EMERSON
Industrial Automation

User Guide

Unidrive M702

Model size 3, 4 and 6

Universal Variable Speed AC drive for induction and permanent magnet motors

Part Number: 0478-0002-02
Issue: 2

CONTROL TECHNIQUES

www.controltechniques.com

Original Instructions

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

General information

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

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

Drive firmware version

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

The firmware version of the Ethernet interface can be checked by looking at Pr **24.002**

Environmental statement

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

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

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

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

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

REACH legislation

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

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

http://www.controltechniques.com/REACH

Issue Number: 2

Drive Firmware: 00.10.00.00 onwards

Ethernet Firmware: 01.01.00.14 onwards

How to use this guide

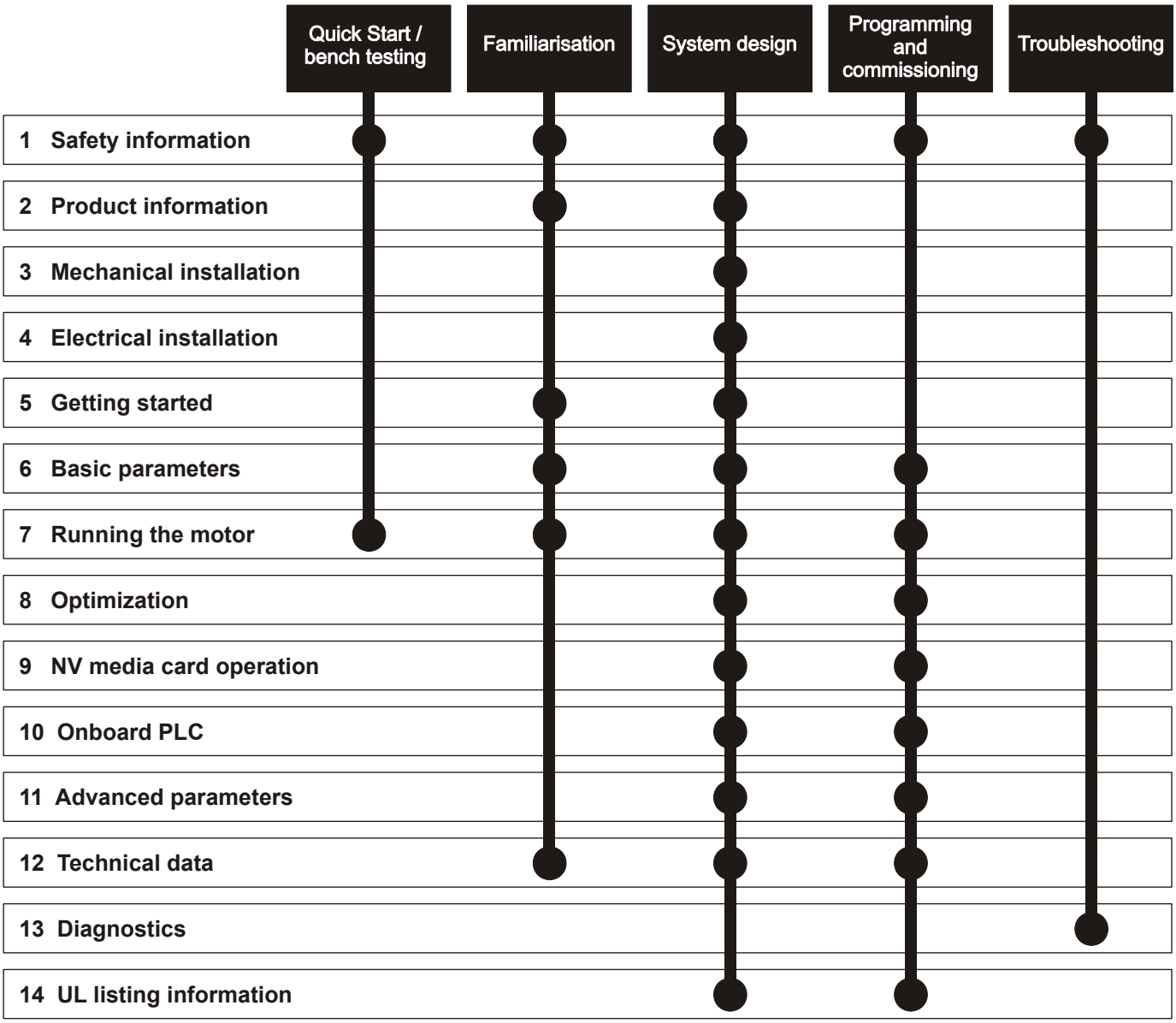
This user guide provides complete information for installing and operating the drive from start to finish.

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

NOTE

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

This map of the user guide helps to find the right sections for the task you wish to complete, but for specific information, refer to *Contents* on page 4:



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Declaration of Conformity

Control Techniques Ltd

The Gro

Newtown

Powys

UK

SY16 3BE

This declaration applies to Unidrive M variable speed drive products, comprising models numbers as shown below:

M*aaa-bbcddddd* Valid characters:	
aaa	702
bb	03
c	2 or 4
ddddd	00050, 00066, 00080, 00106, 00025, 00031, 00045, 00062, 00078, 00100

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

EN 61800-5-1:2007	Adjustable speed electrical power drive systems - safety requirements - electrical, thermal and energy
EN 61800-3:2004	Adjustable speed electrical power drive systems. EMC product standard including specific test methods
EN 61000-6-2:2005	Electromagnetic compatibility (EMC). Generic standards. Immunity standard for industrial environments
EN 61000-6-4:2007	Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments
EN 61000-3-2:2006	Electromagnetic compatibility (EMC), Limits, Limits for harmonic current emissions (equipment input current <16 A per phase)
EN 61000-3-3:2008	Electromagnetic compatibility (EMC), Limits, Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current <16 A

EN 61000-3-2:2006 Applicable where input current <16 A. No limits apply for professional equipment where input power >1 kW.

These products comply with the Low Voltage Directive 2006/95/EC and the Electromagnetic Compatibility Directive 2004/108/EC.

T. Alexander

Vice President, Technology

Newtown

Date: 13th July 2012

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 assemblers who are familiar with 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. Refer to the User Guide. An EMC Data Sheet is also available giving detailed EMC information.

Declaration of Conformity (including 2006 Machinery Directive)

Control Techniques Ltd

The Gro

Newtown

Powys

UK

SY16 3BE

This declaration applies to Unidrive M variable speed drive product range, comprising models numbers composed as shown below:

M*aaa-bbcddddd* Valid characters:	
aaa	702
bb	03
c	2 or 4
ddddd	00050, 00066, 00080, 00106, 00025, 00031, 00045, 00062, 00078, 00100

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

These products fulfil all the relevant provisions of Directives 2006/42/EC (The Machinery Directive) and 2004/108/EC (The EMC Directive)..

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

TÜV Rheinland Industrie Service GmbH

Am Grauen Stein

D-51105 Köln

Notified Body identification number: 0035

EC type-examination certificate number: 01/205/5206/12

The harmonized standards used are shown below:

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

Person authorized to compile the technical file:

C Hargis

Chief Engineer

Address as above

T. Alexander

Vice President, Technology

Newtown

Date: 24th September 2012

IMPORTANT NOTICE

These drive products are intended to be used with appropriate motors, sensors, electrical protection components and other equipment to form complete systems. It is the responsibility of the installer to ensure that the design of the complete 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-related drive in itself does not ensure the safety of the machine.

Compliance with safety and EMC regulations depends upon installing and configuring inverters correctly. The inverters must be installed only by professional assemblers who are familiar with 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. Refer to the Installation Guide.

1 Safety information

1.1 Warnings, Cautions and Notes

WARNING

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

CAUTION

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

NOTE

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

1.2 Electrical safety - general warning

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

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

1.3 System design and safety of personnel

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

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

Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning/ start-up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

The STOP and SAFE TORQUE OFF functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

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

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

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

1.4 Environmental limits

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

1.5 Access

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

1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided. For further information, refer to section 3.2.5 *Fire protection* on page 19.

1.7 Compliance with regulations

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

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

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

2006/42/EC Safety of machinery.
2004/108/EC: Electromagnetic Compatibility.

1.8 Motor

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

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

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

The values of the motor parameters set in the drive affect the protection of the motor. The default values in the drive should not be relied upon.

It is essential that the correct value is entered in Pr **00.046** motor rated current. This affects the thermal protection of the motor.

1.9 Mechanical brake control

The 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.

1.10 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.

1.11 Electrical installation

1.11.1 Electric shock risk

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

AC supply cables and connections

Output cables and connections

Many internal parts of the drive, and external option units

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

1.11.2 Stored charge

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

2 Product information

2.1 Introduction

Universal AC and servo drive

This product family consists of Unidrive M700, Unidrive M701 and Unidrive M702, delivering maximum machine performance.

Common features (Unidrive M700, 701 and 702)

- Universal high performance open and closed loop control for induction, servo, permanent magnet and linear motors
- Automation and motion option module for direct migration of SyPTPro / SM-Applications programs
- Onboard IEC 61131-3 programmable automation and motion control
- Flexibility with speed and position measurement, supporting multiple devices and all common interfaces
- NV Media Card for parameter copying and data storage

Optional features (Unidrive M700, 701 and 702)

- Select up to three option modules including programmable automation and motion control.

Unidrive M700

- Ethernet fieldbus communications
- Single channel SAFE TORQUE OFF (STO) input

Unidrive M701

- Provides a direct replacement / upgrade for Unidrive SP
- 485 serial communications interface
- Single channel SAFE TORQUE OFF (STO) input

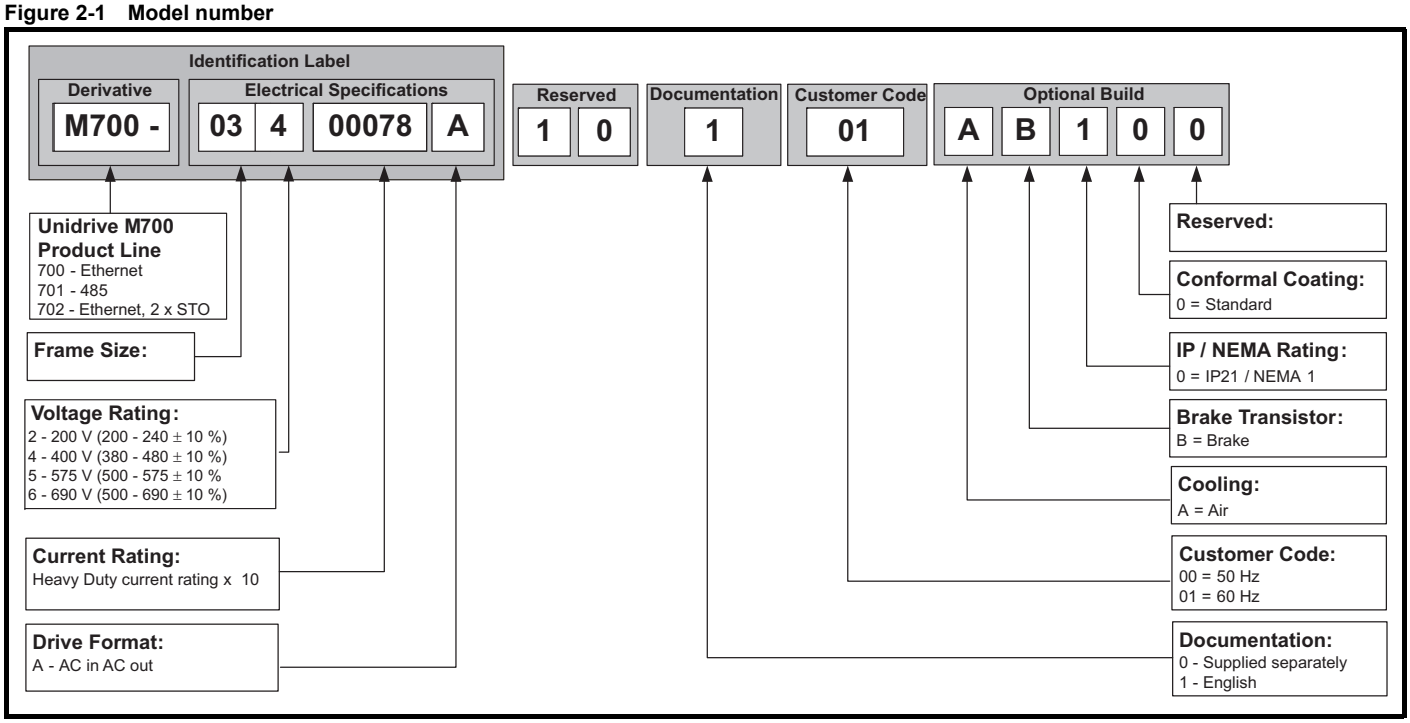
Unidrive M702

- Ethernet fieldbus communications
- Dual channel SAFE TORQUE OFF (STO) input

2.2 Model number

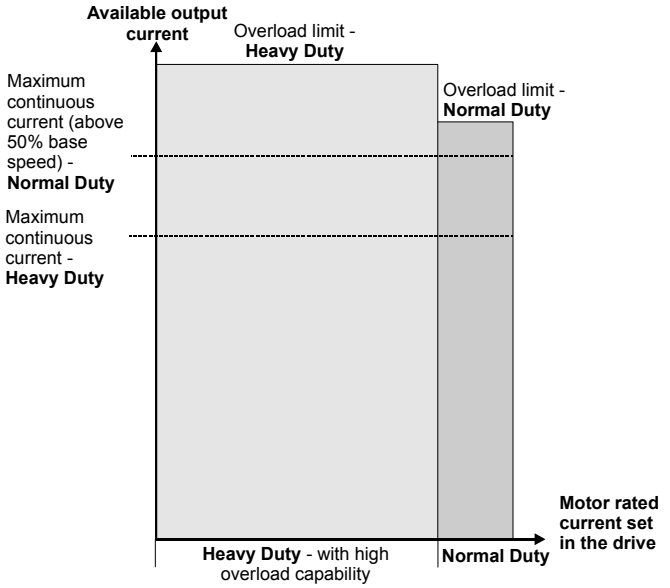
The way in which the model numbers for the Unidrive M700 range are formed is illustrated below:

Figure 2-1 Model number



2.3 Ratings

The drive is dual rated.
The setting of the motor rated current determines which rating applies - Heavy Duty or Normal Duty.
The two ratings are compatible with motors designed to IEC60034.
The graph aside illustrates the difference between Normal Duty and Heavy Duty with respect to continuous current rating and short term overload limits.



Normal Duty

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.

Heavy Duty (default)

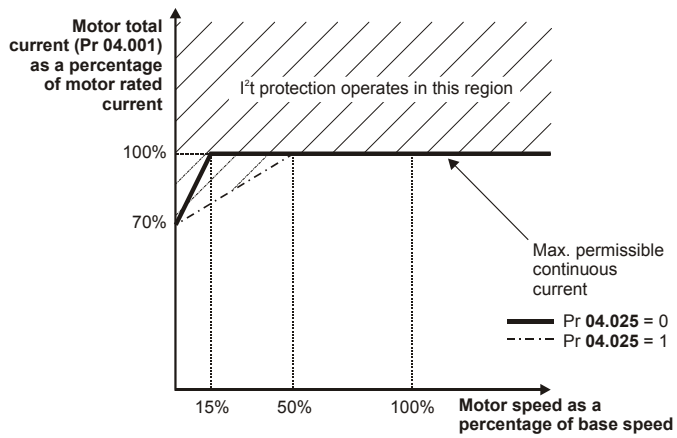
For constant torque applications or applications which require a high overload capability, or full torque is required at low speeds (e.g. winders, hoists).
The thermal protection is set to protect force ventilated induction motors and permanent magnet servo motors by default.

NOTE

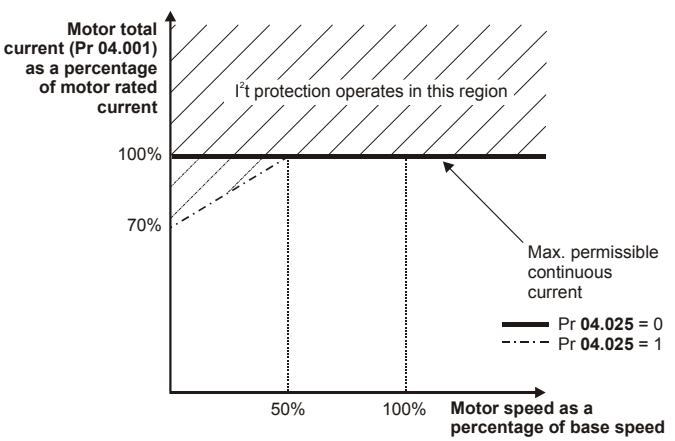
If the application uses a self ventilated (TENV/TEFC) induction motor and increased thermal protection is required for speeds below 50 % base speed, then this can be enabled by setting *Low Speed Thermal Protection Mode* (04.025) = 1.

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



Motor I^2t protection defaults to be compatible with:
- Forced ventilation induction motors
- Permanent magnet servo motors



The continuous current ratings given are for maximum 40 °C (104 °F), 1000 m altitude and 3.0 kHz switching. 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 209.

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

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 230 V	Motor power at 230 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 230 V	Motor power at 230 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 3	03200050	6.6	1.1	1.5	7.2	5	7.5	10.0	0.75	1.0
	03200066	8.0	1.5	2.0	8.8	6.6	9.9	13.2	1.1	1.5
	03200080	11.0	2.2	3.0	12.1	8.0	12.0	16.0	1.5	2.0
	03200106	12.7	3.0	3.0	13.9	10.6	15.9	21.2	2.2	3.0
Frame size 4	04200137	18.0	4.0	5.0	19.8	13.7	26.2	27.4	3.0	3.0
	04200185	24.0	5.5	7.5	26.4	18.5	27.7	37.0	4.0	5.0
Frame size 5	05200250	33.0	7.5	10	36.3	25	37.5	50.0	5.5	7.5
Frame size 6	06200330	50.0	11.0	15.0	55.0	33.0	49.5	66.0	7.5	10.0
	06200440	58.0	15.0	20.0	63.8	44.0	66.0	88.0	11.0	15.0

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

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 400 V	Motor power at 460 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 400 V	Motor power at 460 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 3	03400025	3.4	1.1	1.5	3.7	2.5	3.7	5.0	0.75	1.0
	03400031	4.5	1.5	2.0	4.9	3.1	4.6	6.2	1.1	1.5
	03400045	6.2	2.2	3.0	6.8	4.5	6.7	9.0	1.5	2.0
	03400062	7.7	3.0	5.0	8.4	6.2	9.3	12.4	2.2	3.0
	03400078	10.4	4.0	5.0	11.4	7.8	11.7	15.6	3.0	5.0
	03400100	12.3	5.5	7.5	13.5	10.0	15.0	20.0	4.0	5.0
Frame size 4	04400150	18.5	7.5	10.0	20.3	15.0	22.5	30.0	5.5	10.0
	04400172	24.0	11.0	15.0	26.4	17.2	25.8	34.4	7.5	10.0
Frame size 5	05400270	33.0	15.0	20.0	36.3	27.0	40.5	54.0	11.0	20.0
	05400330	33.0	15.0	20.0	36.3	33.0	49.5	66.0	15.0	20.0
Frame size 6	06400350	38.0	18.5	25.0	41.8	35.0	52.5	70.0	15.0	25.0
	06400420	48.0	22.0	30.0	52.8	42.0	63.0	84.0	18.5	30.0
	06400470	63.0	30.0	40.0	69.3	47.0	70.5	94.0	22.0	30.0

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

Model		Normal Duty				Heavy Duty				
		Maximum continuous output current	Nominal power at 575 V	Motor power at 575 V	Peak current	Maximum continuous output current	Open loop peak current	RFC peak current	Nominal power at 575 V	Motor power at 575 V
		A	kW	hp	A	A	A	A	kW	hp
Frame size 5	05500030	3.9	2.2	3.0	4.3	3.0	4.5	6.0	1.5	2.0
	05500040	6.1	4.0	5.0	6.7	4.0	6.0	8.0	2.2	3.0
	05500069	10.0	5.5	7.5	11.0	6.9	10.3	13.8	4.0	5.0
Frame size 6	06500100	12.0	7.5	10.0	13.2	10.0	15.0	20.0	5.5	7.5
	06500150	17.0	11.0	15.0	18.7	15.0	22.5	30.0	7.5	10.0
	06500190	22.0	15.0	20.0	24.2	19.0	28.5	38.0	11.0	15.0
	06500230	27.0	18.5	25.0	29.7	23.0	34.5	46.0	15.0	20.0
	06500290	34.0	22.0	30.0	37.4	29.0	43.5	58.0	18.5	25.0
	06500350	43.0	30.0	40.0	47.3	35.0	52.5	70.0	22.0	30.0

2.3.1 Typical short term overload limits

The maximum percentage overload limit changes depending on the selected motor. Variations in motor rated current, motor power factor and motor leakage inductance all result in changes in the maximum possible overload. The exact value for a specific motor can be calculated using the equations detailed in Menu 4 in the *Parameter Reference Guide*.

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

Table 2-4 Typical overload limits

Operating mode	RFC from cold	RFC from 100 %	Open loop from cold	Open loop from 100 %
Normal Duty overload with motor rated current = drive rated current	110 % for 165 s	110 % for 9 s	110 % for 165 s	110 % for 9 s
Heavy Duty overload with motor rated current = drive rated current	200 % for 28 s	200 % for 3 s	150 % for 60 s	150 % for 8 s

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

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

NOTE

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

2.4 Operating modes

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

1. Open loop mode
   - Open loop vector mode
   - Fixed V/F mode (V/Hz)
   - Quadratic V/F mode (V/Hz)
2. RFC - A
   - With position feedback sensor
3. RFC - S
   - With position feedback sensor

2.4.1 Open loop mode

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

Open loop vector mode

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

Typically 100 % torque is available down to 1 Hz for a 50 Hz motor.

Fixed V/F mode

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

Typically 100 % torque is available down to 4 Hz for a 50 Hz motor.

Quadratic V/F mode

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

2.4.2 RFC-A mode

Rotor **F**lux **C**ontrol for Asynchronous (induction) motors (**RFC-A**) encompasses closed loop vector control with a position feedback device

With position feedback sensor

For use with induction motors with a feedback device installed. The drive directly controls the speed of the motor using the feedback device to ensure the rotor speed exactly as demanded. Motor flux is accurately controlled at all times to provide full torque all the way down to zero speed.

2.4.3 RFC- S

Rotor **F**lux **C**ontrol for Synchronous (permanent magnet brushless) motors (**RFC-S**) provides closed loop control with position feedback device.

With position feedback sensor

For use with permanent magnet brushless motors with a feedback device installed.

The drive directly controls the speed of the motor using the feedback device to ensure the rotor speed is exactly as demanded. Flux control is not required because the motor is self excited by the permanent magnets which form part of the rotor.

Absolute position information is required from the feedback device to ensure the output voltage is accurately matched to the back EMF of the motor. Full torque is available all the way down to zero speed.

2.5 Compatible position feedback devices

Table 2-5 Supported feedback devices

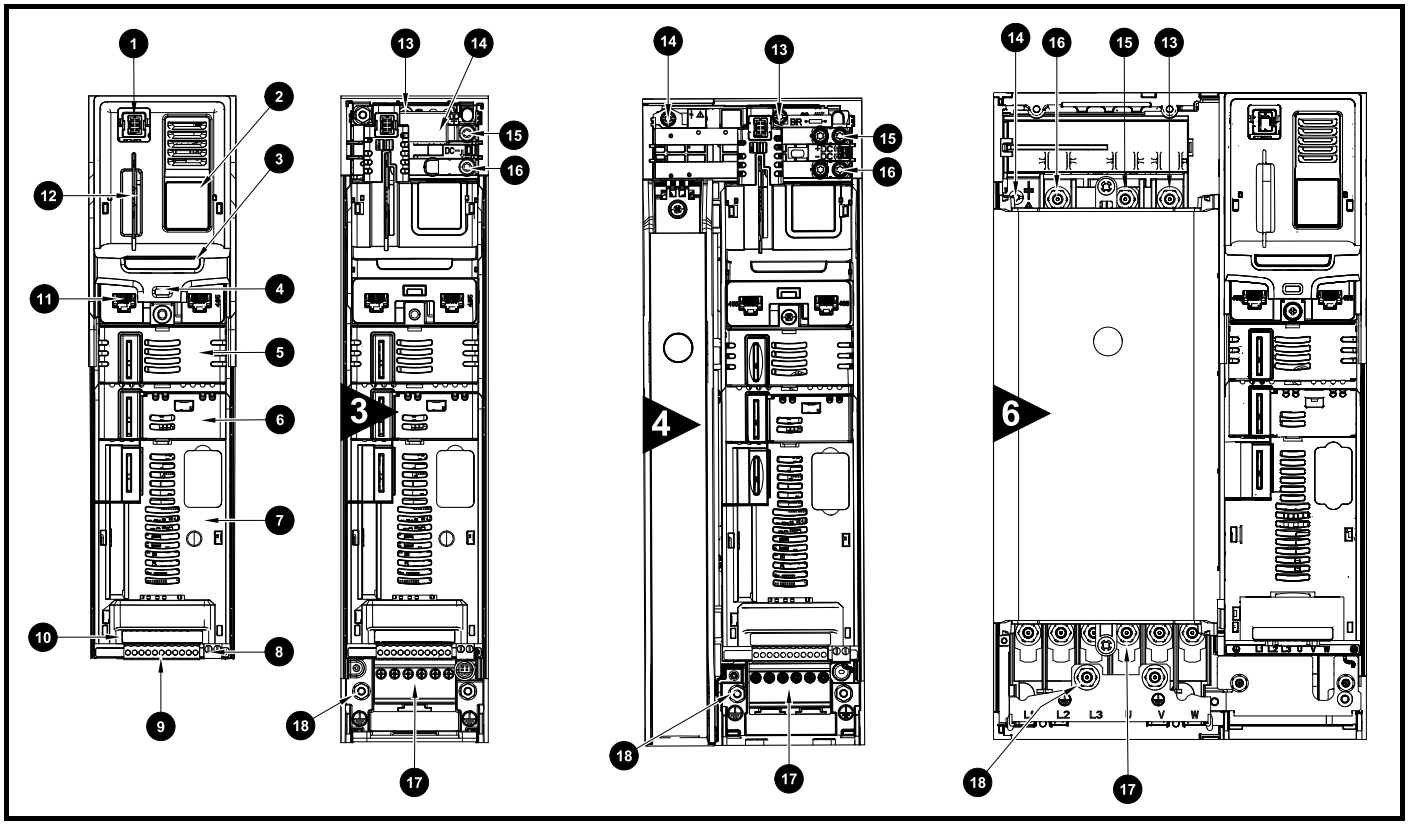
Encoder type	Pr 3.038 setting
Quadrature incremental encoders with or without marker pulse	AB (0)
Quadrature incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	AB Servo (3)
Forward / reverse incremental encoders with or without marker pulse	FR (2)
Forward / reverse incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FR Servo (5)
Frequency and direction incremental encoders with or without marker pulse	FD (1)
Frequency and direction incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FD Servo (4)
Sincos incremental encoders	SC (6)
Sincos incremental with commutation signals	SC Servo (12)
Heidenhain sincos encoders with EnDat comms for absolute position	SC EnDat (9)
Stegmann sincos encoders with Hiperface comms for absolute position	SC Hiperface (7)
Sincos encoders with SSI comms for absolute position	SC SSI (11)
Sincos incremental with absolute position from single sin and cosine signals	SC SC (15)
SSI encoders (Gray code or binary)	SSI (10)
EnDat communication only encoders	EnDat (8)
BiSS communication only encoders* (not currently supported)	BiSS (13)
Resolver (not currently supported)	Resolver (14)
UVW commutation only encoders** (not currently supported)	Commutation only (16)

* Only BiSS type C encoders are supported.

** This feedback device provides very low resolution feedback and should not be used for applications requiring a high level of performance.

2.6 Drive features

Figure 2-2 Features of the drive



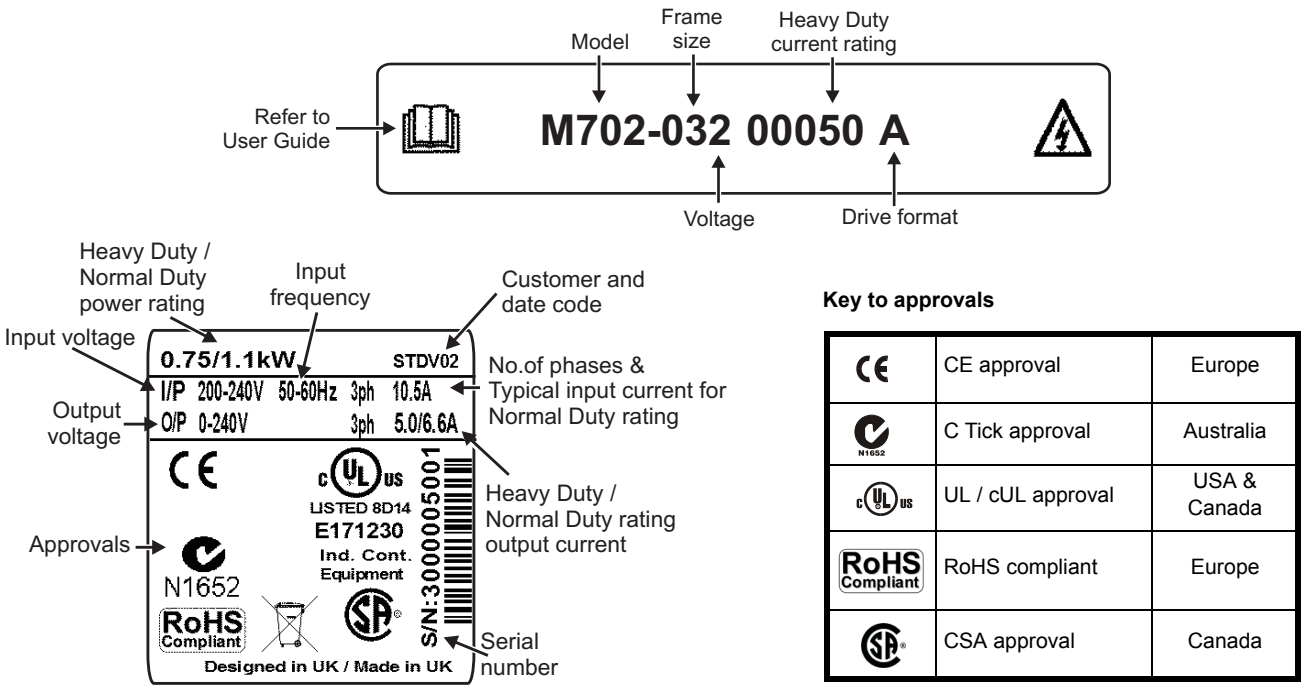
Key

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

2.7 Nameplate description

See Figure 2-2 for location of rating labels.

Figure 2-3 Typical drive rating labels for size 3



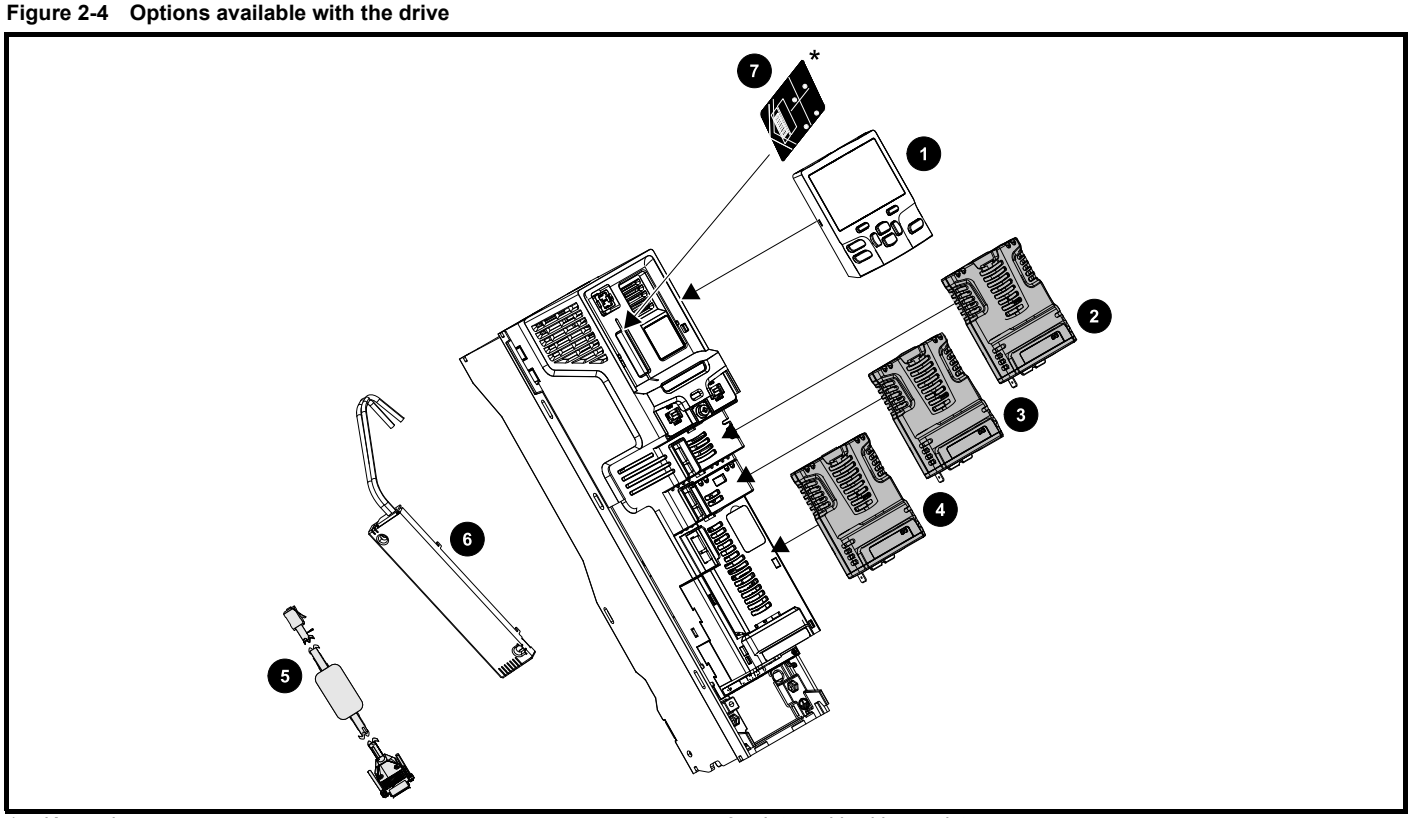
Key to approvals

CE	CE approval	Europe
N1652	C Tick approval	Australia
c UL us	UL / cUL approval	USA & Canada
RoHS Compliant	RoHS compliant	Europe
SP	CSA approval	Canada

Refer to Figure 2-1 *Model number* on page 10 for further information relating to the labels.

2.8 Options

Figure 2-4 Options available with the drive



1. Keypad
2. Option module slot 1
3. Option module slot 2
4. Option module slot 3
5. CT Comms cable
6. Internal braking resistor
7. NV media card

* For further information, refer to Chapter 9 *NV Media Card Operation* on page 111.

WARNING

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

Unidrive M option modules come in two different formats, a standard option module and a large option module. All standard option modules are color-coded in order to make identification easy, whereas the larger option module is black. 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, whereas the large option modules can only be installed to option slot 3. The following tables shows the color-code key and gives further details on their function.

Table 2-6 Option module identification (standard modules)

Type	Option module	Color	Name	Further Details
Feedback		N/A	15-way D-type converter	**Drive encoder input converter** Provides screw terminal interface for encoder wiring and spade terminal for shield
		N/A	Single ended encoder interface (15V or 24V)	**Single ended encoder interface** Provides an interface for single ended ABZ encoder signals, such as those from hall effect sensors. 15 V and 24 V versions are available.
Fieldbus		Purple	SI-PROFIBUS	**Profibus option** PROFIBUS adapter for communications with the drive

Table 2-7 Option module identification (large modules)

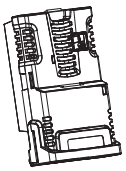
Type	Option module	Name	Further Details
Automation (Applications)		SI-Applications Plus	**SyPTPro Compatible Applications Processor (with CTNet)** 2nd processor for running pre-defined and/or customer created application software with CTNet support.
		SI-Applications Lite V2	**SyPTPro Compatible Applications Processor** 2nd processor for running pre-defined and/or customer created application.
		SI-Register	**SyPTPro Compatible Applications Processor** 2nd processor for running position capture functionality with CTNet support

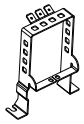
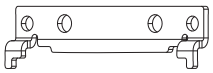
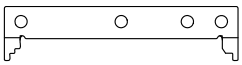
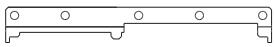
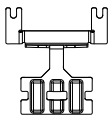
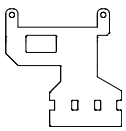
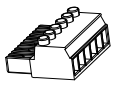
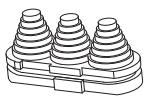
Table 2-8 Keypad identification

Type	Keypad	Name	Further Details
Keypad		KI-Keypad	**LCD keypad option** Keypad with a LCD display

2.9 Items supplied with the drive

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

Table 2-9 Parts supplied with the drive

Description	Size 3	Size 4	Size 6
Control connector	 x 1		
Relay connector	 x 1		
24 V power supply connector			 x 1
Grounding bracket	 x 1		
Surface mounting brackets	 x 2	 x 2	 x 2
Grounding clamp	 x 1		 x 1
DC terminal cover grommets	 x 2		
Nuts			 M6 x 11
M4 x 10 Taptite screws			 x 2
Supply and motor connector	 x 1		
Finger guard grommets			 x 2

3 Mechanical installation

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

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

3.1 Safety information

WARNING

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

WARNING

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

WARNING

Enclosure
The drive is intended to be mounted in an enclosure which prevents access except by trained and authorized personnel, and which prevents the ingress of contamination. It is designed for use in an environment classified as pollution degree 2 in accordance with IEC 60664-1. This means that only dry, non-conducting contamination is acceptable.

3.2 Planning the installation

The following considerations must be made when planning the installation:

3.2.1 Access

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

The IP (Ingress Protection) rating of the drive is installation dependent. For further information, refer to section 3.9 *Enclosing standard drive for high environmental protection* on page 32.

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 30.

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 41*.

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.

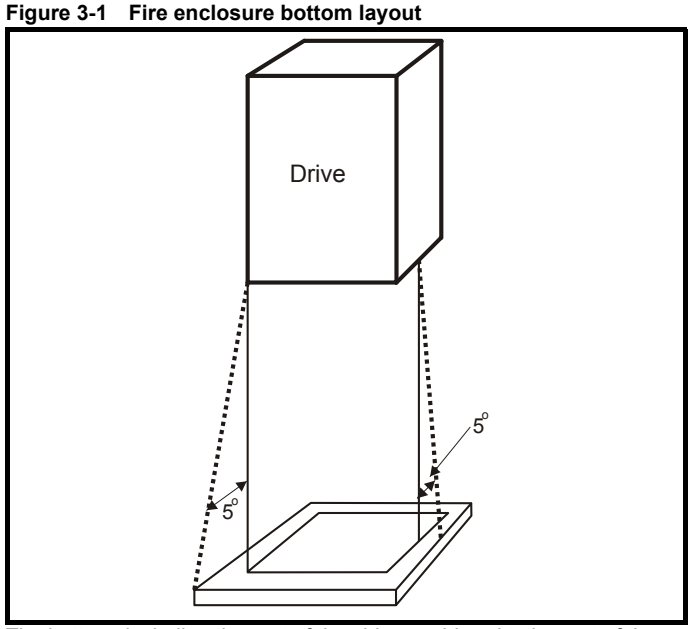
For installation outside the USA, the following (based on IEC 62109-1, standard for PV inverters) is recommended.

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.

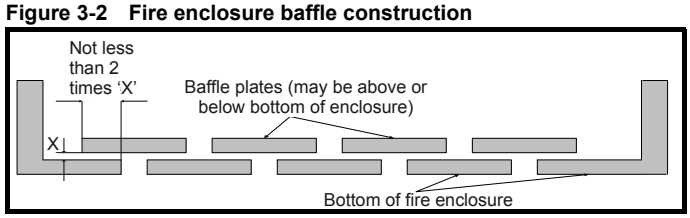
The location and size of the bottom shall cover the area shown in Figure 3-1. Any part of the side which is within the area traced out by the 5° angle is also considered to be part of the bottom of the fire enclosure.

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 53*.

3.2.7 Hazardous areas

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

3.3 Terminal cover removal

WARNING

Isolation device

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

WARNING

Stored charge

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

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

3.3.1 Removing the size 3, 4 and 6 terminal covers

The size 3 drive has two terminal covers, Control / AC / Motor and DC / Braking terminal.
The size 4 has two terminal covers, Control / AC / Motor and DC / Braking terminal.
The size 6 has three terminal covers, Control, DC / braking and AC / Motor terminal.

Figure 3-3 Location and identification of terminal covers

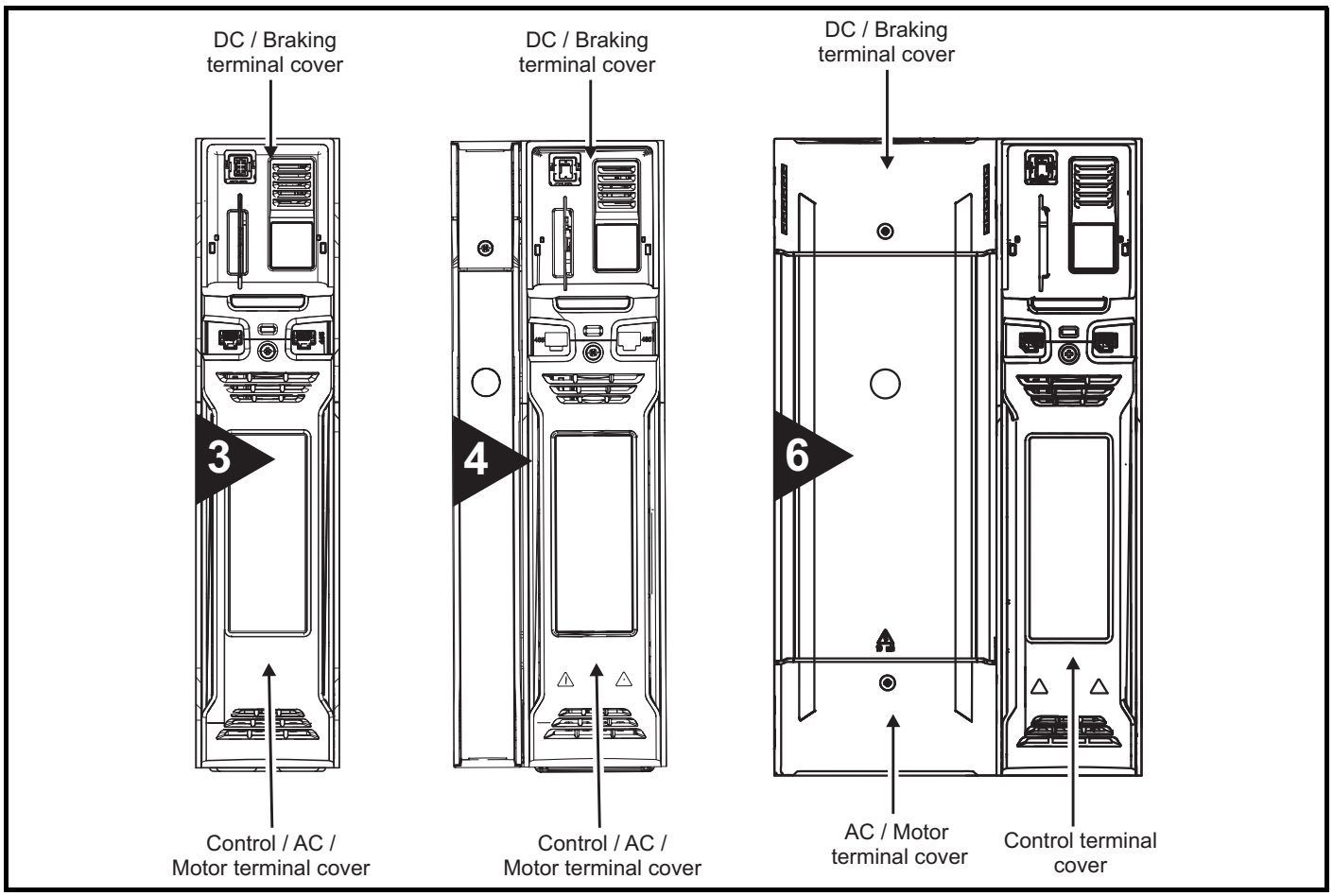
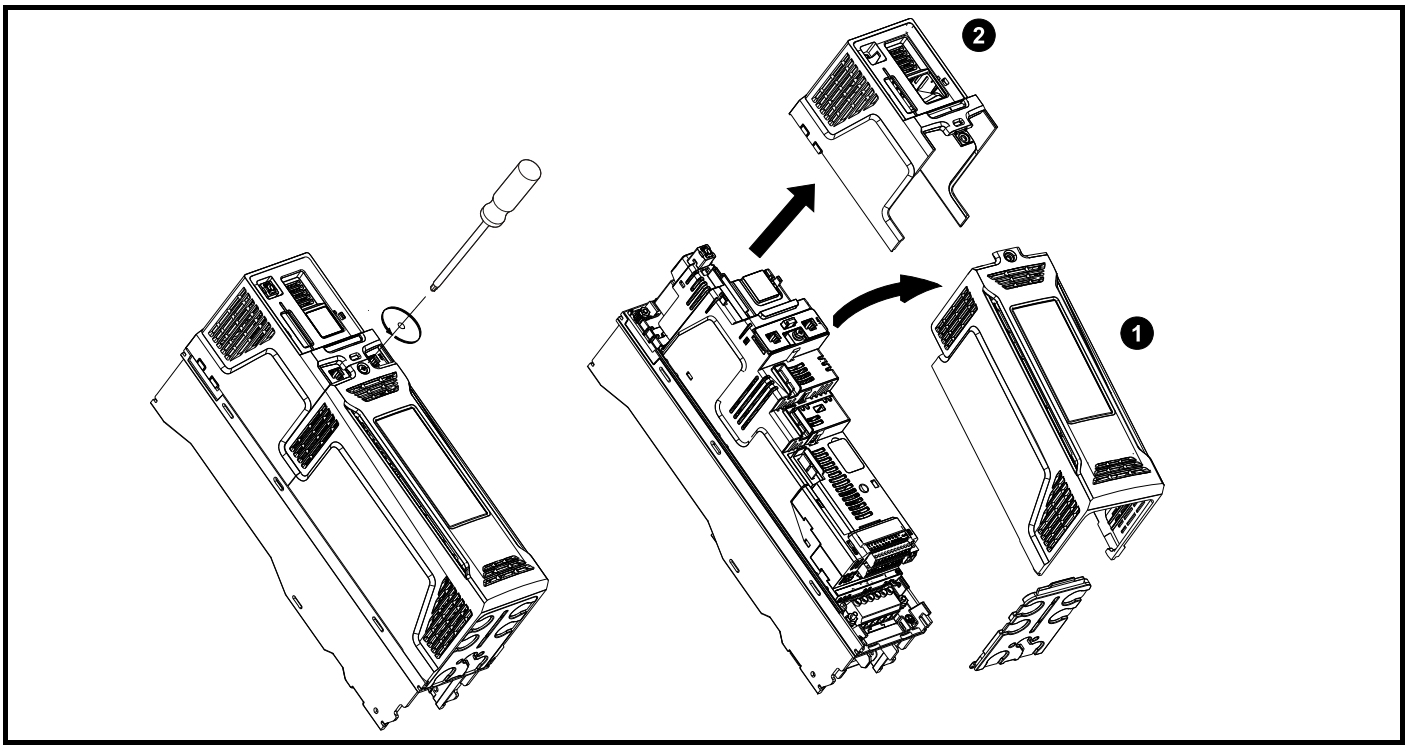


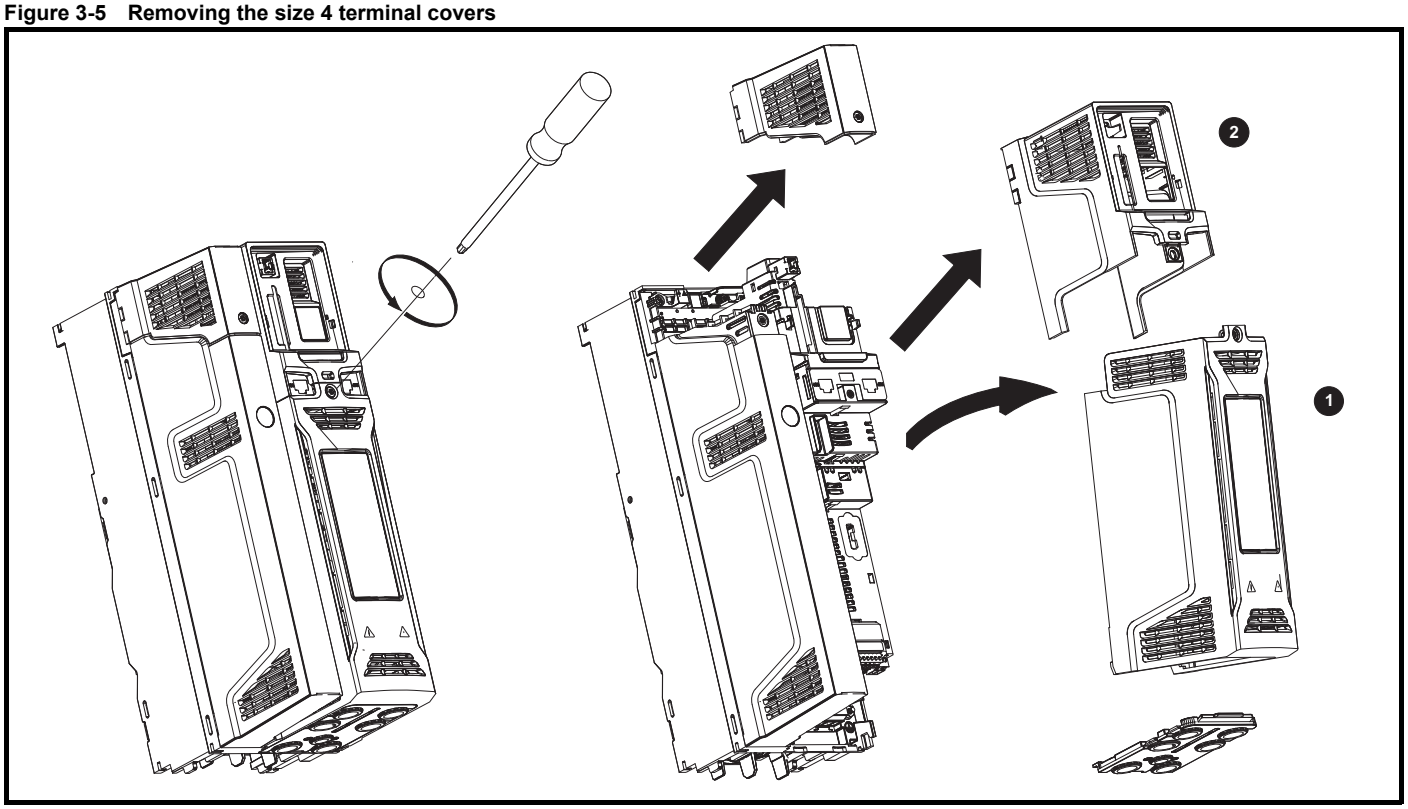
Figure 3-4 Removing the size 3 terminal covers



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

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

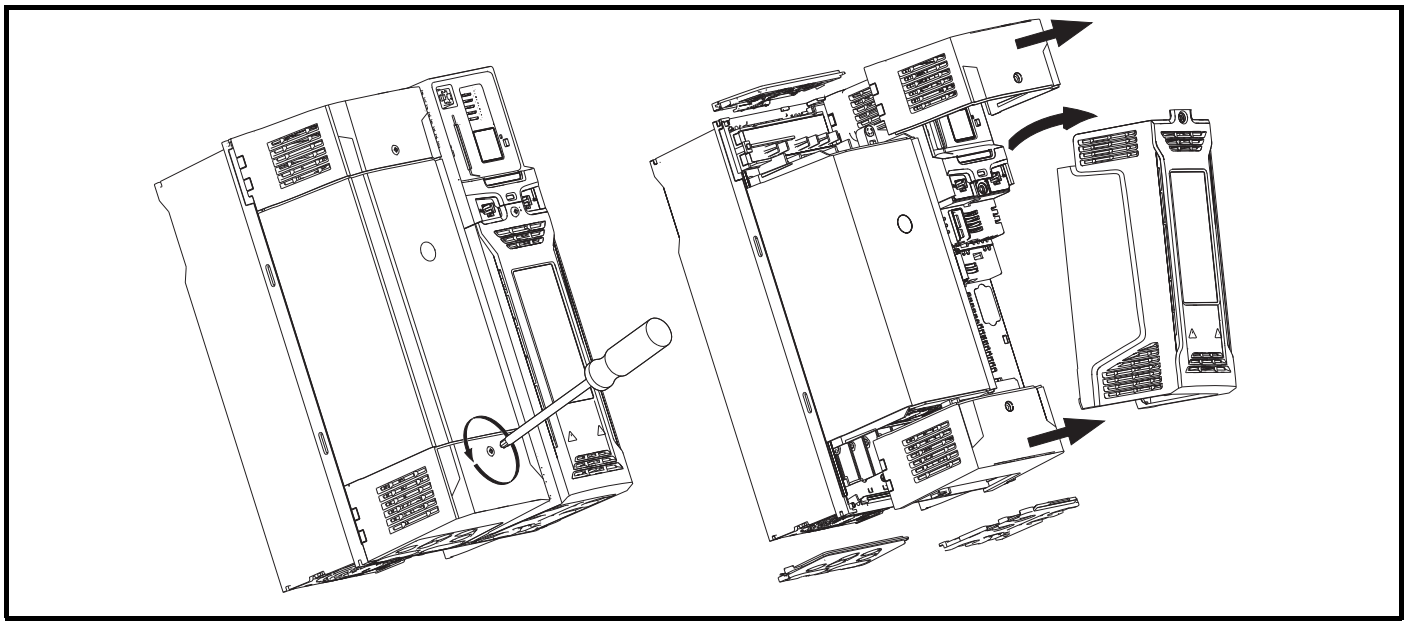
Figure 3-5 Removing the size 4 terminal covers



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

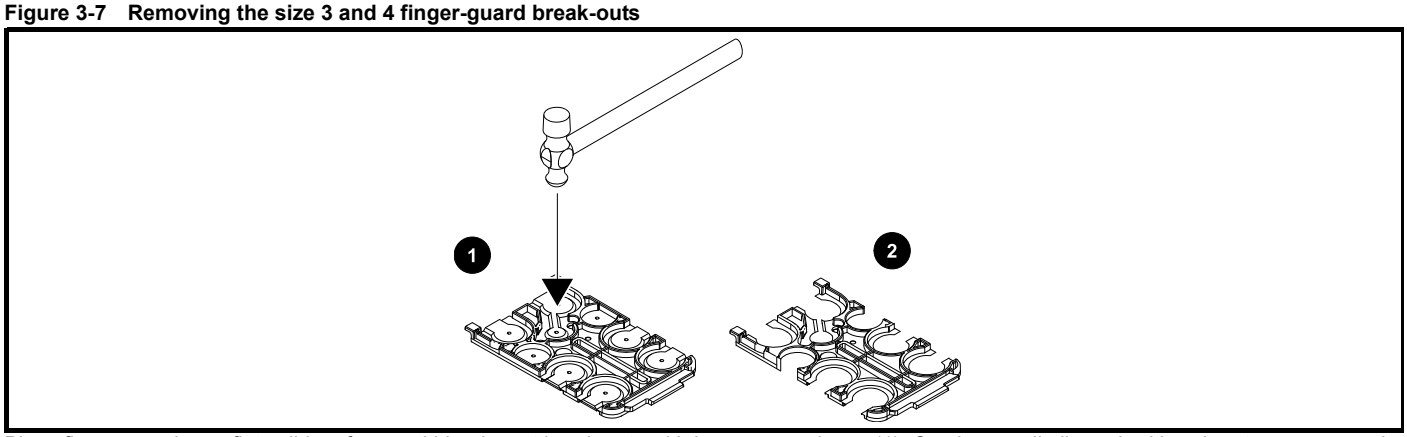
On size 4 drives, the Control / AC / Motor terminal cover must be removed before removal of the DC / Braking terminal cover. When replacing the terminal covers, the screws should be tightened to a maximum torque of 1 N m (0.7 lb ft).

Figure 3-6 Removing the size 6 terminal covers



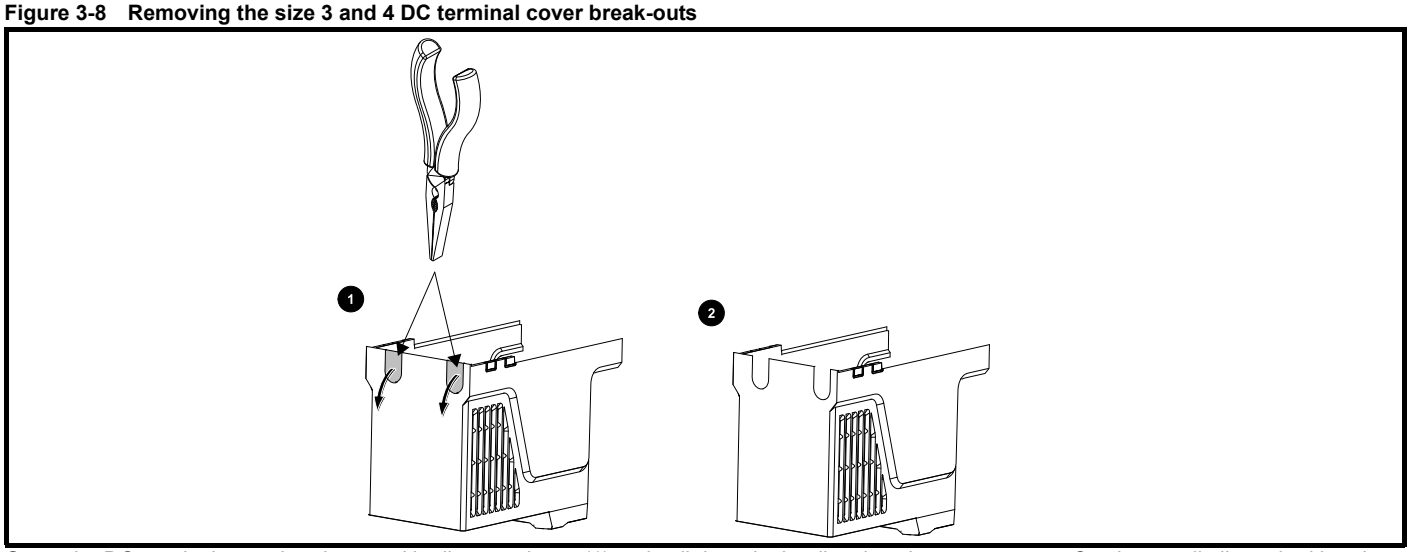
3.3.2 Removing the finger-guard and DC terminal cover break-outs

Figure 3-7 Removing the size 3 and 4 finger-guard break-outs



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.

Figure 3-8 Removing the size 3 and 4 DC terminal cover break-outs



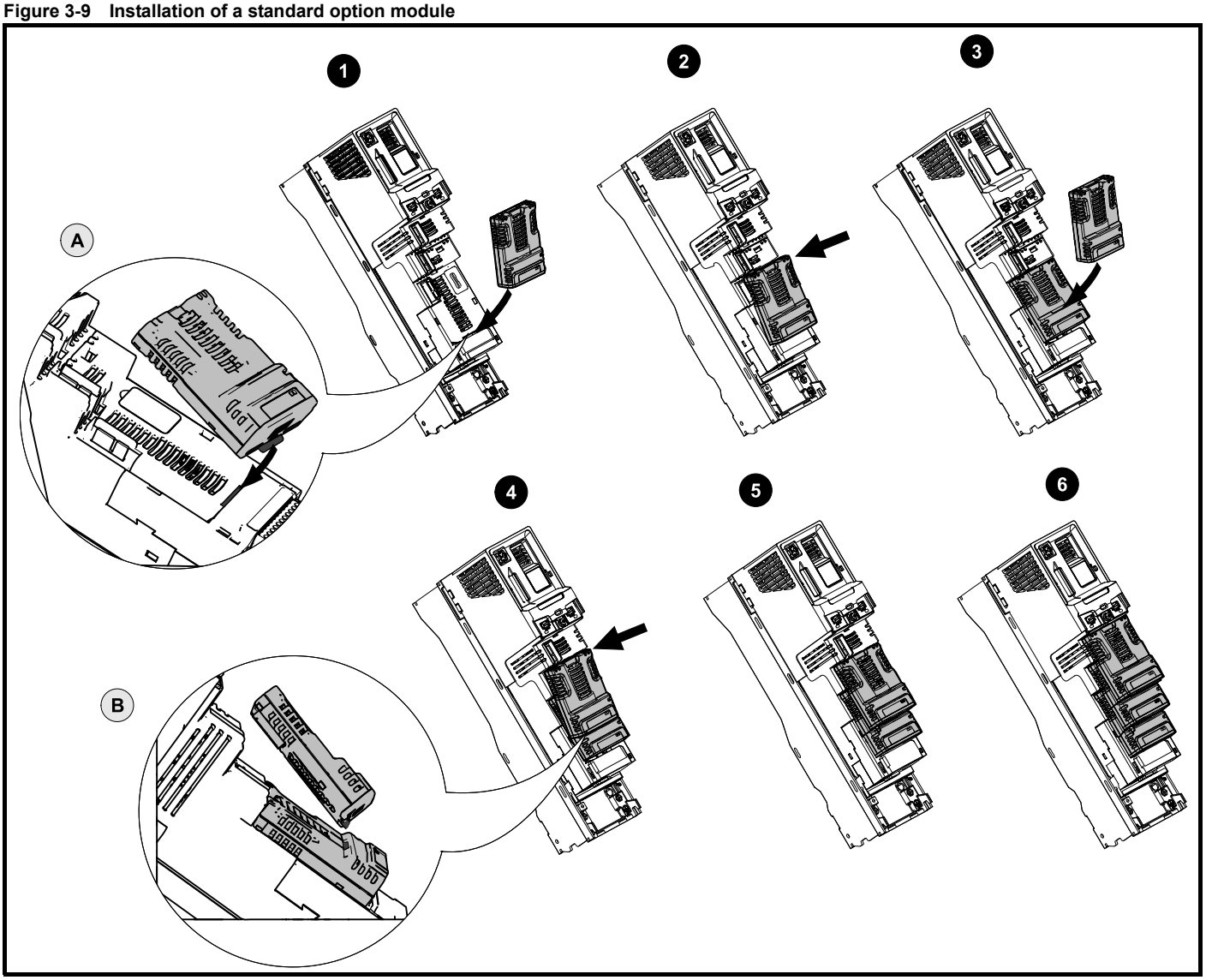
Grasp the DC terminal cover break-outs with pliers as shown (1) and pull down in the direction shown to remove. Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed. Use the DC terminal cover grommets supplied in the accessory box (Table 2-9 on page 18) to maintain the seal at the top of the drive.

3.4 Installing / removing option modules and keypads

CAUTION

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

Figure 3-9 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 2-2 *Features of the drive* on page 15 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

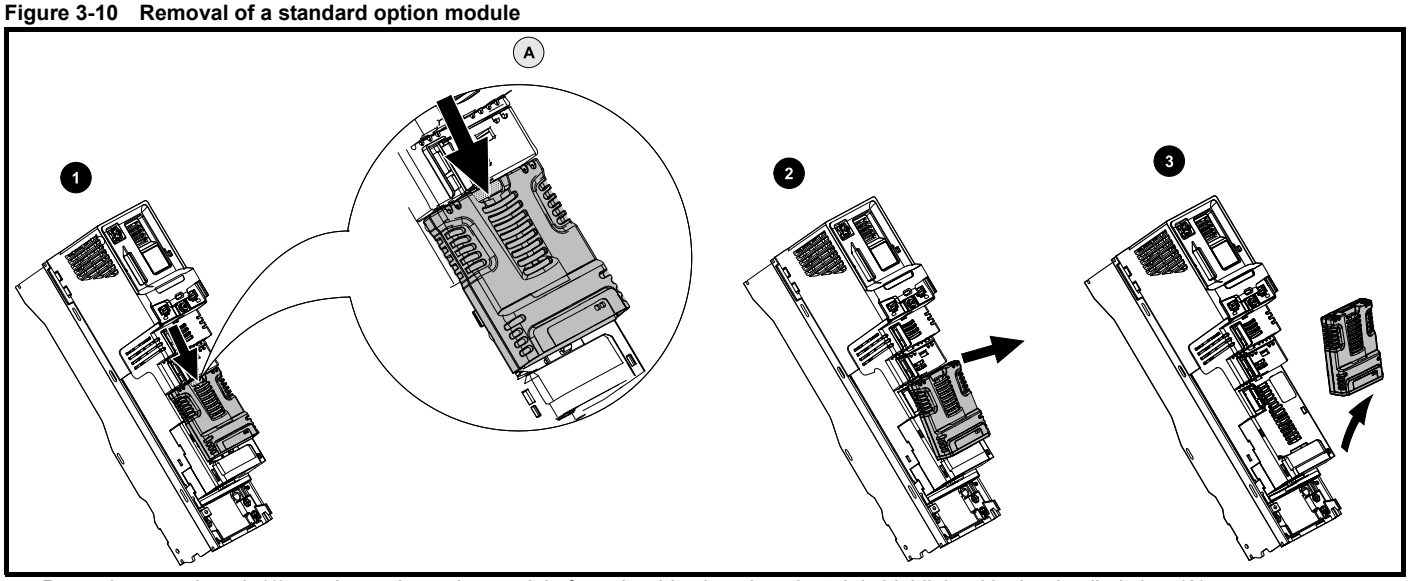
- Move the option module in direction shown (3).
- Align and insert the option module tab in to the slot provided on the already installed option module (4), this is highlighted in the detailed view (B).
- Press down on the option module until it clicks into place. Image (5) shows two option modules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

Installing the third option module

- Repeat the above process.

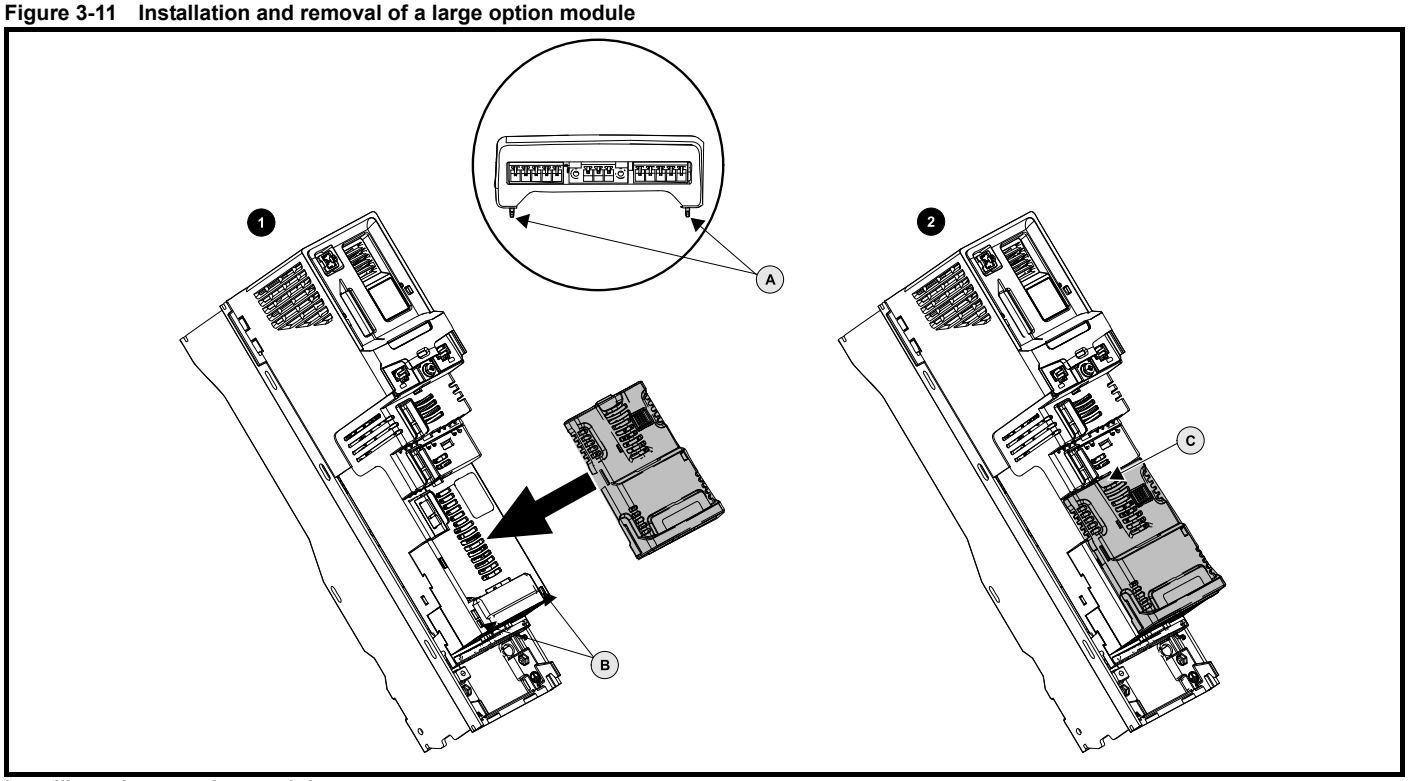
The drive has the facility for all three option module slots to be used at the same time, image (6) shows the three option modules installed.

Figure 3-10 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 3-11 Installation and removal of a large option module



Installing a large option module

- Move the option module in direction shown (1).
- Align and insert the option module tabs (A) into the slot provided (B).
- Press down on the option module until it clicks into place.

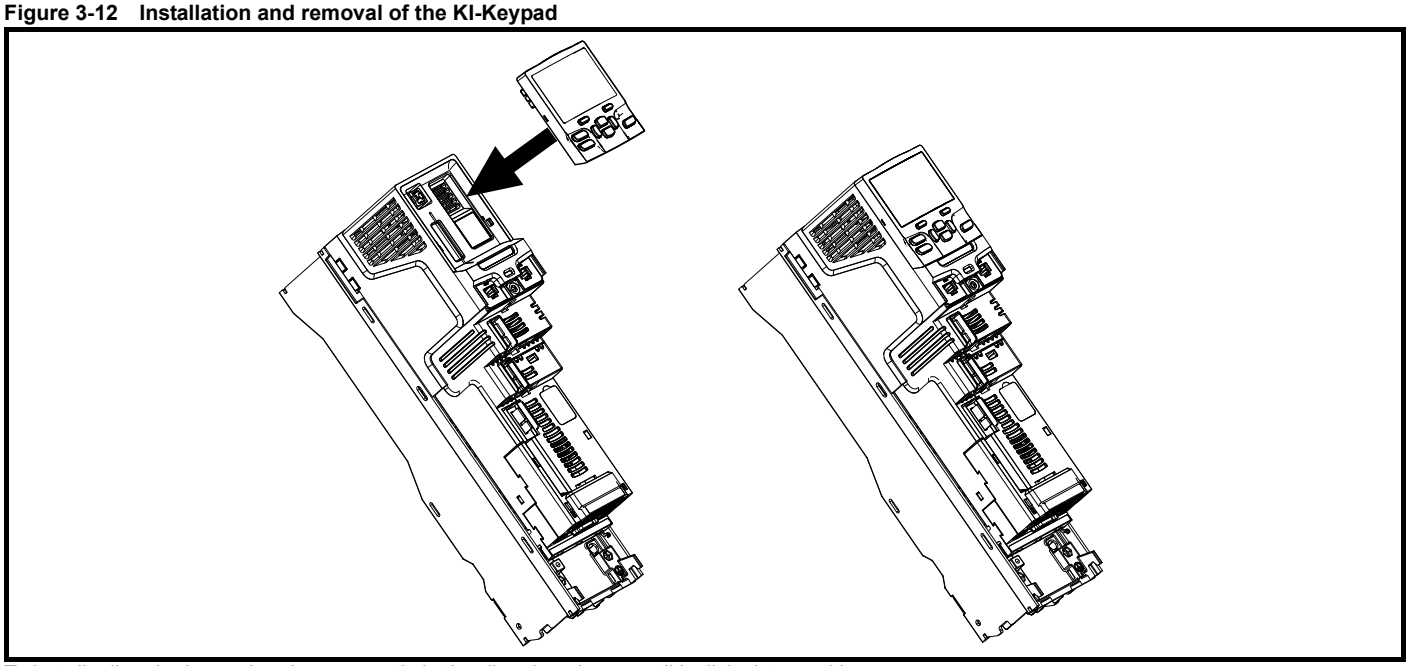
Removing a large option module

- Press down on the tab (2C), tilt the option module towards you and remove.

NOTE

The large option module can only be inserted into slot 3. Additional standard option modules can still be installed and used in slot 2 and slot 1.

Figure 3-12 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.

WARNING

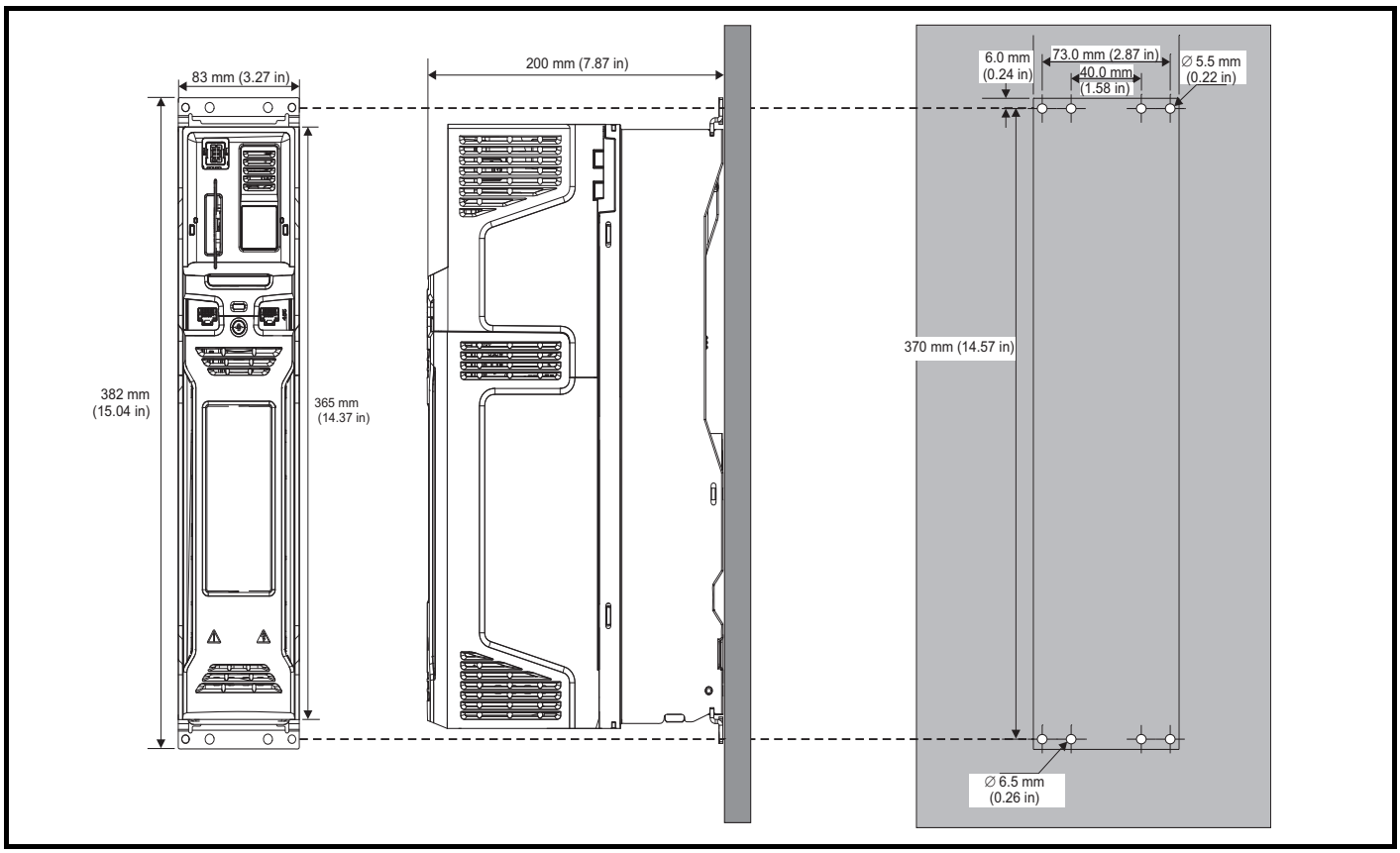
If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70 °C (158 °F). Human contact with the heatsink should be prevented.

WARNING

Many of the drives in this product range weigh in excess of 15 kg (33 lb). Use appropriate safeguards when lifting these models. A full list of drive weights can be found in section 12.1.19 *Weights* on page 216.

3.5.1 Surface mounting

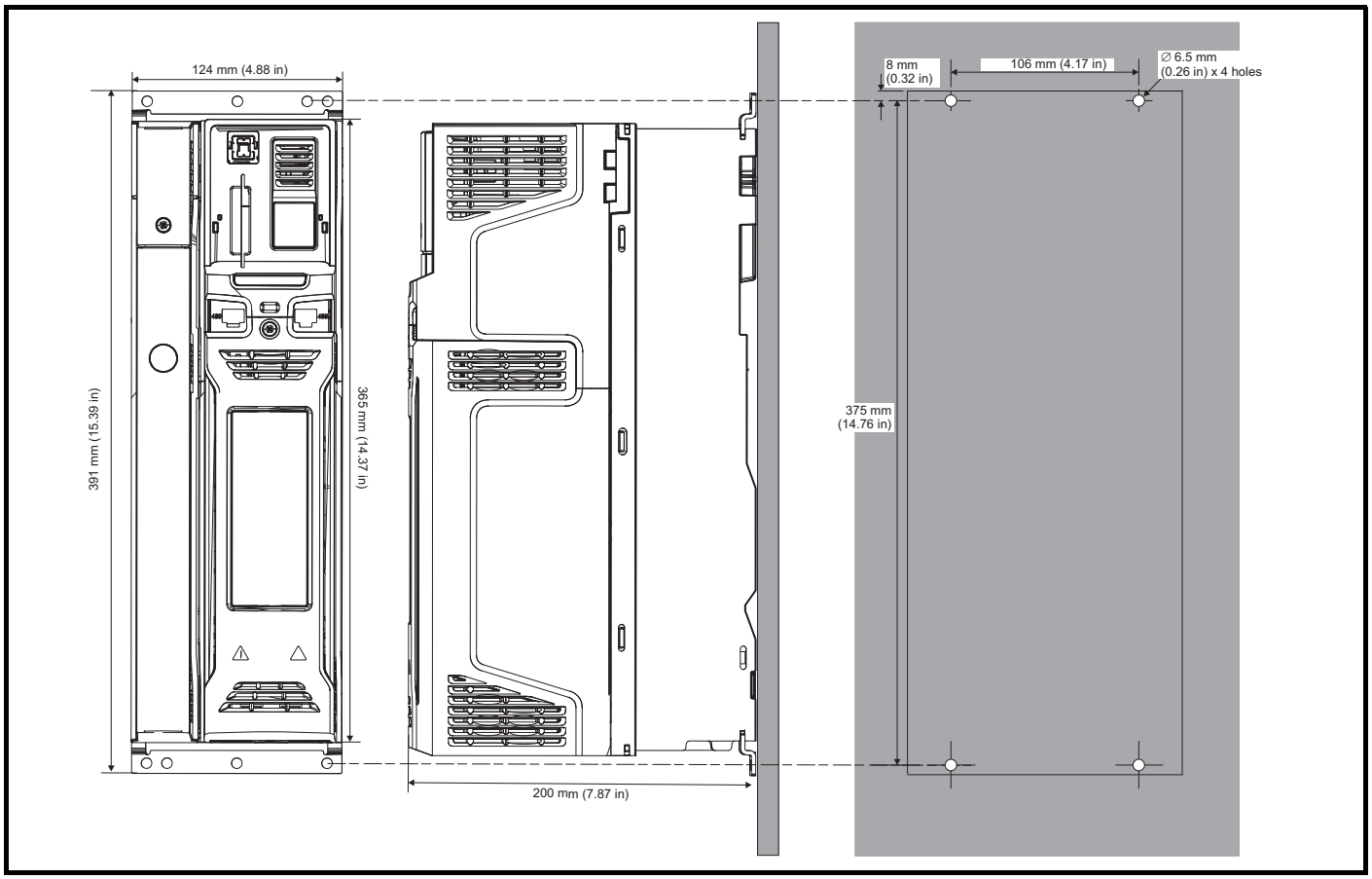
Figure 3-13 Surface mounting the size 3 drive



NOTE

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

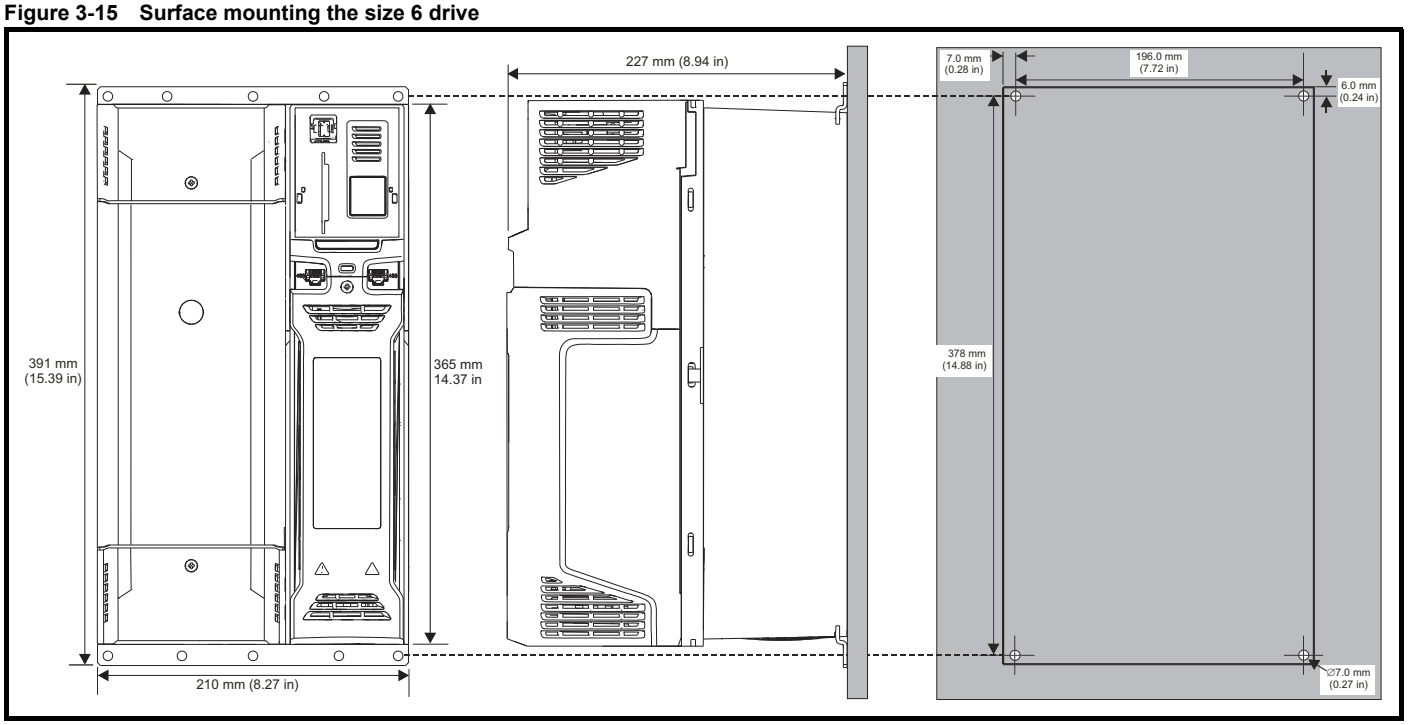
Figure 3-14 Surface mounting the size 4 drive



NOTE

The outer holes in the mounting bracket are to be used for surface mounting. See Table 3-1 for further information.

Figure 3-15 Surface mounting the size 6 drive



NOTE

The outer holes in the mounting bracket are to be used for surface mounting. See Table 3-1 for further information.

3.5.2 Through-panel mounting

Figure 3-16 Through-panel mounting the size 3 drive

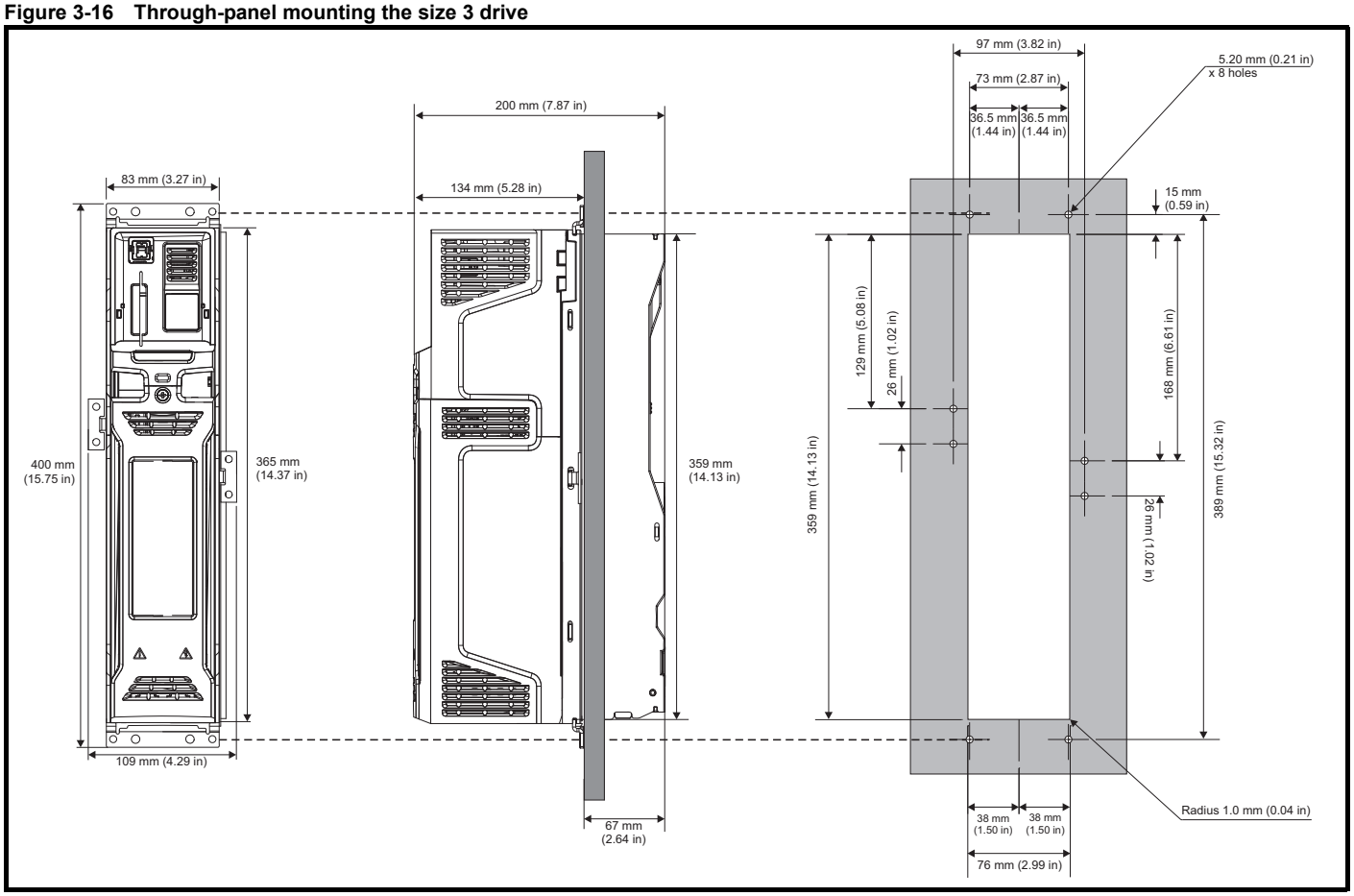


Figure 3-17 Through panel mounting the size 4 drive

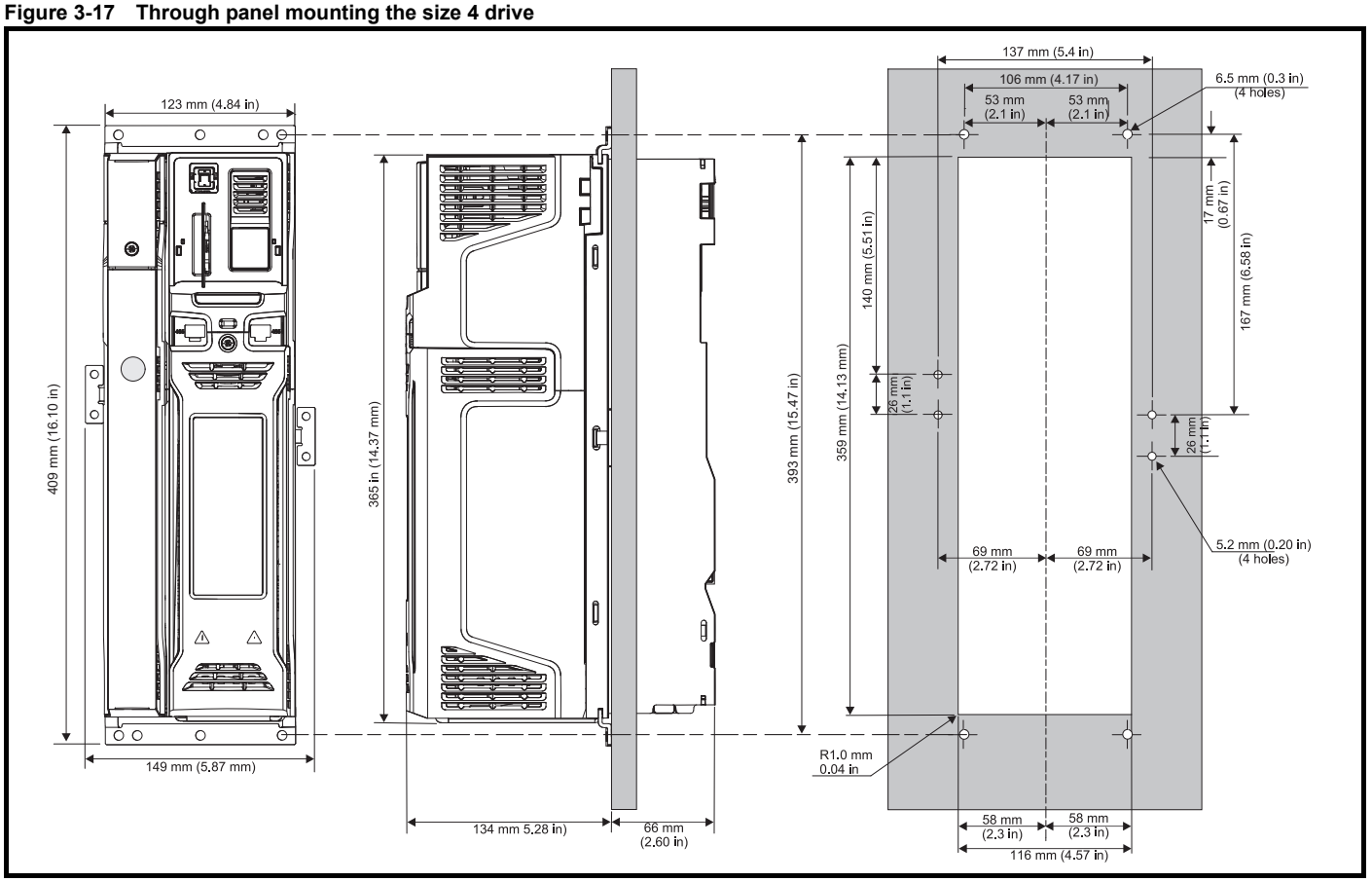
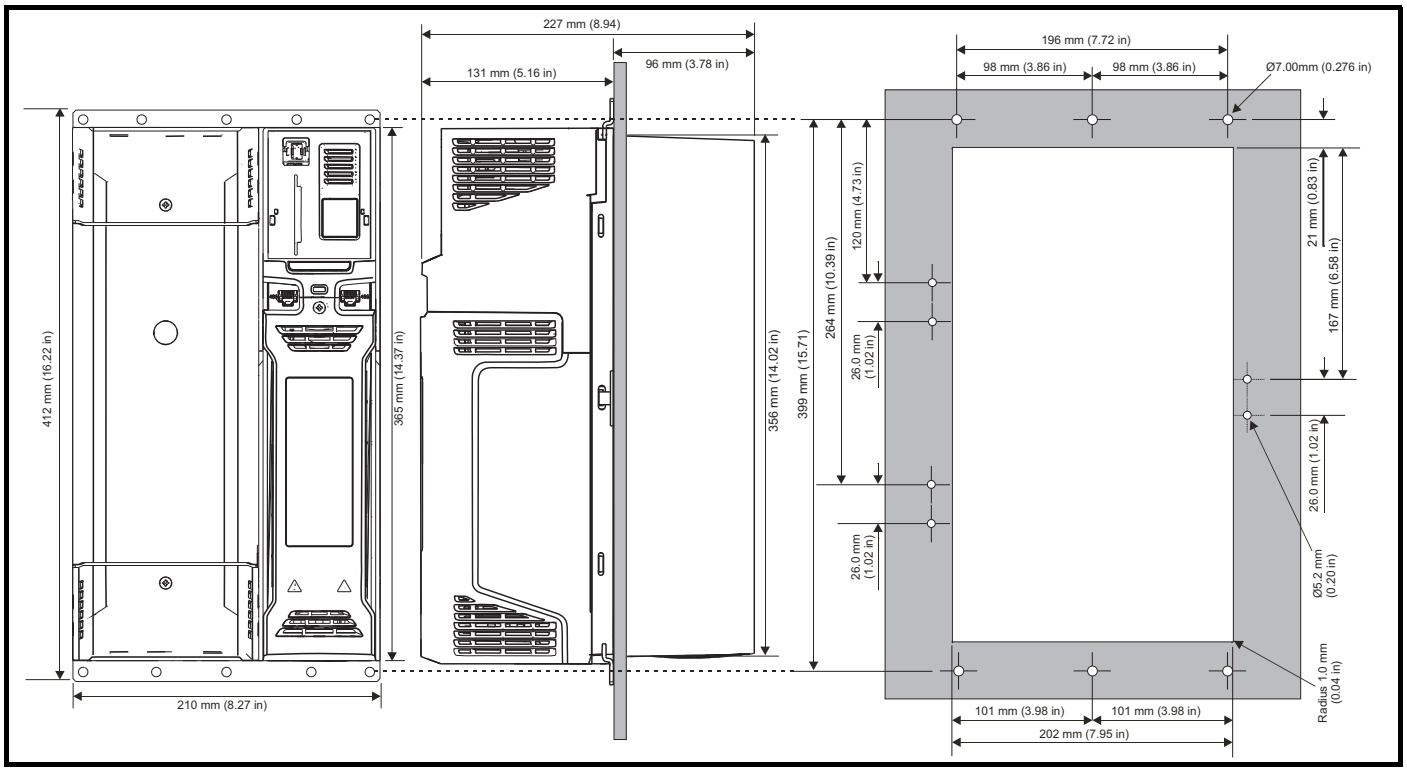


Figure 3-18 Through panel mounting the size 6 drive

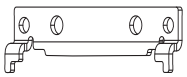
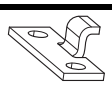
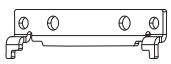
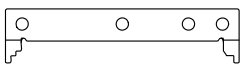
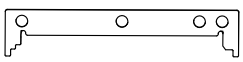
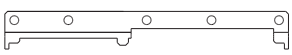
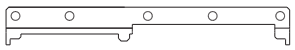


NOTE

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

3.5.3 Mounting brackets

Table 3-1 Mounting brackets

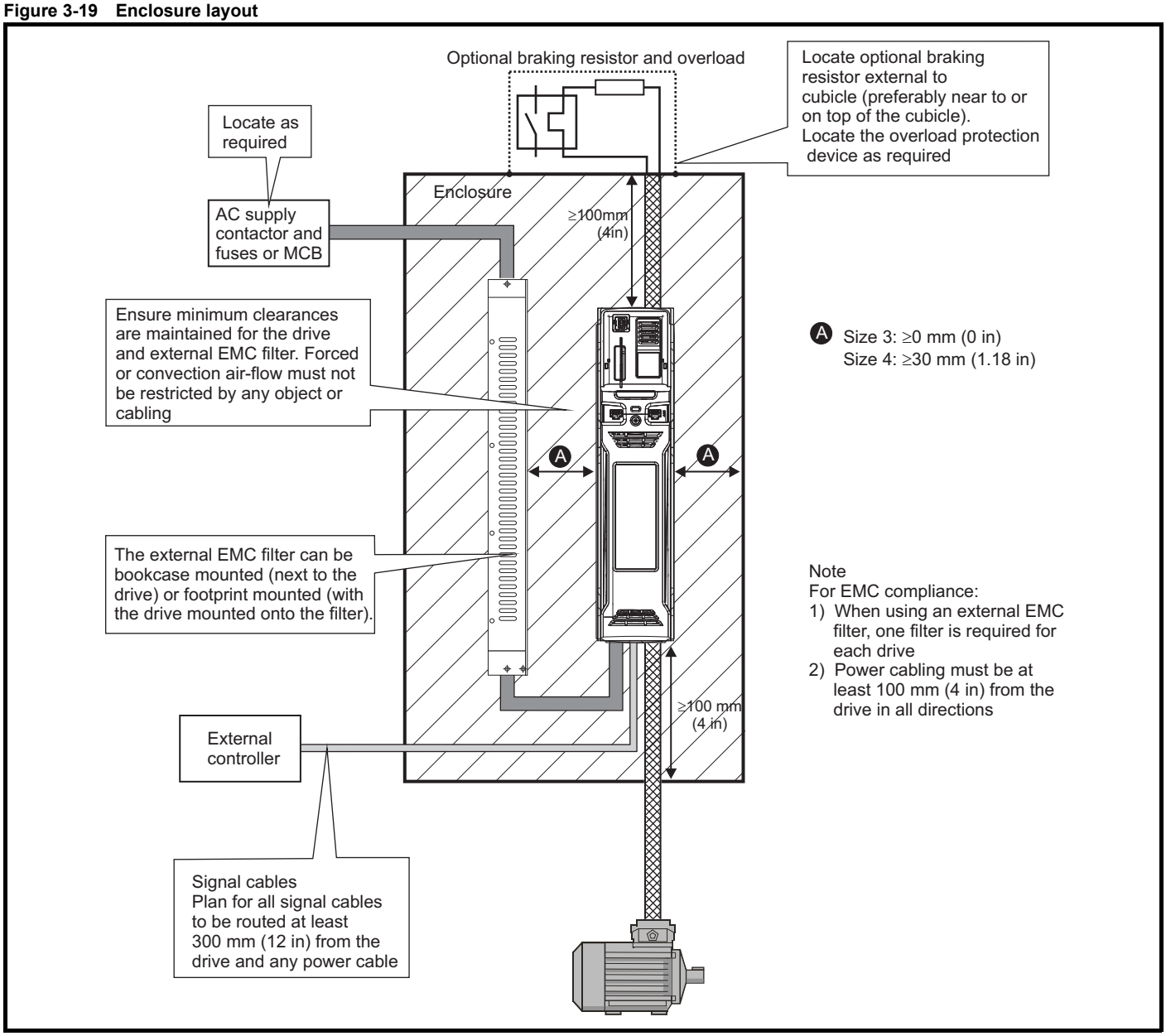
Frame size	Surface	Qty	Through-panel	Qty
3	 Inner hole size: 6.5 mm (0.26 in) Outer hole size: 5.5 mm (0.22 in)	x 2	 Hole size: 5.5 mm (0.22 in)	x 2
			 Inner hole size: 6.5 mm (0.26 in) Outer hole size: 5.5 mm (0.22 in)	x 2
4	 Hole size: 6.5 mm (0.26 in)	x 2	 Hole size: 5.2 mm (0.21 in)	x 3
			 Hole size: 6.5 mm (0.26 in)	x 2
6	 Hole size: 6.5 mm (0.26 in)	x 2	 Hole size: 5.2 mm (0.21 in)	x 3
			 Hole size: 6.5 mm (0.26 in)	x 2

3.6 Enclosure for standard drives

3.6.1 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 3-19 Enclosure layout



3.6.2 Enclosure sizing

1. Add the dissipation figures from section 12.1.2 *Power dissipation* on page 212 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 on page 223 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 $\mathbf{A_e}$ for the enclosure from:

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

Where:

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

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°C
- Maximum ambient temperature outside the enclosure: 30°C

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

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

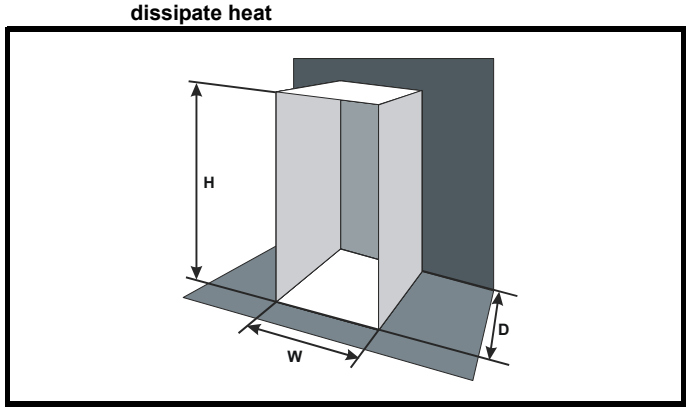
NOTE

Power dissipation for the drives and the external EMC filters can be obtained from Chapter 12 *Technical data* on page 209

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

The value of 5.5 $W/m^2/°C$ 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 3-20 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

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

The minimum required heat conducting area is then:

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

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

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

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

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

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

=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:

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

Where:

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

Where:

$\mathbf{P_0}$ is the air pressure at sea level

$\mathbf{P_I}$ is the air pressure at the installation

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

Example

To calculate the size of an enclosure for the following:

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

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

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

Insert the following values:

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

3.7 Enclosure design and drive ambient temperature

Drive derating is required for operation in high ambient temperatures

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

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

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

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

Where:

T_{ext} = Temperature outside the cabinet
T_{int} = Temperature inside the cabinet
T_{rate} = Temperature used to select current rating from tables in Chapter 12 *Technical data* on page 209.

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 size 3, 4 and 6 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 *Fan removal procedure* on page 40 for information on fan removal. The size 6 is also installed with a variable speed fan to ventilate the capacitor bank.

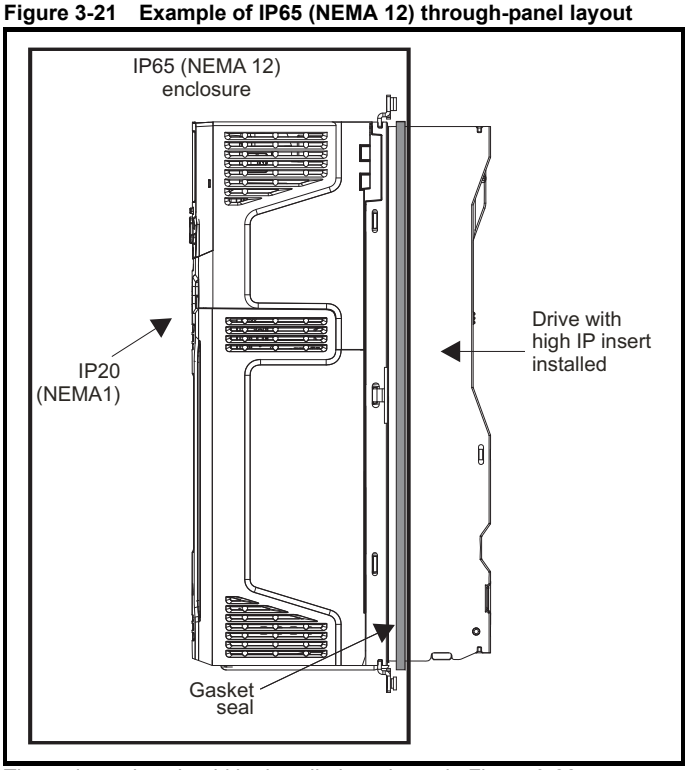
3.9 Enclosing standard drive for high environmental protection

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

The standard drive is rated to IP20 pollution degree 2 (dry, non-conductive contamination only) (NEMA 1). However, it is possible to configure the drive to achieve IP65 rating (NEMA 12) at the rear of the heatsink for through-panel mounting (some current derating is required). Refer to Table 12-2 on page 210.

This allows the front of the drive, along with various switchgear, to be housed in an IP65 (NEMA 12) enclosure with the heatsink protruding through the panel to the external environment. Thus, the majority of the heat generated by the drive is dissipated outside the enclosure maintaining a reduced temperature inside the enclosure. This also relies on a good seal being made between the heatsink and the rear of the enclosure using the gaskets provided.

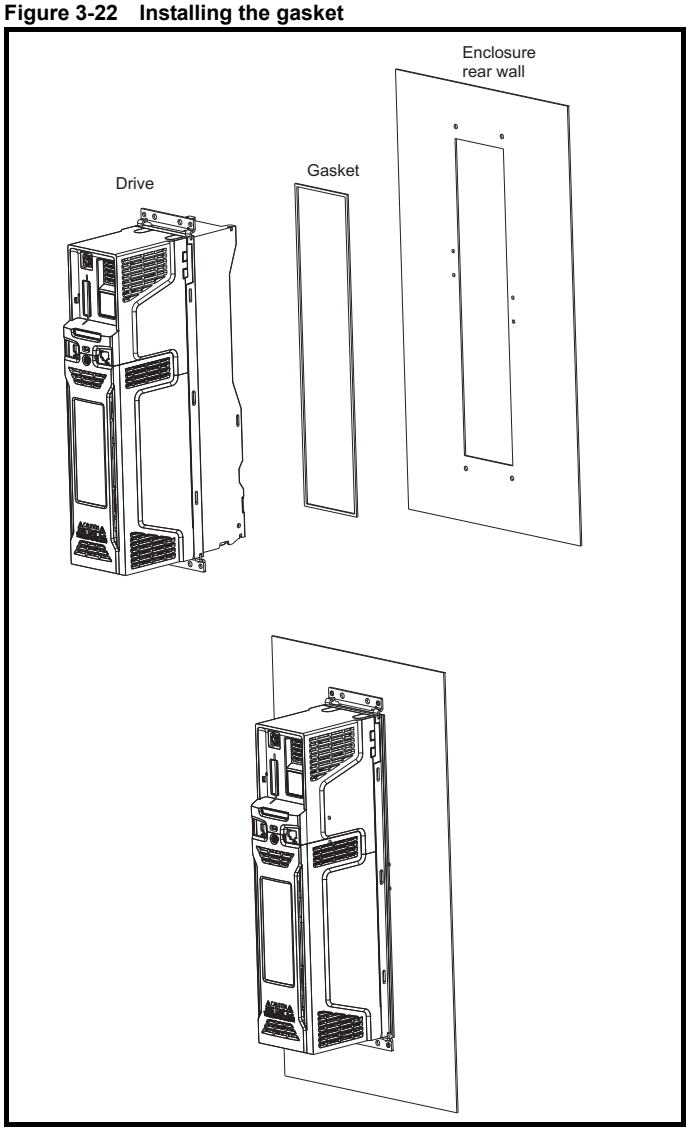
Figure 3-21 Example of IP65 (NEMA 12) through-panel layout



The main gasket should be installed as shown in Figure 3-22.

On drive sizes 3 and 4, 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 3-24 and Figure 3-25.

Figure 3-22 Installing the gasket



To seal the space between the drive and the backplate, use two sealing brackets as shown in Figure 3-23. The sealing brackets are included in the accessories kitbox supplied with the drive.

Figure 3-23 Through panel mounting

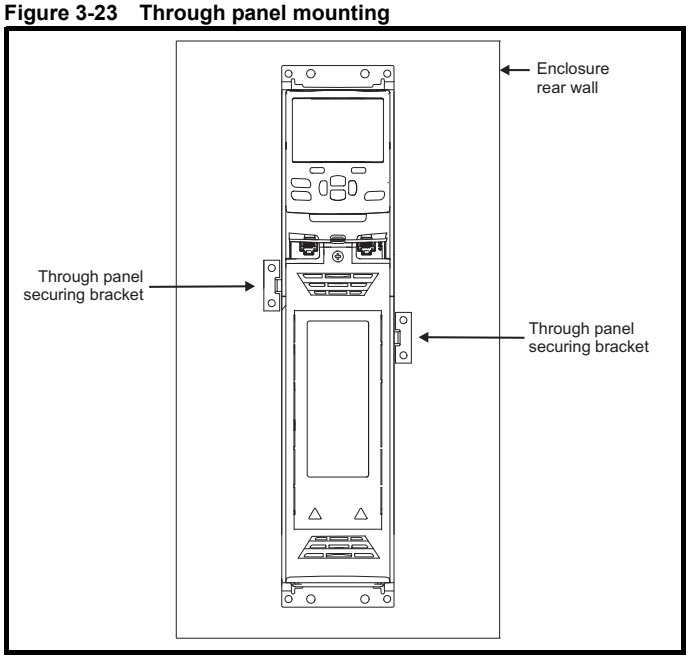
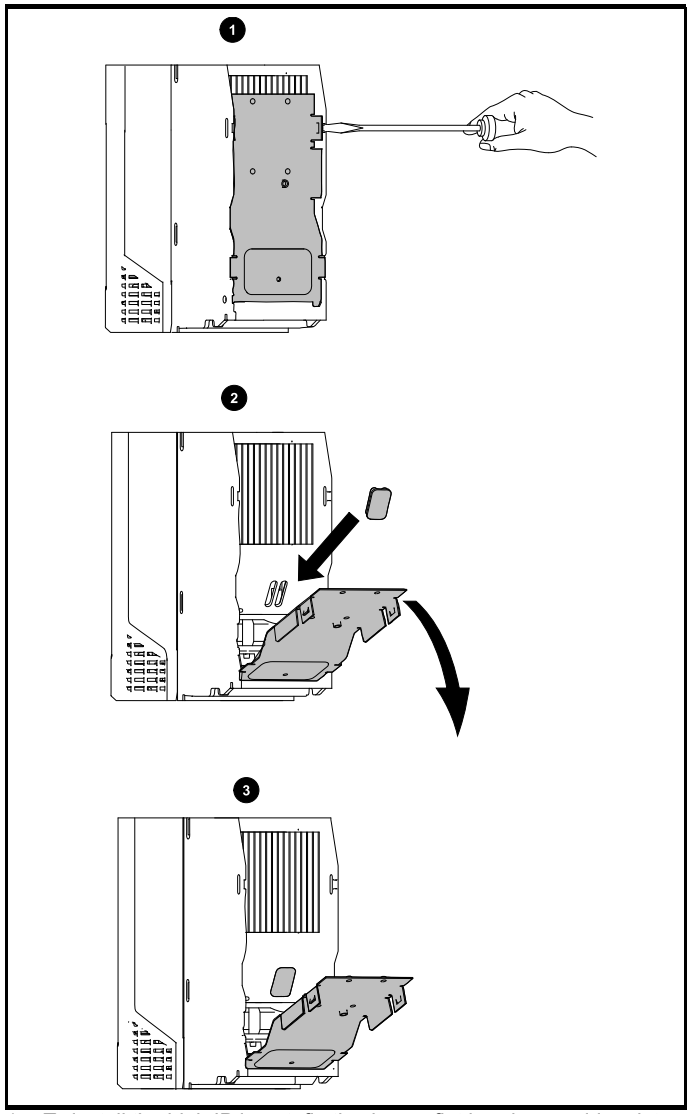


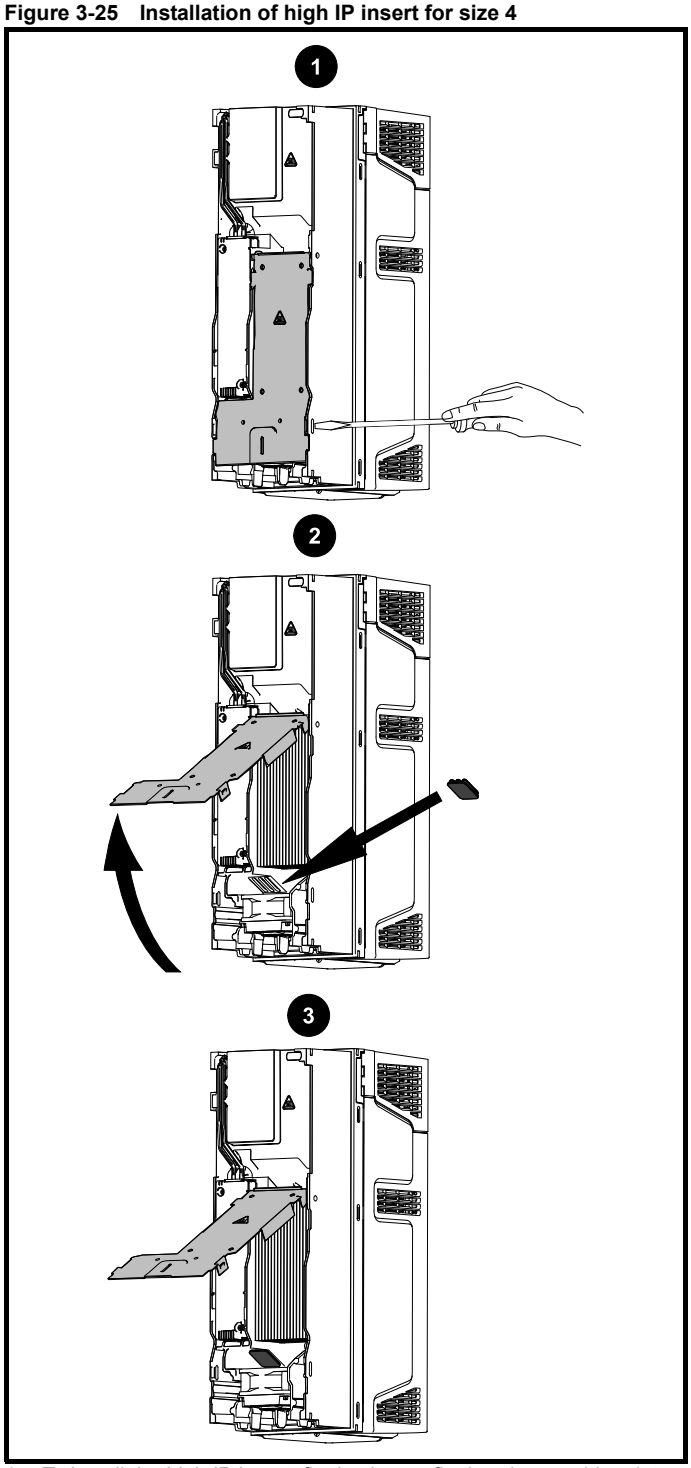
Figure 3-24 Installation of high IP insert for size 3



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).
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.

Figure 3-25 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 3-2 should be followed.

Table 3-2 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 209.

Failure to do so may result in nuisance tripping.

NOTE

When designing an IP65 (NEMA 12) enclosure (Figure 3-21 *Example of IP65 (NEMA 12) through-panel layout* on page 32), consideration should be made to the dissipation from the front of the drive.

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

Frame size	Power loss
3	
4	
6	

3.10 Heatsink mounted brake resistor

WARNING

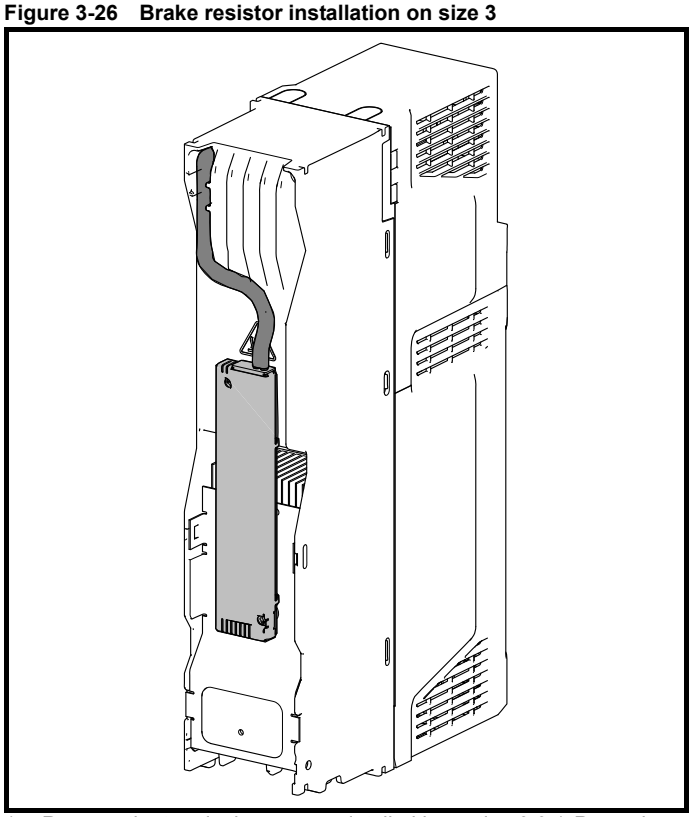
The internal / heatsink mounted braking resistors must only be used with the following drives.
Brake resistor 1220-2752-00 must only be used with size 3 drives. Brake resistor 1299-0003-00 must only be used with size 4 drives.

3.10.1 Size 3 and 4 internal braking resistor

Size 3 and 4 have been designed with an optional space-saving heatsink mounted resistor. The resistor can be installed within the heatsink fins of the drive. When the heatsink resistor is used, an external thermal protection device is not required as the resistor is not designed such that it will fail safely under any fault conditions. The in-built software overload protection is set-up at default to protect the resistor. The resistor is rated to IP54 (NEMA 12).

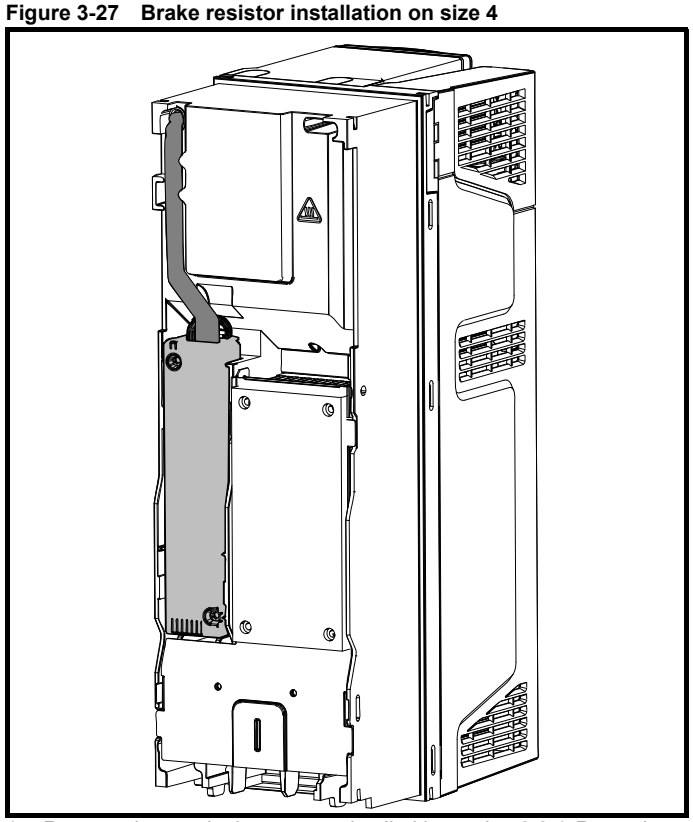
3.10.2 Size 3 and 4 internal braking resistor installation instructions

Figure 3-26 Brake resistor installation on size 3



1. Remove the terminal covers as detailed in section 3.3.1 *Removing the size 3, 4 and 6 terminal covers* on page 20.
2. Remove the internal EMC filter as shown in Figure 4-16 *Removal of the size 3 internal EMC filter* on page 55.
3. Remove the brake resistor bung from the hole in the chassis, the closed end of the bung will need to be pierced so that the cable has access to be routed through.
4. Feed brake resistor bung onto outer insulation of brake resistor cable. The wider end of the bung should be inserted first. The Narrow end should align with end of insulation.
5. Install the braking resistor to the heatsink using captive screws as shown in Figure 3-26. The screws should be tighten to a maximum torque of 2 N m (1.5 lb ft).
6. Route the cables through the provided hole at the rear of the heatsink as shown in Figure 3-26 and take the cable out from the front side of the drive. Ensure the cables are routed between the fins of the heatsink, and the cables are not trapped between the heatsink fins and the resistor.
7. Crimp the cable ends and make appropriate connections. The brake terminals must be tightened to a maximum torque of 2 N m (1.5 lb ft).
8. Replace the terminal covers on the drive, tighten to a maximum torque of 1 N m (0.7 lb ft).

Figure 3-27 Brake resistor installation on size 4



1. Remove the terminal covers as detailed in section 3.3.1 *Removing the size 3, 4 and 6 terminal covers* on page 20.
2. Remove the brake resistor bung from the hole in the chassis, the closed end of the bung will need to be pierced so that the cable has access to be routed through.
3. Feed brake resistor bung onto outer insulation of brake resistor cable. The wider end of the bung should be inserted first. The Narrow end should align with end of insulation.
4. Install the braking resistor to the heatsink using captive screws as shown in Figure 3-27. The screws should be tighten to a maximum torque of 2 N m (1.5 lb ft).
5. Route the cables through the provided hole at the rear of the heatsink as shown in Figure 3-27 and take the cable out from the front side of the drive. Ensure the cables are routed between the tabs of the heatsink, and the cables are not trapped between the heatsink fins and the resistor.
6. Crimp the cable ends and make appropriate connections. The brake terminals must be tightened to a maximum torque of 2 N m (1.5 lb ft).
7. Replace the terminal covers on the drive, tighten to a maximum torque of 1 N m (0.7 lb ft).

3.11 External EMC filter

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

Model	CT part number	Weight	
		kg	lb
200 V			
03200050 to 03200106	4200-3230	1.9	4.20
04200137 to 04200185			
06200330 to 06200440	4200-2300	6.5	14.3
400 V			
03400025 to 03400100	4200-3480	2.0	4.40
04400150 to 04400172			
06400350 to 06400470	4200-4800	6.7	14.8
575 V			
06500100 to 06500350	4200-3690	7.0	15.4

The external EMC filters for size 3 can be footprint or bookcase mounted, see Figure 3-28 and Figure 3-29.

Mount the external EMC filter following the guidelines in section 4.11.5 *Compliance with generic emission standards* on page 58.

Figure 3-28 Footprint mounting the EMC filter

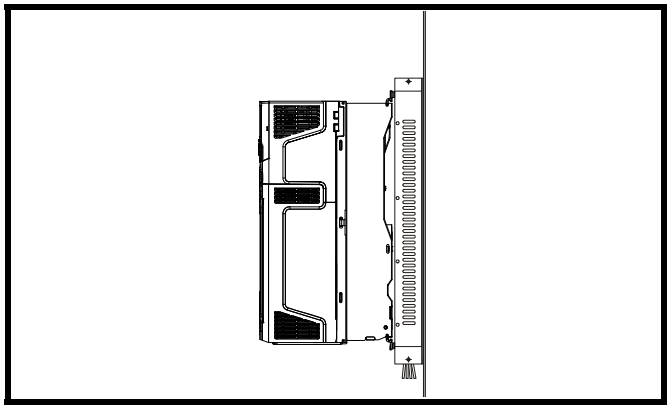


Figure 3-29 Bookcase mounting the EMC filter

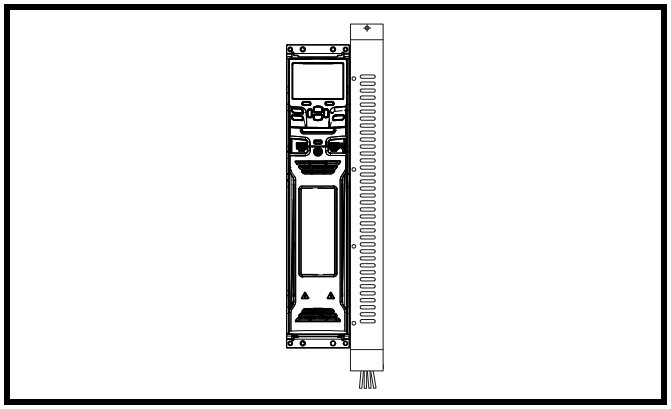
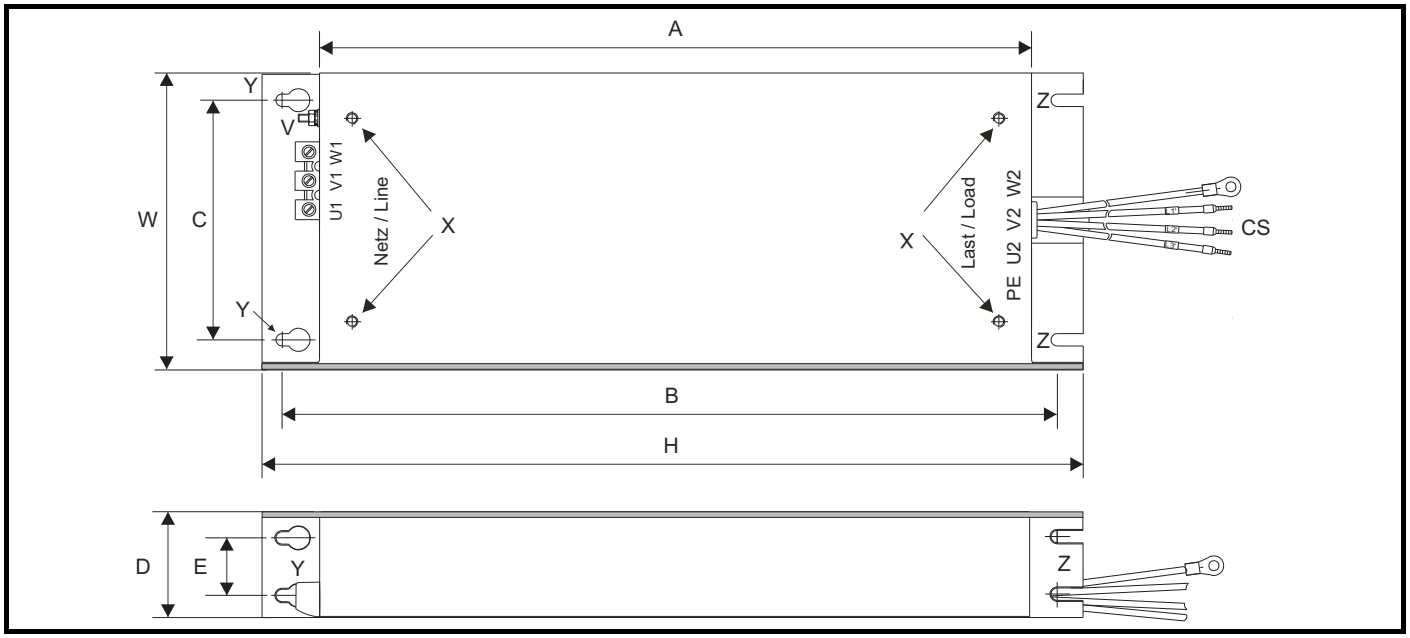


Figure 3-30 Size 3, 4 and 6 external EMC filter



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 3-4 Size 3 external EMC filter dimensions

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

Table 3-5 Size 4 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS

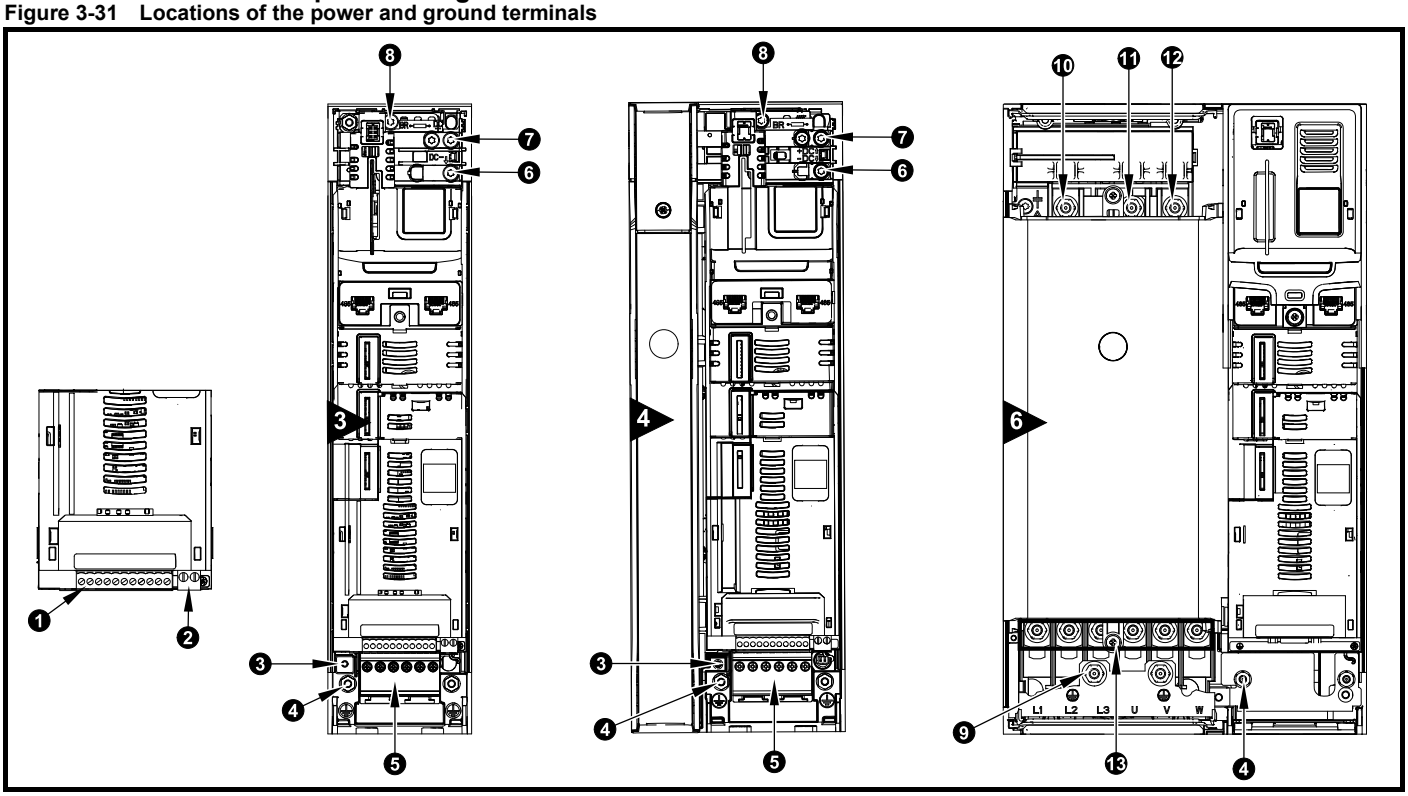
Table 3-6 Size 6 external EMC filter dimensions

CT part number	A	B	C	D	E	H	W	V	X	Y	Z	CS
4200-2300 4200-4500 4200-3690	392 mm (15.43 in)	420 mm (16.54 in)	180 mm (7.09 in)	60 mm (2.36 in)	33 mm (1.30 in)	434 mm (17.09 in)	210 mm (8.27 in)	M6	M6	6.5 mm (0.26 in)	6.5 mm (0.26 in)	16 mm^2 (6 AWG)

3.12 Electrical terminals

3.12.1 Location of the power and ground terminals

Figure 3-31 Locations of the power and ground terminals



Number	Terminal description	Terminal type / size	
1	Control terminals	2.5 mm Slotted head screw	
2	Relay terminals	3.5 mm Slotted head screw	
3	Additional ground connection	M4, Torx T20	
4	Ground connections (size 3 and 4) Grounding bracket securing points (all sizes)	M4 Nut	
5	AC power / Motor terminals (size 3 and 4)	Pozi Pz2	
6	DC bus - (size 3 and 4)	M4, Torx T20	
7	DC bus + (size 3 and 4)		
8	Brake terminal (size 3 and 4)		
9	Ground connections (size 6)	M6 Nut	
10	DC bus - (size 6)		
11	DC bus + (size 6)		
12	Brake terminal (size 6)		
13	AC power / Motor terminals (size 6)		

3.12.2 Terminal sizes and torque settings

WARNING

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

Table 3-7 Drive control and relay terminal data

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

Table 3-8 Drive power terminal data

Model size	AC terminals	DC and braking	Ground terminal
3	Plug-in terminal block 0.8 N m (0.6 lb ft)	Terminal block M4 screws 2.0 N m (1.47 lb ft)	Screw (M4) 2.0 N m (1.47 lb ft)
4			M4 stud 2.0 N m (1.47 lb ft)
6	M6 stud 6 N m(4.42 lb ft)		

The maximum torque for the nuts securing the grounding bracket is 2.0 N m (1.47 lb ft).

Table 3-9 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	13 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		
6	2 way low voltage power 24 V supply connector	1.5 mm^2 (16 AWG)

Table 3-10 External EMC filter terminal data

CT part number	Power connections		Ground connections	
	Max cable size	Max torque	Ground stud size	Max torque
4200-3230	4 mm^2 (12 AWG)	0.8 N m (0.59 lb ft)	M5	3.0 N m (2.2 lb ft)
4200-3480			M5	
4200-2300	16 mm^2 (6 AWG)	2.3 N m (1.70 lb ft)	M6	4.8 N m (2.8 lb ft)
4200-4500				
4200-3690				

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

Those keypads which have 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 3-32 KI-Keypad RTC (rear view)

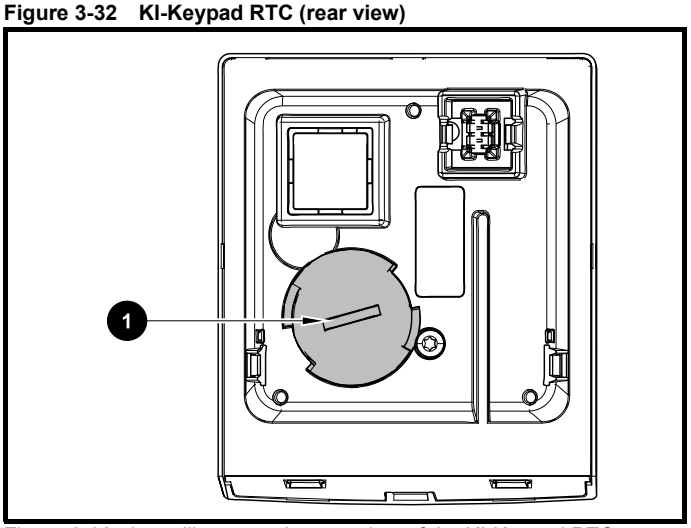


Figure 3-32 above illustrates the rear view of the KI-Keypad RTC.

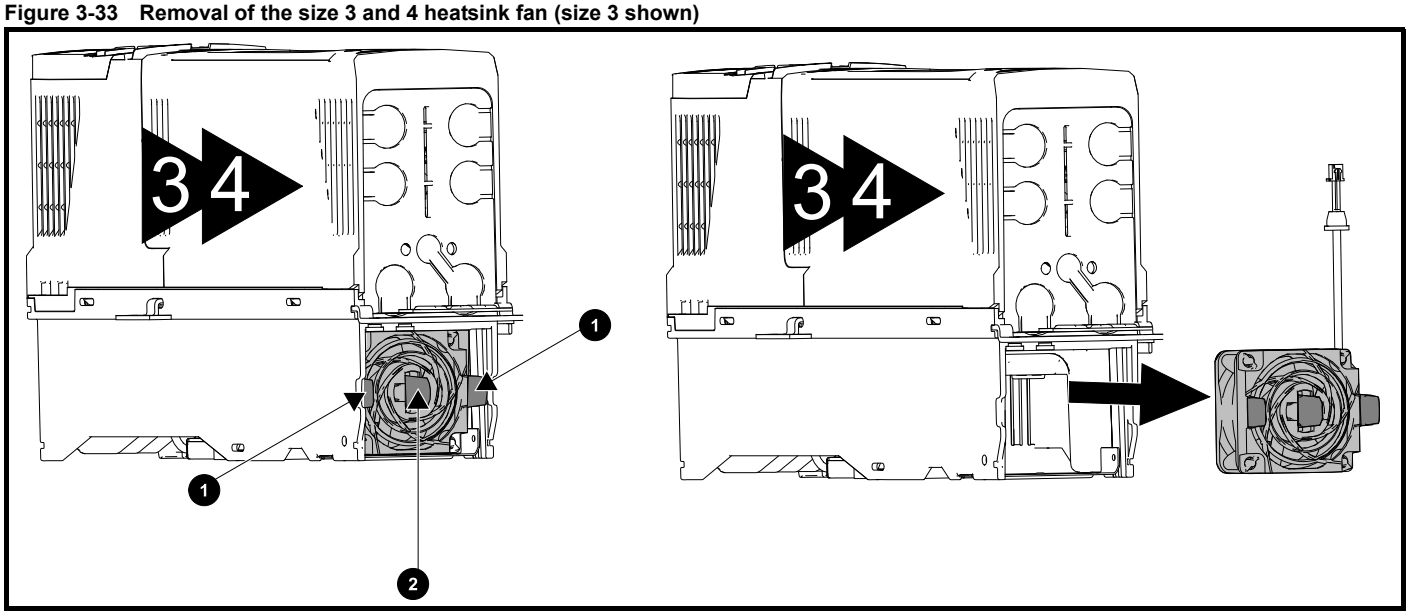
1. To remove the battery cover insert a flat head screwdriver into the slot as shown (1), push and turn anti-clockwise until the battery cover is released.
2. Replace the battery (the battery type is: CR2032).
3. Reverse point 1 above to replace battery cover.

NOTE

Ensure the battery is disposed of correctly.

3.13.2 Fan removal procedure

Figure 3-33 Removal of the size 3 and 4 heatsink fan (size 3 shown)



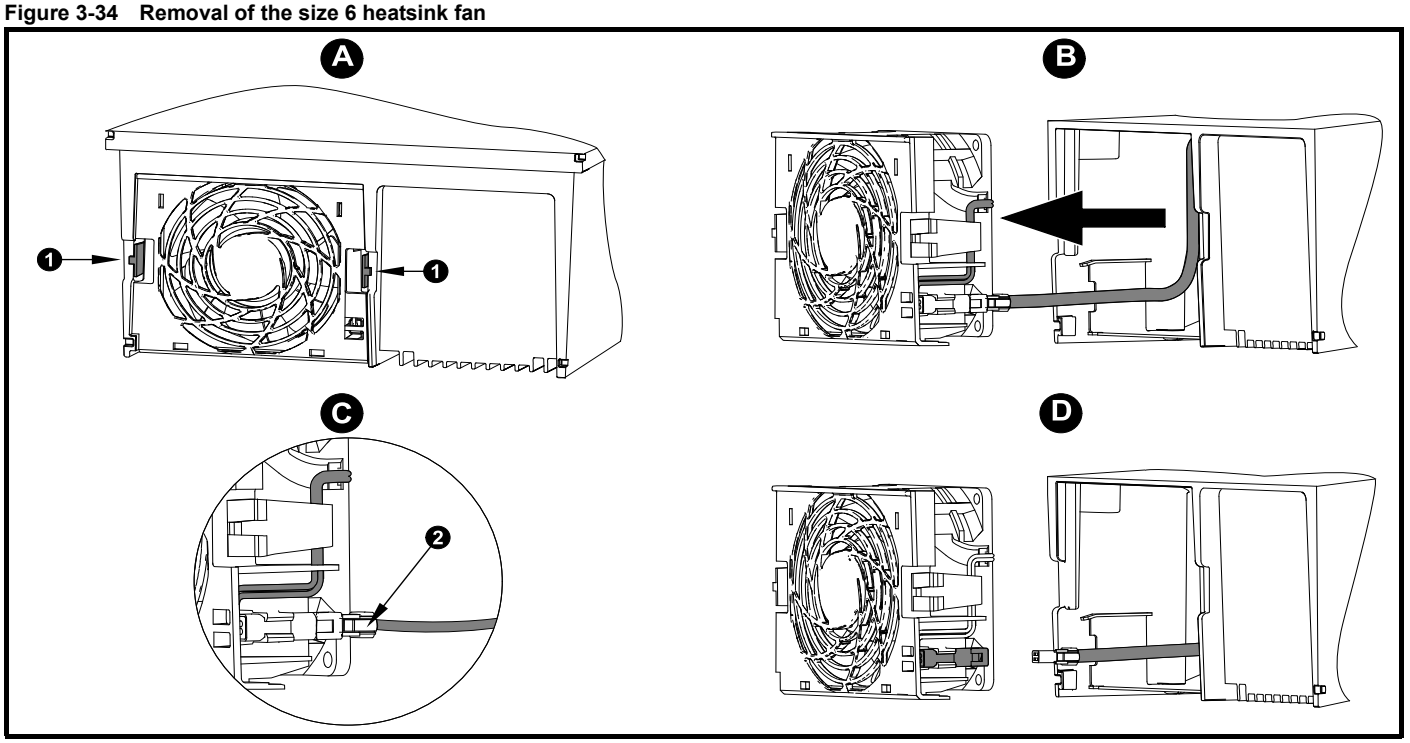
1. Ensure the fan cable is disconnected from the drive prior to attempting fan removal.
2. Press the two tabs (1) inwards to release the fan from the drive frame.
3. Using the central fan tab (2), withdraw the fan assembly from the drive housing.

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.

Figure 3-34 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.

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
- Brake resistor details (selection / ratings)

WARNING

Electric shock risk

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

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

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

WARNING

Isolation device

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

WARNING

STOP function

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

WARNING

SAFE TORQUE OFF function

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

WARNING

Stored charge

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

WARNING

Equipment supplied by plug and socket

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

WARNING

Permanent magnet motors

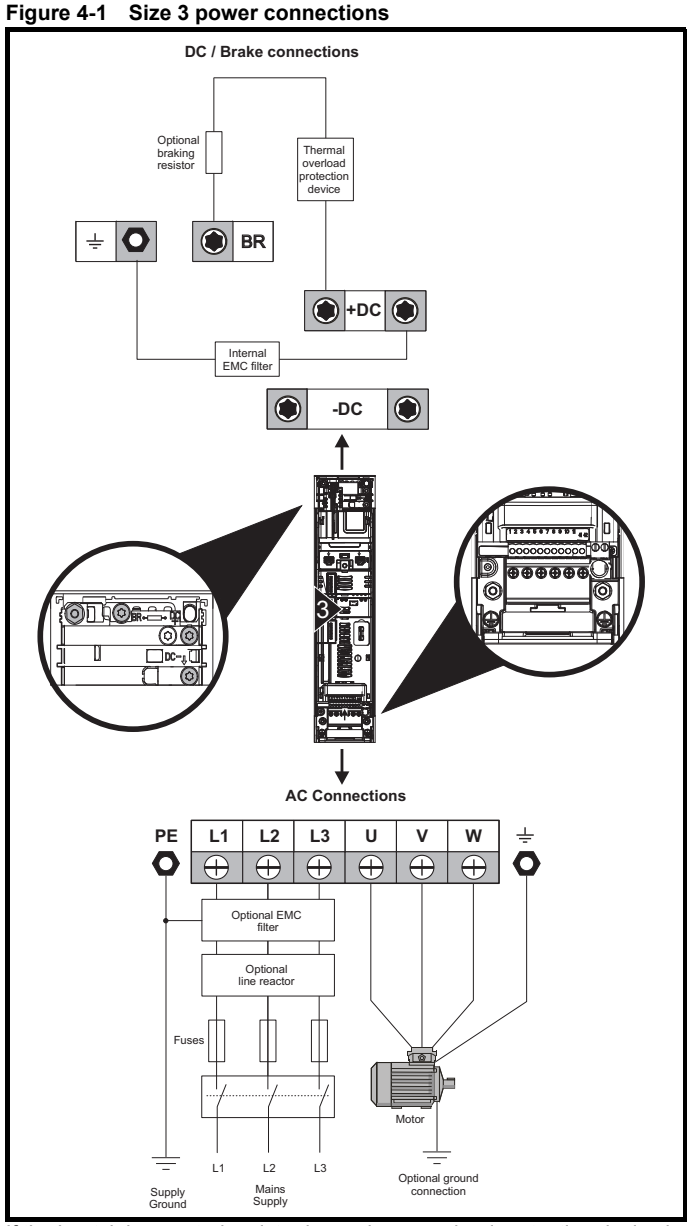
Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.

If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

4.1 Power connections

4.1.1 AC and DC connections

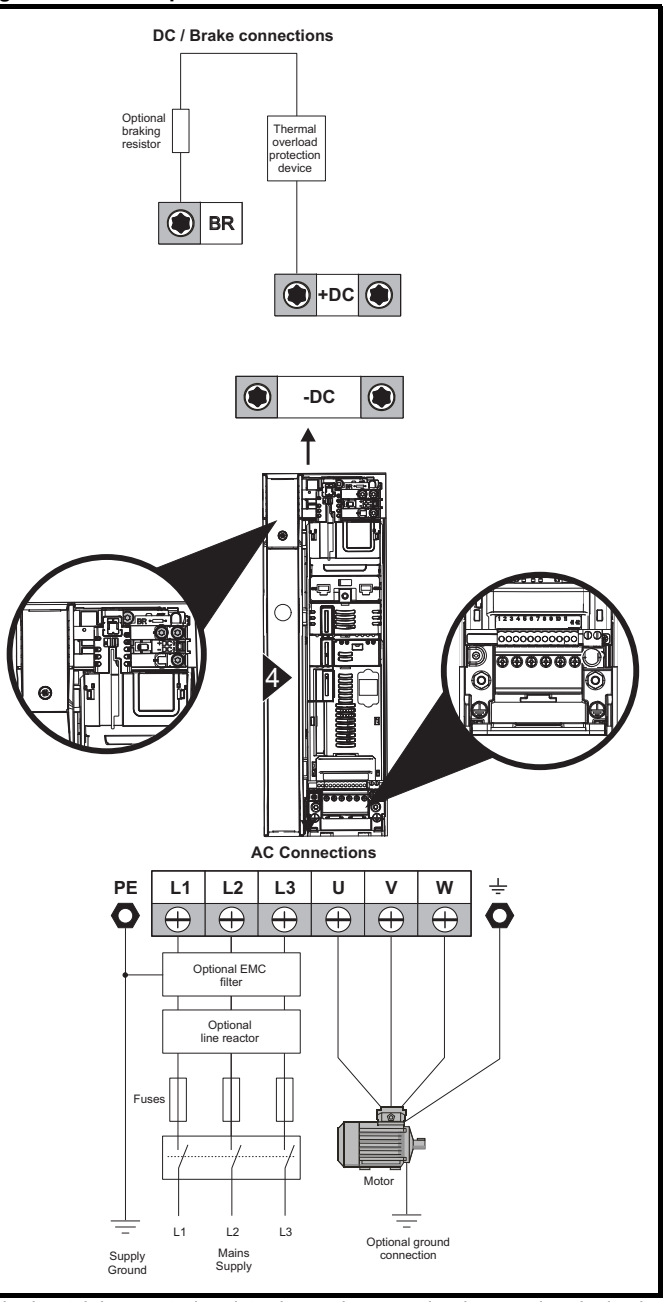
Figure 4-1 Size 3 power connections



If the heatsink mounted resistor is used, an overload protection device is not required. The resistor is designed to fail safely under fault conditions.

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

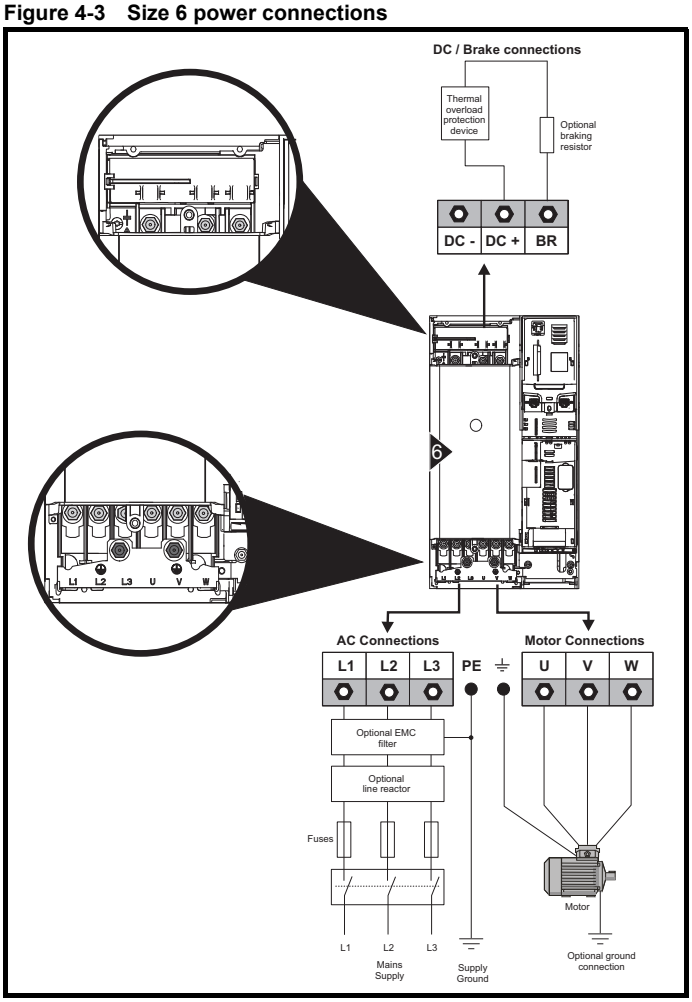
Figure 4-2 Size 4 power connections



If the heatsink mounted resistor is used, an overload protection device is not required. The resistor is designed to fail safely under fault conditions.

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

Figure 4-3 Size 6 power connections



4.1.2 Ground connections

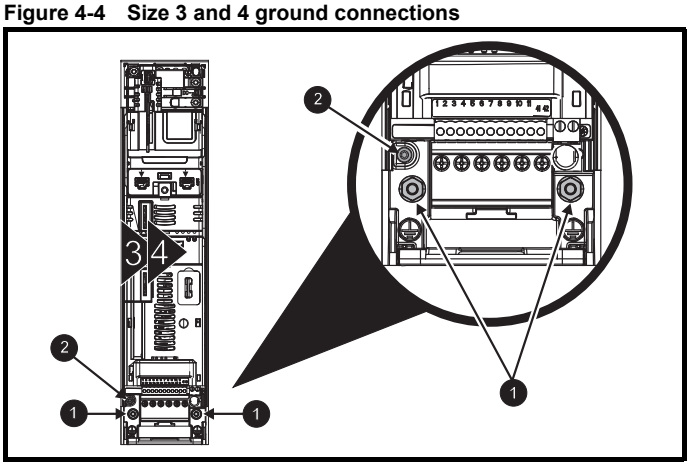
Electrochemical corrosion of grounding terminals
Ensure that grounding terminals are protected against corrosion i.e. as could be caused by condensation.

WARNING

Size 3 and 4

On a size 3 and 4, the supply and motor ground connections are made using the M4 studs located either side of the drive near the plug-in power connector. Refer to Figure 4-4 for additional ground connection.

Figure 4-4 Size 3 and 4 ground connections

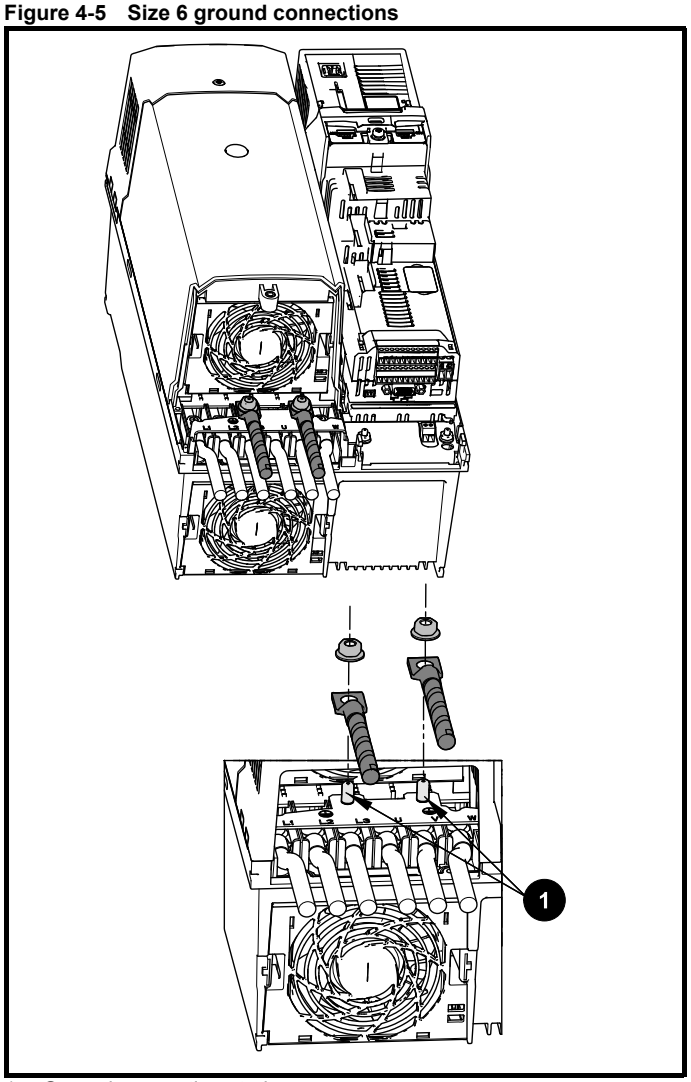


1. Ground connection studs.
2. Additional ground connection.

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 4-5 below.

Figure 4-5 Size 6 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.

Table 4-1 Protective ground cable ratings

Model	Ground conductor size
200 V	
03200050	Either use 10 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
03200066	
03200080	
03200106	
04200137	
04200185	
06200330	
06200440	Either use 16 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
400 V	
03400025	Either use 10 mm2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
03400031	
03400045	
03400062	
03400078	
03400100	
04400150	
04400172	
06400350	
06400420	
06400470	Either use 16 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
575 V	
06500100	Either use 10 mm2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
06500150	
06500190	
06500230	
06500290	
06500350	

4.2 AC supply requirements

Voltage:

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

Number of phases: 3

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

Frequency range: 45 to 66 Hz

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

4.2.1 Supply types

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

- Supplies with voltage up to 600 V may have grounding at any potential, i.e. neutral, centre or corner ("grounded delta")
- Supplies with voltage above 600 V may not have corner grounding

WARNING

If an SI-Applications Plus or SI-Register module is installed in the drive, then the drive must not be used on a corner-grounded or centre-grounded delta supply if the supply voltage is above 300 V. If this is required, please contact the supplier of the drive for more information.

Drives are suitable for use on supplies of installation category III and lower, according to IEC60664-1. This means they may be connected permanently to the supply at its origin in a building, but for outdoor installation additional over-voltage suppression (transient voltage surge suppression) must be provided to reduce category IV to category III.

WARNING

Operation with IT (ungrounded) supplies:
Special attention is required when using internal or external EMC filters with ungrounded supplies, because in the event of a ground (earth) fault in the motor circuit the drive may not trip and the filter could be over-stressed. In this case, either the filter must not be used (removed) or additional independent motor ground fault protection must be provided. For instructions on removal, refer to Figure 4-16 on page 55 (size 3) and Figure 4-18 on page 55 (size 6).
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:

03200050, 03200066, 03200080, 03200106,

03400025, 03400031, 03400045, 03400062

Model sizes 03400078 to 06500350 have an internal DC choke so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions.

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

4.2.3 Input inductor calculation

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

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

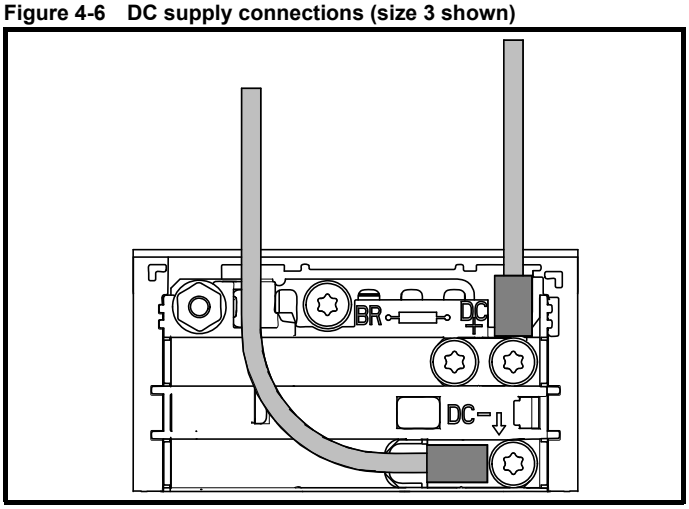
Where:

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

4.3 Supplying the drive with DC

The DC supply connections for size 3 and 4 are located under the DC / Braking terminal cover. Figure 4-6 below shows DC supply connections and cable routing.

Figure 4-6 DC supply connections (size 3 shown)



NOTE

The Internal EMC filter and plastics have been removed from the above Figure 4-6 to demonstrate the routing of the DC cables.

4.4 DC bus paralleling

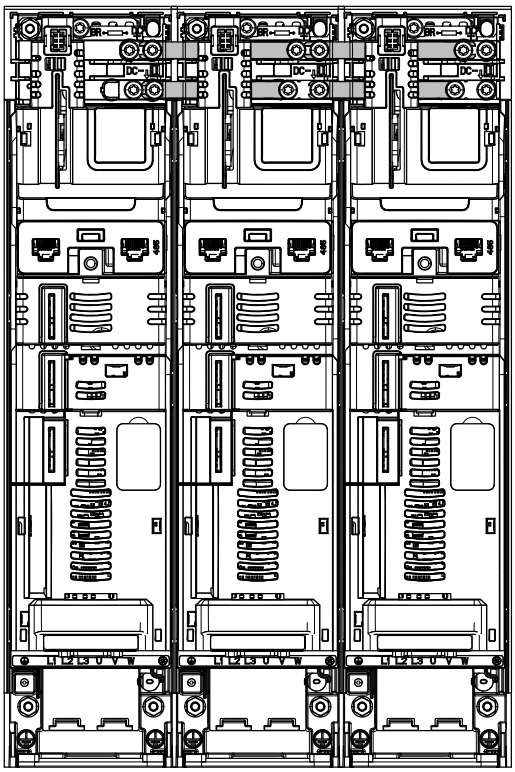
DC bus paralleling using standard cable / busbars is supported by all frame sizes.

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:

1. Return energy from a drive which is being overhauled by the load to a second motoring drive.
2. Allow the use of one braking resistor to dissipate regenerative energy from several drives.

Figure 4-7 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 from Control Techniques.

Frame size	CT part number
3	3470-0048-00
4	3470-0061-00
5	
6	

4.5 24 Vdc supply

The 24 Vdc supply connected to control terminals 9 and 10 provide the following functions:

- It can be used to supplement the drive's own internal 24 V supply when multiple option modules are being used and the current drawn by these module is greater than the drive can supply.
- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules, application modules, encoders or serial communications to continue to operate.
- It can be used to commission the drive when the line power supply is not available, as the display operates correctly. However, the drive will be in the Under voltage trip state unless either line power supply or low voltage DC operation is enabled, therefore diagnostics may not be possible. (Power down save parameters are not saved when using the 24 V back-up power supply input).
- If the DC bus voltage is too low to run the main SMPS in the drive, then the 24 V supply can be used to supply all the low voltage power requirements of the drive. *Low Under Voltage Threshold Select* (06.067) must also be enabled for this to happen.

NOTE

On size 6 and larger, if the power 24 Vdc supply is not connected none of the above mentioned functions can be used and “Waiting For Power Systems” will be displayed on the keypad. The location of the power 24 Vdc can be identified from Figure 4-8 *Location of the 24 Vdc power supply connection (size 6 only)* on page 45.

Table 4-2 24 Vdc Supply connections

Function	Sizes 3-4	Sizes 5-6
Supplement the drive’s internal supply	Terminal 9,10	Terminal 9, 10
Back-up supply for the control circuit	Terminal 9, 10	Terminal 9, 10 51, 52

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

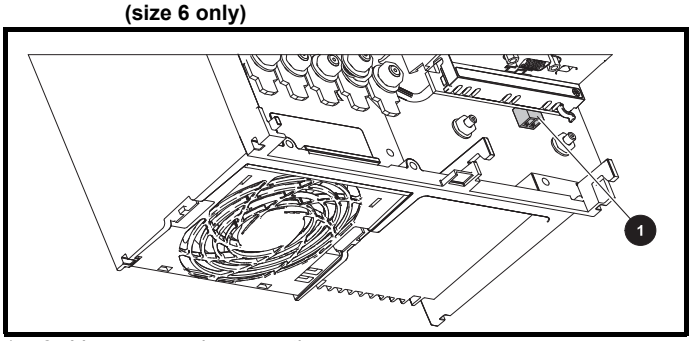
9	**+24 Vdc**
10	**0 V**
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	19.2 V
Maximum continuous operating voltage	28.0 V
Minimum start up voltage	21.6 V
Maximum power supply requirement at 24 V	40 W
Recommended fuse	3 A, 50 Vdc

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	**0 V**
52	**+24 Vdc**
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	80 W
Recommended fuse	4 A @ 50 Vdc

Figure 4-8 Location of the 24 Vdc power supply connection (size 6 only)



1. 24 V power supply connection

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 trip 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, 4 and 6

Minimum continuous operating voltage:	24 V
Minimum start up voltage:	23 V
Nominal continuous operating voltage:	24 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

4.7 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 4-3.

Table 4-3 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 4-4 shows recommended fuse ratings. Failure to observe this requirement will cause risk of fire.

WARNING

Table 4-4 AC Input current and fuse ratings

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse Rating			
				IEC gG		Class CC or Class J	
				Nominal	Maximum	Nominal	Maximum
	A	A	A	A	A	A	A
200 V							
03200050	10.5	10.7	14.1	16	25	16	20
03200066	12.8	13	18.6	20		20	
03200080	17.6	17.8	22.6	25		25	25
03200106	20.3	20.6	29.9	25		25	
04200137	16.8	20.1	26.8	25	25	25	25
04200185	19.3	26.8	36.2	32	32	30	30
06200330	42.4	48.8	56.3	63	63	60	70
06200440	53.4	56.6	75.1	63		70	
400 V							
03400025	5	5	6.5	6	10	10	10
03400031	6.6	6.6	8.1	10		10	
03400045	9.1	9.1	11.7	10		10	
03400062	12.9	13.1	18.4	20	20	20	20
03400078	13.2	13.4	17.5	20		20	
03400100	15.6	15.8	22.5	20		20	
04400150	16.8	18.7	26.6	25	25	25	25
04400172	20	24.3	30.5	32	32	30	30
575 V							
06500100	11.9	13.2	19.3	20	40	20	30
06500150	16.8	18.7	28.9	32		25	
06500190	21.8	24.3	36.7	40		30	
06500230	26.3	29.4	43.9	50	63	35	50
06500290	33	37.1	55.3	50		40	
06500350	40.2	46.9	66.8	63		50	

Table 4-5 AC input current and fuse rating (400V size 6)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse Rating			
				IEC gR		Ferraz HSJ Bussman DFJ	
				Nominal	Maximum	Nominal	Maximum
	A	A	A	A	A	A	A
06400350	32.7	36.5	58.9	63	63	40	70
06400420	41.3	46.2	70.7	63		50	
06400470	51.9	60.6	79.1	63		70	

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 4-6 Cable ratings

Model	Cable size (IEC) mm²				Cable size (UL) AWG			
	Input		output		Input		output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
200 V								
03200050	1.5	4	1.5	4	14	10	14	10
03200066	1.5		1.5		14		14	
03200080	4		4		12		12	
03200106	4		4		12		12	
04200137	6	6	6	8	10	10	10	8
04200185	8							
06200330	16	25	16	25	4	3	4	3
06200440	25		25		3		3	
400 V								
03400025	1.5	4	1.5	4	18	10	18	10
03400031	1.5		1.5		16		16	
03400045	1.5		1.5		14		14	
03400062	2.5		2.5		14		14	
03400078	2.5		2.5		14		14	
03400100	2.5		2.5		12		12	
04400150	6	6	6	8	10	10	10	8
04400172			8					
06400350	10	25	10	25	6	3	6	3
06400420	16		16		4		4	
06400470	25		25		3		3	
575 V								
06500100	2.5	25	2.5	25	14	3	14	3
06500150	4		4		10		10	
06500190	6		6		10		10	
06500230	10		10		8		8	
06500290	10		10		6		6	
06500350	16		10		6		6	

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 B2 (multicore cable in conduit).

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 4-1 *Protective ground cable ratings* on page 43.

4.7.1 Main AC supply contactor
The recommended AC supply contactor type for size 3 and 6 is AC1.

4.8 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* (**00.046**) must be set to suit the motor.

WARNING

Rated Current (**00.046**) must be set correctly to avoid a risk of fire in the event of motor overload.

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

4.8.1 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 4-7, Table 4-8 and Table 4-9.

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 4-7 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**
03200050	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03200066	100 m (330 ft)				75 m (245 ft)		
03200080	130 m (425 ft)			100 m (330 ft)			
03200106	200 m (660 ft)		150 m (490 ft)				
04200137	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04200185							
06200330	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06200440							

Table 4-8 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**
03400025	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03400031	100 m (330 ft)				75 m (245 ft)		
03400045	130 m (425 ft)			100 m (330 ft)			
03400062	200 m (660 ft)		150 m (490 ft)				
03400078							
03400100							
04400150	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04400172							
06400350	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06400420							
06400470							

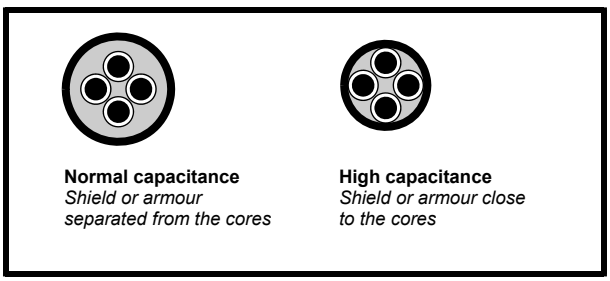
Table 4-9 Maximum motor cable lengths (575 V drives)

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**
06500100	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06500150							
06500190							
06500230							
06500290							
06500350							

4.8.2 High-capacitance / reduced diameter cables
The maximum cable length is reduced from that shown in Table 4-7, Table 4-8 and Table 4-9, 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 4-9 shows how to identify the two types).

Figure 4-9 Cable construction influencing the capacitance



The cable used for Table 4-7, Table 4-8 and Table 4-9 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).

4.8.3 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
- 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 4.8.4 *Multiple motors* on page 50 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.

4.8.4 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 4-10 and Figure 4-11. The maximum cable lengths in Table 4-7, Table 4-8 and Table 4-9 apply to the sum of the total cable lengths from the drive to each motor.

It is recommended that each motor is connected through a protection relay since the drive cannot protect each motor individually. For ⅄ connection, a sinusoidal filter or an output inductor must be connected as shown in Figure 4-11, even when the cable lengths are less than the maximum permissible. For details of inductor sizes, refer to the supplier of the drive.

Figure 4-10 Preferred chain connection for multiple motors

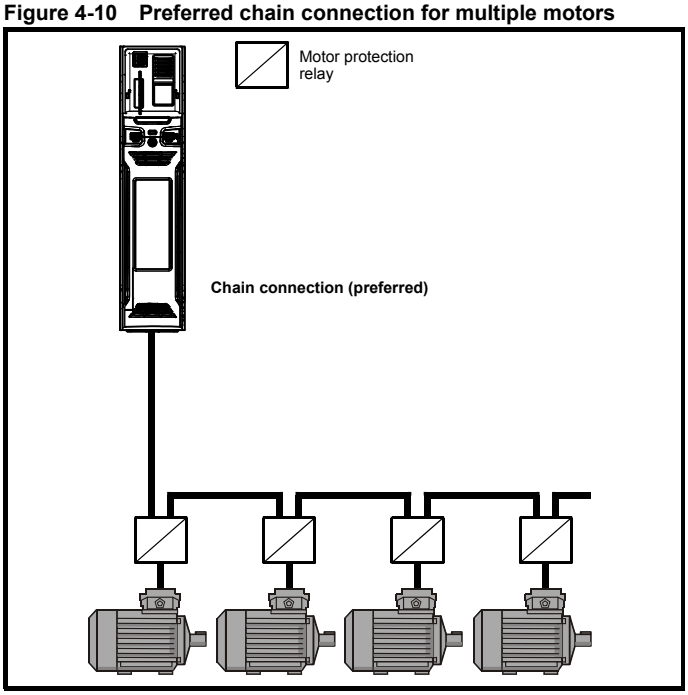
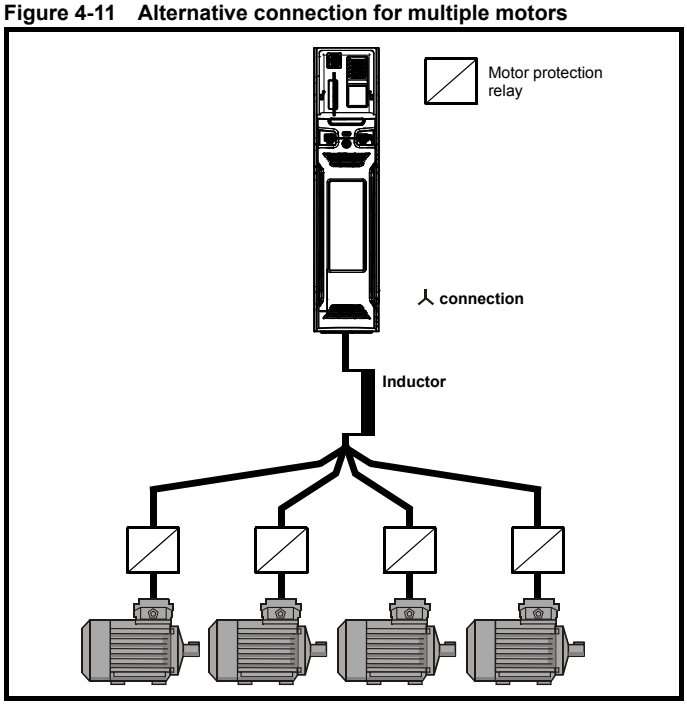


Figure 4-11 Alternative connection for multiple motors



4.8.5 ⅄ / Δ motor operation

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

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

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

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

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

4.8.6 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 (terminal 11 and terminal 13) 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 70.

4.9 Braking

Braking occurs when the drive is decelerating the motor, or is preventing the motor from gaining speed due to mechanical influences. During braking, energy is returned to the drive from the motor.

When motor braking is applied by the drive, the maximum regenerated power that the drive can absorb is equal to the power dissipation (losses) of the drive.

When the regenerated power is likely to exceed these losses, the DC bus voltage of the drive increases. Under default conditions, the drive brakes the motor under PI control, which extends the deceleration time as necessary in order to prevent the DC bus voltage from rising above a user defined set-point.

If the drive is expected to rapidly decelerate a load, or to hold back an overhauling load, a braking resistor must be installed.

Table 4-10 shows the default DC voltage level at which the drive turns on the braking transistor. However the braking resistor turn on and the turn off voltages are programmable with *Braking IGBT Lower Threshold* (06.073) and *Braking IGBT Upper Threshold* (06.074).

Table 4-10 Braking transistor turn on voltage

Drive voltage rating	DC bus voltage level
200 V	390 V
400 V	780 V
575 V	930 V
690 V	1120 V

NOTE

When a braking resistor is used, Pr **00.015** should be set to Fast ramp mode.

WARNING

High temperatures
Braking resistors can reach high temperatures. Locate braking resistors so that damage cannot result. Use cable having insulation capable of withstanding high temperatures.

4.9.1 Heatsink mounted braking resistor

A resistor has been especially designed to be mounted within the heatsink of the drive (size 3 and 4). See section 3.10 *Heatsink mounted brake resistor* on page 34 for mounting details. The design of the resistor is such that no thermal protection circuit is required, as the device will fail safely under fault conditions. On size 3 and 4 the in built software overload protection is set-up at default for the designated heatsink mounted resistor.

Table 4-11 provides the resistor data for each drive rating.

NOTE

The internal / heatsink mounted resistor is suitable for applications with a low level of regen energy only. See Table 4-11.

CAUTION

Braking resistor overload protection parameter settings
Failure to observe the following information may damage the resistor.
The drive software contains an overload protection function for a braking resistor. On size 3 and 4 this function is enabled at default to protect the heatsink mounted resistor. Below are the parameter settings.

Parameter		Size 3		Size 4	
		200V drive	400V drive	200V drive	400V drive
Braking resistor rated power	Pr **10.030**	50 W		100 W	
Braking resistor thermal time constant	Pr **10.031**	3.3 s		2.0 s	
Braking resistor resistance	Pr **10.061**	75 Ω		38 Ω	

For more information on the braking resistor software overload protection, see Pr **10.030,** Pr **10.031 and** Pr **10.061** full descriptions in the *Parameter Reference Guide*. If the resistor is to be used at more than half of its average power rating, the drive cooling fan must be set to full speed by setting Pr **06.045** to 11.

Table 4-11 Heatsink mounted braking resistor data

Parameter	Size 3	Size 4
Part number	1220-2752-00	1299-0003-00
DC resistance at 25 °C	75 Ω	37.5 Ω
Peak instantaneous power over 1 ms at nominal resistance	8 kW	16 kW
Average power over 60 s *	50 W	100 W
Ingress Protection (IP) rating	IP54	
Maximum altitude	2000 m	

* To keep the temperature of the resistor below 70 °C (158 °F) in a 30 °C (86 °F) ambient, the average power rating is 50 W for size 3, 100 W for size 4. The above parameter settings ensure this is the case.

4.9.2 External braking resistor

WARNING

Overload protection
When an external braking resistor is used, it is essential that an overload protection device is incorporated in the braking resistor circuit; this is described in *Figure 4-12 on page 52.*

When a braking resistor is to be mounted outside the enclosure, ensure that it is mounted in a ventilated metal housing that will perform the following functions:

- Prevent inadvertent contact with the resistor
- Allow adequate ventilation for the resistor

When compliance with EMC emission standards is required, external connection requires the cable to be armored or shielded, since it is not fully contained in a metal enclosure. See section 4.11.5 *Compliance with generic emission standards* on page 58 for further details.Internal connection does not require the cable to be armored or shielded.

Minimum resistances and power ratings

Table 4-12 Minimum resistance values and peak power rating for the braking resistor at 40 °C (104 °F)

Model	Minimum resistance*	Instantaneous power rating	Continuous power rating
	Ω	kW	kW
200 V			
03200050	43	3.5	
03200066			
03200080			
03200106	29	5.3	
04200137			
04200185			
06200330	5	30.3	
06200440			
400 V			
03400025	74	8.3	
03400031			
03400045			
03400062			
03400078	58	10.6	
03400100			
04400150			
04400172			
06400350	18	35.5	
06400420			
06400470			
575 V			
06500100	18	50.7	
06500150			
06500190			
06500230			
06500290			
06500350			

* Resistor tolerance: ±10 %

For high-inertia loads or under continuous braking, the *continuous power* dissipated in the braking resistor may be as high as the power rating of the drive. The total *energy* dissipated in the braking resistor is dependent on the amount of energy to be extracted from the load.

The instantaneous power rating refers to the short-term maximum power dissipated during the *on* intervals of the pulse width modulated braking control cycle. The braking resistor must be able to withstand this dissipation for short intervals (milliseconds). Higher resistance values require proportionately lower instantaneous power ratings.

In most applications, braking occurs only occasionally. This allows the continuous power rating of the braking resistor to be much lower than the power rating of the drive. It is therefore essential that the instantaneous power rating and energy rating of the braking resistor are sufficient for the most extreme braking duty that is likely to be encountered.

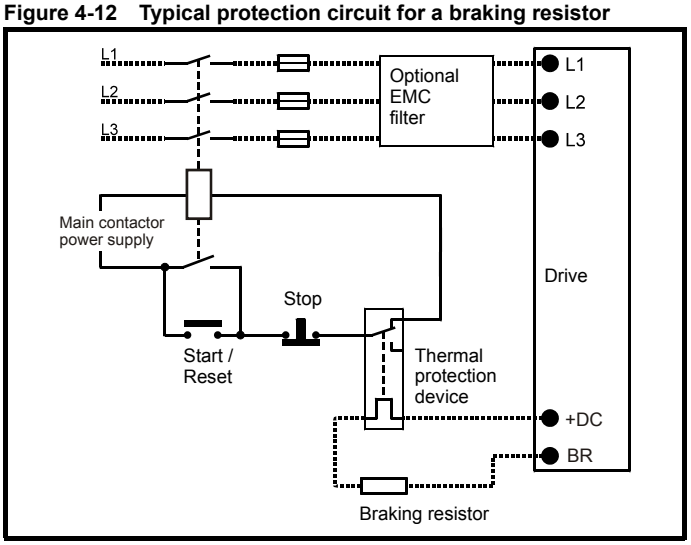
Optimization of the braking resistor requires careful consideration of the braking duty.

Select a value of resistance for the braking resistor that is not less than the specified minimum resistance. Larger resistance values may give a cost saving, as well as a safety benefit in the event of a fault in the braking system. Braking capability will then be reduced, which could cause the drive to trip during braking if the value chosen is too large.

Thermal protection circuit for the braking resistor

The thermal protection circuit must disconnect the AC supply from the drive if the resistor becomes overloaded due to a fault. Figure 4-12 shows a typical circuit arrangement.

Figure 4-12 Typical protection circuit for a braking resistor



See Figure 4-1 on page 41 and Figure 4-3 on page 42 for the location of the +DC and braking resistor connections.

4.9.3 Braking resistor software overload protection

The drive software contains an overload protection function for a braking resistor. In order to enable and set-up this function, it is necessary to enter three values into the drive:

- *Braking Resistor Rated Power* (10.030)
- *Braking Resistor Thermal Time Constant* (10.031)
- *Braking Resistor Resistance* (10.061)

This data should be obtained from the manufacturer of the braking resistors.

Pr **10.039** gives an indication of braking resistor temperature based on a simple thermal model. Zero indicates the resistor is close to ambient and 100 % is the maximum temperature the resistor can withstand. A 'Brake Resistor' alarm is given if this parameter is above 75 % and the braking IGBT is active. A Brake R Too Hot trip will occur if Pr **10.039** reaches 100 %, when Pr **10.037** is set to 0 (default value) or 1.

If Pr **10.037** is equal to 2 or 3, a Brake R Too Hot trip will not occur when Pr **10.039** reaches 100 %, but instead the braking IGBT will be disabled until Pr **10.039** falls below 95 %. This option is intended for applications with parallel connected DC buses where there are several braking resistors, each of which cannot withstand full DC bus voltage continuously. With this type of application it is unlikely the braking energy will be shared equally between the resistors because of voltage measurement tolerances within the individual drives. Therefore with Pr **10.037** set to 2 or 3, then as soon as a resistor has reached its maximum temperature the drive will disable the braking IGBT, and another resistor on another drive will take up the braking energy. Once Pr **10.039** has fallen below 95 % the drive will allow the braking IGBT to operate again.

See the *Parameter Reference Guide* for more information on Pr **10.030**, Pr **10.031**, Pr **10.037** and Pr **10.039**.

This software overload protection should be used in addition to an external overload protection device.

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 54.

With internal filter installed:

Size 3: 28 mA* AC at 400 V 50 Hz

30 µA DC with a 600 V DC bus (10 MΩ)

Size 4: 9.5 mA* AC at 400 V 50 Hz

36 µA DC with a 600 V DC bus (10 MΩ)

Size 6:

* Proportional to the supply voltage and frequency.

With internal filter removed:

Size 3: <1 mA

WARNING

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

4.10.1 Use of residual current device (RCD)

There are three common types of ELCB / RCD:

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

WARNING

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

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

4.11 EMC (Electromagnetic compatibility)

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

Section 4.10.3, 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 209 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 60 for increased surge immunity of control circuits where control wiring is extended.

Section 4.11.4, Requirements for meeting the EMC standard for power drive systems, IEC61800-3 (EN 61800-3:2004).

Section 4.11.5, Requirements for meeting the generic emission standards for the industrial environment, IEC61000-6-4, EN 61000-6-4:2007.

The recommendations of section 4.11.3 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 4.11.4 or section 4.11.5 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 209

The correct external EMC filter must be used and all of the guidelines in section 4.11.3 *General requirements for EMC* on page 56 and section 4.11.5 *Compliance with generic emission standards* on page 58 must be followed.

Table 4-13 Drive and EMC filter cross reference

Model	CT Part number
200 V	
03200050 to 03200106	4200-3230
04200137 to 04200185	
06200330 to 06200440	4200-2300
400 V	
03400025 to 03400100	4200-3480
04400150 to 04400172	
06400350 to 06400470	4200-4800
575 V	
06500100 to 06500350	4200-3690

WARNING

High ground leakage current

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

NOTE

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

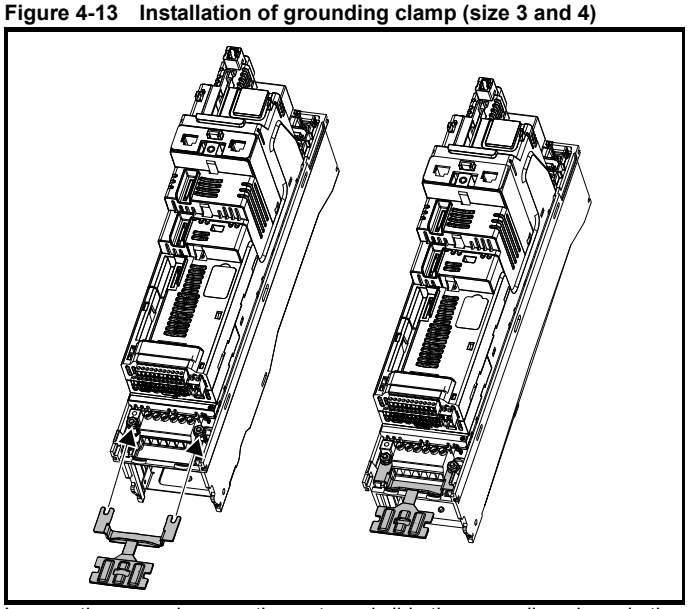
4.11.1 Grounding hardware

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

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

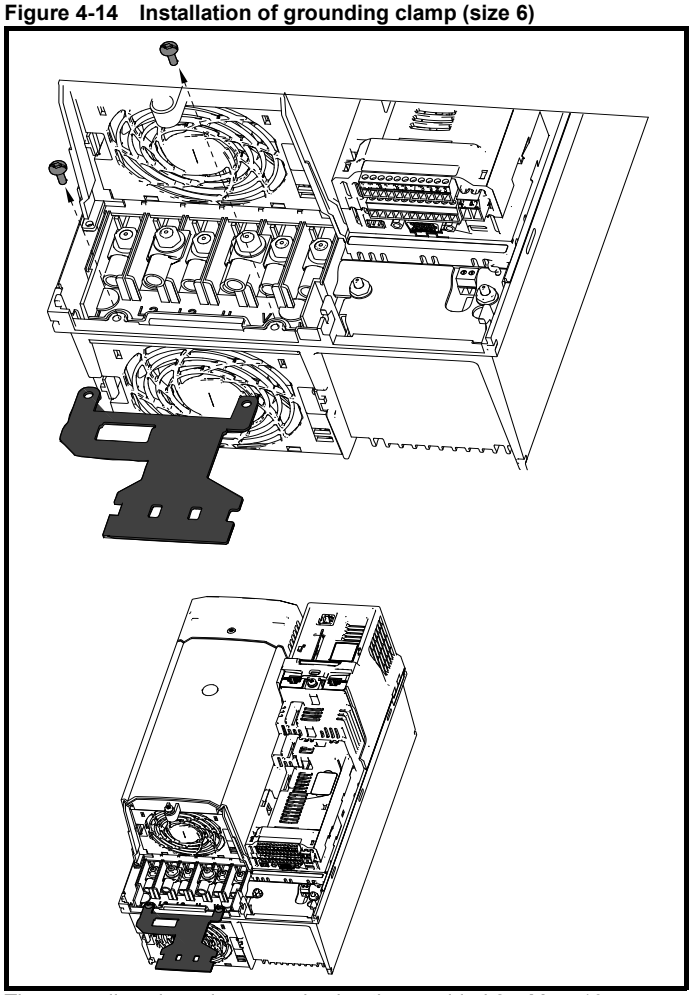
- See Figure 4-13 for details on installing the grounding clamp.
- See Figure 4-15 for details on installing the grounding bracket.

Figure 4-13 Installation of grounding clamp (size 3 and 4)



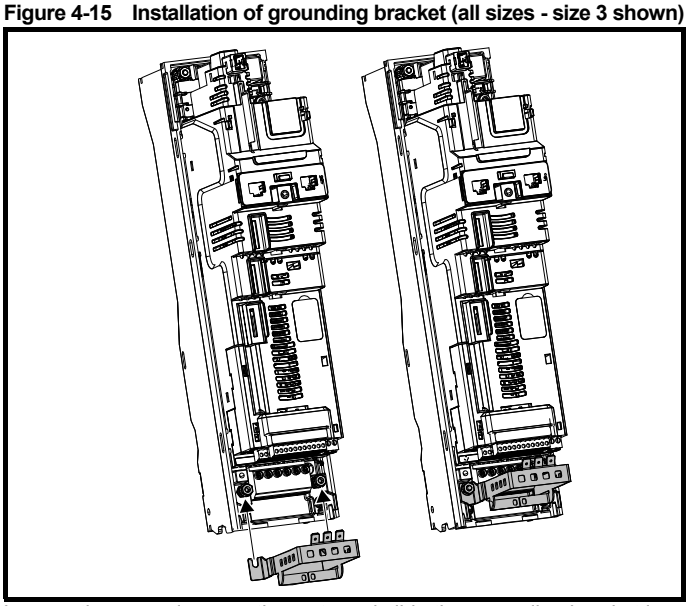
Loosen the ground connection nuts and slide the grounding clamp in the direction shown. Once in place, the ground connection nuts should be tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-14 Installation of grounding clamp (size 6)



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

Figure 4-15 Installation of grounding bracket (all sizes - size 3 shown)



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

WARNING

On size 3 and 4 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 0 V 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 or, in the case of 200 V size 3 only, the external filter is also used.
For instructions on removal refer to Figure 4-16.
For details of ground fault protection contact the supplier of the drive.

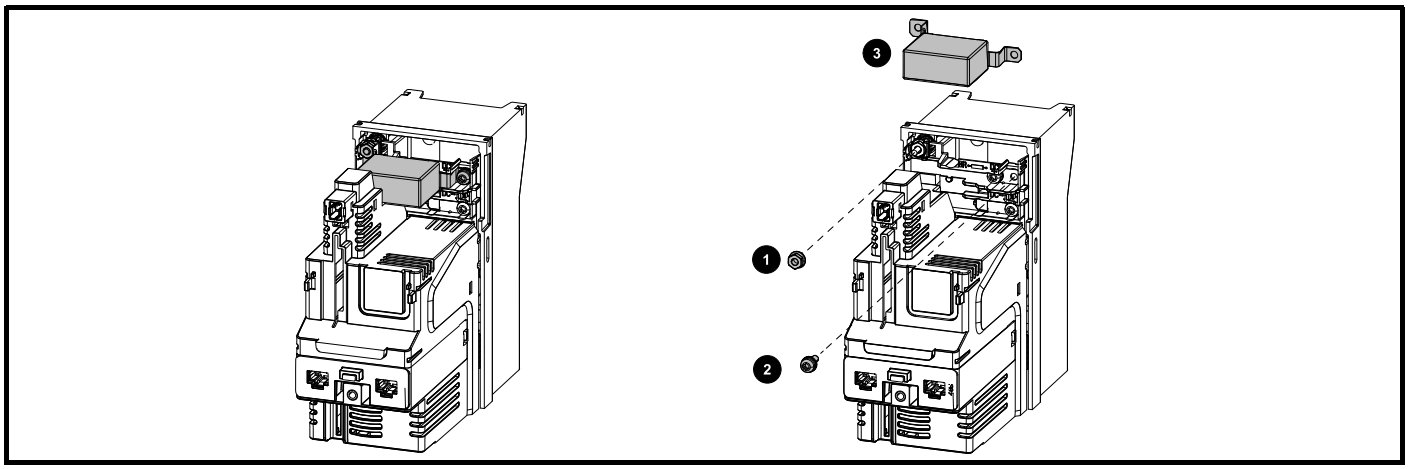
If the drive is used as a motoring drive as part of a regen system, then the internal EMC filter must be removed.

The internal EMC filter reduces radio-frequency emission into the line power supply. Where the motor cable is short, it permits the requirements of EN 61800-3:2004 to be met for the second environment - see section 4.11.4 *Compliance with EN 61800-3:2004 (standard for Power Drive Systems)* on page 58 and section 12.1.26 *Electromagnetic compatibility (EMC)* on page 222. 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 Figure 4-16 for details of removing and installing the internal EMC filter.

WARNING

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

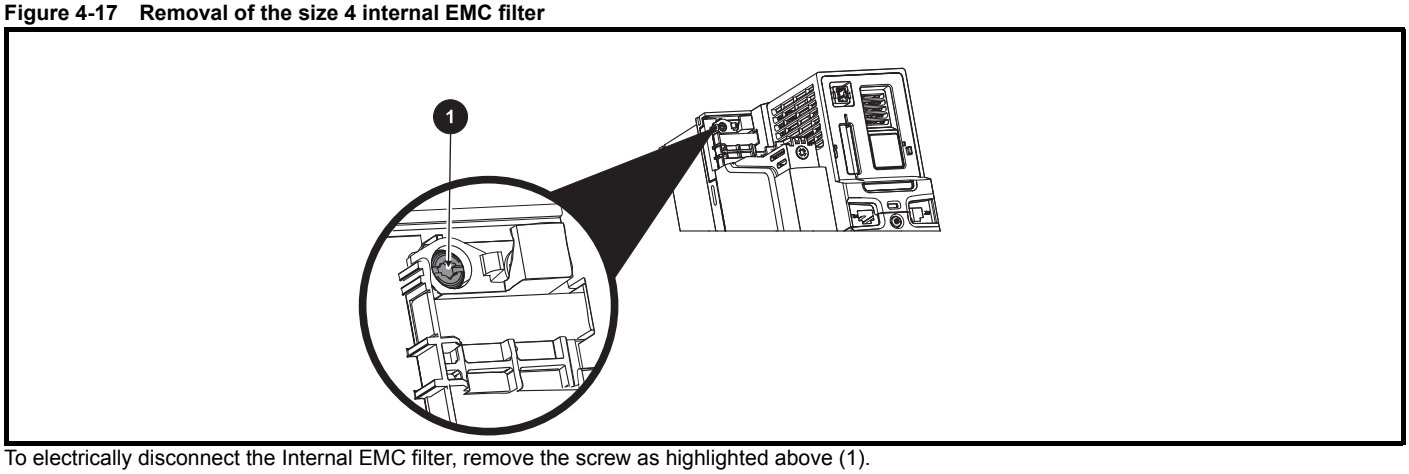
Figure 4-16 Removal of the size 3 internal EMC filter



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

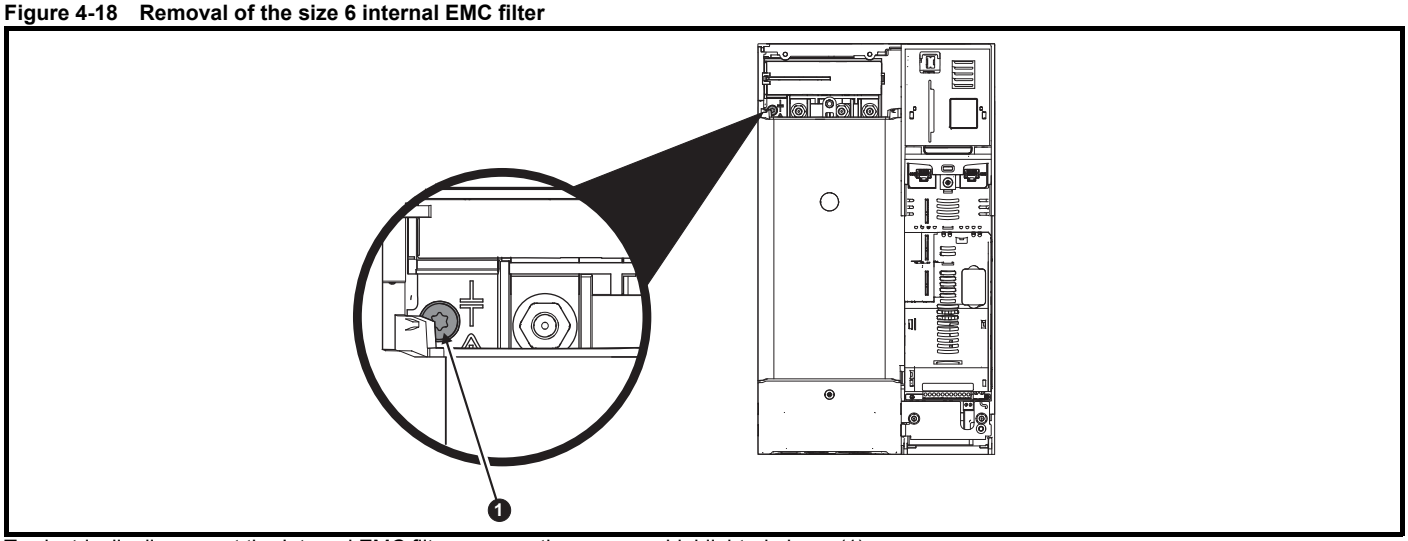
Lift away from the securing points and rotate away from the drive. Ensure the screw and nut are replaced and re-tightened with a maximum torque of 2 N m (1.47 lb ft).

Figure 4-17 Removal of the size 4 internal EMC filter



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

Figure 4-18 Removal of the size 6 internal EMC filter



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

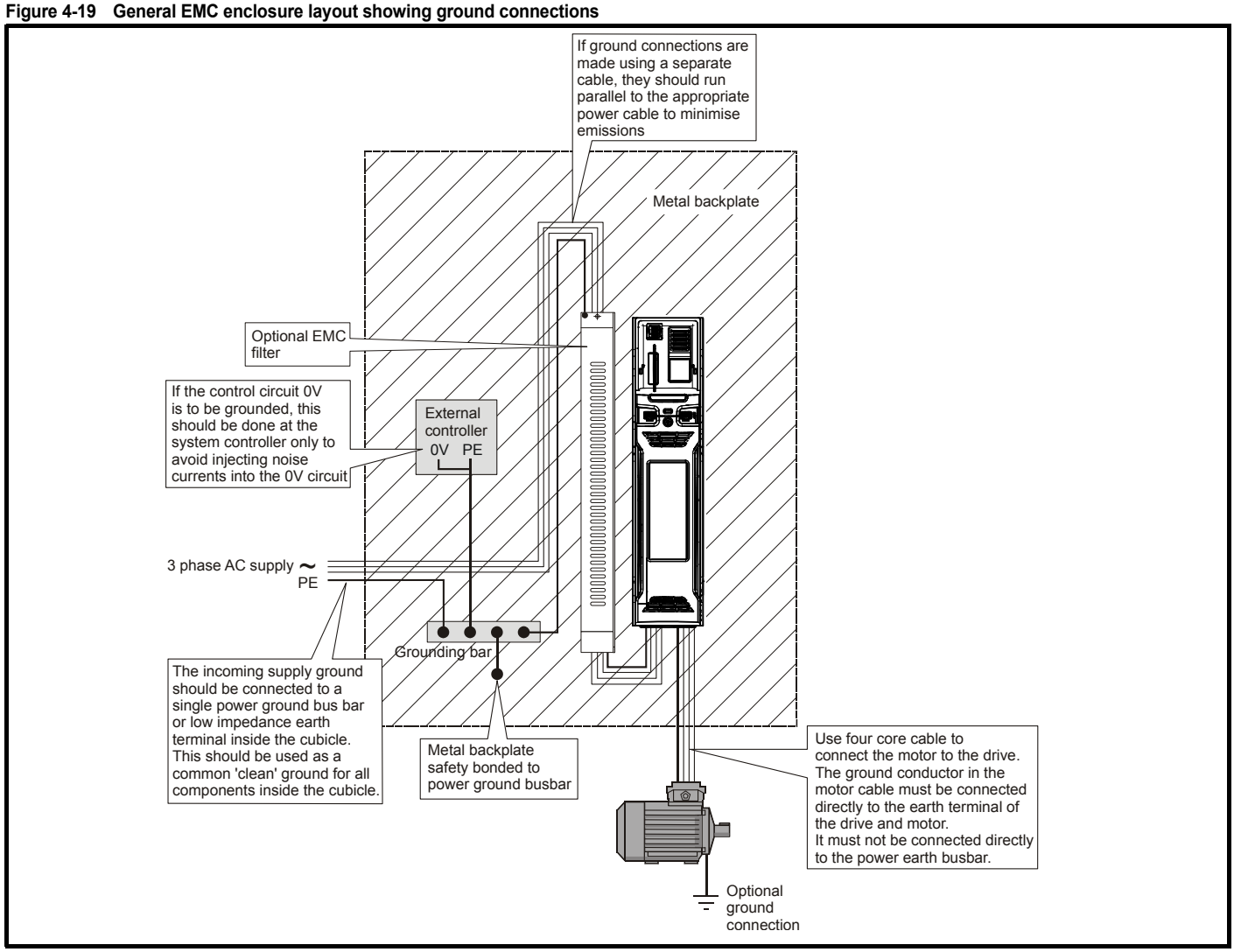
4.11.3 General requirements for EMC

Ground (earth) connections

The grounding arrangements should be in accordance with Figure 4-19, which shows a single drive on a back-plate with or without an additional enclosure.

Figure 4-19 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 4.11.5 *Compliance with generic emission standards* on page 58.

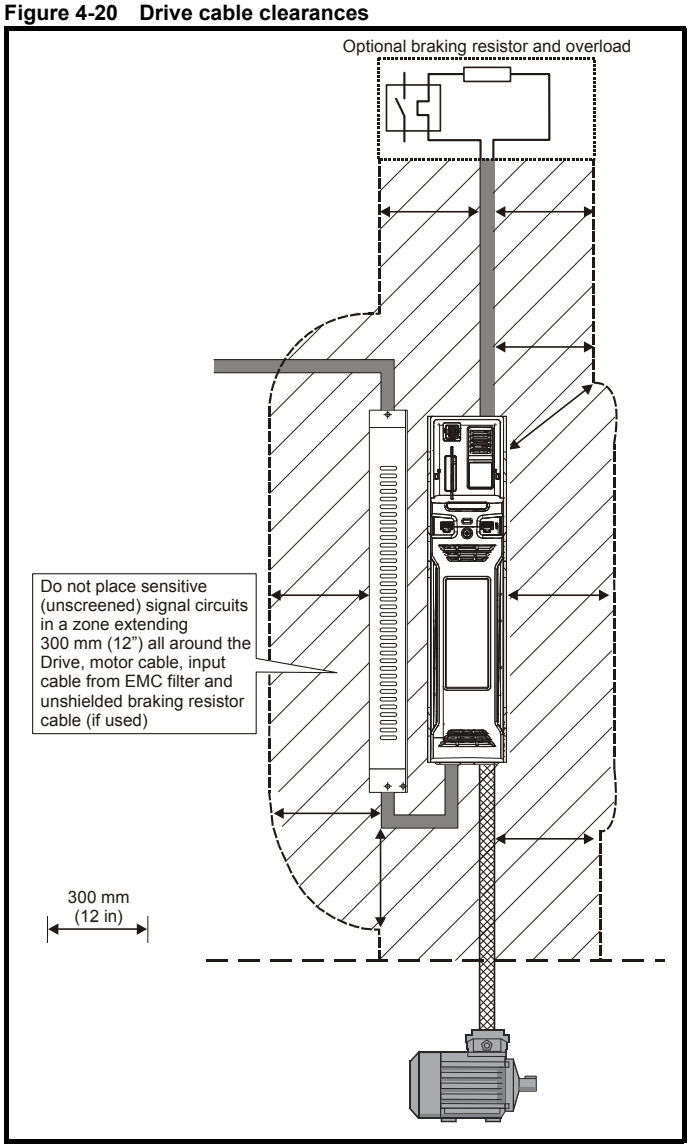
Figure 4-19 General EMC enclosure layout showing ground connections



Cable layout

Figure 4-20 indicates the clearances which should be observed around the drive and related 'noisy' power cables by all sensitive control signals / equipment.

Figure 4-20 Drive cable clearances



NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor, motor brake) 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.

Feedback device cable shielding

Shielding considerations are important for PWM drive installations due to the high voltages and currents present in the output (motor) circuit with a very wide frequency spectrum, typically from 0 to 20 MHz.

The following guidance is divided into two parts:

1. Ensuring correct transfer of data without disturbance from electrical noise originating either within the drive or from outside.
2. Additional measures to prevent unwanted emission of radio frequency noise. These are optional and only required where the installation is subject to specific requirements for radio frequency emission control.

To ensure correct transfer of data, observe the following:

Resolver connections:

- Use a cable with an overall shield and twisted pairs for the resolver signals
- Connect the cable shield to the drive 0V connection by the shortest possible link ("pigtail")
- It is generally preferable not to connect the cable shield to the resolver. However in cases where there is an exceptional level of common-mode noise voltage present on the resolver body, it may be helpful to connect the shield there. If this is done then it becomes essential to ensure the absolute minimum length of "pigtails" at both shield connections, and possibly to clamp the cable shield directly to the resolver body and to the drive grounding bracket.
- The cable should preferably not be interrupted. If interruptions are unavoidable, ensure the absolute minimum length of "pigtail" in the shield connections at each interruption.

Encoder connections:

- Use a cable with the correct impedance
- Use a cable with individually shielded twisted pairs
- Connect the cable shields to 0V at both the drive and the encoder, using the shortest possible links ("pigtails")
- The cable should preferably not be interrupted. If interruptions are unavoidable, ensure the absolute minimum length of "pigtail" in the shield connections at each interruption. Preferably, use a connection method which provides substantial metallic clamps for the cable shield terminations.

The above applies where the encoder body is isolated from the motor and where the encoder circuit is isolated from the encoder body. Where there is no isolation between the encoder circuits and the motor body, and in case of doubt, the following additional requirement must be observed. This gives the best possible noise immunity.

- The shields must be directly clamped to the encoder body (no pigtail) and to the drive grounding bracket. This may be achieved by clamping of the individual shields or by providing an additional overall shield which is clamped.

NOTE

The recommendations of the encoder manufacturer must also be adhered to for the encoder connections.

NOTE

In order to guarantee maximum noise immunity for any application double shielded cable as shown should be used.

In some cases single shielding of each pair of differential signals cables, or a single overall shield with individual shield on the thermistor connections is sufficient. In these cases all the shields should be connected to ground and 0 V at both ends.

If the 0 V is required to be left floating a cable with individual shields and an overall shield must be used.

Figure 4-21 and Figure 4-22 illustrate the preferred construction of cable and the method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or feedback device, with the ground connections made to a ground plate or similar metallic ground surface.

Figure 4-21 Feedback cable, twisted pair

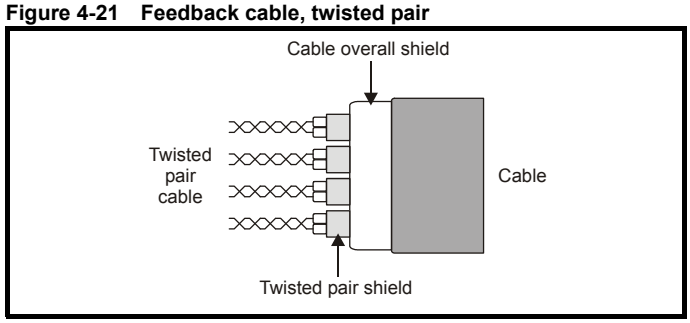
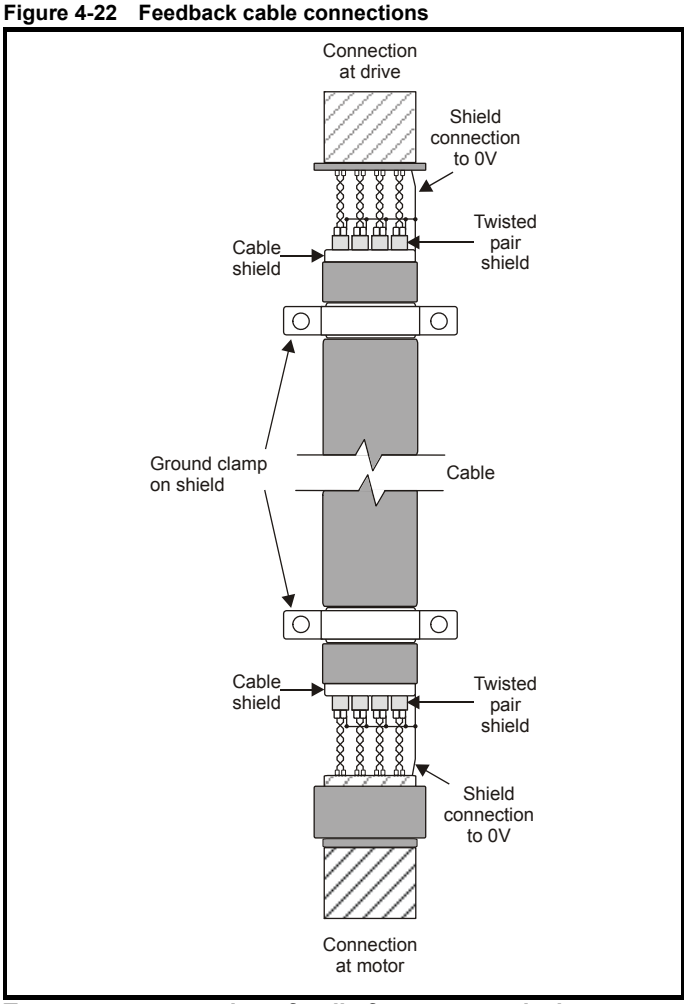


Figure 4-22 Feedback cable connections



To ensure suppression of radio frequency emission, observe the following:

- Use a cable with an overall shield
- Clamp the overall shield to grounded metallic surfaces at both the encoder and the drive, as illustrated in Figure 4-22

4.11.4 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 4.11.5 *Compliance with generic emission standards* on page 58. An external EMC filter will always be required.

CAUTION

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

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

Operation in the second environment

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

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

For longer motor cables, an external filter is required. Where a filter is required, follow the guidelines in Section 4.11.5 *Compliance with generic emission standards* .

Where a filter is not required, follow the guidelines given in section 4.11.3 *General requirements for EMC* on page 56.

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 4.11.5 *Compliance with generic emission standards* be adhered to.

Refer to section 12.1.26 *Electromagnetic compatibility (EMC)* on page 222 for further information on compliance with EMC standards and definitions of environments.

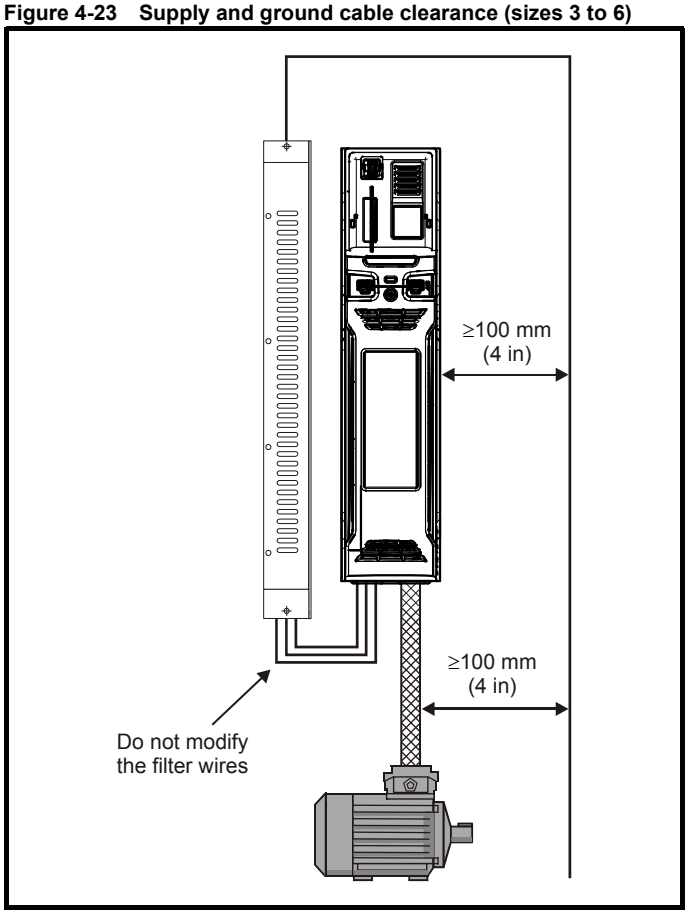
Detailed instructions and EMC information are given in the *EMC Data Sheet* which is available from the supplier of the drive.

4.11.5 Compliance with generic emission standards

The following information applies to frame sizes 3 to 6.

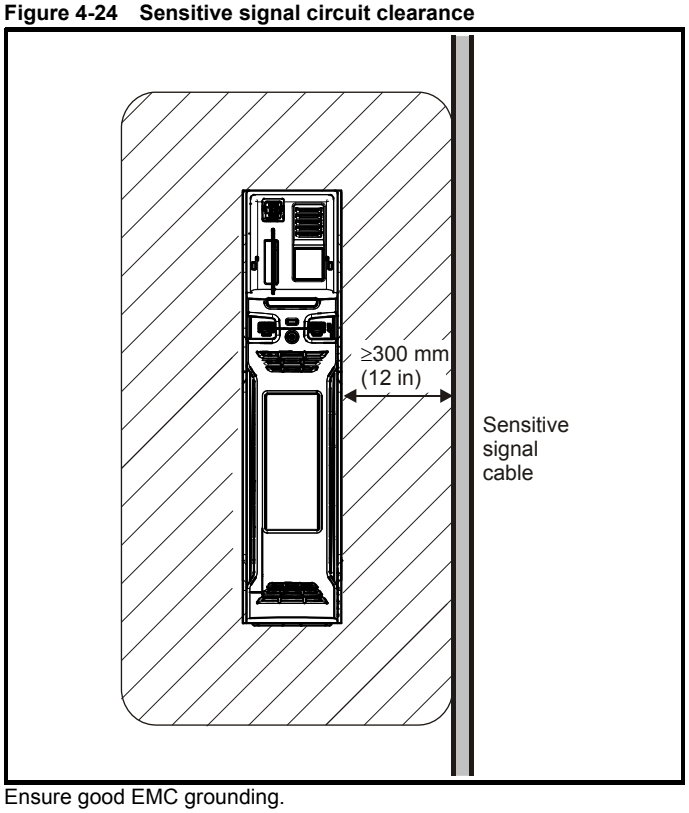
Use the recommended filter and shielded motor cable. Observe the layout rules given in Figure 4-23. Ensure the AC supply and ground cables are at least 100 mm from the power module and motor cable.

Figure 4-23 Supply and ground cable clearance (sizes 3 to 6)



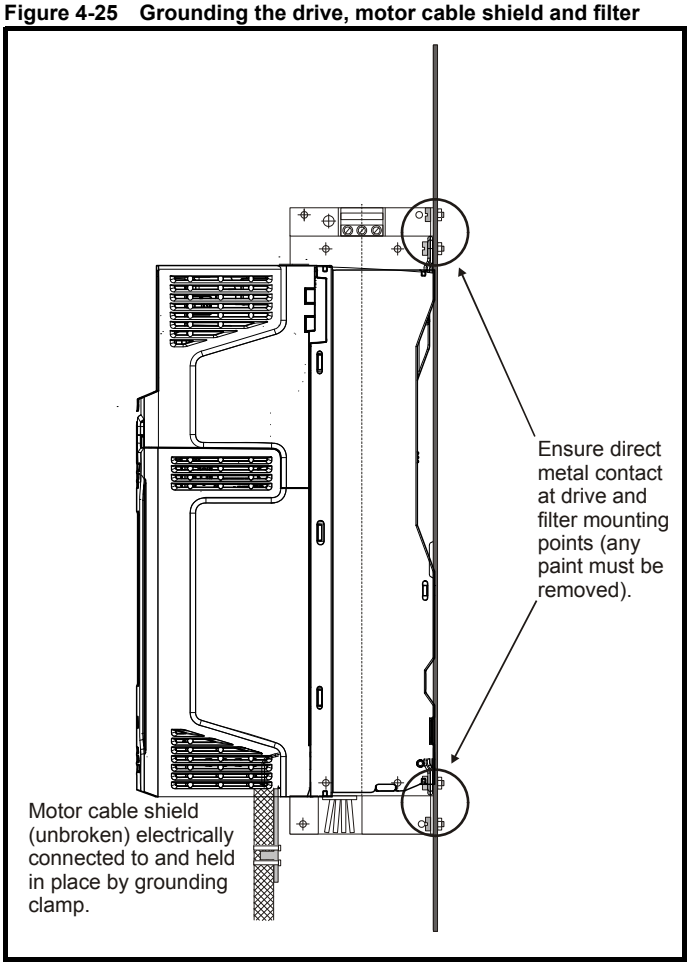
Avoid placing sensitive signal circuits in a zone 300 mm (12 in) in the area immediately surrounding the power module.

Figure 4-24 Sensitive signal circuit clearance



Ensure good EMC grounding.

Figure 4-25 Grounding the drive, motor cable shield and filter

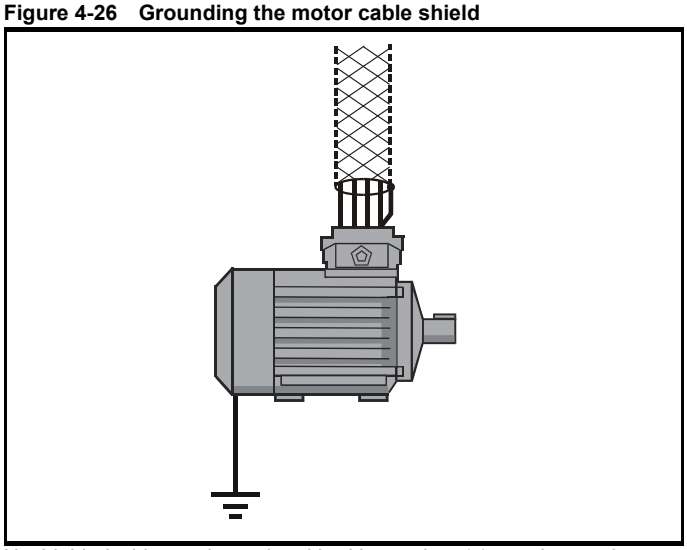


Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50 mm (2 in) long.

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

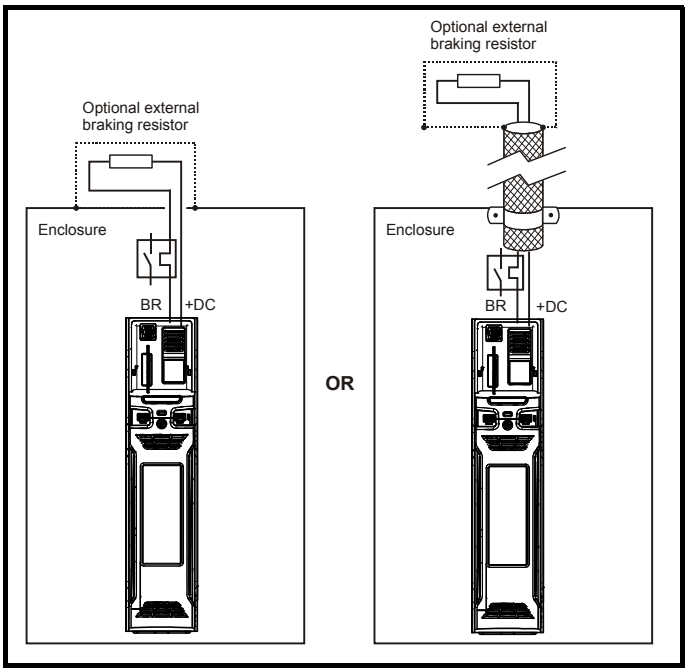
From an EMC consideration it is irrelevant whether the motor cable contains an internal (safety) ground core, or if there is a separate external ground conductor, or where grounding is through the shield alone. An internal ground core will carry a high noise current and therefore it must be terminated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

Figure 4-26 Grounding the motor cable shield



Unshielded wiring to the optional braking resistor(s) may be used provided the wiring runs internally to the enclosure. Ensure a minimum spacing of 300 mm (12 in) from the signal wiring and the AC supply wiring to the external EMC filter. If this condition cannot be met then the wiring must be shielded.

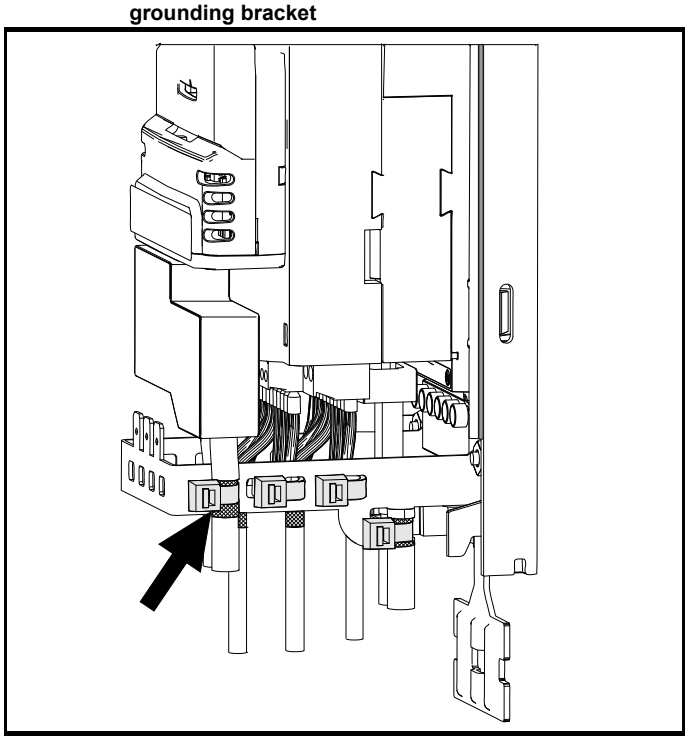
Figure 4-27 Shielding requirements of optional external braking resistor



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 4-28. 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 4-28 Grounding of signal cable shields using the grounding bracket



4.11.6 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:

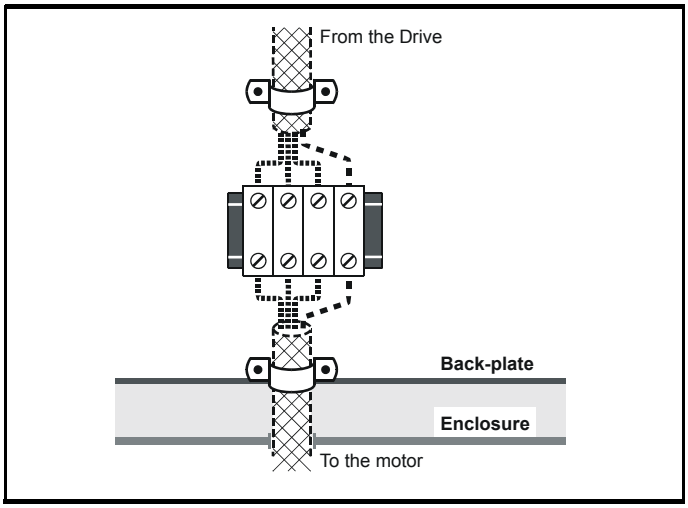
- Connecting the motor cable to a terminal block in the drive enclosure
- Installing a motor isolator / disconnect switch for safety when work is done on the motor

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 4-29 Connecting the motor cable to a terminal block in the enclosure



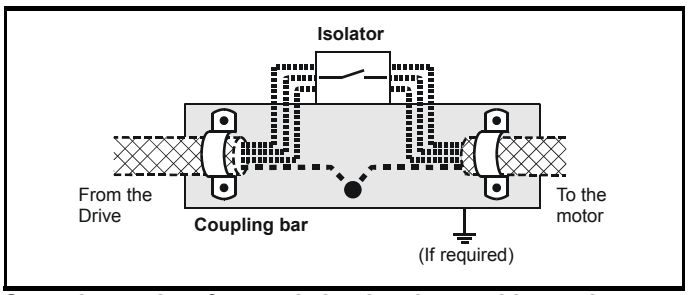
Using a motor isolator / disconnect-switch

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 4-30 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 0 V 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 0 V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0 V) wire.

2. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10 mm^2, or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
3. Additional over-voltage suppression - for the analog and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-31 and Figure 4-32.

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 4-31 Surge suppression for digital and unipolar inputs and outputs

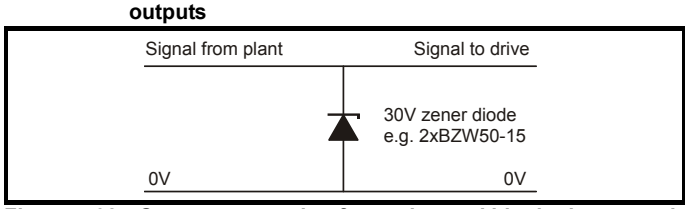
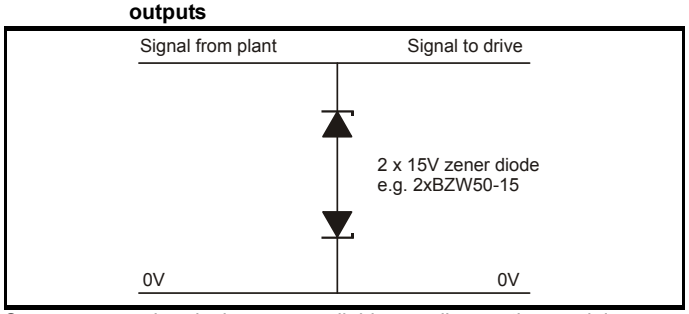


Figure 4-32 Surge suppression for analog and bipolar inputs and outputs



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

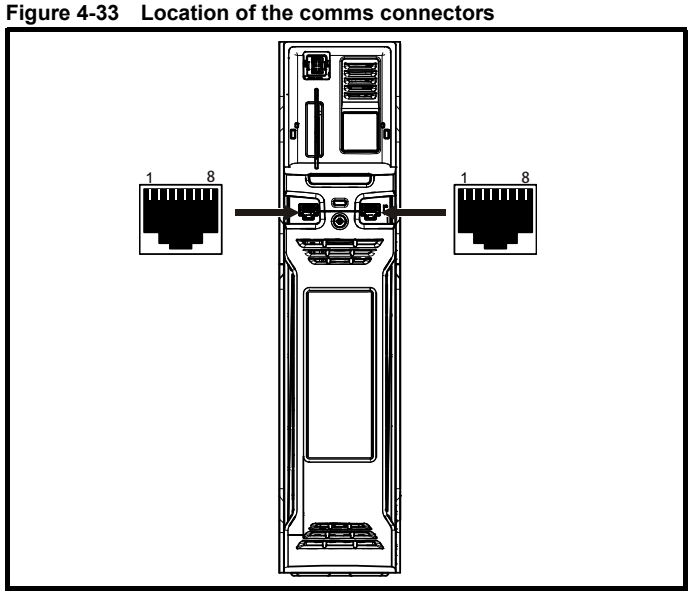
Unipolar TT-UKK5-D/24 DC
Bipolar TT-UKK5-D/24 AC

These devices are not suitable for encoder signals or fast digital data networks because the capacitance of the diodes adversely affects the signal. Most encoders have galvanic isolation of the signal circuit from the motor frame, in which case no precautions are required. For data networks, follow the specific recommendations for the particular network.

4.12 Communications connections

The Unidrive M702 drive offers Ethernet fieldbus communications. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller if required.

Figure 4-33 Location of the comms connectors



4.12.1 Ethernet fieldbus communications

The Ethernet option provides two RJ45 connections with an Ethernet switch for easy network creation.

Standard UTP (unshielded twisted pair) or STP (shielded twisted pair) cables are supported. It is recommended that a minimum specification CAT5e is used in new installations. As the drive supports the 'Auto cross-over detection' a cross-over cable is not required.

NOTE

The shell of the RJ45 connector is isolated from the 0 V of the drive control terminals but it is connected to ground.

4.13 Control connections

4.13.1 General

Table 4-14 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Digital input	2	Destination, invert, logic select	7, 8
Digital input / output	2	Input / output mode select, destination / source, invert, logic select	4, 5
Relay	1	Source, invert	41, 42
Drive enable (SAFE TORQUE OFF)	2		11, 13
+24 V User output	1	Source, invert	2
0 V common	5		1, 3, 6, 10, 12
+24 V External input	1	Destination, invert	9

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:	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 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 or motor brake) 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.

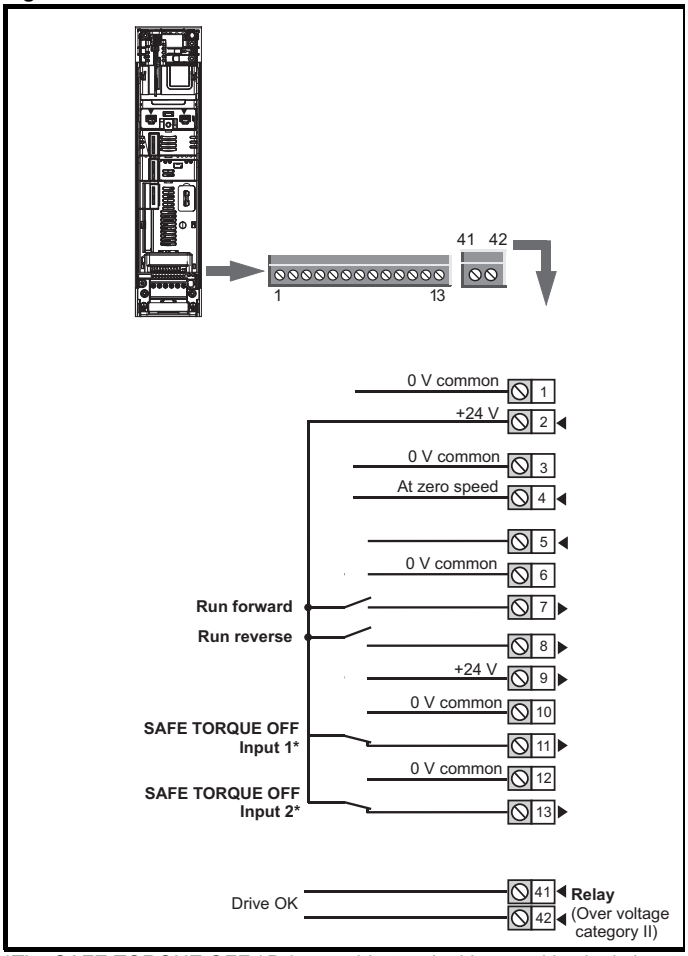
NOTE

Any signal cables which are carried inside the motor cable (i.e. motor thermistor, motor brake) 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).

Figure 4-34 Default terminal functions



*The SAFE TORQUE OFF / Drive enable terminal is a positive logic input only.

4.13.2 Control terminal specification

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

2	+24 V user output (selectable)
Terminal 2 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
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)

3	0 V common
Function	**Common connection for all external devices**

4	Digital Output 1
5	Digital Output 2
Terminal 4 default function	**AT ZERO SPEED output**
Terminal 5 default function	
Type	Positive or negative logic digital inputs, positive logic voltage source outputs
Input / output mode controlled by...	Pr **08.031**, Pr **08.032**
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)
Maximum output current	100 mA 200 mA (total including all Digital I/O)
Common to all modes	
Voltage range	0 V to +24 V
Sample / Update period	250 µs when configured as an input with destinations Pr **06.035** or Pr **06.036**. 2 ms when configured as an output (output will only change at the update rate of the source parameter

6	0 V common
Function	**Common connection for all external devices**

7	Digital Input 4
8	Digital Input 5
Terminal 7 default function	**RUN FORWARD input**
Terminal 8 default function	**RUN REVERSE input**
Type	Negative or positive logic digital inputs
Logic mode controlled by...	Pr **08.029**
Voltage range	0 V 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	250 µs when configured as an input with destinations Pr **06.035** or Pr **06.036**. 600 µs when configured as an input with destination Pr **06.029**. 2 ms in all other cases.

9	+24 V 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	+30.0 Vdc
Minimum start-up voltage	21.6 Vdc
Recommended power supply	40 W 24 Vdc nominal
Recommended fuse	3 A, 50 Vdc

10	0 V common
Function	**Common connection for all external devices**

12	0 V common
Function	**Common connection for all external devices**

Refer to section 4.15 *SAFE TORQUE OFF (STO)* on page 70 for further information.

11	**SAFE TORQUE OFF function input 1 (drive enable)**
13	**SAFE TORQUE OFF function input 2 (drive enable)**
Type	Positive logic only digital input
Voltage range	0 V to +24 V
Absolute maximum applied voltage	30 V
Logic Threshold	10 V ± 5 V
Low state maximum voltage for disable to SIL3 and PL e	5 V
Impedance	>4 mA @15 V from IEC 61131-2, type 1, 3.3 k Ω
Low state maximum current for disable to SIL3 and PL e	0.5 mA
Response time	Nominal: 8 ms Maximum: 20 ms

The SAFE TORQUE OFF function may be used in a safety-related application in preventing the drive from generating torque in the motor to a high level of integrity. The system designer is responsible for ensuring that the complete system is safe and designed correctly according to the relevant safety standards. If the SAFE TORQUE OFF function is not required, these terminals are used for enabling the drive.

41 42	**Relay contacts**
Default function	**Drive OK 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	Normally open
Default contact condition	Closed when power applied and drive OK
Update period	4 ms

51	**0 V**	
52	**+24 Vdc**	
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		80 W
Recommended fuse		4 A @ 50 Vdc

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 Position feedback connections

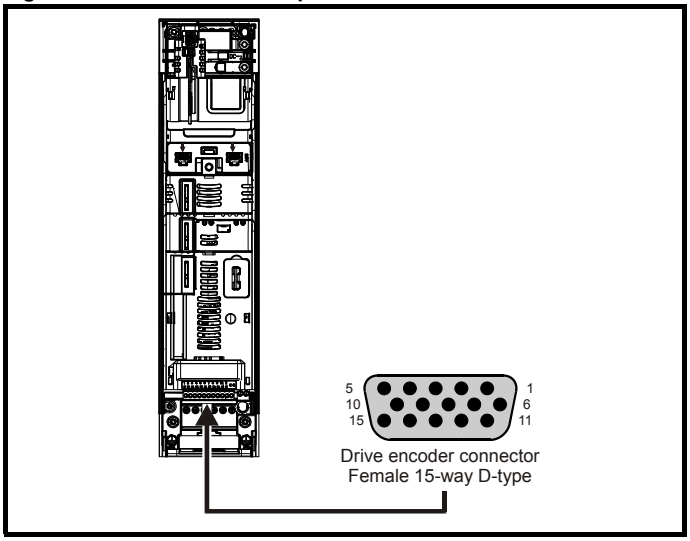
The following functions are provided via the 15-way high density D-type connector on the drive:

- Two position feedback interfaces (P1 and P2).
- One encoder simulation output.
- Two freeze trigger inputs (marker inputs).
- One thermistor input.

The P1 position interface is always available but the availability of the P2 position interface and the encoder simulation output depends on the position feedback device used on the P1 position interface, as shown in Table 4-17.

4.14.1 Location of position feedback connector

Figure 4-35 Location of the position feedback



4.14.2 Compatible position feedback devices

Table 4-15 Supported feedback devices on the P1 position interface

Encoder type	Pr 3.038 setting
Quadrature incremental encoders with or without marker pulse	AB (0)
Quadrature incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	AB Servo (3)
Forward / reverse incremental encoders with or without marker pulse	FR (2)
Forward / reverse incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FR Servo (5)
Frequency and direction incremental encoders with or without marker pulse	FD (1)
Frequency and direction incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FD Servo (4)
Sincos incremental encoders	SC (6)
Sincos incremental with commutation signals	SC Servo (12)
Heidenhain sincos encoders with EnDat comms for absolute position	SC EnDat (9)
Stegmann sincos encoders with Hiperface comms for absolute position	SC Hiperface (7)
Sincos encoders with SSI comms for absolute position	SC SSI (11)
Sincos incremental with absolute position from single sin and cosine signals	SC SC (15)
SSI encoders (Gray code or binary)	SSI (10)
EnDat communication only encoders	EnDat (8)
BiSS communication only encoders (not currently supported)	BiSS (13)
Resolver (not currently supported)	Resolver (14)
UVW commutation only encoders* (not currently supported)	Commutation only (16)

* This feedback device provides very low resolution feedback and should not be used for applications requiring a high level of performance

Table 4-16 Supported feedback devices on the P2 position interface

Encoder type	Pr 3.138 setting
Quadrature incremental encoders with or without marker pulse	AB (1)
Frequency and direction incremental encoders with or without marker pulse	FD (2)
Forward / reverse incremental encoders with or without marker pulse	FR (3)
EnDat communication only encoders	EnDat (4)
SSI encoders (Gray code or binary)	SSI (5)
BiSS communication only encoders (not currently supported)	BiSS (6)

Table 4-17 shows the possible combinations of position feedback device types connected to the P1 and P2 position interfaces and the availability of the encoder simulation output.

Table 4-17 Availability of the P2 position feedback interface and the encoder simulation output

Functions		
P1 Position feedback interface	**P2 Position feedback interface**	**Encoder Simulation Output**
AB Servo FD Servo FR Servo SC Servo SC SC Commutation only	None	None
AB FD FR SC Resolver SC Hiperface	AB, FD, FR EnDat, BiSS, SSI	None
	None	Full
SC EnDat SC SSI	AB, FD, FR (No Z marker pulse input)	None
	EnDat, BiSS, SSI	
	None	No Z marker pulse output
EnDat BiSS SSI	AB, FD, FR EnDat, BiSS, SSI	None
	None	Full
	EnDat, BiSS, SSI	No Z marker pulse output

The priority of the position feedback interfaces and the encoder simulation output on the 15-way D-type is assigned in the following order from the highest priority to the lowest.

- P1 position interface (highest)
- Encoder simulation output
- P2 position interface (lowest)

For example, if an AB Servo type position feedback device is selected for use on the P1 position interface, then both the encoder simulation output and the P2 position interface will not be available as this device uses all connections of the 15-way D-type connector. Also, if an AB type position feedback device is selected for use on the P1 position interface and Pr **03.085** is set to a valid source for the encoder simulation output, then the P2 position interface will not be available.

Depending on the device type used on the P1 position interface, the encoder simulation output may not be able support a marker pulse output (e.g. SC EnDat or SC SSI device types). Pr **03.086** shows the status of the encoder simulation output indicating whether the output is disabled, no marker pulse is available or full encoder simulation is available.

NOTE

When using the P1 and P2 position interfaces and the encoder simulation output together, the P2 position interface uses alternative connections on the 15-way D-type connector. Pr **03.172** shows the status of the P2 position interface and indicates if alternative connections are being used for the P2 position interface.

4.14.3 Position feedback connection details

Table 4-18 P1 Position feedback connection details

P1 Position feedback interface Pr 03.038	Connections														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AB (0)	A	A\	B	B\	Z	Z\							+V	0V	Th
FD (1)	F	F\	D	D\	Z	Z\									
FR (2)	F	F\	R	R\	Z	Z\									
AB Servo (3)	A	A\	B	B\	Z	Z\	U	U\	V	V\	W	W\			
FD Servo (4)	F	F\	D	D\	Z	Z\	U	U\	V	V\	W	W\			
FR Servo (5)	F	F\	R	R\	Z	Z\	U	U\	V	V\	W	W\			
SC (6)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\									
SC Hiperface (7)	Cos	Cosref	Sin	Sinref	DATA	DATA\									
EnDat (8)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
SC EnDat (9)	A	A\	B	B\	DATA	DATA\					CLK	CLK\			
SSI (10)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
SC SSI (11)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	DATA	DATA\					CLK	CLK\			
SC Servo (12)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\	U	U\	V	V\	W	W\			
BiSS (13)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
Resolver (14)	Cos H	Cos L	Sin H	Sin L	Ref H	Ref L									
SC SC (15)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\	C*1	C*1	D*2	D*2	Freeze2	Freeze2\			
Commutation Only (16)							U	U\	V	V\	W	W\			

*1 - One sine wave per revolution

*2 - One cosine wave per revolution

Greyed cells are for P2 position feedback connections or simulated encoder outputs.

NOTE

Freeze and Freeze\ on terminals 5 and 6 are for Freeze input 1. Freeze2 and Freeze2\ on terminals 11 and 12 are for Freeze input 2.

Table 4-19 P2 Position feedback and encoder simulation output connection details

P1 Position feedback interface Pr 03.038	P2 Position feedback interface Pr 03.138	Encoder Simulation Output	Connections							
			5	6	7	8	9	10	11	12
AB (0) FD (1) FR (2) SC (6) SC Hiperface (7) Resolver (14)	AB (1)	Disabled*1			A	A\	B	B\	Z	Z\
	FD (2)				F	F\	D	D\	Z	Z\
	FR (3)				F	F\	R	R\	Z	Z\
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\	Freeze2	Freeze2\
	None (0)	AB			Asim	Asim\	Bsim	Bsim\	Zsim	Zsim\
		FD			Fsim	Fsim\	Dsim	Dsim\	Zsim	Zsim\
		FR			Fsim	Fsim\	Rsim\	Rsim\	Zsim	Zsim\
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
SC EnDat (9) SC SSI (11)	AB (1)	Disabled*1			A	A\	B	B\		
	FD (2)				F	F\	D	D\		
	FR (3)				F	F\	R	R\		
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\		
	None (0)	AB			Asim	Asim\	Bsim	Bsim\		
		FD			Fsim	Fsim\	Dsim	Dsim\		
		FR			Fsim	Fsim\	Rsim\	Rsim\		
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
EnDat (8) SSI (10) BiSS (13)	AB (1)	Disabled*1			A	A\	B	B\	Z	Z\
	FD (2)				F	F\	D	D\	Z	Z\
	FR (3)				F	F\	R	R\	Z	Z\
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\	Freeze2	Freeze2\
	None (0)	AB			Asim	Asim\	Bsim	Bsim\	Zsim	Zsim\
		FD			Fsim	Fsim\	Dsim	Dsim\	Zsim	Zsim\
		FR			Fsim	Fsim\	Rsim\	Rsim\	Zsim	Zsim\
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
EnDat (8) SSI (10) BiSS (13) (with no Freeze inputs)	EnDat (4) SSI (5) BiSS (6)	AB	DATA	DATA\	Asim	Asim\	Bsim	Bsim\	CLK	CLK\
		FD	DATA	DATA\	Fsim	Fsim\	Dsim	Dsim\	CLK	CLK\
		FR	DATA	DATA\	Fsim	Fsim\	Rsim\	Rsim\	CLK	CLK\
		SSI	DATA	DATA\	DATAsim	DATAsim\	CLKsim	CLKsim\	CLK	CLK\

*1 The encoder simulation output is disabled when Pr **03.085** is set to zero.

NOTE

The termination resistors are always enabled on the P2 position interface. Wire break detection is not available when using AB, FD or FR position feedback device types on the P2 position interface.

4.14.4 Position feedback terminal specifications

1	**A,F, Cosref, Data, Cos H**
2	**A\,F\ Cosref\, Data\, Cos L**

AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5)	
Type	EIA 485 differential receivers
Maximum input frequency	500 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V

SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-20
Maximum applied differential voltage and common mode voltage range	±4 V

Resolution: The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-20 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port

EnDat (8), SSI (10), BISS (13)	
Type	EIA 485 differential receivers
Maximum input frequency	4 MHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V

Resolver (14)	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 - 8 kHz
Input voltage	0.6 Vrms

Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

3	**B, D, R Sinref, Clock, Sin H**
4	**B\, D\, R\, Sinref\, Clock\, Sin L**

AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5)	
Type	EIA 485 differential receivers
Maximum input frequency	500 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V

SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-20
Maximum applied differential voltage and common mode voltage range	±4 V

Resolution: The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-20 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port

EnDat (8), SSI (10), BISS (13)	
Type	EIA 485 differential receivers
Maximum input frequency	4 MHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V

Resolver (14)	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 – 8 kHz
Input voltage	0.6 Vrms

Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

5	Z, Data, Freeze, Ref H
6	Z\, Data\, Freeze\, Ref L

AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5), SC SC (15)	
Type	EIA 485 differential receivers
Maximum input frequency	512 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V
SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12)	
Type	EIA 485 differential receivers
Maximum input frequency	4 MHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V
EnDat (8), SSI (10), BiSS (13)	
Type	EIA 485 differential receivers
Maximum input frequency	4 MHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to –7 V
Resolver (14)	
Type	Differential voltage
Nominal voltage	0 – 2 Vrms depending on turns ratio
Operating frequency	6 - 8 KHz
Line loading	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

7	U, C, Not used, Not used
8	U\, C\, Not used, Not used

AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA 485 differential receivers
Maximum input frequency	512 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to – 7 V
SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-20
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

9	V, D, Not used, Not used
10	V\, D\, Not used, Not used

AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA 485 differential receivers
Maximum input frequency	512 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to – 7 V
SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-20
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

11	**W, Clock, Not used, Not used**
12	**W\, Clock\, Not used, Not used**
AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA 485 differential receivers
Maximum input frequency	512 kHz
Line loading	
Line termination components	120 Ω (switchable)
Working common mode range	+12 V to – 7 V
SC EnDat (9), SC SSI (11)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-20
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V

Common to all Feedback types

13	**Feedback device supply**
Supply voltage	5.15 V ±2 %, 8 V ± 5 % or 15 V ± 5 %
Maximum output current	300 mA for 5 V and 8 V 200 mA for 15 V
The voltage on Terminal 13 is controlled by Pr **03.036**. The default for this parameter is 5 V (0) but this can be set to 8 V (1) or 15 V (2). Setting the encoder voltage too high for the encoder could result in damage to the feedback device. The termination resistors should be disabled if the outputs from the encoder are higher than 5 V.	

14	**0 V Common**

15	**Motor thermistor input**
Thermistor type is selected in *P1 Thermistor Type* (03.118).	

Sincos encoder resolution

The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-20 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port. The total resolution in bits per revolution is the ELPR plus the number of bits of interpolated information. Although it is possible to obtain 11 bits of interpolation information, the nominal design value is 10 bits.

Table 4-20 Feedback resolution based on frequency and voltage level

Volt/Freq	1 kHz	5 kHz	50 kHz	100 kHz	200 kHz	500 kHz
1.2	11	11	10	10	9	8
1.0	11	11	10	9	9	7
0.8	10	10	10	9	8	7
0.6	10	10	9	9	8	7
0.4	9	9	9	8	7	6

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 either one or both STO inputs are 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.

Data as verified by TÜV Rheinland:

According to EN ISO 13849-1:

PL = e

Category = 4

$MTTF_D$ = High

DC_{av} = High

Mission Time and Proof Test Interval = 20 years

The calculated $MTTF_D$ for the complete STO function is:

STO1 2574 yr

STO2 2716 yr

According to EN 61800-5-2:

SIL = 3

PFH = 4.21×10^{-11} h^{-1}

The SAFE TORQUE OFF input also meets the requirements of EN 81-1 (clause 12.7.3 b) as part of a system for preventing unwanted operation of the motor in a lift (elevator).

SAFE TORQUE OFF can be used to eliminate electro-mechanical contactors, including special safety contactors, which would otherwise be required for safety applications.

The function can be used in safety-related machines or systems which have been designed according to IEC 62061 or IEC 61508, or other standards which are compatible with IEC 61508, since the analysis and the integrity metrics used in EN 61800-5-2 are the same.

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.

Two-channel SAFE TORQUE OFF

Two fully independent input channels are provided for the SAFE TORQUE OFF function.

Each input separately meets the requirements of the standards as defined above, regardless of the state of the other input. If either or both inputs are set at a logic low state, there are no single faults in the drive which can permit the motor to be driven.

It is not necessary to use both channels in order for the drive to meet the requirements of the standards. The purpose of the two channels is to allow connection to machine safety systems where two channels are required, and to facilitate protection against wiring faults. For example, if each channel is connected to a safety-related digital output of a safety-related controller, computer or PLC, then on detection of a fault in one output the drive can still be disabled safely through the other output. Then there are no single wiring faults which can cause a loss of the safety function, i.e. inadvertent enabling of the drive.

In the event that the two-channel operation is not required, the two inputs can be connected together to form a single SAFE TORQUE OFF input. In this case it is important to note that a single short-circuit from the SAFE TORQUE OFF input to a DC supply of approximately +24 V would cause the drive to be enabled. This might occur through a fault in the wiring. This can be excluded according to 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.

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. Because of the risk of human error, the installation must not provide any facility to over-ride the function.

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.

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.

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 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 0 V wiring cannot exceed this value under any loading condition. It is strongly recommended that the SAFE TORQUE OFF circuits be provided with a dedicated 0 V conductors which should be connected to terminals 10 and 12 at the drive.

For more information regarding the SAFE TORQUE OFF input, please see the *Control Techniques Safe Torque Off Engineering Guide* available for download from www.controltechniques.com.

5 Getting started

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

5.1 Understanding the display

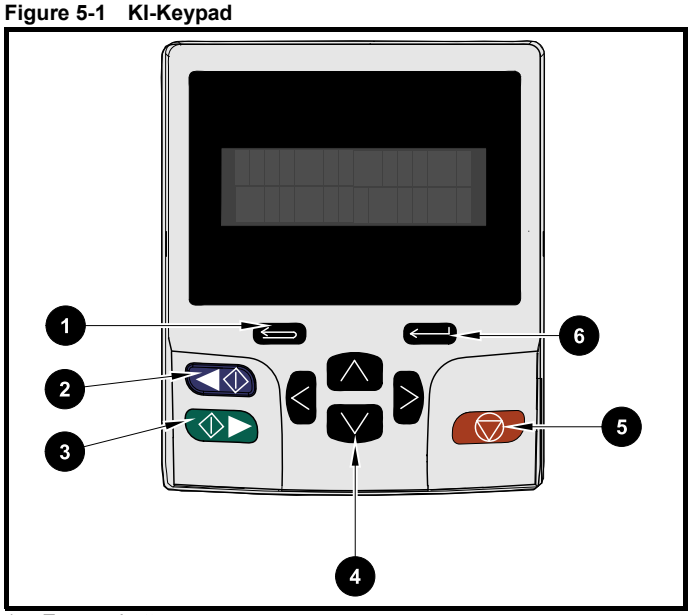
The keypad can only be mounted on the drive.

5.1.1 KI-Keypad

The KI-Keypad display 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-Keypad



1. Escape button
2. Start reverse (Auxiliary button)
3. Start forward
4. Navigation keys (x4)
5. Stop / 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	Priority
	Alarm active	
	Keypad real-time clock battery low	
	Drive security active	
	Motor map 2 active	
	User program running	
	Motor map 2 and User program running	

5.2 Keypad operation

5.2.1 Control buttons

The keypad consists of:

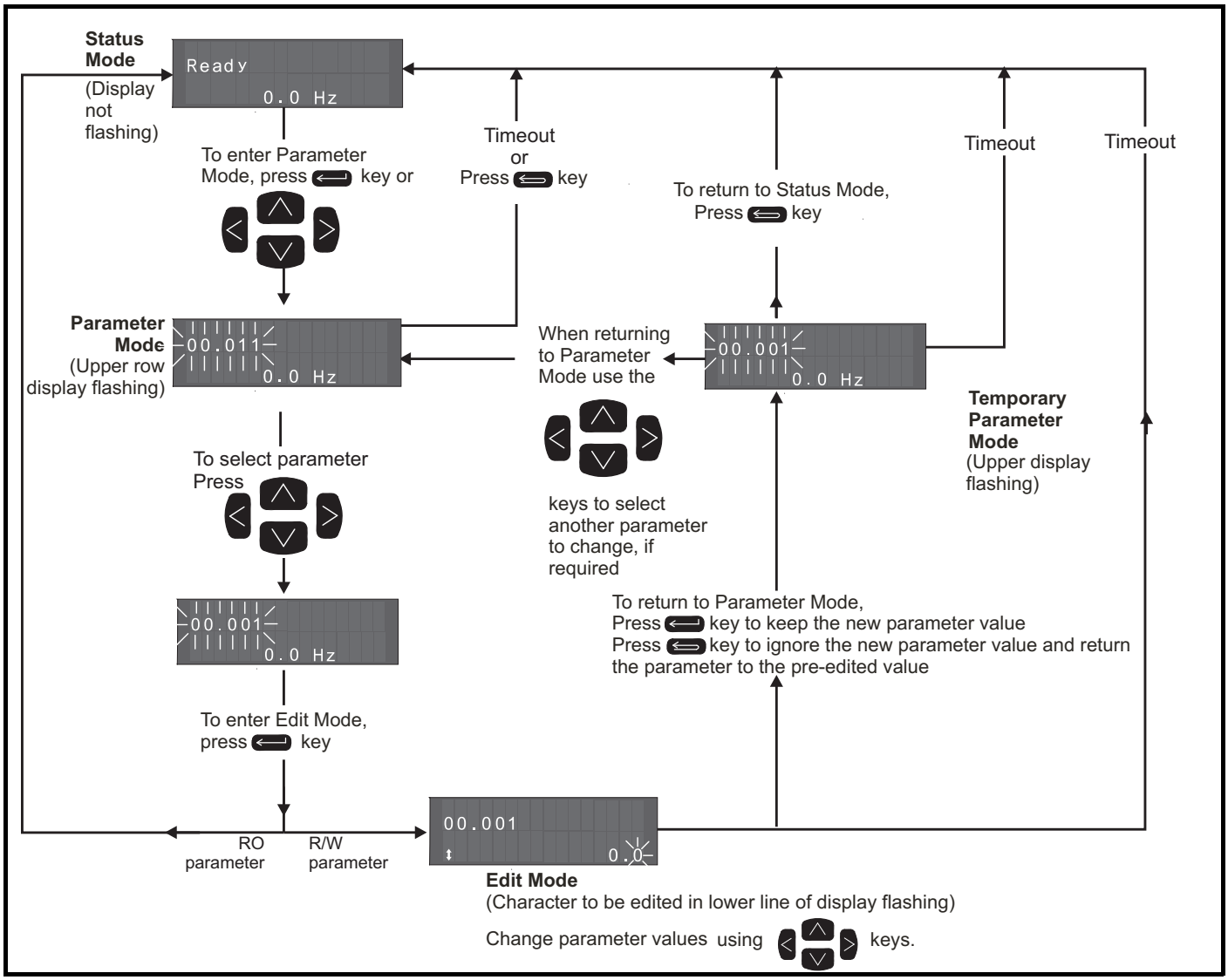
- Navigation Keys - Used to navigate the parameter structure and change parameter values.
- Enter / Mode button - Used to toggle between parameter edit and view mode.
- Escape / Exit button - Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the exit button pressed the parameter value will be restored to the value it had on entry to edit mode.
- Start forward button - Use to provide a 'Run' command if keypad mode is selected.
- Start reverse button - Used to control the drive if keypad mode is selected and the reverse button is activated. If *Enable Auxiliary Key* (06.013) = 1, then the keypad reference is toggled between run forward and run reverse each time the button is pressed. If *Enable Auxiliary Key* (06.013) = 2, then the button functions as a run reverse key.
- Stop / Reset button - Used to reset the drive. In keypad mode can be used for 'Stop'.

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 39 for information on battery replacement.

Figure 5-2 overleaf shows an example on moving between menus and editing parameters.

Figure 5-2 Display modes



NOTE

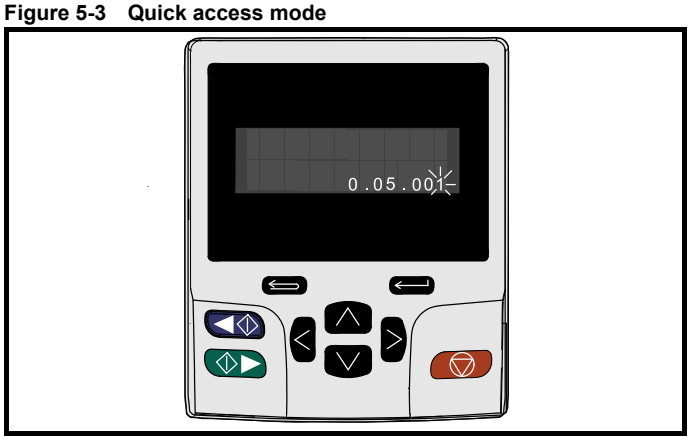
The navigation keys can only be used to move between menus if Pr **00.049** has been set to show 'All Menus'. Refer to section 5.9 *Parameter access level and security* on page 77.

5.2.2 Quick access mode

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

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

Figure 5-3 Quick access mode



5.2.3 Keypad shortcuts

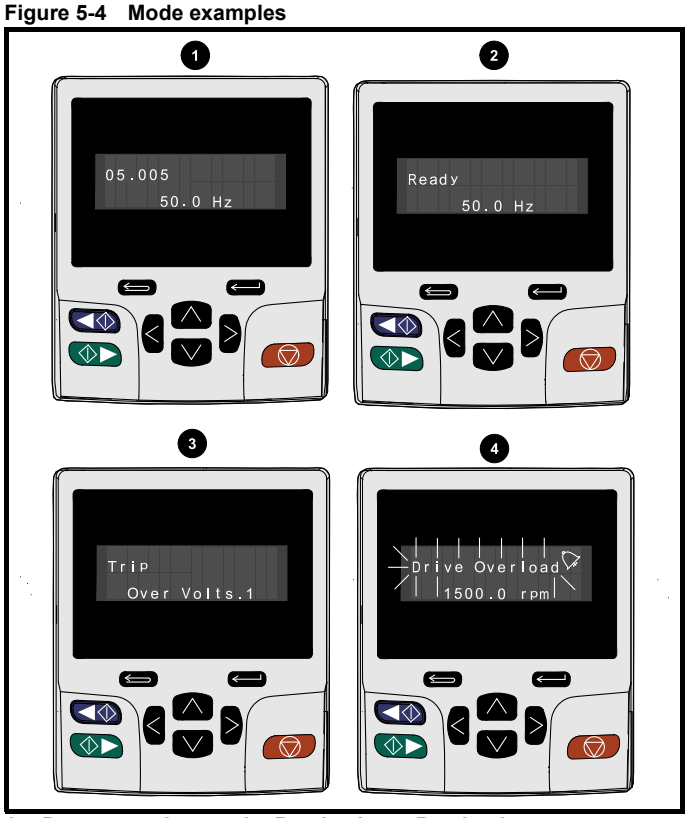
In 'parameter mode':

- If the up and down keypad buttons are pressed together, then the keypad display will jump to the start of the parameter menu being viewed, i.e. Pr **05.005** being viewed, when the above buttons pressed together will jump to Pr **05.000**.
- If the left and right keypad buttons are pressed together, then the keypad display will jump to the last viewed parameter in Menu 0.

In 'parameter edit mode':

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

Figure 5-4 Mode examples



1. **Parameter view mode: Read write or Read only**
2. **Status mode: Drive OK status**

If the drive is ok and the parameters are not being edited or viewed, the upper row of the display will show one of the following:

- 'Inhibit', 'Ready' or 'Run'.

3. **Status mode: Trip status**

When the drive is in trip condition, the upper row of the display will indicate that the drive has tripped and the lower row of the display will show the trip code. For further information regarding trip codes. refer to Table 13-4 *Trip indications* on page 226.

4. **Status mode: Alarm status**

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

WARNING

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

NOTE

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

NOTE

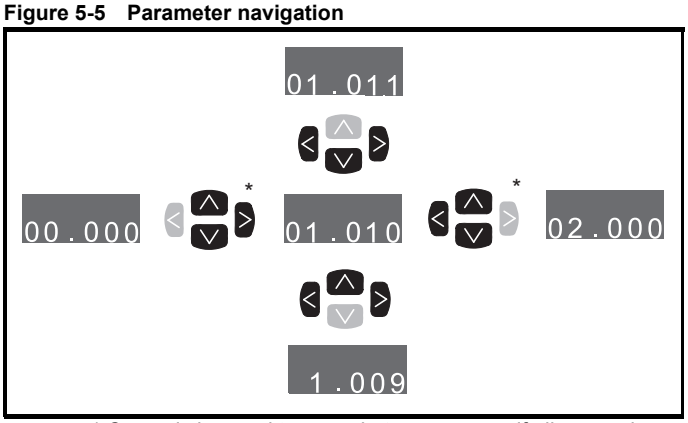
For new parameter-values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *Saving parameters* on page 77.

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 **00.049** 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 77

Figure 5-5 Parameter navigation



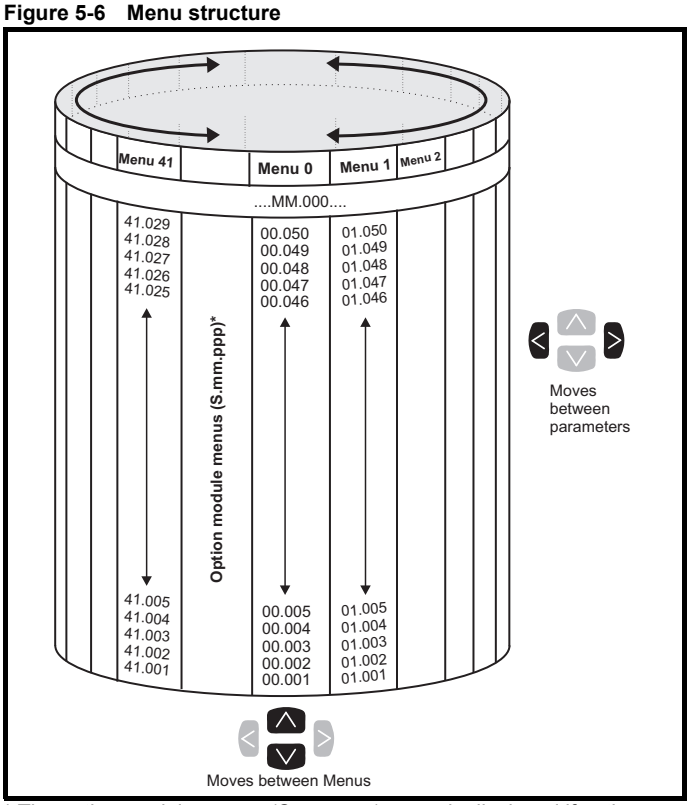
* Can only be used to move between menus if all menus have been enabled (Pr **00.049**). Refer to section 5.9 *Parameter access level and security* on page 77.

The menus and parameters roll over in both directions.

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

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

Figure 5-6 Menu structure



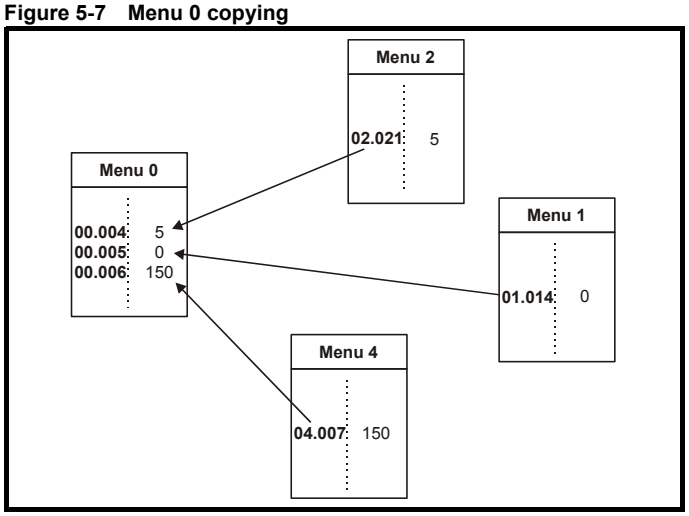
* The option module menus (S.mm.ppp) are only displayed if option modules are installed. Where S signifies the option module slot number and the mm.ppp signifies the menu and the parameter number of the option module's internal menus and parameter.

5.4 Menu 0

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive. The parameters displayed in Menu 0 can be configured in Menu 22.
Appropriate parameters are copied from the advanced menus into Menu 0 and thus exist in both locations.

For further information, refer to Chapter 6 *Basic parameters* on page 80.

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-Keypad.

The option module menus are displayed as S.mm.ppp. 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. Menu 4.00.xxx is the same as menu 24.xxx.

Table 5-3 Advanced menu descriptions

Menu	Description
0	Commonly used basic set-up parameters for quick / easy programming
1	Frequency / Speed reference
2	Ramps
3	Frequency slaving, speed feedback and speed control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	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
21	Second motor parameters
22	Menu 0 set-up
23	Not allocated
24	Ethernet module (slot 4) set-up menu
25	Option module slot 1 application parameters
26	Option module slot 2 application parameters
27	Option module slot 3 application parameters
28	Option module slot 4 application parameters
29	Reserved menu
30	Onboard user programming application menu
31-41	Advanced motion controller set-up parameters
Slot 1	Slot 1 option menus*
Slot 2	Slot 2 option menus*
Slot 3	Slot 3 option menus*
Slot 4	Ethernet menus

* Only displayed when the option modules are installed.

5.5.1 KI-Keypad set-up menu

To enter the keypad set-up menu press and hold the escape button on the keypad from status mode. All the keypad parameters are saved to the keypad non-volatile memory when exiting from the keypad set-up menu.

To exit from the keypad set-up menu press the escape or or button. Below are the keypad set-up parameters.

Table 5-4 KI-Keypad set-up parameters

Parameters		Range	Type
Keypad.01	Language selection	English (1)	RW
Keypad.02	Show parameter units	OFF (0), On (1)	RW
Keypad.03	Backlight level	0 to 100 %	RW
Keypad.04*	Keypad real-time clock date	01.01.10 to 31.12.99	RO
Keypad.05*	Keypad real-time clock time	00:00:00 to 23:59:59	RO
Keypad.06	Keypad software version	00.00.00.00 to 99.99.99.99	RO

* These parameters are only displayed on the KI-Keypad RTC.

NOTE

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

5.5.2 Display messages

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

Table 5-5 Status indications

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

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 5-6 Alarm indications

Alarm string	Description
Brake Resistor	Brake resistor overload. *Braking Resistor Thermal Accumulator* (10.039) in the drive has reached 75.0 % of the value at which the drive will trip.
Motor Overload	*Motor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Ind Overload	Regen inductor overload. *Inductor Protection Accumulator* (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is >100 %.
Drive Overload	Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.
Limit Switch	Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped.

Table 5-7 Option module and NV media card and other status indications at power-up

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

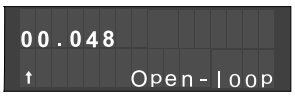
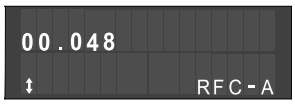
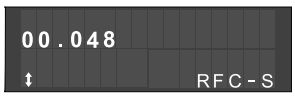
5.6 Changing the operating mode

Changing the operating mode returns all parameters to their default value, including the motor parameters. *User security status* (00.049) and *User security code* (00.034) 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. terminals 11 and 13 are 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 **0.048** as follows:

Pr 00.048 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.

NOTE

Entering 1253 or 1254 in Pr **mm.000** will only load defaults if the setting of Pr **00.048** has been changed.

5.7 Saving parameters

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

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

Procedure

1. Select 'Save Parameters'* in Pr **mm.000** (alternatively enter a value of 1000* in Pr **mm.000**)
2. Either:

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

* If the drive is in the under voltage state (i.e. when the control terminal 9 and 10 are being supplied from a low voltage DC supply) a value of 1001 must be entered into Pr **mm.000** to perform a save function.

5.8 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drives memory. *User security status* (00.049) and *User security code* (00.034) are not affected by this procedure.

Procedure

1. Ensure the drive is not enabled, i.e. terminals 11 and 13 are 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 5-8.

Table 5-8 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 **00.049** 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 **00.034** 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 **00.049**. 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 **00.034** 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 **00.034** 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 77 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 77 for further information regarding access level.

5.12 Communications

The Unidrive M702 drive offers Ethernet fieldbus communications. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller if required.

5.12.1 Ethernet communications

The drive offers fieldbus communications via Ethernet, this enables the drive set-up, operation and monitoring to be carried out with a PC or controller. The drive provides two RJ45 connections with an Ethernet switch for easy network creation. The Ethernet option provides support for the following protocols:

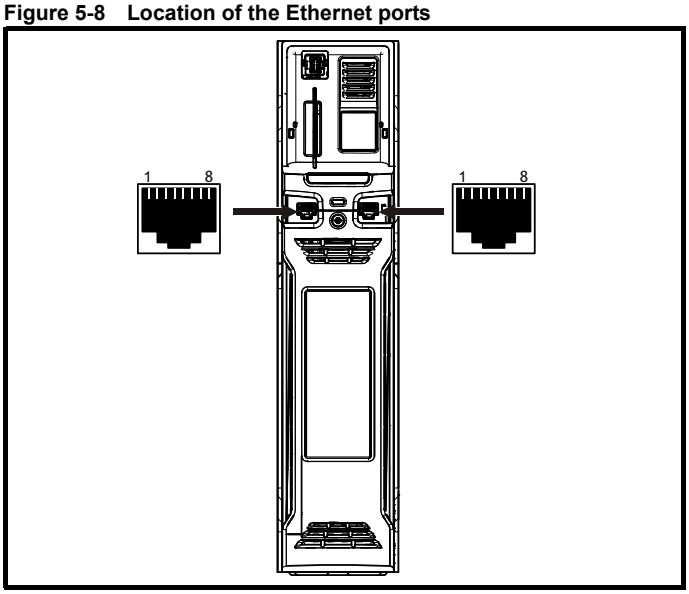
- Modbus TCP
- EtherNet /IP*
- Web pages*
- Email*
- Synchronization with IEEE1588

*Features have not been implemented but will be available soon.

In addition to two RJ45 connectors, each port provides a status LED for diagnostic / information purposes.

LED status	Description
Off	Ethernet connection not detected
Solid green	Ethernet connection detected but no data
Flashing green	Ethernet connection detected and data flow

Figure 5-8 Location of the Ethernet ports



NOTE

The shell of the RJ45 connector is isolated from the 0 V of the drive control terminals but it is connected to ground.

Recommended cable

It is recommended that a minimum specification of CAT5e is used in new installations. If the existing cabling is used this may limit the maximum data rate depending on the cable ratings. In noisy environments the use of STP cable will offer additional noise immunity.

Maximum network lengths

The main restriction imposed on the Ethernet cabling is the length of a single segment of the cable, for Copper - UTP/STP CAT 5 cable type, maximum trunk cable length should be limited to 100 m. If distances greater than this are required it may be possible to extend the network with additional switches.

Ethernet set-up parameters

The following section covers the minimum number of parameters required to be set to establish an Ethernet communication.

Table 5-9 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
IP	IP Address	Mac	Mac Address
Date	Date parameter	Time	Time parameter

4.00.007 {24.007}	Reset									
RW	Bit								US	
⇳	Off (0) or On (1)				⇨	Off (0)				

Changes to the Ethernet set-up parameters will not take effect until a *Reset* (4.00.007) has been performed.

4.00.010	Active IP Address									
RO	IP								US	
⇳	000.000.000.000 to 255.255.255.255				⇨					

This parameter displays the Active IP Address. The Active IP Address can also be viewed in Pr **00.037**.

4.02.005	DHCP Enable									
RW	Bit								US	
⇳	Off (0) or On (1)				⇨	On (1)				

If *DHCP Enable* (4.02.005) is set to On (1), the IP address is acquired from the DHCP server and written to *IP Address* (4.02.006).

NOTE

When using manual / static IP address configuration, ensure *Subnet Mask* (4.02.007) and *Default Gateway* (4.02.008) should also be set manually.

4.02.006	IP Address									
RW	IP								US	
⇳	000.000.000.000 to 255.255.255.255				⇨	192.168.001.100				

This parameter controls and displays the IP address of the drive. If *DHCP Enable* (4.02.005) is set to On (1) this parameter will become read-only.

4.02.007	Subnet Mask									
RW	IP								US	
⇳	000.000.000.000 to 255.255.255.255				⇨	255.255.255.000				

This parameter controls and displays the *Subnet Mask* (4.02.007) of the drive.

4.02.008	Default Gateway									
RW	IP								US	
⇳	000.000.000.000 to 255.255.255.255				⇨	192.168.1.254				

This parameter controls and displays the *Default Gateway* (4.02.008) of the drive.

PC Tools support

The discovery protocol feature, which is supported by the Unidrive M PC tools, is able to discover the drives that are connected to a PC, independent of above parameter settings.

6 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 {…}). Menus 22 can be used to configure the parameters in Menu 0.

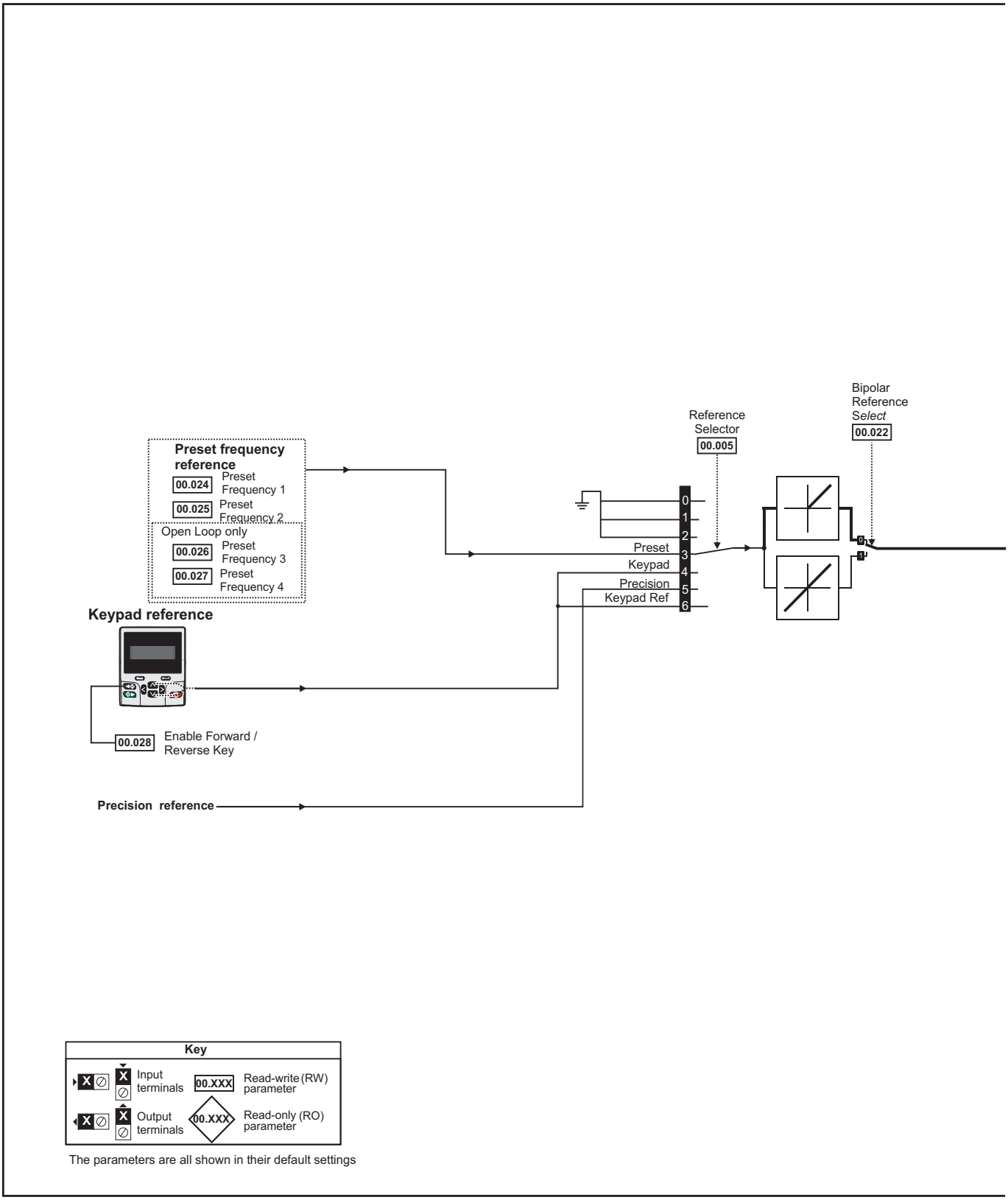
6.1 Menu 0: Basic parameters

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.001	Minimum Reference Clamp	±VM_NEGATIVE_REF_CLAMP1 Hz / rpm			0.0 Hz	0.0 rpm		RW	Num				US
00.002	Maximum Reference Clamp	±VM_POSITIVE_REF_CLAMP Hz / rpm			50Hz default: 50.0 Hz 60Hz default: 60.0 Hz	50Hz default: 1500.0 Hz 60Hz default: 1800.0 Hz	3000.0 rpm	RW	Num				US
00.003	Acceleration Rate 1	±VM_ACCEL_RATE s			5.0 s	2.000 s	0.200 s	RW	Num				US
00.004	Deceleration Rate 1	±VM_ACCEL_RATE s			10.0 s	2.000 s	0.200 s	RW	Num				US
00.005	Reference Selector	Preset (3), Keypad (4), Precision (5), Keypad Ref (6)			Preset (3)			RW	Txt				US
00.006	Symmetrical Current Limit	±VM_MOTOR1_CURRENT_LIMIT %			0.0 %			RW	Num		RA		US
00.007	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
	Speed Controller Proportional Gain Kp1		0.0000 to 200.000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
00.008	Low Frequency Voltage Boost	0.0 to 25.0 %			3.0 %			RW	Num				US
	Speed Controller Integral Gain Ki1		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
00.009	Dynamic V to F Select	Off (0) or On (1)			Off (0)			RW	Bit				US
	Speed Controller Differential Feedback Gain Kd 1		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
00.010	Motor Rpm	±180000 rpm			0 rpm			RW	Bit				US
	Speed Feedback		±VM_SPEED rpm					RO	Num	ND	NC	PT	FI
00.011	Output Frequency	±VM_SPEED_FREQ_REF Hz						RO	Num	ND	NC	PT	FI
	P1 Position			0 to 65535				RO	Num	ND	NC	PT	FI
00.012	Current Magnitude	±VM_DRIVE_CURRENT_UNIPOLAR A						RO	Bit	ND	NC	PT	FI
00.013	Torque Producing Current	±VM_DRIVE_CURRENT A						RO	Bit	ND	NC	PT	FI
00.014	Torque Mode Selector	0 or 1	0 to 5		0			RW	Num				US
00.015	Ramp Mode Select	Fast (0), Standard (1), Std boost (2)	Fast (0), Standard (1)		Standard (1)			RW	Txt				US
00.016	Ramp Enable		Off (0) or On (1)			On (1)		RW	Bit				US
00.017	Current Reference Filter Time Constant		0.0 to 25.0 ms			0.0 ms		RW	Num				US
00.022	Bipolar Reference Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
00.023	Jog Reference	0.0 to 400.0 Hz	0.0 to 4000.0 rpm		0.0			RW	Num				US
00.024	Preset Reference 1	±VM_SPEED_FREQ_REF rpm			0.0			RW	Num				US
00.025	Preset Reference 2	±VM_SPEED_FREQ_REF rpm			0.0			RW	Num				US
00.026	Preset Reference 3	±VM_SPEED_FREQ_REF Hz			0.0			RW	Num				US
	Overspeed Threshold		0 to 50000 rpm			0.0		RW	Num				US
00.027	Preset Reference 4	±VM_SPEED_FREQ_REF Hz			0.0			RW	Num				US
	P1 Rotary Lines Per Revolution		1 to 100000			1024	4096	RW	Num				US
00.028	Enable Auxiliary Key	0 to 2			0			RW	Num				US
00.029	NV Media Card Data Previously Loaded	0 to 999						RO	Num		NC	PT	
00.030	Parameter Cloning	None (0), Read (1), Program (2), Auto (3), Boot (4)			None (0)			RW	Txt		NC		US
00.031	Drive Rated Voltage	200 V (0), 400 V (1), 575 V (2), 690 V (3)						RO	Txt	ND	NC	PT	
00.032	Maximum Heavy Duty Rating	0.000 to 99999.999 A						RO	Num	ND	NC	PT	
00.033	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)			Disable (0)			RW	Txt				US
	Motor Parameter Adaptive Control		0 to 2			0		RW	Num				US
00.034	User Security Code	0 to 2^{31}-1			0			RW	Num	ND	NC	PT	US
00.037	Active IP Address	000.000.000.000 to 255.255.255.255						RO	IP		NC	PT	
00.038	Current Controller Kp Gain	0 to 30000			20	150		RW	Num				US
00.039	Current Controller Ki Gain	0 to 30000			40	2000		RW	Num				US
00.040	Auto-tune	0 to 2	0 to 3	0 to 4	0			RW	Num		NC		
00.041	Maximum Switching Frequency	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)			3kHz (1)			RW	Txt		RA		US

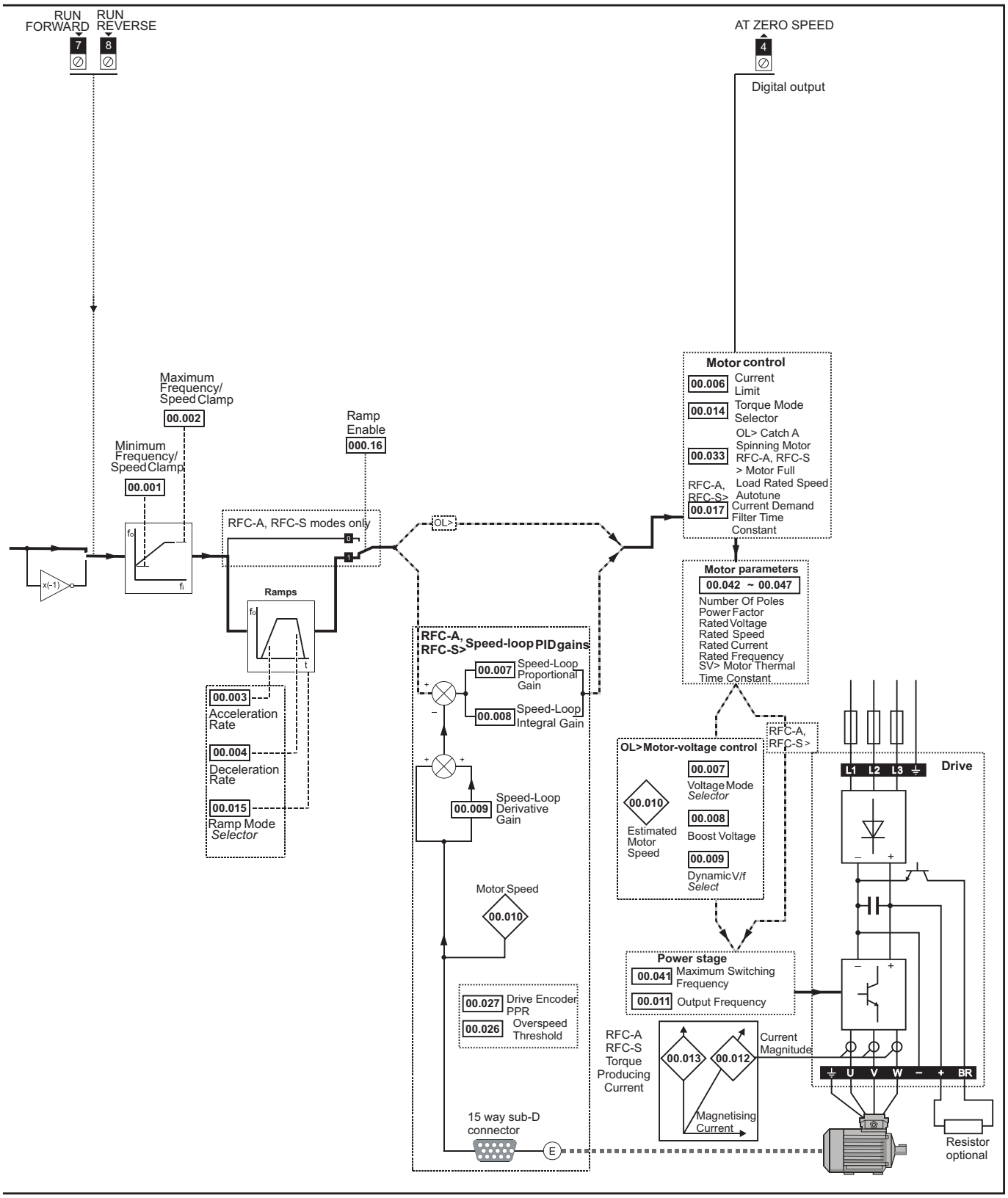
Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.042	Number Of Motor Poles	Automatic (0) to 480 Poles (240)			Automatic (0)		6 Poles (3)	RW	Num				US
00.043	Rated Power Factor	0.000 to 1.000			0.850			RW	Num		RA		US
	Position Feedback Phase Angle			0.0 to 359.9 °				RW	Num	ND			US
00.044	Rated Voltage	±VM_AC_VOLTAGE_SET			200V drive: 230V 50Hz default 400V drive: 400V 60Hz default 400V drive: 460V 575V drive: 575V 690V drive: 690V			RW	Num		RA		US
00.045	Rated Speed	0 to 180000 rpm	0.00 to 50000.00 rpm		50Hz default: 1500 rpm 60Hz default: 1800rpm	50Hz default: 1450 rpm 60Hz default: 1750rpm		RW	Num				US
	Motor Thermal Time Constant 1			1.0 to 3000.0 s			89.0 s	RW	Num				US
00.046	Rated Current	±VM_RATED_CURRENT			Maximum Heavy Duty Rating (11.032)			RW	Num		RA		US
00.047	Rated Frequency	0.0 to 3000.0 Hz	0.0 to 1667.0 Hz		50Hz default: 50.0 Hz 60Hz default: 60.0 Hz			RW	Num				US
00.048	Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3), Regen (4)			Open-loop (1)	RFC-A (2)	RFC-S (3)	RW	Txt	ND	NC	PT	
00.049	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	
00.050	Software Version	0 to 99999999						RO	Num	ND	NC	PT	
00.051	Action On Trip Detection	0 to 31			0			RW	Bin				US

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

Figure 6-1 Menu 0 logic diagram



The parameters are all shown in their default settings


RUN FORWARD
7
RUN REVERSE
8
AT ZERO SPEED
4
Digital output
Maximum Frequency/ Speed Clamp
00.002
Minimum Frequency/ Speed Clamp
00.001
Ramp Enable
000.16
RFC-A, RFC-S modes only
OL>
Ramps
00.003
Acceleration Rate
00.004
Deceleration Rate
00.015
Ramp Mode Selector
Motor control
00.006
Current Limit
00.014
Torque Mode Selector
00.033
OL> Catch A Spinning Motor
RFC-A, RFC-S > Motor Full Load Rated Speed Autotune
RFC-A, RFC-S>
00.017
Current Demand Filter Time Constant
Motor parameters
00.042 ~ 00.047
Number Of Poles
Power Factor
Rated Voltage
Rated Speed
Rated Current
Rated Frequency
SV> Motor Thermal Time Constant
RFC-A, RFC-S> Speed-loop PID gains
00.007
Speed-Loop Proportional Gain
00.008
Speed-Loop Integral Gain
00.009
Speed-Loop Derivative Gain
Motor Speed
00.010
00.027
Drive Encoder PPR
00.026
Overspeed Threshold
15 way sub-D connector
E
OL> Motor-voltage control
00.010
Estimated Motor Speed
00.007
Voltage Mode Selector
00.008
Boost Voltage
00.009
Dynamic V/f Select
RFC-A, RFC-S>
Power stage
00.041
Maximum Switching Frequency
00.011
Output Frequency
RFC-A RFC-S Torque Producing Current
00.013
00.012
Current Magnitude
Magnetising Current
Drive
L1 L2 L3
U V W BR
Resistor optional

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]**	
1000	1	**[Save parameters]**	Save parameters when under voltage is not active and low voltage threshold is not active
6001	2	**[Load file 1]**	Load the drive parameters or user program file from NV media card file 001
4001	3	**[Save to file 1]**	Transfer the drive parameters to parameter file 001
6002	4	**[Load file 2]**	Load the drive parameters or user program file from NV media card file 002
4002	5	**[Save to file 2]**	Transfer the drive parameters to parameter file 002
6003	6	**[Load file 3]**	Load the drive parameters or user program file from NV media card file 003
4003	7	**[Save to file 3]**	Transfer the drive parameters to parameter file 003
12000	8	**[Show non-default]**	Displays parameters that are different from defaults
12001	9	**[Destinations]**	Displays parameters that are set
1233	10	**[Reset 50Hz Defs]**	Load parameters with standard (50 Hz) defaults
1244	11	**[Reset 60Hz Defs]**	Load parameters with US (60 Hz) defaults
1070	12	**[Reset modules]**	Reset all option modules
11001	13	**[Read Enc. NP P1]**	Transfer electronic nameplate motor parameters to the drive from the P1 encoder
11051	14	**[Read Enc. NP P2]**	Transfer electronic nameplate motor parameters to the drive from the P2 encoder

Table 6-2 Functions in Pr mm.000

Value	Action
1000	Save parameters when *Under Voltage Active* (Pr 10.016) is not active and *Low Under Voltage Threshold Select* mode (Pr 06.067 = Off) is not active.
1001	Save parameter under all conditions
1070	Reset all option modules
1233	Load standard (50 Hz) defaults
1234	Load standard (50 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1244	Load US (60 Hz) defaults
1245	Load US (60 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1253	Change drive mode and load standard (50 Hz) defaults
1254	Change drive mode and load US (60 Hz) defaults
1255	Change drive mode and load standard (50 Hz) defaults except for menus 15 to 20 and 24 to 28
1256	Change drive mode and load US (60 Hz) defaults except for menus 15 to 20 and 24 to 28
1299	Reset {Stored HF} trip.
2001*	Create a boot file on a non-volatile media card based on the present drive parameters including all Menu 20 parameters
4yyy*	NV media card: Transfer the drive parameters to parameter file xxx
5yyy*	NV media card: Transfer the onboard user program to onboard user program file xxx
6yyy*	NV media card: Load the drive parameters from parameter file xxx or the onboard user program from onboard user program file xxx
7yyy*	NV media card: Erase file xxx
8yyy*	NV Media card: Compare the data in the drive with file xxx
9555*	NV media card: Clear the warning suppression flag
9666*	NV media card: Clear 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
110S0	Transfer electronic nameplate motor object parameters from the drive to an encoder connected to the drive or an option module.
110S1	Transfer electronic nameplate motor objects parameters from an encoder connected to the drive or option module to the drive parameters.
110S2	As 110S0, but for performance object 1
110S3	As 110S1, but for performance object 1
110S4	As 110S0, but for performance object 2
110S5	As 110S1, but for performance object 2
110S6	Transfer electronic nameplate motor object parameters from the drive to an encoder connected to the drive or an option module in the Unidrive SP format.
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.
15xxx*	Transfer the user program in an option module installed in slot 1 to a non-volatile media card file xxx
16xxx*	Transfer the user program in an option module installed in slot 2 to a non-volatile media card file xxx
17xxx*	Transfer the user program in an option module installed in slot 3 to a non-volatile media card file xxx
18xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 1.
19xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 2.
20xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 3.
21xxx*	Transfer the user program in an option module installed in slot 4 to a non-volatile media card file xxx.
22xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 4.

* See Chapter 9 *NV Media Card Operation* on page 111 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.

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 99*.

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 **00.046** *Rated Current*. This affects the thermal protection of the motor.

CAUTION

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

WARNING

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

7.1 Quick start connections

7.1.1 Basic requirements

This section shows the basic connections which must be made for the drive to run in the required mode. For minimal parameter settings to run in each mode please see the relevant part of section 7.3 *Quick start commissioning / start-up* on page 89.

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

Drive control method	Requirements
Terminal mode	Drive enable Speed / Torque reference Run forward / Run reverse
Keypad mode	Drive enable
Communications	Drive enable Communications link

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

Operating mode	Requirements
Open loop mode	Induction motor
RFC – A mode (with speed feedback)	Induction motor with speed feedback
RFC – S mode (with speed and position feedback)	Permanent magnet motor with speed and position feedback

Speed feedback
Suitable devices are:
- Incremental encoder (A, B or F, D with or without Z)
- Incremental encoder with forward and reverse outputs (F, R with or without Z)
- SINCOS encoder (with, or without Stegmann Hiperface, EnDat or SSI communications protocols)
- BiSS absolute encoder
- EnDat absolute encoder
- Resolver

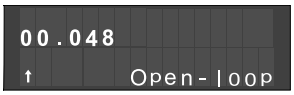
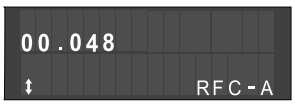
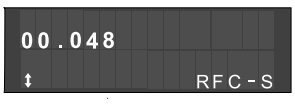
Speed and position feedback
Suitable devices are:
- Incremental encoder (A, B or F, D with or without Z) with commutation signals (U, V, W)
- Incremental encoder with forward and reverse outputs (F, R with or without Z) and commutation outputs (U, V, W)
- SINCOS encoder (with Stegmann Hiperface, EnDat or SSI communications protocols)
- BiSS absolute encoder
- EnDat absolute encoder
- Resolver

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 **00.049**) and *User Security Code* (Pr **00.034**) are not affected by this procedure).

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

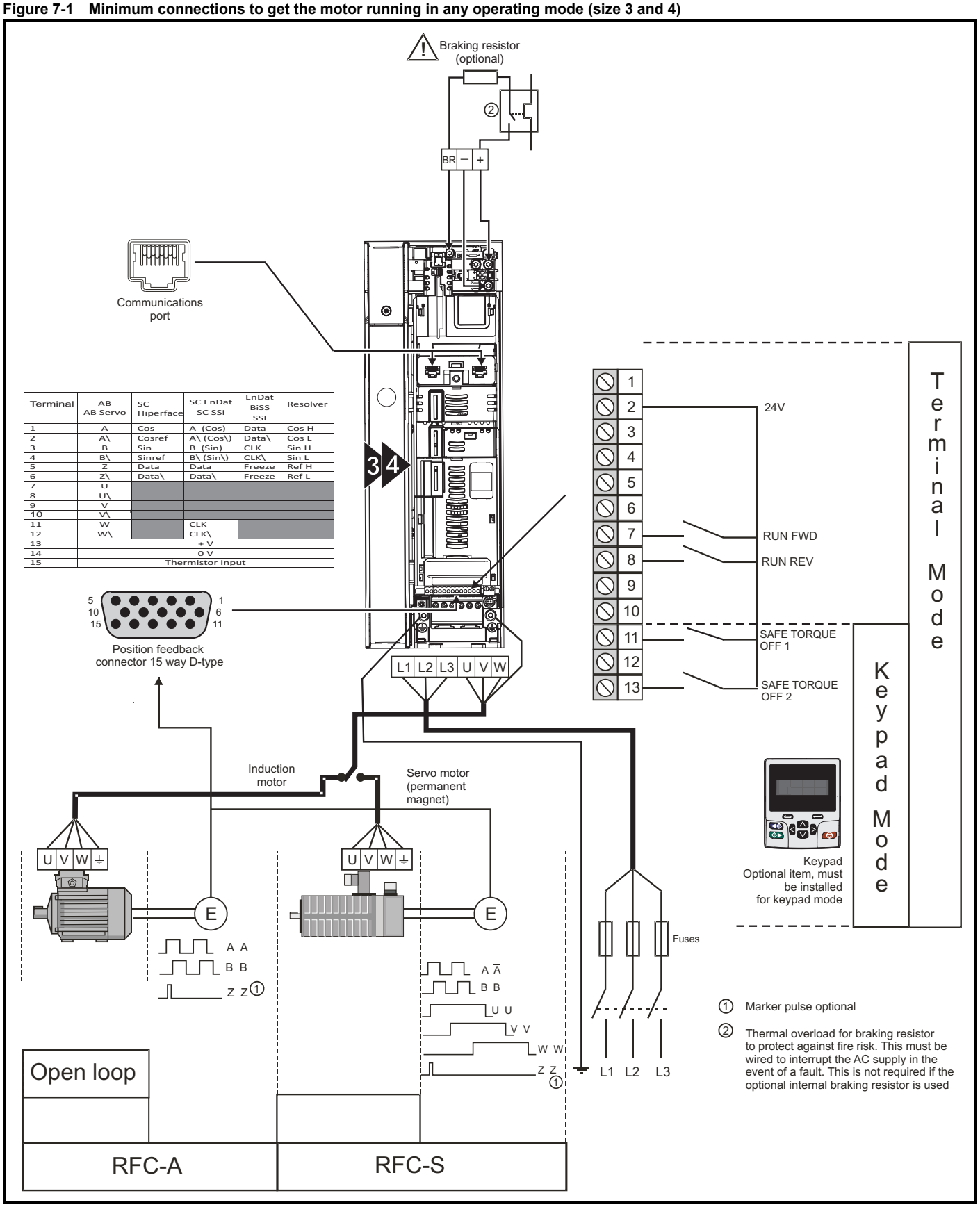
1. Enter either of the following values in Pr **mm.000**, as appropriate:
   1253 (50 Hz AC supply frequency)
   1254 (60 Hz AC supply frequency)
2. Change the setting of Pr **00.048** as follows:

Pr 00.048 setting		Operating mode
	1	Open-loop
	2	RFC-A
	3	RFC-S

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

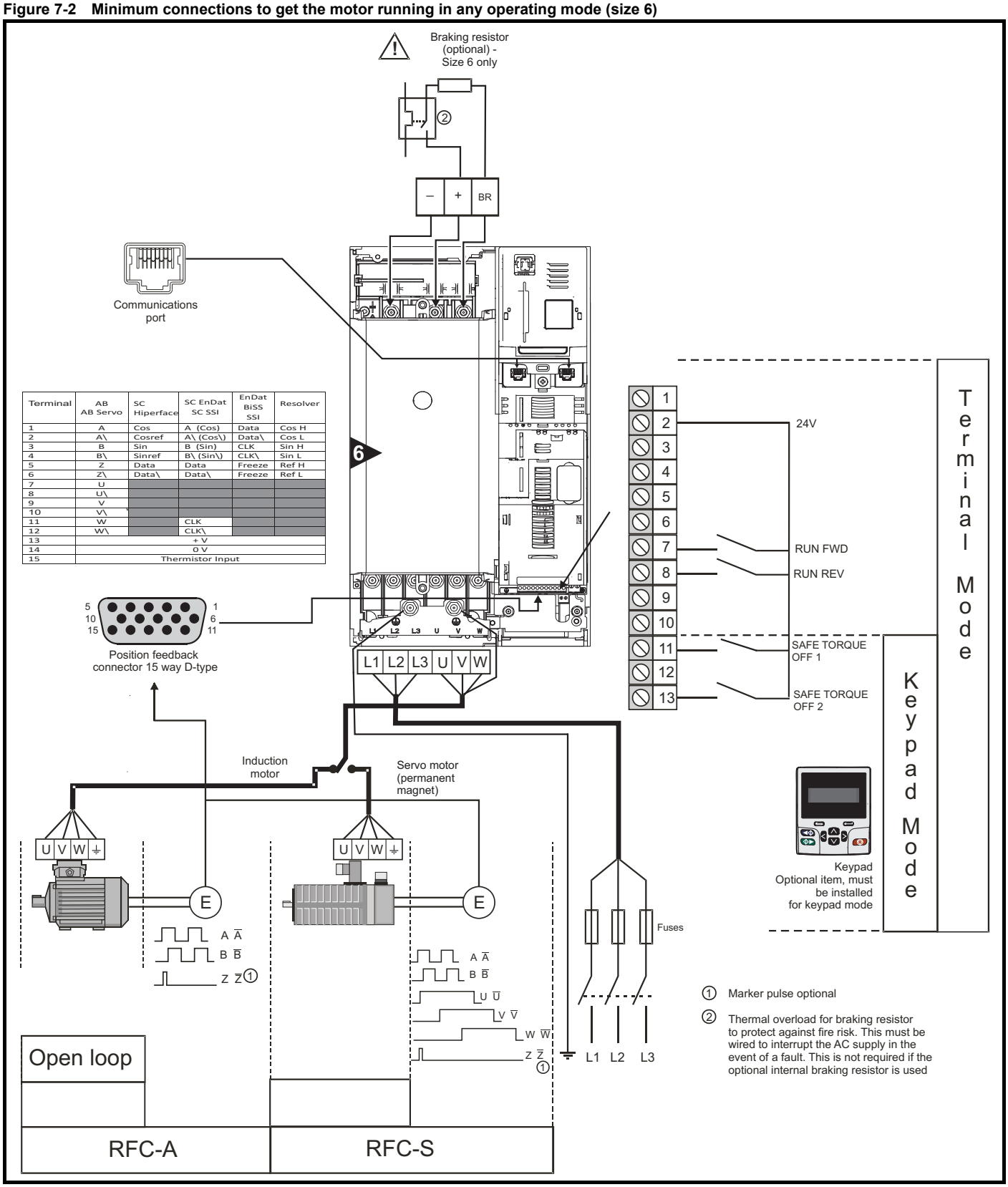
3. Either:
- Press the red  reset button
- Toggle the reset digital input
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100 (ensure that Pr. **mm.000** returns to 0).

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



Terminal	AB AB Servo	SC Hiperface	SC EnDat SC SSI	EnDat BiSS SSI	Resolver
1	A	Cos	A (Cos)	Data	Cos H
2	A\	Cosref	A\ (Cos\)	Data\	Cos L
3	B	Sin	B (Sin)	CLK	Sin H
4	B\	Sinref	B\ (Sin\)	CLK\	Sin L
5	Z	Data	Data	Freeze	Ref H
6	Z\	Data\	Data\	Freeze	Ref L
7	U				
8	U\				
9	V				
10	V\				
11	W		CLK		
12	W\		CLK\		
13	+ V				
14	0 V				
15	Thermistor Input				

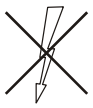
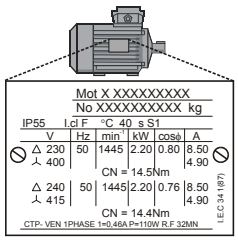
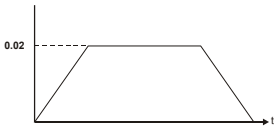
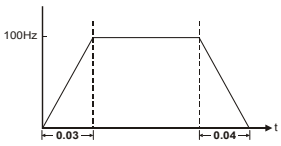
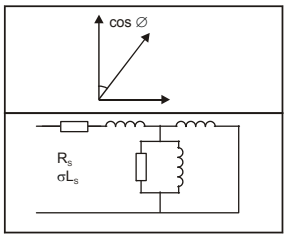
Figure 7-2 Minimum connections to get the motor running in any operating mode (size 6)



Terminal	AB AB Servo	SC Hiperface	SC EnDat SC SSI	EnDat BiSS SSI	Resolver
1	A	Cos	A (Cos)	Data	Cos H
2	A\	Cosref	A\ (Cos\)	Data\	Cos L
3	B	Sin	B (Sin)	CLK	Sin H
4	B\	Sinref	B\ (Sin\)	CLK\	Sin L
5	Z	Data	Data	Freeze	Ref H
6	Z\	Data\	Data\	Freeze	Ref L
7	U				
8	U\				
9	V				
10	V\				
11	W		CLK		
12	W\		CLK\		
13	+ V				
14	0 V				
15	Thermistor Input				

7.3 Quick start commissioning / start-up

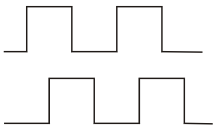
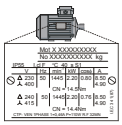
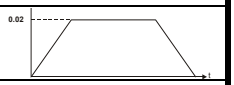
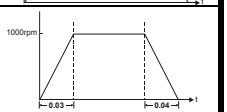
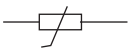
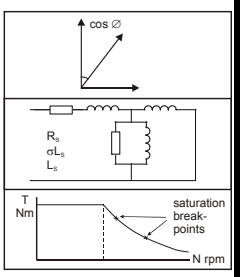
7.3.1 Open loop

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminals 11 and 13) • Run signal is not given • Motor is connected	
Power-up the drive	Verify that Open Loop mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 77. Ensure: • Drive displays 'Inhibit' If the drive trips, see section 13 *Diagnostics* on page 224.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.047** (Hz) • Motor rated current in Pr **00.046** (A) • Motor rated speed in Pr **00.045** (rpm) • Motor rated voltage in Pr **00.044** (V) - check if ⅄ or △ connection	
Set maximum frequency	Enter: • Maximum frequency in Pr **00.002** (Hz)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/100 Hz) • Deceleration rate in Pr **00.004** (s/100 Hz) (If braking resistor installed, set Pr **00.015** = FAST. Also ensure Pr **10.030** and Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118).	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive. **WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. A stationary autotune measures the stator resistance of the motor and the voltage offset in 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 **00.043**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^2/_3$ base speed in the direction selected. The rotating autotune measures the power factor of the motor. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune or set Pr **00.040** = 2 for a rotating autotune • Close the Drive Enable signals (terminals 11 and 13). The drive will display 'Ready'. • Close the run signal (terminal 7 or 8). The lower display will flash 'Autotune' while the drive is performing the autotune. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 13 *Diagnostics* on page 224. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1000 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 mode (with position feedback)

Induction motor with position feedback

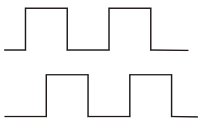
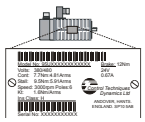
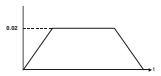
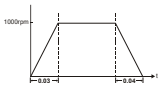
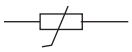
For simplicity only an incremental quadrature encoder will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section 7.4 *Setting up a feedback device* on page 92.

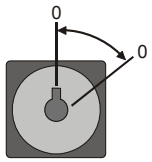
Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminals 11 and 13) • Run signal is not given • Motor and feedback device are connected	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 77. Ensure: • Drive displays 'Inhibit' If the drive trips, see Chapter 13 *Diagnostics* on page 224.	
Set motor feedback parameters	**Incremental encoder basic set-up** Enter: • Drive encoder type in Pr **03.038** = AB (0): Quadrature encoder • Encoder power supply in Pr. **03.036** = 5 V (0), 8 V (1) or 15 V (2). **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled Pr **03.039** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. • Drive encoder Lines Per Revolution (LPR) in Pr **03.034** (set according to encoder) • Drive encoder termination resistor setting in Pr **03.039**: **0** = A-A\, B-B\, Z-Z\ termination resistors disabled **1** = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled **2** = A-A\, B-B\, Z-Z\ termination resistors enabled	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.047** (Hz) • Motor rated current in Pr **00.046** (A) • Motor rated speed in Pr **00.045** (rpm) • Motor rated voltage in Pr **00.044** (V) - check if ⅄ or △ connection	
Set maximum speed	Enter: • Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000 rpm) • Deceleration rate in Pr **00.004** (s/1000 rpm) (If braking resistor installed, set Pr **00.015** = FAST. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118).	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. **WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. The stationary autotune measures the stator resistance and transient inductance of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** 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 **00.043**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^2/_3$ base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune or set Pr **00.040** = 2 for a rotating autotune • Close the drive enable signal (terminals 11 and 13). The drive will display 'Ready'. • Close the run signal (terminal 7 or 8). The lower display will flash 'Autotune' while the drive is performing the autotune. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill If the drive trips, see Chapter 13 *Diagnostics* on page 224. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1000 in Pr **mm.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.3.3 RFC-S mode (with position feedback)

Permanent magnet motor with a position feedback

For simplicity only an incremental quadrature encoder with commutation outputs will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section 7.4 *Setting up a feedback device* on page 92.

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminals 11 and 13) • Run signal is not given • Motor and feedback device are connected	
Power-up the drive	Verify that RFC-S mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *Changing the operating mode* on page 77. Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 13 *Diagnostics* on page 224.	
Set motor feedback parameters	**Incremental encoder basic set-up** Enter: • Drive encoder type in Pr. **03.038** = AB Servo (3): Quadrature encoder with commutation outputs • Encoder power supply in Pr. **03.036** = 5 V (0), 8 V (1) or 15 V (2). **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled Pr **03.039** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. • Drive encoder Pulses Per Revolution in Pr **03.034** (set according to encoder) • Drive encoder termination resistor setting in Pr **03.039**: **0** = A-A\, B-B\, Z-Z\ termination resistors disabled **1** = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled **2** = A-A\, B-B\, Z-Z\ termination resistors enabled	
Enter motor nameplate details	Enter: • Motor rated current in Pr **00.046** (A) Ensure that this equal to or less than the Heavy Duty rating of the drive otherwise 'Motor Too Hot' trips may occur during the autotune. • Number of poles in Pr **00.042** • Motor rated voltage in Pr **00.044** (V)	
Set maximum speed	Enter: • Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000 rpm) • Deceleration rate in Pr **00.004** (s/1000 rpm) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118).	

Action	Detail	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive.The drive is able to perform a stationary, rotating, mechanical load measurement or locked rotor test auotune. The motor must be at a standstill before an autotune is enabled. It is suggested that a rotating auto tune is used for accurate measurement for position feedback phase angle. • 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 is performed to locate the flux axis of the motor. The stationary autotune measures the stator resistance, inductance in flux axis, voltage offset at zero current, maximum voltage offset, inductance in torque axis with no load on the motor and current at maximum voltage offset of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. If Sensorless mode is not selected then *Position Feedback Phase Angle* (03.025) is set-up for the selected position feedback. • A rotating autotune should only be used if the motor is uncoupled. The rotating autotune will rotate the motor by up to 2 mechanical revolutions in the direction selected, regardless of the reference provided to obtain the position feedback phase angle. A stationary autotune is then performed to obtain stator resistance, inductance in flux axis, voltage offset at zero current, maximum voltage offset, inductance in torque axis with no load on the motor and current at maximum voltage offset of the motor. From the above obtained parameters the current loop gains are calculated, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. **WARNING** The rotating autotune will rotate the motor by up to 2 mechanical revolutions in the direction selected, regardless of the reference provided. After a short delay, the motor is further rotated through a electrical revolution. 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. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune, Pr **00.040** = 2 for a rotating autotune. • Close the run signal (terminal 7 or 8). • Close the drive enable signal (terminals 11 and 13). The lower display will flash 'Autotune' while the drive is performing the test. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips it cannot be reset until the drive enable signal (terminals 11 and 13) has been removed. See Chapter 13 *Diagnostics* on page 224. • Remove the drive enabled and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1000 in Pr **mm.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.4 Setting up a feedback device

7.4.1 P1 position interface

This section shows the parameter settings which must be made to use each of the compatible feedback device types with P1 position interface on the drive. For more information on the parameters listed here please refer to the *Parameter Reference Guide.*

Table 7-3 Parameters required for feedback device set-up on the P1 position interface

Parameter	AB, FD, FR, AB Servo, FD Servo , FR Servo, SC, SC Servo	SC Hiperface	SC EnDat SC SSI	EnDat	SSI	BiSS	Resolver
P1 Rotary Turns Bits (03.033)		●	●	●	✓	●	
P1 Rotary Lines Per Revolution (03.034)	✓	●	●				
P1 Comms Bits (03.035)		●	●	●	✓	●	
P1 Supply Voltage (03.036)*	✓	✓	✓	✓	✓	✓	
P1 Comms Baud Rate (03.037)			✓	✓	✓	✓	
P1 Device Type (03.038)	✓	✓	✓	✓	✓	✓	✓
P1 Auto–configuration Select (03.041)		✓	✓	✓		✓	
P1 Resolver Poles (03.065)							✓
P1 Resolver Excitation (03.066)							✓

✓ Information required to be entered by the user.

● Parameter can be set-up automatically by the drive through auto-configuration parameter. Must be set by the user if auto-configuration is disabled (i.e. Pr **03.041** = Disabled (0)).

* Pr **03.036**: If the output voltage from the encoder is >5 V, then termination resistors must be disabled by setting Pr **03.039** to 0.

Table 7-3 shows a summary of the parameters required to set-up each feedback device. More detailed information follows.

7.4.2 P1 position interface: Detailed feedback device commissioning / start-up information

Standard quadrature encoder with or without commutation signals (A, B, Z or A, B, Z, U, V, W), or Sincos encoder with or without UVW commutation signals	
Device Type (03.038)	**AB** (0) for a quadrature encoder without commutation signals * **AB Servo** (3) for a quadrature encoder with commutation signals **SC** (6) for a Sincos encoder without commutation signals * **SC Servo** (12) for a Sincos encoder with commutation signals
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled. Set Pr **03.039** to 0
Rotary Line Per Revolution (03.034)	Set to the number of lines or sine waves per revolution of the encoder.
Termination Select (03.039) (AB or AB Servo only)	**0** = A, B, Z termination resistors disabled **1** = A, B termination resistors enabled and Z termination resistors disabled **2** = A, B, Z termination resistors enabled
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection 1 x x x — Disable trips *Encoder 1* to *Encoder 7* So for example, to enable the wire break error detection, set Pr **03.040** to 0001.

* These settings should only be used in RFC-A mode. If used in RFC-S mode a phase offset test must be performed after every power up.

Incremental encoder with Frequency and Direction (F and D) or Forward and Reverse (CW and CCW) signals with or without commutation signals.	
Device Type (03.038)	**FD** (1) for frequency and direction signals without commutation signals* **FR** (3) for forward and reverse signals without commutation signals* **FD** Servo (4) for frequency and direction signals with commutation signals **FR** Servo (5) for forward and reverse signals with commutation signals
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled. Set Pr **03.039** to 0
Rotary Line Per Revolution (03.034)	Set to the number of pulses per revolution of the encoder divided by 2.
Termination Select (03.039)	0 = F or CW, D or CCW, Z termination resistors disabled 1 = F or CW, D or CCW termination resistors enabled and Z termination resistors disabled 2 = For CW, D or CCW, Z termination resistors enabled
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection 1 x x x — Disable trips *Encoder 1* to *Encoder 7* So for example, to enable the wire break error detection, set Pr **03.040** to 0001.

* These settings should only be used in RFC-A mode. If used in RFC-S mode a phase offset test must be performed after every power up.

Absolute Sincos encoder with Hiperface or EnDat serial communication, or Absolute EnDat communication only encoder or BiSS encoder	
Device Type (03.038)	**SC Hiperface** (7) for a Sincos encoder with Hiperface serial communications **EnDat** (8) for an EnDat communications only encoder **SC EnDat** (9) for a Sincos encoder with EnDat serial communications **BiSS** (13) for a BiSS communication only encoder
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2)
Auto-configuration Select (03.041)	Auto-configuration is enabled at default and automatically sets up the following parameters. *Rotary Turns Bits* (03.033) *Rotary Lines Per Revolutions* (03.034) *Comms Bits* (03.035) These parameters can be entered manually when Pr 03.041 is set to Disabled (0).
Comms Baud Rate (03.037)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection x x 1 x — Enable phase error detection 1 x x x — Disable trips *Encoder 1* to *Encoder 7* So for example, to enable the wire break and phase error detection, set Pr **03.040** to 0011.

Absolute SSI communications only encoder, or Absolute Sincos encoder with SSI communications	
Device Type (03.038)	**SSI** (10) for a SSI communications only encoder **SC SSI** (11) for a Sincos encoder with SSI serial communications
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2)
Rotary Line Per Revolution (03.034)	Set the number of sine waves per revolution of the encoder
SSI Binary Mode (03.048)	Off = Gray Code On = Binary Mode
Rotary Turns Bits (03.033)	Set to the number of turns bits for the encoder (this is normally 12 bits for a SSI encoder)
Comms Bits (03.035)	Total number of bits of position information (this is usually 25 bits for a SSI encoder)
Comms Baud Rate (03.037)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection x x 1 x — Enable phase error detection x 1 x x — Enable SSI power supply alarm bit monitor 1 x x x — Disable trips *Encoder 1* to *Encoder 7* So for example, to enable the wire break and phase error detection, set Pr **03.040** to 0011.

UVW commutation signal only encoders*	
Device Type (03.038)	Commutation Only (16) for a quadrature encoder with commutation signals*
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2)
Error Detection Level (03.040)	Set to zero to disable wire break detection

* This feedback device provides very low resolution feedback and should not be used for applications requiring a high level of performance.

Due to the low resolution of UVW communication only encoders, it is recommended that the *P1 Feedback Filter* (03.042) is set to its maximum value. A value of 1 ms to 2 ms may also be required in the *Current Demand Filter* (04.012) and it is also recommended that the speed loop gains are set to a low value to obtain stable operation.

Resolver	
Device Type (03.038)	Resolver (14)
Resolver Poles (03.065)	Set number of Resolver poles 2 poles, 4 poles, 6 poles, 8 poles
Resolver Excitation (03.066)	Set Resolver excitation voltage and frequency **6 V** Auto (0), **4 V** Auto (1), **6 V** 6 kHz (2), **4 V** 6 kHz (3), **6 V** 8 kHz (4), **4 V** 8 kHz (5)
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection 1 x x x — Disable trips *Encoder 1* to *Encoder 7* So for example, to enable the wire break error detection, set Pr **03.040** to 0001.

7.4.3 P2 position interface

This section shows the parameter settings which must be made to use each of the compatible feedback device types with the P2 position interface on the drive. For more information on the parameters listed here please refer to the *Parameter Reference Guide*. If the position feedback device connected to the P2 position interface is required to be used for motor control feedback then Pr **03.026** will need to be set to P2 Drive (1).

Table 7-4 Parameters required for feedback device set-up on the P2 position interface

Parameter	AB, FD, FR	EnDat	SSI	BiSS
P2 Rotary Turns Bits (03.133)		●	●	●
P2 Rotary Lines Per Revolution (03.134)	✓			
P2 Comms Bits (03.135)		●	●	●
P2 Comms Baud Rate (03.137)		✓	✓	✓
P2 Device Type (03.138)	✓	✓	✓	✓
P2 Auto–configuration Select (03.141)		✓		✓

✓ Information required to be entered by the user.

● Parameter can be set-up automatically by the drive through auto-configuration. Parameter must be set by the user if auto-configuration is disabled (i.e. Pr **03.041** = Disabled (0)).

The P2 position interface does not have its own independent power supply output. Therefore, any position feedback device connected to the P2 position interface must either share the P1 power supply output on pin 13 of the 15-way D-type, or be supplied from an external source.

NOTE

The termination resistors are always enabled on the P2 position interface. Wire break detection is not available when using AB, FD or FR position feedback device types on the P2 position interface.

Table 7-4 shows a summary of the parameters required to set-up each feedback device. More detailed information follows.

Standard quadrature encoder (A, B, Z)	
Device Type (03.138)	**AB** (1) for a quadrature encoder
Rotary Line Per Revolution (03.134)	Set to the number of lines per revolution of the encoder

Incremental encoder with Frequency and Direction (F and D), or Forward and Reverse (CW and CCW) signals	
Device Type (03.138)	**FD** (2) for frequency and direction signals without commutation signals **FR** (3) for forward and reverse signals without commutation signals
Rotary Line Per Revolution (03.134)	Set to the number of pulses per revolution of the encoder divided by 2

Absolute EnDat communication only encoder or BiSS encoder	
Device Type (03.138)	**EnDat** (4) for an EnDat communications only encoder **BiSS** (6) for a BiSS communication only encoder
Auto-configuration Select (03.141)	Auto-configuration is enabled at default and automatically sets up the following parameters: *Rotary Turns Bits* (03.133) *Comms Bits* (03.135) These parameters can be entered manually when Pr **03.141** is set to Disabled (0).
Comms Baud Rate (03.137)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.140)	**Bit** 3 2 1 0 / **Description** 1 x x x — Disable trips *Encoder 4* to *Encoder 7*

Absolute SSI communications only encoder	
Device Type (03.138)	**SSI** (5) for a SSI communications only encoder
SSI Binary Mode (03.048)	**Off** (0) = Gray Code **On** (1) = Binary Mode
Rotary Turns Bits (03.133)	Set to the number of turns bits for the encoder (this is usually 12 bits for a multi-turn SSI encoder)
Comms Bits (03.135)	Total number of bits of position information for the encoder (this is usually 25 bits for a multi-turn SSI encoder)
Comms Baud Rate (03.137)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.140)	**Bit** 3 2 1 0 / **Description** x 1 x x — *Enable SSI power supply alarm bit monitor* 1 x x x — Disable trips *Encoder 4* to *Encoder 7*

7.5 Encoder Simulation Output Set-up

The drive supports three modes of encoder simulation output.

- Hardware mode - Incremental signals (AB, FD, FR)
- Software mode - Incremental signals (AB, FD, FR)
- Software mode - Absolute SSI data

The availability of the encoder simulation output on the 15-way D-type on the drive is dependent on the type of feedback device connected to the P1 position interface. See Table 4-17 on page 65 for more information on the availability of the encoder simulation output. The status of the encoder simulation output can be seen in *Encoder Simulation Status* (03.086) as follows:

None (0) The encoder simulation output is not enabled or is not available
Full (1) Full encoder simulation with marker output is available
No Marker (2) Encoder simulation without marker output is available

This section shows the parameter settings which must be made to use the encoder simulation output on the drive. For more information on the parameters listed here please refer to the *Parameter Reference Guide*.

7.5.1 Hardware mode - Incremental signals (AB, FD, or FR)

Hardware mode provides incremental signals derived via hardware from the P1 position feedback interface on the drive, with negligible delay. The supported incremental output signals are AB, FD and FR. Hardware mode only produces an output when the input device connected to the P1 position interface is AB, FD, FR, SC, SC Hiperface, SC EnDat or SC SSI type devices. It should be noted that with a SINCOS source device the output is based on the zero crossings of the sine wave inputs and does not include interpolation.

Hardware mode set-up	
Encoder Simulation Source (03.085)	This parameter must be set to **03.029** to select the P1 position interface as the source.
Encoder Simulation Mode (03.088)	Set to a value of **Hardware (0)**
Encoder Simulation Hardware Divider (03.089)	This parameter defines the divider ratio between the device connected to the P1 position feedback interface and the output. **0** = 1/1 **1** = 1/2 **2** = 1/4 **3** = 1/8 **4**= 1/16 **5** = 1/32 **6** = 1/64 **7** = 1/128
Encoder Simulation Hardware Marker Lock (03.090)	**0** = The marker output is derived directly from the marker input **1** = The incremental output signals are adjusted on each marker event so that the A and B are high with an AB type output, or F is high with an FD or FR type output
EncoderSimulationOutputMode(03.098)	**AB/Gray** (0) for a AB quadrature output signals **FD/Binary** (1) for Frequency and Direction output signals **FR/Binary** (2) for Forward and Reverse output signals

7.5.2 Software mode - Incremental signals (AB, FD, or FR)

In software mode the encoder simulation output is derived via software from the selected source with a minimum delay of 250 µs which may be extended with *Encoder Simulation Sample Period* (03.087). For incremental output signals, the resolution of the output can be defined by either selecting the required output lines per revolution or by an output ratio.

Lines per revolution

The output resolution of the encoder simulation output is defined by *Encoder Simulation Output Lines Per Revolution* (03.092).

AB quadrature output signals, software mode setup – Lines per revolution	
Encoder Simulation Source (03.085)	Set to the parameter number of the position source Pr **03.029** to use the P1 position interface on the drive as the source. Pr **03.129** to use the P2 position interface on the drive as the source. This parameter can be set to any other valid position reference generated by the drive or an option module.
Encoder Simulation Mode (03.088)	Set to a value of **Lines Per Rev (1)**
Encoder Simulation Output Lines Per Revolution (03.092)	Set to the required output lines per revolution. The maximum output lines per revolution are 16384.
Encoder Simulation Output Mode (03.098)	**AB/Gray** (0) for a AB quadrature output signals

Frequency and Direction or Forward and Reverse output signals, software mode setup – Lines per revolution	
Encoder Simulation Source (03.085)	Set to the parameter number of the position source Pr **03.029** to use the P1 position interface on the drive as the source. Pr **03.129** to use the P2 position interface on the drive as the source. This parameter can be set to any other valid position reference generated by the drive or an option module.
Encoder Simulation Mode (03.088)	Set to a value of **Lines Per Rev (1)**
Encoder Simulation Output Lines Per Revolution (03.092)	Set to the required output pulse per revolution divided by 2. For example if 2000 pulses per revolution is required, set this parameter to 1000.
Encoder Simulation Output Mode (03.098)	**FD/Binary** (1) for Frequency and Direction output signals **FR/Binary** (2) for Forward and Reverse output signals

Ratio

In ratio mode the resolution of the input source is based on a 16 bit position feedback device (i.e. equivalent to an AB quadrature encoder with a resolution of 16384 lines per revolution). The output resolution of the encoder simulation output is defined by the ratio of *Encoder Simulation Numerator* (03.093) and *Encoder Simulation Denominator* (03.094).

AB quadrature output signals, software mode setup – Ratio Frequency and Direction or Forward and Reverse output signals, software mode setup	
Encoder Simulation Source (03.085)	Set to the parameter number of the position source Pr **03.029** to use the P1 position interface on the drive as the source. Pr **03.129** to use the P2 position interface on the drive as the source. This parameter can be set to any other valid position reference generated by the drive or an option module.
Encoder Simulation Mode (03.088)	Set to a value of **Ratio (2)**
Encoder Simulation Numerator (03.093) and *Encoder Simulation Denominator* (03.094)	Set these two parameters to give the required output ratio.
Encoder Simulation Output Mode (03.098)	**AB/Gray** (0) for a AB quadrature output signals **FD/Binary** (1) for Frequency and Direction output signals **FR/Binary** (2) for Forward and Reverse output signals

Software mode - Absolute SSI data

In software mode the encoder simulation output is derived via software from the selected source with a minimum delay of 250 μs which may be extended with *Encoder Simulation Sample Period* (03.087). In SSI output mode drive will simulate an SSI encoder, where the number of bits and the format of the position message can be adjusted.

Absolute SSI data, software mode setup	
Encoder Simulation Source (03.085)	Set to the parameter number of the position source Pr **03.029** to use the P1 position interface on the drive as the source. Pr **03.129** to use the P2 position interface on the drive as the source. This parameter can be set to any other valid position reference generated by the drive or an option module.
Encoder Simulation Mode (03.088)	Set to a value of **SSI (3)**
Encoder Simulation SSI Turns Bits (03.096)	Set to the number of bits representing the number of turns in the position message.
Encoder Simulation SSI Comms Bits (03.097)	Set to the number bits in the whole position message.
Encoder Simulation Output Mode (03.098)	**AB/Gray** (0) for position data in Gray code format **FD/Binary** (1) or **FR/Binary** (2) for position data in binary format

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

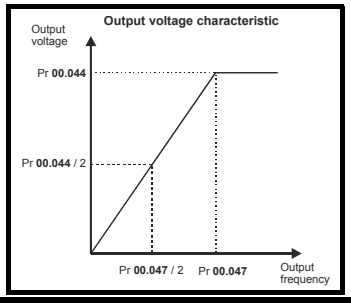
8.1.1 Open loop motor control

Pr 00.046 {05.007} *Rated Current*	**Defines the maximum continuous motor current**

- The rated current parameter must be set to the maximum continuous current of the motor. (See section 8.2 *Maximum motor rated current* on page 108, for information about setting this parameter higher than the maximum Heavy Duty current rating). The motor rated current is used in the following:
- Current limits (see section section 8.3 *Current limits* on page 108, for more information)
- Motor thermal overload protection (see section section 8.4 *Motor thermal protection* on page 108, for more information)
- Vector mode voltage control (see *Open Loop Control Mode* (00.007), later in this table)
- Slip compensation (see *Enable Slip Compensation* (05.027), later in this table)
- Dynamic V/F control

Pr 00.044 {05.009} *Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.047 {05.006} *Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Rated Voltage* (00.044) and the *Rated Frequency* (00.047) are used to define the voltage to frequency characteristic applied to the motor (see *Open Loop Control Mode* (00.007), later in this table). The *Rated Frequency* (00.047) is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see *Rated Speed* (00.045), later in this table).



Pr 00.045 {05.008} *Rated Speed*	**Defines the full load rated speed of the motor**
Pr 00.042 {05.011} *Number Of Motor Poles*	**Defines the number of motor poles**

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

Rated slip (Hz) = Motor rated frequency - (Number of pole pairs x [Motor rated speed / 60]) = $\mathbf{00.047} = \left(\frac{\mathbf{00.042}}{\mathbf{2}} \times \frac{\mathbf{00.045}}{\mathbf{60}}\right)$

If Pr **00.045** is set to 0 or to synchronous speed, slip compensation is disabled. If slip compensation is required this parameter should be set to the nameplate value, which should give the correct rpm for a hot machine. Sometimes it will be necessary to adjust this when the drive is commissioned because the nameplate value may be inaccurate. Slip compensation will operate correctly both below base speed and within the field-weakening region. Slip compensation is normally used to correct for the motor speed to prevent speed variation with load. The rated load rpm can be set higher than synchronous speed to deliberately introduce speed droop. This can be useful to aid load sharing with mechanically coupled motors.

Pr **00.042** is also used in the calculation of the motor speed display by the drive for a given output frequency. When Pr **00.042** is set to 'Auto', the number of motor poles is automatically calculated from the rated frequency Pr **00.047**, and the motor rated speed Pr **00.045**.

Number of poles = 120 x (*Rated Frequency* (00.047) / *Rated Speed* (00.045)) rounded to the nearest even number.

Pr 00.043 {05.010} *Rated Power Factor*	**Defines the angle between the motor voltage and current**

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. The power factor is used in conjunction with the *Rated Current* (00.046), 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 00.040), below).

Pr 0.40 {5.12} 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), *Transient Inductance* (05.024), *Voltage Offset At Zero Current* (05.058), *Maximum Voltage Offset* (05.059) and *Current At Maximum Voltage Offset* (05.060) which are required for good performance in vector control modes (see *Open Loop Control Mode* (00.007), 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 **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).

- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, as above, then a rotating test is performed in which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (05.006) x 2/3, and the frequency is maintained at that level for 4 seconds. *Stator Inductance* (05.025) is measured and this value is used in conjunction with other motor parameters to calculate *Rated Power Factor* (05.010). To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).

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 terminals 11 and 13, 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 00.007 {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* (00.047), 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* (00.043), *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 00.040 *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* (00.007) 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* (00.007), 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 **00.008**, 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* (00.047), 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* (00.0 47), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of the speed of the motor shaft. This mode should not be used if a high starting torque is required.

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

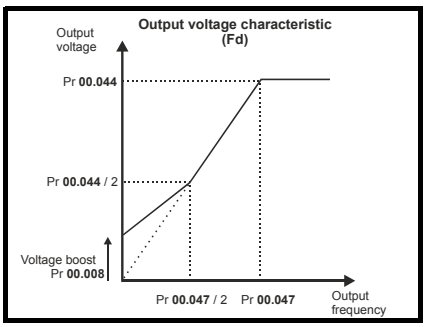
Fixed boost

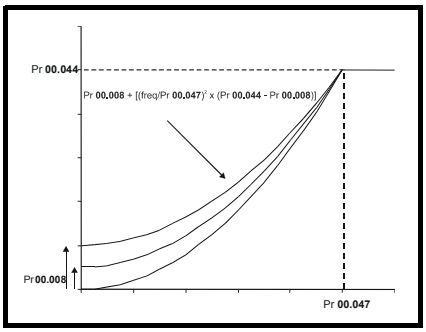
Neither the stator resistance nor the voltage offset are used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by parameter Pr **00.008**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed boost available:

(2) **Fixed** = This mode provides the motor with a linear voltage characteristic from 0 Hz to *Rated Frequency* (00.047), 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* (00.047), 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.

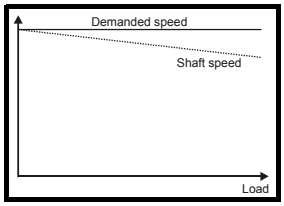
For both these modes, at low frequencies (from 0Hz to ½ x Pr **00.047**) a voltage boost is applied defined by Pr **00.008** as shown below:





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 **00.045** (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 **00.045**, slip compensation will be disabled. If too small a value is entered in Pr **00.045**, 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 mode

Induction motor with Position feedback

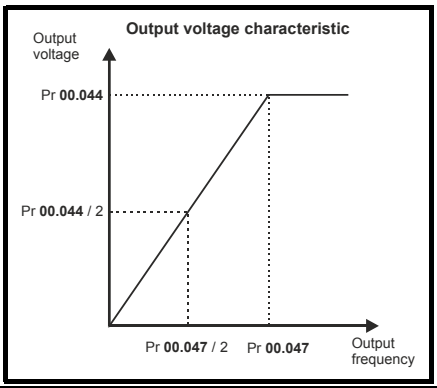
Pr 00.046 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

The motor rated current parameter must be set to the maximum continuous current of the motor. (See section 8.2 *Maximum motor rated current* on page 108, for information about setting this parameter higher than the maximum Heavy Duty current rating.) The motor rated current is used in the following:

- Current limits (see section 8.3 *Current limits* on page 108, for more information).
- Motor thermal overload protection (see section 8.4 *Motor thermal protection* on page 108, for more information)
- Vector control algorithm

Pr 00.044 {05.009} *Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.047 {05.006} *Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Rated Voltage* (00.044) and the *Rated Frequency* (00.047) are used to define the voltage to frequency characteristic applied to the motor (see *Open Loop Control Mode* (00.007), later in this table). The motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see motor *Rated Speed (*00.045), later in this table).



Pr 00.045 {05.008} *Rated Speed*	**Defines the full load rated speed of the motor**
Pr 00.042 {05.011} *Number Of Motor Poles*	**Defines the number of motor poles**

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

Incorrect setting of this parameter has the following effects:

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

The nameplate value is normally the value for a hot motor; however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. Either a fixed value can be entered in this parameter or an optimization system may be used to automatically adjust this parameter (see *Motor Parameter Adaptive Control* (05.016), later in this table).

When Pr **00.042** is set to 'Auto', the number of motor poles is automatically calculated from the motor *Rated Frequency* (00.047), and the motor *Rated Speed* (00.045).

Number of poles = 120 x (Motor *Rated Frequency* (00.047 / Motor *Rated Speed* (00.045) rounded to the nearest even number.

Pr 00.043 {5.10} *Rated Power Factor*	**Defines the angle between the motor voltage and current**

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. If the *Stator Inductance* (05.025) is set to zero then the power factor is used in conjunction with the motor *Rated Current* (00.046) and other motor parameters to calculate the rated active and magnetising currents of the motor, which are used in the vector control algorithm. If the stator inductance has a non-zero value this parameter is not used by the drive, but is continuously written with a calculated value of power factor. The stator inductance can be measured by the drive by performing a rotating autotune (see *Autotune* (Pr 00.040), later in this table).

Pr 00.040 {05.012} *Autotune*

There are three autotune tests available in RFC-A mode, a stationary test, a rotating test and an inertia measurement 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. An inertia measurement test should be performed separately to a stationary or rotating autotune.

NOTE

It is highly recommended that a rotating autotune is performed (Pr **00.040** set to 2).

- 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 **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).
- A rotating autotune should only be used if the motor is unloaded. A rotating autotune first performs a stationary autotune, a rotating test is then performed which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (05.006) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (05.025), and the motor saturation breakpoints (Pr **05.029**, Pr **05.030**, Pr **06.062** and Pr **05.063**) are 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 **00.040** to 2, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).
- The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains (see Speed loop gains) and to provide torque feed-forwards when required during acceleration. During the inertia measurement test motor is accelerated with the currently selected ramps up to a speed of *Rated Speed* (05.008) / 4, and this speed is maintained at this level for 60 seconds. The *Motor And Load Inertia* (03.018) and load compensation parameters (*Load Compensation Param 1* (04.031) to *Load Compensation Param 4* (04.034)) are measured. If the required speed is not achieved on the final attempt the test is aborted and an Autotune trip is initiated. To perform an Inertia measurement autotune, set Pr **00.040** to 3, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8). 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 terminals 11 and 13, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

Pr 05.016 *Motor Parameter Adaptive Control*

The motor *Rated Speed* (00.045) in conjunction with the motor *Rated Frequency* (00.047) defines the full load slip of the motor. The slip is used in the motor model for RFC-A control. The full load slip of the motor varies with rotor resistance which can vary significantly with motor temperature. When Pr **05.016** is set to 1 or 2 the drive can automatically sense if the value of slip defined by Pr **00.047** and Pr **00.045** has been set incorrectly or if it has varied with motor temperature. If the value is incorrect Pr **00.045** is automatically adjusted. Pr **00.045** is not saved at power-down, and so when the drive is powered-down and up again it will return to the last saved value. If the new value is required at the next power-up it must be saved by the user.

The adaptive control system is only enabled when the |*Output Frequency* (05.001)| is above *Rated Frequency* (05.006) / 8, and the |*Percentage Load* (04.020)| is greater than 60 %. The adaptive control system is disabled again if the |*Percentage Load* (04.020)| falls below 50 %. For best optimization results the correct values of *Stator Resistance* (05.017), *Transient Inductance* (05.024), *Stator Inductance* (05.025), *Saturation Breakpoint 1* (05.029), *Saturation Breakpoint 2* (05.062), *Saturation Breakpoint 3* (05.030) and *Saturation Breakpoint 4* (05.063) should be used. If *Motor Parameter Adaptive Control* (05.016) = 1 the gain of the adaptive control system is low and hence the rate at which it converges is slow. If *Motor Parameter Adaptive Control* (05.016) = 2 the gain is increased by a factor of 16 and the convergence rate is increased.

Pr 00.038 {04.013} / Pr 00.039 {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 00.040, 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 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {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. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009)** are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

Speed Controller Proportional Gain (Kp), Pr **00.007** {**03.010**} and Pr **03.013**

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 **00.008** {**03.011**} and Pr **03.014**

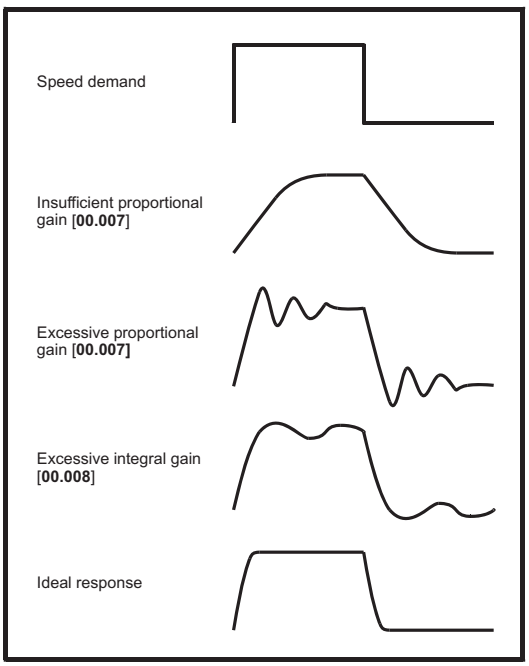
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of 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 **00.009** {**03.012**} and Pr **03.015**

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.

There are three methods of tuning the speed loop gains dependant on the setting of Pr **03.017**:

1. Pr **03.017** = 0, User set-up.
   This involves the connecting of an oscilloscope to analog output 1 to monitor the speed feedback.
   Give the drive a step change in speed reference and monitor the response of the drive on the oscilloscope.
   The proportional gain (Kp) should be set up initially. The value should be increased up to the point where the speed overshoots and then reduced slightly.
   The integral gain (Ki) should then be increased up to the point where the speed becomes unstable and then reduced slightly.
   It may now be possible to increase the proportional gain to a higher value and the process should be repeated until the system response matches the ideal response as shown.
   The diagram shows the effect of incorrect P and I gain settings as well as the ideal response.
2. Pr **03.017** = 1, Bandwidth set-up
   If bandwidth based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   Pr **03.020** - Required bandwidth,
   Pr **03.021** - Required damping factor,
   Pr **03.018** - Motor and load inertia.
   The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see Autotune Pr **00.040**, earlier in this table).
3. Pr **03.017** = 2, Compliance angle set-up
   If compliance angle based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   Pr **03.019** - Required compliance angle,
   Pr **03.021** - Required damping factor,
   Pr **03.018** - Motor and load inertia The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see *Autotune* Pr 00.040, earlier in this table).
4. Pr **03.017** = 3, Kp gains times 16
   If *Speed Controller Set-up Method* (03.017) = 3 the selected proportional gain used by the drive is multiplied by 16.



5. Pr **03.017** = 4 - 6

If *Speed Controller Set-up Method* (03.017) is set to a value from 4 to 6 the *Speed Controller Proportional Gain Kp1* (03.010) and *Speed Controller Integral Gain Ki1* (03.011) are automatically set up to give the bandwidths given in the table below and a damping factor of unity.

These settings give low, standard or high performance.

Speed Controller Set-up Method (03.017)	Performance	Bandwidth
4	Low	5 Hz
5	Standard	25 Hz
6	High	100 Hz

8.1.3 RFC-S mode

Permanent magnet motor with Position feedback

Pr 00.046 {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:

- Current limits (see section 8.3 *Current limits* on page 108, for more information)
- Motor thermal overload protection (see section 8.4 *Motor thermal protection* on page 108, for more information)

Pr 00.042 {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 **00.042** is set to "Auto" the number of poles is 6.

Pr 00.040 {05.012} *Autotune*	

There are four autotune tests available in RFC-S mode, a stationary autotune, a rotating autotune, an inertia measurement test and a locked rotor test to measure load dependent parameters.

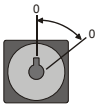
- *Stationary Autotune*

The stationary autotune can be used when the motor is loaded and it is not possible uncouple the load from motor shaft. This test can be used to measure all the necessary parameters for basic control. During the stationary autotune, a test is performed to locate the flux axis of the motor. However this test may not be able to calculate such an accurate value for the *Position Feedback Phase Angle* (03.025) as compared to rotating autotune. A stationary test is performed to measure *Stator Resistance* (05.017), *Ld* (05.024), *Voltage Offset At Zero Current* (05.058), *Maximum Voltage Offset* (05.059), *Current At Maximum Voltage Offset* (05.060), *No Load Lq* (05.068) and *No Load Phase Offset* (05.070). If *Enable Stator Compensation* (05.049) = 1 then *Stator Base Temperature* (05.048) is made equal to *Stator Temperature* (05.046). 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). If sensorless mode is not selected then *Position Feedback Phase Angle* (03.025) is set up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).

- *Rotating Autotune*

The rotating autotune must be performed on unloaded motor. This test can be used to measure all the necessary parameters for the basic control and parameters for cancelling the effects of the cogging torque.

During the rotating autotune, *Rated Current* (05.007) is applied and the motor is rotated by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the required direction. If sensorless mode is not selected then the *Position Feedback Phase Angle* (03.025) is set-up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). A stationary test is then performed to measure *Stator Resistance* (05.017), *Ld* (05.024), *Voltage Offset At Zero Current* (05.058), *Maximum Voltage Offset* (05.059), *Current At Maximum Voltage Offset* (05.060) and *No Load Lq* (05.068). *Stator Resistance* (05.017) and *Ld* (05.024) are used to set up *Current Controller Kp Gain* (04.013) and *Current Controller Ki Gain* (04.014). This is only done once during the test, and so the user can make further adjustments to the current controller gains if required. After a delay of 5 s the motor is rotated through a further electrical revolution and *Cogging Data Parameter 1* (05.074) to *Cogging Data Parameter 8* (05.081) are measured. To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8).



- *Inertia measurement test*

The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains (see *Speed loop gains*) and to provide torque feed-forwards when required during acceleration. During the inertia measurement test motor is accelerated with the currently selected ramps up to a speed of *Rated Speed* (05.008) / 4, and this speed is maintained at this level for 60 seconds. The *Motor And Load Inertia* (03.018) and load compensation parameters (*Load Compensation Param 1* (04.031) to *Load Compensation Param 4* (04.034)) are measured. If the required speed is not achieved on the final attempt the test is aborted and an Autotune trip is initiated. To perform an Inertia measurement autotune, set Pr **00.040** to 3, and provide the drive with both an enable signal (on terminals 11 and 13) and a run signal (on terminal 7 or 8). 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 terminals 11 and 13, setting the drive *Enable Parameter* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

- *Locked rotor test*

This test can be used to measure the parameters necessary to operate in sensorless mode at low speeds using signal injection, or to exploit the torque produced from saliency, provided all the basic control parameters have been set-up correctly. The test can only be carried out if the rotor is locked is such a way that it will not move even when a torque producing current equal to *Rated Current* (05.007) is applied to the motor. *Rated Load Lq* (05.069), *Rated Load Offset* (05.071) and *Maximum Low Speed Sensorless Mode Current* (05.072) are measured. To perform a *Rotating* autotune, set Pr **00.040** to 4, and provide the drive with both an enable signal (terminals 11 and 13) and a run signal (on terminal 7 or 8).

Pr 00.038 {04.013} / Pr 00.039 {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 00.040, 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 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {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. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009**) are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

Speed Controller Proportional Gain (Kp), Pr **00.007** {**03.010**} and Pr **03.013**

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 **00.008** {**03.011**} and Pr **03.014**

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.

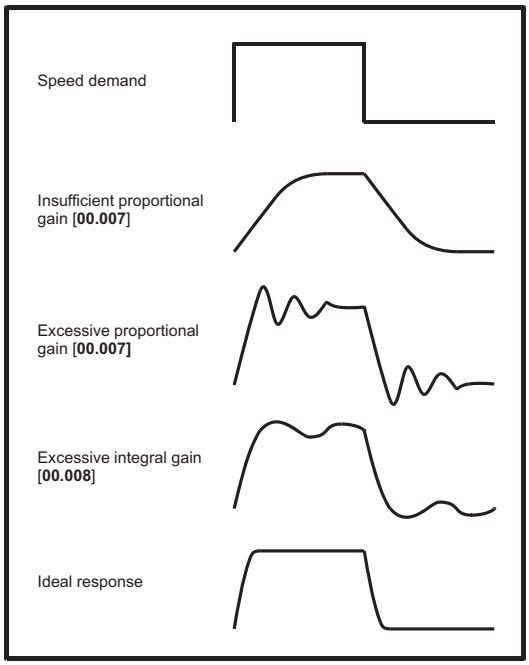
Differential Gain (Kd), Pr **00.009** {**03.012**} and Pr **03.015**

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

Speed loop gains (cont)
(Pr 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {03.012})

There are three methods of tuning the speed loop gains dependant on the setting of Pr **03.017**:

1. Pr **03.017** = 0, User set-up.
   This involves the connecting of an oscilloscope to analog output 1 to monitor the speed feedback.
   Give the drive a step change in speed reference and monitor the response of the drive on the oscilloscope.
   The proportional gain (Kp) should be set up initially. The value should be increased up to the point where the speed overshoots and then reduced slightly.
   The integral gain (Ki) should then be increased up to the point where the speed becomes unstable and then reduced slightly.
   It may now be possible to increase the proportional gain to a higher value and the process should be repeated until the system response matches the ideal response as shown.
   The diagram shows the effect of incorrect P and I gain settings as well as the ideal response.
2. Pr **03.017** = 1, Bandwidth set-up
   If bandwidth based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   Pr **03.020** - Required bandwidth,
   Pr **03.021** - Required damping factor,
   Pr **03.018** - Motor and load inertia.
   The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see *Autotune* Pr 00.040, earlier in this table).
3. Pr **03.017** = 2, Compliance angle set-up
   If compliance angle based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:
   Pr **03.019** - Required compliance angle,
   Pr **03.021** - Required damping factor,
   Pr **03.018** - Motor and load inertia.The drive can be made to measure the motor and load inertia by performing an inertia measurement autotune (see *Autotune* Pr 00.040, earlier in this table).
4. Pr **03.017** = 3, Kp gains times 16
   If *Speed Controller Set-up Method* (03.017) = 3 the selected proportional gain used by the drive is multiplied by 16.



5. Pr **03.017** = 4 - 6

If *Speed Controller Set-up Method* (03.017) is set to a value from 4 to 6 the *Speed Controller Proportional Gain Kp1* (03.010) and *Speed Controller Integral Gain Ki1* (03.011) are automatically set up to give the bandwidths given in the table below and a damping factor of unity.

These settings give low, standard or high performance.

Speed Controller Set-up Method (03.017)	Performance	Bandwidth
4	Low	5 Hz
5	Standard	25 Hz
6	High	100 Hz

8.2 Maximum motor rated current

The maximum motor rated current allowed by the drive is greater than the *Maximum Heavy Duty Current Rating* (11.032). The ratio between the Normal Duty rating and the *Maximum Heavy Duty Current Rating* (11.032) varies between drive sizes. The values for the Normal and Heavy Duty rating can be found in section 2.3 *Ratings* on page 11. If the motor *Rated Current* (00.046) is set above the *Maximum Heavy Duty Current Rating* (11.032), the current limits and the motor thermal protection scheme are modified (see section 8.3 *Current limits* on page 108 and section 8.4 *Motor thermal protection* on page 108 for more information).

8.3 Current limits

The default setting for the current limit parameters for size 3 is:

- 165 % x motor rated current for open loop mode
- 175 % x motor rated current for RFC-A and RFC-S modes

There are three parameters which control the current limits:

- Motoring current limit: power flowing from the drive to the motor
- Regen current limit: power flowing from the motor to the drive
- Symmetrical current limit: current limit for both motoring and regen operation

The lowest of either the motoring and regen current limit, or the symmetrical current limit applies.

The maximum setting of these parameters depends on the values of motor rated current, drive rated current and the power factor.

Increasing the motor rated current (Pr **00.046**/**05.007**) above the Heavy Duty rating (default value), will automatically reduce the current limits in Pr **04.005** to Pr **04.007**. If the motor rated current is then set to or below the Heavy Duty rating, the current limits will be left at their reduced values.

The drive can be oversized to permit a higher current limit setting to provide higher accelerating torque as required up to a maximum of 1000 %.

8.4 Motor thermal protection

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

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

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

Where:

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

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

Where:

I = *Current Magnitude* (04.001)

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

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

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

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

Where:

T = *Motor Protection Accumulator* (04.019)

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

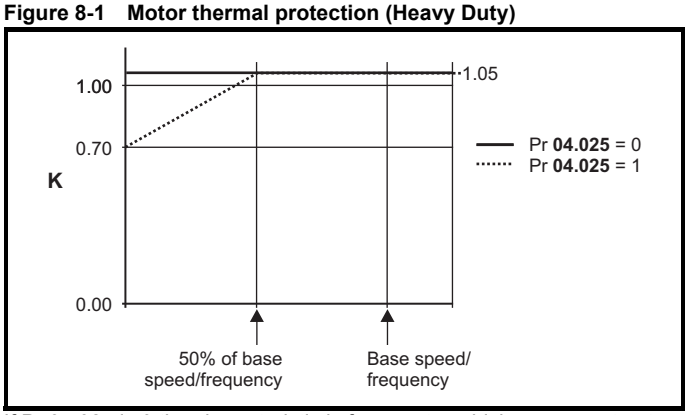
$\tau 1$ = *Motor Thermal Time Constant 1* (04.015)

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

K_1 = Varies, see below

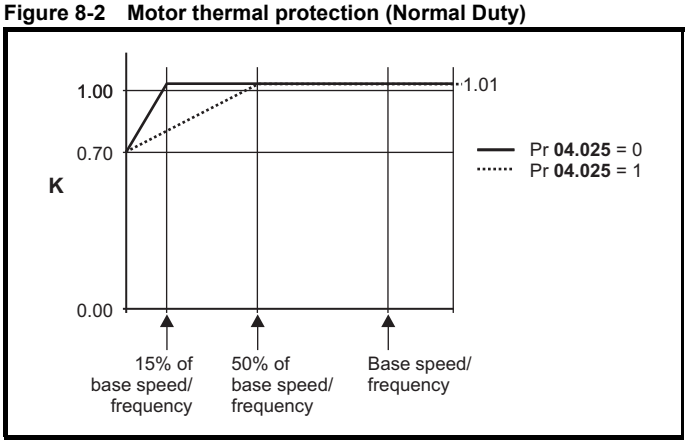
If *Rated Current* (05.007) ≤ *Maximum Heavy Duty Current* (11.032)

Figure 8-1 Motor thermal protection (Heavy Duty)



If Pr **04.025** is 0 the characteristic is for a motor which can operate at rated current over the whole speed range. Induction motors with this type of characteristic normally have forced cooling. If Pr **04.025** is 1 the characteristic is intended for motors where the cooling effect of motor fan reduces with reduced motor speed below 50 % of base speed/ frequency. The maximum value for K1 is 1.05, so that above the knee of the characteristics the motor can operate continuously up to 105 % current.

Figure 8-2 Motor thermal protection (Normal Duty)



Both settings of Pr **04.025** are intended for motors where the cooling effect of the motor fan reduces with reduced motor speed, but with different speeds below which the cooling effect is reduced. If Pr **04.025** is 0 the characteristic is intended for motors where the cooling effect reduces with motor speed below 15 % of base speed/frequency. If Pr **04.025** is 1 the characteristic is intended for motors where the cooling effect reduces with motor speed below 50 % of base speed/frequency. The maximum value for K1 is 1.01, so that above the knee of the characteristics the motor can operate continuously up to 101 % current.

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

The current limit is set back to the user defined level when Pr **04.019** falls below 95 %. The thermal model temperature accumulator is reset to zero at power-up and accumulates the temperature of the motor while them drive remains powered-up. If the rated current defined by Pr **05.007** is altered, the accumulator is reset to zero.

The default setting of the thermal time constant (Pr **04.015**) is 89 s which is equivalent to an overload of 150 % for 60 s from cold.

8.5 Switching frequency

The default switching frequency is 3 kHz (6 kHz in RFC-S mode), 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								
6								

If 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 209.
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	

8.6 High speed operation

8.6.1 Encoder feedback limits

The maximum encoder frequency should be prevented from exceeding 500 kHz. In RFC-A and RFC-S modes the maximum speed that can be entered in to the speed reference clamps (Pr **01.006** and Pr **01.007**) can be limited by the drive. This is defined by the following (subject to an absolute maximum of 40,000 rpm):

$$\text{Maximum speed limit (rpm)} = \frac{500\text{ kHz} \times 60}{\text{ELPR}}$$

$$= \frac{3.0 \times 10^7}{\text{ELPR}}$$

Where:

ELPR is the equivalent encoder lines per revolution and is the number of lines that would be produced by a quadrature encoder.

- Quadrature encoder ELPR = number of lines per revolution
- F and D encoder ELPR = number of lines per revolution / 2
- SINCOS encoder ELPR = number of sine waves per revolution

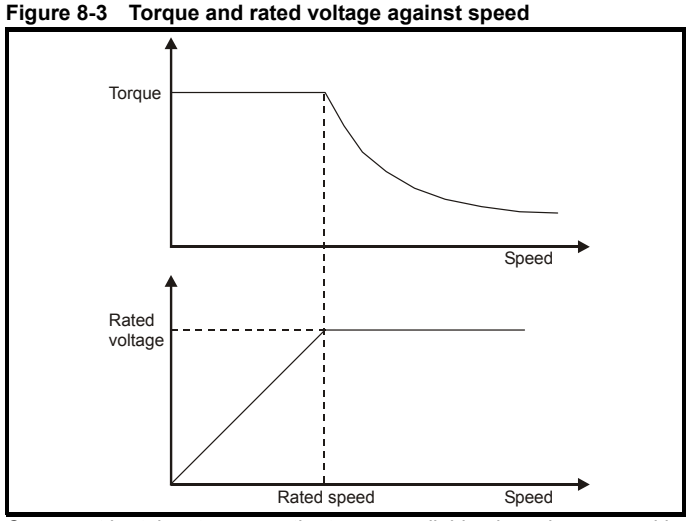
This maximum speed limit is defined by the device selected with the speed feedback selector (Pr **03.026**), and the ELPR set for the position feedback device. In RFC-A mode it is possible to disable this limit via Pr **03.024**, so that the drive can be switched between operation with and without feedback when the speed becomes too high for the feedback device. The maximum speed limit is defined as above when Pr **03.024** = 0 and is 36,000 rpm when Pr **03.024** = 1,2, 3 or 4.

8.6.2 Field weakening (constant power) operation

(Open loop and RFC-A mode only)

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

Figure 8-3 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.

The saturation breakpoint parameters (Pr **05.029**, Pr **05. 030**, Pr **05.062** and Pr **05.063**) found during the autotune in RFC-A mode ensure the magnetizing current is reduced in the correct proportion for the specific motor. (In open loop mode the magnetizing current is not actively controlled).

8.6.3 Servo high speed operation

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

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

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

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

8.6.4 Maximum speed / frequency

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

8.6.5 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.

9 NV Media Card Operation

9.1 Introduction

The Non-Volatile Media Card feature enables simple configuration of parameters, parameter back-up and drive copying using a SMARTCARD or SD card in the future. The drive offers backward compatibility for a Unidrive SP SMARTCARD.

The SMARTCARD can be used for:

- Parameter copying between drives
- Saving drive parameter sets

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

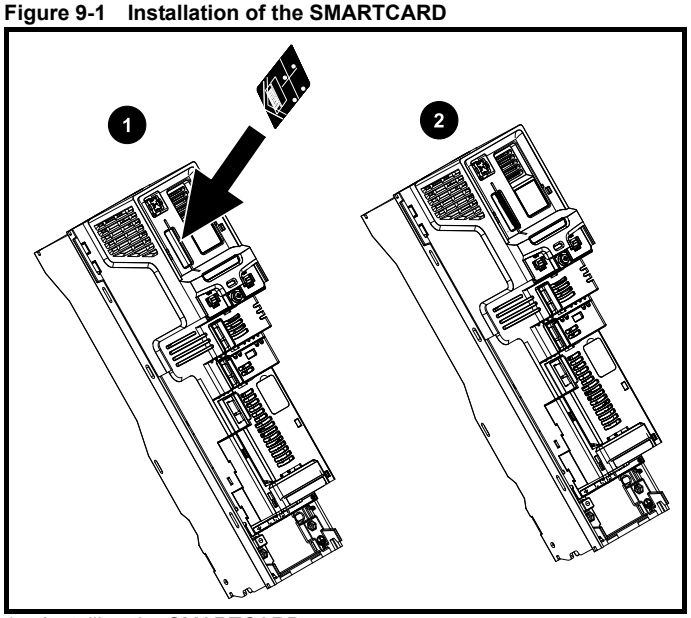
Ensure SMARTCARD is inserted with the contacts facing the right-hand side of the drive.

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

WARNING

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

Figure 9-1 Installation of the SMARTCARD



1. Installing the SMARTCARD
2. SMARTCARD installed

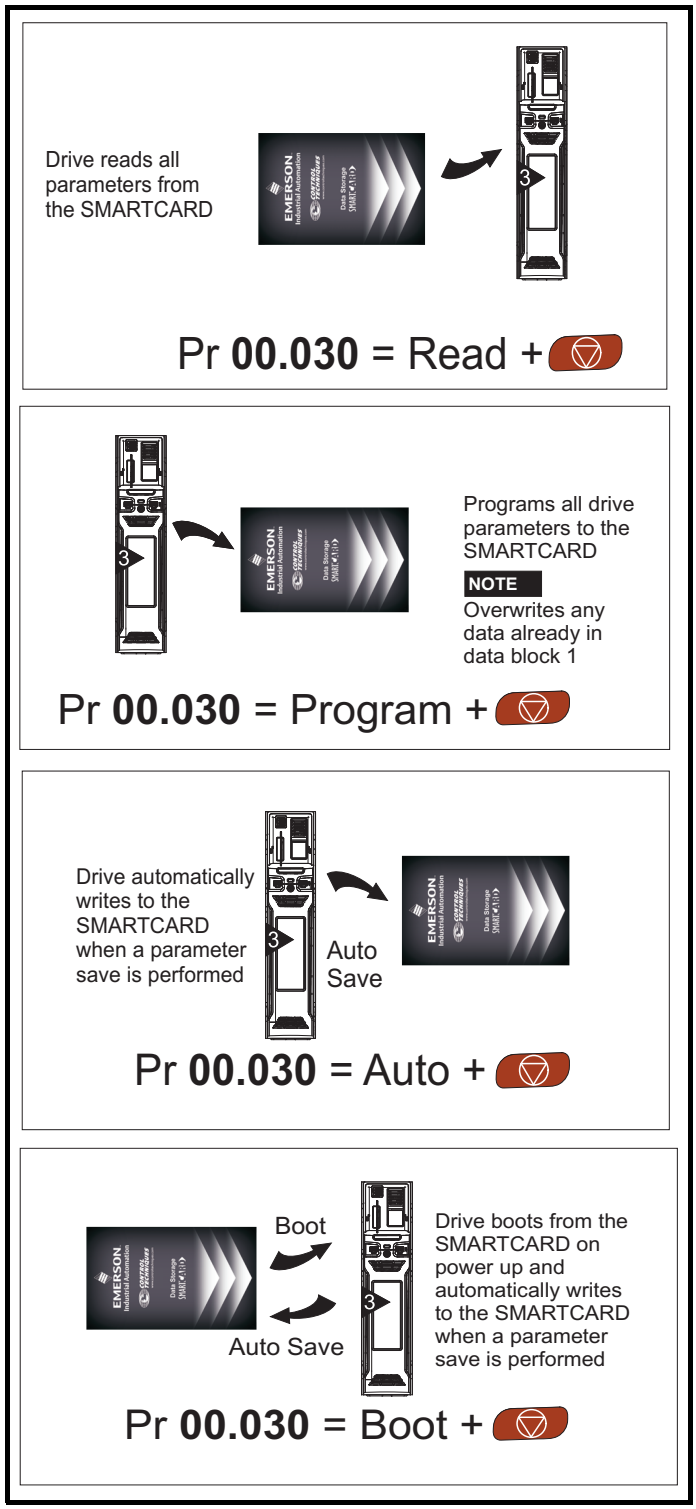
9.2 SMARTCARD support

The SMARTCARD can be used to store one drive parameter set from the Unidrive M in data block 001 on the SMARTCARD.

The Unidrive M is compatible with a Unidrive SP SMARTCARD and is able to read and translate the Unidrive SP parameter set into a compatible parameter set for Unidrive M. This is only possible if the Unidrive SP parameter set was transferred to the SMARTCARD using the difference from defaults transfer method (i.e. 4yyy transfer). The Unidrive M is not able to read any other type of Unidrive SP data block on the card. Although it is possible to transfer difference from default data blocks from a Unidrive SP into the Unidrive M, 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 SMARTCARD operation



The whole card may be protected from writing or erasing by setting the read-only flag as detailed section 9.3.9 *9888 / 9777 - Setting and clearing the SMARTCARD read only flag* on page 113.

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 codes

Code	Action
2001	Transfer drive parameters as difference from defaults to a bootable SMARTCARD block in data block number 001
4001	Transfer drive data as difference from defaults to SMARTCARD block number 001
6yyy	Transfer SMARTCARD data block yyy to the drive
9555	Clear SMARTCARD warning suppression flag
9666	Set SMARTCARD warning suppression flag
9777	Clear SMARTCARD read-only flag
9888	Set SMARTCARD read-only flag
9999	Erase SMARTCARD

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 SMARTCARD

4001 - Writes defaults differences to the SMARTCARD

The data block only contains the parameter differences from the last time default settings were loaded.

All parameters except those with the NC (Not clonable) coding bit set are transferred to the SMARTCARD. In addition to these parameters all menu 20 parameters (except Pr **20.000**), can be transferred to the SMARTCARD.

Writing a parameter set to the SMARTCARD (Pr 11.042 = Program (2))

Setting Pr **11.042** to Program (2) and resetting the drive will save the parameters to the SMARTCARD, i.e. this is equivalent to writing 4001 to Pr **mm.000**. All SMARTCARD 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 SMARTCARD

6yyy - Reading from SMARTCARD

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 SMARTCARD 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** and Pr **21.027** to Pr **21.029** *Motoring Current Limits*

Pr **04.024**, *User Current Maximum Scaling*

Pr **05.007**, Pr **21.007** *Rated Current*

Pr **05.009**, Pr **21.009** *Rated Voltage*

Pr **05.010**, Pr **21.010** *Rated Power Factor*

Pr **05.017**, Pr **21.012** *Stator Resistance*

Pr **05.018** *Maximum Switching Frequency*

Pr **05.024**, Pr **21.014** *Transient Inductance*

Pr **05.025**, Pr **21.024** *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 SMARTCARD (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 SMARTCARD 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 SMARTCARD. The latest menu 0 parameter set in the drive is therefore always backed up on the SMARTCARD. 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 SMARTCARD when Pr **mm.000** is set to 'Save Parameters' or a 1000 and the drive reset.

All SMARTCARD 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 SMARTCARD 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 SMARTCARD if auto mode is still required.

When Pr **11.042** is set to Auto (3) and the parameters in the drive are saved, the SMARTCARD is also updated, and therefore the SMARTCARD 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 SMARTCARD. The drive will display 'Card Write' during this operation. This is done to ensure that if a user puts a new SMARTCARD in during power down the new SMARTCARD 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 SMARTCARD.

9.3.4 Booting up from the SMARTCARD 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 SMARTCARD 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 SMARTCARD this makes the copying SMARTCARD 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 SMARTCARD 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 800yy - Comparing the drive full parameter set with the SMARTCARD values

Setting 8yyy in Pr **mm.000**, will compare the SMARTCARD 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 700yy / 9999 - Erasing data from the SMARTCARD values

Data can be erased from the SMARTCARD either one block at a time or all blocks in one go.

- Setting 7yyy in Pr **mm.000** will erase SMARTCARD data block yyy
- Setting 9999 in Pr **mm.000** will erase all SMARTCARD data blocks

9.3.8 9666 / 9555 - Setting and clearing the SMARTCARD 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 SMARTCARD read only flag

The SMARTCARD 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 SMARTCARD 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 {00.029}	NV Media Card File Previously Loaded					
RO	Num		NC	PT		
⇳	0 to 999			⇨	0	

This parameter shows the number of the data block last transferred from a SMARTCARD to the drive. If defaults are subsequently reloaded this parameter is set to 0.

11.037	NV Media Card File Number					
RW	Num					
⇳	0 to 999			⇨	0	

This parameter should have the data block number which the user would like the information displayed in Pr **11.038**, Pr **11.039** and Pr **11.040**.

11.038	NV Media Card File Type					
RO	Txt	ND	NC	PT		
⇳	0 to 6			⇨	0	

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		
⇳	0 to 9999			⇨	0	

Displays the version number of the file selected in Pr **11.037**.

11.040	NV Media Card File Checksum					
RO	Num	ND	NC	PT		
⇳	-2^{31} to $2^{31}-1$			⇨	0	

Displays the checksum of the data block selected in Pr **11.037**.

11.042	Parameter Cloning					
RW	Txt		NC			US*
⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)			⇨	0	

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 SMARTCARD

Program (2) = Program a parameter set to the SMARTCARD

Auto (3) = Auto save

Boot (4) = Boot mode

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 224 for more information on NV Media Card trips.

10 Onboard PLC

10.1 Onboard PLC and Machine Control Studio

The drive has the ability to store and execute a 16 kB Onboard PLC user program without the need for additional hardware in the form of an option module.

Machine Control Studio (MC Studio) is an IEC61131-3 development environment designed for use with Unidrive M and compatible application modules. MC Studio is based on CoDeSys from 3S-Smart Software Solutions.

All of the programming languages defined in the IEC standard IEC 61131-3 are supported in the MC Studio development environment.

- ST (Structured text)
- LD (Ladder diagram)
- FBD (Function block diagram)
- IL (Instruction list)
- SFC (Sequential function chart)
- CFC (Continuous Function Chart). CFC is an extension to the standard IEC programming languages

MC Studio provides a complete environment for the development of user programs. Programs can be created, compiled and downloaded to a Unidrive M or compatible applications module for execution, via the communications port on the front of the drive. The run-time operation of the compiled program on the target can also be monitored using MC Studio and facilities are provided to interact with the program on the target by setting new values for target variables and parameters.

The Onboard PLC and MC Studio form the first level of functionality in a range of programmable options for Unidrive M.

MC Studio can be downloaded from www.controltechniques.com.

See the MC Studio help file for more information regarding using MC Studio, creating user programs and downloading user programs to the drive.

10.2 Benefits

The combination of the Onboard PLC and MC Studio, means that the drive can replace nano and some micro PLCs in many applications

MC Studio benefits from access to the standard CoDeSys function and function block libraries as well as those from third parties. Functions and function blocks available as standard in MC Studio include, but not limited to, the following:

- Arithmetic blocks
- Comparison blocks
- Timers
- Counters
- Multiplexers
- Latches
- Bit manipulation

Typical applications for the Onboard PLC include:

- Ancillary pumps
- Fans and control valves
- Interlocking logic
- Sequences routines
- Custom control words.

10.3 Features

The Unidrive M Onboard PLC user program has the following features:

10.3.1 Tasks

The Onboard PLC allows use of two tasks.

- Clock: A high priority real time task. The clock task interval can be set from 4 ms to 262 s in multiples of 4 ms. The parameter *Onboard User Program: Clock Task Time Used* (11.051) shows the percentage of the available time used by clock task. A read or write of a drive parameter by the user program takes a finite period of time. It is possible to select up to 10 parameters as fast access parameter which reduced the amount of time it takes for the user program to read from or write to a drive parameter. This is useful when using a clock task with a fast update rate as selecting a parameter for fast access reduces the amount of the clock task resource required to access parameters.
- Freewheeling: A non-real time background task. The freewheeling task is scheduled for a short period once every 64 ms. The time for which the task is scheduled will vary depending on the loading of the drive's processor. When scheduled, several scans of the user program may be performed. Some scans may execute in microseconds. However, when the main drive functions are scheduled there will be a pause in the execution of the program causing some scans to take many milliseconds. The parameter *Onboard User Program: Freewheeling Tasks Per Second* (11.050) shows the number of times the freewheeling task has started per second.

10.3.2 Variables

The Onboard PLC supports the use of variables with the data types of Boolean, integer (8 bit, 16 bit and 32 bit, signed and unsigned), floating point (64 bit only), strings and time.

10.3.3 Custom menu

MC Studio can construct a custom drive menu to reside in menu 30 on the drive. The following properties of each parameter can be defined using MC Studio:

- Parameter name
- Number of decimal places
- The units for the parameter to be display on the keypad.
- The minimum, maximum and default values
- Memory handling (i.e. power down save, user save or volatile)
- Data type. The drive provides a limited set of 1 bit, 8 bit, 16 bit and 32 bit integer parameters to create the customer menu.

Parameters in this customer menu can be accessed by the user program and will appear on the keypad.

10.3.4 Limitations

Compared with the Applications Modules when programmed with MC Studio, the Onboard PLC user program has the following limitations:

- The maximum program size is 16384 bytes including header and optional source code.
- The drive is rated for 100 program downloads. This limitation is imposed by the flash memory used to store the program within the drive.
- There is only one real-time task with a minimum period of 4 ms.
- The freewheeling background task runs at a low priority. The drive is prioritized to perform the clock task and its major functions first, e.g. motor control, and will use any remaining processing time to execute the freewheeling task as a background activity. As the drive's processor becomes more heavily loaded, less time is spent executing the freewheeling task.
- Breakpoints, single stepping and online program changes are not possible.
- The Graphing tool is not supported.
- The variable data types REAL (32 bit floating point), LWORD (64 bit integer) and WSTRING (Unicode string), and retained variables are not supported.

10.4 Onboard PLC parameters

The following parameters are associated with the Onboard PLC user program.

11.047	Onboard User Program: Enable					
RW	Txt				US	
⇳	Stop (0) or Run (1)			⇨	Run (1)	

This parameter stops and starts the user program.

0 - Stop the User Program

The onboard user program is stopped. If it is restarted by setting *Onboard User Program: Enable* (11.047) to a non-zero value the background task starts from the beginning.

1 - Run the User Program

The user program will execute.

11.048	Onboard User Program: Status					
RO	Txt		NC	PT		
⇳	-2147483648 to 2147483647			⇨		

This parameter is read-only and indicates the status of the user program in the drive. The user program writes the value to this parameter.

11.049	Onboard User Program: Programming Events					
RO	Uni		NC	PT	PS	
⇳	-2147483648 to 2147483647			⇨		

This parameter holds the number of times an Onboard PLC user program download has taken place and is 0 on dispatch from the factory. The drive is rated for one hundred ladder program downloads. This parameter is not altered when defaults are loaded.

11.050	Onboard User Program: Freewheeling Tasks Per Second					
RO	Uni		NC	PT		
⇳	0 to 65535			⇨		

This parameter shows the number of times the freewheeling task has started per second.

11.051	Onboard User Program: Clock Task Time Used					
RO			NC	PT		
⇳	0.0 to 100.0 %			⇨		

This parameter shows the percentage of the available time used by the user program clock task.

11.055	Onboard User Program: Clock Task Scheduled Interval					
RO			NC	PT		
⇳	0 to 262140 ms			⇨		

This parameter shows the interval at which the clock task is scheduled to run at in ms.

10.5 Onboard PLC trips

If the drive detects an error in the user program it will initiate a User Program trip. The sub-trip number for the User Program trip details the reason for the error. See Chapter 13 *Diagnostics* on page 224 for more information on the User Program trip.

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* on the CD ROM supplied with the product.

WARNING

These advanced parameters are listed for reference purposes only. The lists in this chapter do not include sufficient information for adjusting these parameters. Incorrect adjustment can affect the safety of the system, and damage the drive and or external equipment. Before attempting to adjust any of these parameters, refer to the *Advanced User Guide*.

Table 11-1 Menu descriptions

Menu	Description
0	Commonly used basic set-up parameters for quick / easy programming
1	Frequency / Speed reference
2	Ramps
3	Frequency slaving, speed feedback and speed control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	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
21	Second motor parameters
22	Menu 0 set-up
23	Not allocated
24	Ethernet module (slot 4) set-up menu
25	Option module slot 1 application parameters
26	Option module slot 2 application parameters
27	Option module slot 3 application parameters
28	Option module slot 4 application parameters
29	Reserved menu
30	Onboard user programming application menu
31-41	Advanced motion controller set-up parameters
Slot 1	Slot 1 option menus*
Slot 2	Slot 2 option menus*
Slot 3	Slot 3 option menus*
Slot 4	Ethernet menus

* Only displayed when the option modules are installed.

Operation mode abbreviations:

Open-loop: Sensorless control for induction motors

RFC-A: Asynchronous Rotor Flux Control for induction motors

RFC-S: Synchronous Rotor Flux 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
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					
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	05.012	05.016	05.017	05.023	05.024	05.025	05.010	05.029	05.030				
Binary sum	09.029	09.030	09.031	09.032	09.033	09.034							
Bipolar speed	01.010												
Brake control	12.040 to 12.049												
Braking	10.011	10.010	10.030	10.031	06.001	02.004	02.002	10.012	10.039	10.040	10.061		
Catch a spinning motor	06.009	05.040											
Coast to stop	06.001												
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 T4	08.001	08.011	08.021										
Digital I/O T5	08.002	08.012	08.022										
Digital input T7	08.004	08.014	08.024										
Digital input T8	08.005	08.015	08.025										
Digital lock	13.010	13.001 to 13.009			13.011	13.012	13.016	03.022	03.023	13.019 to 13.023			
Digital output T2	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			
Display timeout	11.041												
Drive active	10.002	10.040											
Drive derivative	11.028	11.033	11.064										
Drive OK	10.001	08.027	08.007	08.017	10.036	10.040							
Dynamic performance	05.026												
Dynamic V/F	05.013												
Electronic nameplate	03.049												
Enable	06.015	08.009	08.010	08.040									
Encoder reference	03.043	03.044	03.045	03.046									
Encoder set up	03.033	03.034 to 03.042			03.047	03.048	03.133	03.134 to 03.142					
External trip	10.032	08.010	08.007										
Fan speed	06.045												
Fast disable	06.029												
Field weakening - induction motor	05.029	05.030	01.006	05.028									
Field weakening - servo	05.022	01.006	05.009										
Filter change	06.019	06.018											
Frequency reference selection	01.014	01.015											
Frequency slaving	03.001	03.013	03.014	03.015	03.016	03.017	03.018						
Hard speed reference	03.022	03.023											
Heavy duty rating	05.007	11.032											
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									
Jog reference	01.005	02.019	02.029										
Keypad reference	01.017	01.014	01.043	01.051	06.012	06.013							
Kt	05.032												
Limit switches	06.035	06.036											
Line power supply loss	06.003	10.015	10.016	05.005									
Local position reference	13.020 to 13.023												
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					
Low voltage supply	06.044	06.046	06.066	06.067									
Marker pulse	03.032	03.031											
Maximum speed	01.006												
Menu 0 set-up	11.001 to 11.022			Menu 22									

Feature	Related parameters (Pr)												
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							
Motor map 2	Menu 21		11.45										
Motorized potentiometer	09.021	09.022	09.023	09.024	09.025	09.026	09.027	09.028					
Offset speed reference	01.004	01.038	01.009										
Onboard PLC	11.047 to 11.051												
Open collector digital outputs	08.030												
Open loop vector mode	05.014	05.017	05.023										
Operating mode	00.048	11.031	03.024	05.014									
Orientation	13.010	13.013 to 13.015											
Output	05.001	05.002	05.003	05.004									
Overspeed threshold	03.008												
Phase angle	03.025	05.012											
PID controller	Menu 14												
Position feedback - drive	03.028	03.029	03.030	03.050									
Positive logic	08.029												
Power up parameter	11.022	11.021											
Precision reference	01.018	01.019	01.020	01.044									
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 autotune	05.016	05.008											
Regenerating	10.010	10.011	10.030	10.031	06.001	02.004	02.002	10.012	10.039	10.040			
Relative jog	13.017 to 13.019												
Relay output	08.007	08.017	08.027										
Reset	10.033	08.002	08.022	10.034	10.035	10.036	10.001						
RFC mode (encoder less CLV mode)	03.024	03.042	04.012	05.040									
S ramp	02.006	02.007											
Sample rates	05.018												
SAFE TORQUE OFF input	08.009	08.010	08.040										
Security code	11.030	11.044											
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	03.027	03.028	03.029	03.030	03.031	03.042						
Speed reference selection	01.014	01.015	01.049	01.050	01.001								
Status word	10.040												
Supply	06.044	05.005	06.046										
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							
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	06.046	05.005										
Warning	10.019	10.012	10.017	10.018	10.040								
Zero speed indicator bit	03.005	10.003											

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 the value listed below
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 the value listed below
Definition	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE[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	Open-loop mode If *Ramp Rate Units* (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 If *Ramp Rate Units* (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.0 x Pr **01.006** / 100.0 VM_ACCEL_RATE[MIN] = 0.0 RFC-A, RFC-S modes If *Ramp Rate Units* (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.000 If *Ramp Rate Units* (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.000 x Pr **01.006** / 1000.0 VM_ACCEL_RATE[MIN] = 0.000 If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006**.

VM_AMC_ROLL_OVER	Range applied the position parameters in the advanced motion controller
Units	User units
Range of [MIN]	0 or -2^{31}
Range of [MAX]	0 or $-2^{31}-1$
Definition	VM_AMC_ROLL_OVER[MAX] = $2^{31}-1$ VM_AMC_ROLL_OVER[MIN] = 2^{31}

VM_AMC_UNIPOLAR_ROLL_OVER	Range applied the position parameters in the advanced motion controller that are restricted to positive values
Units	User units
Range of [MIN]	0
Range of [MAX]	0 to 2^{31}-1
Definition	VM_AMC_UNIPOLAR_ROLL_OVER[MAX] = VM_AMC_ROLL_OVER[MAX] VM_AMC_UNIPOLAR_ROLL_OVER[MIN] = 0

VM_DC_VOLTAGE	Range applied to parameters showing DC Voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to the value listed below
Definition	VM_DC_VOLTAGE[MAX] is the full scale DC link voltage feedback (over voltage trip level) for the drive. This level is drive voltage rating dependent. See Table 11-4 VM_DC_VOLTAGE[MIN] = 0

VM_DC_VOLTAGE_SET	Range applied to DC Voltage reference parameters
Units	V
Range of [MIN]	0
Range of [MAX]	0 to the value listed below
Definition	VM_DC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_DC_VOLTAGE_SET[MIN] = 0

VM_DRIVE_CURRENT	Range applied to parameters showing current in A
Units	A
Range of [MIN]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) or Kc value for the drive and is given by *Full Scale Current Kc* (11.061). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]

VM_DRIVE_CURRENT_UNIPOLAR	Unipolar version of VM_DRIVE_CURRENT
Units	A
Range of [MIN]	0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT_UNIPOLAR[MAX] = VM_DRIVE_CURRENT[MAX] VM_DRIVE_CURRENT_UNIPOLAR[MIN] = 0.000

VM_HIGH_DC_VOLTAGE	Range applied to parameters showing high DC Voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1500
Definition	VM_HIGH_DC_VOLTAGE[MAX] is the full scale DC link voltage feedback for the high DC link voltage measurement which can measure the voltage if it goes above the normal full scale value. This level is drive voltage rating dependent. See Table 11-4 VM_HIGH_DC_VOLTAGE[MIN] = 0

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

VM_MOTOR1_CURRENT_LIMIT **VM_MOTOR2_CURRENT_LIMIT**	Range applied to current limit parameters
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0 **Open-loop** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos($\sin^{-1}$(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** sin ϕ I_{Trated} = Pr **05.007** x cos ϕ cos ϕ = Pr **05.010** I_{MaxRef} is 0.7 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty), otherwise it is the lower of 0.7 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty). **RFC-A** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos($\sin^{-1}$(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** x cos ϕ_1 ITrated = Pr 05.007 x sin ϕ_1 ϕ_1 = cos-1 (Pr **05.010**) + ϕ_2. ϕ_1 is calculated during an autotune. See the variable minimum / maximum calculations in the *Parameter Reference Guide* for more information regarding ϕ_2. I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty), otherwise it is the lower of 0.9 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty). **RFC-S and Regen** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{MaxRef} / Pr **05.007**) x 100 % Where: I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty), otherwise it is the lower of 0.9 x Pr **11.061** or 1.1 x Pr **11.060** (i.e. Normal duty). For VM_MOTOR2_CURRENT_LIMIT[MAX] use Pr **21.007** instead of Pr **05.007** and Pr **21.010** instead of Pr **05.010**.

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	See table below VM_NEGATIVE_REF_CLAMP2 is defined in the same way except that Pr **21.001** is used instead of Pr **01.006**.

***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_CLAMP	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	In open-loop mode VM_POSITIVE_REF_CLAMP[MAX] is fixed at 550.0 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. The limit is based on the position feedback device selected with *Motor Control Feedback Select* (03.026). It is possible to disable this limit if the *RFC Feedback Mode* (03.024) = 2 or 3 (i.e. VM_POSITIVE_REF_CLAMP[MAX] = 50000.0). The table below shows how VM_POSITIVE_REF_CLAMP[MAX] is defined for different feedback device types See table below In all modes VM_POSITIVE_REF_CLAMP[MIN] is fixed at 0.0

Feedback device	**VM_POSITIVE_REF_CLAMP[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 / linear sine wave pitch in mm) mm/s
Resolver	(1000 Hz x 60 / resolver pole pairs) rpm (1000 Hz / pole pitch in mm / resolver pole pairs) 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	VM_POWER[MAX] is rating dependent and is chosen to allow for the maximum power that can be output by the drive with maximum a.c. output voltage, at maximum controlled current and unity power factor. VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000 VM_POWER[MIN] = -VM_POWER[MAX]

VM_RATED_CURRENT	Range applied to rated current parameters
Units	A
Range of [MIN]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_RATED_CURRENT [MAX] = *Maximum Rated Current* (11.060) and is dependent on the drive rating. This is the Normal Duty rating of the drive. VM_RATED_CURRENT [MIN] = 0.00

VM_REGEN_REACTIVE	Range applied to the reactive current reference in Regen mode
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_REGEN_REACTIVE[MAX] = ?(VM_MOTOR1_CURRENT_LIMIT2 - ILimit2) where ILimit gives the highest level of the active current reference that can occur. This value is defined by the current limit values. If the current limits are all set to their maximum values (i.e. VM_MOTOR1_CURRENT_LIMIT) then there is no current capability left for the reactive current. However, if the current limits are reduced the resulting headroom can be used for the reactive current. ILimit is defined by a combination of all the current limits excluding any reduction of the current limit due to the motor thermal model. VM_REGEN_REACTIVE[MIN] = - VM_REGEN_REACTIVE[MAX]

VM_SPEED	Range applied to parameters showing speed
Units	Open-loop, RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop, RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop, RFC-A, RFC-S: 0.0 to 50000.0
Definition	This variable minimum/maximum defines the range of speed monitoring parameters. To allow headroom for overshoot the range is set to twice the range of the speed references. VM_SPEED[MAX] = 2 x VM_SPEED_FREQ_REF[MAX] VM_SPEED[MIN] = 2 x VM_SPEED_FREQ_REF[MIN]

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 3000.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	If Pr **01.008** = 0: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** If Pr **01.008** = 1: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** or |Pr **01.007**|, whichever is larger. If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006** and Pr **21.002** instead of Pr **01.007**. 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 Menu 1 reference parameters
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 3000.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_SPEED_FREQ_REF_UNIPOLAR[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]

If the second motor map is selected (Pr **11.045** = 1) Pr **21.002** is used instead of Pr **01.007**.

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	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	VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX] VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 11-4

VM_SWITCHING_FREQUENCY	Range applied the switching frequency parameters
Units	
Range of [MIN]	0
Range of [MAX]	6
Definition	VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent VM_SWITCHING_FREQUENCY[MIN] = 0

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	

***Select Motor 2 Parameters* (11.045)**	**VM_TORQUE_CURRENT [MAX]**
0	VM_MOTOR1_CURRENT_LIMIT[MAX]
1	VM_MOTOR2_CURRENT_LIMIT[MAX]

VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]

VM_TORQUE_CURRENT_UNIPOLAR	Unipolar version of VM_TORQUE_CURRENT
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX] VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0

VM_USER_CURRENT	Range applied to torque reference and percentage load parameters with one decimal place
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024) VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX]

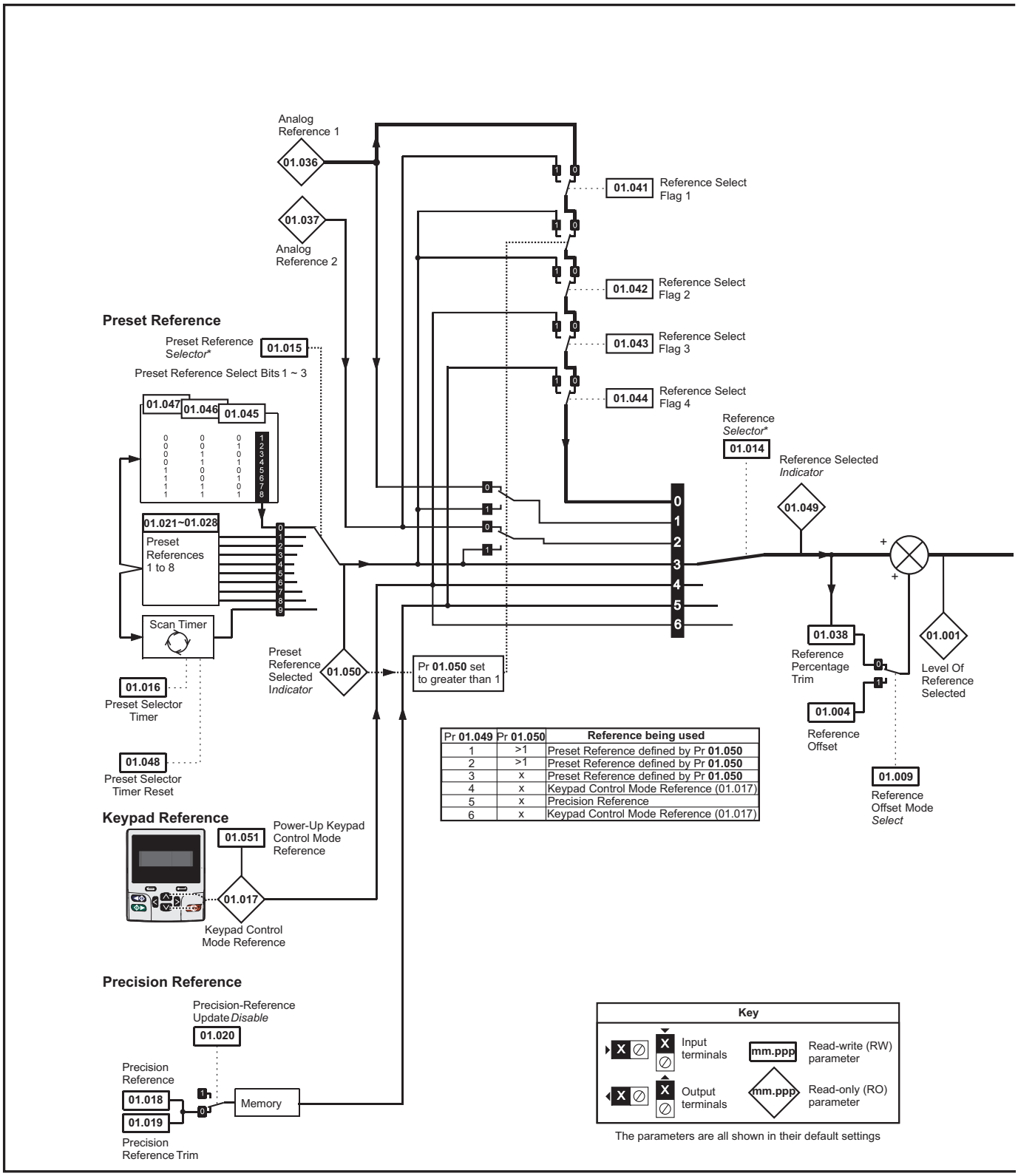
VM_USER_CURRENT_HIGH_RES	Range applied to torque reference and percentage load parameters with two decimal places
Units	%
Range of [MIN]	-1000.00 to 0.00
Range of [MAX]	0.0 to 1000.00
Definition	VM_USER_CURRENT_HIGH_RES[MAX] = *User Current Maximum Scaling* (04.024) with an additional decimal place VM_USER_CURRENT_HIGH_RES[MIN] = -VM_USER_CURRENT_HIGH_RES[MAX]

Table 11-4 Voltage ratings dependant values

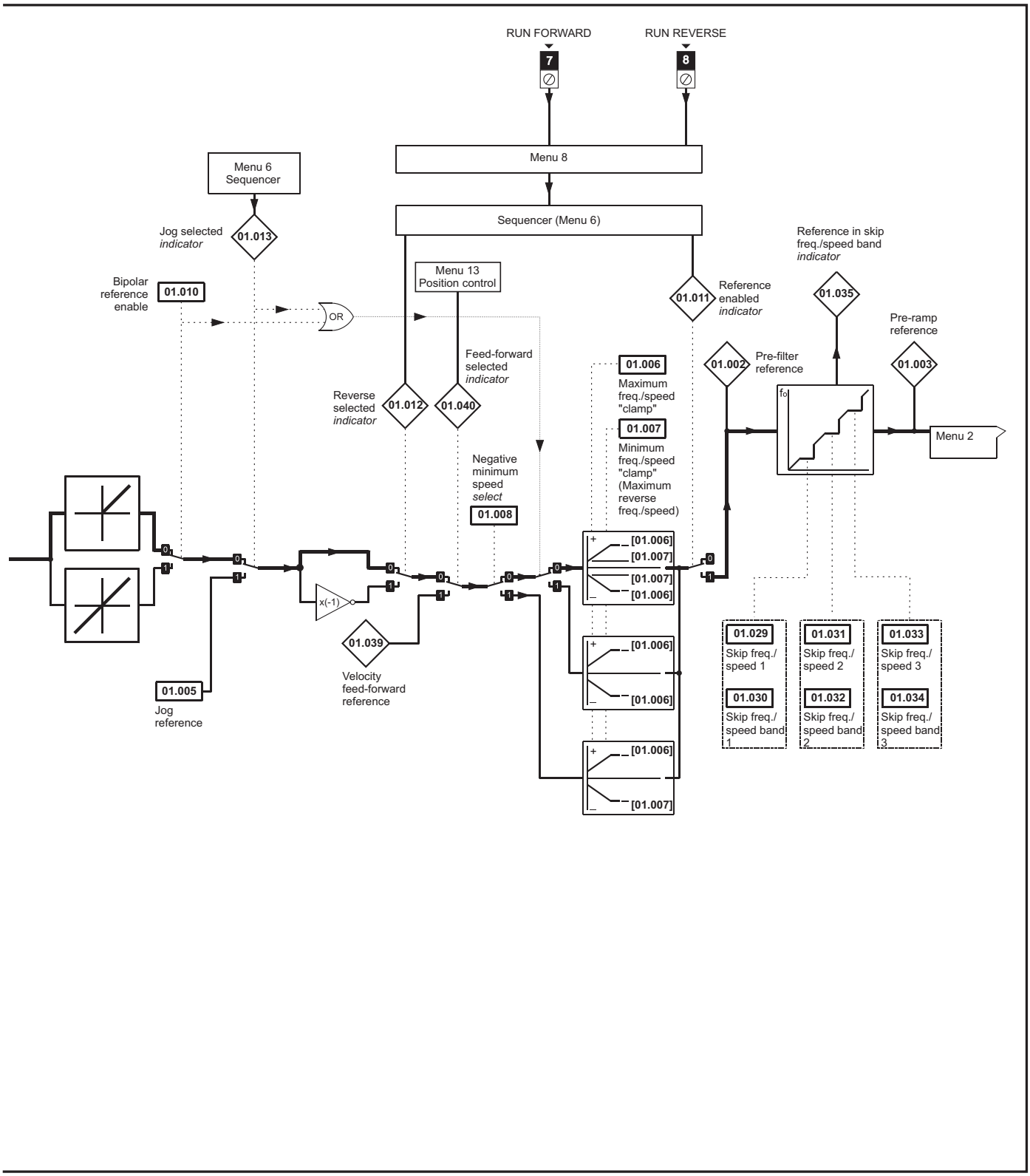
Variable min/max	**Voltage level (V)**			
	200 V	**400 V**	**575 V**	**690 V**
VM_DC_VOLTAGE_SET(MAX]	400	800	955	1150
VM_DC_VOLTAGE(MAX]	415	830	990	1190
VM_AC_VOLTAGE_SET(MAX]	240	480	575	690
VM_AC_VOLTAGE[MAX]	325	650	780	930
VM_STD_UNDER_VOLTS[MIN]	175	330	435	435
VM_SUPPLY_LOSS_LEVEL{MIN]	205	410	540	540
VM_HIGH_DC_VOLTAGE	1500	1500	1500	1500

11.1 Menu 1: Frequency / speed reference

Figure 11-1 Menu 1 logic diagram



Pr **01.049**	Pr **01.050**	Reference being used
1	>1	Preset Reference defined by Pr **01.050**
2	>1	Preset Reference defined by Pr **01.050**
3	x	Preset Reference defined by Pr **01.050**
4	x	Keypad Control Mode Reference (01.017)
5	x	Precision Reference
6	x	Keypad Control Mode Reference (01.017)

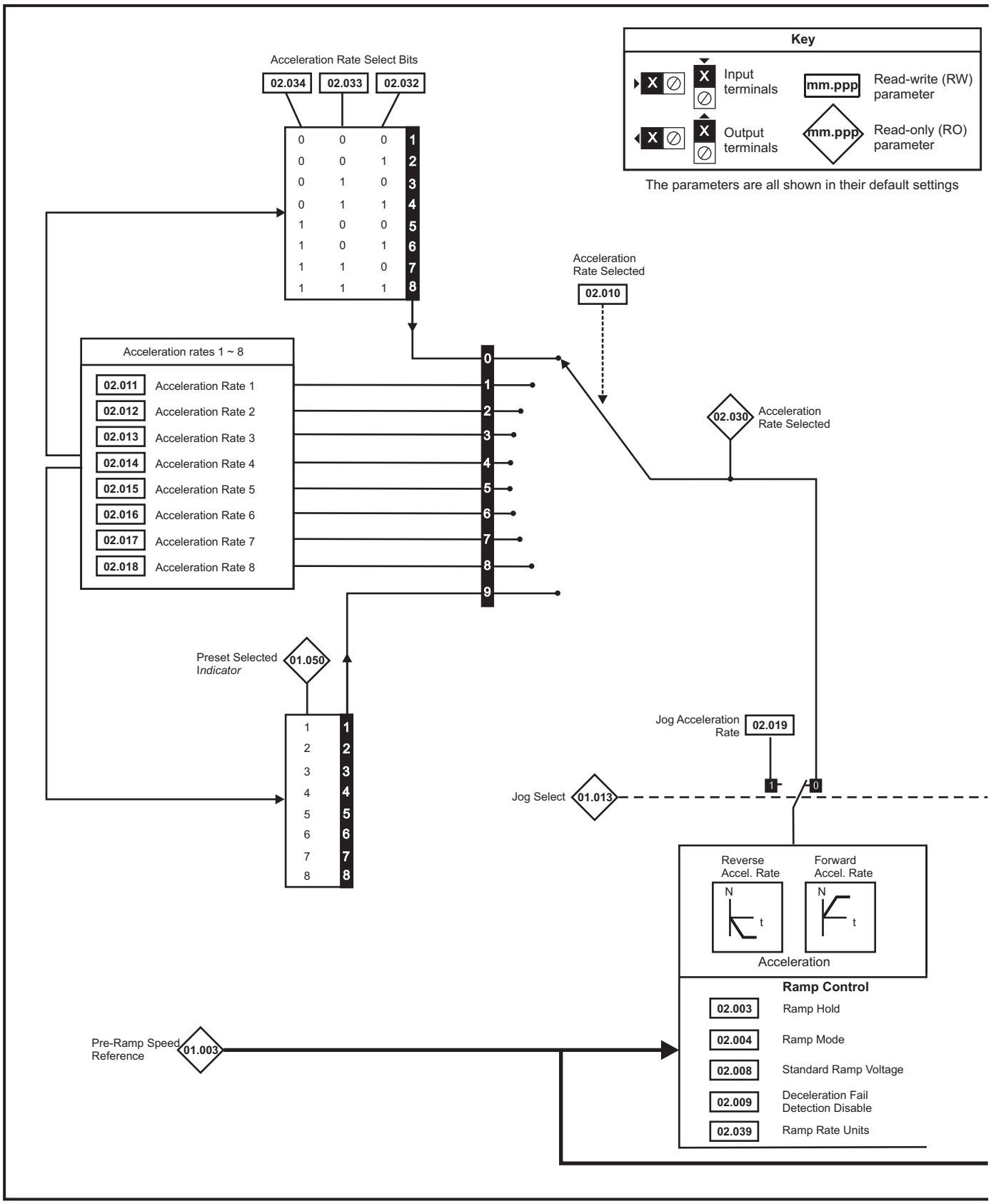

RUN FORWARD
RUN REVERSE
7
8
Menu 8
Menu 6 Sequencer
Sequencer (Menu 6)
Jog selected indicator
01.013
Bipolar reference enable
01.010
OR
Menu 13 Position control
01.011
Reference enabled indicator
Reference in skip freq./speed band indicator
01.035
Pre-ramp reference
01.003
01.002
Pre-filter reference
Feed-forward selected indicator
01.040
Reverse selected indicator
01.012
01.006
Maximum freq./speed "clamp"
01.007
Minimum freq./speed "clamp" (Maximum reverse freq./speed)
Negative minimum speed select
01.008
Menu 2
x(-1)
01.039
Velocity feed-forward reference
01.005
Jog reference
[01.006]
[01.007]
01.029
Skip freq./ speed 1
01.030
Skip freq./ speed band 1
01.031
Skip freq./ speed 2
01.032
Skip freq./ speed band 2
01.033
Skip freq./ speed 3
01.034
Skip freq./ speed band 3

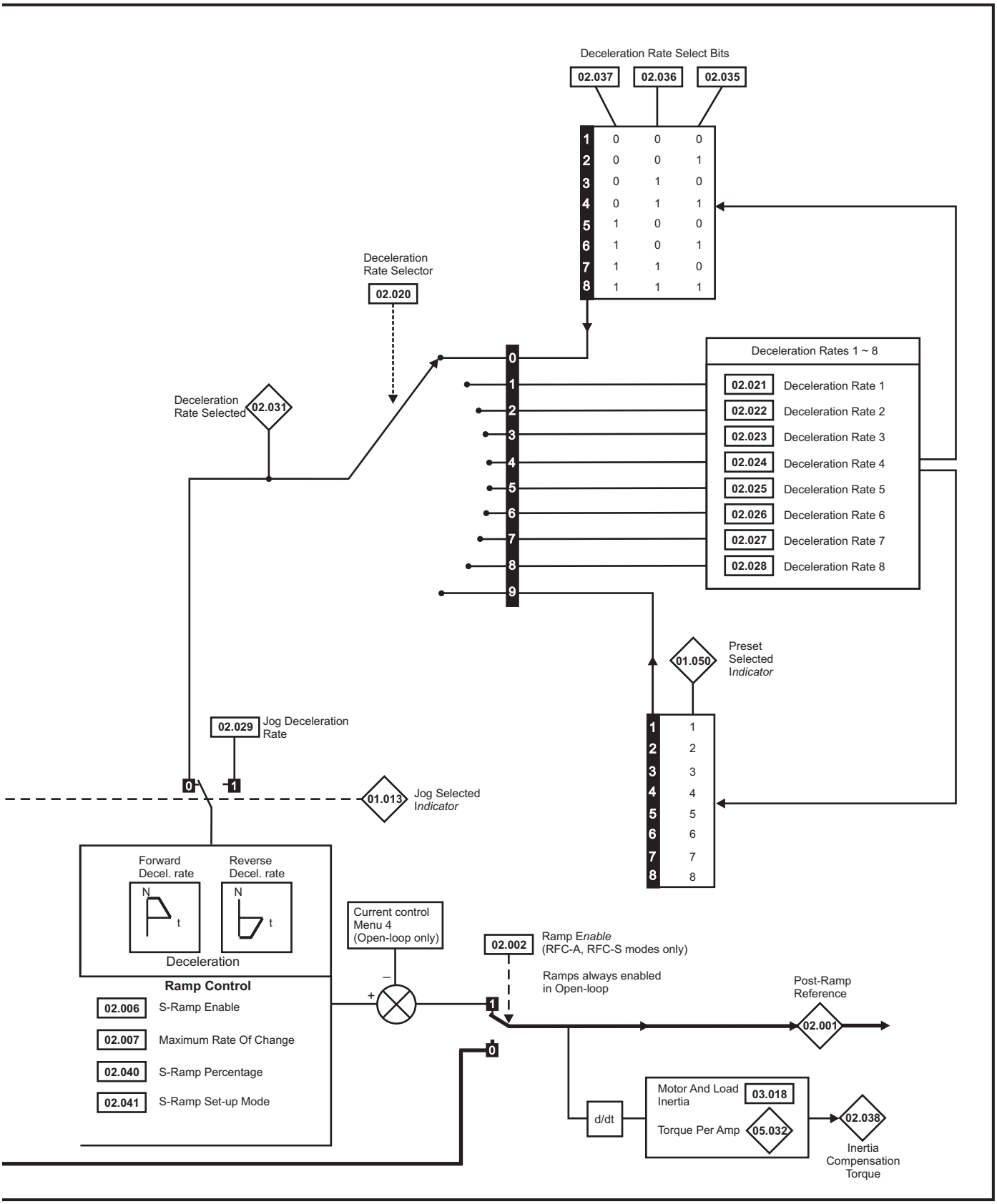
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
01.001	Reference Selected	±VM_SPEED_FREQ_REF Hz	±VM_SPEED_FREQ_REF rpm	0.0			RO	Num	ND	NC	PT	
01.002	Pre-Skip Filter Reference						RO	Num	ND	NC	PT	
01.003	Pre-Ramp Reference						RO	Num	ND	NC	PT	
01.004	Reference Offset						RW	Num				US
01.005	Jog Reference	0.0 - 400.0 Hz	0.0 - 4000.0 rpm				RW	Num				US
01.006	Maximum Reference Clamp	±VM_POSITIVE_REF_ CLAMP Hz	±VM_POSITIVE_REF_ CLAMP rpm	Eur: 50.0 USA: 60.0	Eur: 1500.0 USA: 1800.0	Eur: 3000.0 USA; 3000.0	RW	Num				US
01.007	Minimum Reference Clamp	±VM_NEGATIVE_REF_ CLAMP1	±VM_NEGATIVE_REF_ CLAMP1	0			RW	Num				US
01.008	Negative Reference Clamp	Off (0) or On (1)		Off (0)			RW	Bit				US
01.009	Reference Offset Select						RW	Bit				US
01.010	Bipolar Reference Enable						RW	Bit				US
01.011	Reference On						RO	Bit	ND	NC	PT	
01.012	Reverse Select						RO	Bit	ND	NC	PT	
01.013	Jog Select						RO	Bit	ND	NC	PT	
01.014	Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2) Preset (3), Keypad (4), Precision (5) Keypad Ref (6)		Preset (3)			RW	Txt	ND			US
01.015	Preset Selector	0 to 9		0			RW	Num				US
01.016	Preset Selector Time	0 to 400.0 s		10.0			RW	Num				US
01.017	Keypad Control Mode Reference	±VM_SPEED_FREQ_USER_REFS		0			RO	Num		NC	PT	PS
01.018	Precision Reference Coarse						RW	Num				US
01.019	Precision Reference Fine	0.000 to 0.099 Hz	0.000 to 0.099 rpm	0.000 to 0.099 rpm			RW	Num				us
01.020	Precision Reference Update Disable	Off (0) or On (1)					RW	Bit		NC		
01.021	Preset Reference 1	±VM_SPEED_FREQ_REF		0			RW	Num				US
01.022	Preset Reference 2						RW	Num				US
01.023	Preset Reference 3						RW	Num				US
01.024	Preset Reference 4						RW	Num				US
01.025	Preset Reference 5						RW	Num				US
01.026	Preset Reference 6						RW	Num				US
01.027	Preset Reference 7						RW	Num				US
01.028	Preset Reference 8						RW	Num				US
01.029	Skip Reference 1	0.0 to 3000.0 Hz	0.0 to 40, 000 rpm	0			RW	Num				US
01.030	Skip Reference Band 1	0.0 to 25.0 Hz	0.0 to 250 rpm				RW	Num				US
01.031	Skip Reference 2	0.0 to 3000.0 Hz	0.0 to 40, 000 rpm				RW	Num				US
01.032	Skip Reference Band 2	0.0 to 25.0 Hz	0.0 to 250 rpm				RW	Num				US
01.033	Skip Reference 3	0.0 to 3000.0 Hz	0.0 to 40, 000 rpm				RW	Num				US
01.034	Skip Reference Band 3	0.0 to 25.0 Hz	0.0 to 250 rpm				RW	Num				US
01.035	Reference In Rejection Zone	Off (0) or On (1)	Off (0) or On (1)	Off (0)			RO	Bit	ND	NC	PT	
01.036	Analog Reference 1	±VM_SPEED_FREQ_USER_ REFS Hz	±VM_SPEED_FREQ_USER_ REFS rpm	0.0			RO	Num		NC		
01.037	Analog Reference 2						RO	Num		NC		
01.038	Percentage Trim	±100.00 %		0.00			RW	Num		NC		
01.039	Speed Feed-forwards	±VM_SPEED_FREQ_REF		0.0			RO	Num	ND	NC	PT	
01.040	Speed Feed-forwards Select	Off (0) or On (1)		Off (0)			RO	Bit	ND	NC	PT	
01.041	Reference Select Flag 1						RO	Bit	ND	NC	PT	
01.042	Reference Select Flag 2						RO	Bit	ND	NC	PT	
01.043	Reference Select Flag 3						RO	Bit	ND	NC	PT	
01.044	Reference Select Flag 4						RO	Bit	ND	NC	PT	
01.045	Preset Select Flag 1						RO	Bit	ND	NC	PT	
01.046	Preset Select Flag 2						RO	Bit	ND	NC	PT	
01.047	Preset Select Flag 3						RO	Bit	ND	NC	PT	
01.048	Preset Selector Timer Reset						RO	Bit	ND	NC	PT	
01.049	Reference Selected Indicator	1 to 5		3			RO	Num	ND	NC	PT	
01.050	Preset Selected Indicator	1 to 8		1			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		0			RW	Num				
01.055	Linear Speed Select		Off (0) or On (1)		Off (0)		RW	Bit				
01.056	Linear Speed Selected						RW	Bit	ND	NC	PT	US
01.057	Force Reference Direction	None (0), Forward (1), Reverse (2)		None (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

11.2 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram




Deceleration Rate Select Bits
02.037
02.036
02.035
1 0 0 0
2 0 0 1
3 0 1 0
4 0 1 1
5 1 0 0
6 1 0 1
7 1 1 0
8 1 1 1
Deceleration Rate Selector
02.020
Deceleration Rate Selected
02.031
Deceleration Rates 1 ~ 8
02.021 Deceleration Rate 1
02.022 Deceleration Rate 2
02.023 Deceleration Rate 3
02.024 Deceleration Rate 4
02.025 Deceleration Rate 5
02.026 Deceleration Rate 6
02.027 Deceleration Rate 7
02.028 Deceleration Rate 8
01.050
Preset Selected Indicator
02.029
Jog Deceleration Rate
01.013
Jog Selected Indicator
Forward Decel. rate
Reverse Decel. rate
Deceleration
Ramp Control
02.006 S-Ramp Enable
02.007 Maximum Rate Of Change
02.040 S-Ramp Percentage
02.041 S-Ramp Set-up Mode
Current control Menu 4 (Open-loop only)
02.002
Ramp Enable (RFC-A, RFC-S modes only)
Ramps always enabled in Open-loop
Post-Ramp Reference
02.001
d/dt
Motor And Load Inertia
03.018
Torque Per Amp
05.032
02.038
Inertia Compensation Torque

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	0.0			RO	Num	ND	NC	PT	
02.002	Ramp Enable		Off (0) or On (1)		On (1)		RW	Bit				US
02.003	Ramp Hold	Off (0) or On (1)		Off (0)			RW	Bit				US
02.004	Ramp Mode	Fast (0), Standard (1), Std boost (2)	Fast (0), Standard (1)	Standard (1)			RW	Txt				US
02.005	Disable Ramp Output		Off (0) or On (1)		Off (0)		RW	Bit				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					US
02.008	Standard Ramp Voltage	±VM_DC_VOLTAGE_SET V		200 V drive : 375 V 400 V drive : 750 / 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) or On (1)	Off (0)			RW	Bit				US
02.010	Acceleration Rate Selector	0 to 9	0 to 9	0			RW	Num				US
02.011	Acceleration Rate 1	±VM_ACCEL_RATE s/100 Hz	±VM_ACCEL_RATE s/1000 rpm	5.0	2.000	0.200	RW	Num				US
02.012	Acceleration Rate 2						RW	Num				US
02.013	Acceleration Rate 3						RW	Num				US
02.014	Acceleration Rate 4						RW	Num				US
02.015	Acceleration Rate 5						RW	Num				US
02.016	Acceleration Rate 6						RW	Num				US
02.017	Acceleration Rate 7						RW	Num				US
02.018	Acceleration Rate 8						RW	Num				US
02.019	Jog Acceleration Rate			0.2	0.000		RW	Num				US
02.020	Deceleration Rate Selector	0 to 9		0			RW	Num				US
02.021	Deceleration Rate 1	±VM_ACCEL_RATE s/100 Hz	±VM_ACCEL_RATE s/1000 rpm	10.0	2.000	0.200	RW	Num				US
02.022	Deceleration Rate 2						RW	Num				US
02.023	Deceleration Rate 3						RW	Num				US
02.024	Deceleration Rate 4						RW	Num				US
02.025	Deceleration Rate 5						RW	Num				US
02.026	Deceleration Rate 6						RW	Num				US
02.027	Deceleration Rate 7						RW	Num				US
02.028	Deceleration Rate 8						RW	Num				US
02.029	Jog Deceleration Rate			0.2	0.000		RW	Num				US
02.030	Acceleration Rate Selected	0 to 8		0			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						RW	Bit		NC		
02.034	Acceleration Rate Select Bit 2						RW	Bit		NC		
02.035	Deceleration Rate Select Bit 0						RW	Bit		NC		
02.036	Deceleration Rate Select Bit 1						RW	Bit		NC		
02.037	Deceleration Rate Select Bit 2						RW	Bit		NC		
02.038	Inertia Compensation Torque		±1000.0 %		0.0 %		RO	Num	ND	NC	PT	
02.039	Ramp Rate Units	Off = 100 Hz (0) or On = Maximum frequency (1)	Off = 1000 rpm or 1000 mm/s (0) or On = Maximum frequency (1)	Off = 100 Hz (0)	Off = 1000 rpm or 1000 mm/s (0)		RW	BIt				US
02.040	S Ramp Percentage	0.0 to 50.0 %		0.0			RW					US
02.041	S Ramp Set-up Mode	0 to 2		0			RW	Num				US
02.042	Maximum Rate Of Change Of Acceleration 1	0.0 to 300.0	0.000 to 100.000	0.0	0.000		RW	Num				US
02.043	Maximum Rate Of Change Of Acceleration 2						RW	Num				US
02.044	Maximum Rate Of Change Of Acceleration 3						RW	Num				US
02.045	Maximum Rate Of Change Of Acceleration 4						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

11.3 Menu 3: Frequency slaving, speed feedback and speed control

Figure 11-3 Menu 3 Open-loop logic diagram

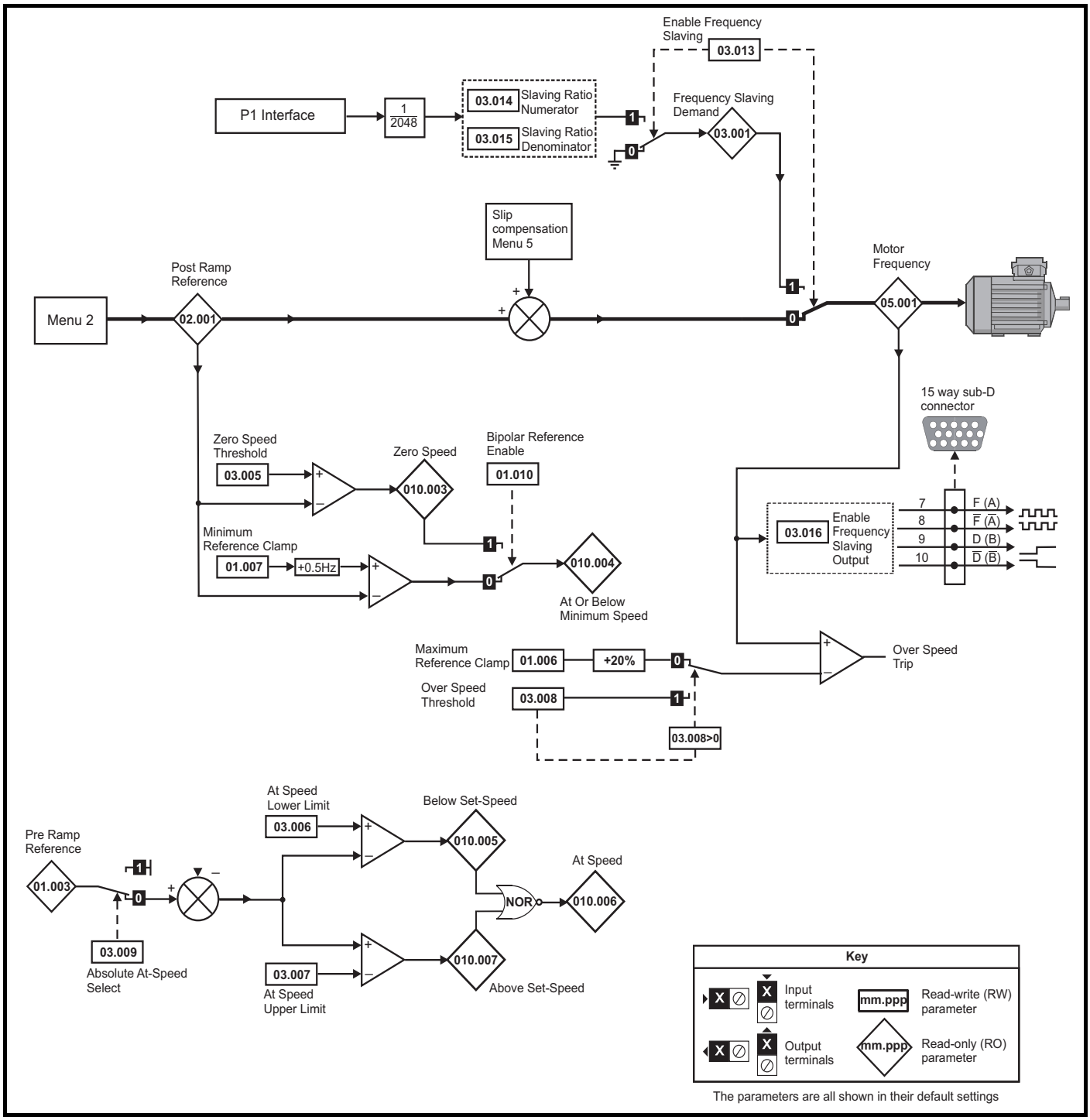
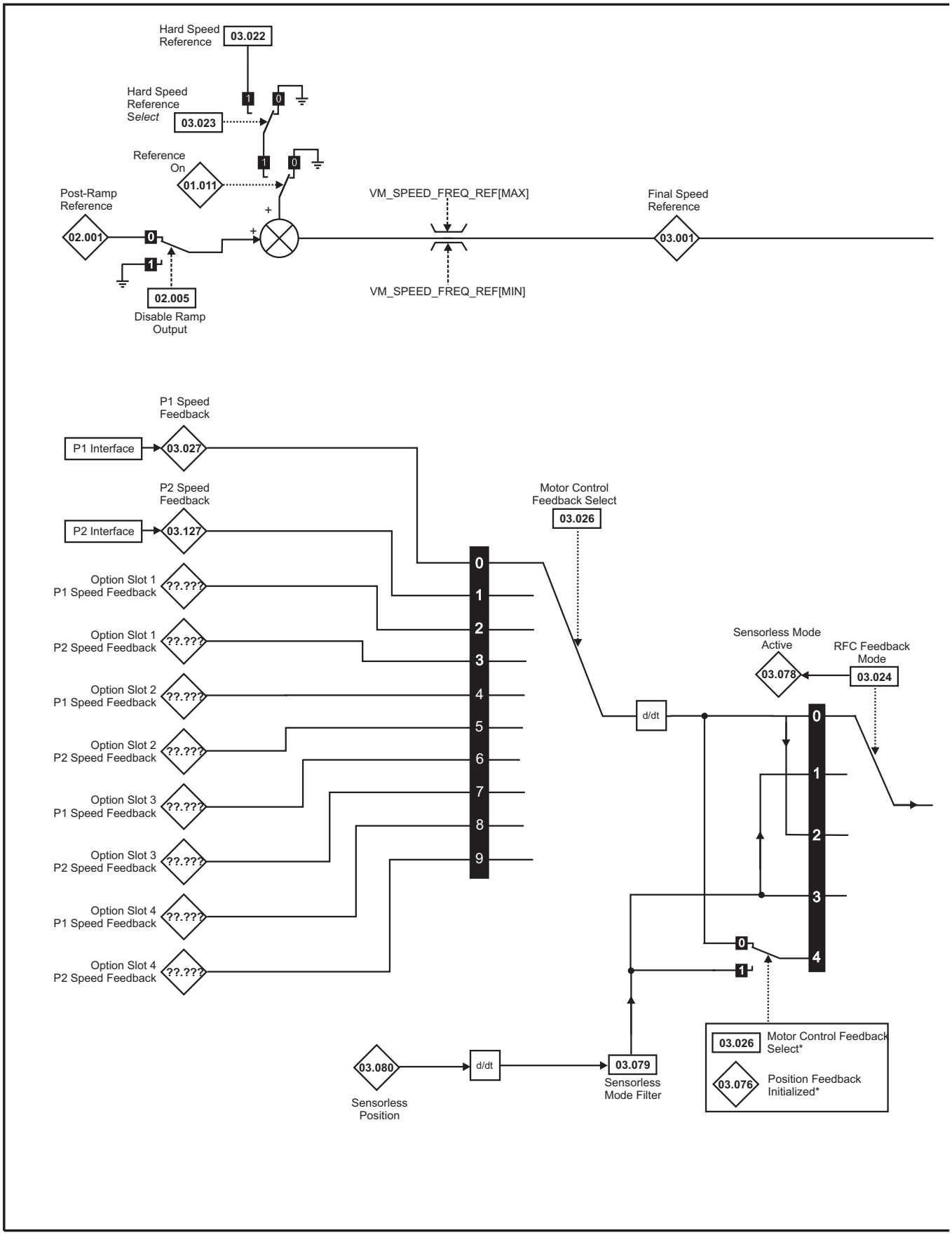


Figure 11-4 Menu 3 RFC-A, RFC-S logic diagram



NOTE

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

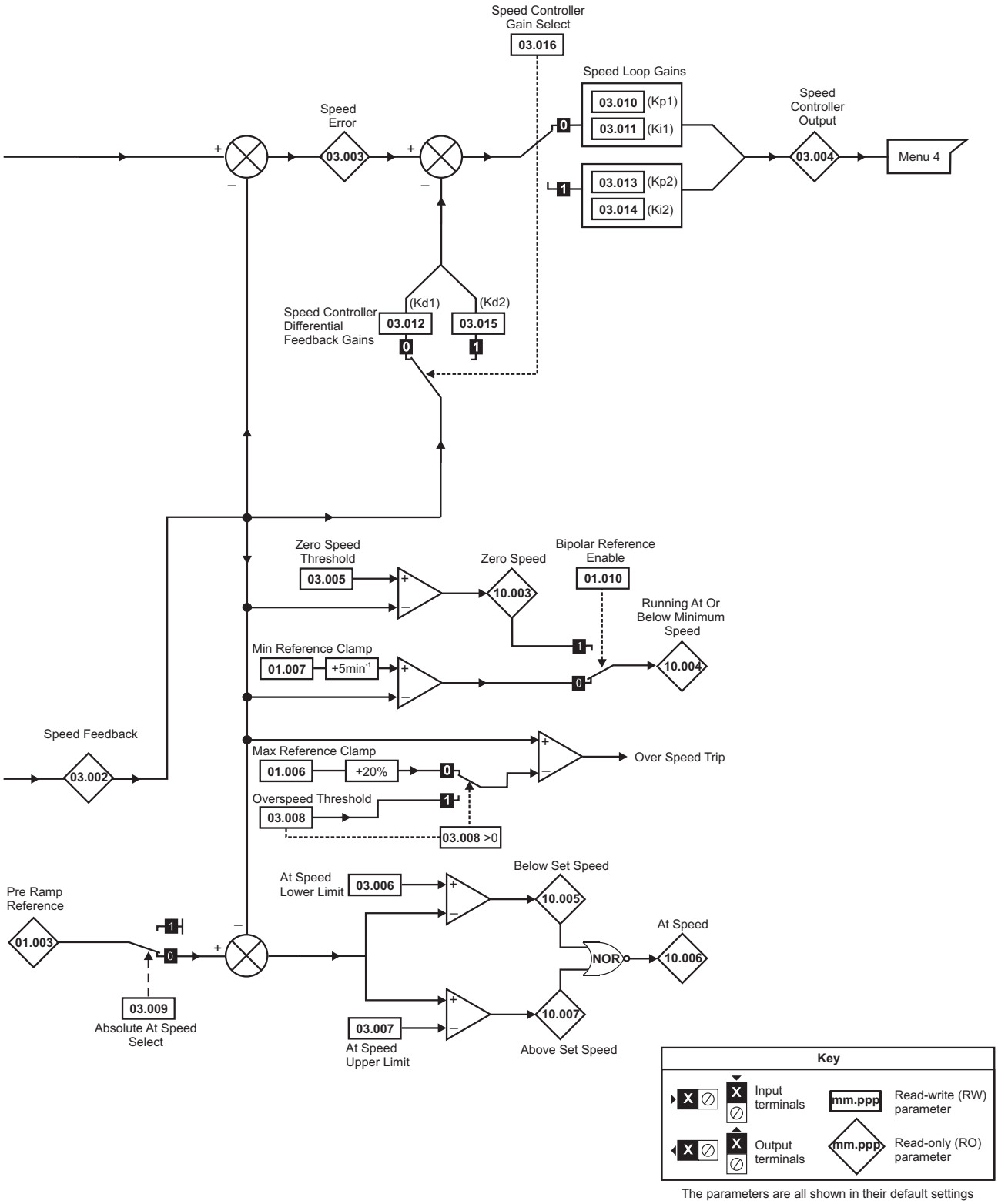

Speed Controller Gain Select
03.016
Speed Loop Gains
03.010 (Kp1)
03.011 (Ki1)
03.013 (Kp2)
03.014 (Ki2)
Speed Error
03.003
Speed Controller Output
03.004
Menu 4
Speed Controller Differential Feedback Gains
(Kd1)
(Kd2)
03.012
03.015
Zero Speed Threshold
03.005
Zero Speed
10.003
Bipolar Reference Enable
01.010
Running At Or Below Minimum Speed
10.004
Min Reference Clamp
01.007
+5min-1
Speed Feedback
03.002
Max Reference Clamp
01.006
+20%
Over Speed Trip
Overspeed Threshold
03.008
03.008 >0
Pre Ramp Reference
01.003
At Speed Lower Limit
03.006
Below Set Speed
10.005
At Speed
NOR
10.006
03.009
Absolute At Speed Select
03.007
At Speed Upper Limit
10.007
Above Set Speed
Key
Input terminals
Output terminals
mm.ppp
Read-write (RW) parameter
Read-only (RO) parameter
The parameters are all shown in their default settings

Figure 11-5 P1 Interface

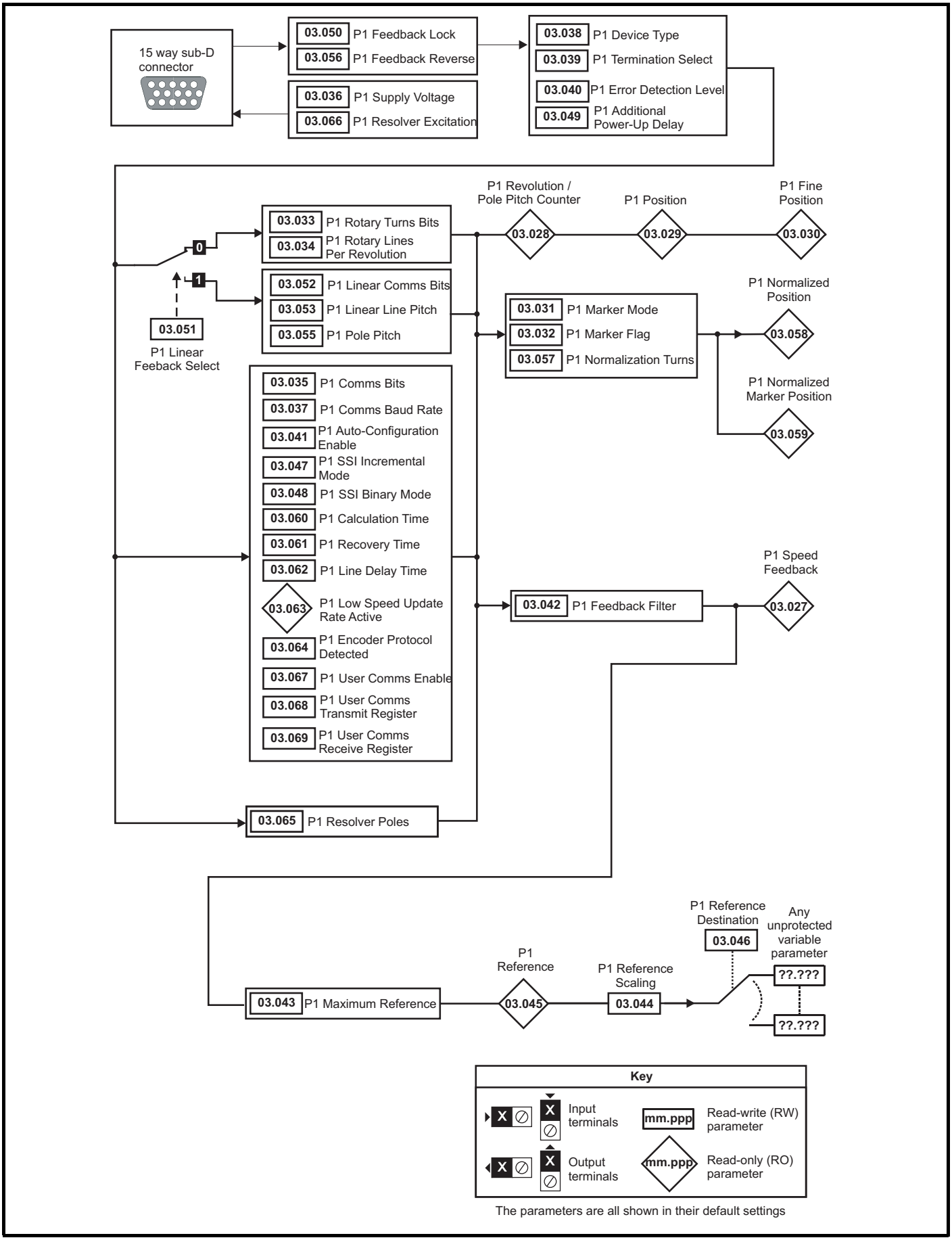


Figure 11-6 P2 Interface

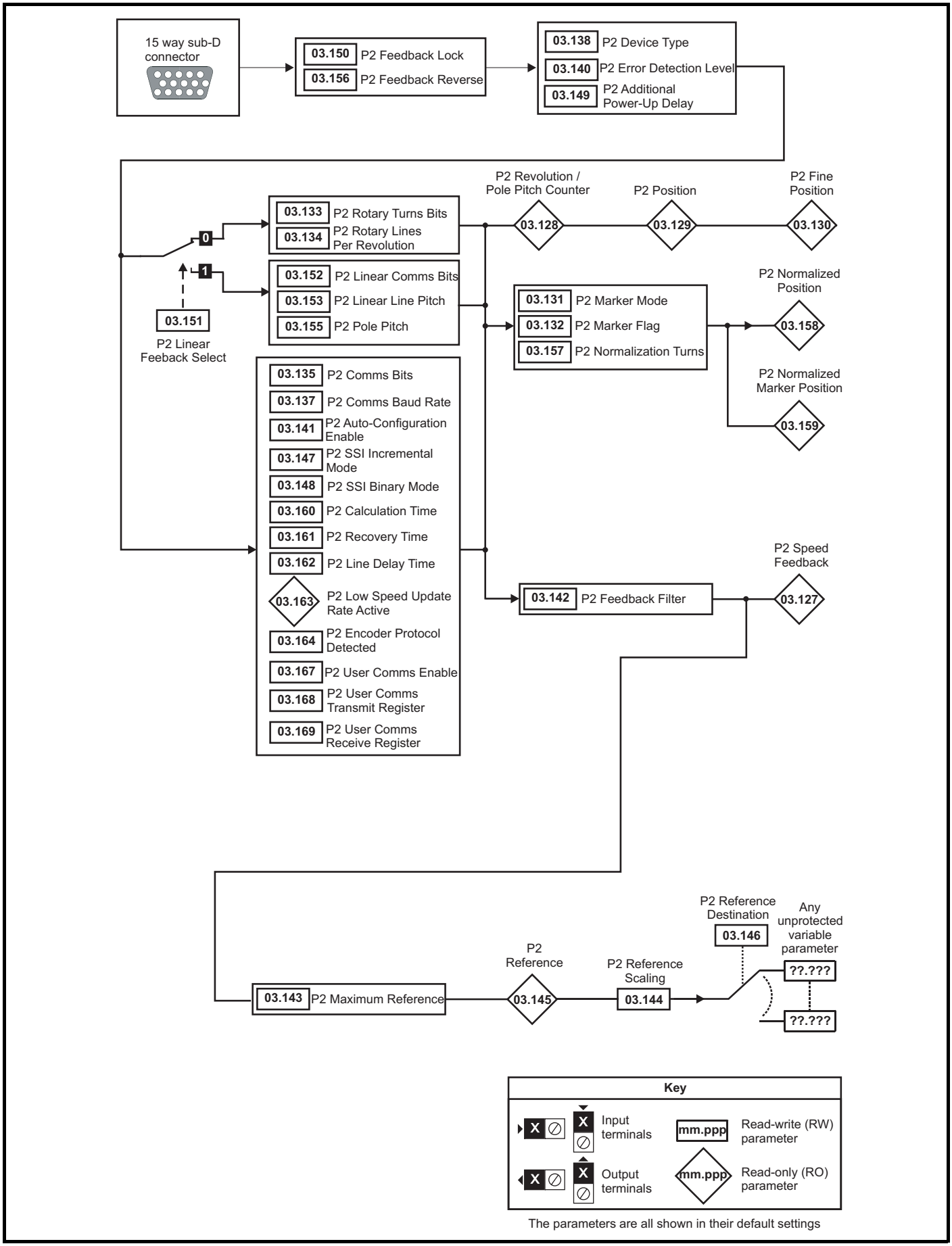
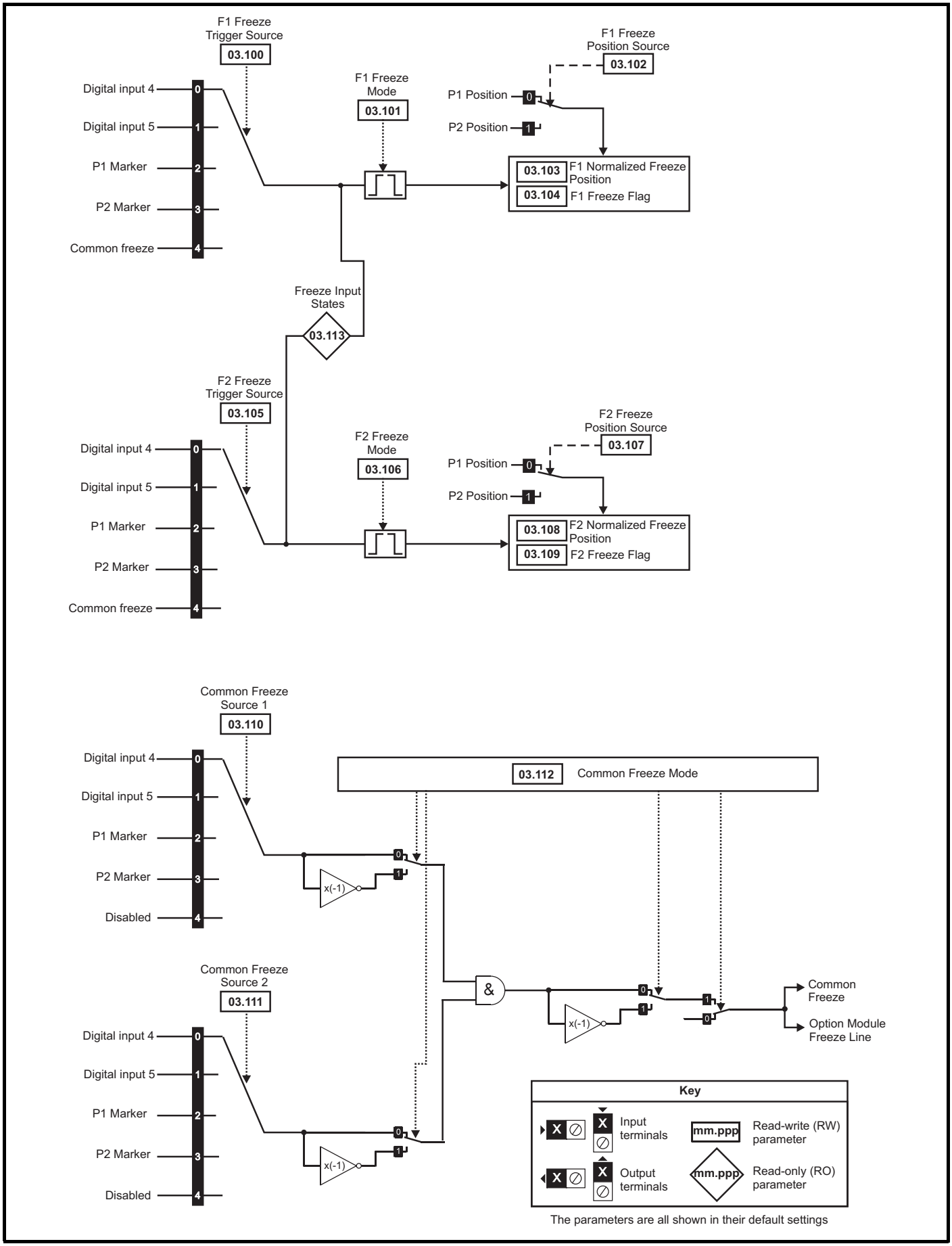


Figure 11-7 Freeze system logic



The parameters are all shown in their default settings

Figure 11-8 P1 Position feedback interface thermistor input

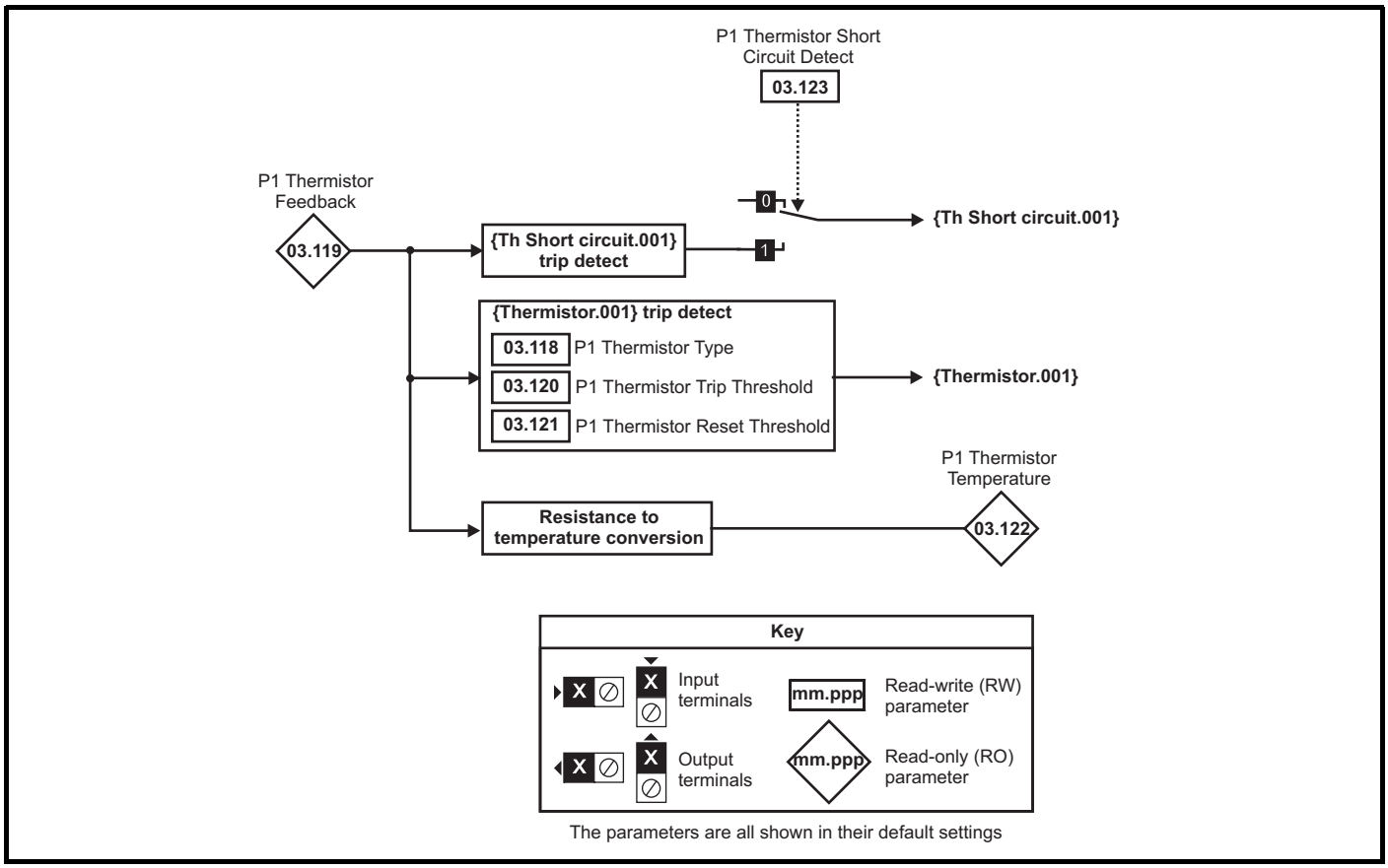
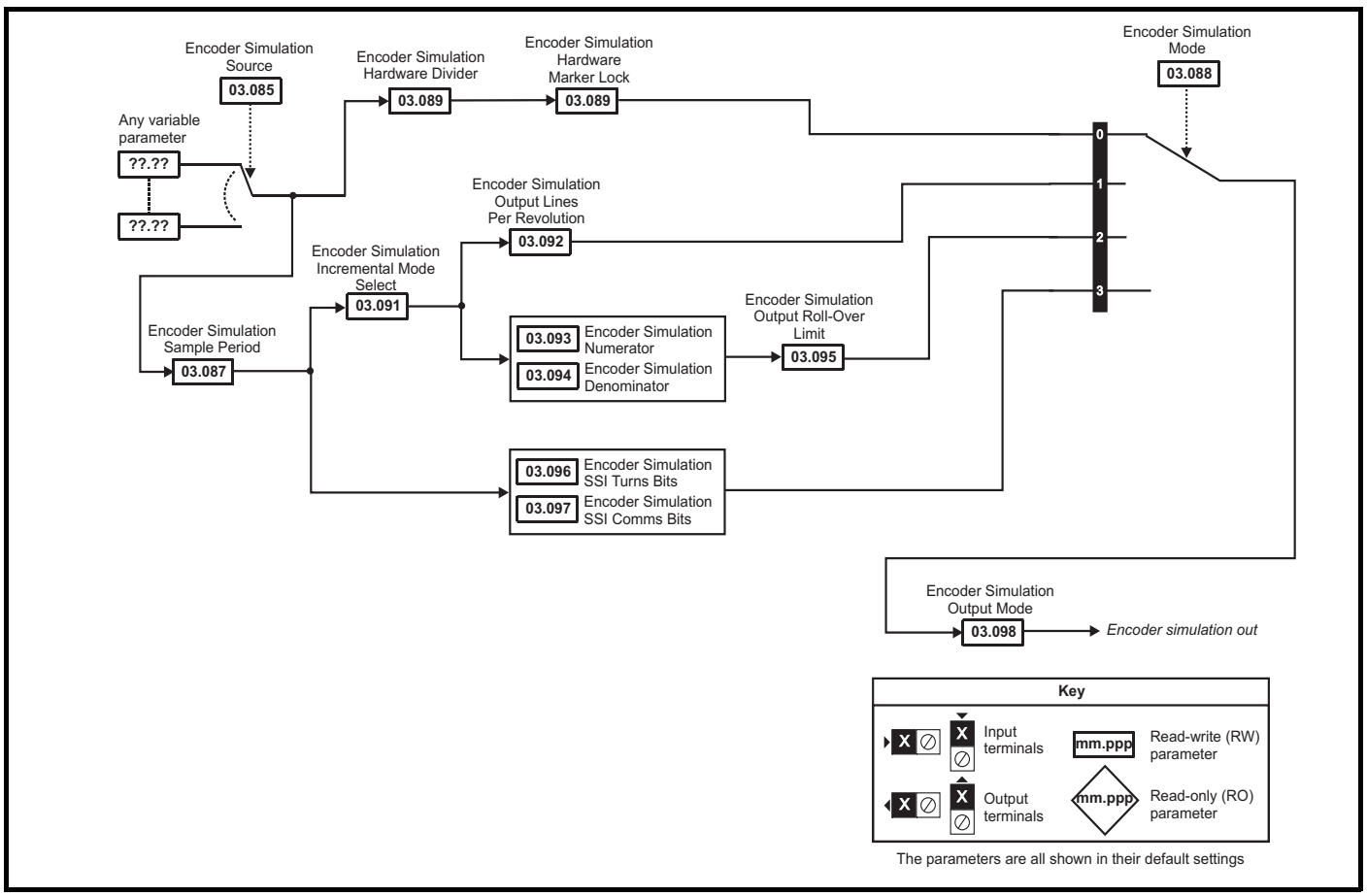


Figure 11-9 Encoder simulation



Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.001	Open-loop> Frequency Slaving Demand	±1000.0 Hz						RO	Num	ND	NC	PT	FI
	RFC> Final Speed Reference		±VM_SPEED					RO	Num	ND	NC	PT	FI
03.002	Speed Feedback							RO	Num	ND	NC	PT	FI
03.003	Speed Error							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					RW	Num				US
03.006	At Speed Lower Limit	0.0 to 3000.0 Hz	0 to 50000 rpm		1.0 Hz	5 rpm		RW	Num				US
03.007	At Speed Upper Limit							RW	Num				US
03.008	Over Speed Threshold				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	0.0100 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	1.00 s^2/rad	RW	Num				US
03.012	RFC> Speed Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
03.013	Open-loop> Enable Frequency Slaving	Off (0) or On (1)			Off (0)			RW	Bit				US
	RFC> Speed Controller Proportional Gain Kp2		0.0000 to 200.0000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
03.014	Open-loop> Slaving Ratio Numerator	0.000 to 1.000			1.000			RW	Num				US
	RFC> Speed Controller Integral Gain Ki2		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
03.015	Open-loop> Slaving Ratio Denominator	0.000 to 1.000			1.000			RW	Num				US
	RFC> Speed Controller Differential Feedback Gain Kd2		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
03.016	Open-loop> Reference Frame Angle	0 to 65535						RO	Num	ND	NC	PT	
	RFC> Speed Controller Gain Select		Off (0) or On (1)			Off (0)		RW	Bit				US
03.017	Speed Controller Set-up Method		Disabled (0), Bandwidth (1), Comp Angle (2), Kp Gain Times 16 (3), Low Performance (4), Std Performance (5), High Performance (6)			Disabled (0)		RW	Txt				US
03.018	Motor And Load Inertia		0.00000 to 1000.00000 kgm^2			0.00000 kgm^2		RW	Num				US
03.019	Compliance Angle		0.0 to 360.0 °			4.0 °		RW	Num				US
03.020	Bandwidth		0 to 1000 Hz			10 Hz		RW	Num				US
03.021	Damping Factor		0.0 to 10.0			1.0		RW	Num				US
03.022	Hard Speed Reference		±VM_SPEED_FREQ_REF	±VM_SPEED		0.0		RW	Num				US
03.023	Hard Speed Reference Select		Off (0) or On (1)			Off (0)		RW	Bit				US
03.024	RFC Feedback Mode		Feedback (0), Sensorless (1), Feedback NoMax (2), Sensorless NoMax (3), Automatic (4)			Feedback (0)		RW	Txt				US
03.025	Position Feedback Phase Angle			0.0 to 359.9 °			0.0 °	RW	Num	ND			US
03.026	Motor Control Feedback Select		P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), P1 Slot 3 (6), P2 Slot 3 (7), P1 Slot 4 (8), P2 Slot 4 (9)			P1 Drive (0)		RW	Txt				US
03.027	P1 Speed Feedback	±VM_SPEED						RO	Num	ND	NC	PT	FI
03.028	P1 Revolution/Pole Pitch Counter	0 to 65535						RO	Num	ND	NC	PT	
03.029	P1 Position	0 to 65535						RO	Num	ND	NC	PT	
03.030	P1 Fine Position	0 to 65535						RO	Num	ND	NC	PT	
03.031	P1 Marker Mode	0 to 15			0			RW	Bin				US
03.032	P1 Marker Flag	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.033	P1 Rotary Turns Bits	0 to 16			16			RW	Num				US
03.034	P1 Rotary Lines Per Revolution	1 to 100000			1024		4096	RW	Num				US
03.035	P1 Comms Bits	0 to 48			0			RW	Num				US
03.036	P1 Supply Voltage	5V (0), 8V (1), 15V (2)			5V (0)			RW	Txt				US
03.037	P1 Comms Baud Rate	100K (0), 200K (1), 300K (2), 400K (3), 500K (4), 1M (5), 1.5M (6), 2M (7), 4M (8)			300K (2)			RW	Txt				US

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.038	P1 Device Type	AB (0), FD (1), FR (2), AB Servo (3), FD Servo (4), FR Servo (5), SC (6), SC Hiperface (7), EnDat (8), SC EnDat (9), SSI (10), SC SSI (11), SC Servo (12), BiSS (13), Resolver (14), SC SC (15), Commutation Only (16)			AB (0)		AB Servo (3)	RW	Txt				US
03.039	P1 Termination Select	0 to 2			1			RW	Num				US
03.040	P1 Error Detection Level	0 to 15			0	1		RW	Bin				US
03.041	P1 Auto-configuration Select	Disabled (0) or Enabled (1)			Enabled (1)			RW	Txt				US
03.042	P1 Feedback Filter	Disabled (0), 1 (1), 2 (2), 4 (3), 8 (4), 16 (5) ms			Disabled (0)			RW	Txt				US
03.043	P1 Maximum Reference	0 to 50000 rpm			1500 rpm		3000 rpm	RW	Num				US
03.044	P1 Reference Scaling	0.000 to 4.000			1.000			RW	Num				US
03.045	P1 Reference	±100.0 %			0.0 %			RO	Num	ND	NC	PT	FI
03.046	P1 Reference destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
03.047	P1 SSI Incremental Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.048	P1 SSI Binary Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.049	P1 Additional Power-up Delay	0.0 to 25.0 s			0.0 s			RW	Num				US
03.050	P1 Feedback Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.051	P1 Linear Feedback Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.052	P1 Linear Comms Pitch	0.001 to 100.000			0.001			RW	Num				US
03.053	P1 Linear Line Pitch	0.001 to 100.000			0.001			RW	Num				US
03.054	P1 Linear Comms And Line Pitch Units	millimetres (0) or micrometres (1)			millimetres (0)			RW	Txt				US
03.055	P1 Pole Pitch	0.01 to 1000.00 mm			10.00 mm			RW	Num				US
03.056	P1 Feedback Reverse	Off (0) or On (1)			Off (0)			RW	Bit				US
03.057	P1 Normalization Turns	0 to 16			16			RO	Num				US
03.058	P1 Normalized Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.059	P1 Normalized Marker Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.060	P1 Calculation Time	0 to 20 µs			5 µs			RW	Num				US
03.061	P1 Recovery Time	5 to 100 µs			30 µs			RW	Num				US
03.062	P1 Line Delay Time	0 to 5000 ns			0 ns			RW	Num				US
03.063	P1 Low Speed Update Rate Active	Off (0) or On (1)			Off (0)			RO	Bit	ND	NC	PT	
03.064	P1 Encoder Protocol Detected	None (0), Hiperface (1), EnDat 2.1 (2), EnDat 2.2 (3), BiSS (4)			None (0)			RW	Txt	ND	NC	PT	
03.065	P1 Resolver Poles	2 Pole (1) to 8 Pole (4)			2 Pole (1)			RW	Txt				US
03.066	P1 Resolver Excitation	6V Auto (0), 4V Auto (1), 6V 6kHz (2), 4V 6kHz (3), 6V 8kHz (4), 4V 8kHz (5)			6V Auto (0)			RW	Txt				US
03.067	P1 User Comms Enable	0 to 2			0			RW	Num				US
03.068	P1 User Comms Transmit Register	0 to 65535			0			RW	Num				
03.069	P1 User Comms Receive register	0 to 65535			0			RW	Num				
03.070	P1 Position Feedback Signals	0 to 63						RO	Num	ND	NC	PT	
03.071	P1 Error Detected	Off (0) or On (1)			Off (0)			RW	Bit	ND	NC	PT	
03.075	Initialise Position Feedback	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.076	Position Feedback Initialized	0 to 1023			0			RO	Bin		NC	PT	
03.078	Sensorless Mode Active		Off (0) or On (1)					RO	Bit	ND	NC	PT	
03.079	Sensorless Mode Filter		4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms			4 (0) ms		RW	Txt				US
03.080	Sensorless Position		-2^{31} to $+2^{31}-1$					RO	Num	ND	NC	PT	
03.083	Full Motor Object Nameplate Transfer	Off (0) or On (1)			Off (0)			RW	Bit				US
03.085	Encoder Simulation Source	0.000 to 59.999			3.016	0.000		RW	Num			PT	US
03.086	Encoder Simulation Status	None (0), Full (1), No Marker Pulse (2)						RO	Txt	ND	NC	PT	
03.087	Encoder Simulation Sample Period	0.25 (0), 1 (1), 4, (2), 16 (3) ms			4 (2) ms	0.25 (0) ms		RW	Txt				US
03.088	Encoder Simulation Mode	Hardware (0), Lines Per Rev (1), Ratio (2), SSI (3)			Lines Per Rev (1)	Hardware (0)		RW	Txt				US
03.089	Encoder Simulation Hardware Divider	0 to 7			0			RW	Num				US
03.090	Encoder Simulation Hardware Marker Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.091	Encoder Simulation Incremental Mode Select	Off (0) or On (1)			On (1)	Off (0)		RW	Bit				US
03.092	Encoder Simulation Output Lines Per Revolution	1 to 16384			1024	4096		RW	Num				US
03.093	Encoder Simulation Numerator	1 to 65536			65536			RW	Num				US
03.094	Encoder Simulation Denominator	1 to 65536			65536			RW	Num				US

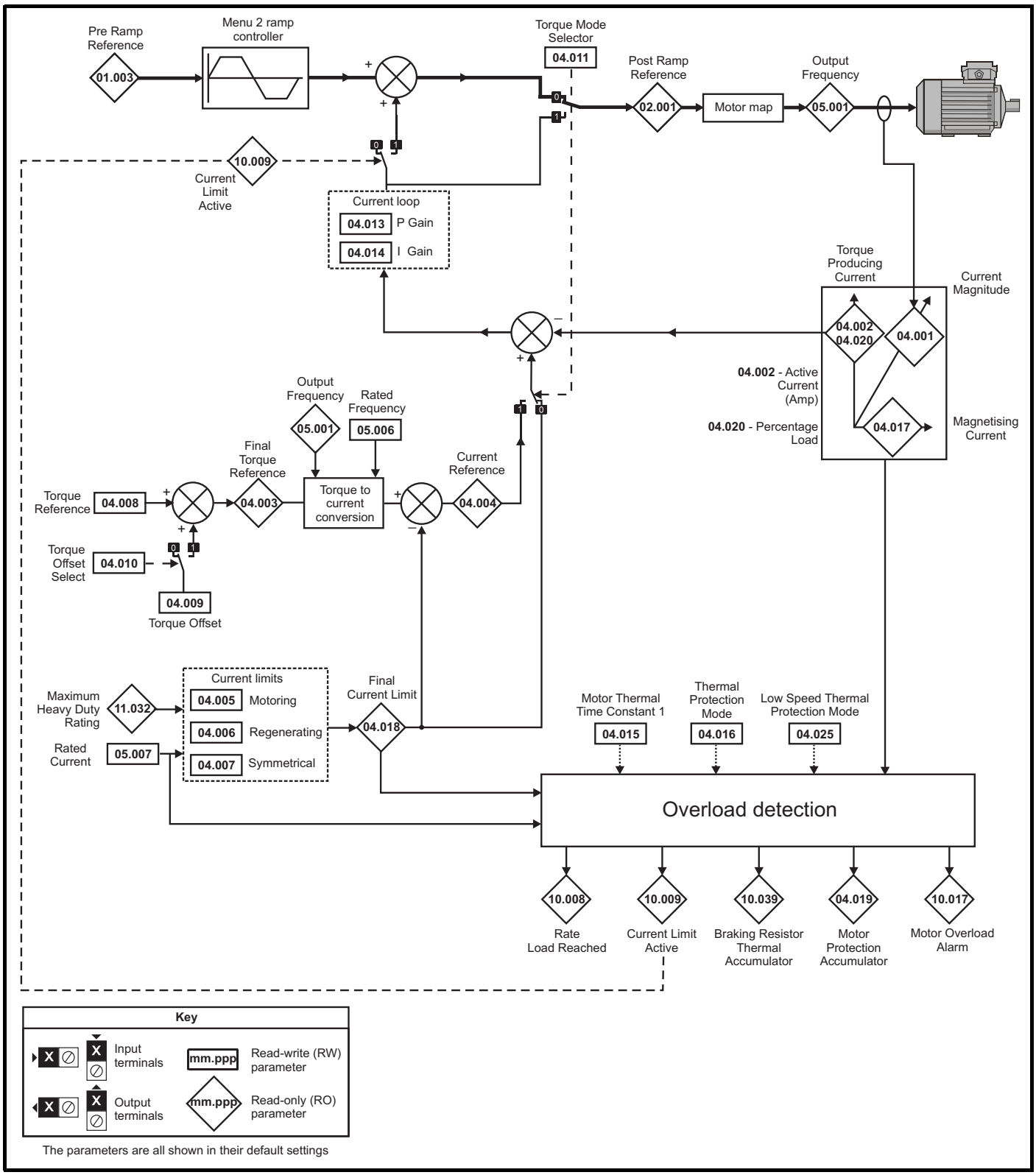
Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.095	Encoder Simulation Output Roll-over Limit	1 to 65535			65535			RW	Num				US
03.096	Encoder Simulation SSI Turns Bits	0 to 16			16			RW	Num				US
03.097	Encoder Simulation SSI Position Bits	2 to 48			33			RW	Num				US
03.098	Encoder Simulation Output Mode	AB/Gray (0), FD/Binary (1), FR/Binary (2)			AB/Gray (0)			RW	Txt				US
03.100	F1 Freeze Trigger Source	Dig I/O 4 (0), Dig I/O 5 (1), Z1 (2), Z2 (3), Common (4)			Dig I/O 4 (0)			RW	Txt				US
03.101	F1 Freeze Mode	Rising 1st (0), Falling 1st (1), Rising all (2), Falling all (3)			Rising 1st (0)			RW	Txt				US
03.102	F1 Freeze Position Source	P1 (0) or P2 (1)			P1 (0)			RW	Txt				US
03.103	F1 Normalized Freeze Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.104	F1 Freeze Flag	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.105	F2 Freeze Trigger Source	Dig I/O 4 (0), Dig I/O 5 (1), Z1 (2), Z2 (3), Common (4)			Dig I/O 4 (0)			RW	Txt				US
03.106	F2 Freeze Mode	Rising 1st (0), Falling 1st (1), Rising all (2), Falling all (3)			Rising 1st (0)			RW	Txt				US
03.107	F2 Freeze Position Source	P1 (0) or P2 (1)			P1 (0)			RW	Txt				US
03.108	F2 Normalized Freeze Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.109	F2 Freeze Flag	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.110	Common Freeze Source 1	Dig I/O 4 (0), Dig I/O 5 (1), Z1 (2), Z2 (3),Disabled (4)			Dig I/O 4 (0)			RW	Txt				US
03.111	Common Freeze Source 2	Dig I/O 4 (0), Dig I/O 5 (1), Z1 (2), Z2 (3),Disabled (4)			Dig I/O 4 (0)			RW	Txt				US
03.112	Common Freeze Mode	Bit 0: Source 1 input invert Bit 1: Source 2 input invert Bit 2: Output invert Bit 3: Output enable			0			RW	Bin				US
03.113	Freeze Input States	0 to 3						RO	Num	ND	NC	PT	
03.118	P1 Thermistor Type	DIN44082 (0), KTY84-T (1), 0.5mA-T (2), 2.0mA-T (3), KTY84 (4), 0.5mA (5), 2.0mA (6)			DIN44082 (0)			RW	Txt				US
03.119	P1 Thermistor Feedback	0 to 10000 Ω						RO	Num	ND	NC	PT	
03.120	P1 Thermistor Trip Threshold	0 to 10000 Ω			3300 Ω			RW	Num				US
03.121	P1 Thermistor Reset Threshold	0 to 10000 Ω			1800 Ω			RW	Num				US
03.122	P1 Thermistor Temperature	-50.0 to 300.0 °C						RO	Num	ND	NC	PT	
03.123	P1 Thermistor Short Circuit Detect	Off (0) or On (1)			Off (0)			RW	Bit				US
03.127	P2 Speed Feedback	±VM_SPEED						RO	Num	ND	NC	PT	FI
03.128	P2 Revolution/Pole Pitch Counter	0 to 65535						RO	Num	ND	NC	PT	
03.129	P2 Position	0 to 65535						RO	Num	ND	NC	PT	
03.130	P2 Fine Position	0 to 65535						RO	Num	ND	NC	PT	
03.131	P2 Marker Mode	0 to 15			0			RW	Bin				US
03.132	P2 Marker Flag	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.133	P2 Rotary Turns Bits	0 to 16			16			RW	Num				US
03.134	P2 Rotary Lines Per Revolution	1 to 100000			1024		4096	RW	Num				US
03.135	P2 Comms Bits	0 to 48			0			RW	Num				US
03.137	P2 Comms Baud Rate	100K (0), 200K (1), 300K (2), 400K (3), 500K (4), 1M (5), 1.5M (6), 2M (7), 4M (8)			300K (2)			RW	Txt				US
03.138	P2 Device type	None (0), AB (1), FD (2), FR (3), EnDat (4), SSI (5), BiSS (6)			None (0)			RW	Txt				US
03.140	P2 Error Detection Level	0 to 15			1			RW	Bin				US
03.141	P2 Auto-configuration Select	Disabled (0), Enabled (1), No Baud Rate (2)			Enabled (1)			RW	Txt				US
03.142	P2 Feedback Filter	Disabled (0), 1 (1), 2 (2), 4 (3), 8 (4), 16 (5) ms			Disabled (0)			RW	Txt				US
03.143	P2 Maximum Reference	0 to 50000 rpm			1500 rpm		3000 rpm	RW	Num				US
03.144	P2 Reference Scaling	0.000 to 4.000			1.000			RW	Num				US
03.145	P2 Reference	±100.0 %			0.0 %			RO	Num	ND	NC	PT	FI
03.146	P2 Reference Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
03.147	P2 SSI Incremental Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.148	P2 SSI Binary Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.149	P2 Additional Power-up Delay	0.0 to 25.0 s			0.0 s			RW	Num				US
03.150	P2 Feedback Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.151	P2 Linear Feedback Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.152	P2 Linear Comms Pitch	0.001 to 100.000			0.001			RW	Num				US
03.153	P2 Linear Line Pitch	0.001 to 100.00			0.001			RW	Txt				US
03.154	P2 Linear Comms And Line Pitch Units	Millimetres (0) or Micrometres (1)			Millimetres (0)			RW	Txt				US
03.155	P2 Pole Pitch	0.01 to 1000.00 mm			10.00 mm			RW	Num				US
03.156	P2 Feedback Reverse	Off (0) or On (1)			Off (0)			RW	Bit				US

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.157	P2 Normalization Turns	0 to 16			16			RO	Num				US
03.158	P2 Normalized Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.159	P2 Normalized Marker Position	-2^{31} to $+2^{31}-1$						RO	Num	ND	NC	PT	
03.160	P2 Calculation Time	0 to 20 µs			5 µs			RW	Num				US
03.161	P2 Recovery Time	5 to 100 µs			30 µs			RW	Num				US
03.162	P2 Line Delay Time	0 to 5000 ns			0 ns			RW	Num				US
03.163	P2 Low Speed Update Rate Active	Off (0) or On (1)			Off (0)			RO	Bit	ND	NC	PT	
03.164	P2 Encoder Protocol Detected	None (0), Hiperface (1), EnDat 2.1 (2), EnDat 2.2 (3), BiSS (4)			None (0)			RW	Txt	ND	NC	PT	
03.167	P2 User Comms Enable	0 to 2			0			RW	Num				US
03.168	P2 User Comms Transmit Register	0 to 65535			0			RW	Num				
03.169	P2 User Comms Receive Register	0 to 65535			0			RW	Num				
03.171	P2 Error Detected	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.172	P2 Status	None (0), AB (1), FD (2), FR (3), EnDat (4), SSI (5), BiSS (6), EnDat Alt (7), SSI Alt (8), BiSS Alt (9)						RO	Txt	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

11.4 Menu 4: Torque and current control

Figure 11-10 Menu 4 Open loop logic diagram



The parameters are all shown in their default settings

Figure 11-11 Menu 4 RFC-A logic diagram

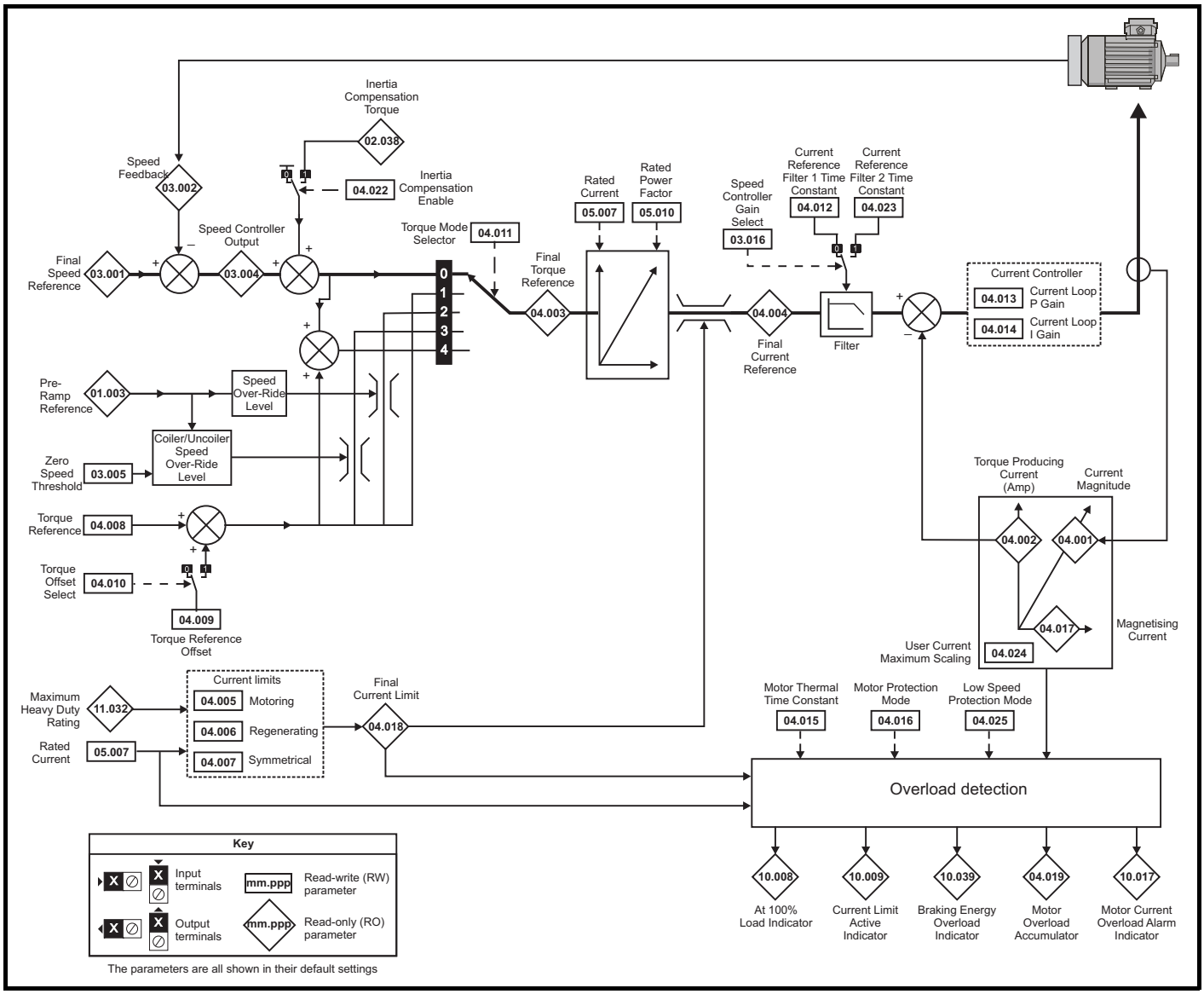
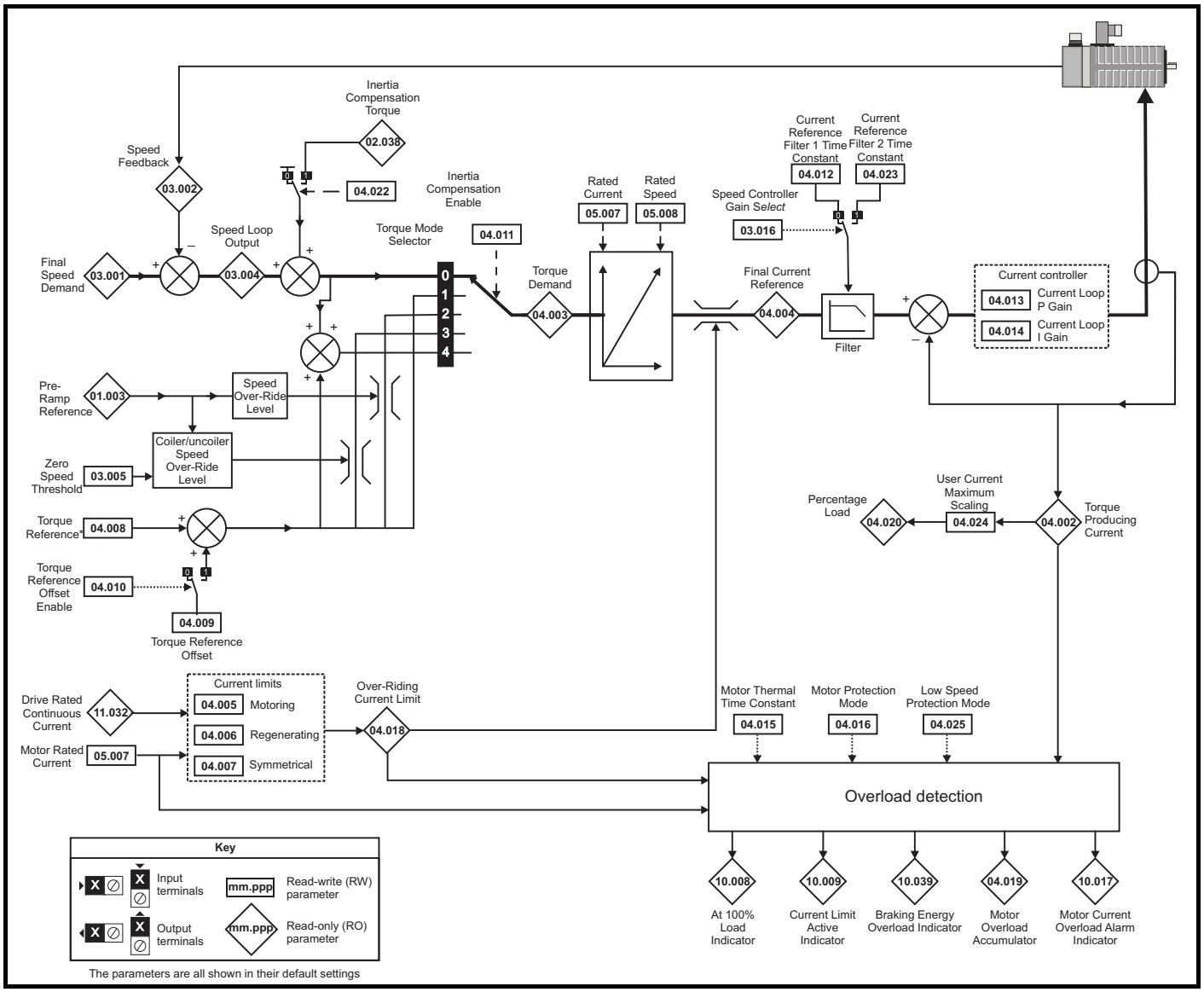


Figure 11-12 Menu 4 RFC-S logic diagram



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
04.001	Current Magnitude	±VM_DRIVE_CURRENT_UNIPOLAR					RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current	±VM_DRIVE_CURRENT					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	±VM_MOTOR1_CURRENT_LIMIT		0.0 %			RW	Num		RA		US
04.006	Regenerating Current Limit	±VM_MOTOR1_CURRENT_LIMIT					RW	Num		RA		US
04.007	Symmetrical Current Limit	±VM_MOTOR1_CURRENT_LIMIT					RW	Num		RA		US
04.008	Torque Reference	±VM_USER_CURRENT_HIGH_RES		0.00 %			RW	Num				US
04.009	Torque Offset	±VM_USER_CURRENT		0.0 %			RW	Num				US
04.010	Torque Offset Select	Off (0) or On (1)		Off (0)			RW	Bit				US
04.011	Torque Mode Selector	0 or 1	0 to 5	0			RW	Num				US
04.012	Current Reference Filter 1 Time Constant		0.0 to 25.0 ms		0.0 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	0 to 3		0			RW	Bin				US
04.017	Magnetising Current	±VM_DRIVE_CURRENT					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
04.022	Inertia Compensation Enable		Off (0) or On (1)		Off (0)		RW	Bit				US
04.023	Current Reference Filter 2 Time Constant		0.0 to 25.0 ms		0.0 ms		RW	Num				US
04.024	User Current Maximum Scaling	±VM_TORQUE_CURRENT_UNIPOLAR		165.0 %	175.0 %		RW	Num		RA		US
04.025	Low Speed Thermal Protection Mode	0 or 1		0			RW	Num				US
04.026	Percentage Torque	±VM_USER_CURRENT					RO	Num	ND	NC	PT	FI
04.027	Low Load Detection Level	0.0 to 100.0 %		0.0 %			RW	Num				US
04.028	Low Load Detection Speed/Frequency Threshold	±VM_SPEED_FREQ_REF_UNIPOLAR		0.0			RW	Num				US
04.029	Enable Trip On Low Load	Off (0) or On (1)		Off (0)			RW	Bit				US
04.030	Current Controller Mode		Off (0) or On (1)		Off (0)		RW	Bit				US
04.031	Notch Filter Centre Frequency		50 to 1000 Hz		500 Hz		RW	Num				US
04.032	Notch Filter Bandwidth		0 to 500 Hz		0 Hz		RW	Num				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						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

11.5 Menu 5: Motor control

Figure 11-13 Menu 5 Open-loop logic diagram

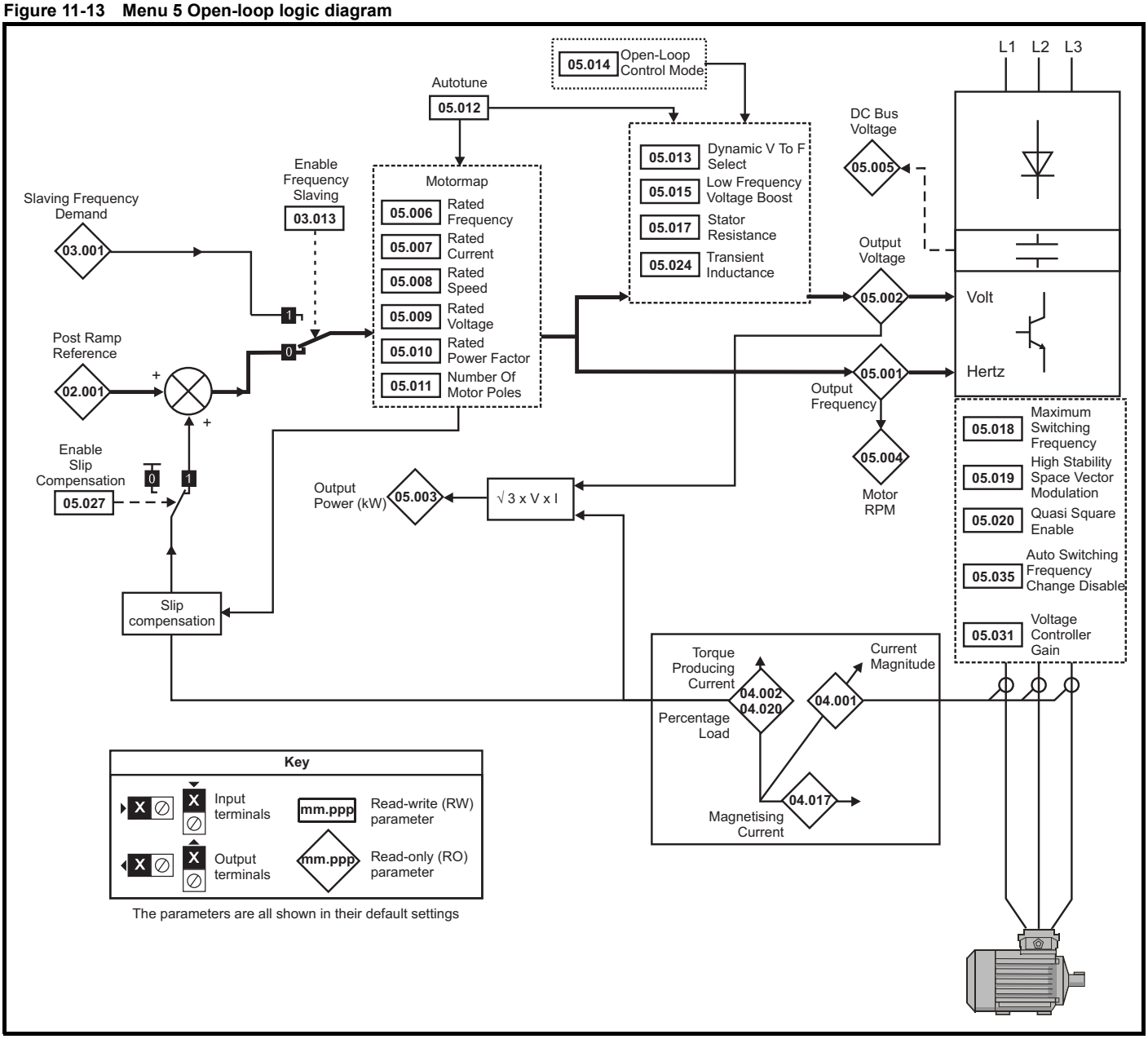
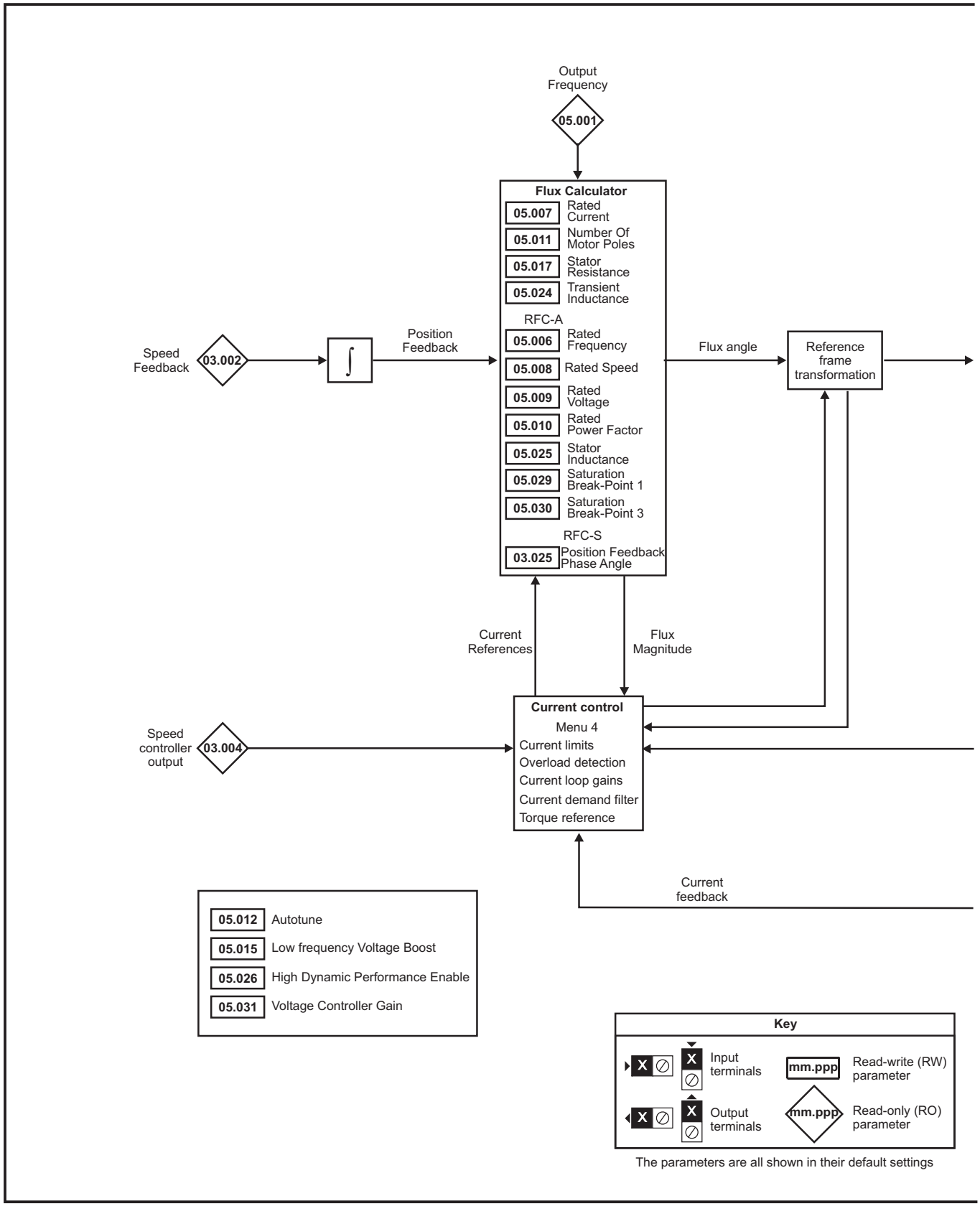
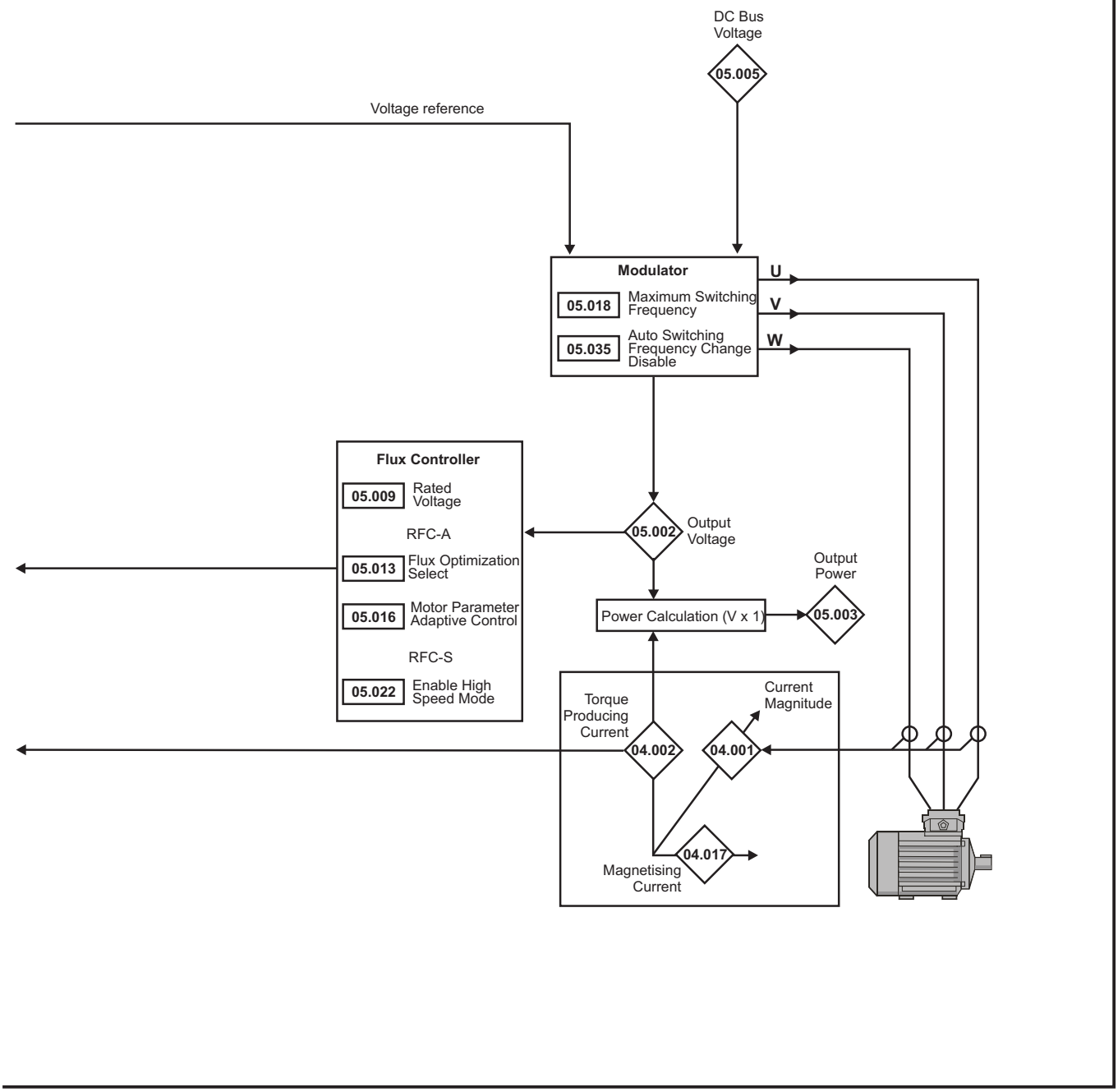


Figure 11-14 Menu 5 RFC-A, RFC-S logic diagram




DC Bus Voltage
05.005
Voltage reference
Modulator
05.018
Maximum Switching Frequency
05.035
Auto Switching Frequency Change Disable
U
V
W
Flux Controller
05.009
Rated Voltage
RFC-A
05.013
Flux Optimization Select
05.016
Motor Parameter Adaptive Control
RFC-S
05.022
Enable High Speed Mode
05.002
Output Voltage
Output Power
Power Calculation (V x 1)
05.003
Torque Producing Current
Current Magnitude
04.002
04.001
04.017
Magnetising Current

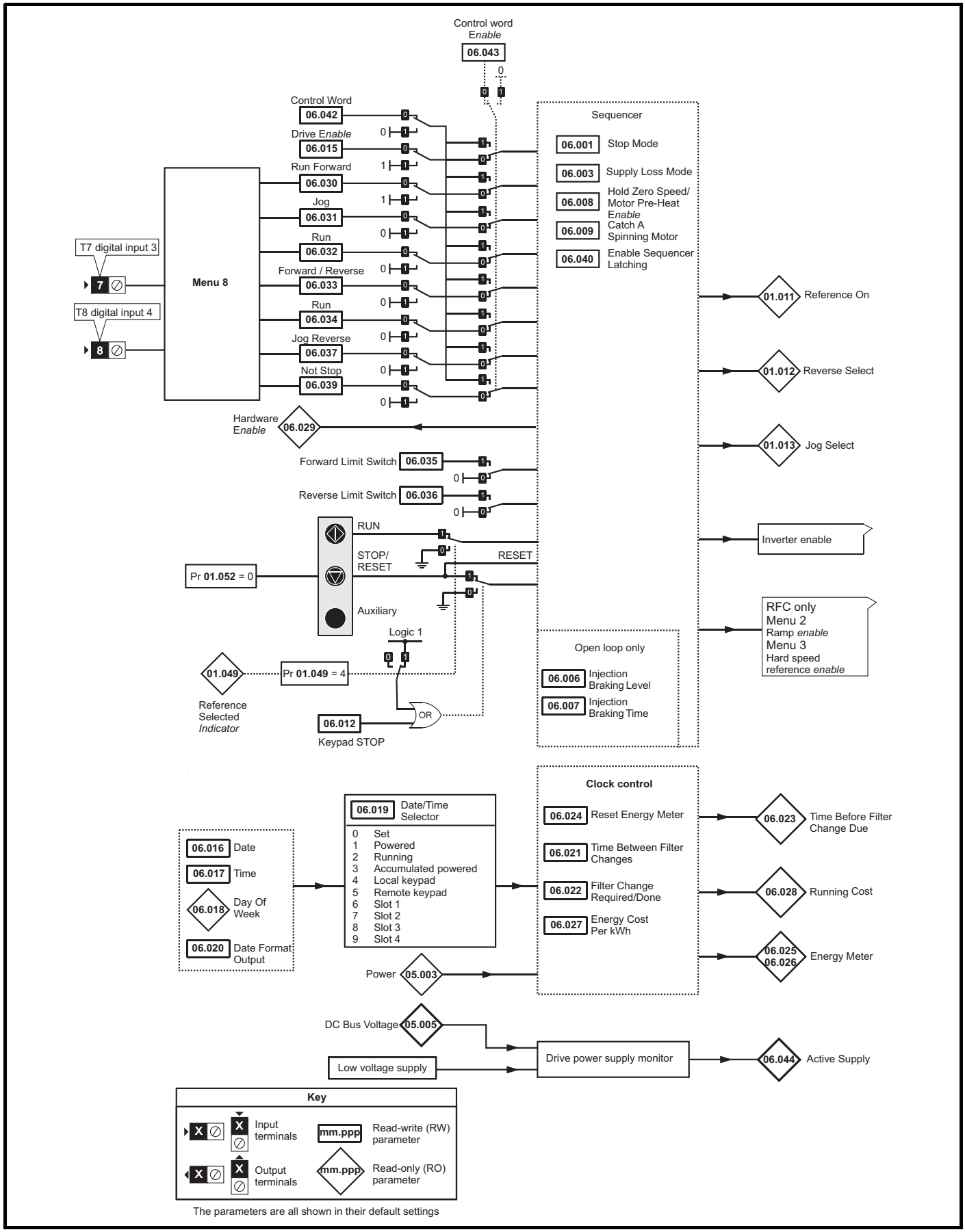
Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.001	Output Frequency	±VM_SPEED_FREQ_REF	±2000.0 Hz					RO	Num	ND	NC	PT	
05.002	Output Voltage	±VM_AC_VOLTAGE						RO	Num	ND	NC	PT	
05.003	Output Power	±VM_POWER						RO	Num	ND	NC	PT	
05.004	Motor Rpm	±180000 rpm						RO	Num	ND	NC	PT	
05.005	D.C. Bus Voltage	±VM_DC_VOLTAGE						RO	Num	ND	NC	PT	
05.006	Rated Frequency	0.0 to 3000.0 Hz	0.0 to 1667.0 Hz		Eur - 50.0 Hz USA - 60.0 Hz			RW	Num				US
05.007	Rated Current	±VM_RATED_CURRENT			0.000 A			RW	Num		RA		US
05.008	Rated Speed	0 to 180000 rpm	0.00 to 50000.00 rpm		Eur - 1500 rpm USA - 1800 rpm	Eur - 1450.00 rpm USA - 1750.00 rpm	3000.00 rpm	RW	Num				US
05.009	Rated Voltage	±VM_AC_VOLTAGE_SET			200V drive: 230 V Eur - 400V drive: 400 V USA - 400V drive: 460 V 575V drive: 575 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)		6 Poles (3)						
05.012	Autotune	0 to 2	0 to 3	0 to 4	0			RW	Num		NC		
05.013	Flux Optimization Select	Off (0) or On (1)			Off (0)			RW	Bit				US
05.014	Open-loop Control Mode / Action On Enable	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Current 1P (6)		None (0), Phase (1), Phase Init (2)	Ur I (4)		None (0)	RW	Txt				US
05.015	Low Frequency Voltage Boost	0.0 to 25.0 %			3.0 %			RW	Num				US
05.016	Motor Parameter Adaptive Control		0 to 2			2		RW	Num				US
05.017	Stator Resistance	0.000000 to 1000.000000 Ω			0.000000 Ω			RW			RA		US
05.018	Maximum Switching Frequency	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)			3 kHz (1)		6 kHz (3)	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							RW	Bit				US
05.022	Enable High Speed Mode			Off (0) or On (1)			Off (0)	RW	Bit				US
05.023	D.c. Bus Voltage High Range	±VM_HIGH_DC_VOLTAGE						RO	Num	ND	NC	PT	
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
05.026	High Dynamic Performance Enable		Off (0) or On (1)			Off (0)		RW	Bit				US
05.027	Enable Slip Compensation	Off (0) or On (1)			On (1)			RW	Bit				US
05.028	Flux Control Compensation Disable		Off (0) or On (1)			Off (0)		RW	Bit				US
05.029	Saturation Breakpoint 1		0.0 to 100.0 %			50.0 %		RW	Num				US
05.030	Saturation Breakpoint 3					75.0 %		RW	Num				US
05.031	Voltage Controller Gain	1 to 30			1			RW	Num				US
05.032	Torque Per Amp		0.00 to 500.00 Nm/A					RO	Num	ND	NC	PT	
05.034	Percentage Flux		0.0 to 150.0 %					RO	Num	ND	NC	PT	
05.035	Auto-switching Frequency Change Disable	Enabled (0), Disabled (1), No Ripple Detect (2)			Enabled (0)			RW	Txt				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	
05.040	Spin Start Boost	0.0 to 10.0			1.0			RW	Num				US
05.042	Reverse Output Phase Sequence	Off (0) or On (1)			Off (0)			RW	Bit				US
05.044	Stator Temperature Source	P1 Drive (2), P1 Slot 1 (3), P1 Slot 2 (4), P1 Slot 3 (5), P1 Slot 4 (6)			P1 Drive (2)			RW	Txt				US
05.045	User Stator Temperature	-50 to 300 °C			0 °C			RW	Num				
05.046	Stator Temperature							RO	Num	ND	NC	PT	
05.047	Stator Temperature Coefficient	0.00000 to 0.10000 °C^{-1}			0.00390 °C-1			RW	Num				US
05.048	Stator Base Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.049	Enable Stator Compensation	Off (0) or On (1)			Off (0)			RW	Bit				US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.051	Rotor Temperature Source	User (1), P1 Drive (2), P1 Slot 1 (3), P1 Slot 2 (4), P1 Slot 3 (5), P1 Slot 4 (6)			P1 Drive (2)			RW	Txt				US
05.052	User Rotor Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.053	Rotor Temperature							RO	Num	ND	NC	PT	
05.054	Rotor Temperature Coefficient	0.00000 to 0.10000 °C^{-1}			0.00390			RW	Num				US
05.055	Rotor Base Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.056	Enable Rotor Compensation	Off (0) or On (1)			Off (0)			RW	Bit				US
05.058	Inductance Measurement Test Current			-128 to 127 %				RO	Num		NC	PT	US
05.059	Maximum Deadtime Compensation	0.000 to 10.000 µs						RO	Num		NC	PT	US
05.060	Current At Maximum Deadtime Compensation	0.00 to 100.00 %						RO	Num		NC	PT	US
05.062	Saturation Breakpoint 2		0.0 to 100.0 %			0.0 %		RW	Num				US
05.063	Saturation Breakpoint 4							RW	Num				US
05.064	RFC Low Speed Mode			Injection (0) or Current (1)			Injection (0)	RW	Txt				US
05.065	Saliency Torque Control			Off (0) or On (1)			Off (0)	RW	Bit				US
05.066	Torque Ripple Compensation							RW	Bit				US
05.068	No-load Lq			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.069	Rated load Lq							RW	Num		RA		US
05.070	No-load Phase Offset			0.0 to 359.9 °			0.0 °	RW	Num				US
05.071	Rated Load Phase Offset							RW	Num				US
05.072	Maximum Low Speed Sensorless Mode			0.0 to 1000.0 %			0.0 %	RW	Num		RA		US
05.074	Cogging Data Parameter 1			0 to 1000			0	RW	Num				US
05.075	Cogging Data Parameter 2							RW	Num				US
05.076	Cogging Data Parameter 3							RW	Num				US
05.077	Cogging Data Parameter 4							RW	Num				US
05.078	Cogging Data Parameter 5							RW	Num				US
05.079	Cogging Data Parameter 6							RW	Num				US
05.080	Cogging Data Parameter 7							RW	Num				US
05.081	Cogging Data Parameter 8							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

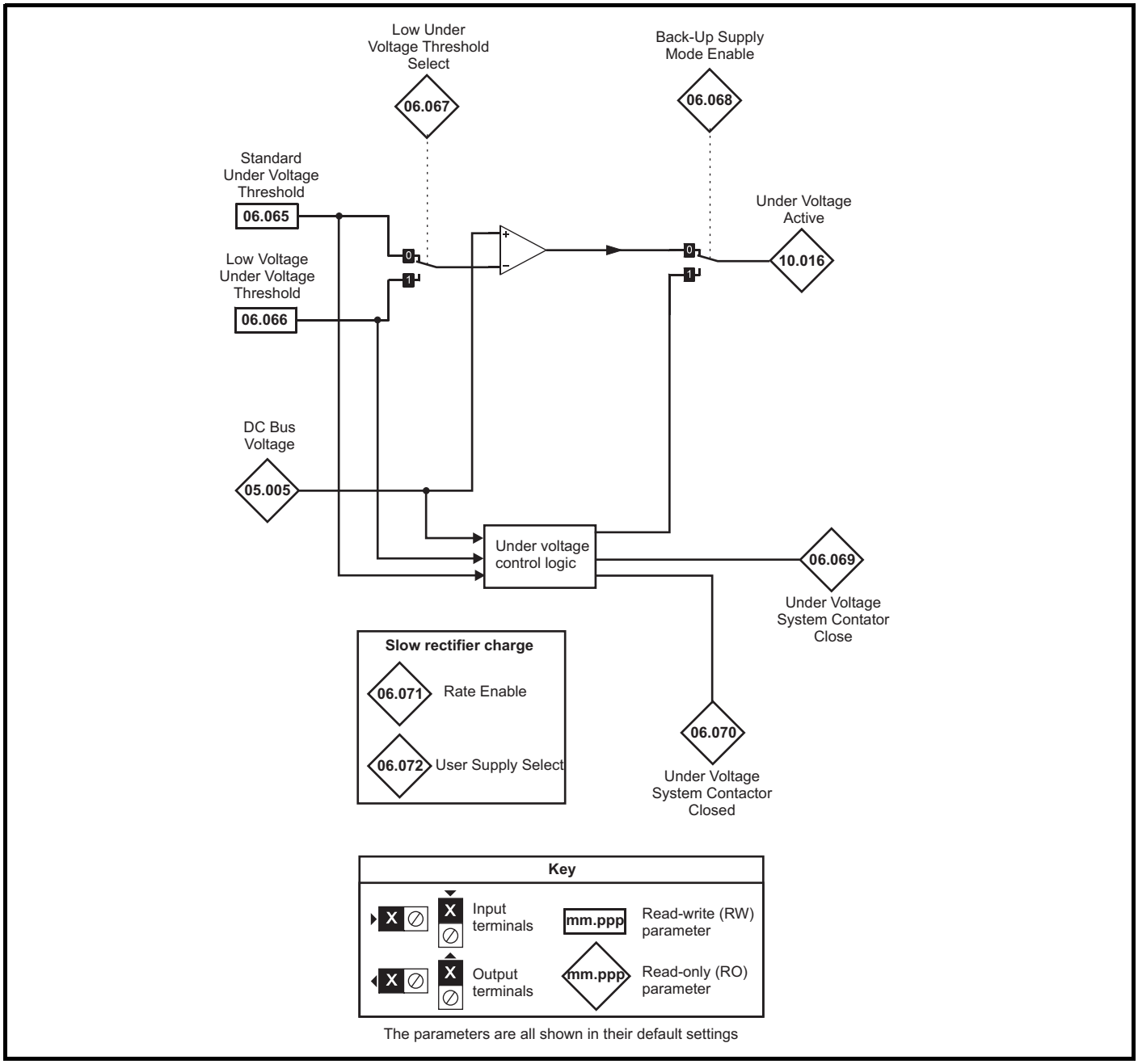
11.6 Menu 6: Sequencer and clock

Figure 11-15 Menu 6 logic diagram



The parameters are all shown in their default settings

Figure 11-16 Menu 6 Low voltage operation



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.001	Stop Mode	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5)	Coast (0), Ramp (1), No Ramp (2)	Ramp (1)	Ramp (1)	No Ramp (2)	RW	Txt				US
06.002	Limit Switch Stop Mode		Stop (0) or Ramp (1)		Stop (0)		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 25.0 s		1.0 s			RW	Num				US
06.008	Hold Zero Speed	Off (0) or On (1)		Off (0)		On (1)	RW	Bit				US
06.009	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)	Enable (1)		RW	Txt				US
06.010	Enable Conditions	0 to 2047					RO	Bin	ND	NC	PT	
06.011	Sequencer State Machine Inputs	0 to 127					RO	Bin	ND	NC	PT	
06.012	Enable Stop Key	Off (0) or On (1)		Off (0)			RW	Bit				US
06.013	Enable Auxiliary Key	Disabled (0), Forward / Reverse (2), Reverse (3)		Disabled (0)			RW	Num				US
06.015	Drive Enable	Off (0) or On (1)		On (1)			RW	Bit		NC		US
06.016	Date	0 to 311299					RW	Date	ND	NC	PT	
06.017	Time	0 to 235959					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)		Powered (1)			RW	Txt				US
06.020	Date Format	Std (0) or US (1)		Std (0)			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	-999.9 to 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		
06.031	Jog						RW	Bit		NC		
06.032	Run Reverse						RW	Bit		NC		
06.033	Forward/Reverse						RW	Bit		NC		
06.034	Run						RW	Bit		NC		
06.035	Forward Limit Switch						RW	Bit		NC		
06.036	Reverse Limit Switch						RW	Bit		NC		
06.037	Jog Reverse						RW	Bit		NC		
06.039	Not Stop						RW	Bit		NC		
06.040	Enable Sequencer Latching						RW	Bit				US
06.041	Drive Event Flags	Bit 0: Defaults loaded Bit 1: Drive mode changed		0			RW	Bin		NC		
06.042	Control Word	0 to 32767					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
06.046	Supply Loss Hold Disable	Off (0) or On (1)		Off (0)			RW	Bit				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	±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	Allow Motoring Load		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	

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.057	Sleep Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.059	Output Phase Loss Detection Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.060	Standby Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.061	Standby Mode Mask	0 to 127		0			RW	Bin				US
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	±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						RW	Bit				US
06.069	Under-Voltage System Contactor Close						RO	Bit	ND	NC	PT	
06.070	Under-Voltage System Contactor Closed			Off (0)			RW	Bit				US
06.071	Slow Rectifier Charge Rate Enable						RW	Bit				US
06.072	User Supply Select						RW	Bit				US
06.073	Braking IGBT Lower Threshold	±VM_DC_VOLTAGE_SET		200 V drive: 390 V 400 V drive: 780 V 575 V drive: 930 V 690 V drive: 1120 V			RW	Num				US
06.074	Braking IGBT Upper Threshold			200 V drive: 390 V 400 V drive: 780 V 575 V drive: 930 V 690 V drive: 1120 V			RW	Num				US
06.075	Low Voltage Braking IGBT Threshold			0 V			RW	Num				US
06.076	Low Voltage Braking IGBT Threshold Select	Off (0) or On (1)		Off (0)			RW	Bit				

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

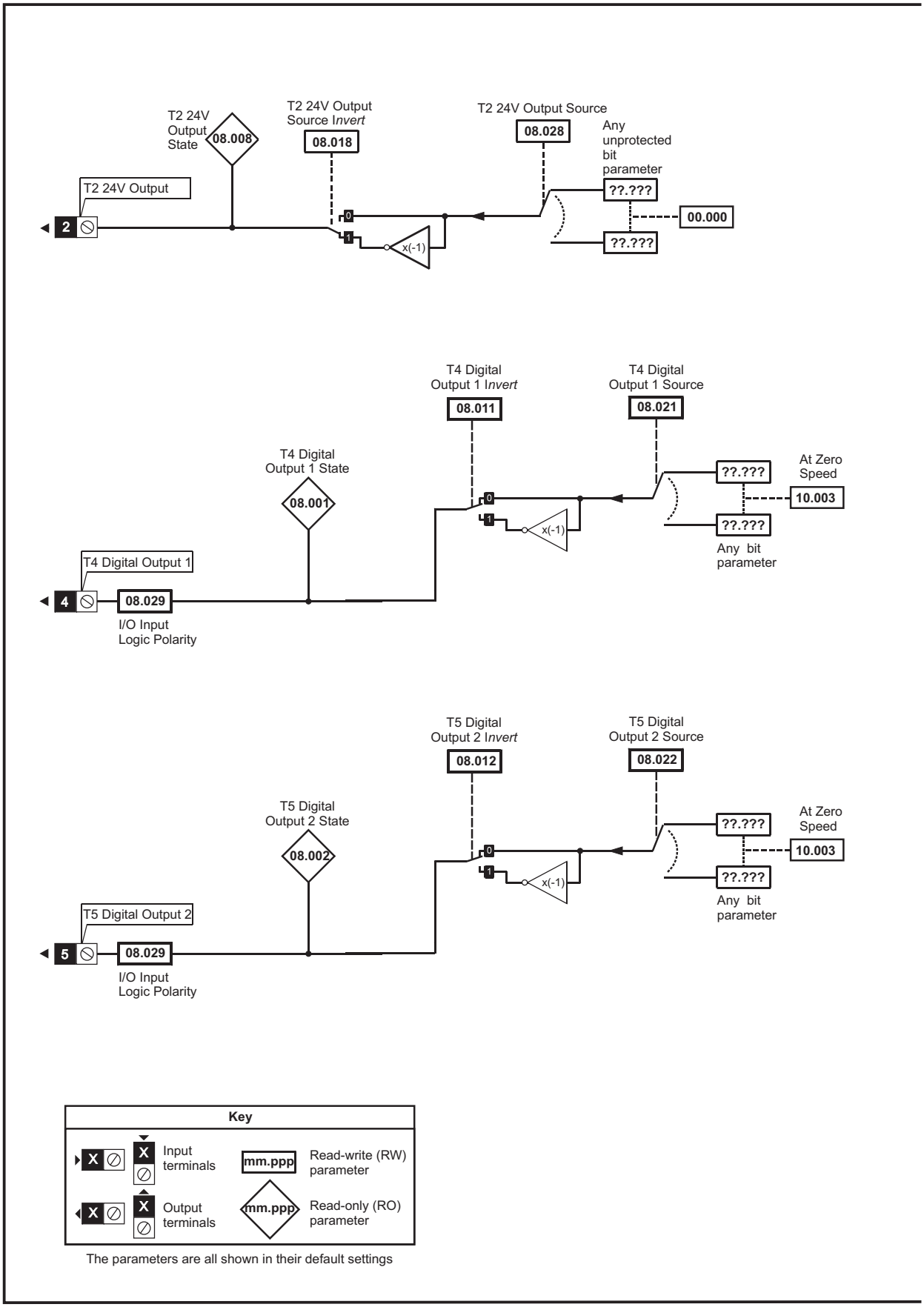
11.7 Menu 7: Temperature monitoring

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
07.004	Monitored Temperature 1	±250 °C					RO	Num	ND	NC	PT	
07.005	Monitored Temperature 2						RO	Num	ND	NC	PT	
07.006	Monitored Temperature 3						RO	Num	ND	NC	PT	
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						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			1001			RW	Num				US
07.039	Temperature Monitor Select 2			1002			RW	Num				US
07.052	Temperature Monitor Select 3			1			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

11.8 Menu 8: Digital I/O

Figure 11-17 Menu 8 logic diagram



The parameters are all shown in their default settings

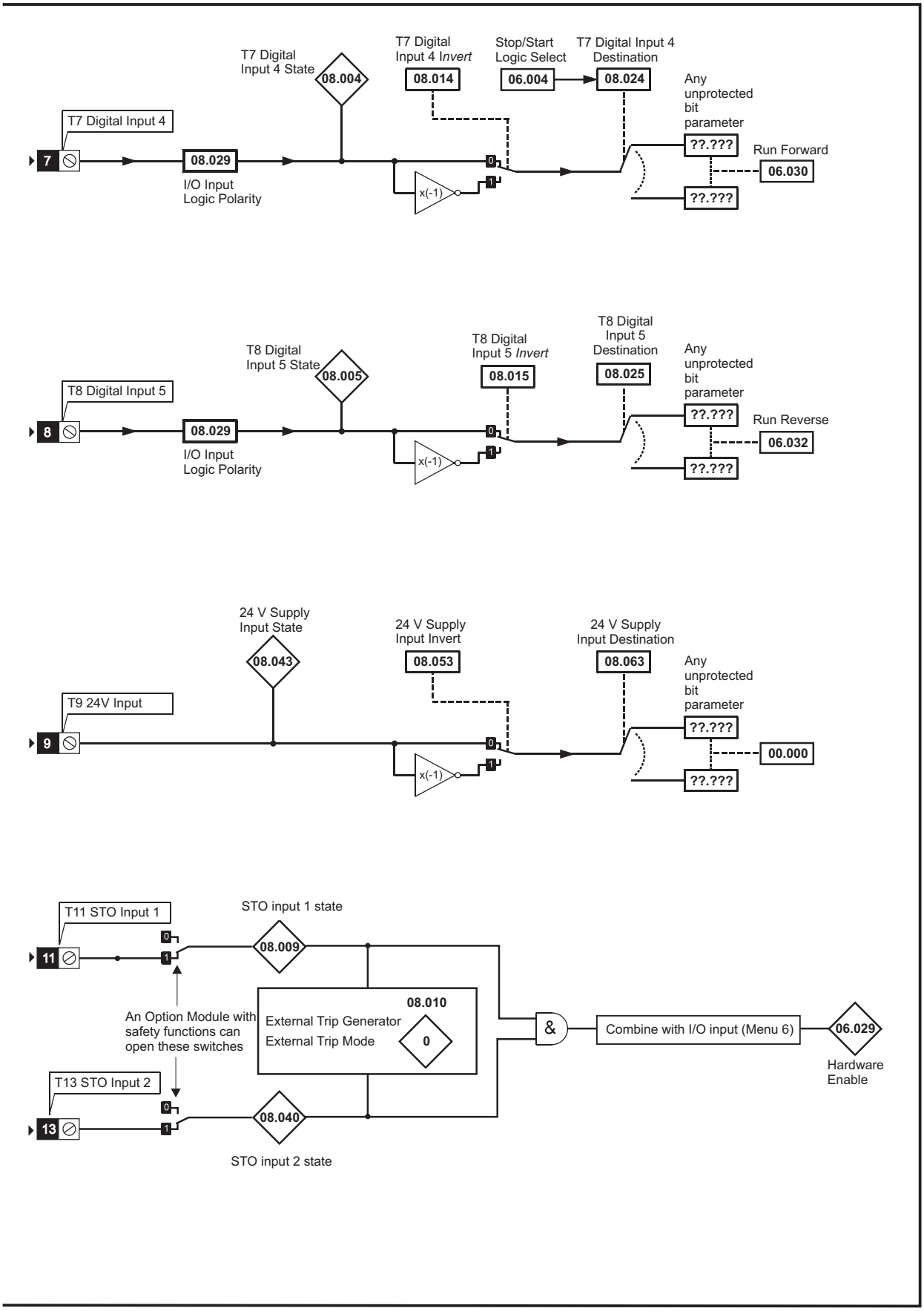

T7 Digital Input 4 State
08.004
T7 Digital Input 4 Invert
08.014
Stop/Start Logic Select
06.004
T7 Digital Input 4 Destination
08.024
Any unprotected bit parameter
??.???
??.???
Run Forward
06.030
T7 Digital Input 4
7
08.029
I/O Input Logic Polarity
x(-1)
T8 Digital Input 5 State
08.005
T8 Digital Input 5 Invert
08.015
T8 Digital Input 5 Destination
08.025
Any unprotected bit parameter
??.???
??.???
Run Reverse
06.032
T8 Digital Input 5
8
08.029
I/O Input Logic Polarity
x(-1)
24 V Supply Input State
08.043
24 V Supply Input Invert
08.053
24 V Supply Input Destination
08.063
Any unprotected bit parameter
??.???
??.???
00.000
T9 24V Input
9
x(-1)
T11 STO Input 1
11
STO input 1 state
08.009
An Option Module with safety functions can open these switches
08.010
External Trip Generator
External Trip Mode
0
&
Combine with I/O input (Menu 6)
06.029
Hardware Enable
T13 STO Input 2
13
08.040
STO input 2 state

Figure 11-18 Menu 8 logic (cont)

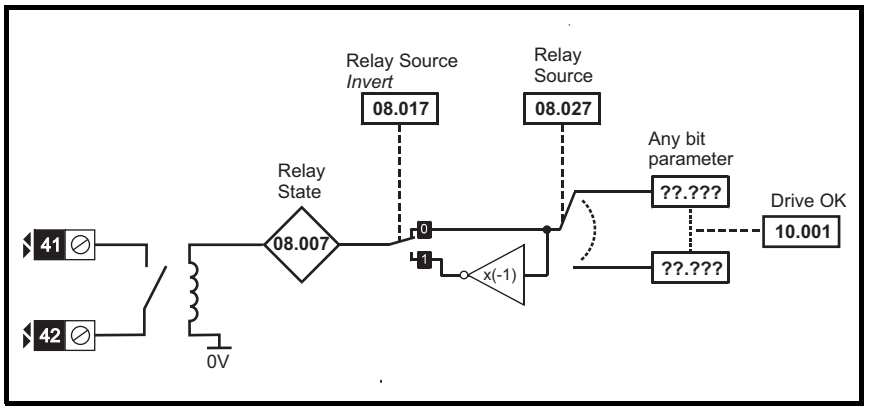
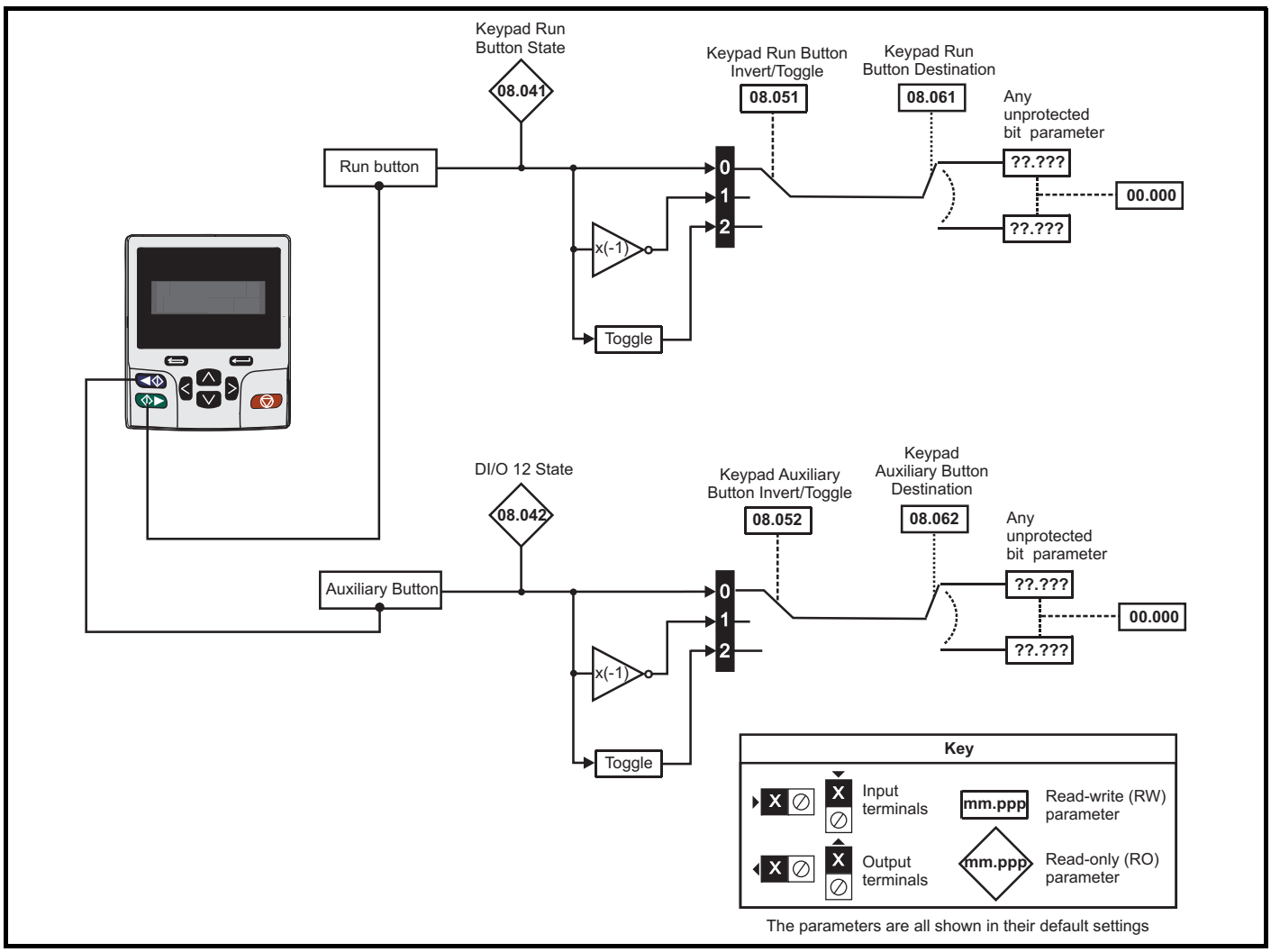


Figure 11-19 Menu 8 logic (cont)



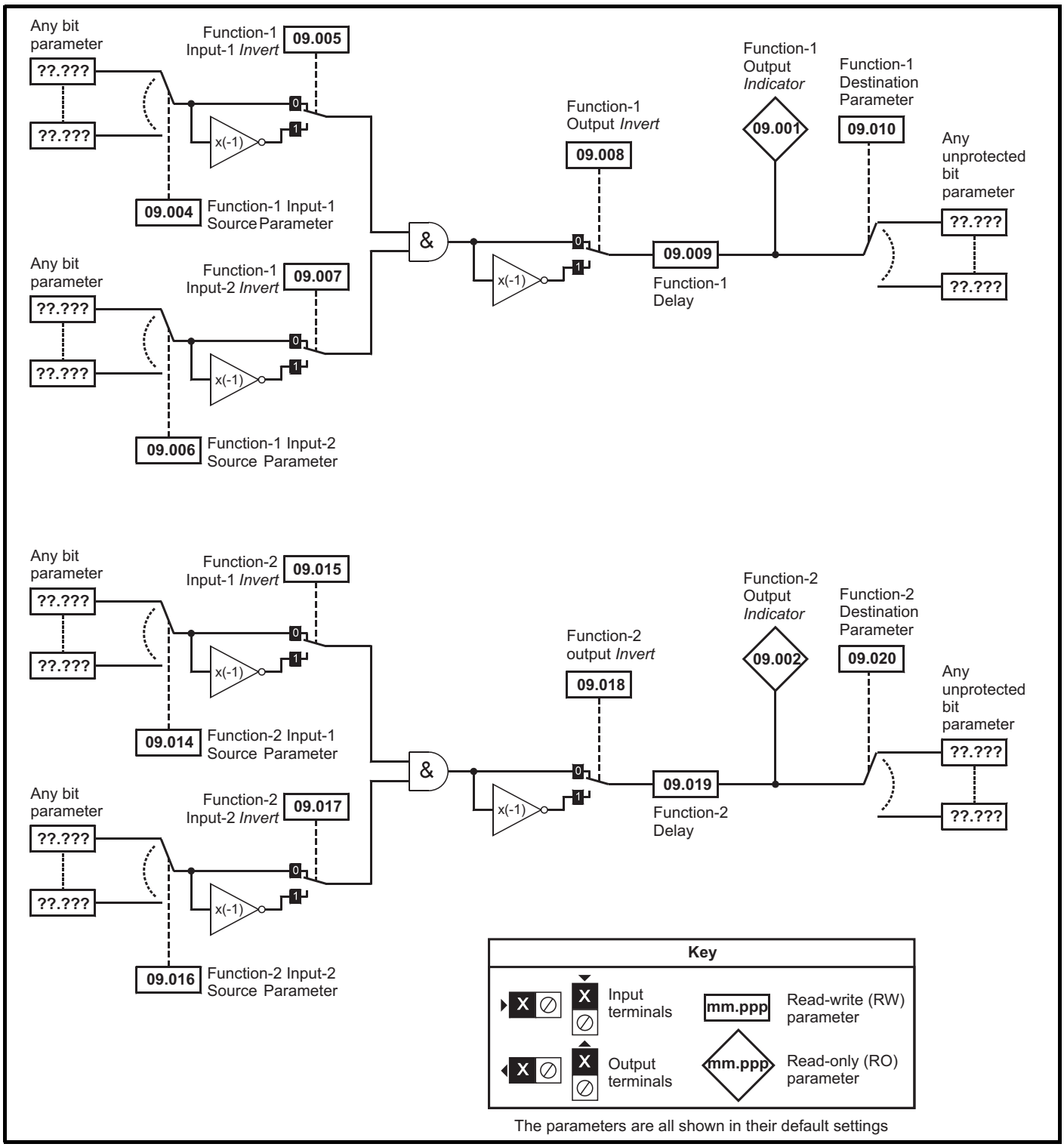
The parameters are all shown in their default settings

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						RO	Bit	ND	NC	PT	
08.004	Digital Input 04 State						RO	Bit	ND	NC	PT	
08.005	Digital Input 05 State						RO	Bit	ND	NC	PT	
08.007	Relay Output State						RO	Bit	ND	NC	PT	
08.008	24V Supply Output State						RO	Bit	ND	NC	PT	
08.009	STO Input 01 State						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						RW	Txt				US
08.014	Digital Input 04 Invert						RW	Txt				US
08.015	Digital Input 05 Invert						RW	Txt				US
08.017	Relay Invert						RW	Txt				US
08.018	24V Supply Output Invert			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		10.003			RW	Num	DE		PT	US
08.022	Digital I/O 02 Source/Destination			0.000			RW	Num	DE		PT	US
08.024	Digital Input 04 Destination			6.030			RW	Num	DE		PT	US
08.025	Digital Input 05 Destination			6.032			RW	Num	DE		PT	US
08.027	Relay Output Source			10.001			RW	Num			PT	US
08.028	24V Supply Output Source			0.000			RW	Num			PT	US
08.029	Input Logic Polarity	Negative Logic (0) or Positive Logic (1)		Positive Logic (1)			RW	Txt				US
08.040	STO Input 02 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.041	Keypad Run Button State						RO	Bit	ND	NC	PT	
08.042	Keypad Auxiliary Button State						RO	Bit	ND	NC	PT	
08.043	24V Supply Input State						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						RW	Txt				US
08.053	24V Supply Input Invert	Not Invert (0) or Invert (1)					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						RW	Num	DE		PT	US
08.063	24V Supply Input Source						RW	Num			PT	US
08.071	DI/O Output Enable Register 1	0 to 65535		0			RW	Bin			PT	US
08.072	DI/O Input Register 1						RO	Bin			PT	
08.073	DI/O Output Register 1			0			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

11.9 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 11-20 Menu 9 logic diagram: Programmable logic



The parameters are all shown in their default settings

Figure 11-21 Menu 9 logic diagram: Motorized pot and binary sum

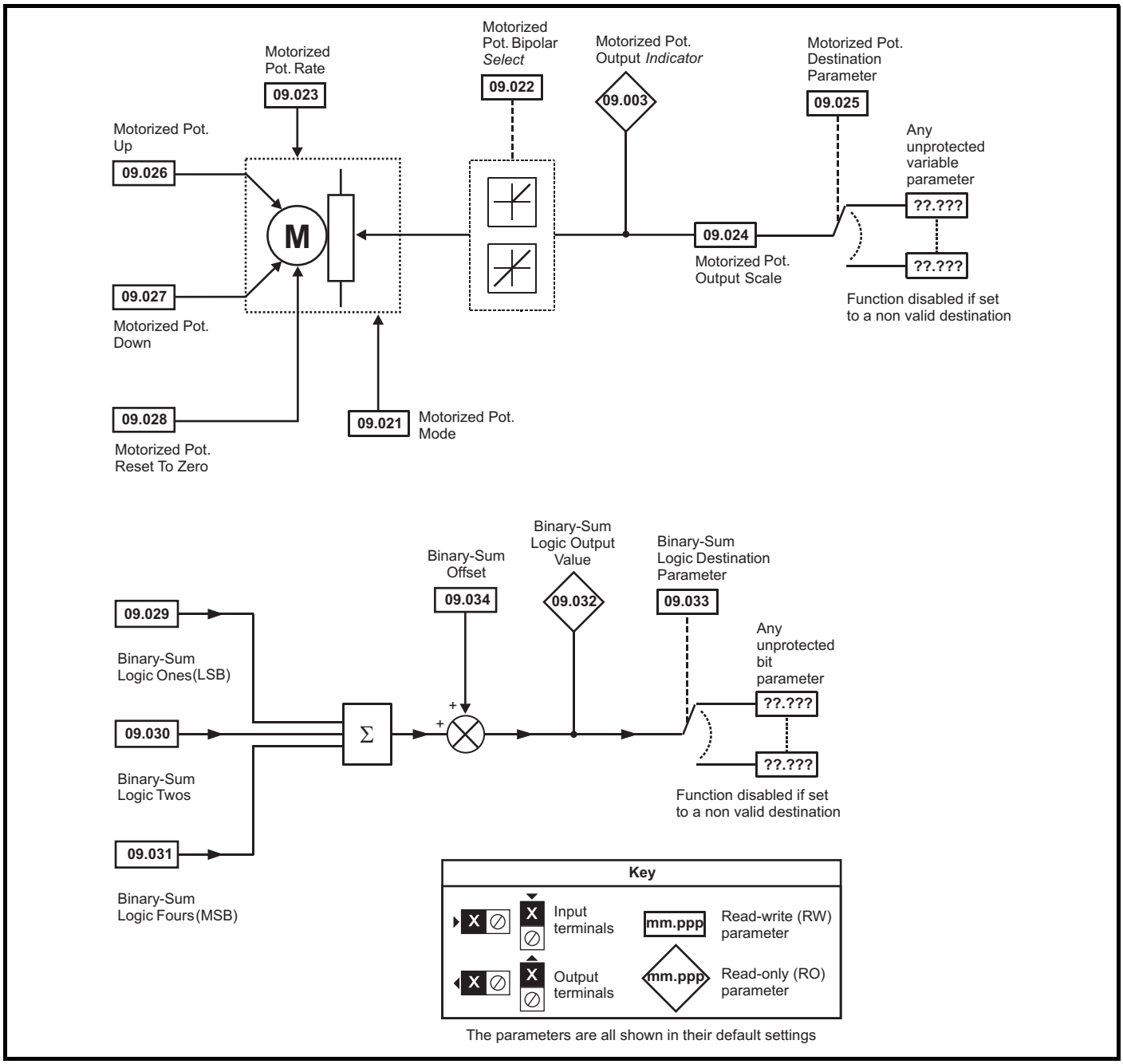
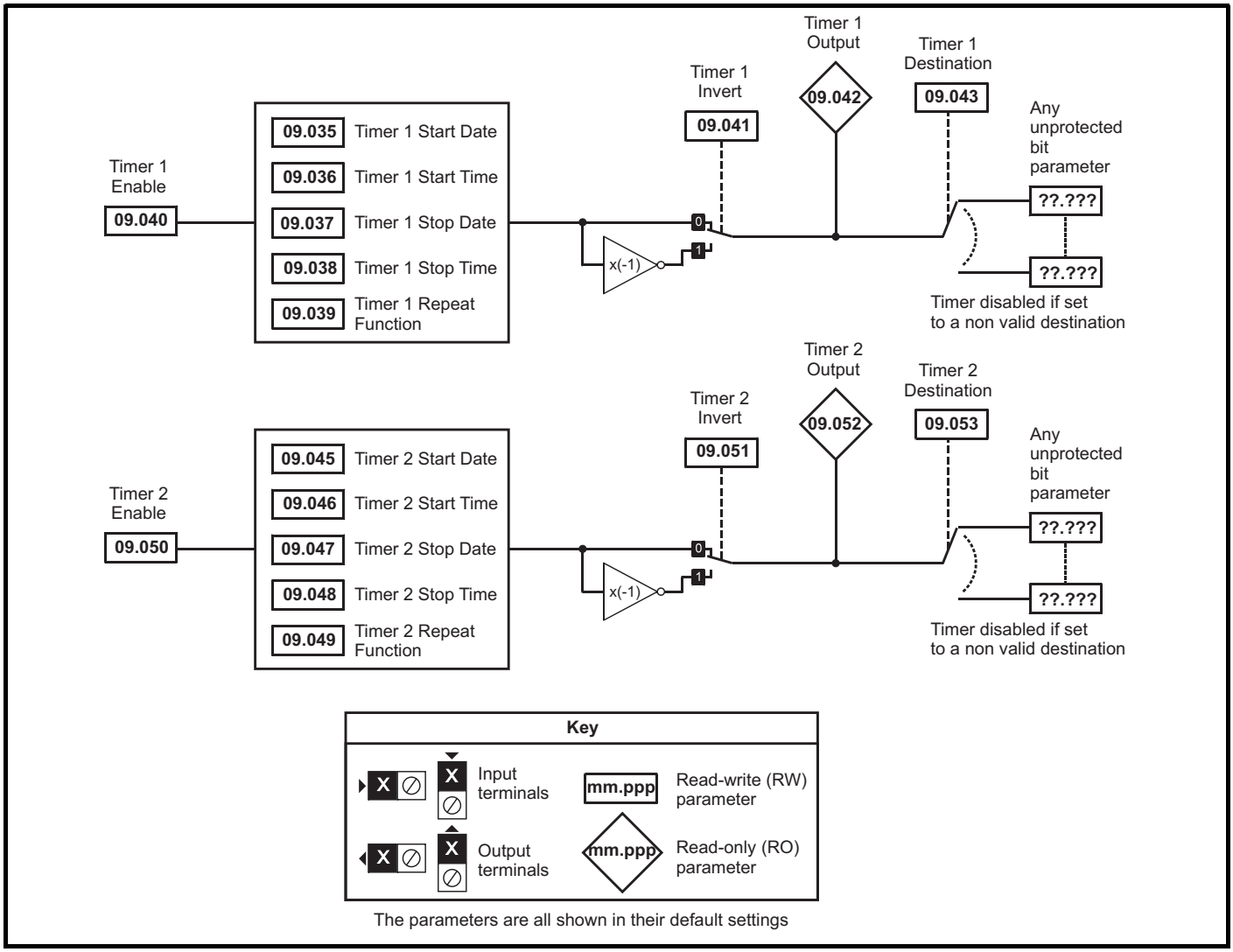
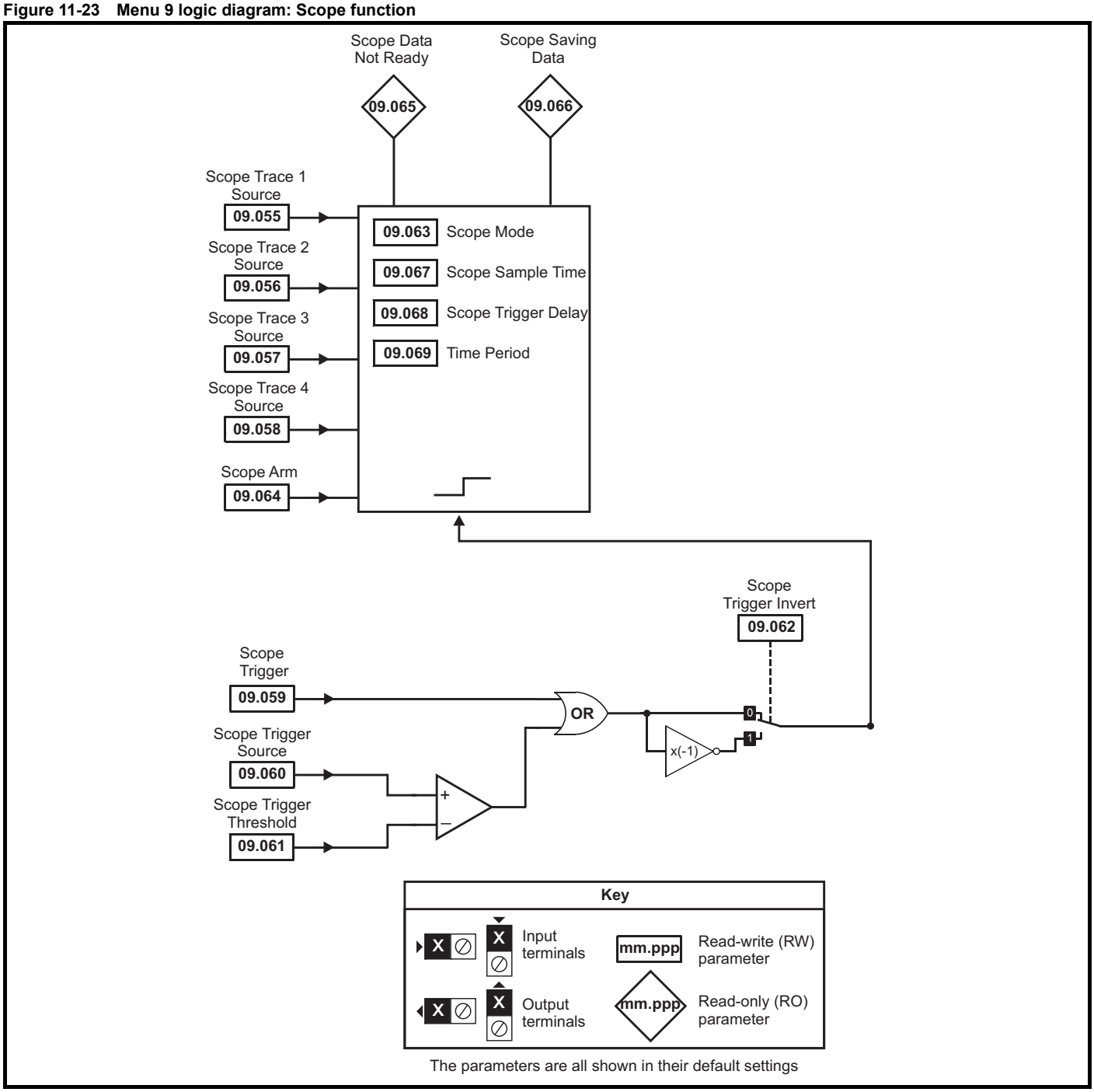


Figure 11-22 Menu 9 logic diagram: Timers



The parameters are all shown in their default settings

Figure 11-23 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						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	DE			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	DE			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						RW	Bit				US
09.009	Logic Function 1 Delay	±25.0 s		0.0s			RW	Num				US
09.010	Logic Function 1 Destination	0.000 to 59.999		0.000			RW	DE			PT	US
09.014	Logic Function 2 Source 1						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						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	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	DE			PT	US
09.026	Motorized Pot Up	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.027	Motorized Pot Down						RW	Bit		NC		
09.028	Motorized Pot Reset						RW	Bit		NC		
09.029	Binary Sum Ones						RW	Bit		NC		
09.030	Binary Sum Twos						RW	Bit		NC		
09.031	Binary Sum Fours						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	DE			PT	US
09.034	Binary Sum Offset	0 to 248		0			RW	Num				US
09.035	Timer 1 Start Date	0 to 311299					RW	Date				US
09.036	Timer 1 Start Time	0 to 235959					RW	Time				US
09.037	Timer 1 Stop Date	0 to 311299					RW	Date				US
09.038	Timer 1 Stop Time	0 to 235959					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						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	0 to 311299		0			RW	Date				US
09.046	Timer 2 Start Time	0 to 235959					RW	Time				US
09.047	Timer 2 Stop Date	0 to 311299					RW	Date				US
09.048	Timer 2 Stop Time	0 to 235959					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						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						RW	Num			PT	US
09.056	Scope Trace 2 Source						RW	Num			PT	US
09.057	Scope Trace 3 Source						RW	Num			PT	US
09.058	Scope Trace 4 Source						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

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
09.061	Scope Trigger Threshold	-2^{31} to $+2^{31}-1$		0			RW	Num				US
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						RO	Bit	ND	NC	PT	
09.067	Scope Sample Time	1 to 200		1			RW	Num				US
09.068	Scope Trigger Delay	0 to 100 %		0 %			RW	Num				US
09.069	Scope Time Period	0.00 to 200000.00 ms					RO	Num	ND	NC	PT	
09.070	Scope Auto-save Mode	Disabled (0), Overwrite (1), Keep (2)		Disabled (0)			RW	Txt				US
09.071	Scope Auto-save File Number	0 to 99					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)					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

11.10 Menu 10: Status and trips

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
10.001	Drive OK	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.002	Drive Active						RO	Bit	ND	NC	PT	
10.003	Zero Speed						RO	Bit	ND	NC	PT	
10.004	Running At Or Below Minimum Speed						RO	Bit	ND	NC	PT	
10.005	Below Set Speed						RO	Bit	ND	NC	PT	
10.006	At Speed						RO	Bit	ND	NC	PT	
10.007	Above Set Speed						RO	Bit	ND	NC	PT	
10.008	Rate Load Reached						RO	Bit	ND	NC	PT	
10.009	Current Limit Active						RO	Bit	ND	NC	PT	
10.010	Regenerating						RO	Bit	ND	NC	PT	
10.011	Braking IGBT Active						RO	Bit	ND	NC	PT	
10.012	Braking Resistor Alarm						RO	Bit	ND	NC	PT	
10.013	Reverse Direction Commanded						RO	Bit	ND	NC	PT	
10.014	Reverse Direction Running						RO	Bit	ND	NC	PT	
10.015	Supply Loss						RO	Bit	ND	NC	PT	
10.016	Under Voltage Active						RO	Bit	ND	NC	PT	
10.017	Motor Overload Alarm						RO	Bit	ND	NC	PT	
10.018	Drive Over-temperature Alarm						RO	Bit	ND	NC	PT	
10.019	Drive Warning						RO	Bit	ND	NC	PT	
10.020	Trip 0	0 to 255					RO	Txt	ND	NC	PT	PS
10.021	Trip 1						RO	Txt	ND	NC	PT	PS
10.022	Trip 2						RO	Txt	ND	NC	PT	PS
10.023	Trip 3						RO	Txt	ND	NC	PT	PS
10.024	Trip 4						RO	Txt	ND	NC	PT	PS
10.025	Trip 5						RO	Txt	ND	NC	PT	PS
10.026	Trip 6						RO	Txt	ND	NC	PT	PS
10.027	Trip 7						RO	Txt	ND	NC	PT	PS
10.028	Trip 8						RO	Txt	ND	NC	PT	PS
10.029	Trip 9						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					RW	Num				US
10.032	External Trip	Off (0) or On (1)		Off (0)			RW	Bit		NC		
10.033	Drive Reset						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 ok	Off (0) or On (1)		Off (0)			RW	Bit				US
10.037	Action On Trip Detection	Bit 0: Stop on defined non-important trips Bit 1: Disable braking resistor overload detection Bit 2: Disable phase loss stop Bit 3: Disable braking resistor temperature monitoring Bit 4: Disable parameter freeze on trip		0			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	0 to 32767					RO	Bin	ND	NC	PT	
10.041	Trip 0 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.042	Trip 0 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.043	Trip 1 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.044	Trip 1 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.045	Trip 2 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.046	Trip 2 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.047	Trip 3 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.048	Trip 3 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.049	Trip 4 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.050	Trip 4 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.051	Trip 5 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.052	Trip 5 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.053	Trip 6 Date	0 to 311299					RO	Date	ND	NC	PT	PS

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
10.054	Trip 6 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.055	Trip 7 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.056	Trip 7 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.057	Trip 8 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.058	Trip 8 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.059	Trip 9 Date	0 to 311299					RO	Date	ND	NC	PT	PS
10.060	Trip 9 Time	0 to 235959					RO	Time	ND	NC	PT	PS
10.061	Braking Resistor Resistance	0.00 to 10000.00 Ω		See Table 11-5			RW	Num				US
10.062	Low Load Detected Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.063	Local Keypad Battery Low						RO	Bit	ND	NC	PT	
10.064	Remote Keypad Battery Low						RO	Bit	ND	NC	PT	
10.065	Auto-tune Active						RO	Bit	ND	NC	PT	
10.066	Limit Switch Active						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	0 to 1023					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						RO	Num	ND	NC	PT	PS
10.072	Trip 2 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.073	Trip 3 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.074	Trip 4 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.075	Trip 5 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.076	Trip 6 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.077	Trip 7 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.078	Trip 8 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.079	Trip 9 Sub-trip Number						RO	Num	ND	NC	PT	PS
10.080	Stop Motor	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.081	Phase Loss						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)					RO	Txt	ND	NC	PT	
10.102	Trip Reset Source	0 to 1023					RO	Num	ND	NC	PT	PS
10.103	Trip Time Identifier	-2^{31} to $+2^{31}-1$					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	
10.106	Potential Drive Damage Conditions	0 to 15					RO	Bin	ND	NC	PT	PS

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

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
Size 3	50 W	3.3 s	75 Ω
Size 4	100 W	2.0 s	38 Ω
All other ratings and frame sizes	0.000		0.00

11.11 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						RW	Num			PT	US
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		0.010			RW	Num				US
11.028	Drive Derivative	0 to 255		3			RO	Num	ND	NC	PT	
11.029	Software Version	0 to 99999999					RO	Num	ND	NC	PT	
11.030	User Security Code	0 to 2^{31}-1		0			RW	Num	ND	NC	PT	US
11.031	User Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3), Regen (4)		Open-loop (1)	RFC-A (2)	RFC-S (3)	RW	Txt	ND	NC	PT	
11.032	Maximum Heavy Duty Rating	0.000 to 99999.999					RO	Num	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	
11.035	Number Of Power Modules	-1 to 32		-1			RW	Num				US
11.036	NV Media Card File Previously Loaded	0 to 999					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	-2^{31} to +2^{31}-1					RO	Num	ND	NC	PT	
11.042	Parameter Cloning	None (0), Read (1), Program (2), Auto (3), Boot (4)		None (0)			RW	Txt		NC		US
11.043	Load Defaults	None (0), Standard (1), US (2)					RW	Txt		NC		
11.044	User Security Status	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)		Menu 0 (0)			RW	Txt	ND		PT	
11.045	Select Motor 2 Parameters	Motor 1 (0) or Motor 2 (1)		Motor 1 (0)			RW	Txt				US
11.046	Defaults Previously Loaded	0 to 2000					RO	Num	ND	NC	PT	US
11.047	Onboard User Program: Enable	Stop (0) or Run (1)		Run (1)			RW	Txt				US
11.048	Onboard User Program: Status	-2^{31} to +2^{31}-1					RO	Num	ND	NC	PT	
11.049	Onboard User Program: Programming Events	0 to 65535					RO	Num	ND	NC	PT	
11.050	Onboard User Program: Freewheeling Tasks Per Second						RO	Num	ND	NC	PT	
11.051	Onboard User Program: Clock Task Time Used	0.0 to 100.0 %					RO	Num	ND	NC	PT	
11.052	Serial Number LS	0 to 999999999					RO	Num	ND	NC	PT	
11.053	Serial Number MS						RO	Num	ND	NC	PT	
11.054	Drive Date Code	0 to 65535					RO	Num	ND	NC	PT	
11.055	Onboard User Program: Clock Task Scheduled Interval	0 to 262140 ms					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),		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						RO	Num	ND	NC	PT	
11.063	Product Type	0 to 255					RO	Num	ND	NC	PT	
11.064	Product Identifier Characters	-2^{31} to +2^{31}-1					RO	Chr	ND	NC	PT	
11.065	Drive Rating And Configuration	0 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						RO	Num	ND	NC	PT	
11.068	Internal I/O Identifier						RO	Num	ND	NC	PT	
11.069	Position Feedback Interface Identifier						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 32					RO	Num	ND	NC	PT	US
11.072	NV Media Card Create Special File	0 or 1		0			RW	Num		NC		
11.073	NV Media Card Size	0 to 100000					RO	Num	ND	NC	PT	
11.074	NV Media Card Space Left						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						RO	Bit	ND	NC	PT	
11.077	NV Media Card File Required Version	0 to 9999		0			RW	Num	ND	NC	PT	

Parameter		Range(⇕)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
11.079	Drive Name Characters 1-4	-2^{31} to $+2^{31}-1$		0			RW	Chr			PT	US
11.080	Drive Name Characters 5-8						RW	Chr			PT	US
11.081	Drive Name Characters 9-12						RW	Chr			PT	US
11.082	Drive Name Characters 13-16						RW	Chr			PT	US
11.084	Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3), Regen (4)					RO	Txt	ND	NC	PT	US
11.085	Security Status	None (0), Read-only (1), Status-only (2), No Access (3)					RO	Txt	ND	NC	PT	PS
11.086	Menu Access Status	Menu 0 (0) or All Menus (1)					RO	Txt	ND	NC	PT	PS
11.090	Keypad Port Serial Address	1 to 16		1			RW	Num				US
11.091	Product Identifier Characters 1	-2^{31} to $+2^{31}-1$					RO	Chr	ND	NC	PT	
11.092	Product Identifier Characters 2						RO	Chr	ND	NC	PT	
11.093	Product Identifier Characters 3						RO	Chr	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

11.12 Menu 12: Threshold detectors, variable selectors and brake control function

Figure 11-24 Menu 12 logic diagram

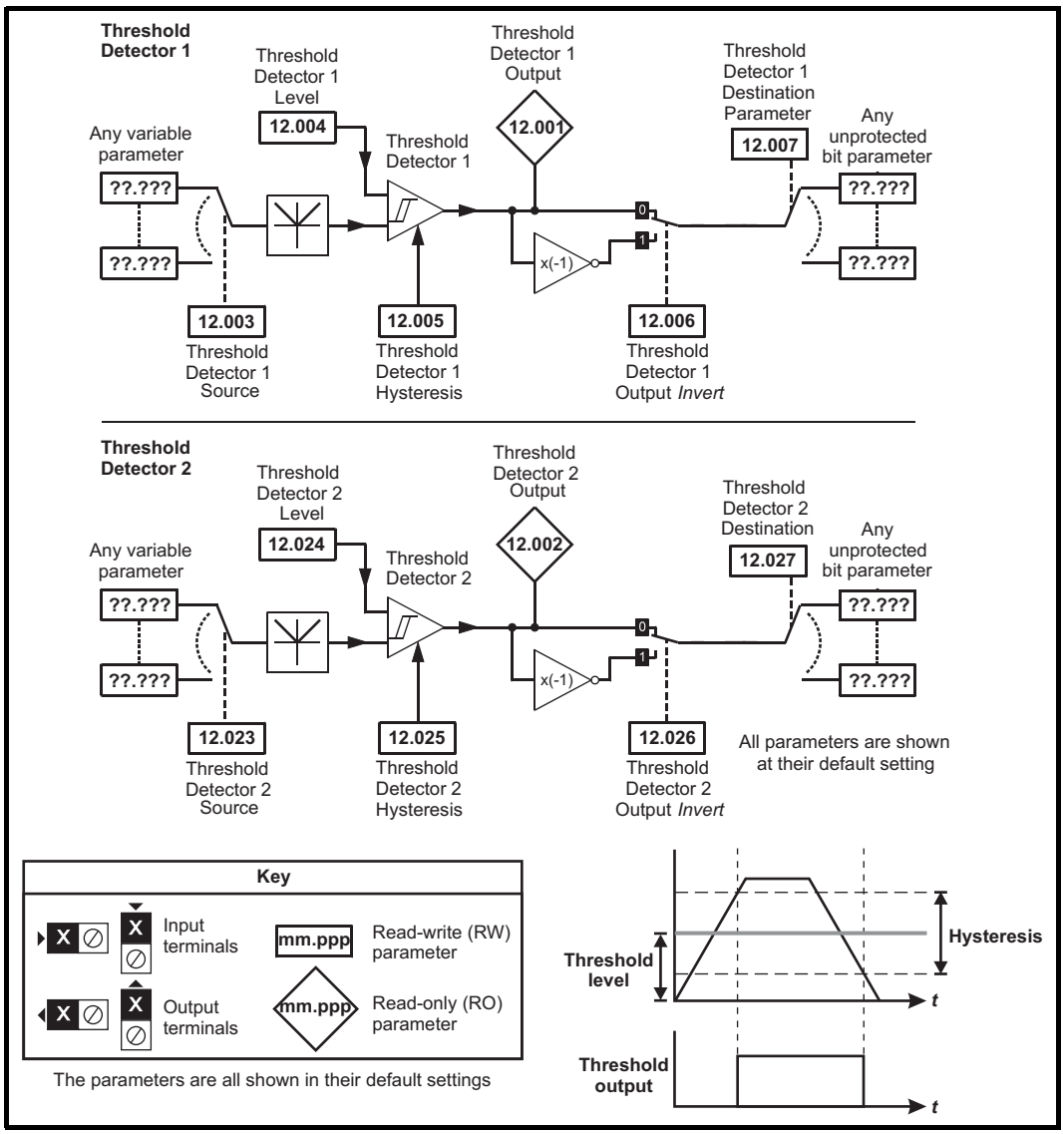
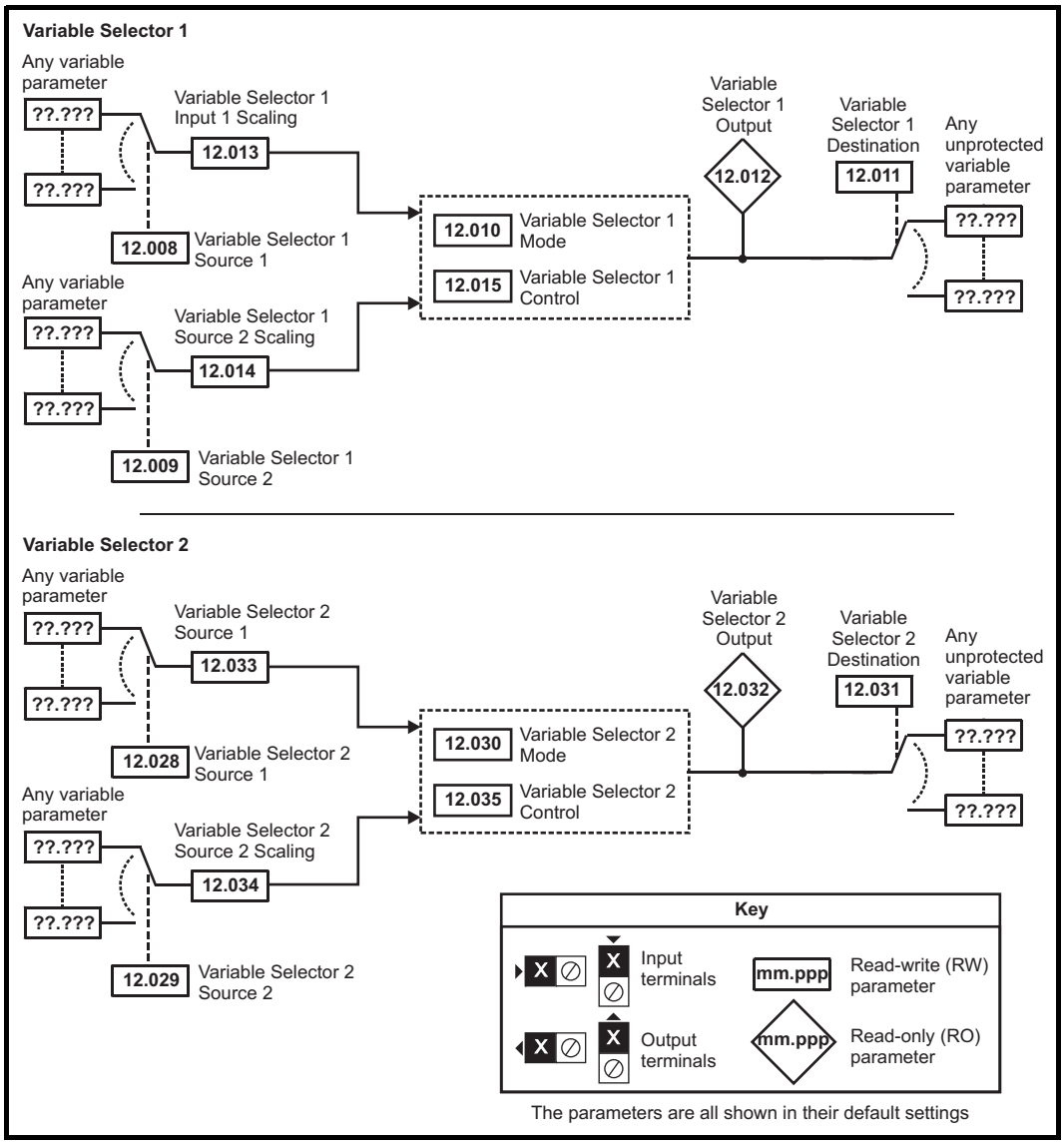


Figure 11-25 Menu 12 logic diagram (continued)



The parameters are all shown in their default settings

WARNING

The 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.

WARNING

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of a NV media card in boot mode or an SI-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

Figure 11-26 Open-loop brake function

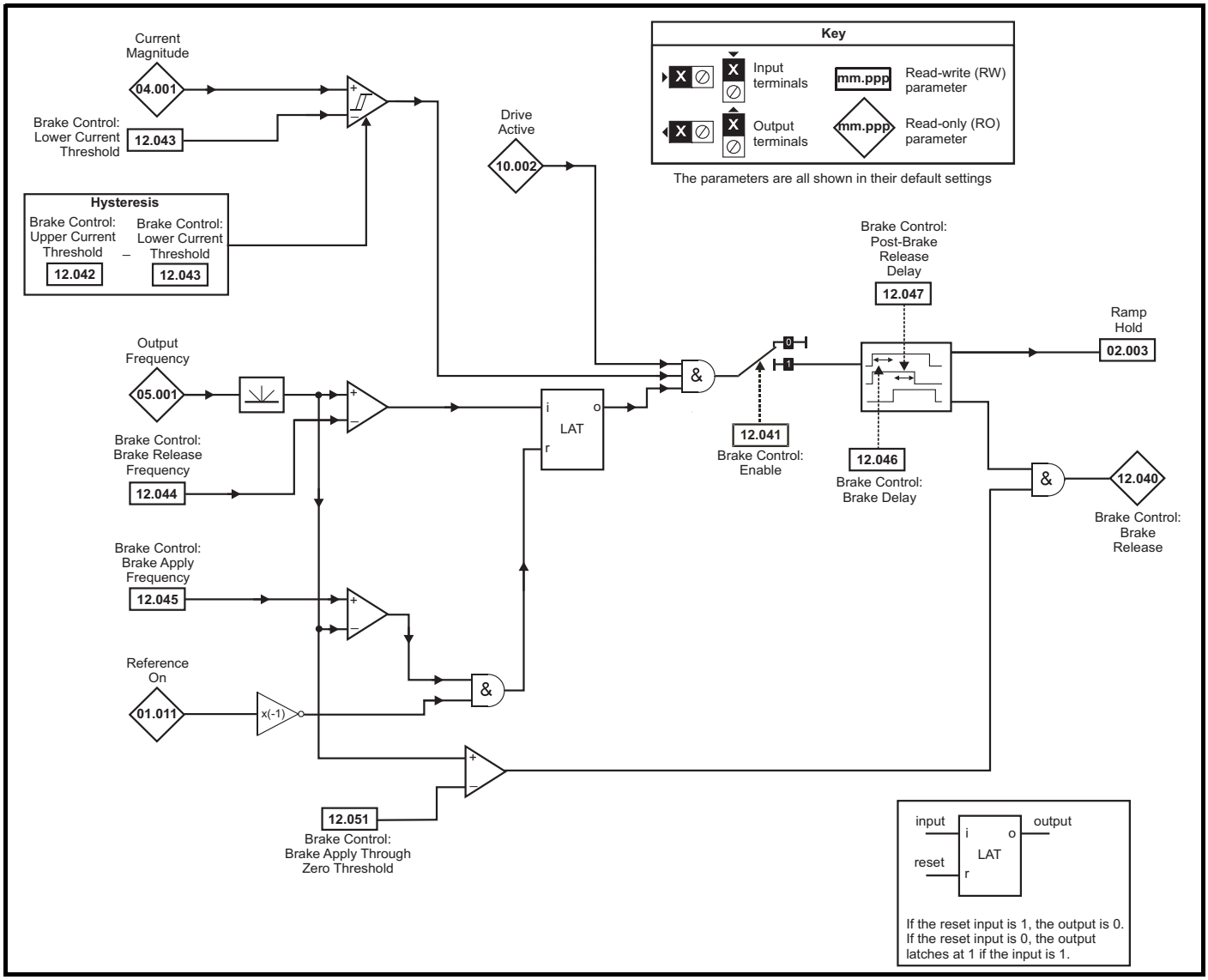
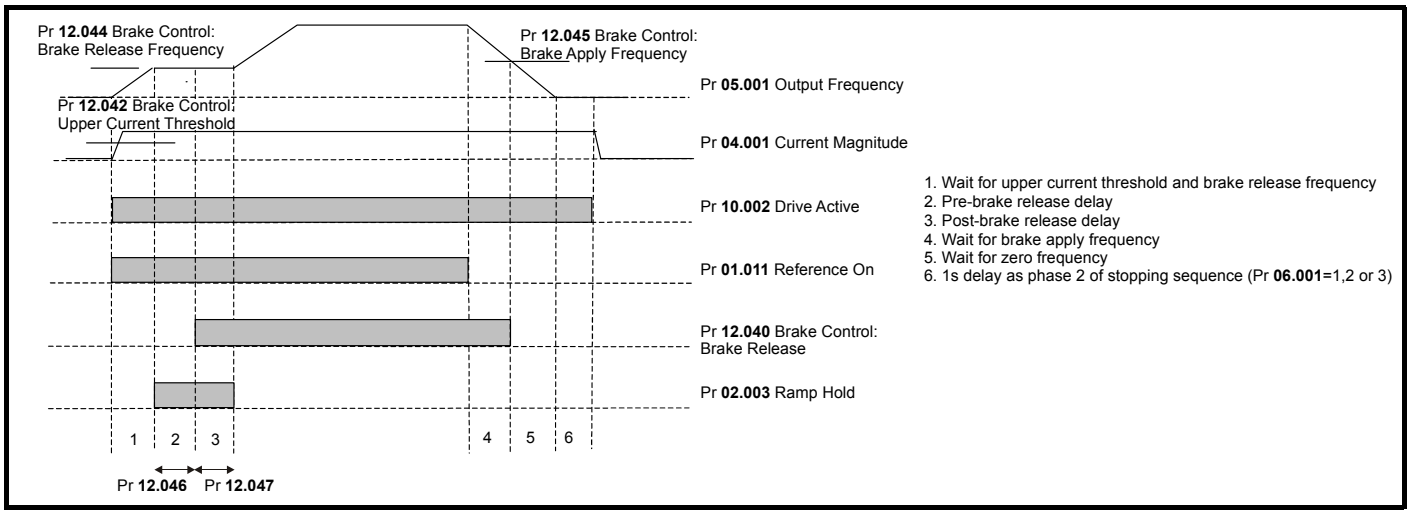


Figure 11-27 Open-loop brake sequence



WARNING

The 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.

WARNING

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of a NV media card in boot mode or an SI-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

Figure 11-28 RFC-A mode with brake controller mode (12.052) =1

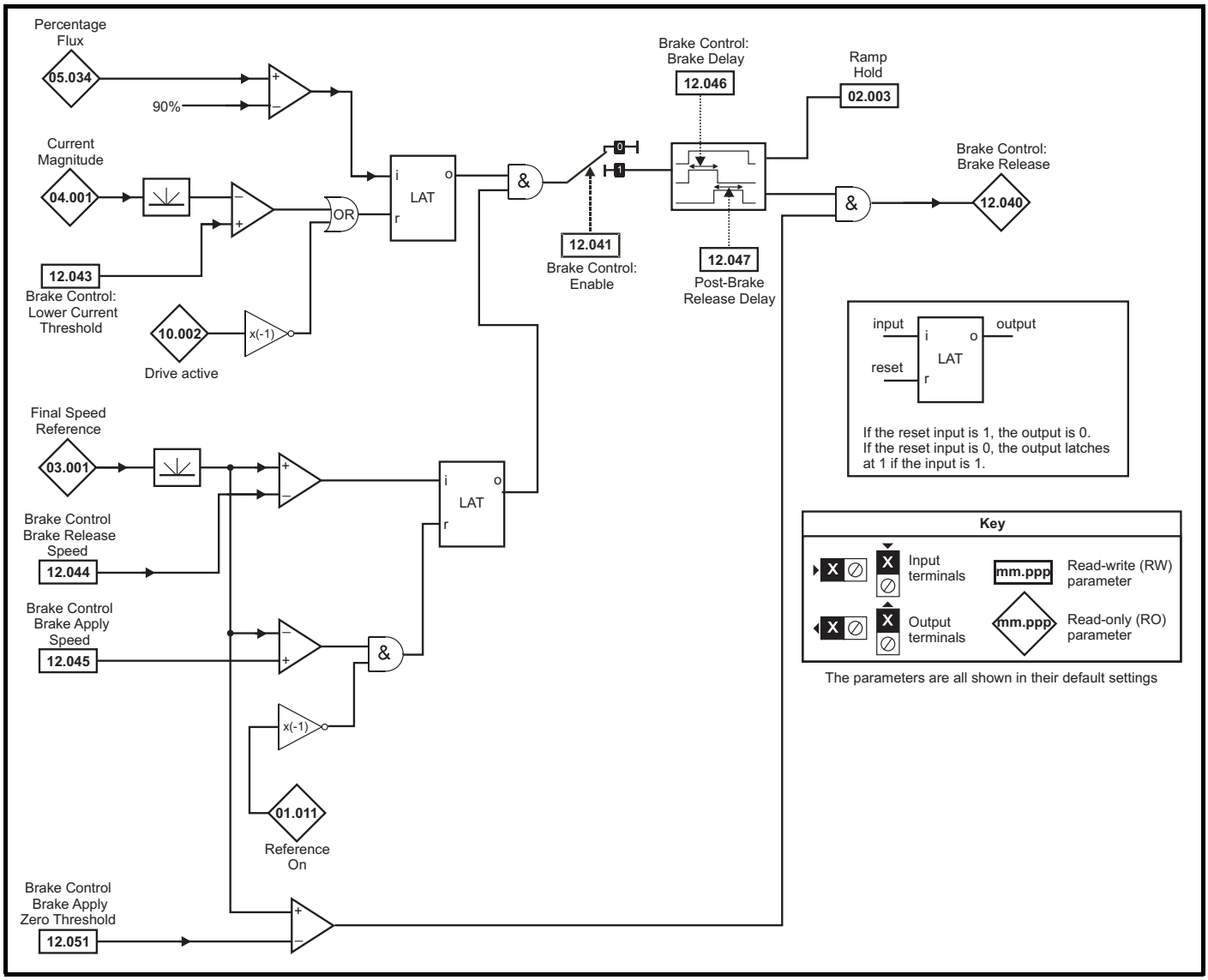
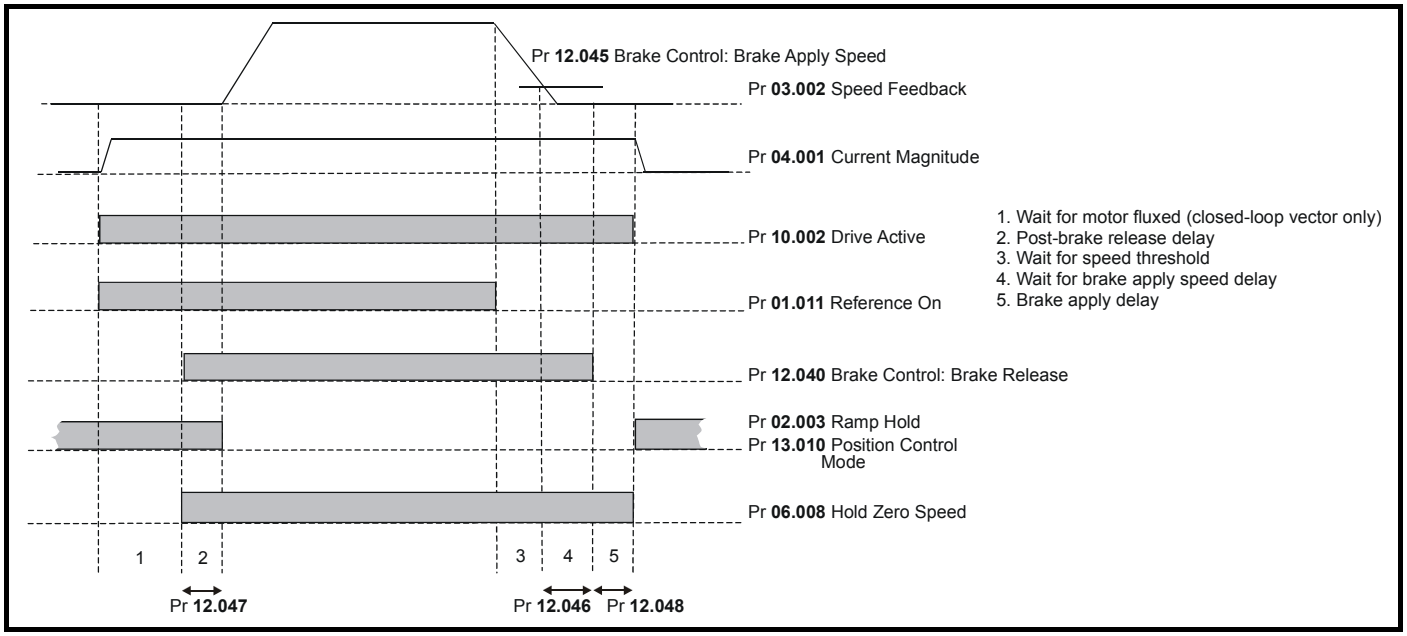


Figure 11-29 RFC-A brake sequence



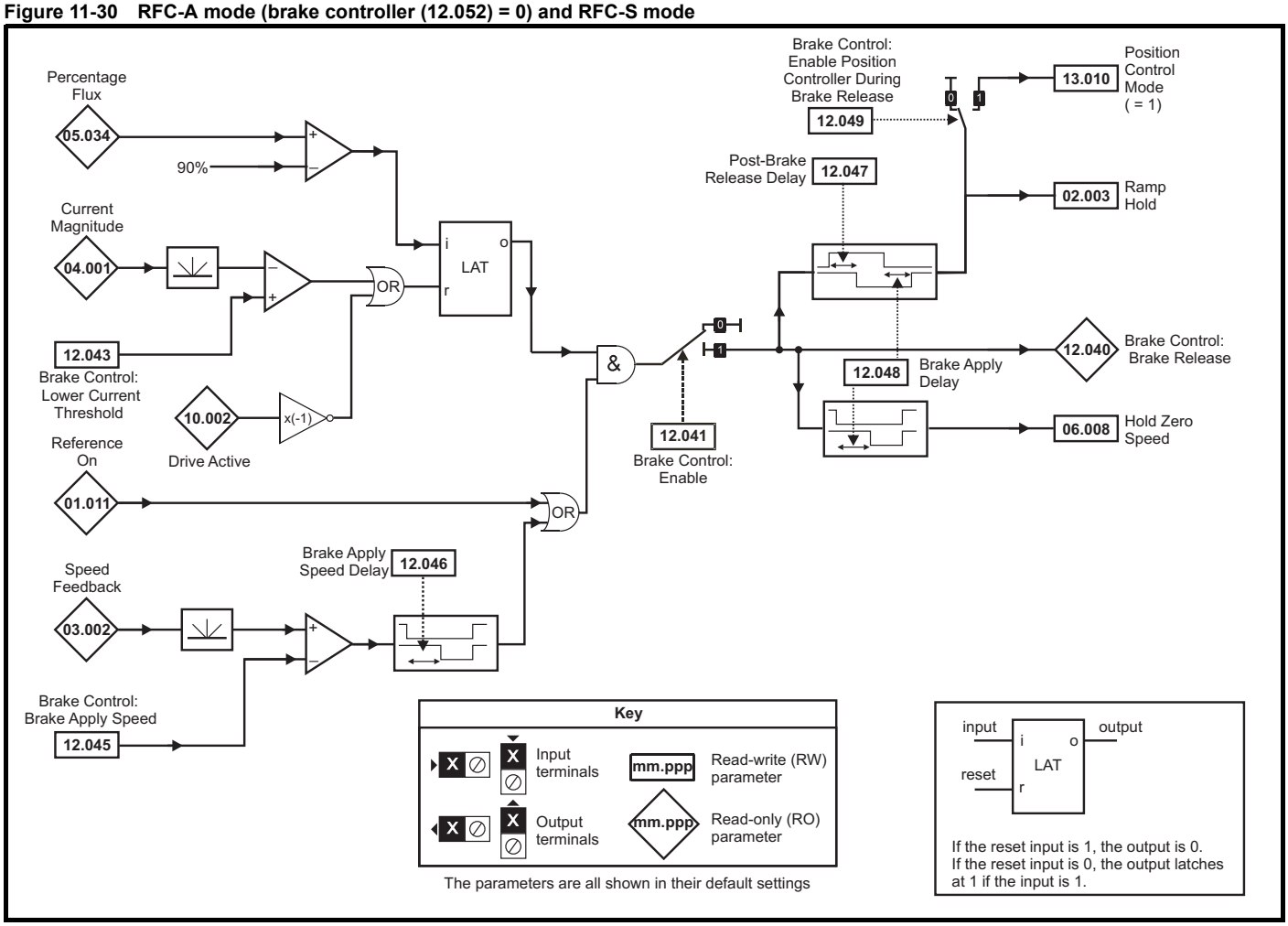
WARNING

The 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.

WARNING

The control terminal relay can be selected as an output to release a brake. If a drive is set up in this manner and a drive replacement takes place, prior to programming the drive on initial power up, the brake may be released.
When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered. The use of a NV media card in boot mode or an SI-Applications module can ensure drive parameters are immediately programmed to avoid this situation.

Figure 11-30 RFC-A mode (brake controller (12.052) = 0) and RFC-S mode

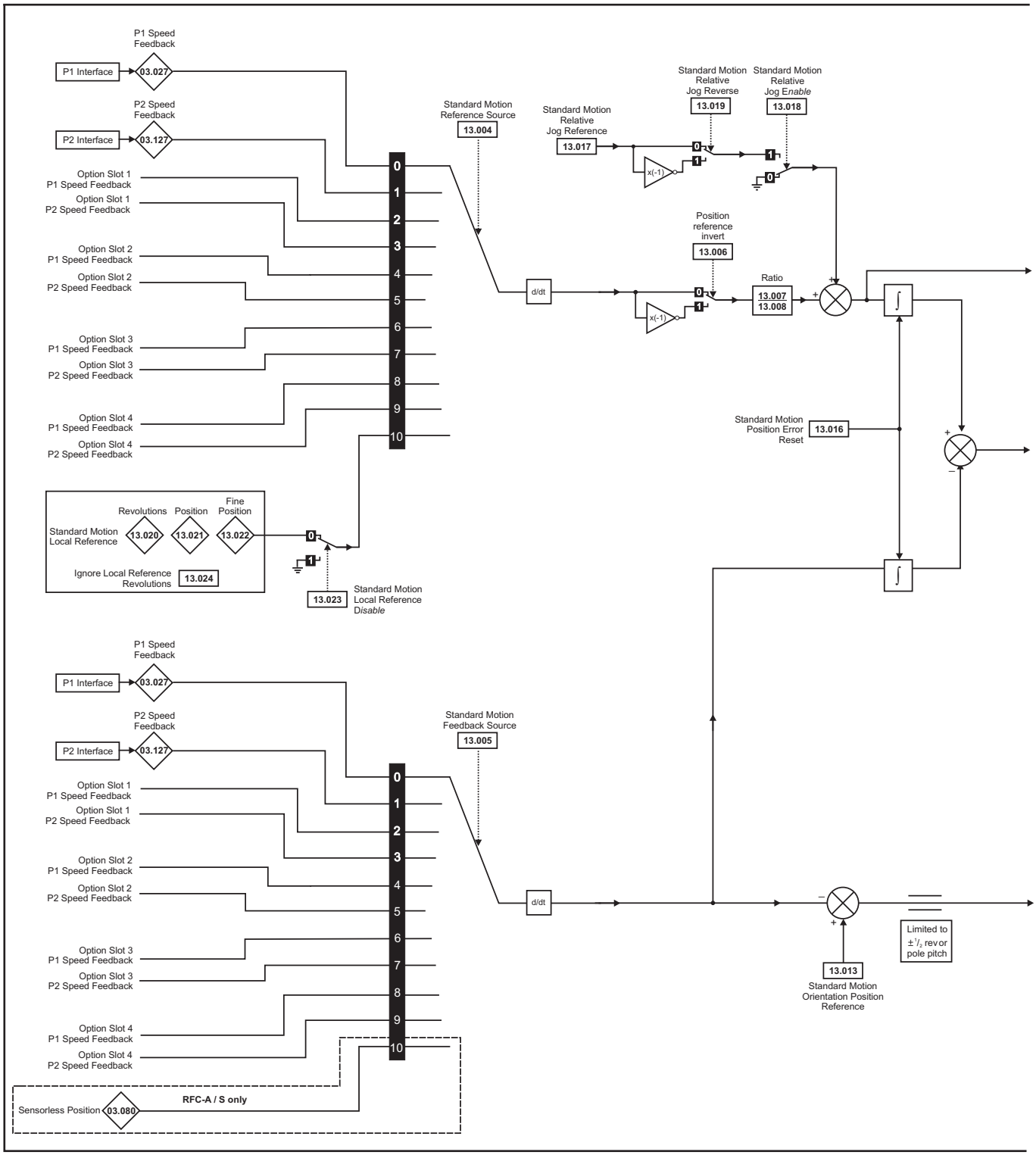


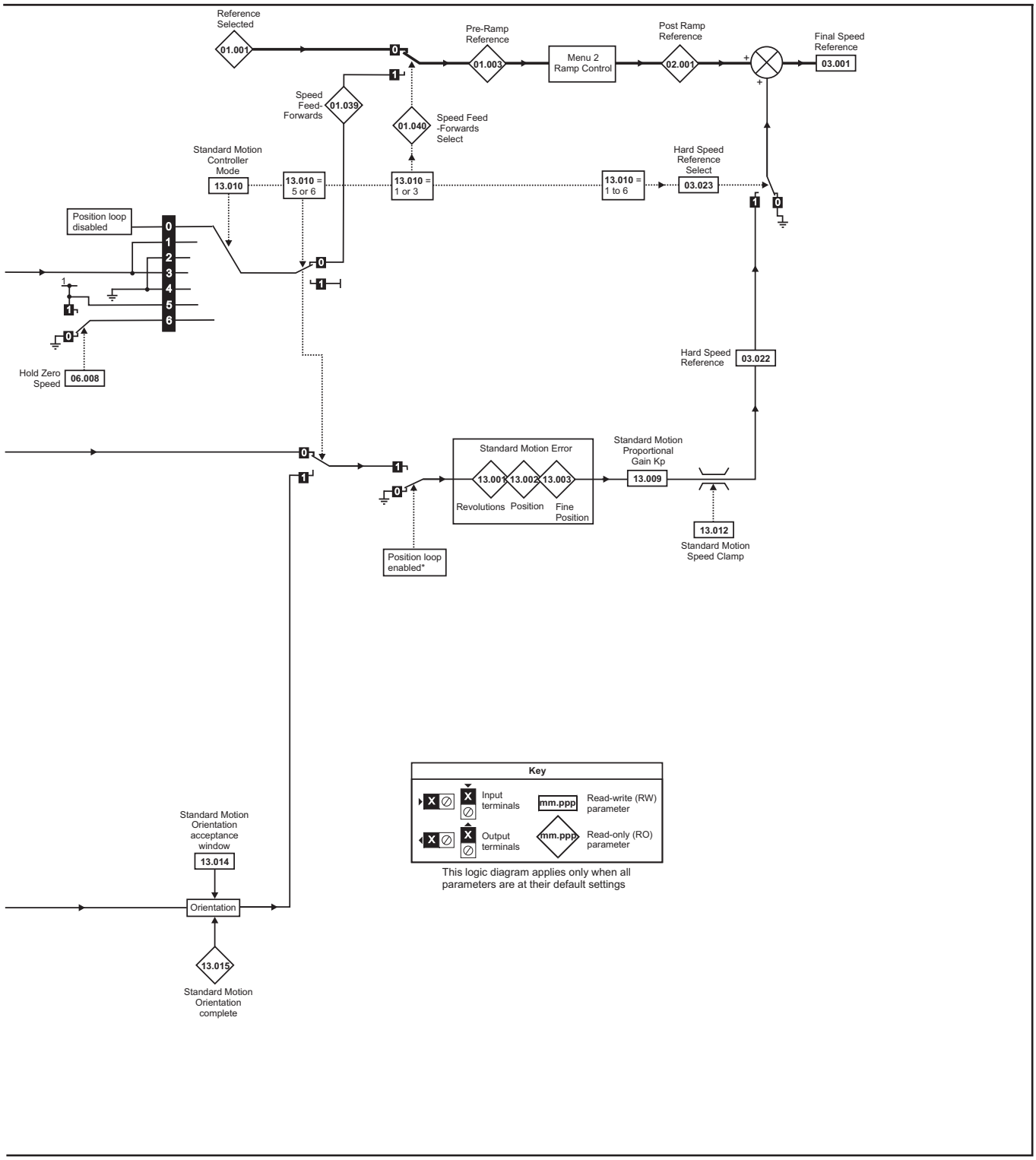
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC- A / S	OL	RFC-A	RFC-S						
12.001	Threshold Detector 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output						RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source	0.000 to 59.999		0.000			RW	Num			PT	US
12.004	Threshold Detector 1 Level	0.00 to 100.00 %		0.00 %			RW	Num				US
12.005	Threshold Detector 1 Hysteresis	0.00 to 25.00 %					RW	Num				US
12.006	Threshold Detector 1 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
12.007	Threshold Detector 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.008	Variable Selector 1 Source 1						RW	Num			PT	US
12.009	Variable Selector 1 Source 2						RW	Num			PT	US
12.010	Variable Selector 1 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9), Sectional (10)		Input 1 (0)			RW	Txt				US
12.011	Variable Selector 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.012	Variable Selector 1 Output	±100.00 %					RO	Num	ND	NC	PT	
12.013	Variable Selector 1 Source 1 Scaling	±4.000		1.000			RW	Num				US
12.014	Variable Selector 1 Source 2 Scaling						RW	Num				US
12.015	Variable Selector 1 Control	0.00 to 100.00		0.00			RW	Num				US
12.016	Variable Selector 1 Enable	Off (0) or On (1)		On (1)			RW	Bit				US
12.023	Threshold Detector 2 Source	0.000 to 59.999		0.000			RW	Num			PT	US
12.024	Threshold Detector 2 Level	0.00 to 100.00 %		0.00 %			RW	Num				US
12.025	Threshold Detector 2 Hysteresis	0.00 to 25.00 %					RW	Num				US
12.026	Threshold Detector 2 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
12.027	Threshold Detector 2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
12.028	Variable Selector 2 Source 1						RW	Num			PT	US
12.029	Variable Selector 2 Source 2						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						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
12.040	Brake Control: Brake Release						RO	Bit	ND	NC	PT	
12.041	Brake Control: Enable			Off (0)			RW	Bit				US
12.042	Brake Control: Upper Current Threshold	0 to 200 %		50 %			RW	Num				US
12.043	Brake Control: Lower Current Threshold	0 to 200 %		10 %			RW	Num				US
12.044	Brake Control: Brake Release Speed	0.0 to 20.0 Hz	0 to 200 rpm	1.0 Hz	10 rpm		RW	Num				US
12.045	Brake Control: Brake Apply Speed			2.0 Hz	5 rpm		RW	Num				US
12.046	Brake Control: Brake Delay	0.0 to 25.0 s		1.0 s			RW	Num				US
12.047	Brake Control: Post-brake Release Delay						RW	Num				US
12.048	Brake Control: Brake Apply Delay		0.0 to 25.0 s		1.0 s		RW	Num				US
12.049	Brake Control: Enable Position Control During Brake Release		Off (0) or On (1)		Off (0)		RW	Bit				US
12.050	Brake Control: Initial Direction	Ref (0), Forward (1), Reverse (2)		Ref (0)			RW	Txt				US
12.051	Brake Control: Brake Apply Through Zero Threshold	0.0 to 25.0 Hz	0 to 250 rpm	0.0 Hz	0 rpm		RW	Num				US
12.052	Brake Control: Mode		Off (0) or On (1)		Off (0)		RW	Bit				US

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

11.13 Menu 13: Standard motion controller

Figure 11-31 Menu 13 logic diagram





*The position controller is disabled and the error integrator is also reset under the following conditions:

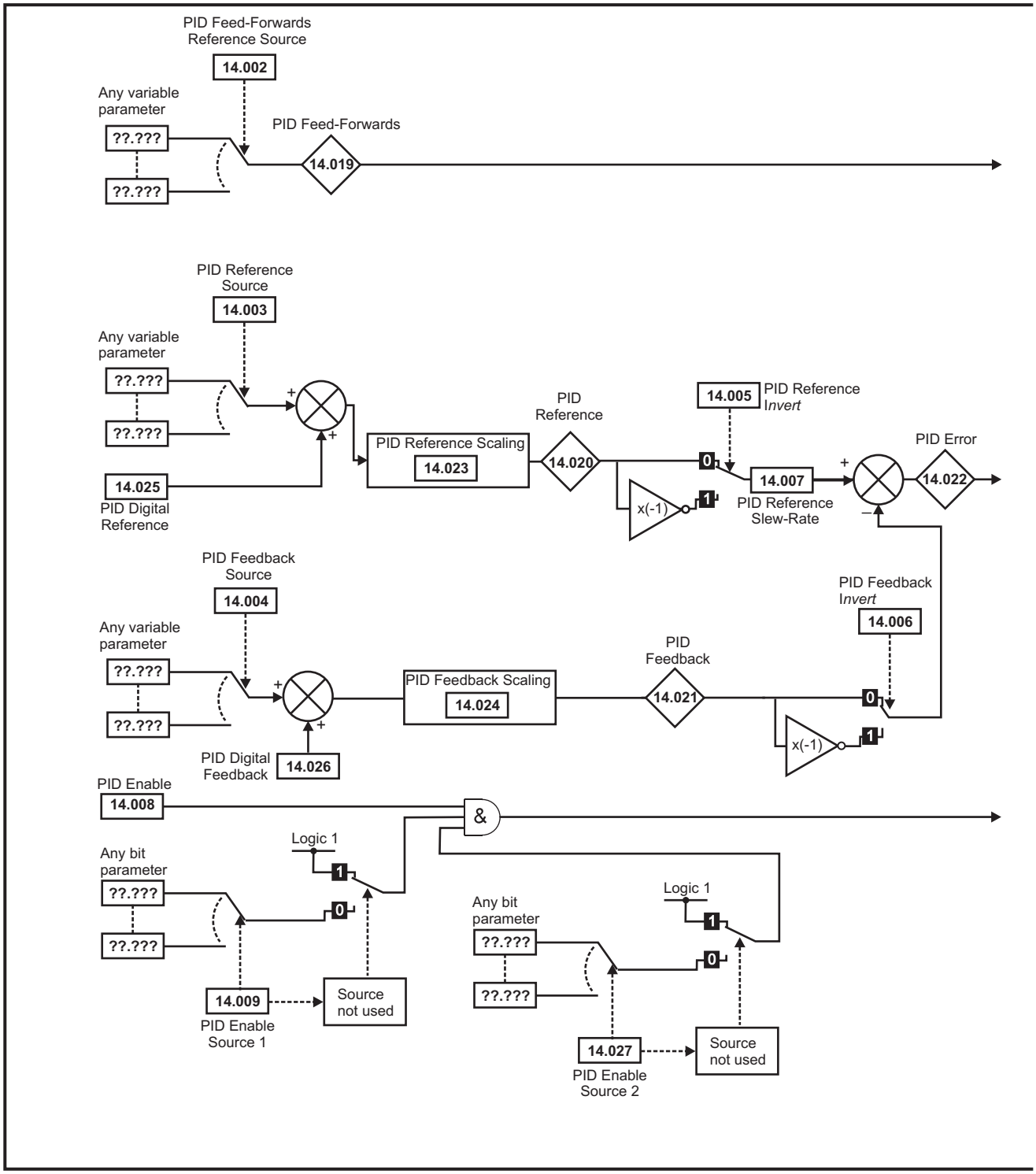
1. If the drive is disabled (i.e. inhibited, ready or tripped)
2. If the position controller mode (Pr **13.010**) is changed. The position controller is disabled transiently to reset the error integrator.
3. The absolute mode parameter (Pr **13.011**) is changed. The position controller is disabled transiently to reset the error integrator.
4. One of the position sources is invalid.
5. The position feedback initialized parameter (Pr **03.048**) is zero.

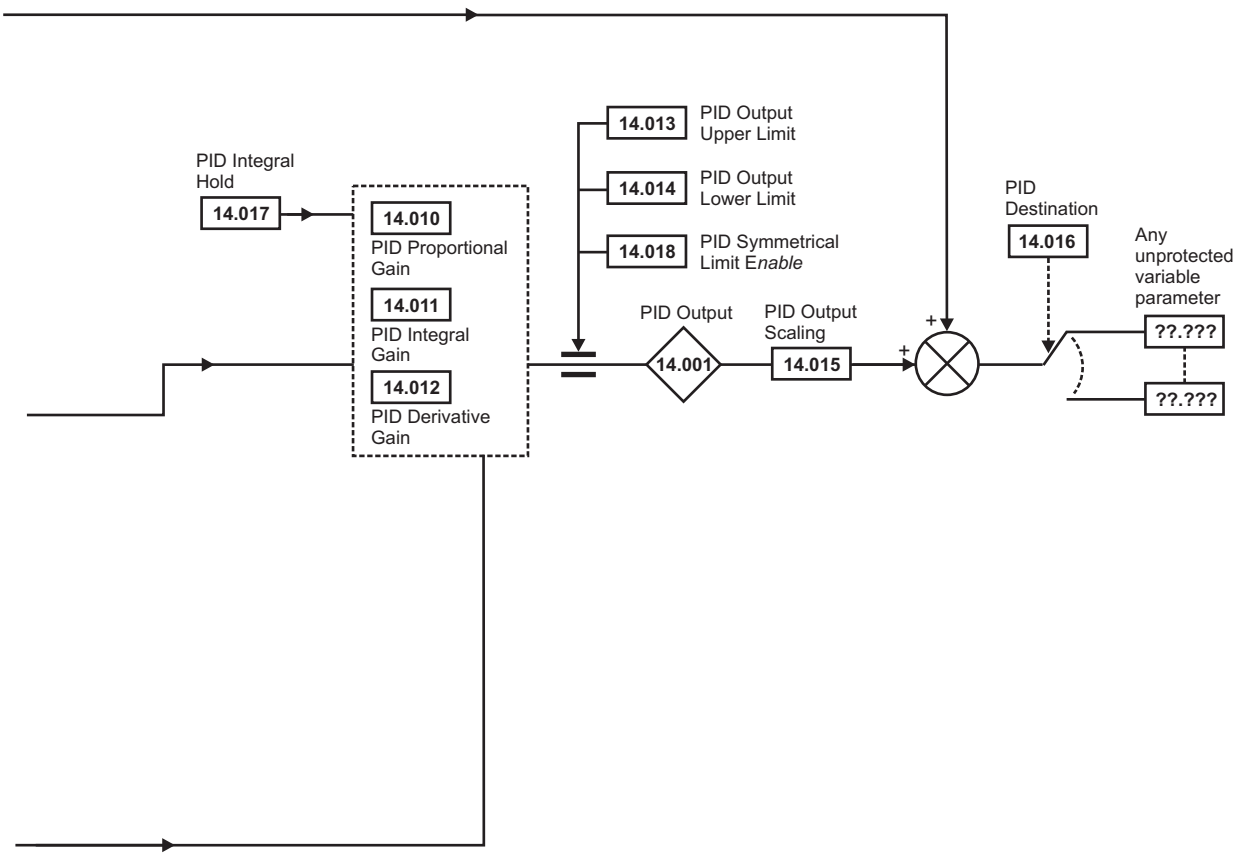
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
13.001	Standard Motion Revolutions Error	-32768 to 32767 revs					RO	Num	ND	NC	PT	
13.002	Standard Motion Position Error	-32768 to 32767					RO	Num	ND	NC	PT	
13.003	Standard Motion Fine Position Error						RO	Num	ND	NC	PT	
13.004	Standard Motion Reference Source	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), P1 Slot 3 (6), P2 Slot 3 (7), P1 Slot 4 (8), P2 Slot 4 (9), Local (10)		P1 Drive (0)			RW	Txt				US
13.005	Standard Motion Feedback Source	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), P1 Slot 3 (6), P2 Slot 3 (7), P1 Slot 4 (8), P2 Slot 4 (9)	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), P1 Slot 3 (6), P2 Slot 3 (7), P1 Slot 4 (8), P2 Slot 4 (9), Sensorless (10)	P1 Drive (0)			RW	Txt				US
13.006	Standard Motion Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				
13.007	Standard Motion Ratio Numerator	0.000 to 4.000		1.000			RW	Num				US
13.008	Standard Motion Ratio Denominator						RW	Num				US
13.009	Standard Motion Proportional Gain Kp	0.00 to 100.00		25.00			RW	Num				US
13.010	Standard Motion Controller Mode	Disabled (0), Rigid FFwd (1), Rigid (2), Non-Rigid FFwd (3), Non-Rigid (4), Orientate Stop (5), Orientate (6)		Disabled (0)			RW	Num				US
13.011	Standard Motion Absolute Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
13.012	Standard Motion Speed Clamp	0 to 250 rpm		150 rpm			RW	Num				US
13.013	Standard Motion Orientation Position Reference	0 to 65535		0			RW	Num				US
13.014	Standard Motion Orientation Acceptance Window	0 to 4096		256			RW	Num				US
13.015	Standard Motion Orientation Complete	Off (0) or On (1)					RO	Bit	ND	NC	PT	
13.016	Standard Motion Position Error Reset			Off (0)			RW	Bit		NC		
13.017	Standard Motion Relative Jog Reference	0.0 to 4000.0 rpm		0.0 rpm			RW	Num				US
13.018	Standard Motion Relative Jog Enable	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.019	Standard Motion Relative Jog Reverse						RW	Bit		NC		
13.020	Standard Motion Local Reference Revolutions	0 to 65535 revs		0 revs			RW	Num		NC		
13.021	Standard Motion Local Reference Position	0 to 65535		0			RW	Num		NC		
13.022	Standard Motion Local Reference Fine Position						RW	Num		NC		
13.023	Standard Motion Local Reference Disable	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.024	Standard Motion Ignore Local Reference Revolutions						RW	Bit				US

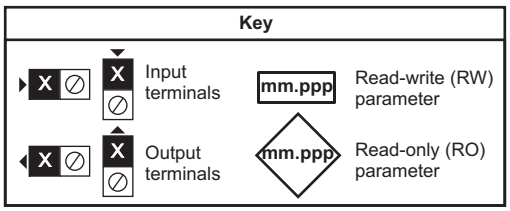
RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

11.14 Menu 14: User PID controller

Figure 11-32 Menu 14 Logic diagram







The parameters are all shown in their default settings

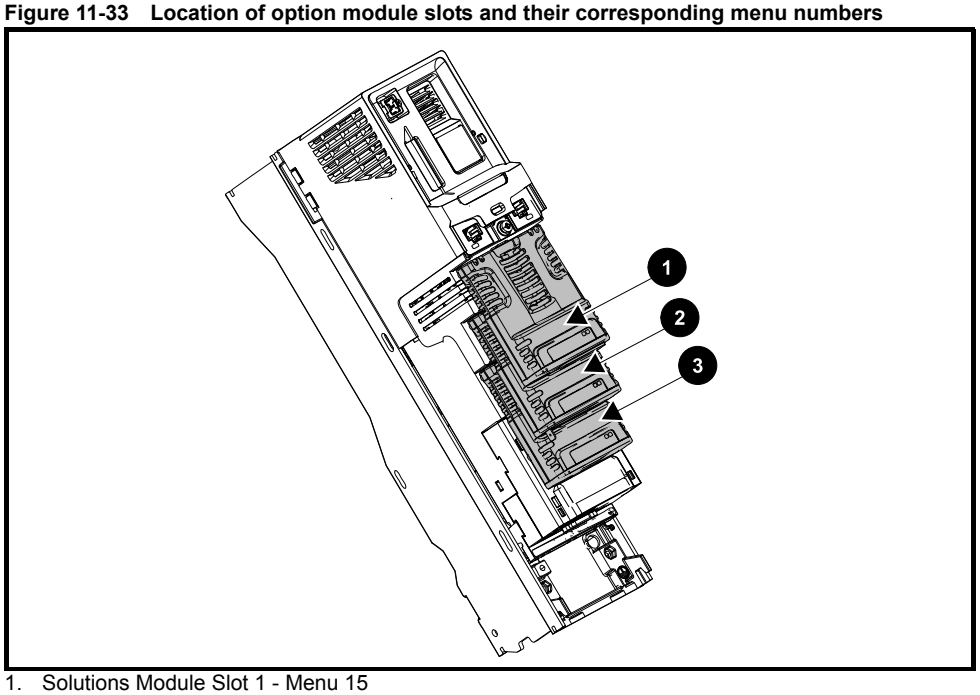
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
14.001	PID1 Output	±100.00 %					RO	Num	ND	NC	PT	
14.002	PID1 Feed-forwards Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.003	PID1 Reference Source						RW	Num			PT	US
14.004	PID1 Feedback Source						RW	Num			PT	US
14.005	PID1 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.006	PID1 Feedback Invert						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			0.500			RW	Num				US
14.012	PID1 Differential Gain			0.000			RW	Num				US
14.013	PID1 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.014	PID1 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.015	PID1 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.016	PID1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.017	PID1 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.018	PID1 Symmetrical Limit Enable						RW	Bit				US
14.019	PID1 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.020	PID1 Reference						RO	Num	ND	NC	PT	
14.021	PID1 Feedback						RO	Num	ND	NC	PT	
14.022	PID1 Error						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						RW	Num				US
14.025	PID1 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.026	PID1 Digital Feedback						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						RW	Num			PT	US
14.034	PID2 Feedback Source						RW	Num			PT	US
14.035	PID2 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.036	PID2 Feedback Invert						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			0.500			RW	Num				US
14.042	PID2 Differential Gain			0.000			RW	Num				US
14.043	PID2 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.044	PID2 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.045	PID2 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.046	PID2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.047	PID2 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.048	PID2 Symmetrical Limit Enable						RW	Bit				US
14.049	PID2 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.050	PID2 Reference						RO	Num	ND	NC	PT	
14.051	PID2 Feedback						RO	Num	ND	NC	PT	
14.052	PID2 Error						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						RW	Num				US
14.055	PID2 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.056	PID2 Digital Feedback						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			RW	Num				US

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	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						RW	Bit				US
14.062	PID1 Feedback Square Root Enable 2						RW	Bit				US

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

11.15 Menus 15, 16 and 17: Option module set-up

Figure 11-33 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 to 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	

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	
304	SI-Applications Plus	Automation (Applications)
305	SI-Applications Lite V2	
306	SI-Register	
443	SI-PROFIBUS	Fieldbus

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	Application Menu 1 Read-only Integer 2						RO	Num				US
18.003	Application Menu 1 Read-only Integer 3						RO	Num				US
18.004	Application Menu 1 Read-only Integer 4						RO	Num				US
18.005	Application Menu 1 Read-only Integer 5						RO	Num				US
18.006	Application Menu 1 Read-only Integer 6						RO	Num				US
18.007	Application Menu 1 Read-only Integer 7						RO	Num				US
18.008	Application Menu 1 Read-only Integer 8						RO	Num				US
18.009	Application Menu 1 Read-only Integer 9						RO	Num				US
18.010	Application Menu 1 Read-only Integer 10						RO	Num				US
18.011	Application Menu 1 Read-write Integer 11						RW	Num				US
18.012	Application Menu 1 Read-write Integer 12						RW	Num				US
18.013	Application Menu 1 Read-write Integer 13						RW	Num				US
18.014	Application Menu 1 Read-write Integer 14						RW	Num				US
18.015	Application Menu 1 Read-write Integer 15						RW	Num				US
18.016	Application Menu 1 Read-write Integer 16						RW	Num				US
18.017	Application Menu 1 Read-write Integer 17						RW	Num				US
18.018	Application Menu 1 Read-write Integer 18						RW	Num				US
18.019	Application Menu 1 Read-write Integer 19						RW	Num				US
18.020	Application Menu 1 Read-write Integer 20						RW	Num				US
18.021	Application Menu 1 Read-write Integer 21						RW	Num				US
18.022	Application Menu 1 Read-write Integer 22						RW	Num				US
18.023	Application Menu 1 Read-write Integer 23						RW	Num				US
18.024	Application Menu 1 Read-write Integer 24						RW	Num				US
18.025	Application Menu 1 Read-write Integer 25						RW	Num				US
18.026	Application Menu 1 Read-write Integer 26						RW	Num				US
18.027	Application Menu 1 Read-write Integer 27						RW	Num				US
18.028	Application Menu 1 Read-write Integer 28						RW	Num				US
18.029	Application Menu 1 Read-write Integer 29						RW	Num				US
18.030	Application Menu 1 Read-write Integer 30						RW	Num				US
18.031	Application Menu 1 Read-write bit 31	Off (0) or On (1)		Off (0)			RW	Bit				US
18.032	Application Menu 1 Read-write bit 32						RW	Bit				US
18.033	Application Menu 1 Read-write bit 33						RW	Bit				US
18.034	Application Menu 1 Read-write bit 34						RW	Bit				US
18.035	Application Menu 1 Read-write bit 35						RW	Bit				US
18.036	Application Menu 1 Read-write bit 36						RW	Bit				US
18.037	Application Menu 1 Read-write bit 37						RW	Bit				US
18.038	Application Menu 1 Read-write bit 38						RW	Bit				US
18.039	Application Menu 1 Read-write bit 39						RW	Bit				US
18.040	Application Menu 1 Read-write bit 40						RW	Bit				US
18.041	Application Menu 1 Read-write bit 41						RW	Bit				US
18.042	Application Menu 1 Read-write bit 42						RW	Bit				US
18.043	Application Menu 1 Read-write bit 43						RW	Bit				US
18.044	Application Menu 1 Read-write bit 44						RW	Bit				US
18.045	Application Menu 1 Read-write bit 45						RW	Bit				US
18.046	Application Menu 1 Read-write bit 46						RW	Bit				US
18.047	Application Menu 1 Read-write bit 47						RW	Bit				US
18.048	Application Menu 1 Read-write bit 48						RW	Bit				US
18.049	Application Menu 1 Read-write bit 49						RW	Bit				US
18.050	Application Menu 1 Read-write bit 50						RW	Bit				US
18.051	Application Menu 1 Power-down Save long Integer 51	-2^{31} to $+2^{31}-1$		0			RW	Num				PS
18.052	Application Menu 1 Power-down Save long Integer 52						RW	Num				PS
18.053	Application Menu 1 Power-down Save long Integer 53						RW	Num				PS
18.054	Application Menu 1 Power-down Save long Integer 54						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	Application Menu 2 Read-only Integer 2						RO	Num	ND	NC	PT	
19.003	Application Menu 2 Read-only Integer 3						RO	Num	ND	NC	PT	
19.004	Application Menu 2 Read-only Integer 4						RO	Num	ND	NC	PT	
19.005	Application Menu 2 Read-only Integer 5						RO	Num	ND	NC	PT	
19.006	Application Menu 2 Read-only Integer 6						RO	Num	ND	NC	PT	
19.007	Application Menu 2 Read-only Integer 7						RO	Num	ND	NC	PT	
19.008	Application Menu 2 Read-only Integer 8						RO	Num	ND	NC	PT	
19.009	Application Menu 2 Read-only Integer 9						RO	Num	ND	NC	PT	
19.010	Application Menu 2 Read-only Integer 10						RO	Num	ND	NC	PT	
19.011	Application Menu 2 Read-write Integer 11						RW	Num				US
19.012	Application Menu 2 Read-write Integer 12						RW	Num				US
19.013	Application Menu 2 Read-write Integer 13						RW	Num				US
19.014	Application Menu 2 Read-write Integer 14						RW	Num				US
19.015	Application Menu 2 Read-write Integer 15						RW	Num				US
19.016	Application Menu 2 Read-write Integer 16						RW	Num				US
19.017	Application Menu 2 Read-write Integer 17						RW	Num				US
19.018	Application Menu 2 Read-write Integer 18						RW	Num				US
19.019	Application Menu 2 Read-write Integer 19						RW	Num				US
19.020	Application Menu 2 Read-write Integer 20						RW	Num				US
19.021	Application Menu 2 Read-write Integer 21						RW	Num				US
19.022	Application Menu 2 Read-write Integer 22						RW	Num				US
19.023	Application Menu 2 Read-write Integer 23						RW	Num				US
19.024	Application Menu 2 Read-write Integer 24						RW	Num				US
19.025	Application Menu 2 Read-write Integer 25						RW	Num				US
19.026	Application Menu 2 Read-write Integer 26						RW	Num				US
19.027	Application Menu 2 Read-write Integer 27						RW	Num				US
19.028	Application Menu 2 Read-write Integer 28						RW	Num				US
19.029	Application Menu 2 Read-write Integer 29						RW	Num				US
19.030	Application Menu 2 Read-write Integer 30						RW	Num				US
19.031	Application Menu 2 Read-write bit 31	Off (0) or On (1)		Off (0)			RW	Bit				US
19.032	Application Menu 2 Read-write bit 32						RW	Bit				US
19.033	Application Menu 2 Read-write bit 33						RW	Bit				US
19.034	Application Menu 2 Read-write bit 34						RW	Bit				US
19.035	Application Menu 2 Read-write bit 35						RW	Bit				US
19.036	Application Menu 2 Read-write bit 36						RW	Bit				US
19.037	Application Menu 2 Read-write bit 37						RW	Bit				US
19.038	Application Menu 2 Read-write bit 38						RW	Bit				US
19.039	Application Menu 2 Read-write bit 39						RW	Bit				US
19.040	Application Menu 2 Read-write bit 40						RW	Bit				US
19.041	Application Menu 2 Read-write bit 41						RW	Bit				US
19.042	Application Menu 2 Read-write bit 42						RW	Bit				US
19.043	Application Menu 2 Read-write bit 43						RW	Bit				US
19.044	Application Menu 2 Read-write bit 44						RW	Bit				US
19.045	Application Menu 2 Read-write bit 45						RW	Bit				US
19.046	Application Menu 2 Read-write bit 46						RW	Bit				US
19.047	Application Menu 2 Read-write bit 47						RW	Bit				US
19.048	Application Menu 2 Read-write bit 48						RW	Bit				US
19.049	Application Menu 2 Read-write bit 49						RW	Bit				US
19.050	Application Menu 2 Read-write bit 50						RW	Bit				US
19.051	Application Menu 2 Power-down Save long Integer 51	-2^{31} to $+2^{31}-1$		0			RW	Num				PS
19.052	Application Menu 2 Power-down Save long Integer 52						RW	Num				PS
19.053	Application Menu 2 Power-down Save long Integer 53						RW	Num				PS
19.054	Application Menu 2 Power-down Save long Integer 54						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	Application Menu 3 Read-write Integer 1	-32768 to 32767		0			RW	Num				
20.002	Application Menu 3 Read-write Integer 2						RW	Num				
20.003	Application Menu 3 Read-write Integer 3						RW	Num				
20.004	Application Menu 3 Read-write Integer 4						RW	Num				
20.005	Application Menu 3 Read-write Integer 5						RW	Num				
20.006	Application Menu 3 Read-write Integer 6						RW	Num				
20.007	Application Menu 3 Read-write Integer 7						RW	Num				
20.008	Application Menu 3 Read-write Integer 8						RW	Num				
20.009	Application Menu 3 Read-write Integer 9						RW	Num				
20.010	Application Menu 3 Read-write Integer 10						RW	Num				
20.011	Application Menu 3 Read-write Integer 11						RW	Num				
20.012	Application Menu 3 Read-write Integer 12						RW	Num				
20.013	Application Menu 3 Read-write Integer 13						RW	Num				
20.014	Application Menu 3 Read-write Integer 14						RW	Num				
20.015	Application Menu 3 Read-write Integer 15						RW	Num				
20.016	Application Menu 3 Read-write Integer 16						RW	Num				
20.017	Application Menu 3 Read-write Integer 17						RW	Num				
20.018	Application Menu 3 Read-write Integer 18						RW	Num				
20.019	Application Menu 3 Read-write Integer 19						RW	Num				
20.020	Application Menu 3 Read-write Integer 20						RW	Num				
20.021	Application Menu 3 Read-write Long Integer 21	-2^{31} to $+2^{31}-1$					RW	Num				
20.022	Application Menu 3 Read-write Long Integer 22						RW	Num				
20.023	Application Menu 3 Read-write Long Integer 23						RW	Num				
20.024	Application Menu 3 Read-write Long Integer 24						RW	Num				
20.025	Application Menu 3 Read-write Long Integer 25						RW	Num				
20.026	Application Menu 3 Read-write Long Integer 26						RW	Num				
20.027	Application Menu 3 Read-write Long Integer 27						RW	Num				
20.028	Application Menu 3 Read-write Long Integer 28						RW	Num				
20.029	Application Menu 3 Read-write Long Integer 29						RW	Num				
20.030	Application Menu 3 Read-write Long Integer 30						RW	Num				
20.031	Application Menu 3 Read-write Long Integer 31						RW	Num				
20.032	Application Menu 3 Read-write Long Integer 32						RW	Num				
20.033	Application Menu 3 Read-write Long Integer 33						RW	Num				
20.034	Application Menu 3 Read-write Long Integer 34						RW	Num				
20.035	Application Menu 3 Read-write Long Integer 35						RW	Num				
20.036	Application Menu 3 Read-write Long Integer 36						RW	Num				
20.037	Application Menu 3 Read-write Long Integer 37						RW	Num				
20.038	Application Menu 3 Read-write Long Integer 38						RW	Num				
20.039	Application Menu 3 Read-write Long Integer 39						RW	Num				
20.040	Application Menu 3 Read-write Long Integer 40						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 21: Second motor parameters

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
21.001	M2 Maximum Reference Clamp	±VM_POSITIVE_REF_CLAMP			50.0	1500.0	3000	RW	Num				US
21.002	M2 Minimum Reference Clamp	±VM_NEGATIVE_REF_CLAMP2	±VM_NEGATIVE_REF_CLAMP1		0.0			RW	Num				US
21.003	M2 Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2) Preset (3), Keypad (4), Precision (5) Keypad Ref (6)			Preset (3)			RW	Txt				US
21.004	M2 Acceleration Rate 1	±VM_ACCEL_RATE			0.0	0.000		RW	Num				US
21.005	M2 Deceleration Rate 1							RW	Num				US
21.006	M2 Rated Frequency	0.0 to 3000.0 Hz	0.0 to 1667.0 Hz		Eur - 50.0 Hz USA - 60.0 Hz			RW	Num				US
21.007	M2 Rated Current	±VM_RATED_CURRENT			0.000 A			RW	Num		RA		US
21.008	M2 Rated Speed	0 to 180000 rpm	0 to 50000.0 rpm		Eur - 1500 rpm USA - 1800 rpm	Eur - 1450.0 rpm USA - 1800.0 rpm	3000.00 rpm	RW	Num				US
21.009	M2 Rated Voltage	±VM_AC_VOLTAGE_SET			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
21.010	M2 Rated Power Factor	0.000 to 1.000			0.850			RW	Num		RA		US
21.011	M2 Number Of Motor Poles	Automatic (0) to 480 Poles (240)			Automatic (0)		6 Poles (3)	RW	Txt				US
21.012	M2 Stator Resistance	0.000000 to 1000.000000 Ω			0.000000 Ω			RW	Num		RA		US
21.014	M2 Transient Inductance / Ld	0.000 to 500.000 mH			0.000 mH			RW	Num		RA		US
21.015	Motor 2 Active	Off (0) or On (1)						RO	Bit	ND	NC	PT	
21.016	M2 Motor Thermal Time Constant 1	1.0 to 3000.0 s			89.0 s			RW	Num				US
21.017	M2 Speed Controller Proportional Gain Kp1		0.0000 to 200.0000			0.0300		RW	Num				US
21.018	M2 Speed Controller Integral Gain Ki1		0.00 to 655.35			0.01	1.00	RW	Num				US
21.019	M2 Speed Controller Differential Feedback Gain Kd1		0.00000 to 0.65535			0.00000		RW	Num				US
21.020	M2 Position Feedback Phase Angle			0.0 to 359.9 °				RW	Num	ND			US
21.021	M2 Motor Control Feedback Select		P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), P1 Slot 3 (6), P2 Slot 3 (7), P1 Slot 4 (8), P2 Slot 4 (9)			P1 Drive (0)		RW	Txt				US
21.022	M2 Current Controller Kp Gain	0 to 30000			20	150		RW	Num				US
21.023	M2 Current Controller Ki Gain				40	2000		RW	Num				US
21.024	M2 Stator Inductance	0.00 to 5000.00 mH			0.00 mH			RW	Num		RA		US
21.025	M2 Saturation Breakpoint 1		0.0 to 100.0 %			50.0 %		RW	Num				US
21.026	M2 Saturation Breakpoint 3					75.0 %		RW	Num				US
21.027	M2 Motoring Current Limit	±VM_MOTOR2_CURRENT_LIMIT			165.0 %		0.0 %	RW	Num		RA		US
21.028	M2 Regenerating Current Limit							RW	Num		RA		US
21.029	M2 Symmetrical Current Limit							RW	Num		RA		US
21.032	M2 Current Reference Filter Time Constant 1		0.0 to 25.0 ms			0.0 ms		RW	Num				US
21.033	M2 Low Speed Thermal Protection Mode	0 or 1			0			RW	Num				US
21.034	M2 Current Controller Mode		Off (0) or On (1)			Off (0)		RW	Bit				US
21.035	M2 Load Compensation Param 1		0 to 0			0		RW	Num				US
21.036	M2 Load Compensation Param 2							RW	Num				US
21.037	M2 Load Compensation Param 3							RW	Num				US
21.038	M2 Load Compensation Param 4							RW	Num				US
21.039	M2 Motor Thermal Time Constant 2	1.0 to 3000.0 s			89.0 s			RW	Num				US
21.040	M2 Motor Thermal Time Constant 2 Scaling	0 to 100 %			0 %			RW	Num				US
21.041	M2 Saturation Breakpoint 2		0.0 to 100.0 %			0.0 %		RW	Num				US
21.042	M2 Saturation Breakpoint 4							RW	Num				US
21.043	RFC-A> M2 Torque Per Amp		0.00 to 500.00			0.00		RO	Num	ND	NC	PT	
	RFC-S> M2 Torque Per Amp			0.00 to 500.00 Nm/A			0.00 Nm/A	RW	Num				US
21.044	M2 No-load Lq			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
21.045	M2 Rated Load Lq							RW	Num		RA		US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
21.046	M2 No-load Phase Offset			0.0 to 359.9 °			0.0 °	RW	Num				US
21.047	M2 Rated Load Phase Offset							RW	Num				US
21.048	M2 Maximum Low Speed Sensorless Mode Current			0.0 to 1000.0 %			0.0 %	RW	Num		RA		US
21.049	M2 Cogging Data Parameter 1			0 to 1000			0	RW	Num				US
21.050	M2 Cogging Data Parameter 2							RW	Num				US
21.051	M2 Cogging Data Parameter 3							RW	Num				US
21.052	M2 Cogging Data Parameter 4							RW	Num				US
21.053	M2 Cogging Data Parameter 5							RW	Num				US
21.054	M2 Cogging Data Parameter 6							RW	Num				US
21.055	M2 Cogging Data Parameter 7							RW	Num				US
21.056	M2 Cogging Data Parameter 8							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

11.20 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					1.007		RW	Num			PT	US
22.002	Parameter 00.002 Set-up					1.006		RW	Num			PT	US
22.003	Parameter 00.003 Set-up					2.011		RW	Num			PT	US
22.004	Parameter 00.004 Set-up					2.021		RW	Num			PT	US
22.005	Parameter 00.005 Set-up					1.014		RW	Num			PT	US
22.006	Parameter 00.006 Set-up					4.007		RW	Num			PT	US
22.007	Parameter 00.007 Set-up				5.014	3.010		RW	Num			PT	US
22.008	Parameter 00.008 Set-up				5.015	3.011		RW	Num			PT	US
22.009	Parameter 00.009 Set-up				5.013	3.012		RW	Num			PT	US
22.010	Parameter 00.010 Set-up				5.004	3.002		RW	Num			PT	US
22.011	Parameter 00.011 Set-up				5.001		3.029	RW	Num			PT	US
22.012	Parameter 00.012 Set-up					4.001		RW	Num			PT	US
22.013	Parameter 00.013 Set-up					4.002		RW	Num			PT	US
22.014	Parameter 00.014 Set-up					4.011		RW	Num			PT	US
22.015	Parameter 00.015 Set-up					2.004		RW	Num			PT	US
22.016	Parameter 00.016 Set-up				0.000	2.002		RW	Num			PT	US
22.017	Parameter 00.017 Set-up				8.026	4.012		RW	Num			PT	US
22.018	Parameter 00.018 Set-up					0.000		RW	Num			PT	US
22.019	Parameter 00.019 Set-up					0.000		RW	Num			PT	US
22.020	Parameter 00.020 Set-up					0.000		RW	Num			PT	US
22.021	Parameter 00.021 Set-up					0.000		RW	Num			PT	US
22.022	Parameter 00.022 Set-up					1.010		RW	Num			PT	US
22.023	Parameter 00.023 Set-up					1.005		RW	Num			PT	US
22.024	Parameter 00.024 Set-up					1.021		RW	Num			PT	US
22.025	Parameter 00.025 Set-up					1.022		RW	Num			PT	US
22.026	Parameter 00.026 Set-up				1.023	3.008		RW	Num			PT	US
22.027	Parameter 00.027 Set-up				1.024	3.034		RW	Num			PT	US
22.028	Parameter 00.028 Set-up					6.013		RW	Num			PT	US
22.029	Parameter 00.029 Set-up		0.000 to 59.999			11.036		RW	Num			PT	US
22.030	Parameter 00.030 Set-up					11.042		RW	Num			PT	US
22.031	Parameter 00.031 Set-up					11.033		RW	Num			PT	US
22.032	Parameter 00.032 Set-up					11.032		RW	Num			PT	US
22.033	Parameter 00.033 Set-up				6.009	5.016	0.000	RW	Num			PT	US
22.034	Parameter 00.034 Set-up					11.030		RW	Num			PT	US
22.035	Parameter 00.035 Set-up					0.000		RW	Num			PT	US
22.036	Parameter 00.036 Set-up					0.000		RW	Num			PT	US
22.037	Parameter 00.037 Set-up					24.010		RW	Num			PT	US
22.038	Parameter 00.038 Set-up					4.013		RW	Num			PT	US
22.039	Parameter 00.039 Set-up					4.014		RW	Num			PT	US
22.040	Parameter 00.040 Set-up					5.012		RW	Num			PT	US
22.041	Parameter 00.041 Set-up					5.018		RW	Num			PT	US
22.042	Parameter 00.042 Set-up					5.011		RW	Num			PT	US
22.043	Parameter 00.043 Set-up				5.010		3.025	RW	Num			PT	US
22.044	Parameter 00.044 Set-up				5.009			RW	Num			PT	US
22.045	Parameter 00.045 Set-up				5.008		4.015	RW	Num			PT	US
22.046	Parameter 00.046 Set-up					5.007		RW	Num			PT	US
22.047	Parameter 00.047 Set-up				5.006		0.000	RW	Num			PT	US
22.048	Parameter 00.048 Set-up					11.031		RW	Num			PT	US
22.049	Parameter 00.049 Set-up					11.044		RW	Num			PT	US
22.050	Parameter 00.050 Set-up					11.029		RW	Num			PT	US
22.051	Parameter 00.051 Set-up					10.037		RW	Num			PT	US
22.052	Parameter 00.052 Set-up							RW	Num			PT	US
22.053	Parameter 00.053 Set-up							RW	Num			PT	US
22.054	Parameter 00.054 Set-up							RW	Num			PT	US
22.055	Parameter 00.055 Set-up					0.000		RW	Num			PT	US
22.056	Parameter 00.056 Set-up							RW	Num			PT	US
22.057	Parameter 00.057 Set-up							RW	Num			PT	US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
22.058	Parameter 00.058 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.059	Parameter 00.059 Set-up							RW	Num			PT	US
22.060	Parameter 00.060 Set-up							RW	Num			PT	US
22.061	Parameter 00.061 Set-up							RW	Num			PT	US
22.062	Parameter 00.062 Set-up							RW	Num			PT	US
22.063	Parameter 00.063 Set-up							RW	Num			PT	US
22.064	Parameter 00.064 Set-up							RW	Num			PT	US
22.065	Parameter 00.065 Set-up							RW	Num			PT	US
22.066	Parameter 00.066 Set-up							RW	Num			PT	US
22.067	Parameter 00.067 Set-up							RW	Num			PT	US
22.068	Parameter 00.068 Set-up							RW	Num			PT	US
22.069	Parameter 00.069 Set-up							RW	Num			PT	US
22.070	Parameter 00.070 Set-up							RW	Num			PT	US
22.071	Parameter 00.071 Set-up							RW	Num			PT	US
22.072	Parameter 00.072 Set-up							RW	Num			PT	US
22.073	Parameter 00.073 Set-up							RW	Num			PT	US
22.074	Parameter 00.074 Set-up							RW	Num			PT	US
22.075	Parameter 00.075 Set-up							RW	Num			PT	US
22.076	Parameter 00.076 Set-up							RW	Num			PT	US
22.077	Parameter 00.077 Set-up							RW	Num			PT	US
22.078	Parameter 00.078 Set-up							RW	Num			PT	US
22.079	Parameter 00.079 Set-up							RW	Num			PT	US
22.080	Parameter 00.080 Set-up							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

11.21 Menu 24: Ethernet status and monitoring

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
24.001	Module ID	0 to 65535			430			RO	Num	ND	NC	PT	
24.002	Software Version	00.00.00.00 to 99.99.99.99						RO	Num	ND	NC	PT	
24.003	Hardware Version	0.00 to 99.99						RO	Num	ND	NC	PT	
24.004	Serial Number LS	0 to 99999999						RO	Num	ND	NC	PT	
24.005	Serial Number MS	0 to 99999999						RO	Num	ND	NC	PT	
24.006	Status	Bootldr-Update (-2), Bootldr-Idle (-1), Initializing (0), OK (1), Config (2), Error (3)						RO	Txt	ND	NC	PT	
24.007	Reset	0 to 1			0			RW	Bit		NC		
24.008	Default	0 to 1			0			RW	Bit		NC		
24.009	Active Alarm Bits	0000000000000000 to 1111111111111111						RO	Bin		NC		
24.010	Active IP Address	000.000.000.000 to 255.255.255.255						RO	IP		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

11.21.1 Slot 4 Menu 0: Ethernet status and monitoring

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.00.001	Module ID	0 to 65535			430			RO	Num	ND	NC	PT	
4.00.002	Software Version	00.00.00.00 to 99.99.99.99						RO	Num	ND	NC	PT	
4.00.003	Hardware Version	0.00 to 99.99						RO	Num	ND	NC	PT	
4.00.004	Serial Number LS	0 to 99999999						RO	Num	ND	NC	PT	
4.00.005	Serial Number MS	0 to 99999999						RO	Num	ND	NC	PT	
4.00.006	Status	Bootldr-Update (-2), Bootldr-Idle (-1), Initializing (0), OK (1), Config (2), Error (3)						RO	Txt	ND	NC	PT	
4.00.007	Reset	0 to 1			0			RW	Bit		NC		
4.00.008	Default	0 to 1			0			RW	Bit		NC		
4.00.009	Active Alarm Bits	0000000000000000 to 1111111111111111						RO	Bin		NC		
4.00.010	Active IP Address	000.000.000.000 to 255.255.255.255						RO	IP		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

11.21.2 Slot 4 Menu 2: Ethernet configuration

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.02.003	Network Status	Initializing (0), Links Down (1), DHCP In Progress (2), No Address (3), Ready (4), Active (5)						RO	Txt	ND	NC	PT	
4.02.004	Network Message Count	0 to 65535						RO	Num	ND	NC	PT	
4.02.005	DHCP Enable	Off (0) or On (1)			On (1)			RW	Num				US
4.02.006	IP Address	000.000.000.000 to 255.255.255.255			192.168.001.100			RW	IP				US
4.02.007	Subnet Mask	000.000.000.000 to 255.255.255.255			255.255.255.000			RW	IP				US
4.02.008	Default Gateway	000.000.000.000 to 255.255.255.255			192.168.1.254			RW	IP				US
4.02.009	Primary DNS	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US
4.02.010	Secondary DNS	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US
4.02.011	MAC Address	00:00:00:00:00:00 to FF:FF:FF:FF:FF:FF						RO	Mac	ND	NC	PT	
4.02.020	Priority Protocol	None (0), Modbus TCP (1), Ethernet/IP (2)			0			RW	Txt				US
4.02.021	Web Server Enable	Off (0) or On (1)			On (1)			RW	Bit				US
4.02.022	Web Server Port	0 to 65535			80			RW	Num				US
4.02.023	Email Enable	Off (0) or On (1)			On (1)			RW	Bit				US
4.02.024	Ethernet MTU	158 to 1500			1500			RW	Num				US
4.02.025	Gateway Mode	Switch (0), Gateway (1), Strict Gateway (2)			Switch (0)			RW	Txt				US
4.02.030	VLAN Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
4.02.031	VLAN ID	0 to 255			0			RW	Num				US

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

11.21.3 Slot 4 Menu 9: Resources

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.09.001	Cyclic Tx Links Free	0 to 255						RO	Num	ND	NC		
4.09.002	Cyclic Rx Links Free							RO	Num	ND	NC		
4.09.003	Fieldbus Links Free							RO	Num	ND	NC		
4.09.004	Cyclic Mappings Free							RO	Num	ND	NC		
4.09.009	Idle Task % Free	0 to 255 %						RO	Num	ND	NC		
4.09.010	Synchronous Task % Free							RO	Num	ND	NC		
4.09.020	Synchronous Task % Worst Free							RO	Num	ND	NC		
4.09.030	PCB Temperature	-128 to 127 °C						RO	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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter						

11.21.4 Slot 4 Menu 10: Easy Mode

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.10.001	Enable	Off (0) or On (1)			On (1)			RW	Bit				US
4.10.002	Reset	Off (0) or On (1)			Off (0)			RW	Bit				
4.10.003	Default	Off (0) or On (1)			Off (0)			RW	Bit				
4.10.004	Message Rate	0 to 100 ms			0 ms			RW	Num				US
4.10.010	Tx1 Link Profile	0 to 0			0			RW	Num				US
4.10.011	Tx1 Link Number	0 to 255			0			RW	Num				US
4.10.012	Tx1 Source Parameter	0 to 4.99.999			0			RW	Num			PT	US
4.10.013	Tx1 Parameter Count	0 to 32			0			RW	Num				US
4.10.014	Tx1 Link Transmission Type	Unicast (0), Broadcast (1), Muliticast1 (2), Multicast2 (3), Multicast3 (4), Multicast4 (5)			Unicast (0)			RW	Txt				US
4.10.015	Tx1 Destination Address	000.000.000.000 to 255.255.255.255			255.255.255.255			RW	IP	DE			US
4.10.019	Tx1 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				
4.10.020	Tx2 Link Profile	0 to 0			0			RW	Num				US
4.10.021	Tx2 Link Number	0 to 255			0			RW	Num				US
4.10.022	Tx2 Source Parameter	0 to 4.99.999			0.000			RW	Num			PT	US
4.10.023	Tx2 Parameter Count	0 to 32			0			RW	Num				US
4.10.024	Tx2 Link Transmission Type	Unicast (0), Broadcast (1), Muliticast1 (2), Multicast2 (3), Multicast3 (4), Multicast4 (5)			Unicast (0)			RW	Txt				US
4.10.025	Tx2 Destination Address	000.000.000.000 to 255.255.255.255			255.255.255.255			RW	IP	DE			US
4.10.029	Tx2 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				
4.10.030	Tx3 Link Profile	0 to 0			0			RW	Num				US
4.10.031	Tx3 Link Number	0 to 255			0			RW	Num				US
4.10.032	Tx3 Source Parameter	0 to 4.99.999			0.00.000			RW	Num			PT	US
4.10.033	Tx3 Parameter Count	0 to 32			0			RW	Num				US
4.10.034	Tx3 Link Transmission Type	Unicast (0), Broadcast (1), Muliticast1 (2), Multicast2 (3), Multicast3 (4), Multicast4 (5)			Unicast (0)			RW	Txt				US
4.10.035	Tx3 Destination Address	000.000.000.000 to 255.255.255.255			255.255.255.255			RW	IP	DE			US
4.10.039	Tx3 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				
4.10.040	Rx1 Link Profile	0 to 0			0.000			RW	Num				US
4.10.041	Rx1 Link Number	0 to 255			0.000			RW	Num				US
4.10.042	Rx1 Destination Parameter	0 to 4.99.999			0.00.000			RW	Num	DE			US
4.10.043	Rx1 Parameter Count	0 to 32			0.000			RW	Num				US
4.10.044	Rx1 Source Type	Direct (0), Multicast1 (1), Multicast2 (2), Multicast3 (3), Multicast4 (4)			Direct (0)			RW	Txt				US
4.10.045	Rx1 Timeout	0 to 65535 ms			100 ms			RW	Num				US
4.10.046	Rx1 Timeout Action	Trip (0), Clear output (1), Hold last (2)			Trip (0)			RW	Txt				US
4.10.047	Rx1 Timeout Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.10.048	Rx1 Timeout Event Type	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.10.049	Rx1 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				
4.10.050	Rx2 Link Profile	0 to 0			0.000			RW	Num				US
4.10.051	Rx2 Link Number	0 to 255			0.000			RW	Num				US
4.10.052	Rx2 Destination Parameter	0 to 4.99.999			0.00.000			RW	Num	DE			US
4.10.053	Rx2 Parameter Count	0 to 32			0.000			RW	Num				US

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.10.054	Rx2 Source Type	Direct (0), Multicast1 (1), Multicast2 (2), Multicast3 (3), Multicast4 (4)			Direct (0)			RW	Txt				US
4.10.055	Rx2 Timeout	0 to 65535 ms			100 ms			RW	Num				US
4.10.056	Rx2 Timeout Action	Trip (0), Clear output (1), Hold last (2)			Trip (0)			RW	Txt				US
4.10.057	Rx2 Timeout Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.10.058	Rx2 Timeout Event Type	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.10.059	Rx2 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				
4.10.060	Rx3 Link Profile	0 to 0			0.000			RW	Num				US
4.10.061	Rx3 Link Number	0 to 255			0.000			RW	Num				US
4.10.062	Rx3 Destination Parameter	0 to 4.99.999			0.00.000			RW	Num	DE			US
4.10.063	Rx3 Parameter Count	0 to 32			0.000			RW	Num				US
4.10.064	Rx3 Source Type	Direct (0), Multicast1 (1), Multicast2 (2), Multicast3 (3), Multicast4 (4)			Direct (0)			RW	Txt				US
4.10.065	Rx3 Timeout	0 to 65535 ms			100 ms			RW	Num				US
4.10.066	Rx3 Timeout Action	Trip (0), Clear output (1), Hold last (2)			Trip (0)			RW	Txt				US
4.10.067	Rx3 Timeout Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.10.068	Rx3 Timeout Event Type	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.10.069	Rx3 Link Status	Invalid profile (-16), Invalid mapping (-15), Read only param (-14), Timeout (-8), In error (-7), Link num in use (-6), Not editable (-5), Invalid link num (-4), Invalid args (-3), Too many links (-2), Out of memory (-1), OK (0)						RO	Txt				

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						

11.21.5 Slot 4 Menu 11: Synchronization

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.11.001	Preferred Sync Master	0 to 4			1			RW	Num				US
4.11.002	Master Clock Domain	0 to 3			0			RW	Num				US
4.11.004	Grandmaster IP Address	000.000.000.000 to 255.255.255.255						RO	IP	ND	NC		
4.11.005	Grandmaster MAC Address	00:00:00:00:00:00 to FF:FF:FF:FF:FF:FF						RO	Mac	ND	NC	PT	
4.11.006	Synchronization Jitter From Grandmaster	-2147483648 to 2147483647 ns						RO	Num	ND	NC	PT	
4.11.007	Synchronization Jitter Threshold	10 to 4294967295			1000			RW	Num				US
4.11.008	Module Synchronized Flag	Off (0) or On (1)						RO	Bit				
4.11.009	Inhibit Drive Synchronization	Off (0) or On (1)			Off (0)			RW	Bit				US
4.11.010	PTP Date	00-00-00 to 31-12-99						RO	Date	ND	NC	PT	
4.11.011	PTP Time	00:00:00 to 23:59:59						RO	Time	ND	NC	PT	
4.11.013	Network Transport Layer Select	802.3 (0), UDP (1)			UDP (1)			RW	Txt				US
4.11.014	1 Step Clock Correction	Off (0) or On (1)			Off (0)			RW	Bit				US
4.11.015	PTP Delay Measurement Select	E2E DELAY (0), P2P DELAY (1)			P2P DELAY (1)			RW	Txt				US
4.11.016	PTP Sync Rate	-4 to 4			-2			RW	Num				US
4.11.020	Network Error Count	0 to 4294967295						RO	Num	ND	NC	PT	
4.11.030	Tx1 Link Maximum Network Delay	0 to 100 ms			0 ms			RW	Num				US
4.11.031	Tx2 Link Maximum Network Delay	0 to 100 ms			0 ms			RW	Num				US
4.11.032	Tx3 Link Maximum Network Delay	0 to 100 ms			0 ms			RW	Num				US
4.11.040	Rx1 Late Synchronization Frame Action	Off (0), Trip (1), Do not use (2), Use (3)			Off (0)			RW	Txt				US
4.11.041	Rx1 Late Synchronization Frame Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.11.042	Rx1 Late Synchronization Frame Event	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.11.050	Rx2 Late Synchronization Frame Action	Off (0), Trip (1), Do not use (2), Use (3)			Off (0)			RW	Txt				US
4.11.051	Rx2 Late Synchronization Frame Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.11.052	Rx2 Late Synchronization Frame Event	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.11.060	Rx3 Late Synchronization Frame Action	Off (0), Trip (1), Do not use (2), Use (3)			Off (0)			RW	Txt				US
4.11.061	Rx3 Late Synchronization Frame Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.11.062	Rx3 Late Synchronization Frame Event	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter						

11.21.6 Slot 4 Menu 15: Modbus

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.15.001	Enable	Off (0) or On (1)			On (1)			RW	Bit				US
4.15.002	Reset	Off (0) or On (1)			Off (0)			RW	Bit				
4.15.003	Default	Off (0) or On (1)						RW	Bit				
4.15.004	Modbus Configuration Error	No error (0), Port in use (1), Timeout event (2)						RO	Txt				
4.15.005	Modbus Listening Port	0 to 65535			502			RW	Num				
4.15.006	Maximum Connections	0 to 4			2			RW	Num				US
4.15.007	Maximum Priority Connections	0 to 4			1			RW	Num				US
4.15.008	Maximum Connections Per Client	1 to 4			2			RW	Num				US
4.15.009	Modbus Timeout	1 to 10000 ms			100 ms			RW	Num				US
4.15.010	Modbus Timeout Action	Trip (0), No action (1)			No action (1)			RW	Txt				US
4.15.011	Modbus Timeout Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.15.012	Modbus Timeout Event Type	No event (0), Event (1), Event1 (2), Event2 (3), Event3 (4)			No event (0)			RW	Txt				US
4.15.013	Modbus Resister Addressing Mode	Standard (0), Modified (1)			Standard (0)			RW	Txt				US
4.15.020	Priority Connection 1	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US
4.15.021	Priority Connection 2	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US
4.15.022	Priority Connection 3	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US
4.15.023	Priority Connection 4	000.000.000.000 to 255.255.255.255			000.000.000.000			RW	IP				US

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

11.21.7 Slot 4 Menu 20: Ethernet / IP

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.20.001	Enable Ethernet/IP	Off (0) or On (1)			On (1)			RW	Bit				US
4.20.002	Reset	Off (0) or On (1)			Off (0)			RW	Bit				
4.20.003	Default	Off (0) or On (1)			Off (0)			RW	Bit				
4.20.004	Configuration Error	No error (0), RPI event dst (1), RPI event type (2), IDLE event dst (3), IDLE event type (4), Input mapping (5), Output mapping (6), In cons trig pr (7), Out cons trig pr (8)			No error (0)			RO	Txt	ND			
4.20.007	Cyclic Data Transfers Per Second	0 to 65535						RO	Num	ND	NC	PT	
4.20.011	RPI Timeout Action	Trip (0), Send fit values (1), Clear output (2), Hold last (3), No Action (4)			Hold last (3)			RW	Txt				US
4.20.012	RPI Timeout Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.20.013	RPI Timeout Event Type	No event (0), Trigger Event (1), Trigger Event 1 (2), Trigger Event 2 (3), Trigger Event 3 (4), Trigger Event 4 (5)			No event (0)			RW	Txt				US
4.20.015	PLC Idle Action	Trip (0), Send fit values (1), Clear output (2), Hold last (3), No Action (4)			No Action (4)			RW	Txt				US
4.20.016	PLC Idle Event Destination	This slot (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)			This slot (0)			RW	Txt				US
4.20.017	PLC Idle Event Type	No event (0), Trigger Event (1), Trigger Event 1 (2), Trigger Event 2 (3), Trigger Event 3 (4), Trigger Event 4 (5)			No event (0)			RW	Txt				US
4.20.018	Active Input Assembly Object	100-Primaryl (0), 70-BscSpdCtrll (1), 71-ExtSpedCtrll (2), 72-SpdTqCtrll (3), 73-ExtSpdTqCtrll (4)			100-Primaryl (0)			RO	Txt				
4.20.019	Active Output Assembly Object	101-Primaryl (0), 20-BscSpdCtrll (1), 21-ExtSpedCtrll (2), 22-SpdTqCtrll (3), 23-ExtSpdTqCtrll (4)			101-Primaryl (0)			RO	Txt				
4.20.020	Input Assembly Object Size	4 to 80			8			RW	Num				
4.20.021	Output Assembly Object Size	4 to 80			8			RW	Num				US
4.20.024	Input Assembly Object Process Time	0 to 65535						RO	Num	ND	NC		
4.20.025	Output Assembly Object Process Time	0 to 65535						RO	Num	ND	NC		
4.20.026	Input Assembly Object Consistency Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
4.20.027	Input Assembly Object Consistency Trigger Parameter	0.00.000 to 4.99.999			0.00.000			RW	Num				
4.20.028	Input Assembly Object Consistency Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
4.20.029	Output Assembly Object Consistency Trigger Parameter	0.00.000 to 4.99.999			0.00.000			RW	Num				US
4.20.030	Custom Vender ID	257 - CT (0), 553 - CT America (1)			257-CT (0)			RW	Txt				
4.20.031	Custom product code	0 to 65535			0			RW	Num				US
4.20.032	Custom product revision code	0 to 65535			0			RW	Num				US
4.20.033	Actual Product Code	0 to 65535						RO	Num				
4.20.034	Actual Product Revision	0 to 65535											
4.20.040	Type of Motor 1	2-FC DC (0), 6-WRI (1), 7-SCI (2), 9-Sin PM BL (3), 10-Trap PM BL (4)						RO	Txt			PT	US
4.20.041	Type of Motor 2	2-FC DC (0), 6-WRI (1), 7-SCI (2), 9-Sin PM BL (3), 10-Trap PM BL (4)						RO	Txt			PT	US

11.21.8 Menu 21 Ethernet / IP In Mappings

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.21.001	Input Mapping Parameter 1	0.00.000 to 4.99.999			0.10.040			RW	Num	DE		PT	US
4.21.002	Input Mapping Parameter 2				0.02.001			RW	Num	DE		PT	US
4.21.003	Input Mapping Parameter 3				0.00.000			RW	Num	DE		PT	US
4.21.004	Input Mapping Parameter 4							RW	Num	DE		PT	US
4.21.005	Input Mapping Parameter 5							RW	Num	DE		PT	US
4.21.006	Input Mapping Parameter 6							RW	Num	DE		PT	US
4.21.007	Input Mapping Parameter 7							RW	Num	DE		PT	US
4.21.008	Input Mapping Parameter 8							RW	Num	DE		PT	US
4.21.009	Input Mapping Parameter 9							RW	Num	DE		PT	US
4.21.010	Input Mapping Parameter 10							RW	Num	DE		PT	US
4.21.011	Input Mapping Parameter 11							RW	Num	DE		PT	US
4.21.012	Input Mapping Parameter 12							RW	Num	DE		PT	US
4.21.013	Input Mapping Parameter 13							RW	Num	DE		PT	US
4.21.014	Input Mapping Parameter 14							RW	Num	DE		PT	US
4.21.015	Input Mapping Parameter 15							RW	Num	DE		PT	US
4.21.016	Input Mapping Parameter 16							RW	Num	DE		PT	US
4.21.017	Input Mapping Parameter 17							RW	Num	DE		PT	US
4.21.018	Input Mapping Parameter 18							RW	Num	DE		PT	US
4.21.019	Input Mapping Parameter 19							RW	Num	DE		PT	US
4.21.020	Input Mapping Parameter 20							RW	Num	DE		PT	US

11.21.9 Menu 22 Ethernet / IP Out Mappings

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.22.001	Output Mapping Parameter 1	0.00.000 to 4.99.999			0.06.042			RW	Num	DE		PT	US
4.22.002	Output Mapping Parameter 2				0.01.021			RW	Num	DE		PT	US
4.22.003	Output Mapping Parameter 3				0.00.000			RW	Num	DE		PT	US
4.22.004	Output Mapping Parameter 4							RW	Num	DE		PT	US
4.22.005	Output Mapping Parameter 5							RW	Num	DE		PT	US
4.22.006	Output Mapping Parameter 6							RW	Num	DE		PT	US
4.22.007	Output Mapping Parameter 7							RW	Num	DE		PT	US
4.22.008	Output Mapping Parameter 8							RW	Num	DE		PT	US
4.22.009	Output Mapping Parameter 9							RW	Num	DE		PT	US
4.22.010	Output Mapping Parameter 10							RW	Num	DE		PT	US
4.22.011	Output Mapping Parameter 11							RW	Num	DE		PT	US
4.22.012	Output Mapping Parameter 12							RW	Num	DE		PT	US
4.22.013	Output Mapping Parameter 13							RW	Num	DE		PT	US
4.22.014	Output Mapping Parameter 14							RW	Num	DE		PT	US
4.22.015	Output Mapping Parameter 15							RW	Num	DE		PT	US
4.22.016	Output Mapping Parameter 16							RW	Num	DE		PT	US
4.22.017	Output Mapping Parameter 17							RW	Num	DE		PT	US
4.22.018	Output Mapping Parameter 18							RW	Num	DE		PT	US
4.22.019	Output Mapping Parameter 19							RW	Num	DE		PT	US
4.22.020	Output Mapping Parameter 20							RW	Num	DE		PT	US

11.21.10 Menu 23 Ethernet / IP Fault Values

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
4.23.001	Output Fault Value 1	-2147483648 to 2147483647			0			RW	Num			PT	US
4.23.002	Output Fault Value 2							RW	Num			PT	US
4.23.003	Output Fault Value 3							RW	Num			PT	US
4.23.004	Output Fault Value 4							RW	Num			PT	US
4.23.005	Output Fault Value 5							RW	Num			PT	US
4.23.006	Output Fault Value 6							RW	Num			PT	US
4.23.007	Output Fault Value 7							RW	Num			PT	US
4.23.008	Output Fault Value 8							RW	Num			PT	US
4.23.009	Output Fault Value 9							RW	Num			PT	US
4.23.010	Output Fault Value 10							RW	Num			PT	US
4.23.011	Output Fault Value 11							RW	Num			PT	US
4.23.012	Output Fault Value 12							RW	Num			PT	US
4.23.013	Output Fault Value 13							RW	Num			PT	US
4.23.014	Output Fault Value 14							RW	Num			PT	US
4.23.015	Output Fault Value 15							RW	Num			PT	US
4.23.016	Output Fault Value 16							RW	Num			PT	US
4.23.017	Output Fault Value 17							RW	Num			PT	US
4.23.018	Output Fault Value 18							RW	Num			PT	US
4.23.019	Output Fault Value 19							RW	Num			PT	US
4.23.020	Output Fault Value 20							RW	Num			PT	US

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' and 'Heavy Duty' refer to section 2.1 *Introduction* on page 10.

Table 12-1 Maximum permissible continuous output current @ 40 °C (104 °F) ambient

Model	Normal Duty									Heavy Duty							
	Nominal rating		Maximum permissible continuous output current (A) for the following switching frequencies							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	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V																		
03200050	1.1	1.5	6.6							0.7	1.0	5.0						
03200066	1.5	2.0	8.0							1.1	1.5	6.6						
03200080	2.2	3.0	11.0					10.9	9.0	1.5	2.0	8.0					7.8	6.6
03200106	3.0	3.0	12.7					10.9	9.0	2.2	3.0	10.6			10.4	9.4	7.8	6.6
04200137	4.0	5.0	18.0							3.0	3.0	13.7						
04200185	5.5	7.5	25.0					24.2	22.0	4.0	5.0	18.5						17.7
06200330	11.0	15.0	50.0					43.0		7.5	10.0	33.0					30.7	
06200440	15.0	20.0	58.0				53.3	42.9		11.0	15.0	44.0				39.6	32.5	
400 V																		
03400025	1.1	1.5	3.4							0.7	1.0	2.5						
03400031	1.5	2.0	4.5							1.1	1.5	3.1						
03400045	2.2	3.0	6.2						5.2	1.5	2.0	4.5						4.2
03400062	3.0	5.0	7.7					6.2	4.9	2.2	3.0	6.2					5.0	4.2
03400078	4.0	5.0	10.4				8.8	6.4	4.9	3.0	5.0	7.8			7.3	6.2	4.6	3.6
03400100	5.5	7.5	12.3			10.6	8.8	6.4	4.9	4.0	5.0	10.0	9.7	8.7	7.3	6.2	4.6	3.6
04400150	7.5	10.0	18.5					14.6	11.1	5.5	10.0	15.0				14.4	11.5	9.4
04400172	11.0	15.0	24.0			21.8	19.2	14.6	11.28	7.5	10.0	17.2			16.1	14.4	11.5	9.4
06400350	18.5	25.0	38.0					30.7		15.0	25.0	35.0			35.0	30.1	23.1	
06400420	22.0	30.0	48.0			47.5	40.8	30.7		18.5	30.0	42.0		41.5	35.2	29.8	23.1	
06400470	30.0	40.0	63.0	57.3		47.8	40.3	30.8		22.0	30.0	47.0	45.6	41.8	35.2	30.0	23.0	
575 V																		
06500100	7.50	10.0	12.0							5.5	7.5	10.0						
06500150	11.0	15.0	17.0							7.5	10.0	15.0						
06500190	15.0	20.0	22.0					20.4		11.0	15.0	19.0					15.6	
06500230	18.5	25.0	27.0				26.1	20.0		15.0	20.0	23.0				20.0	15.4	
06500290	22.0	30.0	34.0			31.3	26.2	20.0		18.5	25.0	29.0			23.8	20.0	15.3	
06500350	30.0	40.0	43.0	39.5		30.9	26.2	19.7		22.0	30.0	35.0	34.0	29.7	23.8	19.9	15.4	

Table 12-2 Maximum permissible continuous output current @ 40 °C (104 °F) ambient with high IP insert installed

Model	Normal Duty							Heavy Duty						
	Maximum permissible continuous output current (A) for the following switching frequencies							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	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
03200050	6.6							5.0						
03200066	8.0							6.6						
03200080	11.0						9.7	8.0						6.9
03200106	12.7					11.0	9.7	10.6			10.4	9.3	8.0	6.9
04200137	18.0				16.3	14.2	13.1	13.7						13.1
04200185	24.7	22.5	20.7	18.2	16.5	14.2	13.2	18.5			18.1	16.2	14.2	13.1
400 V														
03400025	3.4						3.3	2.5						
03400031	4.5			4.4	4.1	3.6	3.3	3.1						
03400045	5.1	4.9	4.7	4.4	4.1	3.6	3.3	4.5			4.4	4.1	3.6	3.2
03400062	7.7					6.2	5.2	6.2				5.6	4.5	3.8
03400078	10.4			9.9	9.0	6.4	4.8	7.8				6.6	4.8	3.6
03400100	12.3	11.9	11.1	10.0	9.0	6.4	4.8	10.0		9.4	7.8	6.6	4.8	3.6
04400150	8.7					8.3	7.0	8.7					8.4	7.0
04400172	8.6					8.4	6.9							

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

Model	Normal Duty							Heavy Duty						
	Maximum permissible continuous output current (A) for the following switching frequencies							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	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
03200050	6.6							5.0						
03200066	8.0							6.6						6.0
03200080	11.0					9.9	8.3	8.0					7.2	6.1
03200106	12.7		12.6	12.2	11.7	9.9	8.3	10.6		10.6	9.5	8.6	7.2	6.1
04200137	18.0							13.7						
04200185	22.25						20.25	18.5				17.9	16.2	14.8
06200330	50.0				49.0	39.0		33.0					29.0	
06200440	58.0			56.0	49.0	39.0		44.0			41.0	36.0	29.0	
400 V														
03400025	3.4							2.5						
03400031	4.5							3.1						
03400045	6.2				5.9	5.5	4.7	4.5					4.2	3.4
03400062	7.6	7.2	6.9	6.4	5.9	5.5	4.7	6.2			6.0	5.2	4.2	3.4
03400078	10.4			9.4	8.1	5.8	4.4	7.8			7.1	5.9	4.3	3.4
03400100	11.9	11.2	10.5	9.4	7.8	5.7	4.3	10.0	9.5	8.5	7.1	5.9	4.3	3.4
04400150	18.1	17.6	17.0	16.5	15.9	12.4	9.4	15.0			14.8	13.2	10.6	8.7
04400172	18.0	17.5	17.0	16.3	15.8	12.2	9.3	17.2		16.8	14.8	13.2	10.6	8.6
06400350	38.0				33.0	25.0		35.0			29.0	25.0	19.0	
06400420	48.0		47.0	39.0	33.0	25.0		42.0	42.0	38.0	32.0	27.0	21.0	
06400470	59.0	53.0	47.0	39.0	33.0	25.0		47.0	42.0	38.0	32.0	27.0	21.0	
575 V														
06500100	12.0							10.0						
06500150	17.0					13.4		15.0					13.9	
06500190	22.0					18.2		19.0					14.0	
06500230	27.0				23.5	17.8		23.0			21.6	18.2	14.0	
06500290	34.0			28.2	23.4	18.0		29.0		27.2	21.7	18.0	13.9	
06500350	43.0	41.71	36.12	27.9	23.6	18.0		35.0	31.1	27.3	21.7	18.2	14.0	

12.1.2 Power dissipation

Table 12-4 Losses @ 40°C (104°F) ambient

Model	Normal Duty									Heavy Duty								
	Nominal rating		Drive losses (w) taking into account any current derating for the given conditions							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	kW	hp	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V																		
03200050	1.1	1.5		93	95	99	104	113	122	0.75	1.0		78	80	84	87	94	101
03200066	1.5	2.0		100	102	107	113	122	133	1.1	1.5		89	91	94	99	108	116
03200080	2.2	3.0		123	126	133	139	147	135	1.5	2.0		97	99	105	109	114	106
03200106	3.0			136	141	149	158	149	138	2.2	3.0		115	118	120	115	108	102
04200137	4.0	5.0								3.0	3.0							
04200185	5.5	7.5								4.0	5.0							
06200330	11	15		394	413	452	490	483		7.5	10		277	290	316	342	394	
06200440	15	20		463	484	528	531	483		11	15		366	382	417	424	393	
400 V																		
03400025	1.1	1.5		80	84	94	103	123	141	0.75	1.0		79	76	83	92	108	124
03400031	1.5	2.0		88	92	104	115	137	160	1.1	1.5		69	73	82	91	107	124
03400045	2.2	3.0		104	112	125	139	167	182	1.5	2.0		83	88	99	109	131	142
03400062	3.0	5.0		114	122	137	153	166	171	2.2	3.0		98	105	118	131	131	141
03400078	4.0			145	158	180	173	164	166	3.0	5.0		115	125	135	131	134	135
03400100	5.0	7.5		160	177	172	168	167	166	4.0	5.0		134	131	129	131	134	135
04400150																		
04400172																		
06400350	18.5	25		417	456	532	613	679		15	25		389	424	498	532	559	
06400420	22	30		515	561	657	670	679		18.5	30		455	497	520	523	551	
06400470	30	40		656	677	657	665	681		22	30		511	516	520	525	551	
575 V																		
06500100	7.5	10		215	239	287	334			5.5	7.5		187	208	249	291		
06500150	11	15		284	315	376	438			7.5	10		265	294	351	410		
06500190	15	20		362	399	484	568			11	15		317	350	418	496		
06500230	18.5	25		448	505	596	682			15	20		382	421	508	523		
06500290	22	30								18.5	25							
06500350	30	40								22	30							

Table 12-5 Losses @ 40°C (104°F) ambient with high IP insert installed

Model	Normal Duty							Heavy Duty						
	Drive losses (W) taking into consideration any current derating for the given conditions							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	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
03200050														
03200066														
03200080														
03200106														
04200137														
04200185														
400 V														
03400025														
03400031														
03400045														
03400062														
03400078														
03400100														
04400150														
04400172														

Table 12-6 Losses @ 50°C (122°F) ambient

Model	Normal Duty							Heavy Duty						
	Drive losses (w) taking into account any current derating for the given conditions							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	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
200 V														
03200050														
03200066														
03200080														
03200106														
04200137														
04200185														
06200330														
06200440														
400 V														
03400025														
03400031														
03400045														
03400062														
03400078														
03400100														
04400150														
04400172														
06400350														
06400420														
06400470														
575 V														
06500100														
06500150														
06500190														
06500230														
06500290														
06500350														

Table 12-7 Power losses from the front of the drive when through-panel mounted

Frame size	Power loss
3	
4	
6	

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:

03200050, 03200066, 03200080, 03200106,

03400025, 03400031, 03400045, 03400062

Model sizes 03400078 to 06500350 have an internal DC choke so they do not require AC line reactors except for cases of excessive phase unbalance or extreme supply conditions.

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: 240 V
400 V drive: 480 V
575 V drive: 575 V
690 V drive: 690 V

12.1.6 Temperature, humidity and cooling method

Ambient temperature operating range:

- 20 °C to 50 °C (- 4 °F to 122 °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 +50 °C (122 °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 (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 the drive sizes 3 and 4, 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 12-8.

Table 12-8 IP Rating degrees of protection

First digit		Second digit	
Protection against contact and ingress of foreign bodies		Protection against ingress of water	
0	No protection	0	No protection
1	Protection against large foreign bodies ϕ > 50 mm (large area contact with the hand)	1	Protection against vertically falling drops of water
2	Protection against medium size foreign bodies ϕ > 12 mm (finger)	2	Protection against spraywater (up to 15 ° from the vertical)
3	Protection against small foreign bodies ϕ > 2.5 mm (tools, wires)	3	Protection against spraywater (up to 60 ° from the vertical)
4	Protection against granular foreign bodies ϕ > 1mm (tools, wires)	4	Protection against splashwater (from all directions)
5	Protection against dust deposit, complete protection against accidental contact.	5	Protection against heavy splash water (from all directions, at high pressure)
6	Protection against dust ingress, complete protection against accidental contact.	6	Protection against deckwater (e.g. in heavy seas)
7	-	7	Protection against immersion
8	-	8	Protection against submersion

Table 12-9 UL enclosure ratings

UL rating	Description
Type 1	Enclosures are intended for indoor use, primarily to provide a degree of protection against limited amounts of falling dirt.
Type 12	Enclosures are intended for indoor use, primarily to provide a degree of protection against dust, falling dirt and dripping non-corrosive liquids.

12.1.10 Corrosive gasses

Concentrations of corrosive gases must not exceed the levels given in:

- Table A2 of EN 50178:1998
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighborhood of industrial sources with chemical emissions.

12.1.11 RoHS compliance

The drive meets EU directive 2002-95-EC 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 60068-2-27: Test Eb:
Severity: 18 g, 6 ms, half sine
No. of Bumps: 600 (100 in each direction of each axis)

Random Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard:IEC 60068-2-64: Test Fh:
Severity: 1.0 m^2/s^3 (0.01 g^2/Hz) ASD from 5 to 20 Hz
-3 dB/octave from 20 to 200 Hz
Duration: 30 minutes in each of 3 mutually perpendicular axes.

Sinusoidal Vibration Test

Testing in each of three mutually perpendicular axes in turn.
Referenced standard: IEC 60068-2-6: Test Fc:
Frequency range: 5 to 500 Hz
Severity: 3.5 mm peak displacement from 5 to 9 Hz
10 m/s^2 peak acceleration from 9 to 200 Hz
15 m/s^2 peak acceleration from 200 to 500 Hz
Sweep rate: 1 octave/minute
Duration: 15 minutes in each of 3 mutually perpendicular axes.

EN 61800-5-1:2007, Section 5.2.6.4. referring to IEC 60068-2-6

Frequency range: 10 to 150 Hz
Amplitude: 10 to 57 Hz at 0.075 mm pk
57 to 150 Hz at 1g p
Sweep rate: 1 octave/minute
Duration: 10 sweep cycles per axis in each of 3 mutually perpendicular axes

12.1.13 Starts per hour

By electronic control: unlimited

By interrupting the AC supply: ≤20 (equally spaced)

12.1.14 Start up time

This is the time taken from the moment of applying power to the drive, to the drive being ready to run the motor:

Sizes 3:

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 acoustic noise produced by the drive. The heatsink fan on size 3, 4 and 6 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.

Table 12-10 gives the acoustic noise 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	35	30
4	40	35
6	48	40

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	391 mm (15.39 in)	83 mm (3.27 in)	200 mm (7.87 in)	134 mm (5.28 in)	67 mm (2.64 in)
4		124 mm (4.88 in)			66 mm (2.59 in)
6		210 mm (8.27 in)	227 mm (8.94 in)	131 mm (5.16 in)	96 mm (3.78 in)

12.1.19 Weights

Table 12-12 Overall drive weights

Size	Model	kg	lb
3	03400078, 03400100	4.5	9.9
	All other variants	4.0	8.8
4	All variants	6.5	14.3
6			

12.1.20 SAFE TORQUE OFF data

Data as verified by TÜV Rheinland:

According to EN ISO 13849-1:

PL = e

Category = 4

$MTTF_D$ = High

DC_{av} = High

Mission Time and Proof Test Interval = 20 years

The calculated $MTTF_D$ for the complete STO function is:

STO1 2574 yr

STO2 2716 yr

According to EN 61800-5-2:

SIL = 3

PFH = 4.21×10^{-11} h^{-1}

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.

12.1.21 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.

WARNING

Table 12-14 AC Input current and fuse ratings

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse Rating			
				IEC gG		Class CC or Class J	
				Nominal	Maximum	Nominal	Maximum
	A	A	A	A	A	A	A
200 V							
03200050	10.5	10.7	14.1	16	25	16	20
03200066	12.8	13	18.6	20		20	
03200080	17.6	17.8	22.6	25		25	25
03200106	20.3	20.6	29.9	25		25	
04200137	16.8	20.1	26.8	25	25	25	25
04200185	19.3	26.8	36.2	32	32	30	30
06200330	42.4	48.8	56.3	63	63	60	70
06200440	53.4	56.6	75.1	63		70	
400 V							
03400025	5	5	6.5	6	10	10	10
03400031	6.6	6.6	8.1	10		10	
03400045	9.1	9.1	11.7	10		10	
03400062	12.9	13.1	18.4	20	20	20	20
03400078	13.2	13.4	17.5	20		20	
03400100	15.6	15.8	22.5	20		20	
04400150	16.8	18.7	26.6	25	25	25	25
04400172	20	24.3	30.5	32	32	30	30
575 V							
06500100	11.9	13.2	19.3	20	40	20	30
06500150	16.8	18.7	28.9	32		25	
06500190	21.8	24.3	36.7	40		30	
06500230	26.3	29.4	43.9	50	63	35	50
06500290	33	37.1	55.3	50		40	
06500350	40.2	46.9	66.8	63		50	

Table 12-15 AC input current and fuse rating (400V size 6)

Model	Typical input current	Maximum continuous input current	Maximum overload input current	Fuse Rating			
				IEC gR		Ferraz HSJ Bussman DFJ	
				Nominal	Maximum	Nominal	Maximum
	A	A	A	A	A	A	A
06400350	32.7	36.5	58.9	63	63	40	70
06400420	41.3	46.2	70.7	63		50	
06400470	51.9	60.6	79.1	63		70	

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 12-16 Cable ratings

Model	Cable size (IEC) mm^2				Cable size (UL) AWG			
	Input		output		Input		output	
	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum	Nominal	Maximum
200 V								
03200050	1.5	4	1.5	4	14	10	14	10
03200066								
03200080	4		4		12		12	
03200106								
04200137	6	6	6	8	10	10	10	8
04200185	8							
06200330	16	25	16	25	4	3	4	3
06200440	25		25		3		3	
400 V								
03400025	1.5	4	1.5	4	18	10	18	10
03400031					16		16	
03400045					14		14	
03400062	2.5		2.5					
03400078								
03400100					12		12	
04400150	6	6	6	8	10	10	10	8
04400172			8					
06400350	10	25	10	25	6	3	6	3
06400420	16		16		4		4	
06400470	25		25		3		3	
575 V								
06500100	2.5	25	2.5	25	14	3	14	3
06500150	4		4		10		10	
06500190	6		6					
06500230	10		10		8		8	
06500290					6		6	
06500350	16							

12.1.22 Protective ground cable ratings

Table 12-17 Protective ground cable ratings

Model	Ground conductor size
200 V	
03200050	Either use 10 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
03200066	
03200080	
03200106	
04200137	
04200185	
06200330	
06200440	Either use 16 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
400 V	
03400025	Either use 10 mm2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
03400031	
03400045	
03400062	
03400078	
03400100	
04400150	
04400172	
06400350	
06400420	
06400470	Either use 16 mm^2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
575 V	
06500100	Either use 10 mm2 cable **or** 2 cables of the same cross sectional area as the recommended phase cables
06500150	
06500190	
06500230	
06500290	
06500350	

12.1.23 Maximum motor cable lengths

Table 12-18 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**
03200050	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03200066	100 m (330 ft)				75 m (245 ft)		
03200080	130 m (425 ft)			100 m (330 ft)			
03200106	200 m (660 ft)		150 m (490 ft)				
04200137	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04200185							
06200330	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06200440							

Table 12-19 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**
03400025	65 m (210 ft)					50 m (165 ft)	37 m (120 ft)
03400031	100 m (330 ft)				75 m (245 ft)		
03400045	130 m (425 ft)			100 m (330 ft)			
03400062	200 m (660 ft)		150 m (490 ft)				
03400078							
03400100							
04400150	200 m (660 ft)		150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	37 m (120 ft)
04400172							
06400350	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06400420							
06400470							

Table 12-20 Maximum motor cable lengths (575 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**
06500100	300 m (984 ft)	200 m (660 ft)	150 m (490 ft)	100 m (330 ft)	75 m (245 ft)	50 m (165 ft)	
06500150							
06500190							
06500230							
06500290							
06500350							

- 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 12-18 and Table 12-19 if high capacitance motor cables are used. For further information, refer to section 4.8.2 *High-capacitance / reduced diameter cables* on page 49.

12.1.24 Braking resistor values

Table 12-21 Minimum resistance values and peak power rating for the braking resistor at 40 °C (104 °F)

Model	Minimum resistance*	Instantaneous power rating	Continuous power rating
	Ω	kW	kW
200 V			
03200050	43	3.5	
03200066			
03200080			
03200106	29	5.3	
04200137			
04200185			
06200330	5	30.3	
06200440			
400 V			
03400025	74	8.3	
03400031			
03400045			
03400062			
03400078	58	10.6	
03400100			
04400150			
04400172			
06400350	18	35.5	
06400420			
06400470			
575 V			
06500100	18	50.7	
06500150			
06500190			
06500230			
06500290			
06500350			

* Resistor tolerance: ±10 %

12.1.25 Torque settings

Table 12-22 Drive control and relay terminal data

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

Table 12-23 Drive power terminal data

Model size	AC terminals	DC and braking	Ground terminal
3	Plug-in terminal block 0.8 N m (0.6 lb ft)	Terminal block M4 screws 2.0 N m (1.47 lb ft)	Screw (M4) 2.0 N m (1.47 lb ft)
4			M4 stud 2.0 N m (1.47 lb ft)
6	M6 stud 6 N m (4.42 lb ft)		

The maximum torque for the nuts securing the grounding bracket is 2.0 N m (1.47 lb ft).

Table 12-24 Plug-in terminal block maximum cable sizes

Model size	Terminal block description	Max cable size
All	13 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		
6	2 way low voltage power 24 V supply connector	1.5 mm^2 (16 AWG)

12.1.26 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 12-25 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 *Surge immunity of control circuits - long cables and connections outside a building* on page 60 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 12-26 Size 3 emission compliance (200 V drives)

Motor cable length (m)	Switching frequency (kHz)					
	3	4	6	8	12	16
Using internal filter:						
0 – 2	C3		C4			
Using internal filter and external ferrite ring (1 turn):						
0 – 10	C3			C4		
10 - 20	C3		C4			
Using external filter:						
0 – 20	R	I	I	I	I	I
20 - 100	I	-	-	-	-	-

Table 12-27 Size 3 emission compliance (400 V drives)

Motor cable length (m)	Switching frequency (kHz)					
	3	4	6	8	12	16
Using internal filter:						
0 – 5	C3		C4			
Using internal filter and external ferrite ring (2 turns):						
0 – 10	C3				C4	
Using external filter:						
0 – 20	R	I	I	I	I	I
20 - 100	I	-	-	-	-	-

Key (shown in decreasing order of permitted emission level):

E2R EN 61800-3:2004 second environment, restricted distribution (Additional measures may be required to prevent interference)

E2U EN 61800-3:2004 second environment, unrestricted distribution

I Industrial generic standard EN 61000-6-4:2007
EN 61800-3:2004 first environment restricted distribution (The following caution is required by EN 61800-3:2004)

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 61000-6-3:2007
EN 61800-3:2004 first environment unrestricted distribution

EN 61800-3:2004 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.

IEC 61800-3:2004 and EN 61800-3:2004

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	Rated at over 1000 V or over 400 A, intended for use in complex systems in the second environment	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 12-28 Drive and EMC filter cross reference

Model	CT Part number
200 V	
03200050 to 03200106	4200-3230
04200137 to 04200185	
06200330 to 06200440	4200-2300
400 V	
03400025 to 03400100	4200-3480
04400150 to 04400172	
06400350 to 06400470	4200-4800
575 V	
06500100 to 06500350	4200-3690

12.2.1 EMC filter ratings

Table 12-29 Optional external EMC filter details

CT part number	Maximum continuous current		Voltage rating		IP rating	Power dissipation at rated current		Ground leakage		Discharge resistors
	@ 40 °C (104 °F)	@ 50 °C (122 °F)	IEC	UL		@ 40 °C (104 °F)	@ 50 °C (122 °F)	Balanced supply phase-to-phase and phase-to-ground	Worst case	
	A	A	V	V		W	W	mA	mA	MΩ
4200-3230	20	18.5	250	300	20	20	17	2.4	60	1.5
4200-3480	16	15	528	600		13	11	11	151	
4200-2300	55	51	250	300		41	35	4.2	69	
4200-4800	63	58	528	600		54	46	11.2	183	
4200-3690	42	39	760	600		45	39	12	234	

12.2.2 Overall EMC filter dimensions

Table 12-30 Optional external EMC filter dimensions

CT part number	Dimension (mm)						Weight	
	H		W		D			
	mm	inch	mm	inch	mm	inch	kg	lb
4200-3230	372	14.65	80	3.15	41	1.61	1.9	4.20
4200-3480							2.0	4.40
4200-2300	434	17.09	210	8.27	60	2.36	6.5	14.30
4200-4800							6.7	14.80
4200-3690							7.0	15.40

12.2.3 EMC filter torque settings

Table 12-31 Optional external EMC Filter terminal data

CT part number	Power connections				Ground connections		
	Max cable size		Max torque		Ground stud size	Max torque	
	mm^2	AWG	N m	lb ft		N m	lb ft
4200-3230	4	12	0.8	0.59	M5	3.0	2.2
4200-3480							
4200-2300	16	6	2.3	1.70	M6	4.8	2.8
4200-4800							
4200-3690							

13 Diagnostics

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

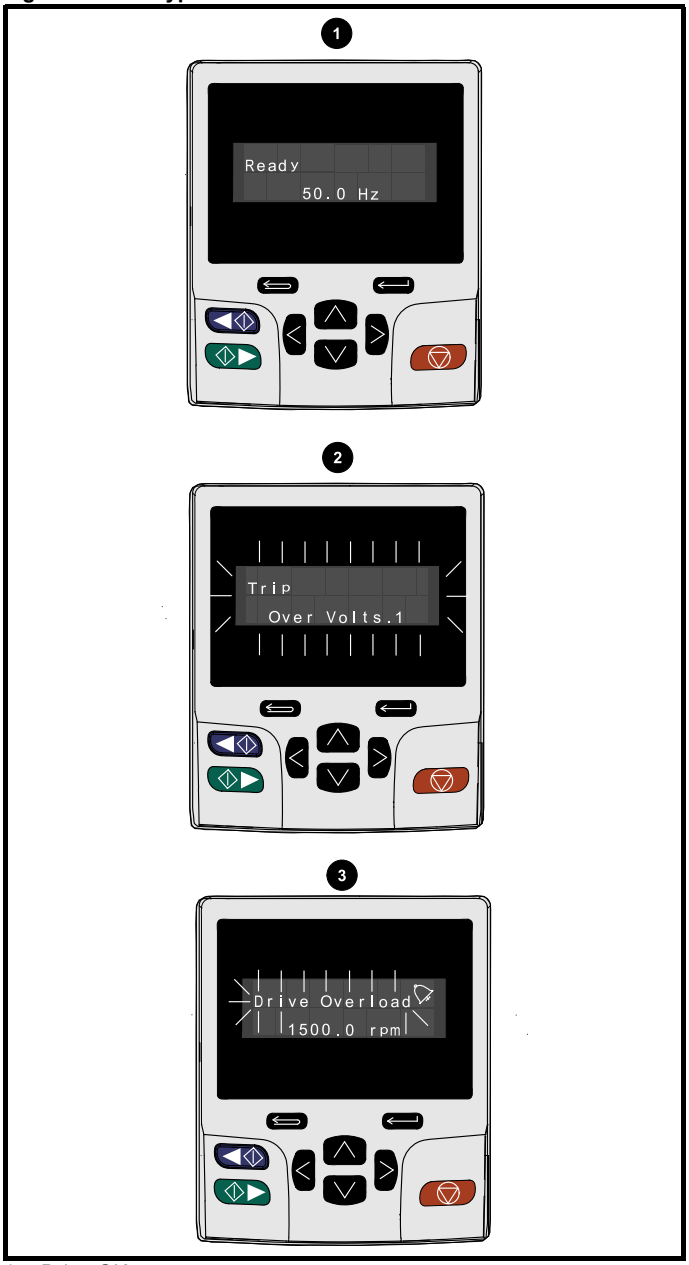
- Trip indications
- Alarm indications
- Status indications

WARNING

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

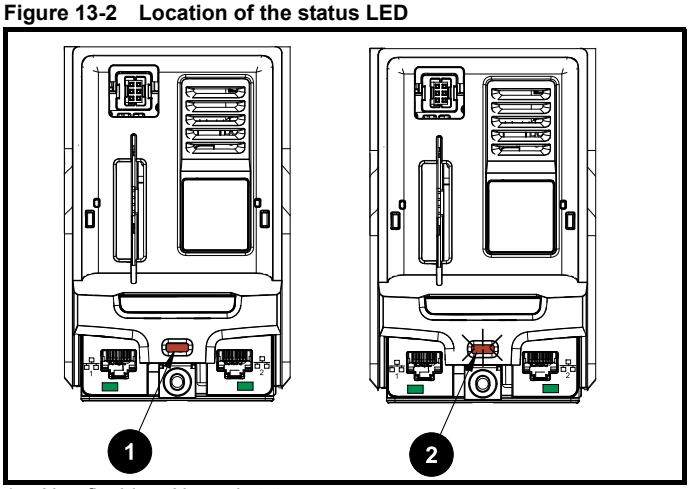
13.1 Status modes (Keypad and LED status)

Figure 13-1 Keypad status modes



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

Figure 13-2 Location of the status LED

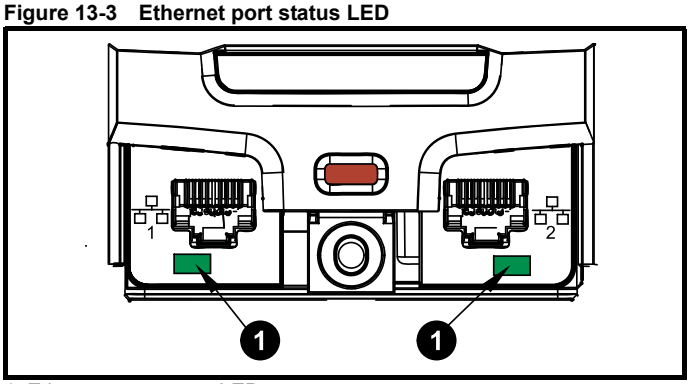


1. Non flashing: Normal status
2. Flashing: Trip status

13.1.1 Ethernet status LEDs

Each of the Ethernet ports provide a status LED for diagnostic and information purposes. Refer to Table 13-1 for Ethernet LED status.

Figure 13-3 Ethernet port status LED



1. Ethernet port status LED.

Table 13-1 Ethernet LED status

LED status	Description
Off	Ethernet connection not detected
Solid green	Ethernet connection detected but no data
Flashing green	Ethernet connection detected and data flow

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.

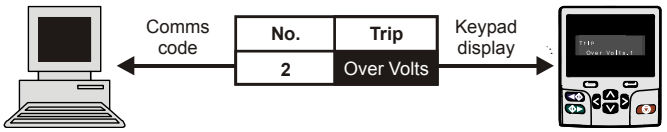
During a trip condition, where a KI-Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip 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 13-4 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr **10.001** 'Drive OK' 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 13-5 to identify the specific trip.

Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 13-4 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 13-4.
4. Perform checks detailed under *Diagnosis*.

13.3 Identifying a trip / trip source

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

A trip can be generated from a control system or from a power system. The sub-trip number associated with the trips listed in Table 13-2 is in the form xxyzz and used to identify the source of the trip.

Table 13-2 Trips associated with xxyzz sub-trip number

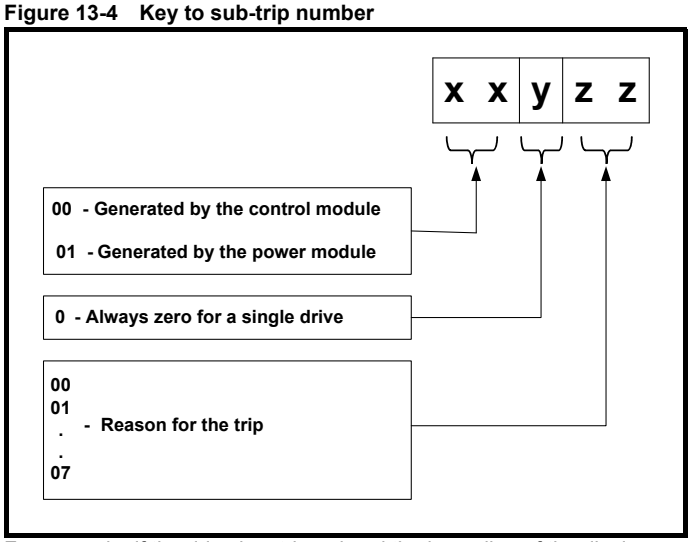
Over Volts	OHt dc bus
OI ac	Phase Loss
OI Brake	Power Comms
PSU	OI Snubber
OHt Inverter	OHt Rectifier
OHt Power	Temp Feedback
OHt Control	Power Data

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

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

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

Figure 13-4 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 13-3 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 13-3 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 13-4 Trip indications

Trip	Diagnosis
An Input 1 Loss	**Analog input 1 current loss**
28	*An Input 1 Loss* trip indicates that a current loss was detected in current mode on Analog input 1 (Terminal 5, 6). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. **Recommended actions:** • Check control wiring is correct • Check control wiring is undamaged • Check the *Analog Input 1 Mode* (07.007) • Current signal is present and greater than 3 mA
An Input 2 Loss	**Analog input 2 current loss**
29	*An Input 2 Loss* indicates that a current loss was detected in current mode on Analog input 2 (Terminal 7). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. **Recommended actions:** • Check control wiring is correct • Check control wiring is undamaged • Check the *Analog Input 2 Mode* (07.011) • Current signal is present and greater than 3 mA
An Output Calib	**Analog output calibration failed**
219	The *An output Calib* trip indicates that one or both of the Analog outputs have failed during the zero offset calibration**.** The failed output can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Output 1 failed (Terminal 9) 2 – Output 2 failed (Terminal 10) **Recommended actions:** • Check the wiring associated with analog outputs • Remove all the wiring that is connected to analog outputs and perform the calibration • If trip persists replace the drive
App Menu Changed	**Customization table for an application module has changed**
217	The *App Menu Changed* trip indicates that the customization table for an application menu has changed. The menu that has been changed can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Menu 18 2 – Menu 19 3 – Menu 20 **Recommended actions:** • Reset the trip and perform a parameter save to accept the new settings
Autotune 1	**Position feedback did not change or required speed could not be reached**
11	The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number. **Sub-trip** / **Reason** 1 – The position feedback did not change when position feedback is being used during rotating autotune. 2 – The motor did not reach the required speed during rotating autotune or mechanical load measurement. **Recommended actions:** • Ensure the motor is free to turn i.e. mechanical brake was released • Ensure Pr **03.026** and Pr **03.038** are set correctly (or appropriate 2nd motor map parameters) • Check feedback device wiring is correct • Check encoder mechanical coupling to the motor

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Autotune 2</td><td>Position feedback direction incorrect</td></tr>
<tr><td>12</td><td>The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The position feedback direction is incorrect when position feedback is being used during a rotating autotune</td></tr>
<tr><td>2</td><td>The motor did not reach the required speed during rotating autotune or mechanical load measurement.</td></tr>
</table>
Recommended actions:
• Check motor cable wiring is correct
• Check feedback device wiring is correct
• Swap any two motor phases</td></tr>
<tr><td>Autotune 3</td><td>Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction</td></tr>
<tr><td>13</td><td>The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Measured inertia has exceeded the parameter range during a mechanical load measurement</td></tr>
<tr><td>2</td><td>The commutation signals changed in the wrong direction during a rotating autotune</td></tr>
</table>
Recommended actions:
• Check motor cable wiring is correct
• Check feedback device U,V and W commutation signal wiring is correct</td></tr>
<tr><td>Autotune 4</td><td>Drive encoder U commutation signal fail</td></tr>
<tr><td>14</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the U commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device U commutation signal wiring is correct (Encoder terminals 7 and 8)</td></tr>
<tr><td>Autotune 5</td><td>Drive encoder V commutation signal fail</td></tr>
<tr><td>15</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the V commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device V commutation signal wiring is correct (Encoder terminals 9 and 10)</td></tr>
<tr><td>Autotune 6</td><td>Drive encoder W commutation signal fail</td></tr>
<tr><td>16</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the W commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device W commutation signal wiring is correct (Encoder terminals 11 and 12)</td></tr>
<tr><td>Autotune 7</td><td>Motor number of poles / position feedback resolution set incorrectly</td></tr>
<tr><td>17</td><td>An Autotune 7 trip is initiated during a rotating autotune, if the motor poles or the position feedback resolution have been set up incorrectly where position feedback is being used.
Recommended actions:
• Check line per revolution for feedback device
• Check the number of poles in Pr 05.011</td></tr>
<tr><td>Autotune Stopped</td><td>Autotune test stopped before completion</td></tr>
<tr><td>18</td><td>The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed.
Recommended actions:
• Check the drive enable signal (Terminals 11 and 13) was active during the autotune
• Check the run command was active in Pr 08.005 during autotune</td></tr>
<tr><td>Brake R Too Hot</td><td>Braking resistor overload timed out (I^2t)</td></tr>
<tr><td>19</td><td>The Brake R Too Hot indicates that braking resistor overload has timed out. The value in Braking Resistor Thermal Accumulator (10.039) is calculated using Braking Resistor Rated Power (10.030), Braking Resistor Thermal Time Constant (10.031) and Braking Resistor Resistance (10.061). The Brake R Too Hot trip is initiated when Braking Resistor Thermal Accumulator (10.039) reaches 100 %.
Recommended actions:
• Ensure the values entered in Pr 10.030, Pr 10.031 and Pr 10.061 are correct
• If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr 10.030, Pr 10.031 or Pr 10.061 to 0 to disable the trip.</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>CAM</td><td>Advanced motion controller CAM failure</td></tr>
<tr><td>99</td><td>The CAM trip indicates that the advanced motion controller CAM has detected a problem.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>CAM index or segment is out of range</td></tr>
<tr><td>2</td><td>AMC CAM Index (35.007) has been made to change by more than 2 in one sample</td></tr>
</table></td></tr>
<tr><td>Card Access</td><td>NV Media Card Write fail</td></tr>
<tr><td>185</td><td>The Card Access trip indicates that the drive was unable to access the NV Media Card. If the trip occurs during the data transfer to the card then the file being written may be corrupted. If the trip occurs when the data being transferred to the drive then the data transfer may be incomplete. If a parameter file is transferred to the drive and this trip occurs during the transfer, the parameters are not saved to non-volatile memory, and so the original parameters can be restored by powering the drive down and up again.
Recommended actions:
• Check NV Media Card is installed / located correctly
• Replace the NV Media Card</td></tr>
<tr><td>Card Boot</td><td>The Menu 0 parameter modification cannot be saved to the NV Media Card</td></tr>
<tr><td>177</td><td>Menu 0 changes are automatically saved on exiting edit mode.
The Card Boot trip will occur if a write to a Menu 0 parameter has been initiated via the keypad by exiting edit mode and Pr 11.042 is set for auto or boot mode, but the necessary boot file has not been created on the NV Media Card to take the new parameter value. This occurs when Pr 11.042 is changed to Auto (3) or Boot (4) mode, but the drive is not subsequently reset.
Recommended actions:
• Ensure that Pr 11.042 is correctly set, and then reset the drive to create the necessary file on the NV Media Card
• Re-attempt the parameter write to the Menu 0 parameter</td></tr>
<tr><td>Card Busy</td><td>NV Media Card cannot be accessed as it is being accessed by an option module</td></tr>
<tr><td>178</td><td>The Card Busy trip indicates that an attempt has been made to access a file on NV Media Card, but the NV Media Card is already being accessed by an Option Module, such as one of the Applications modules. No data is transferred.
Recommended actions:
• Wait for the option module to finish accessing the NV Media Card and re-attempt the required function</td></tr>
<tr><td>Card Data Exists</td><td>NV Media Card data location already contains data</td></tr>
<tr><td>179</td><td>The Card Data Exists trip indicates that an attempt has been made to store data on a NV Media Card in a data block which already contains data.
Recommended actions:
• Erase the data in data location
• Write data to an alternative data location</td></tr>
<tr><td>Card Compare</td><td>NV Media Card file/data is different to the one in the drive</td></tr>
<tr><td>188</td><td>A compare has been carried out between a file on the NV Media Card, a Card Compare trip is initiated if the parameters on the NV Media Card are different to the drive.
Recommended actions:
• Set Pr mm.000 to 0 and reset the trip
• Check to ensure the correct data block on the
• NV Media Card has been used for the compare</td></tr>
<tr><td>Card Drive Mode</td><td>NV Media Card parameter set not compatible with current drive mode</td></tr>
<tr><td>187</td><td>The Card Drive Mode trip is produced during a compare if the drive mode in the data block on the NV Media Card is different from the current drive mode. This trip is also produced if an attempt is made to transfer parameters from a NV Media Card to the drive if the operating mode in the data block is outside the allowed range of operating modes.
Recommended actions:
• Ensure the destination drive supports the drive operating mode in the parameter file.
• Clear the value in Pr mm.000 and reset the drive
• Ensure destination drive operating mode is the same as the source parameter file</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Card Error</td><td>NV Media Card data structure error</td></tr>
<tr><td>182</td><td>The Card Error trip indicates that an attempt has been made to access a NV Media Card but an error has been detected in the data structure on the card. Resetting the trip will cause the drive to erase and create the correct folder structure. The cause of the trip can be identified by the sub-trip.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The required folder and file structure is not present</td></tr>
<tr><td>2</td><td>The HEADER.DAT file is corrupted</td></tr>
<tr><td>3</td><td>Two or more files in the GT8DATA \ DRIVE folder have the same file identification number</td></tr>
</table>
Recommended actions:
• Erase all the data block and re-attempt the process
• Ensure the card is located correctly
• Replace the NV Media Card</td></tr>
<tr><td>Card Full</td><td>NV Media Card full</td></tr>
<tr><td>184</td><td>The Card Full trip indicates that an attempt has been made to create a data block on a NV Media Card, but there is not enough space left on the card.
Recommended actions:
• Delete a data block or the entire NV Media Card to create space
• Use a different NV Media Card</td></tr>
<tr><td>Card No Data</td><td>NV Media Card data not found</td></tr>
<tr><td>183</td><td>The Card No Data trip indicates that an attempt has been made to access non-existent file or block on a NV Media Card.
Recommended actions:
• Ensure data block number is correct</td></tr>
<tr><td>Card Option</td><td>NV Media Card trip; option modules installed are different between source drive and destination drive</td></tr>
<tr><td>180</td><td>The Card Option trip indicates that parameter data or default difference data is being transferred from a NV Media Card to the drive, but the option module categories are different between source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the option modules that are different will be set to the default values and not the values from the card. This trip also applies if a compare is attempted between the data block and the drive.
Recommended actions:
• Ensure the correct option modules are installed.
• Ensure the option modules are in the same option module slot as the parameter set stored.
• Press the red reset button to acknowledge that the parameters for one or more of the option modules installed will be at their default values
• This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive.</td></tr>
<tr><td>Card Product</td><td>NV Media Card data blocks are not compatible with the drive derivative</td></tr>
<tr><td>175</td><td>The Card Product trip is initiated either at power-up or when the card is accessed, If Drive Derivative (11.028) is different between the source and target drives. This trip can be reset and data can be transferred in either direction between the drive and the card.
Recommended actions:
• Use a different NV Media Card
• This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive</td></tr>
<tr><td>Card Rating</td><td>NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different</td></tr>
<tr><td>186</td><td>The Card Rating trip indicates that parameter data is being transferred from a NV Media Card to the drive, but the current and / or voltage ratings are different between source and destination drives. This trip also applies if a compare (using Pr mm.000 set to 8yyy) is attempted between the data block on a NV Media Card and the drive. The Card Rating trip does not stop the data transfer but is a warning that rating specific parameters with the RA attribute may not be transferred to the destination drive.
Recommended actions:
• Reset the drive to clear the trip
• Ensure that the drive rating dependent parameters have transferred correctly</td></tr>
<tr><td>Card Read Only</td><td>NV Media Card has the Read Only bit set</td></tr>
<tr><td>181</td><td>The Card Read Only trip indicates that an attempt has been made to modify a read-only NV Media Card or a read-only data block. A NV Media Card is read-only if the read-only flag has been set.
Recommended actions:
• Clear the read only flag by setting Pr mm.000 to 9777 and reset the drive. This will clear the read-only flag for all data blocks in the NV Media Card</td></tr>
</table>

Trip	Diagnosis
Card Slot	**NV Media Card Trip; Option module application program transfer has failed**
174	The *Card Slot* trip is initiated, if the transfer of an option module application program to or from an application module failed because the option module does not respond correctly. If this happens this trip is produced with the sub-trip indicating the option module slot number. **Recommended actions:** • Ensure the source / destination option module is installed on the correct slot
Configuration	**The number of power modules installed is different from the modules expected**
111	The *Configuration* trip indicates that the *Number Of Power Modules Detected* (11.071) does not match the previous value stored. **Recommended actions:** • Ensure that all the power modules are correctly connected / simultaneously • 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
Control Word	**Trip initiated from the *Control Word* (06.042)**
35	The Control Word trip is initiated by setting bit 12 on the control word in Pr **06.042** when the control word is enabled (Pr **06.043** = On). **Recommended actions:** • Check the value of Pr **06.042.** • Disable the control word in *Control Word Enable* (Pr **06.043**) Bit 12 of the control word set to a one causes the drive to trip on Control Word When the control word is enabled, the trip can only be cleared by setting bit 12 to zero
Current Offset	**Current feedback offset error**
225	The *Current Offset* trip indicates that the current offset is too larger to be trimmed. **Recommended actions:** • Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled • Hardware fault – Contact the supplier of the drive
Data Changing	**Drive parameters are being changed**
97	A user action or a file system write is active that is changing the drive parameters and the drive has been commanded to enable, i.e. *Drive Active* (10.002) = 1. **Recommended actions:** • Ensure the drive is not enabled when one of he following is being carried out Loading defaults Changing drive mode Transferring data from NV Media Card or position feedback device Transferring user programs

Trip	Diagnosis
Derivative Image	**Derivative product image error**

The *Derivative Image* trip indicates that an error has been detected in the derivative product image. The reason for the trip can be identified by the sub-trip number.

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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	
30	The image has failed because either its CRC is incorrect, or there are less than 6 bytes in the image or the image header version is less than 5	Occurs when the drive powers-up or the image is programmed. The image tasks will not run
31	The image requires more RAM for heap and stack than can be provided by the drive.	As 30
32	The image requires an OS function call that is higher than the maximum allowed.	As 30
33	The ID code within the image is not valid	As 30
34	The derivative image has been changed for an image with a different derivative number	As 30
40	The timed task has not completed in time and has been suspended	
41	Undefined function called, i.e. a function in the host system vector table that has not been assigned	As 40
51	Core menu customization table CRC check failed	As 30
52	Customizable menu table CRC check failed	As 30
53	Customizable 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

Recommended actions:

- Contact the supplier of the drive

Trip	Diagnosis
Destination	**Two or more parameters are writing to the same destination parameter**
199	The Destination trip indicates that destination output parameters of two or more logic functions (Menus 3, 7, 8, 9, 12 or 14) within the drive are writing to the same parameter. **Recommended actions:** • Set Pr **mm.000** to 'Destinations' or 12001 and check all visible parameters in all menus for parameter write conflicts
Drive Size	**Power stage recognition: Unrecognized drive size**
224	The *Drive Size* trip indicates that the control PCB has not recognized the drive size of the power circuit to which it is connected. **Recommended action:** • Ensure the drive is programmed to the latest firmware version • Hardware fault - return drive to supplier
EEPROM Fail	**Default parameters have been loaded**
31	The *EEPROM Fail* trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number.

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

Recommended actions:

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

Encoder 1	**Drive position feedback interface power supply overload**
189	The *Encoder 1* trip indicates that the drive encoder power supply has been overloaded. Terminals 13 and 14 of the 15 way D type connector can supply a maximum current of 200 mA @ 15 V or 300 mA @ 8 V and 5 V. **Recommended actions:** • Check encoder power supply wiring • Disable the termination resistors (Pr **03.039** set to 0) to reduce current consumption • For 5 V encoders with long cables, select 8 V (Pr **03.036**) and fit a 5 V voltage regulator close to the encoder • Check the encoder specification to confirm if it is compatible with the encoder port power supply current capability • Replace the encoder • Use an external power supply with higher current capability
Encoder 2	**Drive encoder (Feedback) wire break**
190	The *Encoder 2* trip indicates that the drive has detected a wire break on the 15 way D-type connector on the drive. The exact cause of the trip can be identified from the sub-trip number.

Sub-trip	Reason
10	Drive position feedback interface 1 on any input
20	Drive position feedback interface 2 on any input
11	Drive position feedback interface 1 on the A channel
12	Drive position feedback interface 1 on the B channel
13	Drive position feedback interface 1 on the Z channel

Recommended actions:

- If wire break detection on the drive encoder input is not required, set Pr **03.040** = XXX0 to disable the Encoder 2 trip
- Check cable continuity
- Check wiring of feedback signals is correct
- Check encoder power supply is set correctly (Pr **03.036**)
- Replace encoder

Trip	Diagnosis
Encoder 3	**Phase offset incorrect while running**
191	The *Encoder 3* trip indicates that the drive has detected an incorrect UVW phase angle while running (RFC-S mode only) or SINCOS phase error. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Check encoder shield connections • Ensure the encoder cable is one uninterrupted cable • Check the encoder signal for noise with an oscilloscope • Check the integrity of the encoder mechanical mounting • For a UVW servo encoder, ensure that the phase rotation of the UVW commutation signals is the same as • the phase rotation of the motor • For a SINCOS encoder, ensure that motor and incremental SINCOS connections are correct and that for forward rotation of the motor, the encoder rotates clockwise (when looking at the shaft of the encoder) • Repeat the offset measurement test
Encoder 4	**Feedback device comms failure**
192	The Encoder 4 trip indicates that the encoder communications has timed out or the communications position message transfer time is too long. This trip can also be caused due to wire break in the communication channel between the drive and the encoder. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Ensure the encoder power supply setting (Pr **03.036**) is correct • Complete encoder auto-configuration (Pr **03.041**) • Check the encoder wiring • Replace the feedback device
Encoder 5	**Checksum or CRC error**
193	The *Encoder 5* trip indicates that there is a checksum or CRC error, or the SSI encoder is not ready. The Encoder 5 trip can also indicate a wire break to a communications based encoder. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Check the encoder cable shield connections • Ensure the cable is one uninterrupted cable - remove any connector blocks or if unavoidable minimise the length of any shield pigtails to the connector block • Check the encoder signal for noise with an oscilloscope • Check the comms resolution setting (Pr **03.035**) • If using a Hiperface, EnDat encoder or BiSS encoder carry out an encoder auto-configuration (Pr **03.041** = Enabled) • Replace the encoder
Encoder 6	**Encoder has indicated an error**
194	The *Encoder 6* trip indicates that the encoder has indicated an error or that the power supply has failed to an SSI encoder. The *Encoder 6* trip can also indicate a wire break to an SSI encoder. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • For SSI encoders, check the wiring and encoder power supply setting (Pr **03.036**) • Replace the encoder / contact the supplier of the encoder

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Encoder 7</td><td>Initialization failed</td></tr>
<tr><td>195</td><td>The Encoder 7 trip indicates that the set-up parameters for position feedback device has changed. The feedback device which has caused the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Drive position feedback interface 1</td></tr>
<tr><td>2</td><td>Drive position feedback interface 2</td></tr>
</table>
Recommended actions:
• Reset the trip and perform a save.
• Ensure Pr 3.033 and Pr 03.035 are set correctly or carry out an encoder auto-configuration (Pr 03.041 = Enabled)</td></tr>
<tr><td>Encoder 8</td><td>Position feedback interface has timed out</td></tr>
<tr><td>196</td><td>The Encoder 8 trip indicates that Position feedback interface communications time exceeds 250 μs. The feedback device which has caused the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Drive position feedback interface 1</td></tr>
<tr><td>2</td><td>Drive position feedback interface 2</td></tr>
</table>
Recommended actions:
• Ensure the encoder is connected correctly
• Ensure that the encoder is compatible
• Increase baud rate</td></tr>
<tr><td>Encoder 9</td><td>Position feedback is selected from a option module slot which does not have a feedback option module installed</td></tr>
<tr><td>197</td><td>The Encoder 9 trip indicates that position feedback source selected in Pr 03.026 (or Pr 21.021 for the second motor map) is not valid
Recommended actions:
• Check the setting of Pr 03.026 (or Pr 21.021 if the second motor parameters have been enabled)
• Ensure that the option slot selected in Pr 03.026 has a feedback option module installed</td></tr>
<tr><td>Encoder 10</td><td>RFC-S mode phasing failure due to incorrect phase angle</td></tr>
<tr><td>198</td><td>The Encoder 10 indicates that the phase offset angle in Pr 03.025 (or Pr 21.020 if the second motor map is being used) is incorrect and the drive is unable to control the motor correctly.
Recommended actions:
• Check the encoder wiring
• Check the encoder signals for noise with an oscilloscope
• Check the encoder mechanical coupling
• Perform an auto-tune to measure the encoder phase angle or manually enter the correct phase angle into Pr 03.025
• Spurious Encoder 10 trips can sometimes be seen in very dynamic applications. This trip can be disabled by setting the over-speed threshold in Pr 03.008 to a value greater than zero.</td></tr>
<tr><td>Encoder 12</td><td>Encoder could not be identified during auto-configuration</td></tr>
<tr><td>162</td><td>The Encoder 12 trip indicates that the drive is communicating with the encoder but the encoder type is not recognized.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Drive position feedback interface 1</td></tr>
<tr><td>2</td><td>Drive position feedback interface 2</td></tr>
</table>
Recommended actions:
• Enter the encoder setup parameters manually
• Check to see the encoder supports auto-configuration</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Encoder 13</td><td>Data read from the encoder is out of range during auto-configuration</td></tr>
<tr><td>163</td><td>The Encoder 13 trip indicates that the data read from the encoder was out of the range during auto-configuration. No parameters will be modified with the data read from the encoder as a result of auto configuration.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Parameter</th></tr>
<tr><td>11</td><td>P1 Rotary lines per revolution error</td><td>03.034</td></tr>
<tr><td>12</td><td>P1 Linear comms pitch error</td><td>03.052</td></tr>
<tr><td>13</td><td>P1 Linear line pitch error</td><td>03.053</td></tr>
<tr><td>14</td><td>P1 Rotary turns bits error</td><td>03.033</td></tr>
<tr><td>15</td><td>P1 Communications bits error</td><td>03.035</td></tr>
<tr><td>16</td><td>P1 Calculation time is too long</td><td>03.060</td></tr>
<tr><td>17</td><td>P1 Line delay measured is longer than 5 μs</td><td>03.062</td></tr>
<tr><td>21</td><td>P2 Rotary lines per revolution error</td><td>03.134</td></tr>
<tr><td>22</td><td>P2 Linear comms pitch error</td><td>03.152</td></tr>
<tr><td>23</td><td>P2 Linear line pitch error</td><td>03.153</td></tr>
<tr><td>24</td><td>P2 Rotary turns bits error</td><td>03.133</td></tr>
<tr><td>25</td><td>P2 Communications bits error</td><td>03.135</td></tr>
<tr><td>26</td><td>P2 Calculation time is too long</td><td>03.160</td></tr>
<tr><td>27</td><td>P2 Line delay measured is longer than 5 μs</td><td>03.162</td></tr>
</table>
Recommended actions:
• Enter the encoder setup parameters manually
• Check to see the encoder supports auto-configuration</td></tr>
<tr><td>External Trip</td><td>An External trip is initiated</td></tr>
<tr><td>6</td><td>An External Trip has occurred. The cause of the trip can be identified from the sub trip number displayed after the trip string. See table below. An external trip can also be initiated by writing a value of 6 in Pr 10.038.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>External Trip Mode (08.010) = 1 or 3 and SAFE TORQUE OFF input 1 is low</td></tr>
<tr><td>2</td><td>External Trip Mode (08.010) = 2 or 3 and SAFE TORQUE OFF input 2 is low</td></tr>
<tr><td>3</td><td>External Trip (10.032) = 1</td></tr>
</table>
Recommended actions:
• Check the SAFE TORQUE OFF signal voltage on terminals 11 and 13 equals to 24 V
• Check the value of Pr 08.009 which indicates the digital state of terminal 11 and 13, equates to ‘on’.
• If external trip detection of the SAFE TORQUE OFF input is not required, set Pr 08.010 to OFF (0).
• Check the value of Pr 10.032.
• Select ‘Destinations’ (or enter 12001) in Pr mm.000 and check for a parameter controlling Pr 10.032.
• Ensure Pr 10.032 or Pr 10.038 (= 6) is not being controlled by serial comms</td></tr>
<tr><td>Frequency Range</td><td>Out of range of frequency has been detected in regen mode</td></tr>
<tr><td>168</td><td>The Frequency Range trip indicates that the supply frequency is outside the range defined by Regen Minimum Frequency (03.024) and Regen Maximum Frequency (03.025) for more than 100 ms.
Recommended actions:
• Ensure the supply is operating within the drive specification
• Ensure Pr 03.024 and Pr 03.025 are set correctly
• Check the supply voltage waveform using an oscilloscope
• Reduce the level of supply disturbance</td></tr>
<tr><td>HF01</td><td>Data processing error: CPU address error</td></tr>
<tr><td></td><td>The HF01 trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF02</td><td>Data processing error: DMAC address error</td></tr>
<tr><td></td><td>The HF02 trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF03</td><td>Data processing error: Illegal instruction</td></tr>
<tr><td></td><td>The HF03 trip indicates that an illegal instruction has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
</table>

Trip	Diagnosis
HF04	**Data processing error: Illegal slot instruction**
	The *HF04* trip indicates that an illegal slot instruction has occurred.This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF05	**Data processing error: Undefined exception**
	The *HF05* trip indicates that an undefined exception error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF06	**Data processing error: Reserved exception**
	The *HF06* trip indicates that a reserved exception error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF07	**Data processing error: Watchdog failure**
	The *HF07* trip indicates that a watchdog failure has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF08	**Data processing error: CPU Interrupt crash**
	The *HF08* trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF09	**Data processing error: Free store overflow**
	The *HF09* trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF10	**Data processing error: Parameter routing system error**
	The *HF10* trip indicates that a Parameter routing system error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF11	**Data processing error: Access to EEPROM failed**
	The *HF11* trip indicates that access to the drive EEPROM has failed. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF12	**Data processing error: Main program stack overflow**
	The *HF12* trip indicates that the main program stack over flow has occurred. The stack can be identified by the sub-trip number. This trip indicates that the control PCB on the drive has failed. **Sub-trip** / **Stack** 1 – Freewheeling tasks 2 – Clock tasks 3 – Main system interrupts **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF13	**Data processing error: Firmware incompatible with hardware**
	The *HF13* trip indicates that the drive firmware is not compatible with the hardware. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Re-program the drive with the latest version of the drive firmware for *Unidrive M702* • Hardware fault – Contact the supplier of the drive

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>HF14</td><td>Data processing error: CPU register bank error</td></tr>
<tr><td></td><td>The HF14 trip indicates that a CPU register bank error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF15</td><td>Data processing error: CPU divide error</td></tr>
<tr><td></td><td>The HF15 trip indicates that a CPU divide error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF16</td><td>Data processing error: RTOS error</td></tr>
<tr><td></td><td>The HF16 trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF17</td><td>Data processing error: Clock supplied to the control board is out of specification</td></tr>
<tr><td></td><td>The HF17 trip indicates that the clock supplied to the control board logic is out of specification. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF18</td><td>Data processing error: Internal flash memory has failed</td></tr>
<tr><td></td><td>The HF18 trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Option module initialization timed out</td></tr>
<tr><td>2</td><td>Programming error while writing menu in flash</td></tr>
<tr><td>3</td><td>Erase flash block containing setup menus failed</td></tr>
<tr><td>4</td><td>Erase flash block containing application menus failed</td></tr>
<tr><td>5</td><td>Incorrect setup menu CRC contained in flash</td></tr>
<tr><td>6</td><td>Incorrect application menu CRC contained in flash</td></tr>
<tr><td>7</td><td>Incorrect common application menu 18 CRC contained in flash</td></tr>
<tr><td>8</td><td>Incorrect common application menu 19 CRC contained in flash</td></tr>
<tr><td>9</td><td>Incorrect common application menu 20 CRC contained in flash</td></tr>
</table>
Recommended actions:
• Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>HF19</td><td>Data processing error: CRC check on the firmware has failed</td></tr>
<tr><td></td><td>The HF19 trip indicates that the CRC check on the drive firmware has failed.
Recommended actions:
• Re-program the drive
• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>HF20</td><td>Data processing error: ASIC is not compatible with the hardware</td></tr>
<tr><td></td><td>The HF20 trip indicates that the ASIC version is not compatible with the drive firmware. The ASIC version can be identified from the sub-trip number.
Recommended actions:
• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>Inductor Too Hot</td><td>The regen inductor has overloaded</td></tr>
<tr><td>93</td><td>In Regen mode, this trip indicates a regen inductor thermal overload based on the Rated Current (Pr 05.007) and the Inductor Thermal Time Constant (Pr 04.015). Pr 04.019 displays the inductor temperature as a percentage of the maximum value. The drive will trip on Inductor Too Hot when Pr 04.019 gets to 100 %.
Recommended actions:
• Check the load / current through the inductor has not changed.
• Ensure the Rated Current (Pr 05.007) is not zero.</td></tr>
</table>

Trip	Diagnosis
I/O Overload	**Digital output overload**
26	The *I/O Overload* trip indicates that the total current drawn from 24 V user supply or from the digital output has exceeded the limit. A trip is initiated if one or more of the following conditions: • Maximum output current from one digital output is 100 mA. • The combined maximum output current from outputs 1 and 2 is 100 mA • The combined maximum output current from output 3 and +24 V output is 100 mA **Recommended actions:** • Check total loads on digital outputs • Check control wiring is correct • Check output wiring is undamaged
Island	**Island condition detected in regen mode**
160	The *Island* trip indicates that the AC mains is no longer present and the inverter would be on 'islanded' power supply if it continued to operate. **Recommended actions:** • Check the supply / supply connections to the regen drive
Keypad Mode	**Keypad has been removed when the drive is receiving the speed reference from the keypad**
34	The *Keypad Mode* trip indicates that the drive is in keypad mode [*Reference Selector* (01.014) = 4 or 6] and the keypad has been removed or disconnected from the drive. **Recommended actions:** • Re-install keypad and reset • Change *Reference Selector* (01.014) to select the reference from another source
Line Sync	**Synchronization to the power supply has been lost**
39	The *Line Sync* trip indicates that the inverter has lost the synchronization with the AC supply in Regen mode. **Recommended actions:** • Check the supply / supply connections to the regen drive
Low Load	**The load on the drive has fallen below the low load detection level**
38	When the low load detector is active, the low load condition is detected when the *Percentage Load* (Pr **04.020**) falls below the threshold defined by the *Low Load Detection Level* (Pr **04.027**). *Enable Trip On Low Load* (Pr **04.029**) defines the action taken when low load is detected. If *Enable Trip On Low Load* (Pr **04.029**) = 0, a Low Load warning is displayed and *Low Load Detected Alarm* (Pr **10.062**) = 1. If *Enable Trip On Low Load* (Pr **04.029**) = 1 no warning is given, but a Low Load trip is initiated. **Recommended actions:** • Check the load on the motor has not changed
Motor Too Hot	**Output current overload timed out (I^2t)**
20	The *Motor Too Hot* trip indicates a motor thermal overload based on the output current (Pr **05.007**) and motor thermal time constant (Pr **04.015**). Pr **04.019** displays the motor temperature as a percentage of the maximum value. The drive will trip on *Motor Too Hot* when Pr **04.019** gets to 100 %. **Recommended actions:** • Ensure the load is not jammed / sticking • Check the load on the motor has not changed • If seen during an auto-tune test in RFC-S mode, ensure the motor rated current in Pr **05.007** is ≤ Heavy duty current rating of the drive • Tune the rated speed parameter (RFC-A mode only) • Check feedback signal for noise • Ensure the motor rated current is not zero
Name Plate	**Electronic nameplate transfer has failed**
176	The *Name Plate* trip is initiated if an electronic name plate transfer between the drive and the motor has failed. The exact reason for the trip can be identified from the sub-trip number. **Recommended actions:** • Ensure that the correct data is stored in the encoder by re-transferring the required data from drive into the encoder. • Enter the motor nameplate parameters manually • Replace the feedback device
OHt Brake	**Braking IGBT over-temperature**
101	The *OHt Brake* over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model. **Recommended actions:** • Check braking resistor value is greater than or equal to the minimum resistance value

Trip	Diagnosis
OHt Control	**Control stage over temperature**
23	This *OHt Control* trip indicates that a control stage over-temperature has been detected. From the sub-trip 'xxyzz', the Thermistor location is identified by 'zz'. **Source** / **xx** / **y** / **zz** / **Description** Control system / 00 / 0 / 01 / Control board thermistor 1 over 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:** • 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
OHt dc bus	**DC bus over temperature**
27	The *OHt dc bus* trip indicates a DC bus component over temperature based on a software thermal model. The drive includes a thermal protection system to protect the DC bus components within the drive. This includes the effects of the output current and DC bus ripple. The estimated temperature is displayed as a percentage of the trip level in Pr **07.035**. If this parameter reaches 100 % then an *OHt dc bus* trip is initiated. The drive will attempt to stop the motor before tripping. If the motor does not stop in 10 seconds the drive trips immediately. **Source** / **xx** / **y** / **zz** / **Description** Control system / 00 / 2 / 00 / DC bus thermal model gives trip with sub-trip 0 **Recommended actions:** • Check the AC supply voltage balance and levels • Check DC bus ripple level • Reduce duty cycle • Reduce motor load • Check the output current stability. If unstable; Check the motor map settings with motor nameplate (Pr **05.006**, Pr **05.007**, Pr **05.008**, Pr **05.009**, Pr **05.010**, Pr **05.011**) – (All Modes) Disable slip compensation (Pr **05.027** = 0) – (Open loop) Disable dynamic V to F operation (Pr **05.013** = 0) - (Open loop) Select fixed boost (Pr **05.014** = Fixed) – (Open loop) Select high stability space vector modulation (Pr **05.020** = 1) – (Open loop) Disconnect the load and complete a rotating auto-tune (Pr **05.012**) – (RFC-A, RFC-S) Auto-tune the rated speed value (Pr **05.016** = 1) – (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)
OHt Inverter	**Inverter over temperature based on thermal model**
21	This trip indicates that an IGBT junction over-temperature has been detected based on a software thermal model. **Source** / **xx** / **y** / **zz** / **Description** Control system / 00 / 1 / 00 / Inverter thermal model gives {OHt Inverter} trip with sub-trip 0 **Recommended actions:** • Reduce the selected drive switching frequency • Ensure *Auto-switching Frequency Change Disable* (05.035) is set to OFF • Reduce duty cycle • Decrease acceleration / deceleration rates • Reduce motor load • Check DC bus ripple • Ensure all three input phases are present and balanced

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OHt Power</td><td>Power stage over temperature</td></tr>
<tr><td>22</td><td>This trip indicates that a power stage over-temperature has been detected. From the sub-trip ‘xxyzz’, the Thermistor location is identified by ‘zz’.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>01</td><td>0</td><td>zz</td><td>Thermistor location in the drive defined by zz</td></tr>
</table>
Recommended actions:
• Check enclosure / drive fans are still functioning correctly
• Force the heatsink fans to run at maximum speed
• Check enclosure ventilation paths
• Check enclosure door filters
• Increase ventilation
• Reduce the drive switching frequency
• Reduce duty cycle
• Decrease acceleration / deceleration rates
• Reduce motor load
• Check the derating tables and confirm the drive is correctly sized for the application.
• Use a drive with larger current / power rating</td></tr>
<tr><td>OHt Rectifier</td><td>Rectifier over temperature</td></tr>
<tr><td>102</td><td>The OHt Rectifier indicates that a rectifier over-temperature has been detected. The thermistor location can be identified from the sub-trip number.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>Power module number</td><td>Rectifier number</td><td>zz</td><td>Thermistor location defined by zz</td></tr>
</table>
Recommend actions:
• Check the motor and motor cable insulation with an insulation tester
• Fit an output line reactor or sinusoidal filter
• Force the heatsink fans to run at maximum speeds by setting Pr 06.045 = 11
• Check enclosure / drive fans are still functioning correctly
• Check enclosure ventilation paths
• Check enclosure door filters
• Increase ventilation
• Decrease acceleration / deceleration rates
• Reduce duty cycle
• Reduce motor load</td></tr>
<tr><td>OI ac</td><td>Instantaneous output over current detected</td></tr>
<tr><td>3</td><td>The instantaneous drive output current has exceeded above VM_DRIVE_CURRENT_MAX.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>Rectifier number</td><td rowspan="2">00</td><td rowspan="2">Instantaneous over-current trip when the measured AC current exceeds VM_DRIVE_CURRENT[MAX].</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td></tr>
</table>
Recommended actions:
• Acceleration/deceleration rate is too short
• If seen during auto-tune reduce the voltage boost
• Check for short circuit on the output cabling
• Check integrity of the motor insulation using an insulation tester
• Check feedback device wiring
• Check feedback device mechanical coupling
• Check feedback signals are free from noise
• Is motor cable length within limits for the frame size
• Reduce the values in the speed loop gain parameters - (Pr 03.010, 03.011, 03.012) or (Pr 03.013, 03.014, 03.015)
• Has the phase angle autotune been completed? (RFC-S mode only)
• Reduce the values in current loop gain parameters (RFC-A, RFC-S modes only)</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>OI Brake</td><td>Braking IGBT over current detected: short circuit protection for the braking IGBT activated</td></tr>
<tr><td>4</td><td>The OI Brake trip indicates that over current has been detected in braking IGBT or braking IGBT protection has been activated.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>00</td><td>Braking IGBT instantaneous over-current trip</td></tr>
</table>
Recommended actions:
• Check brake resistor wiring
• Check braking resistor value is greater than or equal to the minimum resistance value
• Check braking resistor insulation</td></tr>
<tr><td>OI dc</td><td>Power module over current detected from IGBT on state voltage monitoring</td></tr>
<tr><td>109</td><td>The OI dc trip indicates that the short circuit protection for the drive output stage has been activated.
Recommended actions:
• Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester
• Replace the drive</td></tr>
<tr><td>OI Snubber</td><td>Snubber over-current detected</td></tr>
<tr><td>92</td><td>The OI Snubber trip indicates that an over-current condition has been detected in the rectifier snubber circuit. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Power system</td><td>Power module number</td><td>Rectifier number</td><td>00</td><td>Rectifier snubber over-current trip detected.</td></tr>
</table>
Recommended actions:
• Ensure the internal EMC Filter is installed
• Ensure the motor cable length does not exceed the maximum for selected switching frequency
• Check for supply voltage imbalance
• Check for supply disturbance such as notching from a DC drive
• Check the motor and motor cable insulation with an insulation tester
• Fit an output line reactor or sinusoidal filter</td></tr>
<tr><td>Option Disable</td><td>Option module does not acknowledge during drive mode changeover</td></tr>
<tr><td>215</td><td>The Option Disable trip indicates that the option module did not acknowledge notifying the drive that communications with the drive has been stopped during the drive mode changeover with in the allocated time.
Recommended trip:
• Reset the trip
• If the trip persists replace the option module</td></tr>
<tr><td>Out Phase Loss</td><td>Output phase loss detected</td></tr>
<tr><td>98</td><td>The Out Phase Loss trip indicates that a phase loss has been detected at the drive output. If Output Phase Loss Detection Enable (06.059) = 1 then output phase loss is detected as follows:
1. When the drive is enabled short pulses are applied to make sure each output phase is connected.
2. During running the output current is monitored and the output phase loss condition is detected if the current contains more than TBD % negative phase sequence current for TBDs.
Recommended action:
• Check motor and drive connections
• To disable the trip set Output Phase Loss Detection Enable (06.059) = 0</td></tr>
<tr><td>Over Frequency</td><td>Output frequency has exceeded the maximum frequency threshold</td></tr>
<tr><td>222</td><td>The Over Frequency trip indicates that the output frequency has exceeded 560 Hz for more than 4 ms.</td></tr>
</table>

Trip	Diagnosis
Over Speed	**Motor speed has exceeded the over speed threshold**
7	In open loop mode, if the *Output Frequency* (05.001) exceeds the threshold set in *Over Speed Threshold* (03.008) in either direction an Over Speed trip is produced. In RFC-A and RFC-S mode, if the Speed Feedback (03.002) exceeds the Over Speed Threshold in Pr **03.008** in either direction an Over Speed trip is produced. If Pr **03.008** is set to 0.0 the threshold is then equal to 1.2 x the value set in Pr **01.006**. In RFC-A and RFC-S mode, if an SSI encoder is being used and Pr **03.047** is set to 0 an Over Speed trip will be produced when the encoder passes through the boundary between its maximum position and zero. **Recommended actions:** • Reduce the *Speed Controller Proportional Gain* (03.010) to reduce the speed overshoot (RFC-A, RFC-S modes only) • If an SSI encoder is being used set Pr **03.047** to 1
Over Volts	**DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds**
2	The *Over Volts* trip indicates that the DC bus voltage has exceeded the VM_DC_VOLTAGE[MAX] or VM_DC_VOLTAGE_SET[MAX] for 15 s. The trip threshold varies depending on voltage rating of the drive as shown below. **Voltage rating** / **VM_DC_VOLTAGE[MAX]** / **VM_DC_VOLTAGE_SET[MAX]** 200 / 415 / 410 400 / 830 / 815 575 / 990 / 970 690 / 1190 / 1175 **Sub-trip Identification** **Source** / **xx** / **y** / **zz** Control system / 00 / 0 / 01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX]. Control system / 00 / 0 / 02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX]. Power system / Power module number / 0 / 00: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX]. **Recommended actions:** • Increase deceleration ramp (Pr **00.004**) • Decrease the braking resistor value (staying above the minimum value) • Check nominal AC supply level • Check for supply disturbances which could cause the DC bus to rise • Check motor insulation using a insulation tester
Phase Loss	**Supply phase loss**
32	The *Phase Loss* trip indicates that the drive has detected an input phase loss or large supply imbalance. The drive will attempt to stop the motor before this trip is initiated. If the motor cannot be stopped in 10 seconds the trip occurs immediately. The *Phase Loss* trip works by monitoring the ripple voltage on the DC bus of the drive, if the DC bus ripple exceeds the threshold, the drive will trip on Phase Loss. Potential causes of the DC bus ripple are input phase loss, Large supply impedance and severe output current instability. **Source** / **xx** / **y** / **zz** Control system / 00 / 0 / 00: Phase loss detected based on control system feedback. The drive attempts to stop the drive before tripping unless bit 2 of *Action On Trip Detection* (10.037) is set to one. Power system / Power module number / Rectifier number / 00: Phase loss has been detected by the rectifier module Control system / 01: Mains loss has been detected by the rectifier module in a multi-power module system, where this must be treated as a phase loss condition to prevent damage to the drive. Input phase loss detection can be disabled when the drive is required to operate from the DC supply or from a single phase supply in *Input Phase Loss Detection Mode* (06.047). **Recommended actions:** • Check the AC supply voltage balance and level at full load • Check the DC bus ripple level with an isolated oscilloscope • Check the output current stability • Reduce the duty cycle • Reduce the motor load • Disable the phase loss detection, set Pr **06.047** to 2.

Trip	Diagnosis
Power Comms	**Communication has been lost / errors detected between power, control and rectifier modules**
90	The *Power Comms* trip is initiated if there is no communications between power, control or the rectifier module or if excessive communication errors have been detected. The reason for the trip can be identified by the sub-trip number.

Source	xx	y	zz
Control system	00	0	01: No communications between the control system and the power system
			02: Excessive communication errors between the control system and power system
	Power module number	Rectifier number	00: Excessive communications errors detected by the rectifier module

Recommended actions:

- Hardware fault – Contact the supplier of the drive

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

Source	xx	y	zz	Description
Control system	00	0	01	No data was obtained from the power board.
Control system	00	0	02	There is no data table in node 1.
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.
Power system	Power module number	0	00	The power data table used internally by the power module has an error.
Power system	Power module number	0	01	The power data table that is uploaded to the control system on power up has an error.
Power system	Power module number	0	02	The power data table used internally by the power module does not match the hardware identification of the power module.

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Trip	Diagnosis
Power Down Save	**Power down save error**
37	The *Power Down Save* trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory.

Recommended actions:

- Perform a 1001 save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up.

Trip	Diagnosis
PSU	**Internal power supply fault**
5	The *PSU* trip indicates that one or more internal power supply rails are outside limits or overloaded.

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

Recommended actions:

- Remove any option modules and perform a reset
- Remove encoder connection and perform a reset
- Hardware fault within the drive – return the drive to the supplier

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>PSU 24V</td><td>24V internal power supply overload</td></tr>
<tr><td>9</td><td>The total user load of the drive and option modules has exceeded the internal 24 V power supply limit. The user load consists of the drive digital outputs and main encoder supply.
Recommended actions:
• Reduce the load and reset
• Provide an external 24 V power supply on control terminal 2
• Remove all option modules</td></tr>
<tr><td>Rating Mismatch</td><td>Power stage recognition: Multi module voltage or current rating mismatch</td></tr>
<tr><td>223</td><td>The Rating Mismatch trip indicates that there is a voltage rating or current rating mismatch in a multi-module drive system. This trip is only applicable to modular drives that are connected in parallel. A mixture of power modules with different voltage or current ratings within the same multi-module drive system is not allowed and will cause a Rating Mismatch trip.
Recommended action:
• Ensure that all modules in a multi-modular drive system are of the same frame size and rating (voltage and current)
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Reserved</td><td>Reserved trips</td></tr>
<tr><td>01
94 -95
103 – 108
161
164 – 197
170 – 173
228 - 247</td><td>These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.
<table>
<tr><th>Trip Number</th><th>Description</th></tr>
<tr><td>01</td><td>Reserved resettable trip</td></tr>
<tr><td>94 -95</td><td>Reserved resettable trip</td></tr>
<tr><td>103 - 108</td><td>Reserved resettable trip</td></tr>
<tr><td>161</td><td>Reserved resettable trip</td></tr>
<tr><td>164 – 197</td><td>Reserved resettable trip</td></tr>
<tr><td>170 - 173</td><td>Reserved resettable trip</td></tr>
<tr><td>228 - 247</td><td>Reserved non-resettable trip</td></tr>
</table></td></tr>
<tr><td>Resistance</td><td>Measured resistance has exceeded the parameter range</td></tr>
<tr><td>33</td><td>The Resistance trip indicates that the measured stator resistance during an auto-tune test has exceeded the maximum possible value of Stator Resistance (05.017).
The stationary auto-tune is initiated using the auto-tune function (Pr 05.012) or in open loop vector mode (Pr 05.014) on the first run command after power up in mode 4 (Ur_I) or on every run command in modes 0 (Ur_S) or 3 (Ur_Auto). This trip can occur if the motor is very small in comparison to the rating of the drive.
Recommended actions:
• Check the motor cable / connections
• Check the integrity of the motor stator winding using a 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</td></tr>
<tr><td>Slot4 Different</td><td>Ethernet interface in slot 4 has changed</td></tr>
<tr><td>254</td><td>The Slot4 Different trip indicates that the Ethernet interface in slot 4 has changed / not found. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>No module was installed previously</td></tr>
<tr><td>2</td><td>A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td></tr>
<tr><td>3</td><td>A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td></tr>
<tr><td>4</td><td>A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus.</td></tr>
<tr><td>>99</td><td>Shows the identifier of the module previously installed.</td></tr>
</table>
Recommended actions:
• To confirm that the parameter changes detected is acceptable, reset the trip and perform a parameter save to ensure that the trip doesn't occur the next time the drive is powered up.
• If the trip persists - Contact the supplier of the drive.</td></tr>
</table>

Trip	Diagnosis
Slot4 Error	**Ethernet interface in slot 4 has detected a fault**
252	The *Slot4 Error* trip indicates that the Ethernet interface in slot 4 on the drive has detected an error. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Trip string	Description
100	Link Loss	Network link has been lost
101	E/IP Timeout	An Ethernet/IP RPI timeout trip has occurred
102	E/IP Read Param	Invalid read consistency parameter
103	E/IP Write Param	Invalid write consistency parameter
104	E/IP Fault	An unexpected Ethernet/IP error has occurred
105	Modbus Timeout	The Modbus connection has timed out
106	DA-RT Timeout	DA-RX Rx link has timeout
107	DA-RT Rx Late	Rx data was received late
108	INIT Switch	
109	INIT PTP	
110	INIT DA-RT	
111	INIT Modbus	
112	INIT SMTP	
113	INIT Ethernet/IP	
114	INIT TCP/IP	
115	Ethernet Failure	
200	Software Fault	Software Fault
201	BG Overrun	Background task overrun
202	Firmware Invalid	Firmware is not compatible for the hardware version
203	Drive Unknown	Unknown drive type
204	DriveUnsupported	Unsupported drive type
205	Mode Unknown	Unknown drive mode
206	Mode Unsupported	Unsupported drive mode
207	FLASH Error	Corrupted Non-volatile FLASH
208	Database Init	Database initialization error
209	File System Init	File system initialization error
210	Mem Allocation	Memory allocation error
211	Filesystem Error	File system error
212	Config Save	Configuration file save error
213	Over Temperature	Option module over temperature
214	Drive Timeout	The drive has not responded within watchdog period
215	eCMP Comms Error	eCMP communication failure
216	TO eCMP Slot1	eCMP communication to slot 1 timeout
217	TO eCMP Slot2	eCMP communication to slot 2 timeout
218	TO eCMP Slot3	eCMP communication to slot 3 timeout
219	TO eCMP Slot4	eCMP communication to slot 4 timeout
220	I/O Overload	Digital output current demand too high
221	Factory Settings	Missing factory settings
222	Functional Test	Functional test failure
223	Config Restore	Configuration file restore error
224	Self Test Error	Power on self test error
225	Runtime Config	Runtime configuration error

Recommended actions:

- Identify the reason for the trip from the trip string or from sub-trip number and resolve the error.
- Reset the trip, If the trip persists, Hardware fault - Contact the supplier of the drive.

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Slot4 HF</td><td>Ethernet interface in slot 4 hardware fault</td></tr>
<tr><td>250</td><td>The Slot4 HF trip indicates that the Ethernet interface in slot 4 on the drive has detected an error. The reason for the error can be identified by the sub-trip number.

<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The module category cannot be identified</td></tr>
<tr><td>2</td><td>All the required customized menu table information has not been supplied or the tables supplied are corrupt</td></tr>
<tr><td>3</td><td>There is insufficient memory available to allocate the comms buffers for this module</td></tr>
<tr><td>4</td><td>The module has not indicated that it is running correctly during drive power-up</td></tr>
<tr><td>5</td><td>Module has been removed after power-up or it has stopped working</td></tr>
<tr><td>6</td><td>The module has not indicated that it has stopped accessing drive parameters during a drive mode change</td></tr>
<tr><td>7</td><td>The module has failed to acknowledge that a request has been made to reset the drive processor</td></tr>
<tr><td>8</td><td>The drive failed to correctly read the menu table from the module during drive power up</td></tr>
<tr><td>9</td><td>The drive failed to upload menu tables from the module and timed out (5 s)</td></tr>
</table>
Recommended actions:
• Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>Slot4 Not Installed</td><td>Ethernet interface in slot 4 has been removed</td></tr>
<tr><td>253</td><td>The Slot4 Not Installed trip indicates that the Ethernet interface in slot 4 on the drive has been removed since the last power-up.
Recommended actions:
• Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>Slot4 Watchdog</td><td>Ethernet interface watchdog service error</td></tr>
<tr><td>251</td><td>The Slot4 Watchdog trip indicates that the Ethernet interface installed in slot 4 has started the option watchdog function and then failed to service the watchdog correctly.
Recommended actions:
• Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>Slot App Menu</td><td>Application menu Customization conflict error</td></tr>
<tr><td>216</td><td>The Slot App Menu trip indicates that more than one option slot has requested to customize the application menus 18, 19 and 20. The sub-trip number indicates which option slot has been allowed to customize the menus.
Recommended actions:
• Ensure that only one of the Application modules is configured to customize the application menus 18, 19 and 20</td></tr>
<tr><td>SlotX Different</td><td>Option module in option slot X has changed</td></tr>
<tr><td>204
209
214</td><td>The SlotX Different trip indicates that the option module in option slot X on the drive is a different type to that installed when parameters were last saved on the drive. The reason for the trip can be identified by the sub-trip number.

<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>No module was installed previously</td></tr>
<tr><td>2</td><td>A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td></tr>
<tr><td>3</td><td>A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td></tr>
<tr><td>4</td><td>A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus.</td></tr>
<tr><td>>99</td><td>Shows the identifier of the module previously installed.</td></tr>
</table>
Recommended actions:
• Turn off the power, ensure the correct option modules are installed in the correct option slots and re-apply the power.
• Confirm that the currently installed option module is correct, ensure option module parameters are set correctly and perform a user save in Pr mm.000.</td></tr>
<tr><td>SlotX Error</td><td>Option module in option slot X has detected a fault</td></tr>
<tr><td>202
207
212</td><td>The SlotX Error trip indicates that the option module in option slot X on the drive has detected an error. The reason for the error can be identified by the sub-trip number.
Recommended actions:
• See relevant Option Module User Guide for details of the trip</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SlotX HF</td><td>Option module X hardware fault</td></tr>
<tr><td>200
205
210</td><td>The SlotX HF trip indicates that the option module in option slot X on the drive has indicated a hardware fault. The possible causes of the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The module category cannot be identified</td></tr>
<tr><td>2</td><td>All the required customized menu table information has not been supplied or the tables supplied are corrupt</td></tr>
<tr><td>3</td><td>There is insufficient memory available to allocate the comms buffers for this module</td></tr>
<tr><td>4</td><td>The module has not indicated that it is running correctly during drive power-up</td></tr>
<tr><td>5</td><td>Module has been removed after power-up or it has stopped working</td></tr>
<tr><td>6</td><td>The module has not indicated that it has stopped accessing drive parameters during a drive mode change</td></tr>
<tr><td>7</td><td>The module has failed to acknowledge that a request has been made to reset the drive processor</td></tr>
<tr><td>8</td><td>The drive failed to correctly read the menu table from the module during drive power up</td></tr>
<tr><td>9</td><td>The drive failed to upload menu tables from the module and timed out (5 s)</td></tr>
</table>
Recommended actions:
• Ensure the option module is installed correctly
• Replace the option module
• Replace the drive</td></tr>
<tr><td>SlotX Not installed</td><td>Option module in option slot X has been removed</td></tr>
<tr><td>203
208
213</td><td>The SlotX Not installed trip indicates that the option module in option slot X on the drive has been removed since the last power up.
Recommended actions:
• Ensure the option module is installed correctly.
• Re-install the option module.
• To confirm that the removed option module is no longer required perform a save function in Pr mm.000.</td></tr>
<tr><td>SlotX Watchdog</td><td>Option module watchdog function service error</td></tr>
<tr><td>201
206
211</td><td>The SlotX Watchdog trip indicates that the option module installed in Slot X has started the option watchdog function and then failed to service the watchdog correctly.
Recommended actions:
• Replace the option module</td></tr>
<tr><td>Soft Start</td><td>Soft start relay failed to close, soft start monitor failed</td></tr>
<tr><td>226</td><td>The Soft Start trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Stored HF</td><td>Hardware trip has occurred during last power down</td></tr>
<tr><td>221</td><td>The Stored HF trip indicates that a hardware trip (HF01 –HF17) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip i.e. stored HF.17.
Recommended actions:
• Enter 1299 in Pr mm.000 and press reset to clear the trip</td></tr>
</table>

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

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

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

Sub-array	Menus	Value
Applications menus	18-20	1
Derivative image	29	2
User program image	30	3
Option slot 1 set-up	15	4
Option slot 1 applications	25	5
Option slot 2 set-up	16	6
Option slot 2 applications	26	7
Option slot 3 set-up	17	8
Option slot 3 applications	27	9
Option slot 4 set-up	24	10
Option slot 4 applications	28	11

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

Source	xx	y	zz
Power system	Power module number	0	Always zero
Power system	Power module number	Rectifier number	Always zero

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Th Brake Res	**Brake resistor over temperature**
10	The *Th Brake Res* is initiated, If hardware based braking resistor thermal monitoring is connected and the resistor overheats. If the braking resistor is not used then this trip must be disabled with bit 3 of Action *On Trip Detection* (10.037) to prevent this trip. **Recommended actions:** • Check brake resistor wiring • Check braking resistor value is greater than or equal to the minimum resistance value • Check braking resistor insulation
Th Short Circuit	**Motor thermistor short circuit**
25	The *Th Short Circuit* 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) is short circuit or low impedance. The cause of the trip can be identified by the sub-trip number.

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

Recommended actions:

- Check thermistor continuity
- Replace motor / motor thermistor

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Thermistor</td><td>Motor thermistor over-temperature</td></tr>
<tr><td>24</td><td>The Thermistor trip indicates that the motor thermistor connected to terminal 8 (analog input 3) on the control connections or terminal 15 on the encoder terminal (15 way D-type connector) has indicated a motor over temperature. The cause of the trip can be identified by the sub-trip number
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Trip initiated from P1 position feedback interface</td></tr>
<tr><td>2</td><td>Trip initiated from analog input 3</td></tr>
</table>
Recommended actions:
• Check motor temperature
• Check thermistor continuity</td></tr>
<tr><td>Undefined</td><td>Drive has tripped and the cause of the trip is Undefined</td></tr>
<tr><td>110</td><td>The Undefined trip indicates that the power system has generated but did not identify the trip the power system. The cause of the trip is unknown.
Recommended actions:
• Hardware fault – return the drive to the supplier</td></tr>
<tr><td>User 24V</td><td>User 24 V supply is not present on control terminals (1,2)</td></tr>
<tr><td>91</td><td>A User 24 V trip is initiated, if User Supply Select (Pr 06.072) is set to 1 or Low Under Voltage Threshold Select (06.067) = 1 and no user 24 V supply is present on control terminals 1 and 2.
Recommended actions:
• Ensure the user 24 V supply is present on control terminals 1 (0 V) and 2 (24 V)</td></tr>
</table>

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

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

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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	
30	The image has failed because either its CRC is incorrect, or there are less than 6 bytes in	Occurs when the drive powers-up or the image is programmed. The image tasks will not run
31	The image requires more RAM for heap and stack than can be provided by the drive.	As 30
32	The image requires an OS function call that is higher than the maximum allowed	As 30
33	The ID code within the image is not valid	As 30
34	The derivative image has been changed for an image with a different derivative number.	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
51	Core menu customization table CRC check failed	As 30
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
61	The option module installed in slot 1 is not allowed with the derivative image	As 30
62	The option module installed in slot 2 is not allowed with the derivative image	As 30
63	The option module installed in slot 3 is not allowed with the derivative image	As 30
64	The option module installed in slot 4 is not allowed with the derivative image	As 30
70	An option module that is required by the derivative image is not installed in any slot.	As 30
71	An option module specifically required to be installed in slot 1 not present	As 30
72	An option module specifically required to be installed in slot 2 not present	As 30
73	An option module specifically required to be installed in slot 3 not present	As 30
74	An option module specifically required to be installed in slot 4 not present	As 30
80	Image is not compatible with the control board	Initiated from within the image code
81	Image is not compatible with the control board serial number	As 80

Trip	Diagnosis
User Prog Trip	**Trip generated by an onboard user program**
96	This trip can be initiated from within an onboard user program using a function call which defines the sub-trip number. **Recommended actions:** • Check the user program
User Save	**User Save error / not completed**
36	The *User Save* trip indicates that an error has been detected in the user save parameters saved in non-volatile memory. For example, following a user save command, If the power to the drive was removed when the user parameters were being saved. **Recommended actions:** • Perform a user save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up. • Ensure that the drive has enough time to complete the save before removing the power to the drive.
User Trip	**User generated trip**
40 -89 **112 -159**	These trips are not generated by the drive and are to be used by the user to trip the drive through an application program. **Recommended actions:** • Check the user program
Volts Range	**Supply voltage out of range detected in Regen mode**
169	The *Volts Range* trip is initiated, if the Regen *Minimum Voltage* (03.026) is set to a non-zero value and the supply voltage is outside the range defined by *Regen Maximum Voltage* (03.027) and *Regen Minimum Voltage* (03.026) for more than 100 ms. **Recommended actions:** • Ensure the supply voltage is operating within the drive specification. • Ensure Pr **03.026** and Pr **03.027** are set correctly • Check the supply voltage waveform using an oscilloscope • Reduce the level of supply disturbance • Set *Maximum Voltage* (03.027) to zero to disable the trip.
Watchdog	**Control word watchdog has timed out**
30	The *Watchdog* trip indicates that the control word has been enabled and has timed out **Recommended actions:**

Table 13-5 Serial communications look up table

No	Trip	No	Trip	No	Trip
1	Reserved 001	92	OI Snubber	198	Encoder 10
2	Over Volts	93	Inductor Too Hot	199	Destination
3	OI ac	94 - 95	Reserved 93 -95	200	Slot1 HF
4	OI Brake	96	User Prog Trip	201	Slot1 Watchdog
5	PSU	97	Data Changing	202	Slot1 Error
6	External Trip	98	Out Phase Loss	203	Slot1 Not installed
7	Over Speed	99	CAM	204	Slot1 Different
8	Reserved 008	100	Reset	205	Slot2 HF
9	PSU24	101	OHt Brake	206	Slot2 Watchdog
10	Th Brake Res	102	OHt Rectifier	207	Slot2 Error
11	Autotune 1	103 - 108	Reserved 103 - 108	208	Slot2 Not installed
12	Autotune 2	109	OI dc	209	Slot2 Different
13	Autotune 3	110	Undefined	210	Slot3 HF
14	Autotune 4	111	Configuration	211	Slot3 Watchdog
15	Autotune 5	112 - 167	User Trip 112 - 167	212	Slot3 Error
16	Autotune 6	168	Frequency Range	213	Slot3 Not installed
17	Autotune 7	169	Voltage Range	214	Slot3 Different
18	Autotune Stopped	170 - 173	Reserved 170 - 173	215	Option Disable
19	Brake R Too Hot	174	Card Slot	216	Slot App Menu
20	Motor Too Hot	175	Card Product	217	App Menu Changed
21	OHt Inverter	176	Name Plate	218	Temp Feedback
22	OHt Power	177	Card Boot	219	An Output Calib
23	OHt Control	178	Card Busy	220	Power Data
24	Thermistor	179	Card Data Exists	221	Stored HF
25	Th Short Circuit	180	Card Option	222	Over Frequency
26	I/O Overload	181	Card Read Only	223	Rating Mismatch
27	OHt dc bus	182	Card Error	224	Drive Size
28	An Input Loss 1	183	Card No Data	225	Current Offset
29	An Input Loss 2	184	Card Full	226	Soft Start
30	Watchdog	185	Card Access	227	Sub-array RAM
31	EEPROM Fail	186	Card Rating	228 - 247	Reserved 228 - 247
32	Phase Loss	187	Card Drive Mode	248	Derivative Image
33	Resistance	188	Card Compare	249	User Program
34	Keypad Mode	189	Encoder 1	250	Slot4 HF
35	Control Word	190	Encoder 2	251	Slot4 Watchdog
36	User Save	191	Encoder 3	252	Slot4 Error
37	Power Down Save	192	Encoder 4	253	Slot4 Not installed
38	Low Load	193	Encoder 5	254	Slot4 Different
39	Line Sync	194	Encoder 6	255	Reset Logs
40 -89	User Trip 40 - 89	195	Encoder 7		
90	Power Comms	196	Encoder 8		
91	User 24V	197	Encoder 9		

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 13-6 Trip categories

Priority	Category	Trips	Comments
1	Internal faults	HF01, HF02, HF03, HF04, HF05, HF06, HF07, HF08, HF09, HF10, HF11, HF12, HF13, HF14, HF15, HF16, HF17, HF18, HF19, HF20	These indicate internal problems and cannot be reset. All drive features are inactive after any of these trips occur. If an KI-Keypad is installed it will show the trip, but the keypad will not function.
1	Stored HF trip	{Stored HF}	This trip cannot be cleared unless 1299 is entered into *Parameter* (**mm.000**) and a reset is initiated.
2	Non-resettable trips	Trip numbers 218 to 247, {Slot1 HF}, {Slot2 HF}, {Slot3 HF} or {Slot4 HF}	These trips cannot be reset.
3	Volatile memory failure	{EEPROM Fail}	This can only be reset if Parameter **mm.000** is set to 1233 or 1244, or if *Load Defaults* (11.043) is set to a non-zero value.
4	NV Media Card trips	Trip numbers 174, 175 and 177 to 188	These trips are priority 5 during power-up.
4	Internal 24V and position feedback interface power supply	{PSU 24} and {Encoder 1}	These trips can override {Encoder 2} to {Encoder 6} trips.
5	Trips with extended reset times	{OI ac}, {OI Brake}, and OI dc}	These trips cannot be reset until 10 s after the trip was initiated.
5	Phase loss and d.c. link power circuit protection	{Phase Loss} and {Oht dc bus}	The drive will attempt to stop the motor before tripping if a {Phase Loss}. 000 trip occurs unless this feature has been disabled (see *Action On Trip Detection* (10.037). The drive will always attempt to stop the motor before tripping if an {Oht dc bus} occurs.
5	Standard trips	All other trips	

13.5 Internal / Hardware trips

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

13.6 Alarm indications

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

Table 13-7 Alarm indications

Alarm string	Description
Brake Resistor	Brake resistor overload. *Braking Resistor Thermal Accumulator* (10.039) in the drive has reached 75 % of the value at which the drive will trip.
Motor Overload	*Motor Protection Accumulator* (04.019) in the drive has reached 75 % of the value at which the drive will trip and the load on the drive is >100 %.
Ind Overload	Regen inductor overload. *Inductor Protection Accumulator* (04.019) in the drive has reached 75 % of the value at which the drive will trip and the load on the drive is >100 %.
Drive Overload	Drive over temperature. *Percentage Of Drive Thermal Trip Level* (07.036) in the drive is greater than 90 %.
Auto Tune	The autotune procedure has been initialized and an autotune in progress.
Limit Switch	Limit switch active. Indicates that a limit switch is active and that is causing the motor to be stopped.

13.7 Status indications

Table 13-8 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
Scan	The drive is enabled in Regen mode and is trying to synchronize to the supply	Enabled
Supply Loss	Supply loss condition has been detected	Enabled
Deceleration	The motor is being decelerated to zero speed / frequency because the final drive run has been deactivated.	Enabled
dc injection	The drive is applying dc injection braking	Enabled
Position	Positioning / position control is active during an orientation stop	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display	Disabled
Active	The regen unit is enabled and synchronized to the supply	Enabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode	Disabled

Table 13-9 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	**User Program**	User program being loaded
User program is being loaded from a NV Media Card to the drive		
Booting	**Option Program**	User program being loaded
User program is being loaded from a NV Media Card to the option module in slot X		
Writing To	**NV Card**	Data being written to NV Media Card
Data is being written to a NV Media Card to ensure that its copy of the drive parameters is correct because the drive is in Auto or Boot mode		
Waiting For	**Power System**	Waiting for power stage
The drive is waiting for the processor in the power stage to respond after power-up		
Waiting For	**Options**	Waiting for an option module
The drive is waiting for the Options Modules to respond after power-up		
Uploading From	**Options**	Loading parameter database
At power-up it may be necessary to update the parameter database held by the drive because an option module has changed or because an applications module has requested changes to the parameter structure. This may involve data transfer between the drive an option modules. During this period ‘Uploading From Options’ is displayed		

13.8 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). 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 13-4 is the value transmitted.

NOTE

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

13.9 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	Frequency slaving demand / 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

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

Size 3 drives have been assessed to meet both UL and cUL requirements.

The Control Techniques UL file number is E171230. Confirmation of UL listing can be found on the UL website: www.ul.com.

14.1 Mounting arrangements

The drive can be mounted in the following configurations:

Frame size	Standard mounting	Tile mounting	Bookcase mounting
03	✓	✓	✓

The terminal tightening torques specified in section 3.12.2 *Terminal sizes and torque settings* on page 38.

14.2 Environment

The dive is able to be mounted under the following environmental conditions;

- Basic drive must be installed in a UL type 1 enclosure
- Basic drive plus metal gland plate is a type 1 approved product
- Basic drive plus type 12 kit, and type 12 enclosure is a through hole mount type 12 approved product (single drive)
- Basic drive plus type 12 kit, and type 12 enclosure is a through hole mount NEMA 12 approved product (multi drive)
- Remote keypad is a type 1 and type 12 approved product
- Drives are able to be mounted in a 40 °C, 50 °C and 55 °C surrounding air ambient. For derated current ratings for 40 °C and 50 °C environment see Table 12-1 and Table 12-3
- Enclosed type 12 drives are rated for 40 °C only
- The drive must be mounted in a pollution degree 2 environment
- The drive is rated for Over Voltage CAT III

14.3 Common UL information

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

- If the drive control stage is supplied by an external power supply (+24 V), the external power supply must be a UL Class 2 power supply
- The drive must use UL listed closed loop connectors for field wired ground connections
- The drive is able to use 60 °C or 75 °C rated wire for 40 °C and 50 °C ambient
- The drive must use 75 °C rated wire when installed in a 55 °C environment

Motor overload protection
The drive provides motor overload protection. The default overload protection level is no higher than 150 % of full-load current (FLC) of the drive in open loop mode and no higher than 175 % of full-load current (FLC) of the drive in closed loop vector or servo modes. It is necessary for the motor rated current to be entered into Pr **00.046** (or Pr **05.007**) for the protection to operate correctly. The protection level may be adjusted below 150 % if required. Refer to section 8.3 *Current limits* on page 108 for more information. The drive also provides motor thermal protection. Refer to section 8.4 *Motor thermal protection* on page 108.

Overspeed protection
The drive provides overspeed protection. However, it does not provide the level of protection provided by an independent high integrity overspeed protection device.

Thermal memory retention
The drive has been approved for thermal memory retention, in accordance with the NEC

14.4 Power dependant UL information

Conformity
The drive conforms to UL listing requirements only when the following is observed.

Fuses
Size 3

- The correct UL-listed fast acting fuses (class CC or class J up to 25 A), e.g. Bussman Limitron KTK-R series, Ferraz Shawmut ATMR series or equivalent, are used in the AC supply.
- The drive can be used with MCBs.Type ABB S203UPKXX up to 25A.

For further details on fusing, refer to in Table 4-4 and Table 4-5 on page 47.

14.5 AC supply specification

The drive is suitable for use in a circuit capable of delivering not more than 100,000 rms symmetrical Amperes at 264 Vac rms maximum (200 V drives), 528 Vac rms maximum (400 V drives) or 600 Vac rms maximum (575 V and 690 V drives).

14.6 Maximum continuous output current

The drive models are listed as having the maximum continuous output currents (FLC) shown in Table 14-1 and Table 14-2, (see Chapter 12 *Technical data* on page 209 for details).

Table 14-1 Maximum continuous output current (200 V drives)

Model	FLC (A)
03200050	5.0
03200066	6.6
03200080	8.0
03200106	10.6

Table 14-2 Maximum continuous output current (400 V drives)

Model	FLC (A)
03400025	2.5
03400031	3.1
03400045	4.5
03400062	6.2
03400078	7.8
03400100	10.0

14.7 UL listed accessories

- KI-Keypad
- KI-Keypad RTC
- KI-Keypad Advanced
- SI-PROFIBUS
- SI-DeviceNet
- SI-CANopen
- SI-Applications Plus
- SI-Applications Lite V2
- SI-Register
- Tile mounting kit
- Metal conduit entry plate
- Type 12 kit
- SD card kit

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0478-0002-02