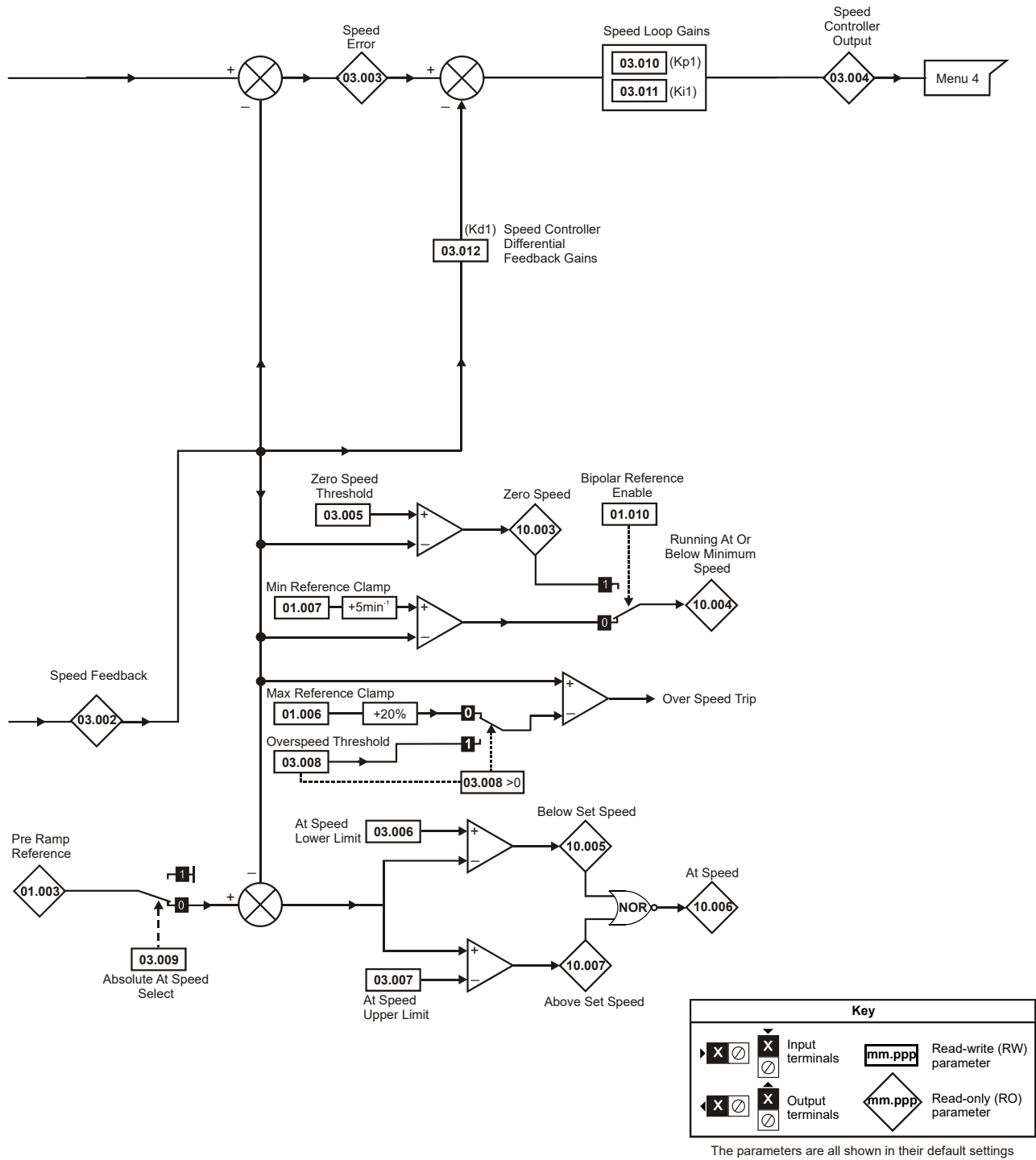


Figure 11-4 Menu 3 RFC-A, RFC-S logic diagram



NOTE

* Automatic change over if the relevant 'bit' of *Position Feedback Initialized* (03.076) is 0.



| 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

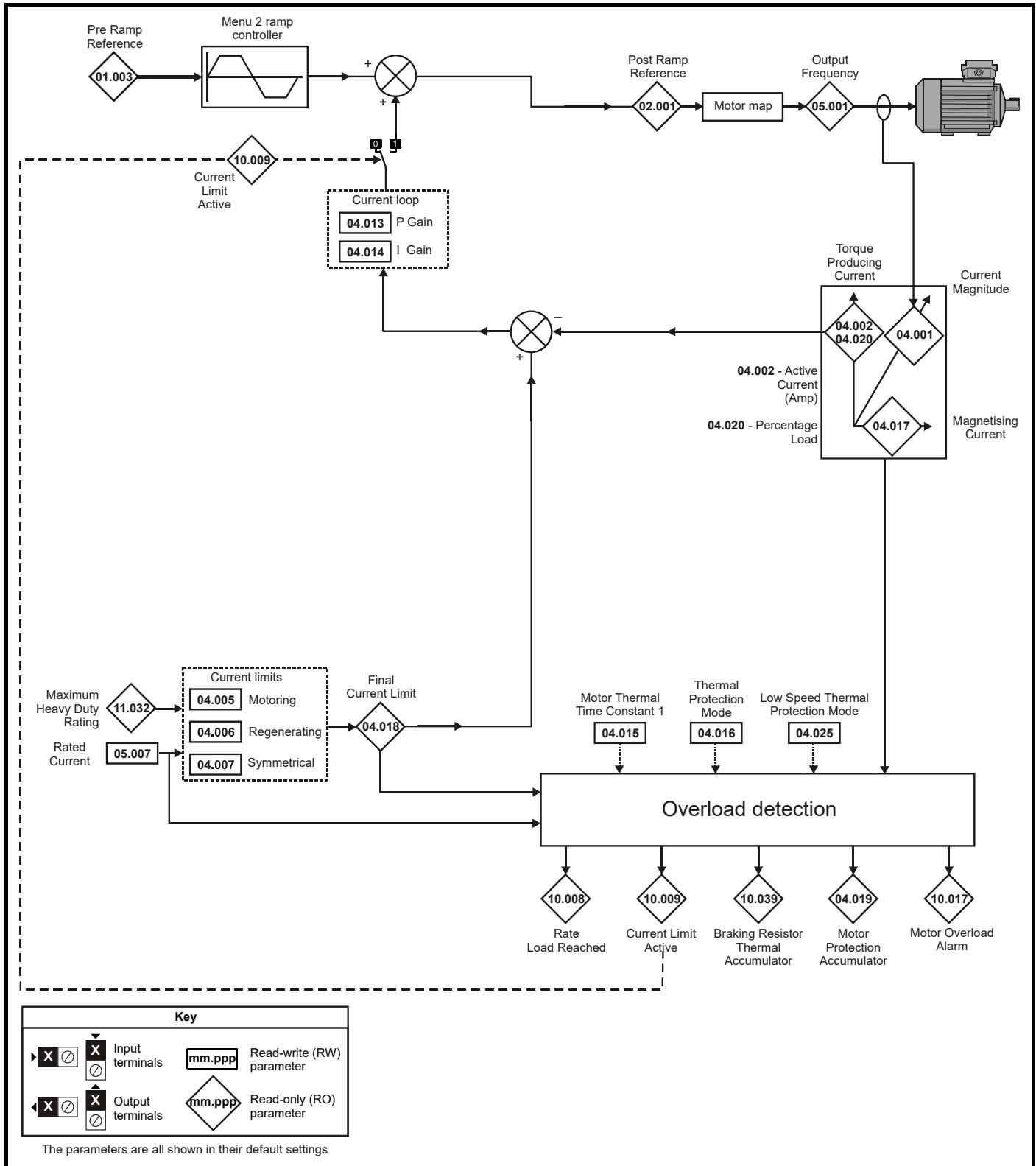


Figure 11-6 Menu 4 RFC-A logic diagram

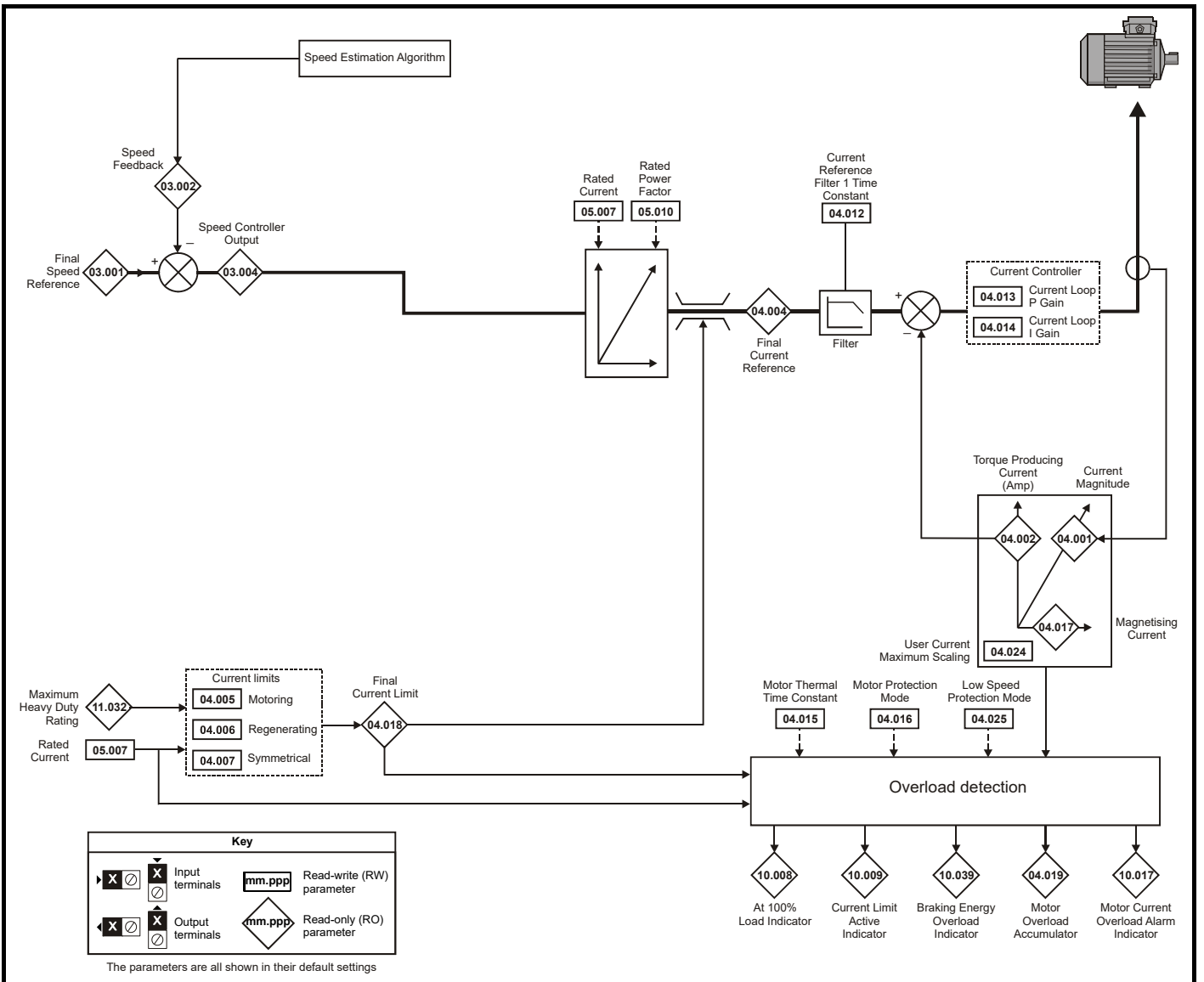
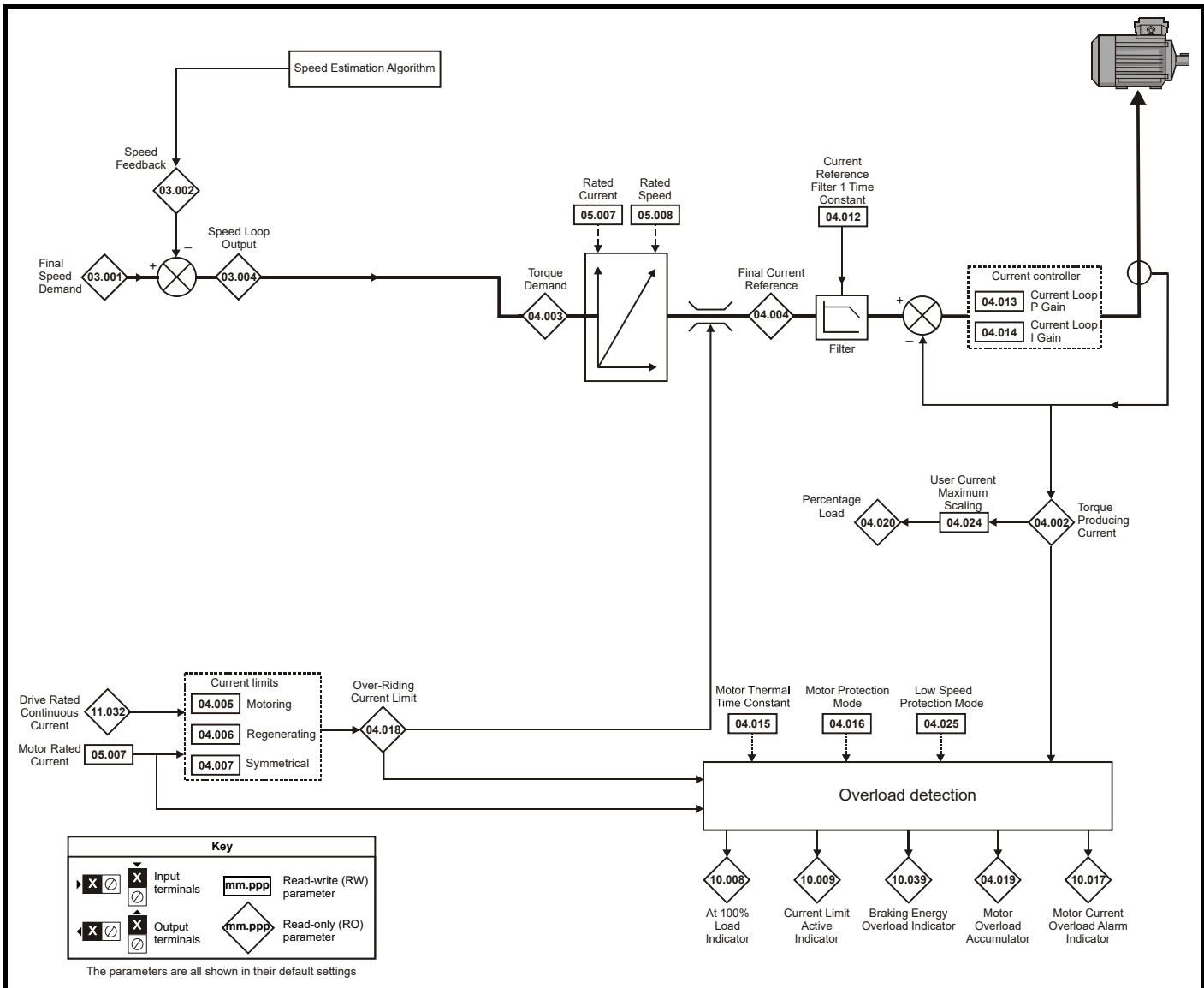


Figure 11-7 Menu 4 RFC-S logic diagram



| 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 to 100% | | 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

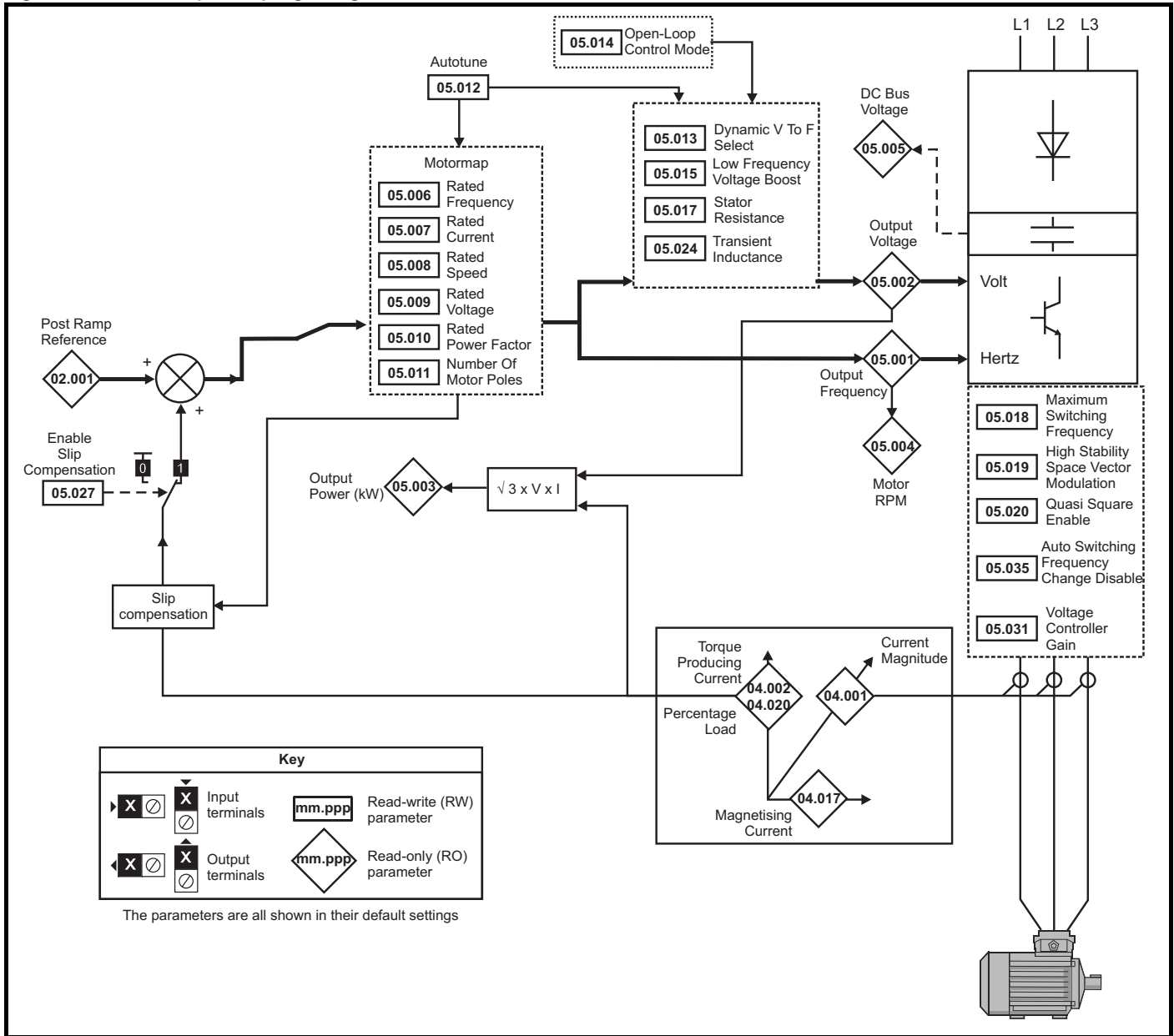
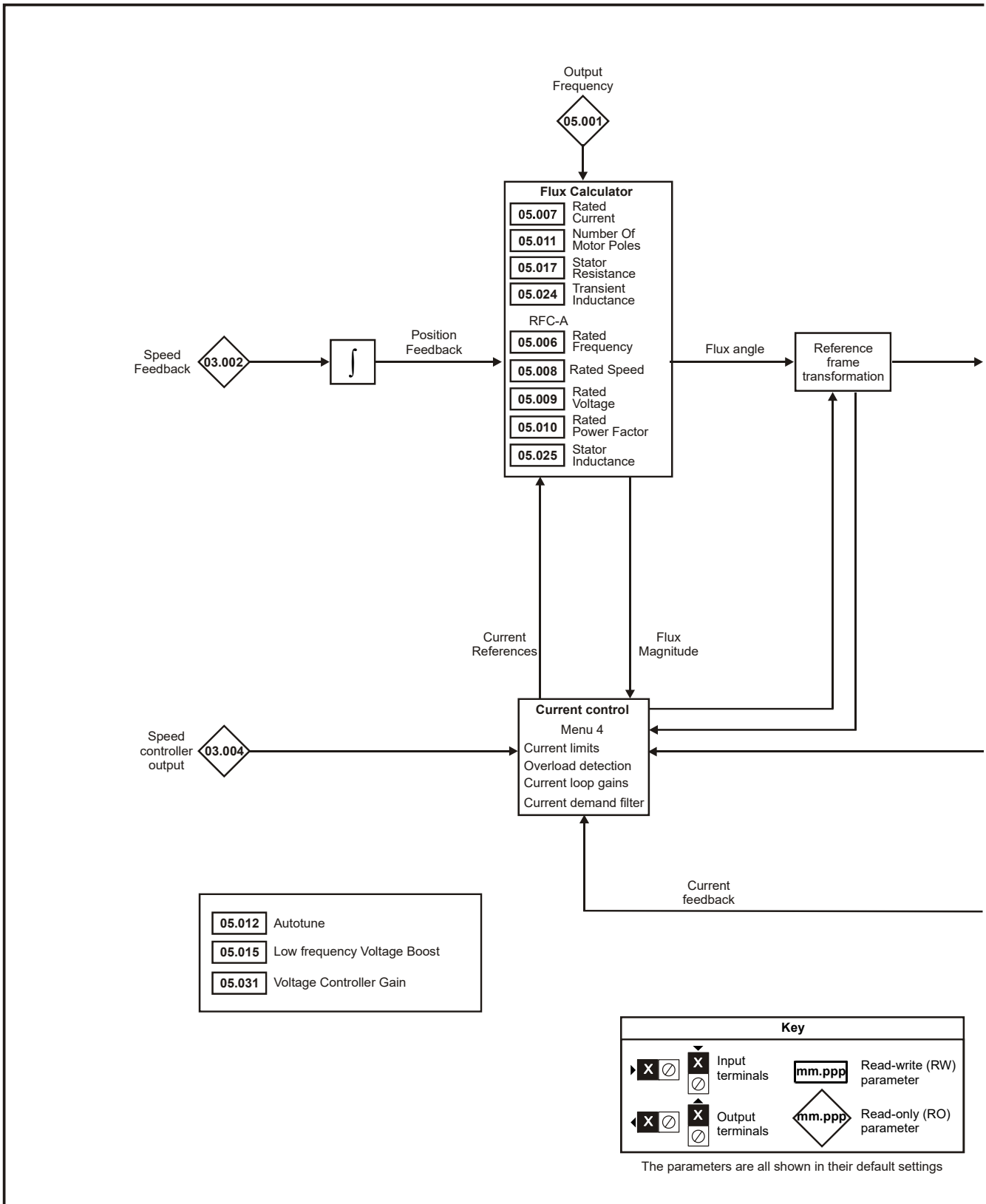
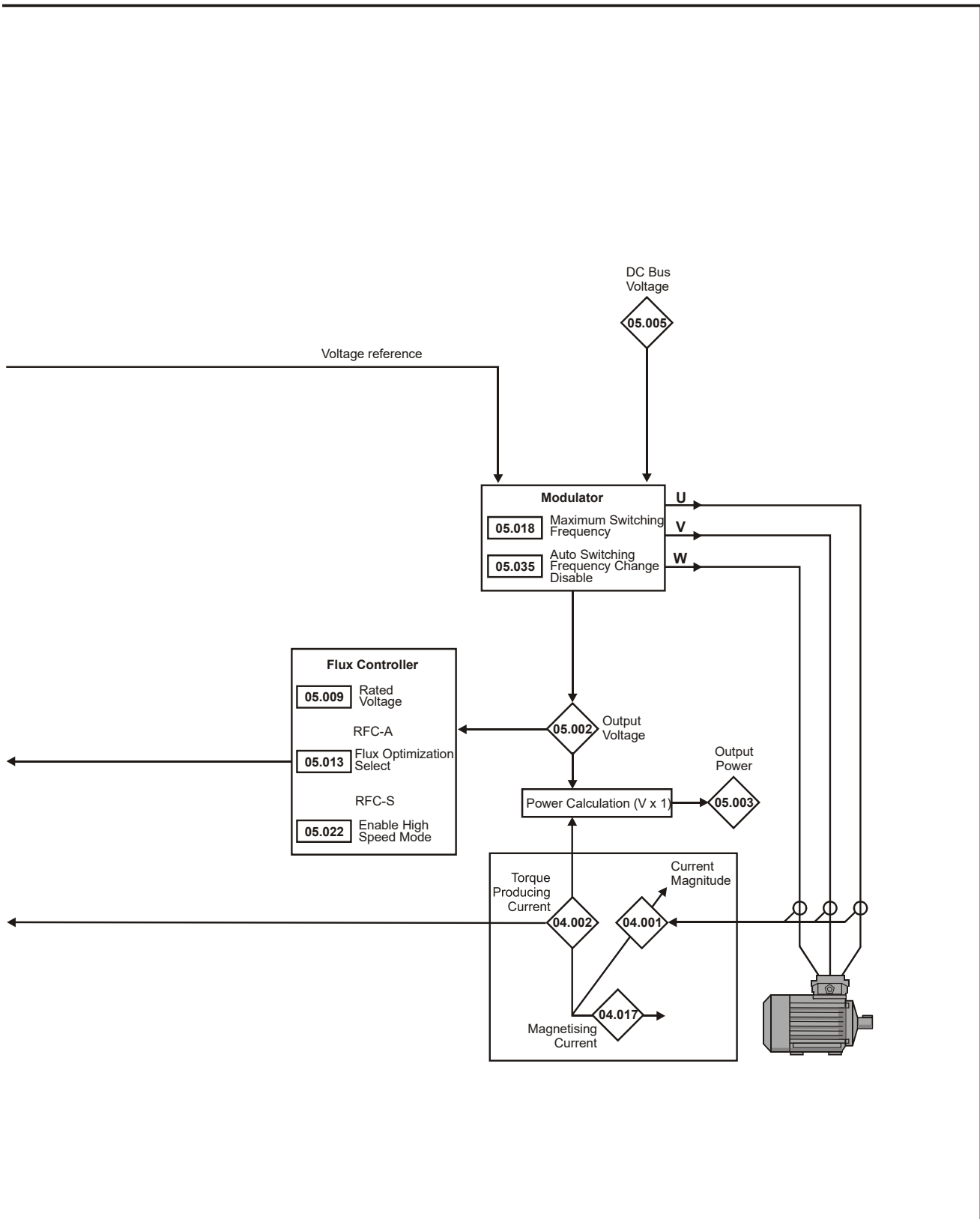


Figure 11-9 Menu 5 RFC-A, RFC-S logic diagram





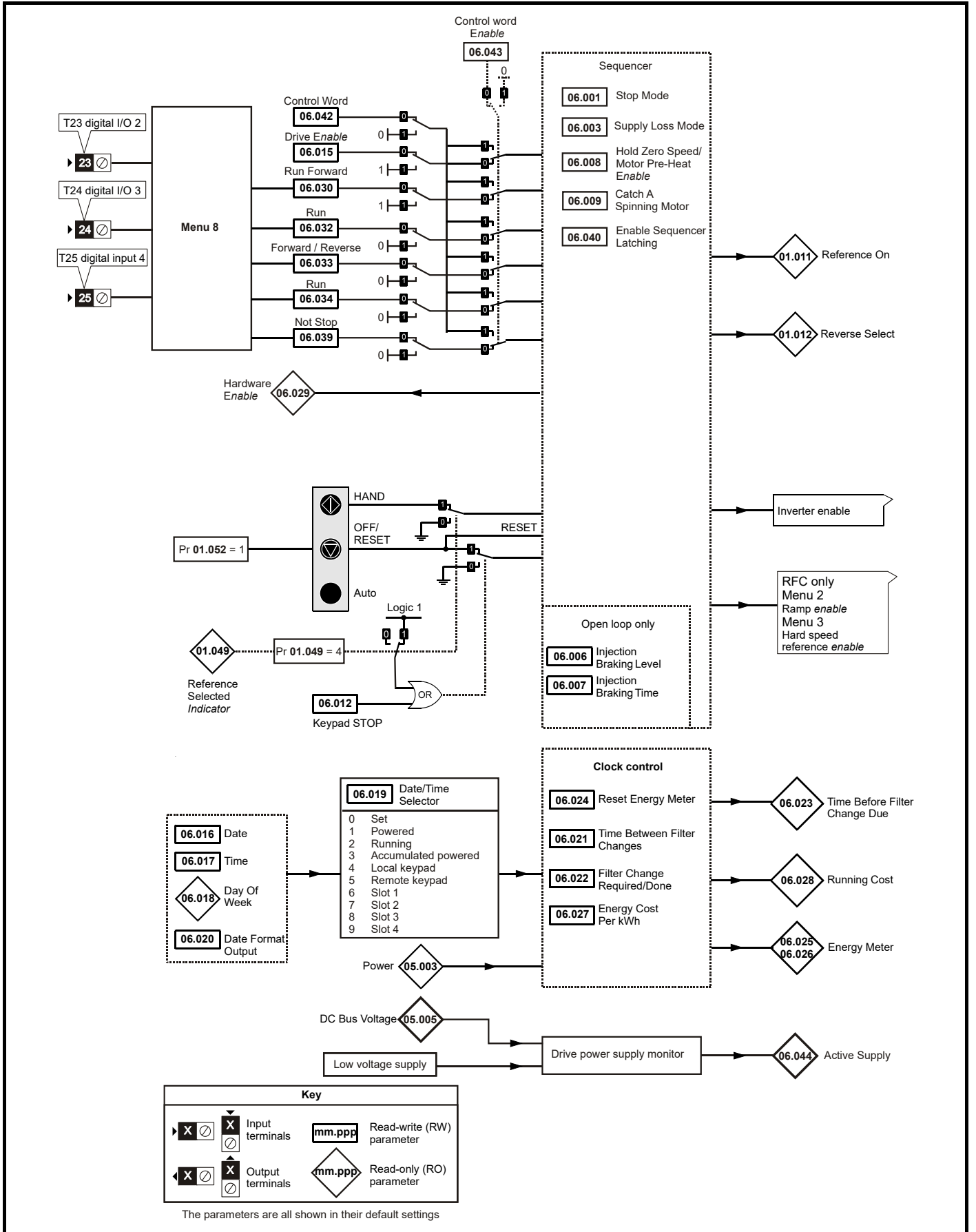
| Parameter | | Range(⊕) | | | Default(⇔) | | | Type | | | | | |
|-----------|---|--|----------------------|---|--|--|-------------|-------------|-----|-----|----|----|----|
| | | OL | RFC-A | RFC-S | OL | RFC-A | RFC-S | | | | | | |
| 05.001 | Output Frequency | VM_SPEED_FREQ_REF Hz | ±2000.0 Hz | | | | | 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



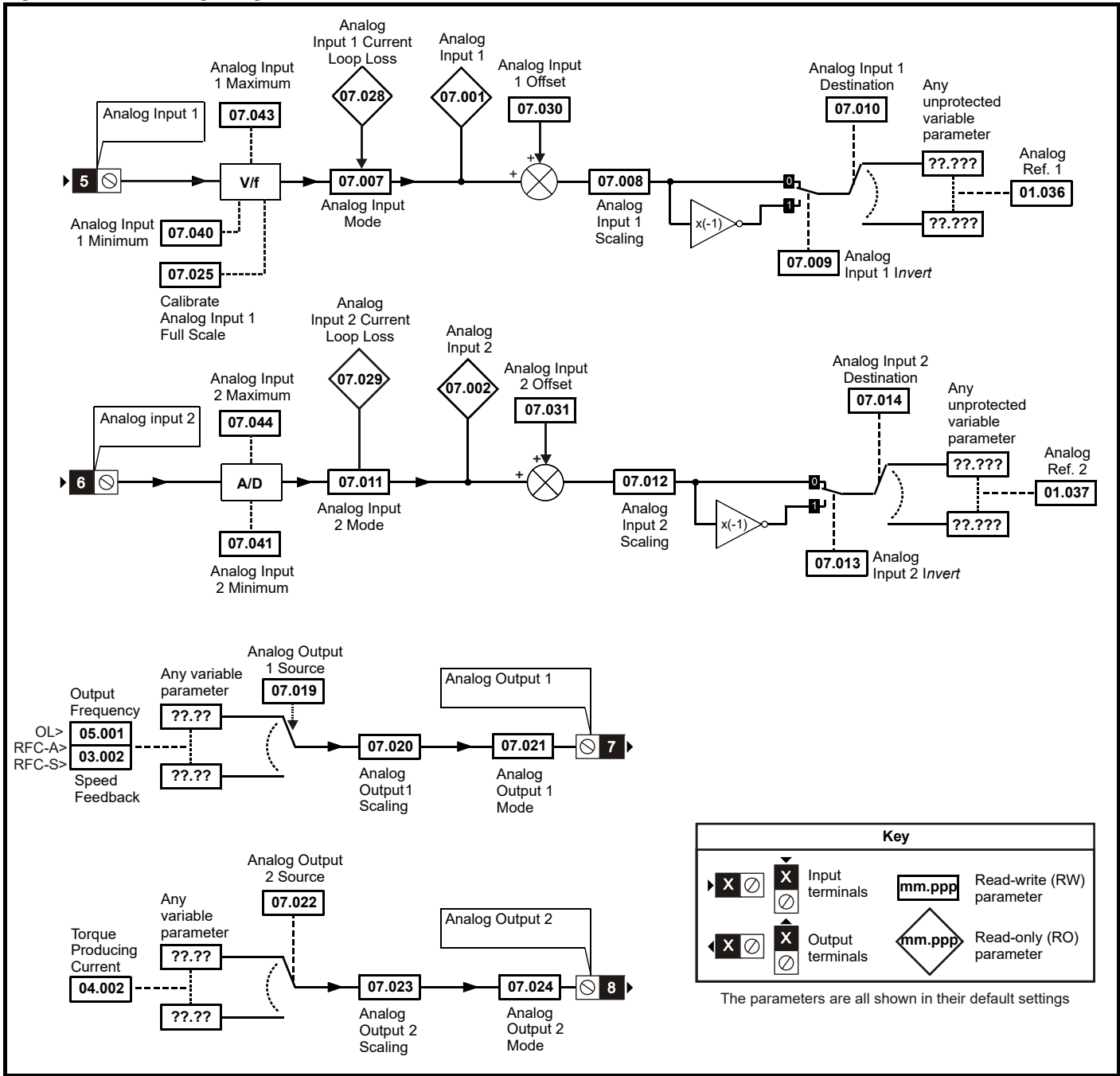
| Parameter | | Range(Φ) | | Default(⇒) | | | Type | | | | | | | |
|-----------|--------------------------------------|---|-----------|---|-------|--|------|--|----|------|----|----|----|----|
| | | OL | RFC-A / S | OL | RFC-A | RFC-S | | | | | | | | |
| 06.001 | Stop Mode | Coast (0), Ramp (1), Ramp 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 | 00000000000000 to 11111111111111 | | | | 00000000000000 | | | 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 | Fl | 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



| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|

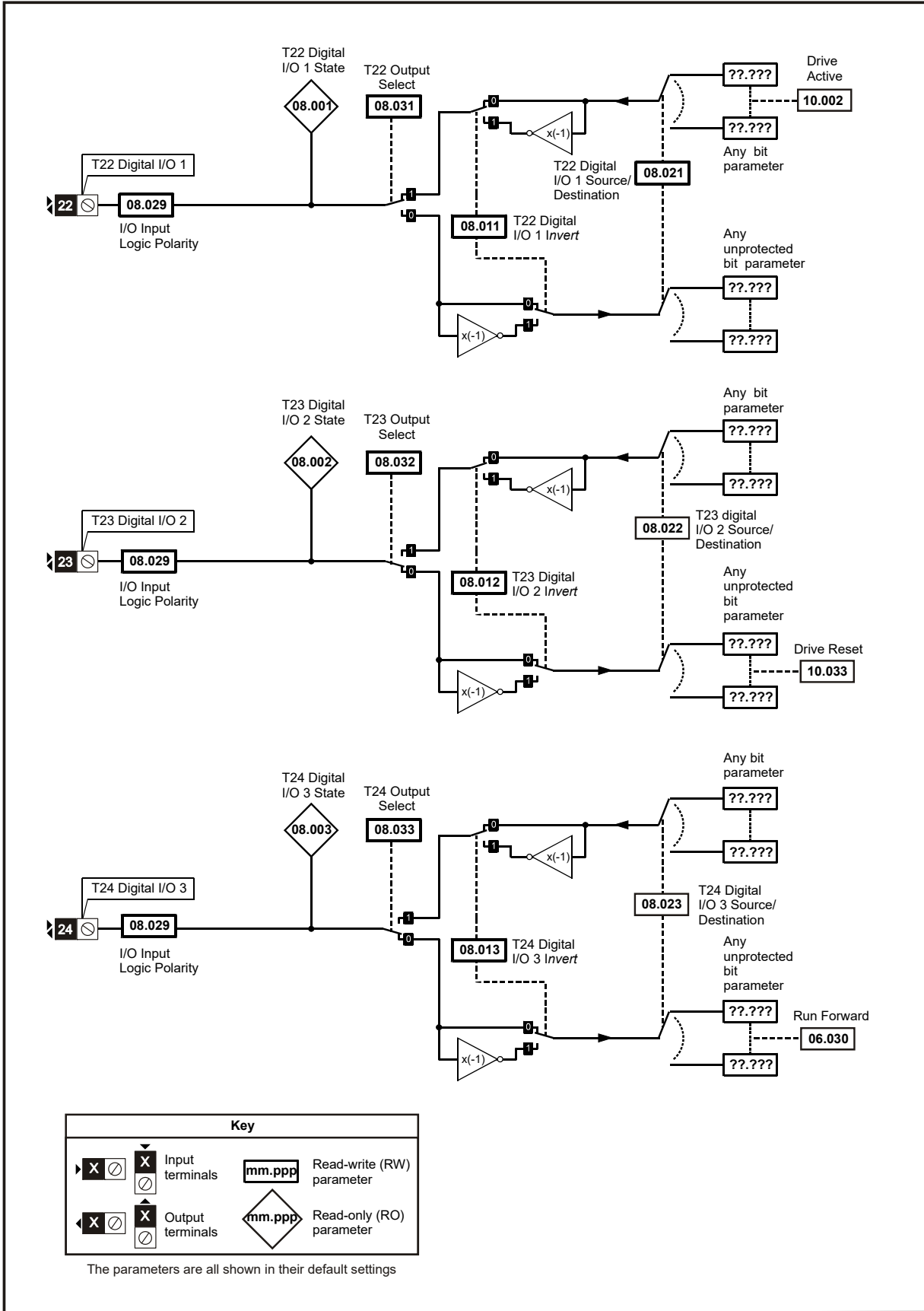
| Parameter | Range(±) | | Default(⇒) | | | Type | | | | | |
|-----------|---|--|------------|--------------|-------|------|-----|----|----|----|----|
| | OL | RFC-A / S | OL | RFC-A | RFC-S | RO | Num | ND | NC | PT | FI |
| 07.001 | Analog Input 1 | ±100.00 % | | | | RO | Num | ND | NC | PT | FI |
| 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|

11.9 Menu 8: Digital I/O

Figure 11-12 Menu 8 logic diagram



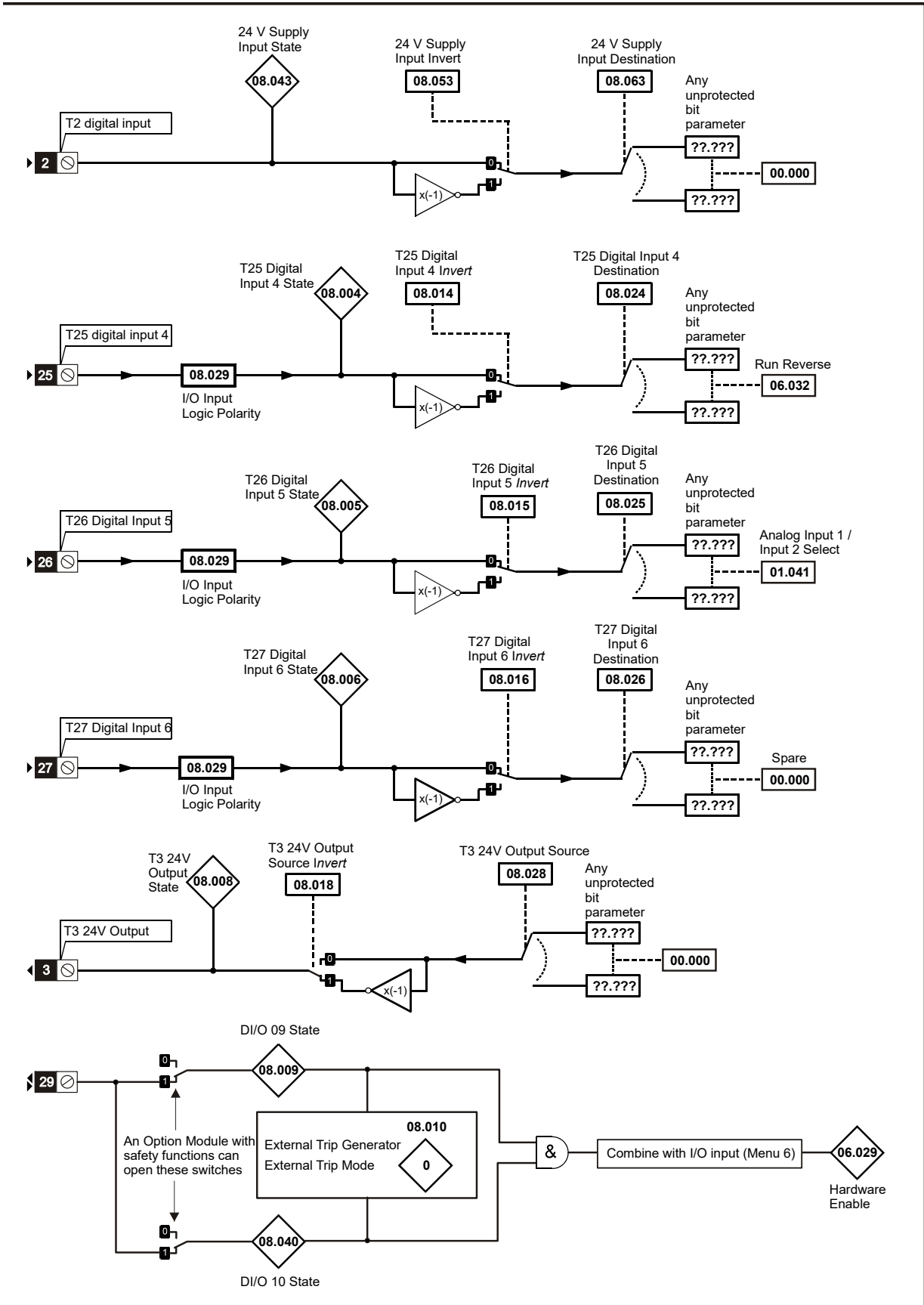


Figure 11-13 Menu 8 logic (cont)

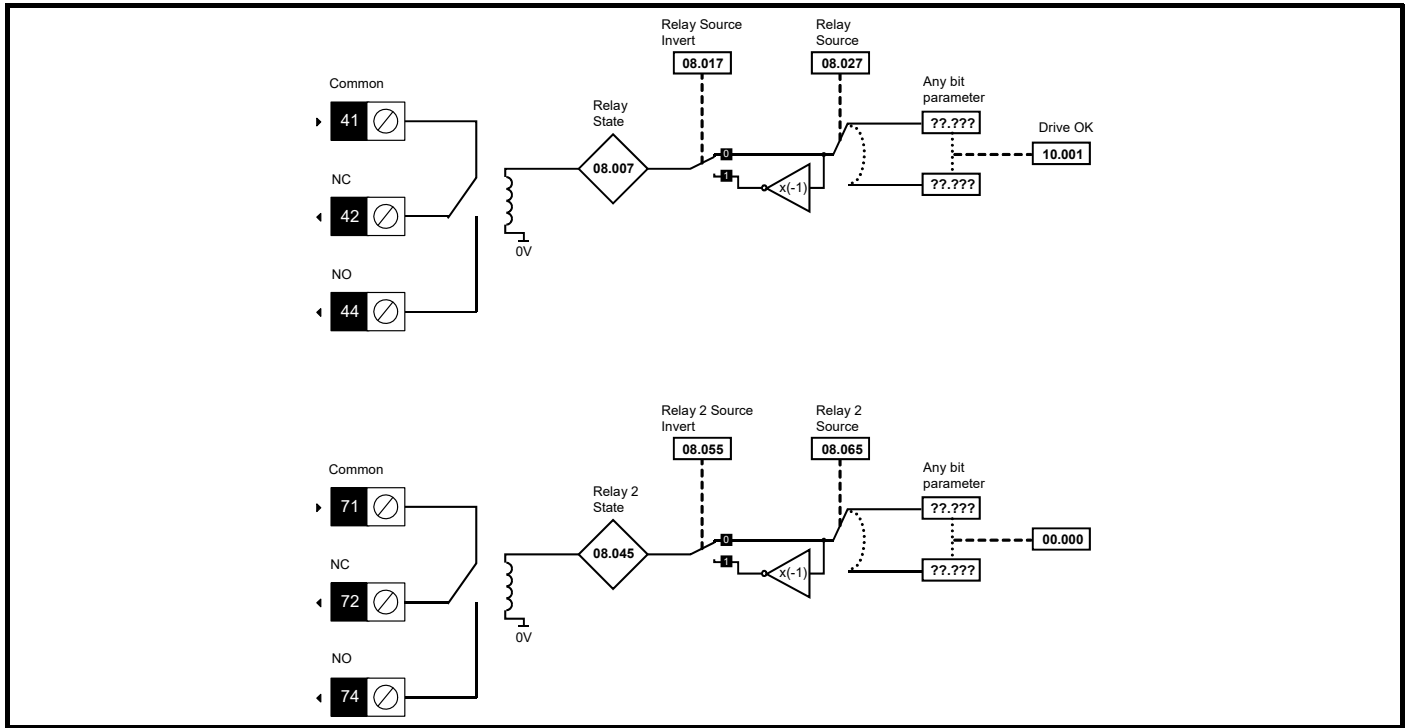
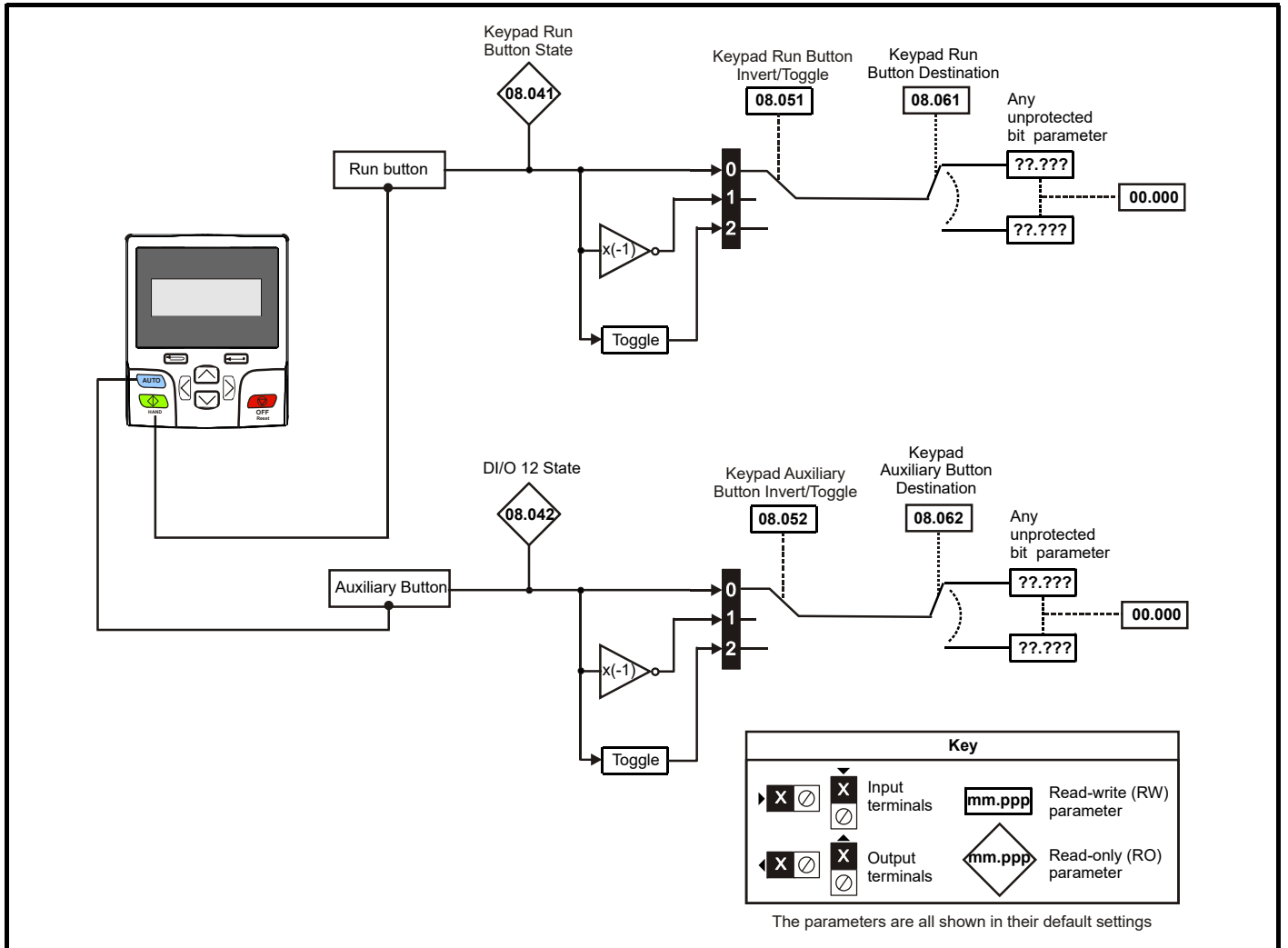


Figure 11-14 Menu 8 logic (cont)



| 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) | | | | RW | Bit | | | | | US |
| 08.033 | Digital I/O 03 Output Select | Off (0) or On (1) | | | Off (0) | 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

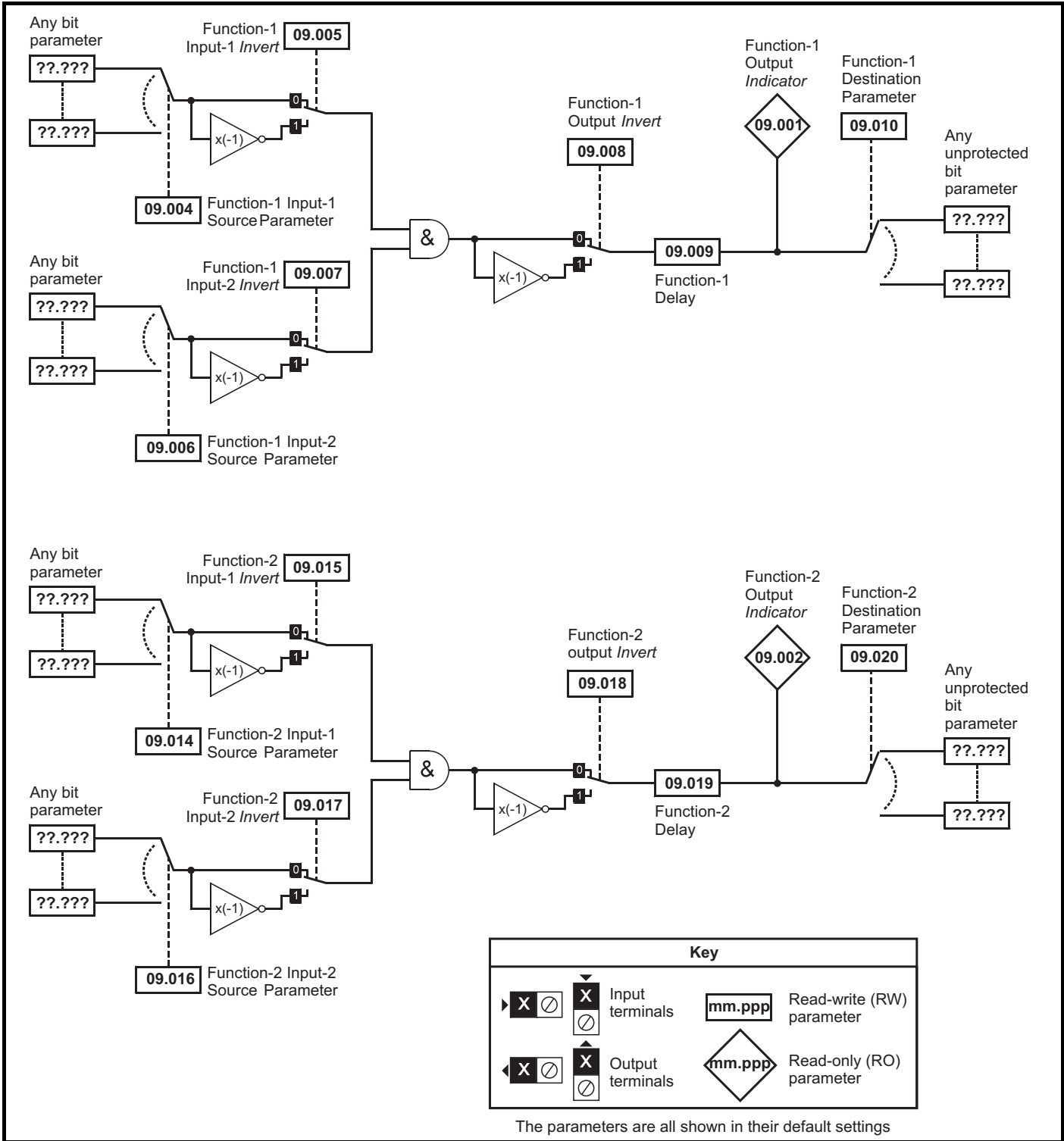


Figure 11-16 Menu 9 logic diagram: Motorized pot and binary sum

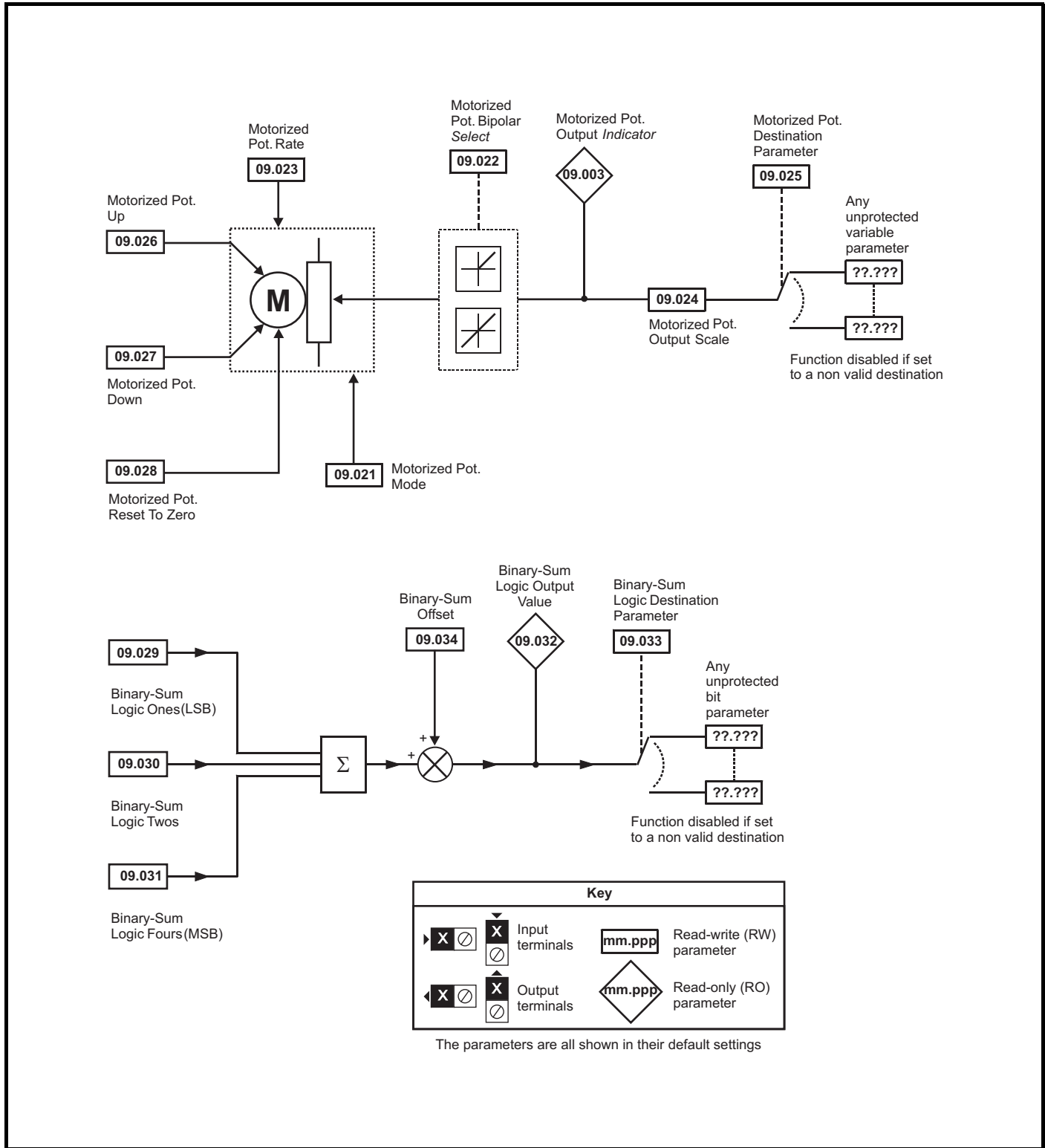


Figure 11-17 Menu 9 logic diagram: Timers

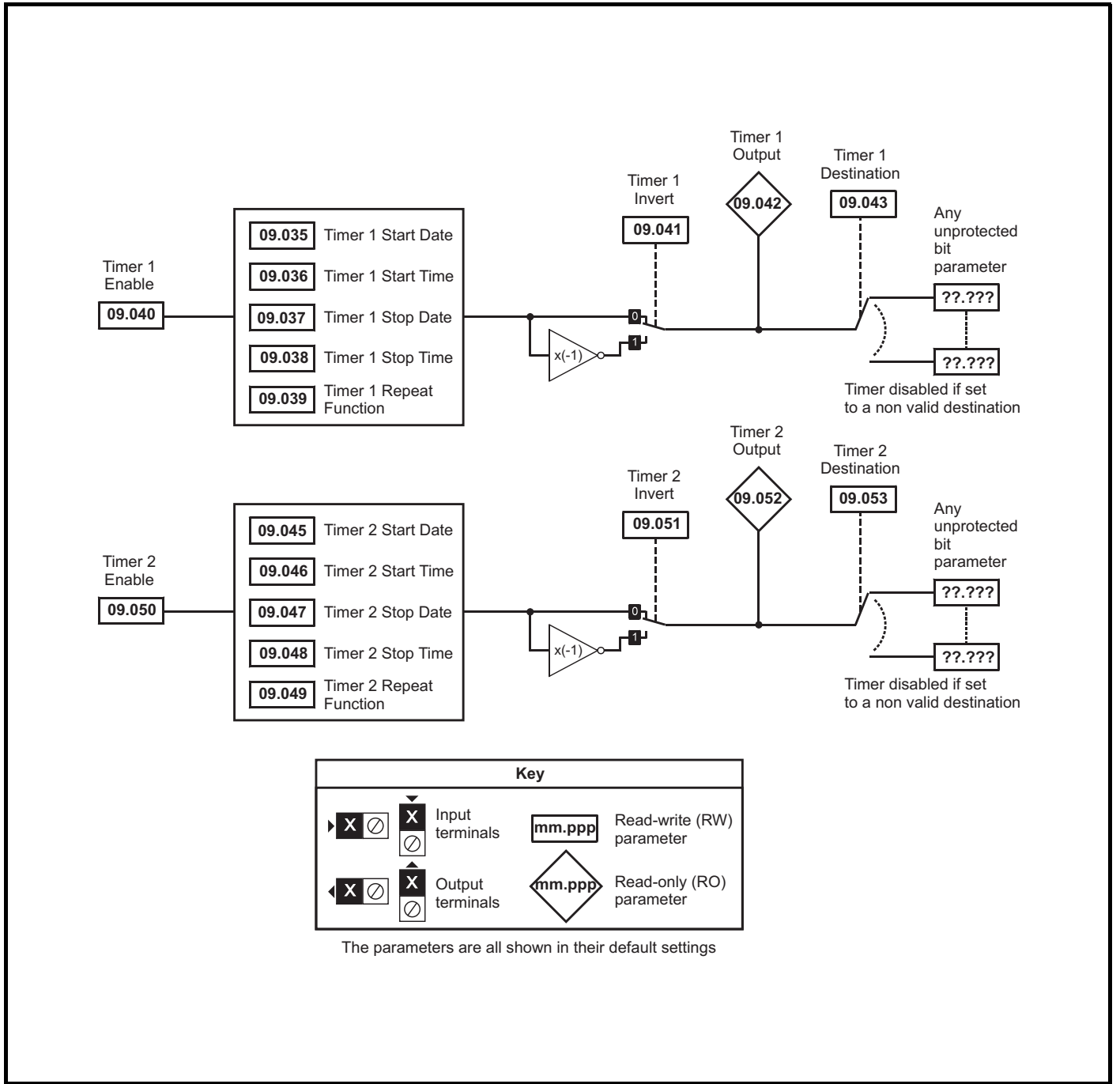
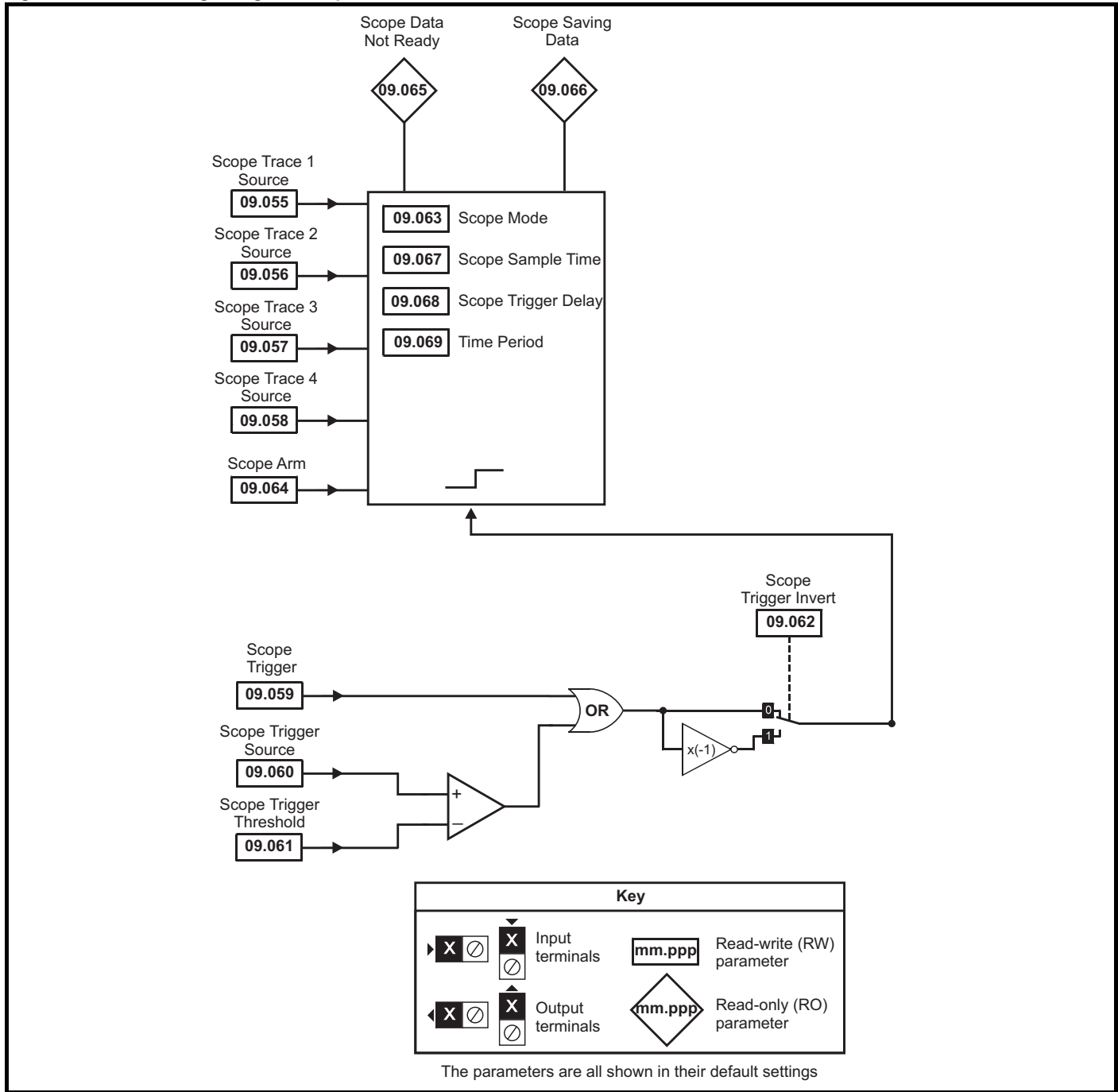


Figure 11-18 Menu 9 logic diagram: Scope function



| 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 | | |
| 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 Healthy | 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 Healthy | 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 | 0000000000000000 to 1111111111111111 | | | | 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|

| 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 | | See Table 11-5 | | | 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) | | | | | Off (0) | | | 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 Healthy On Under Voltage | Off (0) or On (1) | | Off (0) | | | RW | Bit | | | | US | | | |
| 10.069 | Additional Status Bits | 0000000000 to 1111111111 | | Off (0) | | | 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 | Fl | 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) | | | | RW | Txt | | NC | | US | |
| 11.043 | Load Defaults | None (0), Standard (1), US (2) | None (0) | | | 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 | RW | Num | ND | NC | PT | US | | |
| 11.077 | NV Media Card File Required Version | | 0 to 9999 | | | | | | | | | | |
| 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) | | | | | | | | | | |
| 11.085 | Security Status | | None (0), Read-only (1), Status-only (2), No Access (3) | | | | | | | | | | |
| 11.086 | Menu Access Status | | Menu 0 (0) or All Menus (1) | | | | | | | | | | |
| 11.090 | Keypad Port Serial Address | | 1 to16 | | | | | | | | | | |
| 11.091 | Product Identifier Characters 1 | | (-2147483648) to (2147483647) | | | | | RW | Num | | | | US |
| 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 | | | | | | | | | | |
| 11.096 | Number Of Rectifiers Expected | | 0 to 9 | | | | | | | | | | |

| | | | | | | | | | | | | | |
|----|------------------|-----|-------------|------|---------------------|------|------------------|-----|---------------------|-----|---------------------|-----|----------------|
| 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

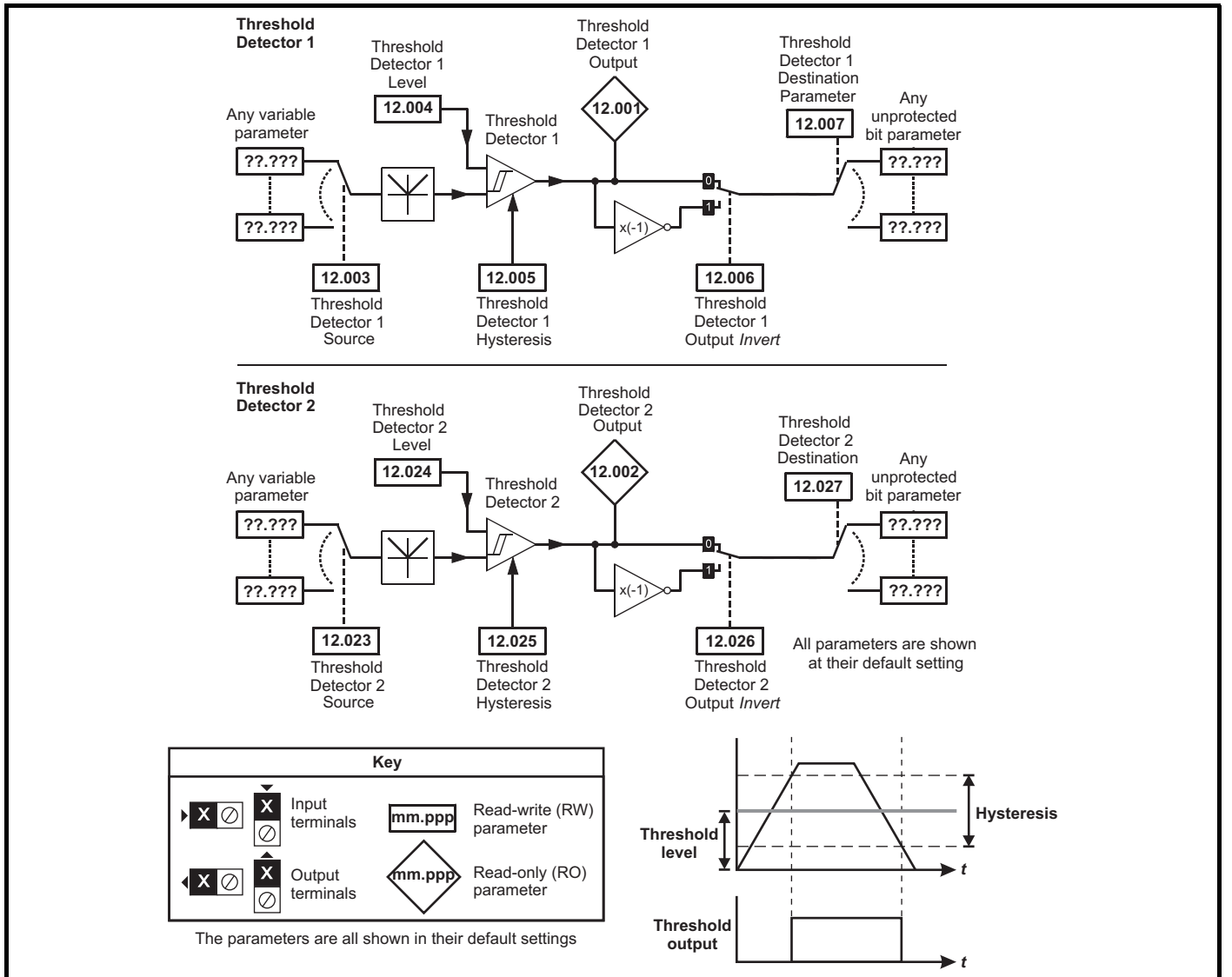
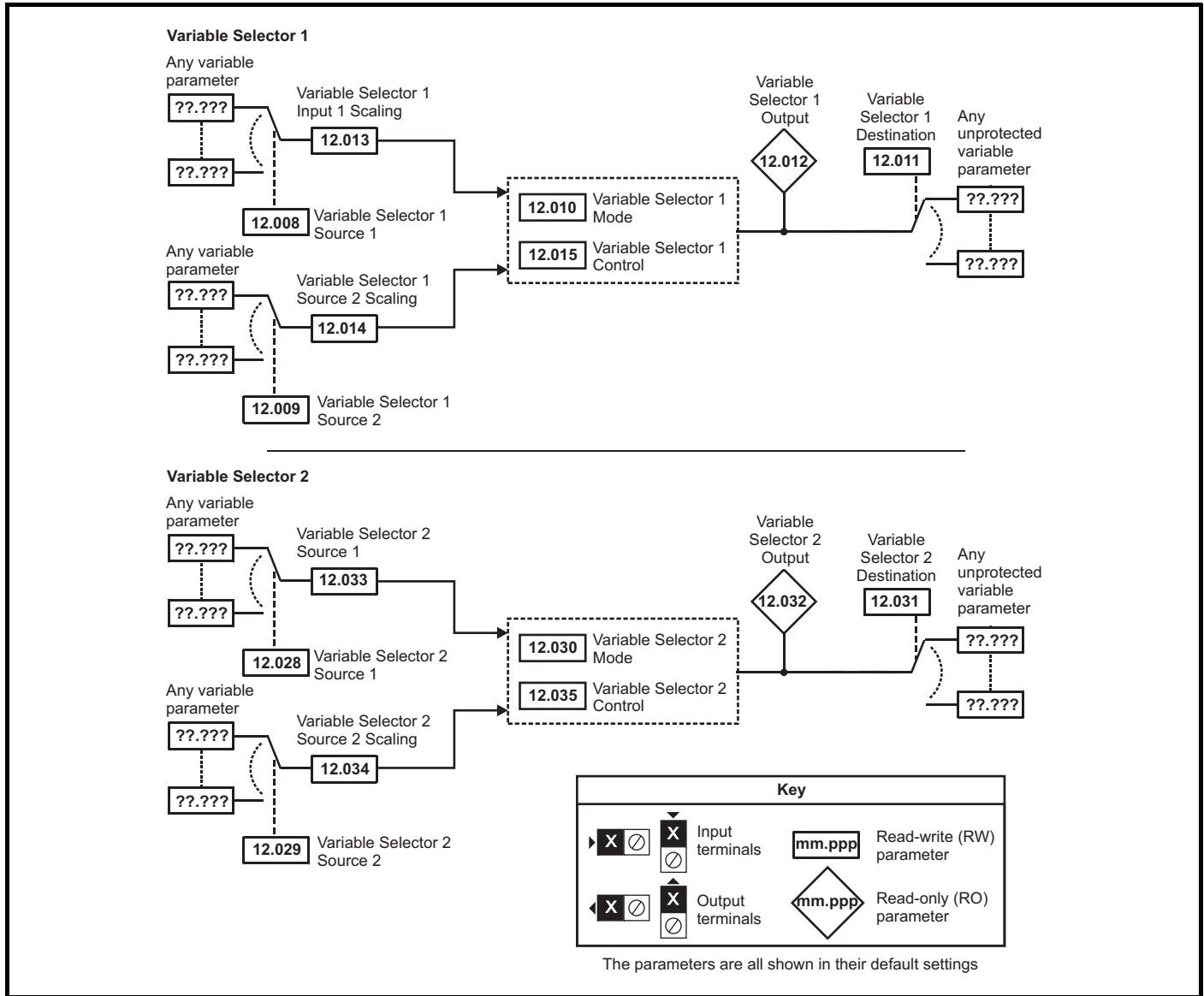


Figure 11-20 Menu 12 logic diagram (continued)



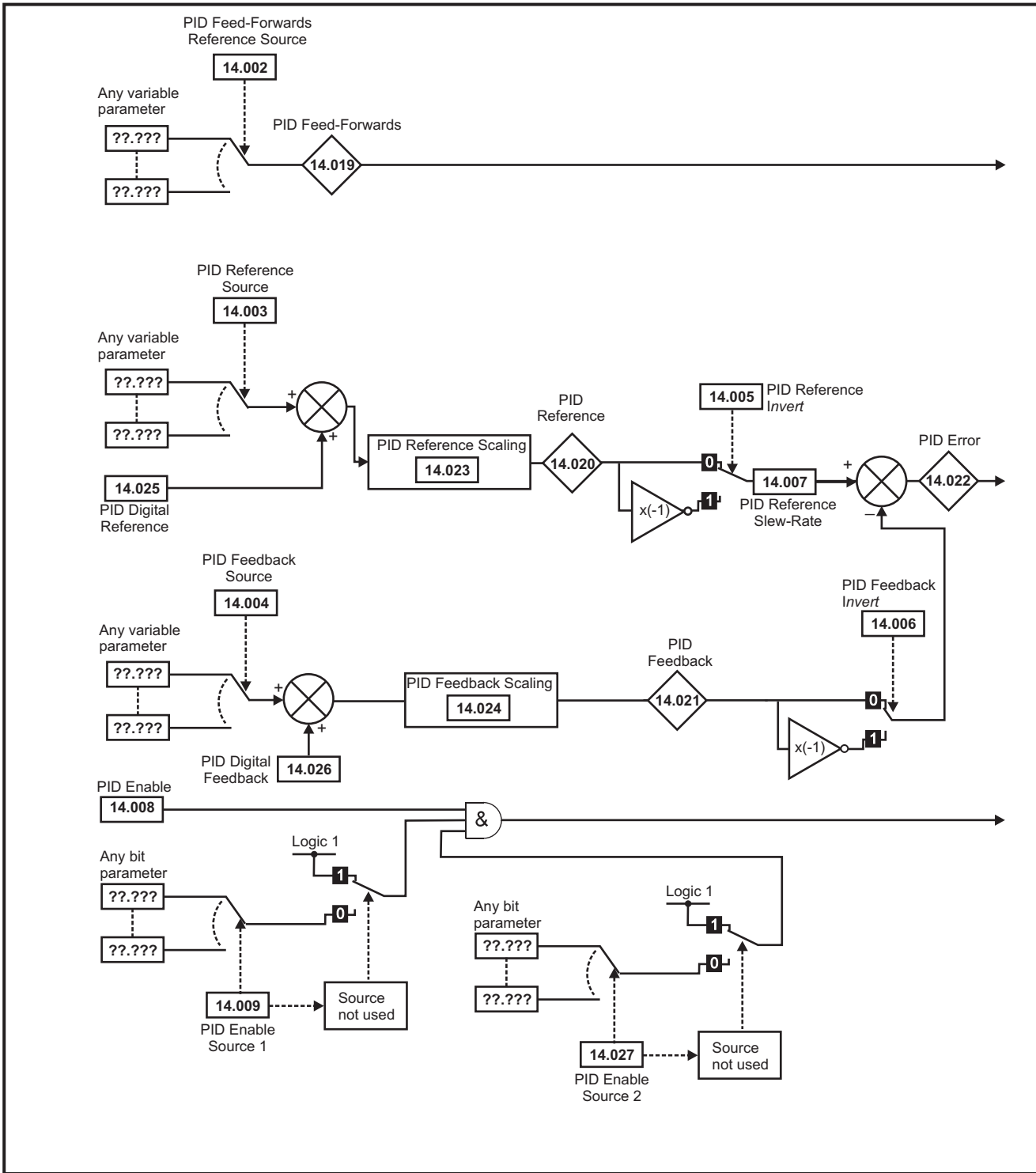
| Parameter | | Range(⇅) | | Default(⇄) | | | Type | | | | | | |
|-----------|--------------------------------------|--|-------------------|------------|-------|-------------|------|-----|----|----|----|----|----|
| | | OL | RFC- A / S | OL | RFC-A | RFC-S | | | | | | | |
| 12.001 | Threshold Detector 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 % | | | | 0.00 % | 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 | | | | | 0.000 | RW | Num | | | PT | US | |
| 12.009 | Variable Selector 1 Source 2 | | | | | 0.000 | 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 % | | | | 0.00 % | 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 |

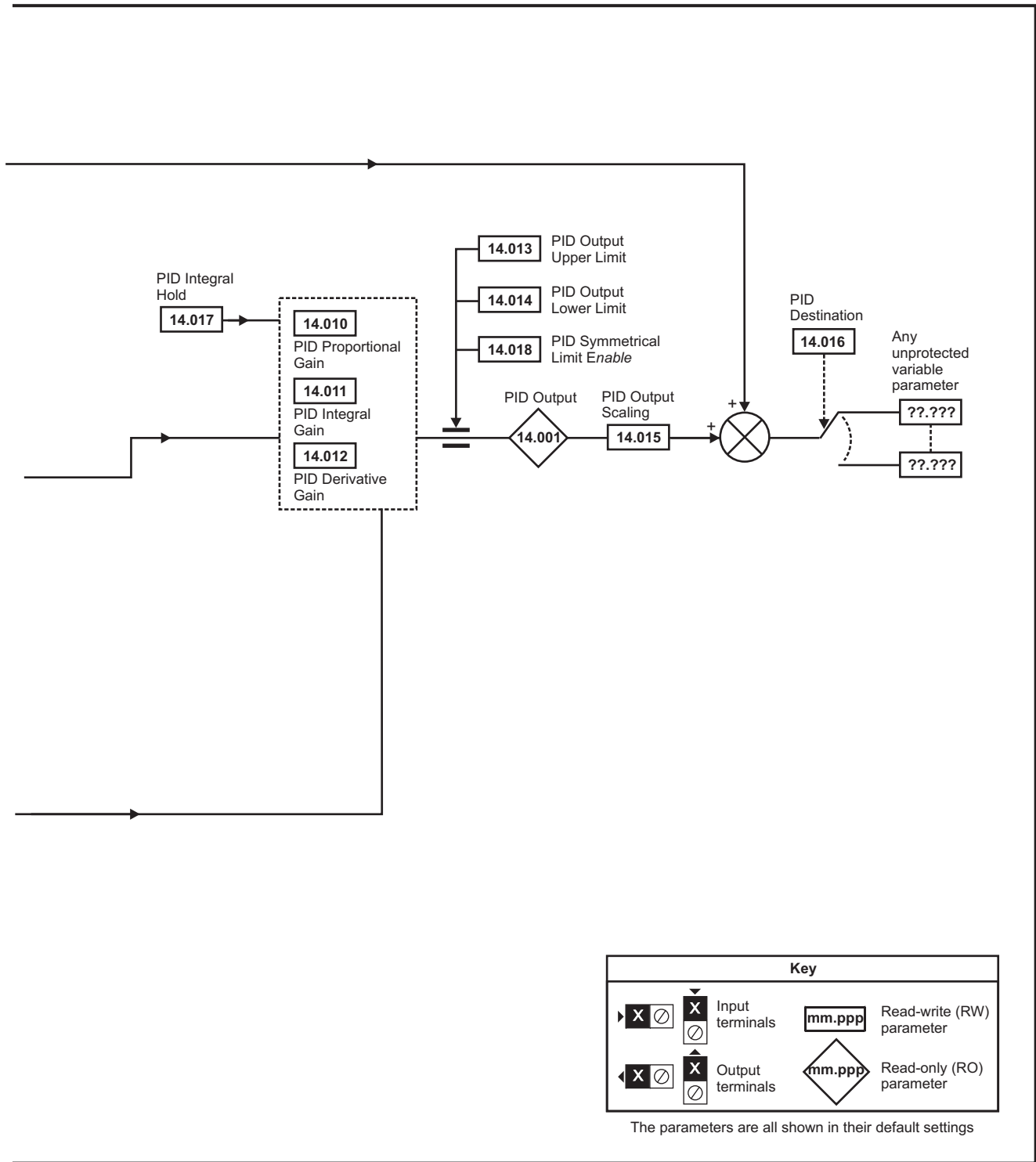
| | | | | | | | | | | | | | |
|----|------------------|----|------------|-----|---------------------|-----|------------------|-----|-------------|-----|------------------|----|-------------|
| RW | Read / Write | RO | Read only | Num | Number parameter | Bit | Bit parameter | Txt | Text string | Bin | 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|

11.14 Menu 14: User PID controller

Figure 11-21 Menu 14 Logic diagram





| 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 | | | | US |
| 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 | | | | US |
| 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 |

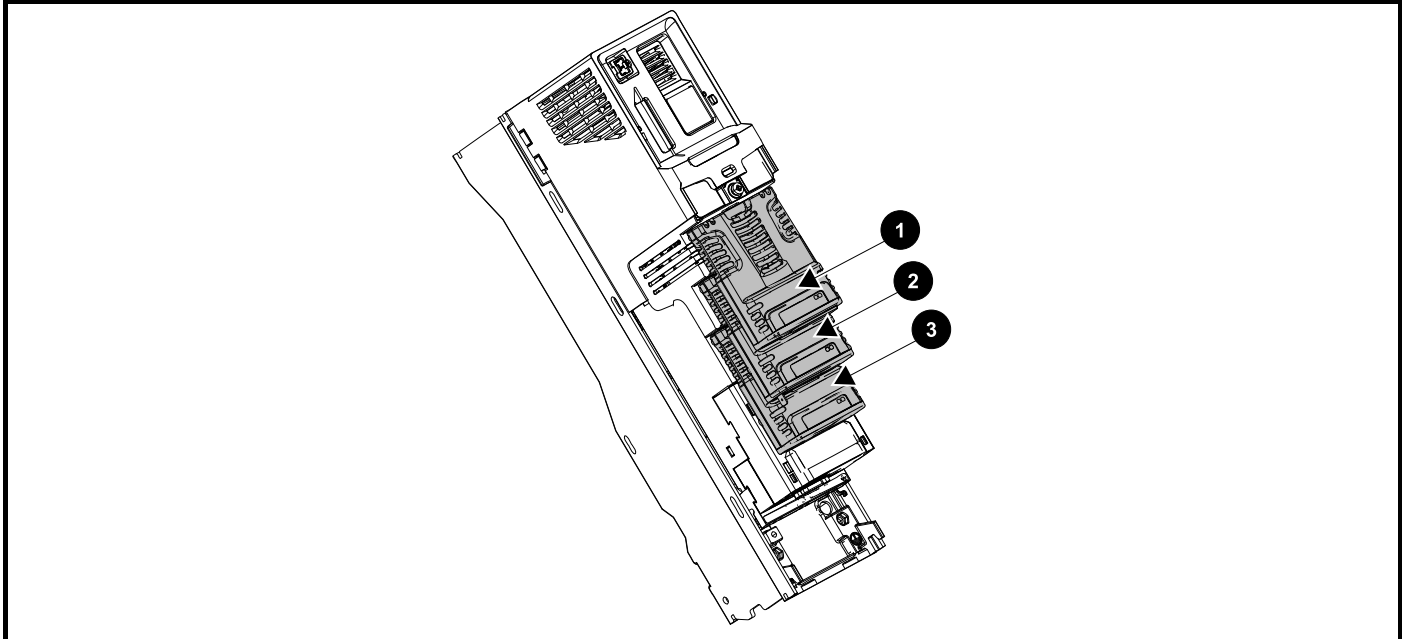
| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|----------------------------|----------------|-------------|------------------------|

| 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 | Fl | 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 | | | 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 | | 0.000 to 59.999 | | 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 |

| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|
| Safety information | Product information | Mechanical installation | Electrical installation | Getting started | Basic parameters | Running the motor | Optimization | NV Media Card Operation | Building Automation | Advanced parameters | Technical data | Diagnostics | UL listing information |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|-------------------------|---------------------|---------------------|----------------|-------------|------------------------|

| 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) | 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 |
| Fl | 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 2.4 *Ratings* on page 16.

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 |
| 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 | | |
| 12404800 | 315 | 500 | 608 | 602 | 547 | 444 | 353 | | |
| 12405660 | 355 | 550 | 660 | 660 | 614 | 488 | 389 | | |
| 12406660 | 450 | 650 | 755 | 747 | 672 | 529 | 423 | | |
| 12407200 | 500 | 700 | 865 | 787 | 709 | 554 | 441 | | |

| 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 | |

| 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 |
| 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

| Model | Normal Duty | | | | | | |
|--------------|--|-------|-------|-------|-------|--------|--------|
| | Maximum permissible continuous output current (A) for the following switching frequencies | | | | | | |
| | 2 kHz | 3 kHz | 4 kHz | 6 kHz | 8 kHz | 12 kHz | 16 kHz |
| 200 V | | | | | | | |
| 03200066 | 6.6 | | | | | | |
| 03200080 | 8.0 | | | | | | |
| 03200110 | 11.0 | | | | | | 9.7 |
| 03200127 | 12.3 | 11.9 | 11.1 | 10.0 | 9.0 | 6.4 | 4.7 |
| 04200180 | 14.5 | | | 13.5 | 12.2 | 10.5 | 9.6 |
| 04200250 | 14.5 | | | 13.5 | 12.2 | 10.5 | 9.6 |
| 05200300 | 25.5 | 25.2 | 24.9 | 24.3 | 23.7 | 22.5 | 21.6 |
| 400 V | | | | | | | |
| 03400034 | 3.4 | | | | | | 3.3 |
| 03400045 | 4.5 | | | 4.4 | 4.1 | 3.6 | 3.3 |
| 03400062 | 5.1 | 5.0 | 4.7 | 4.4 | 4.1 | 3.6 | 3.3 |
| 03400077 | 7.7 | | 7.4 | 6.7 | 6.2 | 5.7 | 5.0 |
| 03400104 | 8.3 | | | 7.6 | 6.9 | 6.0 | 5.2 |
| 03400123 | 8.3 | | | 7.6 | 6.9 | 6.0 | 5.2 |
| 04400185 | 8.6 | | | | | 8.4 | 6.9 |
| 04400240 | 8.6 | | | | | 8.4 | 6.9 |
| 05400300 | 17.1 | 15.6 | 14.4 | 12.6 | 11.4 | 9.6 | 8.7 |
| 575 V | | | | | | | |
| 05500039 | 3.9 | | | | | | |
| 05500061 | 6.1 | | | | | | |
| 05500100 | 10.0 | | | | | | |

Table 12-3 Maximum permissible continuous output current @ 50 °C (122 °F)

| Model | Normal Duty | | | | | | |
|--------------|--|-------|-------|-------|-------|--------|--------|
| | Maximum permissible continuous output current (A) for the following switching frequencies | | | | | | |
| | 2 kHz | 3 kHz | 4 kHz | 6 kHz | 8 kHz | 12 kHz | 16 kHz |
| 200 V | | | | | | | |
| 03200066 | 6.6 | | | | | | |
| 03200080 | 8.0 | | | | | | |
| 03200110 | 11 | | | | | 10.5 | 9.1 |
| 03200127 | 12.7 | | 12.6 | 12.2 | 11.7 | 10.5 | 9.1 |
| 04200180 | 18 | | | | | | |
| 04200250 | 22.2 | | | | | | 20.2 |
| 05200300 | 30 | | | | 29.7 | 25.2 | 21.6 |
| 06200500 | 50 | | | | 49 | 38 | 30 |
| 06200580 | 58 | | | 56 | 49 | 38 | 30.2 |
| 07200750 | 75 | | | | | 59.7 | 48.8 |
| 07200940 | 94 | | | 92.1 | 80 | 59.7 | 48.9 |
| 07201170 | 117 | | 112 | 92.4 | 80 | 59.7 | 49.1 |
| 08201490 | 149 | | | 147 | 133 | 113 | 84 |
| 08201800 | 180 | | 167 | 148 | 133 | 113 | 84 |
| 09202160 | 216 | | | 197 | 168 | 117 | 84 |
| 09202660 | 253 | 237 | 221 | 197 | 168 | 117 | 85 |
| 10203250 | 325 | 320 | 302 | 266 | 241 | 176 | 130 |
| 10203600 | 346 | 320 | 302 | 266 | 241 | 176 | 130 |
| 400 V | | | | | | | |
| 03400034 | 3.4 | | | | | | |
| 03400045 | 4.5 | | | | | | |
| 03400062 | 6.2 | | | | 5.9 | 5.4 | 4.4 |
| 03400077 | 7.6 | 7.2 | 6.9 | 6.4 | 5.9 | 5.4 | 4.4 |
| 03400104 | 10.4 | | | 9.3 | 8.5 | 6.9 | 5.1 |
| 03400123 | 11.9 | 11.2 | 10.5 | 9.3 | 8.5 | 6.9 | 5.2 |
| 04400185 | 18 | 17.5 | 17 | 16.3 | 15.8 | 12.2 | 9.3 |
| 04400240 | 18 | 17.5 | 17 | 16.3 | 15.8 | 12.2 | 9.3 |
| 05400300 | 25.5 | | | 23.6 | 20.4 | 15.6 | 12.3 |
| 06400380 | 38 | | | | 37 | 28 | 21.4 |
| 06400480 | 48 | | | 43 | 36.5 | 27.4 | 21.4 |
| 06400630 | 63 | 58 | 52 | 43 | 37 | 28 | 21.4 |
| 07400790 | 79 | | | | 73.5 | 57.7 | 49 |
| 07400940 | 94 | | | 86.5 | 73.3 | 58.3 | 49 |
| 07401120 | 112 | | 109 | 87.4 | 72.8 | 58.3 | 49.3 |
| 08401550 | 155 | | | 146 | 123 | 93 | 69 |
| 08401840 | 184 | | 180 | 146 | 123 | 93.8 | 69 |
| 09402210 | 221 | | 213 | 175 | 144 | 97 | 69 |
| 09402660 | 253 | 237 | 213 | 176 | 144 | 98 | 69 |
| 10403200 | 320 | | 300 | 259 | 217 | 154 | 112 |
| 10403610 | 343 | 321 | 300 | 260 | 217 | 155 | 112 |

| Model | Normal Duty | | | | | | |
|--------------|--|-------|-------|-------|-------|--------|--------|
| | Maximum permissible continuous output current (A) for the following switching frequencies | | | | | | |
| | 2 kHz | 3 kHz | 4 kHz | 6 kHz | 8 kHz | 12 kHz | 16 kHz |
| 11404370 | 437 | 415 | 374 | 298 | 240 | | |
| 11404870 | 462 | 415 | 374 | 298 | 240 | | |
| 11405070 | 462 | 415 | 374 | 298 | 240 | | |
| 575 V | | | | | | | |
| 05500039 | 3.9 | | | | | | |
| 05500061 | 6.1 | | | | | | |
| 05500100 | 10 | | | | | | |
| 06500120 | 12 | | | | | | |
| 06500170 | 17 | | | | | | 13.4 |
| 06500220 | 22 | | | | | 17.8 | 13.4 |
| 06500270 | 27 | | | | 23.5 | 17.8 | 15 |
| 06500340 | 34 | | | 28.2 | 23.5 | 18 | 15 |
| 06500430 | 43.0 | 41.7 | 36.1 | 28 | 23.7 | 18 | 15 |
| 07500530 | 53 | | | 46.7 | 35.8 | 24.8 | 19 |
| 07500730 | 73 | | 65 | 46.7 | 35.8 | 24.8 | 19 |
| 08500860 | 86 | | | 76.7 | 64.5 | 44.3 | 31.3 |
| 08501080 | 104 | 97.2 | 90.7 | 76.7 | 64.8 | 44.3 | 31.3 |
| 09501250 | 125 | | | 114 | 90 | 62 | 48 |
| 09501500 | 150 | | | 114 | 90 | 62 | 48 |
| 10502000 | 200 | 184 | 154 | 114 | 90 | 62 | 48 |
| 11502480 | 226 | | 198 | | | | |
| 11502880 | 262 | 241 | 198 | | | | |
| 11503150 | 296 | 241 | 198 | | | | |
| 690 V | | | | | | | |
| 07600230 | 23 | | | | | | 19 |
| 07600300 | 30 | | | | | 24.8 | 19 |
| 07600360 | 36 | | | | 35.8 | 24.8 | 19 |
| 07600460 | 46 | | | | 35.8 | 24.8 | 19 |
| 07600520 | 52 | | | 46.7 | 35.8 | 25 | 19 |
| 07600730 | 73 | | 65 | 46.7 | 35.8 | 25 | 19 |
| 08600860 | 86 | | | 76.7 | 64.5 | 44.3 | 31.3 |
| 08601080 | 104 | 97.2 | 90.7 | 76.7 | 64.8 | 44.3 | 31.3 |
| 09601250 | 125 | | | 114 | 90 | 62 | 48 |
| 09601550 | 155 | | 153 | 113 | 89 | 62 | 48 |
| 10601720 | 172 | | 153 | 114 | 89 | 62 | 48 |
| 10601970 | 197 | | 195 | 134 | 102 | 67 | 48 |
| 11602250 | 205 | | 198 | | | | |
| 11602750 | 250 | 241 | 198 | | | | |
| 11603050 | 296 | 241 | 198 | | | | |

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 98.

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 284.

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 Ø and greater (back of a hand) | 1 Protected against vertically falling water drops |
| 2 Protected against solid foreign objects of 12.5mm Ø 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 Ø and greater (tool) | 3 Protected against spraying water |
| 4 Protected against solid foreign objects of 1.0mm Ø 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 gasses 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 m²/s³ (0.01 g²/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/s² peak acceleration from 9 to 200 Hz

15 m/s² 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 |



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 A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|
| | | | | IEC | | | UL / USA | | |
| | | | | 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 | | | 25 | | |
| 03200110 | 14 | 17 | 25 | 25 | | | 25 | | |
| 03200127 | 16 | 20 | 34 | 25 | 25 | gG | 25 | 25 | CC, J or T* |
| 04200180 | 17 | 20 | 30 | 25 | | | 25 | | |
| 04200250 | 23 | 28 | 41 | 32 | 32 | gG | 30 | 30 | CC, J or T* |
| 05200300 | 24 | 31 | 52 | 40 | 40 | | 40 | | |
| 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 | | |
| 07201170 | 91 | 105 | 149 | 125 | 125 | | 125 | | |
| 08201490 | 123 | 137 | 213 | 200 | 200 | gR | 200 | 200 | HSJ |
| 08201800 | 149 | 166 | 243 | | | | 225 | | |
| 09202160 | 172 | 205 | 270 | 250 | 250 | gR | 250 | 250 | HSJ |
| 09202660 | 228 | 260 | 319 | 315 | 315 | | 300 | | |
| 10203250 | 277 | 305 | 421 | 400 | 400 | gR | 400 | 400 | HSJ |
| 10203600 | 333 | 361 | 494 | 450 | 450 | | 450 | | |

Table 12-15 AC Input current and fuse ratings (400 V)

| Model | Typical input current A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|-----|
| | | | | IEC | | | UL / USA | | | |
| | | | | 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 | | | | | | | |
| 03400104 | 12 | 13 | 20 | | | | | | | |
| 03400123 | 14 | 16 | 25 | 20 | 20 | gG | 20 | 20 | CC, J or T* | |
| 04400185 | 17 | 19 | 30 | | | | | | | 25 |
| 04400240 | 22 | 24 | 35 | 32 | 32 | gG | 30 | 30 | CC, J or T* | |
| 05400300 | 26 | 29 | 52 | 40 | 40 | | 35 | | | 35 |
| 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 |
| 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 |

Table 12-16 AC Input current and fuse ratings (575 V)

| Model | Typical input current A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|----|
| | | | | IEC | | | UL / USA | | | |
| | | | | Nominal A | Maximum A | Class | Nominal A | Maximum A | Class | |
| 05500039 | 4 | 4 | 7 | 10 | 20 | gG | 10 | 10 | CC, J or T* | |
| 05500061 | 6 | 7 | 9 | | | | 20 | 20 | | |
| 05500100 | 9 | 11 | 15 | | | | 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 | gG | 35 | 50 | CC, J or T* | |
| 06500340 | 33 | 37 | 63 | | | | 40 | | | 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 A | Maximum continuous input current A | Maximum overload input current A | Fuse rating | | | | | |
|----------|----------------------------|---------------------------------------|-------------------------------------|--------------|--------------|-------|--------------|--------------|-------------|
| | | | | IEC | | | UL / USA | | |
| | | | | Nominal A | Maximum A | Class | Nominal A | Maximum A | Class |
| 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 | 80 | gG | 50 | 80 | CC, J or T* |
| 07600520 | 40 | 44 | 75 | | | | 80 | | |
| 07600730 | 57 | 62 | 92 | 80 | 125 | gR | 100 | 100 | HSJ |
| 08600860 | 74 | 83 | 121 | 125 | | | 125 | 150 | |
| 08601080 | 92 | 104 | 165 | 160 | 160 | gR | 150 | 150 | HSJ |
| 09601250 | 124 | 149 | 194 | 150 | 150 | | 150 | 150 | |
| 09601550 | 145 | 171 | 226 | 200 | 200 | gR | 200 | 200 | HSJ |
| 10601720 | 180 | 202 | 268 | 225 | 225 | | 250 | 250 | |
| 10601970 | 202 | 225 | 313 | 250 | 250 | gR | 250 | 250 | HSJ |
| 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.



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.

CAUTION

Table 12-18 Cable ratings (200V)

| 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 | | | | 4 | | | 12 | | | |
| 03200110 | | | | 4 | | | 12 | | | |
| 03200127 | | | | 4 | | | 12 | | | |
| 04200180 | 6 | 8 | B2 | 6 | 8 | B2 | 10 | 8 | 10 | 8 |
| 04200250 | 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 | | | 3 | | | 3 | | | |
| 07200750 | 35 | 70 | B2 | 35 | 70 | B2 | 2 | 1/0 | 2 | 1/0 |
| 07200940 | | | | 1 | | | 1 | | | |
| 07201170 | | | | 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 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 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) 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 | | | | 12 | | | 12 | | | |
| 03400104 | | | | 12 | | | 12 | | | |
| 03400123 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 12 | 12 | 12 | 12 |
| 04400185 | 4 | 6 | B2 | 4 | 6 | B2 | 10 | 8 | 10 | 8 |
| 04400240 | 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 | | | 4 | | | 4 | | | |
| 06400630 | 25 | | | 3 | | | 3 | | | |
| 07400790 | 35 | 70 | B2 | 35 | 70 | B2 | 1 | 1/0 | 1 | 1/0 |
| 07400940 | 50 | | | 2 | | | 2 | | | |
| 07401120 | 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 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 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 350 | | | 2 x 300 | | | |
| 11404370 | 4 x 95 | C | C | 2 x 185 | 2 x 185 | C | 4 x 3/0 | 2 x 400 | 4 x 3/0 | 2 x 400 |
| 11404870 | | | | 2 x 240 | 2 x 240 | | 4 x 4/0 | | | |
| 11405070 | | | | 2 x 240 | 2 x 240 | | 4 x 4/0 | | | |

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 | | | | | | | 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 | | | 1 | | 1 | |
| 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 | | | | | | | 4 | | 4 | |
| 07600520 | | | | | | | 4 | | 4 | |
| 07600730 | | | | | | | 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 120 | | | 2 x 120 | | | 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 |
|--|--|
| $\leq 10 \text{ mm}^2$ | 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). |
| $> 10 \text{ mm}^2$ and $\leq 16 \text{ mm}^2$ | The same cross-sectional area as the input phase conductor |
| $> 16 \text{ mm}^2$ and $\leq 35 \text{ mm}^2$ | 16 mm^2 |
| $> 35 \text{ mm}^2$ | 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)

| 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) | | | | | | | |
| 03200080 | 100 m (330 ft) | | | | | | | |
| 03200110 | 130 m (425 ft) | | | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 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) | |
| 04200250 | | | | | | | | |
| 05200300 | 200 m (660 ft) | | 150 m (490 ft) | | 100 m (330 ft) | | 75 m (245 ft) | |
| 06200500 | 200 m (660 ft) | | 150 m (490 ft) | | 100 m (330 ft) | | 75 m (245 ft) | |
| 06200580 | | | | | | | | |
| 07200750 | 250 m (820 ft) | | 187 m (614 ft) | | 125 m (410 ft) | | 93 m (305 ft) | |
| 07200940 | | | | | | | | |
| 07201170 | | | | | | | | |
| 08201490 | 250 m (820 ft) | | 187 m (614 ft) | | 125 m (410 ft) | | 93 m (305 ft) | |
| 08201800 | | | | | | | | |
| 09202160 | 250 m (820 ft) | | 187 m (614 ft) | | 125 m (410 ft) | | 93 m (305 ft) | |
| 09202660 | | | | | | | | |
| 10203250 | 250 m (820 ft) | | 187 m (614 ft) | | 125 m (410 ft) | | 93 m (305 ft) | |
| 10203600 | | | | | | | | |

Table 12-24 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) | | | | | | |
| 03400045 | 100 m (330 ft) | | | | | | |
| 03400062 | 130 m (425 ft) | | | | | | |
| 03400077 | 200 m (660 ft) | 150 m (490 ft) | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 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 | 200 m (660 ft) | 150 m (490 ft) | 100 m (330 ft) | 75 m (245 ft) | 50 m (165 ft) | 37 m (120 ft) | |
| 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 12-25 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 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 113.

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 Nm (4.8 lb in) |

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 Nm (6 lb in) | 0.8 Nm (7.2 lb in) | 2.0 Nm (16.8 lb in) | 2.5 Nm (21.6 lb in) | 2.0 Nm (16.8 lb in) | 2.5 Nm (21.6 lb in) |
| 5 | Plug-in terminal block | | T20 Torx (M4) / M4 Nut (7 mm AF) | | M5 Nut (8 mm AF) | |
| | 1.5 Nm (13.2 lb in) | 1.8 Nm (15.6 lb in) | 1.5 Nm (13.2 lb in) | 2.5 Nm (21.6 lb in) | 2.0 Nm (18 lb in) | 5.0 Nm (44.4 lb in) |
| 6 | | | M6 Nut (10 mm AF) | | | |
| | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) | 6.0 Nm (52.8 lb in) | 8.0 Nm (72 lb in) |
| 7 | M8 Nut (13 mm AF) | | M8 Nut (13 mm AF) | | M8 Nut (13 mm AF) | |
| | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) | 12 Nm (106.2 lb in) | 14 Nm (124 lb in) |
| 8 to 11 | M10 Nut (17 mm AF) | | M10 Nut (17 mm AF) | | M10 Nut (17 mm AF) | |
| | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) | 15 Nm (133.2 lb in) | 20 Nm (177.6 lb in) |

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 4 | 6 way AC power connector | 6 mm ² (10 AWG) |
| 5 | 3 way AC power connector 3 way motor connector | 8 mm ² (8 AWG) |
| 6 7 8 9A/9E 10E/11E | 2 way low voltage power 24 V supply connector | 1.5 mm ² (16 AWG) |

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 123 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 MΩ |
|----------------|----------------------------|---------------------|----------------|-----|-----------|------------------------------------|---------------------|--|------------------|---------------------------|
| | @ 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 mA | Worst case mA | |
| | A | A | V | V | | W | W | | | |
| 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 | | kg | lb |
| | mm | inch | mm | inch | mm | inch | | |
| 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 Nm (72 lb in) | M10 | 18 Nm (159.6 lb in) | |
| 4200-0672 | | | | | | |
| 4200-1972 | | 95 mm ² (3/0 AWG) | 20 Nm (177.6 lb in) | M6 | 4.8 Nm (33.6 lb in) | |
| 4200-1662 | | | | | | |
| 4200-0122 | | 16 mm ² (6 AWG) | 2.3 Nm (20.4 lb in) | M5 | 3.0 Nm (26.4 lb in) | |
| 4200-0252 | | | | | | |
| 4200-0272 | | 4 mm ² (12 AWG) | 0.8 Nm (7.2 lb in) | M5 | 3.0 Nm (26.4 lb in) | |
| 4200-0312 | | | | | | |
| 4200-0402 | | 4 mm ² (12 AWG) | 0.8 Nm (7.2 lb in) | M6 | 4.8 Nm (33.6 lb in) | |
| 4200-3230 | | | | | | |
| 4200-3480 | | 16 mm ² (6 AWG) | 2.3 Nm (20.4 lb in) | M6 | 4.8 Nm (33.6 lb in) | |
| 4200-2300 | | | | | | |
| 4200-4800 | | 10.8 mm | N/A | 30 Nm (265.2 lb in) | M10 | 18 Nm (159.6 lb in) |
| 4200-3690 | | | | | | |
| 4200-3021 | | 11 mm | N/A | 30 Nm (265.2 lb in) | M12 | 25 Nm (220.8 lb in) |
| 4200-4460 | | | | | | |
| 4200-1660 | 10.8 mm | N/A | 30 Nm (265.2 lb in) | M12 | 25 Nm (220.8 lb in) | |
| 4200-2210 | | | | | | |
| 4200-0400 | 10.5 mm | N/A | 30 Nm (265.2 lb in) | M12 | 25 Nm (220.8 lb in) | |
| 4200-0690 | | | | | | |

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:

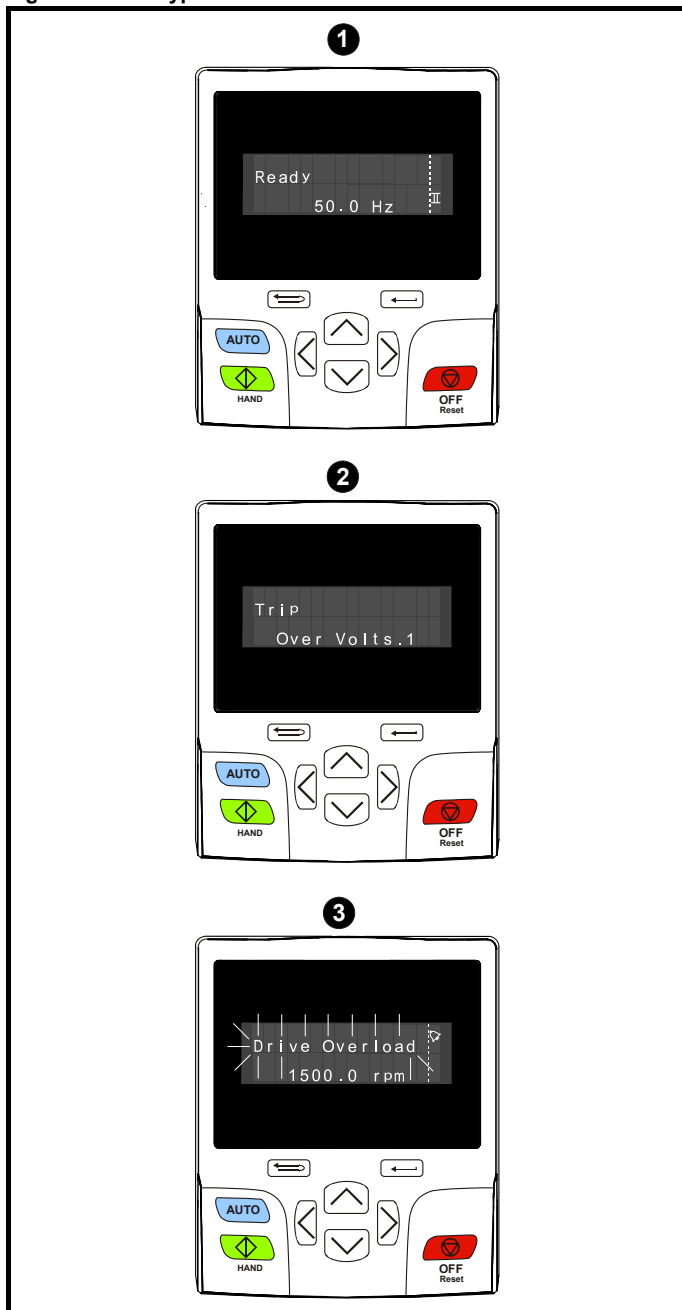
- Trip indications
- Alarm indications
- Status indications



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.

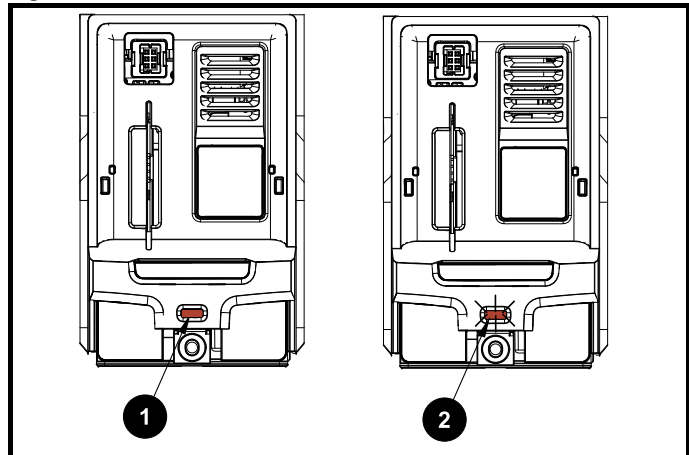
13.1 Status modes (Keypad and LED status)

Figure 13-1 Keypad status modes



1. Drive Healthy 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 Healthy' 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 *Diagnostics*.

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

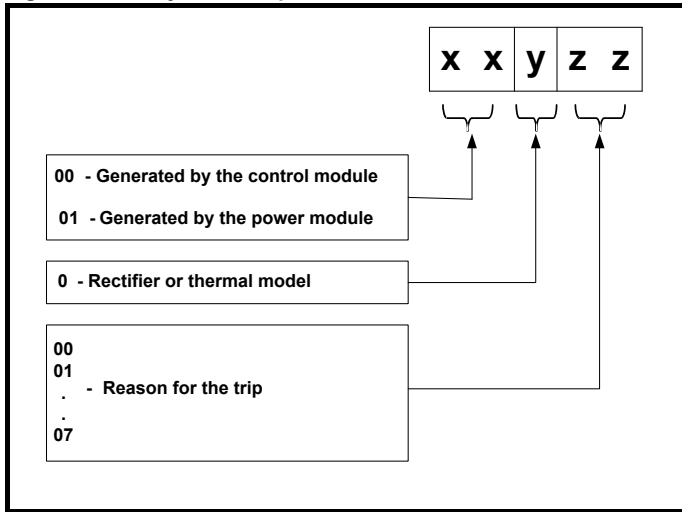
| | |
|--------------|---------------|
| Over Volts | Oht dc bus |
| OI ac | Phase Loss |
| OI Brake | Power Comms |
| PSU | OI Snubber |
| Oht Inverter | Temp Feedback |
| Oht Power | Power Data |
| Oht Control | |

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

| Trip | Diagnosis | | | | | | | | |
|-------------------------|---|----------|--------|---|---|---|---|---|---------|
| An Input 1 Loss | Analog input 1 current loss | | | | | | | | |
| 28 | <p><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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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 | | | | | | | | |
| An Input 2 Loss | Analog input 2 current loss | | | | | | | | |
| 29 | <p><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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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 | | | | | | | | |
| An Output Calib | Analog output calibration failed | | | | | | | | |
| 219 | <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Output 1 failed (Terminal 9)</td> </tr> <tr> <td>2</td> <td>Output 2 failed (Terminal 10)</td> </tr> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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 | Sub-trip | Reason | 1 | Output 1 failed (Terminal 9) | 2 | Output 2 failed (Terminal 10) | | |
| Sub-trip | Reason | | | | | | | | |
| 1 | Output 1 failed (Terminal 9) | | | | | | | | |
| 2 | Output 2 failed (Terminal 10) | | | | | | | | |
| App Menu Changed | Customization table for an application module has changed | | | | | | | | |
| 217 | <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Reset the trip and perform a parameter save to accept the new settings | Sub-trip | Reason | 1 | Menu 18 | 2 | Menu 19 | 3 | Menu 20 |
| Sub-trip | Reason | | | | | | | | |
| 1 | Menu 18 | | | | | | | | |
| 2 | Menu 19 | | | | | | | | |
| 3 | Menu 20 | | | | | | | | |
| Autotune 1 | Position feedback did not change or required speed could not be reached | | | | | | | | |
| 11 | <p>The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure the motor is free to turn i.e. mechanical brake was released • Ensure Pr 03.026 is set correctly (or appropriate 2nd motor map parameter) • Check feedback device wiring is correct • Check encoder mechanical coupling to the motor | Sub-trip | Reason | 1 | The position feedback did not change when position feedback is being used during rotating autotune. | 2 | The motor did not reach the required speed during rotating autotune or mechanical load measurement. | | |
| Sub-trip | Reason | | | | | | | | |
| 1 | The position feedback did not change when position feedback is being used during rotating autotune. | | | | | | | | |
| 2 | The motor did not reach the required speed during rotating autotune or mechanical load measurement. | | | | | | | | |

| Trip | Diagnosis | | | | | | | | |
|---|---|--|--------|---|--|---|---|---|--|
| Autotune 2 | Position feedback direction incorrect | | | | | | | | |
| 12 | The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number. | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | The position feedback direction is incorrect when position feedback is being used during a rotating autotune | 2 | A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position. | | |
| | Sub-trip | Reason | | | | | | | |
| 1 | The position feedback direction is incorrect when position feedback is being used during a rotating autotune | | | | | | | | |
| 2 | A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position. | | | | | | | | |
| <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check motor cable wiring is correct • Check feedback device wiring is correct • Swap any two motor phases | | | | | | | | | |
| Autotune 3 | Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction | | | | | | | | |
| 13 | 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | Measured inertia has exceeded the parameter range during a mechanical load measurement | 2 | The commutation signals changed in the wrong direction during a rotating autotune | 3 | The mechanical load test has been unable to identify the motor inertia |
| | Sub-trip | Reason | | | | | | | |
| | 1 | Measured inertia has exceeded the parameter range during a mechanical load measurement | | | | | | | |
| 2 | The commutation signals changed in the wrong direction during a rotating autotune | | | | | | | | |
| 3 | The mechanical load test has been unable to identify the motor inertia | | | | | | | | |
| <p>Recommended actions for sub-trip 2:</p> <ul style="list-style-type: none"> • Check motor cable wiring is correct • Check feedback device U,V and W commutation signal wiring is correct | | | | | | | | | |
| <p>Recommended actions for sub-trip 3:</p> <ul style="list-style-type: none"> • Increase the test level. • If the test was carried out at standstill repeat the test with the motor rotating within the recommended speed range. | | | | | | | | | |
| Autotune 7 | Motor number of poles / position feedback resolution set incorrectly | | | | | | | | |
| 17 | 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. | | | | | | | | |
| | <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check line per revolution for feedback device • Check the number of poles in Pr 05.011 | | | | | | | | |
| Autotune Stopped | Autotune test stopped before completion | | | | | | | | |
| 18 | The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed. | | | | | | | | |
| | <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check the drive enable signal (Terminal 29) was active during the autotune • Check the run command was active in Pr 08.005 during autotune | | | | | | | | |
| Brake R Too Hot | Braking resistor overload timed out (I^2t) | | | | | | | | |
| 19 | The <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 %. | | | | | | | | |
| | <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure the values entered in Pr 10.030, Pr 10.031 and Pr 10.061 are correct • If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr 10.030, Pr 10.031 or Pr 10.061 to 0 to disable the trip. | | | | | | | | |
| Card Access | NV Media Card Write fail | | | | | | | | |
| 185 | The <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. | | | | | | | | |
| | <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check NV Media Card is installed / located correctly • Replace the NV Media Card | | | | | | | | |

| Trip | Diagnosis | | | | | | | | |
|-------------------------|--|----------|--------|---|---|---|------------------------------|---|--|
| Card Boot | The Menu 0 parameter modification cannot be saved to the NV Media Card | | | | | | | | |
| 177 | <p>Menu 0 changes are automatically saved on exiting edit mode.</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure that Pr 11.042 is correctly set, and then reset the drive to create the necessary file on the NV Media Card • Re-attempt the parameter write to the Menu 0 parameter | | | | | | | | |
| Card Busy | NV Media Card cannot be accessed as it is being accessed by an option module | | | | | | | | |
| 178 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Wait for the option module to finish accessing the NV Media Card and re-attempt the required function | | | | | | | | |
| Card Compare | NV Media Card file/data is different to the one in the drive | | | | | | | | |
| 188 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Set Pr mm.000 to 0 and reset the trip • Check to ensure the correct data block on the NV Media Card has been used for the compare. | | | | | | | | |
| Card Data Exists | NV Media Card data location already contains data | | | | | | | | |
| 179 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Erase the data in data location • Write data to an alternative data location | | | | | | | | |
| Card Drive Mode | NV Media Card parameter set not compatible with current drive mode | | | | | | | | |
| 187 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure the destination drive supports the drive operating mode in the parameter file. • Clear the value in Pr mm.000 and reset the drive • Ensure destination drive operating mode is the same as the source parameter file | | | | | | | | |
| Card Error | NV Media Card data structure error | | | | | | | | |
| 182 | <p>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:</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Erase all the data block and re-attempt the process • Ensure the card is located correctly • Replace the NV Media Card | Sub-trip | Reason | 1 | The required folder and file structure is not present | 2 | The <000> file is corrupted. | 3 | Two or more files in the <MCDF> folder have the same file identification number. |
| Sub-trip | Reason | | | | | | | | |
| 1 | The required folder and file structure is not present | | | | | | | | |
| 2 | The <000> file is corrupted. | | | | | | | | |
| 3 | Two or more files in the <MCDF> folder have the same file identification number. | | | | | | | | |
| Card Full | NV Media Card full | | | | | | | | |
| 184 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Delete a data block or the entire NV Media Card to create space • Use a different NV Media Card | | | | | | | | |

| Trip | Diagnosis | | | | | | | | |
|-----------------------|---|----------|--------|---|---|---|---|---|---|
| Card No Data | NV Media Card data not found | | | | | | | | |
| 183 | <p>The <i>Card No Data</i> trip indicates that an attempt has been made to access non-existent file or block on a NV Media Card. No data is transferred.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure data block number is correct | | | | | | | | |
| Card Option | NV Media Card trip; option modules installed are different between source drive and destination drive | | | | | | | | |
| 180 | <p>The <i>Card Option</i> 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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure the correct option modules are installed. • Ensure the option modules are in the same option module slot as the parameter set stored. • Press the red reset button to acknowledge that the parameters for one or more of the option modules installed will be at their default values • This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive. | | | | | | | | |
| Card Product | NV Media Card data blocks are not compatible with the drive derivative | | | | | | | | |
| 175 | <p>If <i>Drive Derivative (11.028)</i> or <i>Product Type (11.063)</i> 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:</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>If <i>Drive Derivative (11.028)</i> 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 <i>Product Type (11.063)</i> 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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Use a different NV Media Card • This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive | Sub-trip | Reason | 1 | If <i>Drive Derivative (11.028)</i> is different between the source and target drives, this trip is initiated either at power-up or when the SD Card is accessed. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in parameter xx.000, and resetting the drive (this applies the warning suppression flag to the card). | 2 | If <i>Product Type (11.063)</i> is different between the source and target drives or if corruption is detected in the parameter file, this trip is initiated either at power-up or when the SD Card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card. | 3 | A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr xx.000 , and resetting the drive (this applies the warning suppression flag to the card). |
| Sub-trip | Reason | | | | | | | | |
| 1 | If <i>Drive Derivative (11.028)</i> is different between the source and target drives, this trip is initiated either at power-up or when the SD Card is accessed. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in parameter xx.000, and resetting the drive (this applies the warning suppression flag to the card). | | | | | | | | |
| 2 | If <i>Product Type (11.063)</i> is different between the source and target drives or if corruption is detected in the parameter file, this trip is initiated either at power-up or when the SD Card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card. | | | | | | | | |
| 3 | A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr xx.000 , and resetting the drive (this applies the warning suppression flag to the card). | | | | | | | | |
| Card Rating | NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different | | | | | | | | |
| 186 | <p>The <i>Card Rating</i> 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 <i>Card Rating</i> 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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Reset the drive to clear the trip • Ensure that the drive rating dependent parameters have transferred correctly • This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive. | | | | | | | | |
| Card Read Only | NV Media Card has the Read Only bit set | | | | | | | | |
| 181 | <p>The <i>Card Read Only</i> 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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Clear the read only flag by setting Pr mm.000 to 9777 and reset the drive. This will clear the read-only flag for all data blocks in the NV Media Card • This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive. | | | | | | | | |
| Card Slot | NV Media Card Trip; Option module application program transfer has failed | | | | | | | | |
| 174 | <p>The <i>Card Slot</i> 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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure the source / destination option module is installed on the correct slot | | | | | | | | |

| Trip | Diagnosis | | | | | | | | |
|-----------------------|--|----------|--------|---|---|---|---------------------------------|---|--|
| Configuration | The number of power modules installed is different from the modules expected | | | | | | | | |
| 111 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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 <p>This trip is also initiated if the number of external rectifiers connected to each power module is less than the number defined by <i>Number Of Rectifiers Expected</i> (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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure that all the external rectifiers are connected correctly. • Ensure that the value in <i>Number Of Rectifiers Expected</i> (11.096) is correct. | | | | | | | | |
| Control Word | Trip initiated from the Control Word (06.042) | | | | | | | | |
| 35 | <p>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).</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check the value of Pr 06.042. • Disable the control word in <i>Control Word Enable</i> (Pr 06.043) <p>Bit 12 of the control word set to a one causes the drive to trip on Control Word</p> <p>When the control word is enabled, the trip can only be cleared by setting bit 12 to zero</p> | | | | | | | | |
| Current Offset | Current feedback offset error | | | | | | | | |
| 225 | <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Phase</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>U</td> </tr> <tr> <td>2</td> <td>V</td> </tr> <tr> <td>3</td> <td>W</td> </tr> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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 | Sub-trip | Phase | 1 | U | 2 | V | 3 | W |
| Sub-trip | Phase | | | | | | | | |
| 1 | U | | | | | | | | |
| 2 | V | | | | | | | | |
| 3 | W | | | | | | | | |
| Data Changing | Drive parameters are being changed | | | | | | | | |
| 97 | <p>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.</p> <p>Recommended actions:</p> <p>Ensure the drive is not enabled when one of the following is being carried out:</p> <ul style="list-style-type: none"> • Loading defaults • Changing drive mode • Transferring data from NV Media Card or position feedback device • Transferring user programs | | | | | | | | |
| Derivative ID | There is a problem with the identifier associated with derivative image which customizes the drive. | | | | | | | | |
| 247 | <p>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:</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | There should be a derivative image in the product but this has been erased. | 2 | The identifier is out of range. | 3 | The derivative image has been changed. |
| Sub-trip | Reason | | | | | | | | |
| 1 | There should be a derivative image in the product but this has been erased. | | | | | | | | |
| 2 | The identifier is out of range. | | | | | | | | |
| 3 | The derivative image has been changed. | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------------------|---|--|---|----------|---------|--|--|----|---|---|----|---|----|---|----|---|----|---|---|----|---|----|---|----|---|----|---|--|----------|--|--|
| Derivative Image | Derivative Image error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 248 | 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> <th>Comments</th> </tr> </thead> <tbody> <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="4">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> <td></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> </tbody> </table> | Sub-trip | Reason | Comments | 1 to 52 | An error has been detected in the derivative image, contact the supplier of the drive. | | 61 | The option module fitted in slot 1 is not allowed with the derivative image | Occurs when the drive powers-up or the image is programmed. The image tasks will not run. | 62 | The option module fitted in slot 2 is not allowed with the derivative image | 63 | The option module fitted in slot 3 is not allowed with the derivative image | 64 | The option module fitted in slot 4 is not allowed with the derivative image | 70 | An option module that is required by the derivative image is not fitted in any slot | Occurs when the drive powers-up or the image is programmed. The image tasks will not run. | 71 | An option module specifically required to be fitted in slot 1 not present | 72 | An option module specifically required to be fitted in slot 2 not present | 73 | An option module specifically required to be fitted in slot 3 not present | 74 | An option module specifically required to be fitted in slot 4 not present | | 80 to 81 | An error has been detected in the derivative image, contact the supplier of the drive. | |
| | Sub-trip | Reason | Comments | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 to 52 | An error has been detected in the derivative image, contact the supplier of the drive. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 61 | The option module fitted in slot 1 is not allowed with the derivative image | Occurs when the drive powers-up or the image is programmed. The image tasks will not run. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 62 | The option module fitted in slot 2 is not allowed with the derivative image | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 63 | The option module fitted in slot 3 is not allowed with the derivative image | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 64 | The option module fitted in slot 4 is not allowed with the derivative image | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 70 | An option module that is required by the derivative image is not fitted in any slot | Occurs when the drive powers-up or the image is programmed. The image tasks will not run. | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 71 | An option module specifically required to be fitted in slot 1 not present | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 72 | An option module specifically required to be fitted in slot 2 not present | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 73 | An option module specifically required to be fitted in slot 3 not present | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 74 | An option module specifically required to be fitted in slot 4 not present | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 80 to 81 | An error has been detected in the derivative image, contact the supplier of the drive. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Recommended action: Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Destination | Two or more parameters are writing to the same destination parameter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 199 | The <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: <ul style="list-style-type: none"> Set Pr mm.000 to 'Destinations' or 12001 and check all visible parameters in all menus for parameter write conflicts | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Drive Size | Power stage recognition: Unrecognized drive size | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 224 | The <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: <ul style="list-style-type: none"> Ensure the drive is programmed to the latest firmware version Hardware fault - return drive to supplier | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | |
|--|--|---|--------|---|--|---|---|---|---|---|--|---|--------------------------------------|---|---------------------------------------|---|--|---|--|---|---|
| EEPROM Fail | Default parameters have been loaded | | | | | | | | | | | | | | | | | | | | |
| 31 | The <i>EEPROM Fail</i> trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number. | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | The most significant digit of the internal parameter database version number has changed | 2 | The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded | 3 | The drive mode restored from internal non-volatile memory is outside the allowed range for the product or the derivative image does not allow the previous drive mode | 4 | The drive derivative image has changed | 5 | The power stage hardware has changed | 6 | The internal I/O hardware has changed | 7 | The position feedback interface hardware has changed | 8 | The control board hardware has changed | 9 | The checksum on the non-parameter area of the EEPROM has failed |
| | Sub-trip | Reason | | | | | | | | | | | | | | | | | | | |
| | 1 | The most significant digit of the internal parameter database version number has changed | | | | | | | | | | | | | | | | | | | |
| | 2 | The CRC's applied to the parameter data stored in internal non-volatile memory indicate that a valid set of parameters cannot be loaded | | | | | | | | | | | | | | | | | | | |
| | 3 | The drive mode restored from internal non-volatile memory is outside the allowed range for the product or the derivative image does not allow the previous drive mode | | | | | | | | | | | | | | | | | | | |
| | 4 | The drive derivative image has changed | | | | | | | | | | | | | | | | | | | |
| | 5 | The power stage hardware has changed | | | | | | | | | | | | | | | | | | | |
| | 6 | The internal I/O hardware has changed | | | | | | | | | | | | | | | | | | | |
| | 7 | The position feedback interface hardware has changed | | | | | | | | | | | | | | | | | | | |
| 8 | The control board hardware has changed | | | | | | | | | | | | | | | | | | | | |
| 9 | The checksum on the non-parameter area of the EEPROM has failed | | | | | | | | | | | | | | | | | | | | |
| The drive holds two banks of user save parameters and two banks of power down save parameters in non-volatile memory. If the last bank of either set of parameters that was saved is corrupted a User Save or Power Down Save trip is produced. If one of these trips occurs the parameters values that were last saved successfully are used. It can take some time to save parameters when requested by the user and if the power is removed from the drive during this process it is possible to corrupt the data in the non-volatile memory. | | | | | | | | | | | | | | | | | | | | | |
| If both banks of user save parameters or both banks of power down save parameters are corrupted or one of the other conditions given in the table above occurs EEPROM Fail.xxx trip is produced. If this trip occurs it is not possible to use the data that has been saved previously, and so the drive will be in lowest allowed drive mode with default parameters. The trip can only be reset if Pr mm.000 (mm.000) is set to 10, 11, 1233 or 1244 or if <i>Load Defaults</i> (11.043) is set to a non-zero value. | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> • 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 | | | | | | | | | | | | | | | | | | | | | |
| Encoder 9 | Position feedback is selected from a option module slot which does not have a feedback option module installed | | | | | | | | | | | | | | | | | | | | |
| 197 | The <i>Encoder 9</i> trip indicates that position feedback source selected in Pr 03.026 is not valid | | | | | | | | | | | | | | | | | | | | |
| | Recommended actions: | | | | | | | | | | | | | | | | | | | | |
| | <ul style="list-style-type: none"> • Check the setting of Pr 03.026 • Ensure that the option slot selected in Pr 03.026 has a feedback option module installed | | | | | | | | | | | | | | | | | | | | |
| External Trip | An External trip is initiated | | | | | | | | | | | | | | | | | | | | |
| 6 | An <i>External Trip</i> 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td><i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low</td> </tr> <tr> <td>2</td> <td><i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low</td> </tr> <tr> <td>3</td> <td><i>External Trip</i> (10.032) = 1</td> </tr> </tbody> </table> | Sub-trip | Reason | 1 | <i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low | 2 | <i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low | 3 | <i>External Trip</i> (10.032) = 1 | | | | | | | | | | | | |
| | Sub-trip | Reason | | | | | | | | | | | | | | | | | | | |
| | 1 | <i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low | | | | | | | | | | | | | | | | | | | |
| 2 | <i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low | | | | | | | | | | | | | | | | | | | | |
| 3 | <i>External Trip</i> (10.032) = 1 | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> • 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 | | | | | | | | | | | | | | | | | | | | | |
| HF01 | Data processing error: CPU address error | | | | | | | | | | | | | | | | | | | | |
| | The <i>HF01</i> trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed. | | | | | | | | | | | | | | | | | | | | |
| | Recommended actions: | | | | | | | | | | | | | | | | | | | | |
| | <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis |
|-------------|--|
| HF02 | Data processing error: DMAC address error |
| | The <i>HF02</i> trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF03 | Data processing error: Illegal instruction |
| | The <i>HF03</i> trip indicates that an illegal instruction has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF04 | Data processing error: Illegal slot instruction |
| | The <i>HF04</i> trip indicates that an illegal slot instruction has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF05 | Data processing error: Undefined exception |
| | The <i>HF05</i> trip indicates that an undefined exception error has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF06 | Data processing error: Reserved exception |
| | The <i>HF06</i> trip indicates that a reserved exception error has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF07 | Data processing error: Watchdog failure |
| | The <i>HF07</i> trip indicates that a watchdog failure has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF08 | Data processing error: CPU interrupt crash |
| | The <i>HF08</i> trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF09 | Data processing error: Free store overflow |
| | The <i>HF09</i> trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF10 | Data processing error: Parameter routing system error |
| | The <i>HF10</i> trip indicates that a Parameter routing system error has occurred. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |
| HF11 | Data processing error: Access to EEPROM failed |
| | The <i>HF11</i> trip indicates that access to the drive EEPROM has failed. This trip indicates that the control PCB on the drive has failed. Recommended actions: <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | |
|-------------|--|----------|--------|---|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HF12 | <p>Data processing error: Main program stack overflow</p> <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Stack</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | Sub-trip | Stack | 1 | Background tasks | 2 | Timed tasks | 3 | Main system interrupts | | | | | | | | | | | | |
| Sub-trip | Stack | | | | | | | | | | | | | | | | | | | | |
| 1 | Background tasks | | | | | | | | | | | | | | | | | | | | |
| 2 | Timed tasks | | | | | | | | | | | | | | | | | | | | |
| 3 | Main system interrupts | | | | | | | | | | | | | | | | | | | | |
| HF13 | <p>Data processing error: Firmware incompatible with hardware</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Re-program the drive with the latest version of the drive firmware • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF14 | <p>Data processing error: CPU register bank error</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF15 | <p>Data processing error: CPU divide error</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF16 | <p>Data processing error: RTOS error</p> <p>The <i>HF16</i> trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF17 | <p>Data processing error: Clock supplied to the control board is out of specification</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF18 | <p>Data processing error: Internal flash memory has failed</p> <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Hardware fault - Contact the supplier of the drive. | Sub-trip | Reason | 1 | Option module initialization timed out | 2 | Programming error while writing menu in flash | 3 | Erase flash block containing setup menus failed | 4 | Erase flash block containing application menus failed | 5 | Incorrect setup menu CRC contained in flash | 6 | Incorrect application menu CRC contained in flash | 7 | Incorrect common application menu 18 CRC contained in flash | 8 | Incorrect common application menu 19 CRC contained in flash | 9 | Incorrect common application menu 20 CRC contained in flash |
| Sub-trip | Reason | | | | | | | | | | | | | | | | | | | | |
| 1 | Option module initialization timed out | | | | | | | | | | | | | | | | | | | | |
| 2 | Programming error while writing menu in flash | | | | | | | | | | | | | | | | | | | | |
| 3 | Erase flash block containing setup menus failed | | | | | | | | | | | | | | | | | | | | |
| 4 | Erase flash block containing application menus failed | | | | | | | | | | | | | | | | | | | | |
| 5 | Incorrect setup menu CRC contained in flash | | | | | | | | | | | | | | | | | | | | |
| 6 | Incorrect application menu CRC contained in flash | | | | | | | | | | | | | | | | | | | | |
| 7 | Incorrect common application menu 18 CRC contained in flash | | | | | | | | | | | | | | | | | | | | |
| 8 | Incorrect common application menu 19 CRC contained in flash | | | | | | | | | | | | | | | | | | | | |
| 9 | Incorrect common application menu 20 CRC contained in flash | | | | | | | | | | | | | | | | | | | | |
| HF19 | <p>Data processing error: CRC check on the firmware has failed</p> <p>The <i>HF19</i> trip indicates that the CRC check on the drive firmware has failed.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Re-program the drive • Hardware fault - Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | |
|------------------------------|---|------------------------------|---|-------|--------|-------|--------|-------|--------|-------|--------|----------|--------|---|---|---|---|---|---|---|---|
| HF20 | Data processing error: ASIC is not compatible with the hardware | | | | | | | | | | | | | | | | | | | | |
| | The <i>HF20</i> 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: <ul style="list-style-type: none"> Hardware fault - Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| HF23 to HF25 | Hardware fault | | | | | | | | | | | | | | | | | | | | |
| | Recommended actions: <ul style="list-style-type: none"> Hardware fault - Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | |
| I/O Overload | Digital output overload | | | | | | | | | | | | | | | | | | | | |
| 26 | The <i>I/O Overload</i> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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. | | | | | | | | | | | | | | | | | | | | |
| 8 | This trip occurs in RFC-S mode when the drive has detected that the motor inductances are not suitable for the operation being attempted. The trip is either caused because the ratio or difference between Ld and Lq is too small or because the saturation characteristic of the motor cannot be measured. If the inductance ratio or difference is too small this is because one of the following conditions is true: $(\text{No-load } L_q (05.072) - L_d (05.024)) / L_d (05.024) < 0.1$ $(\text{No-load } L_q (05.072) - L_d (05.024)) < (K / \text{Full Scale Current } K_c (11.061))H$ where: <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Drive Rated voltage (11.033)</th> <th>K</th> </tr> </thead> <tbody> <tr> <td>200 V</td> <td>0.0073</td> </tr> <tr> <td>400 V</td> <td>0.0146</td> </tr> <tr> <td>575 V</td> <td>0.0174</td> </tr> <tr> <td>690 V</td> <td>0.0209</td> </tr> </tbody> </table> 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 <i>Rated Current</i> (05.007) is applied in the d axis of the motor in each direction the inductance must fall change at least $(K / (2 \times \text{Full Scale Current } K_c (11.061))) H$. The specific reasons for each of the sub-trips and recommended actions are given in the table below. <table border="1" style="margin-left: 20px;"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The inductance ratio or difference is too small when the drive has been started in sensorless mode.</td> </tr> <tr> <td>2</td> <td>The saturation characteristic of the motor cannot be measured when the drive has been started in sensorless mode.</td> </tr> <tr> <td>3</td> <td>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 <i>Position Feedback Phase Angle</i> (03.025) may not be reliable. Also the measured values of <i>Ld</i> (05.024) and <i>No-load Lq</i> (05.072) may not correspond to the d and q axis respectively.</td> </tr> <tr> <td>4</td> <td>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.</td> </tr> </tbody> </table> Recommended actions for sub-trip 1: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> 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: <ul style="list-style-type: none"> None. The trip acts as a warning. Recommended actions for sub-trip 4: <ul style="list-style-type: none"> 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. | Drive Rated voltage (11.033) | K | 200 V | 0.0073 | 400 V | 0.0146 | 575 V | 0.0174 | 690 V | 0.0209 | 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 <i>Position Feedback Phase Angle</i> (03.025) may not be reliable. Also the measured values of <i>Ld</i> (05.024) and <i>No-load Lq</i> (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. |
| Drive Rated voltage (11.033) | K | | | | | | | | | | | | | | | | | | | | |
| 200 V | 0.0073 | | | | | | | | | | | | | | | | | | | | |
| 400 V | 0.0146 | | | | | | | | | | | | | | | | | | | | |
| 575 V | 0.0174 | | | | | | | | | | | | | | | | | | | | |
| 690 V | 0.0209 | | | | | | | | | | | | | | | | | | | | |
| 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 <i>Position Feedback Phase Angle</i> (03.025) may not be reliable. Also the measured values of <i>Ld</i> (05.024) and <i>No-load Lq</i> (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. | | | | | | | | | | | | | | | | | | | | |

| 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 <i>Keypad Mode</i> trip indicates that the drive is in keypad mode [<i>Reference Selector (01.014)</i> = 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: <ul style="list-style-type: none"> • Re-install keypad and reset • Change <i>Reference Selector (01.014)</i> to select the reference from another source |
| Motor Too Hot | Output current overload timed out (I^2t) |
| 20 | The <i>Motor Too Hot</i> 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 <i>Motor Too Hot</i> when Pr 04.019 gets to 100 %. Recommended actions: <ul style="list-style-type: none"> • 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 \leq 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 |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | |
|--|---|--|-------------|---------------------------------------|--|-------------|-----------------------------------|----|-------------------------|----|--|----------------|----|---|----|---|----------------|----|---|----|---------------------------------------|
| Name Plate | Electronic nameplate transfer has failed | | | | | | | | | | | | | | | | | | | | |
| 176 | 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Description | 1 | Not enough memory space to complete the transfer | 2 | Communication with encoder failed | 3 | The transfer has failed | 4 | The checksum of the stored object has failed | | | | | | | | | | |
| | Sub-trip | Description | | | | | | | | | | | | | | | | | | | |
| | 1 | Not enough memory space to complete the transfer | | | | | | | | | | | | | | | | | | | |
| | 2 | Communication with encoder failed | | | | | | | | | | | | | | | | | | | |
| 3 | The transfer has failed | | | | | | | | | | | | | | | | | | | | |
| 4 | The checksum of the stored object has failed | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> • 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. | | | | | | | | | | | | | | | | | | | | | |
| Oht Brake | Braking IGBT over-temperature | | | | | | | | | | | | | | | | | | | | |
| 101 | The <i>Oht Brake</i> over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model. | | | | | | | | | | | | | | | | | | | | |
| | Recommended actions: | | | | | | | | | | | | | | | | | | | | |
| | <ul style="list-style-type: none"> • Check braking resistor value is greater than or equal to the minimum resistance value | | | | | | | | | | | | | | | | | | | | |
| Oht Control | Control stage over temperature | | | | | | | | | | | | | | | | | | | | |
| 23 | This <i>Oht Control</i> trip indicates that a control stage over-temperature has been detected. From the sub-trip 'xyzz', the Thermistor location is identified by 'zz'. | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> | 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 | I/O board thermistor over temperature |
| | 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 | I/O board thermistor over temperature | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> • 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 | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | |
|---------------------|--|--------|----|--|---|-------------|----------------|----|---|----|---|----------------|----|---|----|----------------------------|----------------|----|---|----|--|
| Oht dc bus | DC bus over temperature | | | | | | | | | | | | | | | | | | | | |
| 27 | <p>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.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>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:</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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; <ul style="list-style-type: none"> • 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) | Source | xx | y | zz | Description | Control system | 00 | 2 | 00 | DC bus thermal model gives trip with sub-trip 0 | Source | xx | y | zz | Description | Control system | 01 | 0 | 00 | Power stage gives trip with sub-trip 0 |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | |
| | Control system | 00 | 2 | 00 | DC bus thermal model gives trip with sub-trip 0 | | | | | | | | | | | | | | | | |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | |
| Control system | 01 | 0 | 00 | Power stage gives trip with sub-trip 0 | | | | | | | | | | | | | | | | | |
| Oht Inverter | Inverter over temperature based on thermal model | | | | | | | | | | | | | | | | | | | | |
| 21 | <p>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:</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions with sub-trip 100:</p> <ul style="list-style-type: none"> • 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 <p>Recommended actions with sub-trip 300:</p> <ul style="list-style-type: none"> • Reduce the braking load. | Source | xx | y | zz | Description | Control system | 00 | 1 | 00 | Inverter thermal model | Control system | 00 | 3 | 00 | Braking IGBT thermal model | | | | | |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | |
| | Control system | 00 | 1 | 00 | Inverter thermal model | | | | | | | | | | | | | | | | |
| | Control system | 00 | 3 | 00 | Braking IGBT thermal model | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|------------------|--|---------------------|------------------|---|--|-------------|----------------|----|---|----|---|--------------|---------------------|------------------|----|--|--------|----|---|----|-------------|--------------|---------------------|---|----|----------------------|--------------|---------------------|---|----|----------------------|--------------|---------------------|---|----|----------------------|--------------|---------------------|---|----|-----------|--------------|---------------------|---|----|----------------------|--------------|---------------------|---|----|--------------|
| Oht Power | Power stage over temperature | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | <p>This trip indicates that a power stage over-temperature has been detected. The sub-trip "xxyz" indicates which thermistor is indicating the over-temperature. The thermistor 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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Multi-module type system:</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </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> <ul style="list-style-type: none"> • 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 | Source | xx | y | zz | Description | Power system | 01 | 0 | zz | Thermistor location defined by zz in the power board | Power system | 01 | Rectifier number | zz | Thermistor location defined by zz in the rectifier | Source | xx | y | zz | Description | Power system | power module number | 0 | 01 | U phase power device | Power system | power module number | 0 | 02 | V phase power device | Power system | power module number | 0 | 03 | W phase power device | Power system | power module number | 0 | 04 | Rectifier | Power system | power module number | 0 | 05 | General power system | Power system | power module number | 0 | 00 | Braking IGBT |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | 01 | 0 | zz | Thermistor location defined by zz in the power board | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | 01 | Rectifier number | zz | Thermistor location defined by zz in the rectifier | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | power module number | 0 | 01 | U phase power device | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | power module number | 0 | 02 | V phase power device | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | power module number | 0 | 03 | W phase power device | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | power module number | 0 | 04 | Rectifier | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | power module number | 0 | 05 | General power system | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | power module number | 0 | 00 | Braking IGBT | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| OI ac | Instantaneous output over current detected | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | <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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • 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) | Source | xx | y | zz | Description | Control system | 00 | 0 | 00 | Instantaneous over-current trip when the measured a.c. current exceeds VM_DRIVE_CURRENT[MAX]. | Power system | Power module number | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control system | 00 | 0 | 00 | Instantaneous over-current trip when the measured a.c. current exceeds VM_DRIVE_CURRENT[MAX]. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | Power module number | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | |
|---|--|-------------------|----|---|-------------|----------------|--------------|---------------------|-------------------|--------------|---|---|----|
| OI Brake | Braking IGBT over current detected: short circuit protection for the braking IGBT activated | | | | | | | | | | | | |
| 4 | 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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> | Source | xx | y | zz | Description | Power system | Power module number | 0 | 00 | Braking IGBT instantaneous over-current trip | | |
| | Source | xx | y | zz | Description | | | | | | | | |
| Power system | Power module number | 0 | 00 | Braking IGBT instantaneous over-current trip | | | | | | | | | |
| <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check brake resistor wiring • Check braking resistor value is greater than or equal to the minimum resistance value • Check braking resistor insulation | | | | | | | | | | | | | |
| OI dc | Power module over current detected from IGBT on state voltage monitoring | | | | | | | | | | | | |
| 109 | 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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <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> </tbody> </table> | Source | xx | y | zz | Control system | 00 | 0 | 00 | Power system | Power module number | 0 | 00 |
| | Source | xx | y | zz | | | | | | | | | |
| Control system | 00 | 0 | 00 | | | | | | | | | | |
| Power system | Power module number | 0 | 00 | | | | | | | | | | |
| <p>Recommended actions:</p> <ul style="list-style-type: none"> • Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester • Replace the drive | | | | | | | | | | | | | |
| OI Snubber | Snubber over-current detected | | | | | | | | | | | | |
| 92 | 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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Power system</td> <td>01</td> <td>Rectifier number*</td> <td>00</td> <td>Rectifier snubber over-current trip detected.</td> </tr> </tbody> </table> | Source | xx | y | zz | Description | Power system | 01 | Rectifier number* | 00 | Rectifier snubber over-current trip detected. | | |
| | Source | xx | y | zz | Description | | | | | | | | |
| Power system | 01 | Rectifier number* | 00 | Rectifier snubber over-current trip detected. | | | | | | | | | |
| <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> <ul style="list-style-type: none"> • 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 • Adjust brake turn on threshold to control the DC bus at a lower level when the drive is regenerating, by reducing the value in Braking IGBT Upper Threshold (Pr 06.074). | | | | | | | | | | | | | |
| Option Disable | Option module does not acknowledge during drive mode changeover | | | | | | | | | | | | |
| 215 | <p>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.</p> <p>Recommended trip:</p> <ul style="list-style-type: none"> • Reset the trip • If the trip persists replace the option module | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|---|--|---|------------------------|--|-----|--|-----|--|-----|--|-----|-----|-----|------|------|--------|----|---|----|----------------|----|---|--|----------------|----|---|---|
| Out Phase Loss | Output phase loss detected | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 98 | <p>The <i>Out Phase Loss</i> trip indicates that a phase loss has been detected at the drive output.</p> <p>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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended action:</p> <ul style="list-style-type: none"> Check motor and drive connections To disable the trip set <i>Output Phase Loss Detection Enable</i> (06.059) = 0 | Sub-trip | Reason | 1 | U phase detected as disconnected when drive enabled to run | 2 | V phase detected as disconnected when drive enabled to run | 3 | W phase detected as disconnected when drive enabled to run | 4 | Output phase loss detected when the drive is running | | | | | | | | | | | | | | | | | |
| | Sub-trip | Reason | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | U phase detected as disconnected when drive enabled to run | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | V phase detected as disconnected when drive enabled to run | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 3 | W phase detected as disconnected when drive enabled to run | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | Output phase loss detected when the drive is running | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Over Speed | Motor speed has exceeded the over speed threshold | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | <p>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.</p> <p>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.</p> <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> 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 <p>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.</p> | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Over Volts | DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | <p>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.</p> <table border="1"> <thead> <tr> <th>Voltage rating</th> <th>VM_DC_VOLTAGE[MAX]</th> <th>VM_DC_VOLTAGE_SET[MAX]</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Sub-trip Identification</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <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> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> 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 | Voltage rating | VM_DC_VOLTAGE[MAX] | VM_DC_VOLTAGE_SET[MAX] | 200 | 415 | 410 | 400 | 830 | 815 | 575 | 990 | 970 | 690 | 1190 | 1175 | Source | xx | y | zz | Control system | 00 | 0 | 01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX]. | Control system | 00 | 0 | 02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX]. |
| | Voltage rating | VM_DC_VOLTAGE[MAX] | VM_DC_VOLTAGE_SET[MAX] | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 200 | 415 | 410 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 400 | 830 | 815 | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 575 | 990 | 970 | | | | | | | | | | | | | | | | | | | | | | | | | |
| 690 | 1190 | 1175 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Source | xx | y | zz | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control system | 00 | 0 | 01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX]. | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control system | 00 | 0 | 02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX]. | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | |
|----------------------|---|----------------------|--|---|----|----------------|---------------------|-------------------|--|------------------|---------------------|----------------------|--|
| Phase Loss | Supply phase loss | | | | | | | | | | | | |
| 32 | <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 border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <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> </tbody> </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>Recommended actions:</p> <ul style="list-style-type: none"> • 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 | Source | xx | y | zz | Control system | 00 | 0 | 00: Phase loss detected from DC bus ripple | Power system (1) | Power module number | Rectifier number (2) | 00: Phase loss detected directly from the supply |
| Source | xx | y | zz | | | | | | | | | | |
| Control system | 00 | 0 | 00: Phase loss detected from DC bus ripple | | | | | | | | | | |
| Power system (1) | Power module number | Rectifier number (2) | 00: Phase loss detected directly from the supply | | | | | | | | | | |
| Phasing error | This indicates that the phase offset angle is incorrect | | | | | | | | | | | | |
| 198 | <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> <ul style="list-style-type: none"> • 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> <ul style="list-style-type: none"> • Ensure that the motor parameters are set-up correctly. • Reduce the speed controller gains. | | | | | | | | | | | | |
| Power Comms | A Power Comms trip indicates a communications problem within the power system of the drive | | | | | | | | | | | | |
| 90 | <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 border="1"> <thead> <tr> <th>Type of drive</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <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> </tbody> </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> <ul style="list-style-type: none"> • Hardware fault – Contact the supplier of the drive | Type of drive | xx | y | zz | Control system | Power module number | Rectifier number* | 00: Excessive communications errors detected by the rectifier module | | | | |
| Type of drive | xx | y | zz | | | | | | | | | | |
| Control system | Power module number | Rectifier number* | 00: Excessive communications errors detected by the rectifier module | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|--|---------------------|--|--|--|----------------|----------------|----|--------------------------------|--------------|--|-------------------|--|---|----|--|----------------|----|---|----|--|----------------|----|---|----|------------------|----------------|----|---|----|--|--------------|---------------------|---|----|--|--------------|---------------------|---|----|---|--------------|---------------------|---|----|--|
| Power Data | Power system configuration data error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 220 | The <i>Power Data</i> trip indicates that there is an error in the configuration data stored in the power system. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> | Source | xx | y | zz | Description | Control system | 00 | 0 | 02 | There is no data table to be uploaded to the control board | Control system | 00 | 0 | 03 | The power system data table is bigger than the space available in the control pod to store it. | Control system | 00 | 0 | 04 | The size of the table given in the table is incorrect. | Control system | 00 | 0 | 05 | Table CRC error. | Control system | 00 | 0 | 06 | The version number of the generator software that produced the table is too low. i.e. a table from a newer generator is required that includes features that have been added to the table that may not be present. | Power system | Power module number | 0 | 00 | The power data table used internally by the power module has an error. (For a multi-power module drive this indicates any error with the code tables in the power system). | Power system | Power module number | 0 | 01 | The power data table that is uploaded to the control system on power up has an error. | Power system | Power module number | 0 | 02 | The power data table used internally by the power module does not match the hardware identification of the power module. |
| | Source | xx | y | zz | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Control system | 00 | 0 | 02 | There is no data table to be uploaded to the control board | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Control system | 00 | 0 | 03 | The power system data table is bigger than the space available in the control pod to store it. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Control system | 00 | 0 | 04 | The size of the table given in the table is incorrect. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Control system | 00 | 0 | 05 | Table CRC error. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Control system | 00 | 0 | 06 | The version number of the generator software that produced the table is too low. i.e. a table from a newer generator is required that includes features that have been added to the table that may not be present. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | Power module number | 0 | 00 | The power data table used internally by the power module has an error. (For a multi-power module drive this indicates any error with the code tables in the power system). | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Power system | Power module number | 0 | 01 | The power data table that is uploaded to the control system on power up has an error. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | Power module number | 0 | 02 | The power data table used internally by the power module does not match the hardware identification of the power module. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power Down Save | Power down save error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37 | 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: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Perform a 1001 save in Pr mm.000 to ensure that the trip doesn't occur the next time the drive is powered up. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PSU | Internal power supply fault | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | The <i>PSU</i> trip indicates that one or more internal power supply rails are outside limits or overloaded. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>Description</th> </tr> </thead> <tbody> <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> </tbody> </table> | Source | xx | y | Description | Control system | 00 | 0 | Internal power supply overload | Power system | Power module number | Rectifier number* | Rectifier internal power supply overload | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Source | xx | y | Description | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control system | 00 | 0 | Internal power supply overload | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | Power module number | Rectifier number* | Rectifier internal power supply overload | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| *For a parallel power-module system the rectifier number will be zero as it is not possible to determine which rectifier has detected the fault. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| PSU 24V | 24V internal power supply overload | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 9 | The total user load of the drive and option modules has exceeded the internal 24 V power supply limit. The user load consists of the drive digital outputs and main encoder supply. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Reduce the load and reset Provide an external 24 V power supply on control terminal 2 Remove all option modules | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | |
|--|---|----------|--------|---|---|---|--|---|--|
| Rating Mismatch | Power stage recognition: Multi module voltage or current rating mismatch | | | | | | | | |
| 223 | <p>The <i>Rating Mismatch</i> 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.</p> <p>Recommended action:</p> <ul style="list-style-type: none"> • 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 | <p>A rectifier has not been set-up correctly in a multi-power module system.</p> <p>Recommended action:</p> <ul style="list-style-type: none"> • Check the inter-power module wiring | | | | | | | | |
| Reserved | Reserved trips | | | | | | | | |
| 01 95 102 104 - 108 161-168 170-173 222 228-246 | <p>These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.</p> | | | | | | | | |
| Resistance | Measured resistance has exceeded the parameter range | | | | | | | | |
| 33 | <p>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 $(VFS / \sqrt{2}) / Full\ Scale\ Current\ Kc$ (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 measure the drive inverter characteristics to provide the compensation necessary for dead-times. If the inverter characteristic measurement fails then sub-trip 2 is applied.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Measured stator resistance exceeded the allowed range</td> </tr> <tr> <td>2</td> <td>It was not possible to measure the inverter characteristic</td> </tr> <tr> <td>3</td> <td>The stator resistance associated with the presently selected motor map exceeds the allowed range</td> </tr> </tbody> </table> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Check that the value that has been entered in the stator resistance does not exceed the allowed range (for the presently selected motor map) • Check the motor cable / connections • Check the integrity of the motor stator winding using an insulation tester • Check the motor phase to phase resistance at the drive terminals • Check the motor phase to phase resistance at the motor terminals • Ensure the stator resistance of the motor falls within the range of the drive model • Select fixed boost mode (Pr 05.014 = Fixed) and verify the output current waveforms with an oscilloscope • Replace the motor | Sub-trip | Reason | 1 | Measured stator resistance exceeded the allowed range | 2 | It was not possible to measure the inverter characteristic | 3 | The stator resistance associated with the presently selected motor map exceeds the allowed range |
| 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 | | | | | | | | |
| Slot App Menu | Application menu Customization conflict error | | | | | | | | |
| 216 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> • Ensure that only one of the Application modules is configured to customize the application menus 18, 19 and 20 | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | |
|---|--|--|--------|---|--|---|--|---|--|---|--|-----|--|---|--|---|--|---|---|---|--|----|------------------------|
| SlotX Different | Option module in option slot X has changed | | | | | | | | | | | | | | | | | | | | | | |
| 204 209 214 | The <i>SlotX Different</i> 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | No module was installed previously | 2 | A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu. | 3 | A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu. | 4 | A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus. | >99 | Shows the identifier of the module previously installed. | | | | | | | | | | |
| | Sub-trip | Reason | | | | | | | | | | | | | | | | | | | | | |
| | 1 | No module was installed previously | | | | | | | | | | | | | | | | | | | | | |
| | 2 | A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu. | | | | | | | | | | | | | | | | | | | | | |
| | 3 | A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu. | | | | | | | | | | | | | | | | | | | | | |
| 4 | A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus. | | | | | | | | | | | | | | | | | | | | | | |
| >99 | Shows the identifier of the module previously installed. | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> 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. | | | | | | | | | | | | | | | | | | | | | | | |
| SlotX Error | Option module in option slot X has detected a fault | | | | | | | | | | | | | | | | | | | | | | |
| 202 207 212 | The <i>SlotX Error</i> 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: | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> See relevant <i>Option Module User Guide</i> for details of the trip | | | | | | | | | | | | | | | | | | | | | | | |
| SlotX HF | Option module X hardware fault | | | | | | | | | | | | | | | | | | | | | | |
| 200 205 210 | The <i>SlotX HF</i> 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <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> </tbody> </table> | Sub-trip | Reason | 1 | The module category cannot be identified | 2 | All the required customized menu table information has not been supplied or the tables supplied are corrupt | 3 | There is insufficient memory available to allocate the comms buffers for this module | 4 | The module has not indicated that it is running correctly during drive power-up | 5 | Module has been removed after power-up or it has stopped working | 6 | The module has not indicated that it has stopped accessing drive parameters during a drive mode change | 7 | The module has failed to acknowledge that a request has been made to reset the drive processor | 8 | The drive failed to correctly read the menu table from the module during drive power up | 9 | The drive failed to upload menu tables from the module and timed out (5 s) | 10 | Menu table CRC invalid |
| | Sub-trip | Reason | | | | | | | | | | | | | | | | | | | | | |
| | 1 | The module category cannot be identified | | | | | | | | | | | | | | | | | | | | | |
| | 2 | All the required customized menu table information has not been supplied or the tables supplied are corrupt | | | | | | | | | | | | | | | | | | | | | |
| | 3 | There is insufficient memory available to allocate the comms buffers for this module | | | | | | | | | | | | | | | | | | | | | |
| | 4 | The module has not indicated that it is running correctly during drive power-up | | | | | | | | | | | | | | | | | | | | | |
| | 5 | Module has been removed after power-up or it has stopped working | | | | | | | | | | | | | | | | | | | | | |
| | 6 | The module has not indicated that it has stopped accessing drive parameters during a drive mode change | | | | | | | | | | | | | | | | | | | | | |
| | 7 | The module has failed to acknowledge that a request has been made to reset the drive processor | | | | | | | | | | | | | | | | | | | | | |
| | 8 | The drive failed to correctly read the menu table from the module during drive power up | | | | | | | | | | | | | | | | | | | | | |
| 9 | The drive failed to upload menu tables from the module and timed out (5 s) | | | | | | | | | | | | | | | | | | | | | | |
| 10 | Menu table CRC invalid | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Ensure the option module is installed correctly Replace the option module Replace the drive | | | | | | | | | | | | | | | | | | | | | | | |
| SlotX Not Fitted | Option module in option slot X has been removed | | | | | | | | | | | | | | | | | | | | | | |
| 203 208 213 | The <i>SlotX Not Fitted</i> trip indicates that the option module in option slot X on the drive has been removed since the last power up. | | | | | | | | | | | | | | | | | | | | | | |
| Recommended actions: | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Ensure the option module is installed correctly. Re-install the option module. To confirm that the removed option module is no longer required perform a save function in Pr mm.000. | | | | | | | | | | | | | | | | | | | | | | | |
| SlotX Watchdog | Option module watchdog function service error | | | | | | | | | | | | | | | | | | | | | | |
| 201 206 211 | The <i>SlotX Watchdog</i> 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: | | | | | | | | | | | | | | | | | | | | | | | |
| <ul style="list-style-type: none"> Replace the option module | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------------------------|--|-------------------|--|-------|------|---------------|------|--------|--|--------------|---------------------|--------|--|----------------|---------------------|-------------------|-------------|-----------|-----|-----------------|-----|-----------|-------|-------|-------------------|-------|---|------------------|----|---|----------------------|----|---|----------------------------|----|---|----------------------|----|---|----------------------------|----|---|----------------------|----|---|----------------------------|----|---|
| Soft Start | Soft start relay failed to close, soft start monitor failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 226 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Stored HF | Hardware trip has occurred during last power down | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 221 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> Enter 1299 in Pr mm.000 and press reset to clear the trip | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub-array RAM | RAM allocation error | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 227 | <p>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.</p> <table border="1" style="display: inline-table; margin-right: 20px;"> <thead> <tr> <th>Parameter size</th> <th>Value</th> </tr> </thead> <tbody> <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> </tbody> </table> <table border="1" style="display: inline-table;"> <thead> <tr> <th>Parameter type</th> <th>Value</th> </tr> </thead> <tbody> <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> </tbody> </table> <table border="1"> <thead> <tr> <th>Sub-array</th> <th>Menus</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>Applications menu</td> <td>18-20</td> <td>1</td> </tr> <tr> <td>Derivative image</td> <td>29</td> <td>2</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> </tbody> </table> | Parameter size | Value | 1 bit | 1000 | 8 bit | 2000 | 16 bit | 3000 | 32 bit | 4000 | 64 bit | 5000 | Parameter type | Value | Volatile | 0 | User save | 100 | Power-down save | 200 | Sub-array | Menus | Value | Applications menu | 18-20 | 1 | Derivative image | 29 | 2 | Option slot 1 set-up | 15 | 4 | Option slot 1 applications | 25 | 5 | Option slot 2 set-up | 16 | 6 | Option slot 2 applications | 26 | 7 | Option slot 3 set-up | 17 | 8 | Option slot 3 applications | 27 | 9 |
| Parameter size | Value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1 bit | 1000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 8 bit | 2000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 16 bit | 3000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32 bit | 4000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 64 bit | 5000 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Parameter type | Value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Volatile | 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User save | 100 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power-down save | 200 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sub-array | Menus | Value | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Applications menu | 18-20 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Derivative image | 29 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 1 set-up | 15 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 1 applications | 25 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 2 set-up | 16 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 2 applications | 26 | 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 3 set-up | 17 | 8 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option slot 3 applications | 27 | 9 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Temp Feedback | Internal thermistor has failed | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 218 | <p>The <i>Temp Feedback</i> trip indicates that an internal thermistor has failed. The thermistor location can be identified by the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <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> </tbody> </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> <ul style="list-style-type: none"> Hardware fault – Contact the supplier of the drive | Source | xx | y | zz | Control board | 00 | 00 | 01: Control board thermistor 1 02: Control board thermistor 2 03: I/O board thermistor | Power system | Power module number | 0 | Zero for temperature feedback provided via power system comms.21, 22 and 23 for direct ELV temperature feedback. | Power system | Power module number | Rectifier number* | Always zero | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Source | xx | y | zz | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Control board | 00 | 00 | 01: Control board thermistor 1 02: Control board thermistor 2 03: I/O board thermistor | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | Power module number | 0 | Zero for temperature feedback provided via power system comms.21, 22 and 23 for direct ELV temperature feedback. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power system | Power module number | Rectifier number* | Always zero | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Th Brake Res | Brake resistor over temperature | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 10 | <p>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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> Check brake resistor wiring Check braking resistor value is greater than or equal to the minimum resistance value Check braking resistor insulation | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis | | | | | | |
|--|---|---|--------|---|---|---|--|
| Th Short Circuit | Motor thermistor short circuit | | | | | | |
| 25 | This trip indicates that a temperature sensor connected to an analogue input or terminal 15 on the position feedback interface has a low impedance (i.e. < 50 Ω). The cause of the trip can be identified by the sub-trip number. | | | | | | |
| | <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>3</td> <td><i>Analog Input 3 Mode (07.015) = 7</i> 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 (03.123) = 1</i> and the resistance of the thermistor connected to the drive P1 position feedback interface is less than 50 Ω.</td> </tr> </tbody> </table> | Sub-trip | Reason | 3 | <i>Analog Input 3 Mode (07.015) = 7</i> and the resistance of the thermistor connected to analog input 3 is less than 50 Ω. | 4 | <i>P1 Thermistor Short Circuit Detect (03.123) = 1</i> and the resistance of the thermistor connected to the drive P1 position feedback interface is less than 50 Ω. |
| | Sub-trip | Reason | | | | | |
| | 3 | <i>Analog Input 3 Mode (07.015) = 7</i> and the resistance of the thermistor connected to analog input 3 is less than 50 Ω. | | | | | |
| 4 | <i>P1 Thermistor Short Circuit Detect (03.123) = 1</i> and the resistance of the thermistor connected to the drive P1 position feedback interface is less than 50 Ω. | | | | | | |
| Recommended actions: | | | | | | | |
| <ul style="list-style-type: none"> • Check thermistor continuity • Replace motor / motor thermistor | | | | | | | |
| Thermistor | Motor thermistor over-temperature | | | | | | |
| 24 | 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 | | | | | | |
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| | Sub-trip | Reason | | | | | |
| | 3 | Trip initiated from analog input 3 | | | | | |
| 4 | Trip initiated from P1 position feedback interface | | | | | | |
| Recommended actions: | | | | | | | |
| <ul style="list-style-type: none"> • Check motor temperature • Check threshold level (07.048) • Check thermistor continuity | | | | | | | |
| Undefined | Drive has tripped and the cause of the trip is Undefined | | | | | | |
| 110 | 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: | | | | | | |
| <ul style="list-style-type: none"> • Hardware fault – return the drive to the supplier | | | | | | | |
| User 24V | User 24 V supply is not present on control terminals (1,2) | | | | | | |
| 91 | A <i>User 24 V</i> trip is initiated, if <i>User Supply Select (Pr 06.072)</i> is set to 1 or <i>Low Under Voltage Threshold Select (06.067) = 1</i> and no user 24 V supply is present on control terminals 1 and 2. | | | | | | |
| | Recommended actions: | | | | | | |
| <ul style="list-style-type: none"> • Ensure the user 24 V supply is present on control terminals 1 (0V) and 2 (24 V) | | | | | | | |

| Trip | Diagnosis | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-----------------------|--|--|--------|----------|---|----------------|--|---|----------------|--|---|--|--|---|--|--|---|--|--|---|--------------------------------|--|---|--|--|----|---|--|----|---|-------|----|--|-------|----|---|-------|----|---|--|----|--|-------|----|--|-------|----|-------------------------------|--|----|--|-------|----|--|-------|----|--|-------|----|--|-------|----|---|-------|----|--|-------|----|--|-------|----|--|-------|----|--|-------|----|--|--------------------------------------|----|--|-------|
| User Program | On board user program error (On Board User Program not supported on H300) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | The <i>User Program</i> 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. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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The image tasks will not run</td> </tr> <tr> <td>31</td> <td>The image requires more RAM for heap and stack than can be provided by the drive.</td> <td>As 30</td> </tr> <tr> <td>32</td> <td>The image requires an OS function call that is higher than the maximum allowed</td> <td>As 30</td> </tr> <tr> <td>33</td> <td>The ID code within the image is not valid</td> <td>As 30</td> </tr> <tr> <td>40</td> <td>The timed task has not completed in time and has been suspended</td> <td></td> </tr> <tr> <td>41</td> <td>Undefined function called, i.e. a function in the host system vector table that has not been</td> <td>As 40</td> </tr> <tr> <td>52</td> <td>Customized menu table CRC check failed</td> <td>As 30</td> </tr> <tr> <td>53</td> <td>Customized menu table changed</td> <td>Occurs when the drive powers-up or the image is programmed and the table has changed. 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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. 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| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
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| 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 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 249 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| User Prog Trip | Trip generated by an onboard user program (On Board User Program not supported on H300) | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | This trip can be initiated from within an onboard user program using a function call which defines the sub-trip number. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 96 | <p>Recommended actions:</p> <ul style="list-style-type: none"> Check the user program | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

| Trip | Diagnosis |
|--------------------|---|
| User Save | User Save error / not completed |
| 36 | <p>The <i>User Save</i> 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.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> 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 | <p>These trips are not generated by the drive and are to be used by the user to trip the drive through an application program.</p> <p>Recommended actions:</p> <ul style="list-style-type: none"> Check the user program |
| Watchdog | Control word watchdog has timed out |
| 30 | <p>The <i>Watchdog</i> trip indicates that the control word has been enabled and has timed out</p> <p>Recommended actions:</p> <p>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.</p> |

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 <i>Parameter (mm.000)</i> 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 <i>Load Defaults (11.043)</i> 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 <i>Action On Trip Detection (10.037)</i>). 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 | 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 and 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 value 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 Nidec 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 41 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 59 for further information.

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

Some drives may be through-hole mounted. Mounting brackets and sealing kits are available from Nidec Industrial Automation. Refer to section 3.5.2 *Through-panel mounting* on page 49 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 273.

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 77 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 77 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 286

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 180. 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 Nidec Industrial Automation.

Alternatively, the inverters may be supplied by converters from the *HVAC Drive-H300* range manufactured by Nidec Industrial Automation.

In these applications the inverters are required to be additionally protected by supplemental fuses.

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

Appendix A Leroy Somer Permanent magnet motor details

| | | Parameters | | | | | | | | | | | | | | | | | | |
|-----------------------|-----------------|----------------------------|----------------------------|---------------|-------------|---------------|-----------------------|-------------------|--------|--------------------|------------------------|------------|-----------------------------|---|---|---|---------------------------------|------------|------------|------------|
| | | 04.013 | 04.014 | 05.007 | 05.008 | 05.009 | 05.011 | 05.017 | 05.024 | 05.033 | 05.069 | 05.072 | 05.075 | 05.078 | 05.082 | 05.084 | 05.087 | | | |
| Motor Rated Frequency | Hz | Current controller Kp Gain | Current controller Ki Gain | Rated current | Rated speed | Rated voltage | Number Of Motor Poles | Stator Resistance | Ld | Volts per 1000 rpm | Over-current TripLevel | No-load Lq | Lq Test Current Measurement | Lq At The Defined Id Test Current Measurement | Lq At The Defined Id Test Current Measurement | Lq At The Defined Id Test Current Measurement | User Defined Rated Torque Angle | | | |
| 1500 range Motor Type | H300 Drive type | 50 | 152 | 269 | 21 | 1500 | 4 | 0.315822 | 7.63 | 72 | 236% | 68.5 | 73 | 44.8 | -108 | 68.5 | 56 | | | |
| | | | | | | | | | | | | | | | | | | 044-00240A | 044-00240A | 044-00240A |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| LSHRM 160 MR1_11 kW | H300 Drive type | 60 | 152 | 269 | 21 | 1800 | 4 | 0.315822 | 7.63 | 72 | 244% | 68.5 | 73 | 44.8 | -108 | 68.5 | 56 | | | |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| | | | | | | | | | | | | | | | | | | 064-00380A | 064-00380A | 064-00380A |
| LSHRM 160 LR1_15 kW | H300 Drive type | 50 | 304 | 493 | 28 | 1500 | 4 | 0.105274 | 2.54 | 42 | 218% | 67.9 | 75 | 40.5 | -106 | 67.9 | 58 | | | |
| | | | | | | | | | | | | | | | | | | 054-00300A | 054-00300A | 054-00300A |
| | | | | | | | | | | | | | | | | | | 054-00300A | 054-00300A | 054-00300A |
| LSHRM 180 M1_18.5 kW | H300 Drive type | 50 | 277 | 444 | 36 | 1800 | 4 | 0.284540 | 7.48 | 79 | 204% | 67.9 | 75 | 40.5 | -106 | 67.9 | 58 | | | |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| LSHRM 180 L1_22 kW | H300 Drive type | 50 | 277 | 444 | 36 | 1800 | 4 | 0.213304 | 5.68 | 73 | 185% | 43.3 | 71 | 31.5 | -109 | 43.3 | 57 | | | |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| | | | | | | | | | | | | | | | | | | 064-00480A | 064-00480A | 064-00480A |
| LSHRM 200 LQ1_30 kW | H300 Drive type | 60 | 190 | 252 | 55 | 1800 | 4 | 0.108310 | 3.49 | 72 | 181% | 27.5 | 69 | 19.7 | -110 | 27.5 | 58 | | | |
| | | | | | | | | | | | | | | | | | | 064-00630A | 064-00630A | 064-00630A |
| | | | | | | | | | | | | | | | | | | 064-00630A | 064-00630A | 064-00630A |
| LSHRM 225 S21_37 kW | H300 Drive type | 60 | 190 | 252 | 56 | 1800 | 4 | 0.088734 | 3.03 | 72 | 177% | 27.5 | 69 | 19.7 | -110 | 27.5 | 58 | | | |
| | | | | | | | | | | | | | | | | | | 074-00790A | 074-00790A | 074-00790A |
| | | | | | | | | | | | | | | | | | | 074-00790A | 074-00790A | 074-00790A |
| LSHRM 250 MG_45 kW | H300 Drive type | 60 | 220 | 172 | 82 | 1500 | 4 | 0.045053 | 2.467 | 77 | 201% | 23.6 | 67 | 14.6 | -111 | 23.6 | 59 | | | |
| | | | | | | | | | | | | | | | | | | 074-00940A | 074-00940A | 074-00940A |
| | | | | | | | | | | | | | | | | | | 074-00940A | 074-00940A | 074-00940A |
| LSHRM 250 ME_55 kW | H300 Drive type | 60 | 220 | 172 | 83 | 1800 | 4 | 0.045053 | 2.467 | 77 | 207% | 23.6 | 67 | 14.6 | -111 | 23.6 | 59 | | | |
| | | | | | | | | | | | | | | | | | | 084-01840A | 084-01840A | 084-01840A |
| | | | | | | | | | | | | | | | | | | 084-01840A | 084-01840A | 084-01840A |
| LSHRM 280 SD_75 kW | H300 Drive type | 60 | 261 | 163 | 134 | 1500 | 4 | 0.024613 | 1.677 | 82 | 185% | 16.7 | 63 | 9.0 | -114 | 16.7 | 61 | | | |
| | | | | | | | | | | | | | | | | | | 084-01550A | 084-01550A | 084-01550A |
| | | | | | | | | | | | | | | | | | | 084-01550A | 084-01550A | 084-01550A |
| LSHRM 280 MD_90 kW | H300 Drive type | 60 | 261 | 154 | 158 | 1800 | 4 | 0.019819 | 1.432 | 80 | 179% | 14.4 | 63 | 7.5 | -114 | 14.4 | 61 | | | |
| | | | | | | | | | | | | | | | | | | 084-02660A | 084-02660A | 084-02660A |
| | | | | | | | | | | | | | | | | | | 084-02660A | 084-02660A | 084-02660A |
| 104-03200E | H300 Drive type | 87 | 149 | 77 | 279 | 2600 | 4 | 0.006606 | 0.477 | 46 | 171% | 4.8 | 63 | 2.5 | -114 | 4.8 | 61 | | | |
| | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | |

| | | Parameters | | | | | | | | | | | | | | | | |
|--------------------------|-----------------|-----------------------|----------------------------|----------------------------|---------------|-------------|---------------|-----------------------|-------------------|---------------------------|--------------------|-------------------------|------------|------------------------------------|--------------------------------|---|--------------------------------|---------------------------------|
| | | 05.006 | 04.013 | 04.014 | 05.007 | 05.008 | 05.009 | 05.011 | 05.017 | 05.024 | 05.033 | 05.069 | 05.072 | 05.075 | 05.078 | 05.082 | 05.084 | 05.087 |
| | | Motor Rated Frequency | Current controller Kp Gain | Current controller Ki Gain | Rated current | Rated speed | Rated voltage | Number Of Motor Poles | Stator Resistance | Transient Inductance / Ld | Volts per 1000 rpm | Over-current Trip Level | No-load Lq | Current For Inductance Measurement | Lq At The Defined Test Current | Lq At The Defined Test Current for Inductance Measurement | Lq At The Defined Test Current | User Defined Rated Torque Angle |
| | | Hz | - | - | A | rpm | V | | Ω | mH | V/kmin-1 | % Inom | mH | % | mH | % | mH | ° |
| 3000 range Motor Type | H300 Drive Type | 044-00240A | 100 | 95 | 213 | 20 | 3000 | 400 | 0.250147 | 4.78 | 43 | 238% | 41.3 | 73 | 27.8 | -108 | 41.3 | 56 |
| | | 044-00240A | 120 | 95 | 213 | 20 | 3600 | 400 | 0.250147 | 4.78 | 43 | 244% | 41.3 | 73 | 27.8 | -108 | 41.3 | 56 |
| | | 064-00240A | 120 | 95 | 213 | 20 | 3600 | 460 | 0.250147 | 4.78 | 43 | 243% | 41.3 | 73 | 27.8 | -108 | 41.3 | 56 |
| | | 064-00480A | 173 | 78 | 173 | 36 | 5200 | 400 | 0.083382 | 1.59 | 25 | 223% | 13.8 | 73 | 9.3 | -108 | 13.8 | 56 |
| LSHRM 160 MR1_15kW | | 064-00380A | 100 | 117 | 223 | 28 | 3000 | 400 | 0.128766 | 2.88 | 39 | 254% | 25.5 | 75 | 17.7 | -106 | 25.5 | 55 |
| | | 054-00300A | 120 | 90 | 172 | 27 | 3600 | 400 | 0.128766 | 2.88 | 39 | 259% | 25.5 | 75 | 17.7 | -106 | 25.5 | 55 |
| | | 064-00380A | 120 | 117 | 223 | 28 | 3600 | 460 | 0.128766 | 2.88 | 39 | 249% | 25.5 | 75 | 17.7 | -106 | 25.5 | 55 |
| | | 064-00630A | 173 | 52 | 100 | 51 | 5200 | 400 | 0.042922 | 0.96 | 23 | 226% | 8.5 | 75 | 5.9 | -106 | 8.5 | 55 |
| LSHRM 160 LR1_18.5kW | | 064-00380A | 100 | 117 | 223 | 34 | 3000 | 400 | 0.128766 | 2.88 | 39 | 209% | 25.5 | 71 | 16.0 | -109 | 25.5 | 57 |
| | | 064-00380A | 120 | 117 | 223 | 33 | 3600 | 400 | 0.128766 | 2.88 | 39 | 214% | 25.5 | 71 | 16.0 | -109 | 25.5 | 57 |
| | | 064-00380A | 120 | 117 | 223 | 33 | 3600 | 460 | 0.128766 | 2.88 | 39 | 212% | 25.5 | 71 | 16.0 | -109 | 25.5 | 57 |
| | | 074-00790A | 173 | 74 | 140 | 62 | 5200 | 400 | 0.042922 | 0.96 | 23 | 186% | 8.5 | 71 | 5.3 | -109 | 8.5 | 57 |
| LSHRM 180 M1_22kW | | 064-00480A | 100 | 104 | 192 | 42 | 3000 | 400 | 0.092501 | 2.13 | 38 | 216% | 15.8 | 76 | 12.6 | -105 | 15.8 | 54 |
| | | 064-00480A | 120 | 104 | 192 | 40 | 3600 | 400 | 0.092501 | 2.13 | 38 | 224% | 15.8 | 76 | 12.6 | -105 | 15.8 | 54 |
| | | 064-00480A | 120 | 104 | 192 | 41 | 3600 | 460 | 0.092501 | 2.13 | 38 | 218% | 15.8 | 76 | 12.6 | -105 | 15.8 | 54 |
| | | 074-00940A | 173 | 64 | 118 | 74 | 5200 | 400 | 0.030834 | 0.71 | 22 | 200% | 5.3 | 76 | 4.2 | -105 | 5.3 | 54 |
| LSHRM 200 LQ1_30kW | | 064-00630A | 100 | 116 | 215 | 57 | 3000 | 400 | 0.092501 | 2.13 | 38 | 159% | 15.8 | 69 | 11.0 | -110 | 15.8 | 58 |
| | | 064-00630A | 120 | 116 | 215 | 57 | 3600 | 400 | 0.092501 | 2.13 | 38 | 158% | 15.8 | 69 | 11.0 | -110 | 15.8 | 58 |
| | | 064-00630A | 120 | 116 | 215 | 57 | 3600 | 460 | 0.092501 | 2.13 | 38 | 160% | 15.8 | 69 | 11.0 | -110 | 15.8 | 58 |
| | | 074-00790A | 120 | 109 | 174 | 70 | 3000 | 400 | 0.053326 | 1.42 | 37 | 178% | 10.8 | 71 | 8.0 | -109 | 10.8 | 57 |
| LSHRM 200 LQ1_37kW | | 074-00790A | 120 | 109 | 174 | 69 | 3600 | 400 | 0.053326 | 1.42 | 37 | 181% | 10.8 | 71 | 8.0 | -109 | 10.8 | 57 |
| | | 074-00790A | 120 | 109 | 174 | 69 | 3600 | 460 | 0.053326 | 1.42 | 37 | 181% | 10.8 | 71 | 8.0 | -109 | 10.8 | 57 |
| | | 074-00940A | 100 | 106 | 142 | 84 | 3000 | 400 | 0.037145 | 1.185 | 38 | 180% | 9.2 | 71 | 6.8 | -109 | 9.2 | 57 |
| | | 074-00940A | 120 | 106 | 142 | 82 | 3600 | 400 | 0.037145 | 1.185 | 38 | 184% | 9.2 | 71 | 6.8 | -109 | 9.2 | 57 |
| LSHRM 225 MY1_45kW | | 074-00940A | 120 | 106 | 142 | 83 | 3600 | 460 | 0.037145 | 1.185 | 38 | 181% | 9.2 | 71 | 6.8 | -109 | 9.2 | 57 |
| | | 074-01120A | 100 | 118 | 104 | 100 | 3000 | 400 | 0.021063 | 1.019 | 43 | 226% | 9.5 | 71 | 5.7 | -109 | 9.5 | 57 |
| | | 074-01120A | 120 | 118 | 104 | 101 | 3600 | 400 | 0.021063 | 1.019 | 43 | 225% | 9.5 | 71 | 5.7 | -109 | 9.5 | 57 |
| | | 074-01120A | 120 | 118 | 104 | 100 | 3600 | 460 | 0.021063 | 1.019 | 43 | 225% | 9.5 | 71 | 5.7 | -109 | 9.5 | 57 |
| LSHRM 280 SC_75 kW | | 084-01550A | 100 | 123 | 109 | 138 | 3000 | 400 | 0.016370 | 0.794 | 38 | 185% | 7.4 | 65 | 4.1 | -113 | 7.4 | 60 |
| | | 084-01550A | 120 | 123 | 109 | 136 | 3600 | 400 | 0.016370 | 0.794 | 38 | 187% | 7.4 | 65 | 4.1 | -113 | 7.4 | 60 |
| | | 084-01550A | 120 | 123 | 109 | 135 | 3600 | 460 | 0.016370 | 0.794 | 38 | 189% | 7.4 | 65 | 4.1 | -113 | 7.4 | 60 |
| | | 084-01840A | 100 | 112 | 88 | 167 | 3000 | 400 | 0.011253 | 0.617 | 38 | 190% | 5.9 | 65 | 3.3 | -113 | 5.9 | 60 |
| LSHRM 280 MC_90 kW | | 084-01840A | 120 | 112 | 88 | 160 | 3600 | 400 | 0.011253 | 0.617 | 38 | 198% | 5.9 | 65 | 3.3 | -113 | 5.9 | 60 |
| | | 084-01840A | 120 | 112 | 88 | 168 | 3600 | 460 | 0.011253 | 0.617 | 38 | 189% | 5.9 | 65 | 3.3 | -113 | 5.9 | 60 |

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