EMERSON
Industrial Automation

Control User Guide

Unidrive M400

Variable Speed AC drive for induction motors

Part Number: 0478-0349-01
Issue: 1

Original Instructions

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

General information

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

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

Drive firmware version

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

The firmware version of the drive can be checked by looking at Pr **11.029** and Pr **11.035**.

Environmental statement

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

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

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

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

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

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

REACH legislation

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

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

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

Control Techniques Limited. Registered Office: The Gro, Newtown, Powys SY16 3BE. Registered in England and Wales. Company Reg. No. 01236886.
Moteurs Leroy-Somer SAS. Headquarters: Bd Marcellin Leroy, CS 10015, 16915 Angoulême Cedex 9, France. Share Capital: 65 800 512 €, RCS Angoulême 338 567 258.

Issue Number: 1

Drive Firmware: 01.04.04 onwards

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

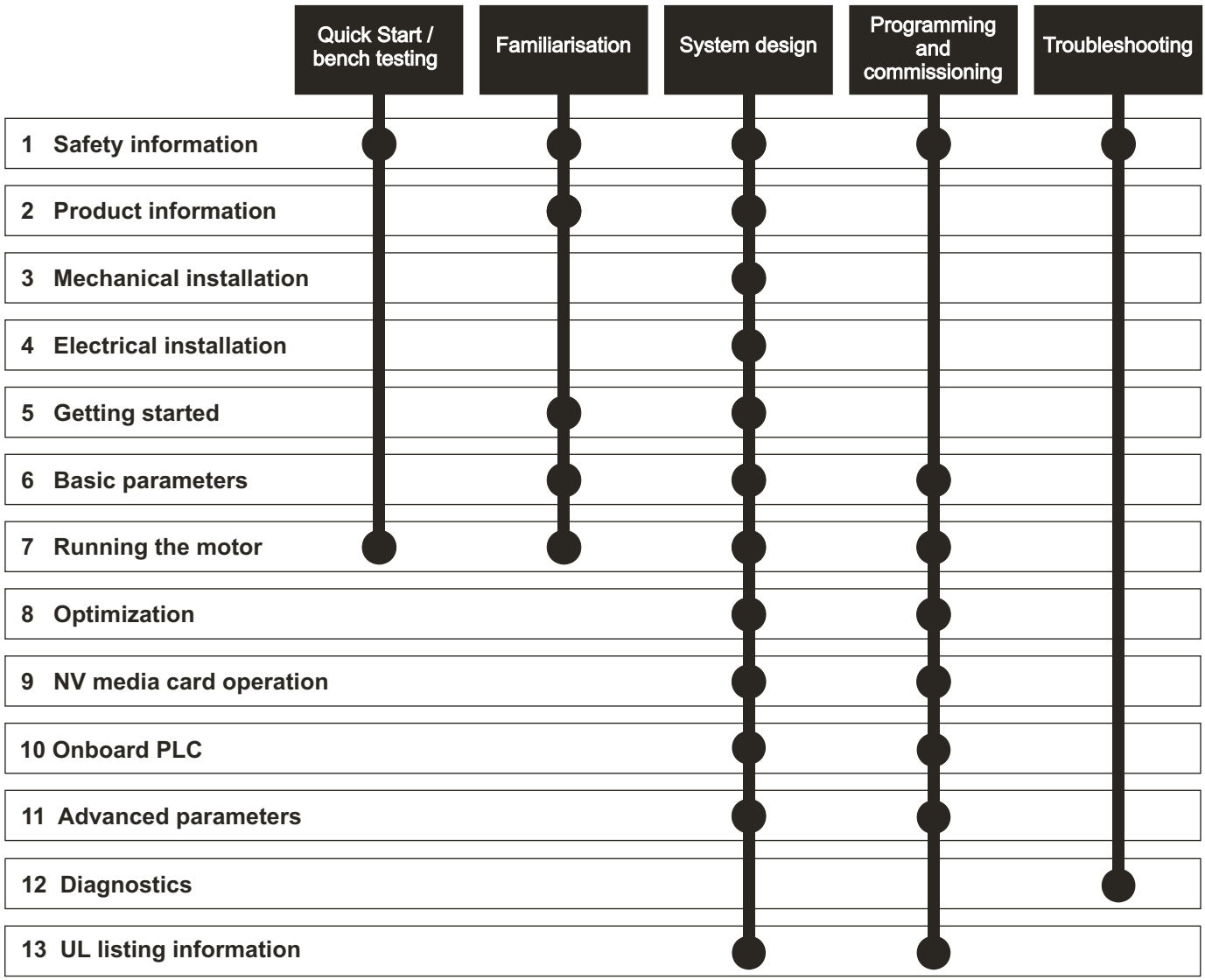
How to use this guide

This guide is intended to be used in conjunction with the appropriate *Power Installation Guide.* The *Power Installation Guide* gives information necessary to physically install the drive. This guide gives information on drive configuration, operation and optimization.

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:



Contents

EU Declaration of Conformity

Control Techniques Ltd
The Gro
Newtown
Powys
UK
SY16 3BE

Moteurs Leroy-Somer
Usine des Agriers
Boulevard Marcellin Leroy
CS10015
16915 Angoulême Cedex 9
France

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

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

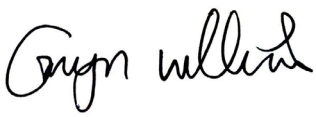
The model number may be followed by additional characters that do not affect the ratings.

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

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

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

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



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

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

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

EU Declaration of Conformity (including 2006 Machinery Directive)

Control Techniques Ltd
The Gro
Newtown
Powys
UK
SY16 3BE

Moteurs Leroy-Somer
Usine des Agriers
Boulevard Marcellin Leroy
CS10015
16915 Angoulême Cedex 9
France

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

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

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

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

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

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

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

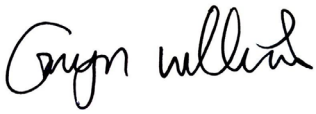
EC type-examination certificate numbers:
01/205/5270.01/14 dated 2014-11-11
01/205/5387.01/15 dated 2015-01-29
01/205/5383.02/15 dated 2015-04-21

Notified body identification number: 0035

The harmonized standards used are shown below:

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

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



G. Williams

Vice President, Technology

Date: 17th March 2016

Place: Newtown, Powys, UK

IMPORTANT NOTICE

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

The drives must be installed only by professional installers who are familiar with requirements for safety and EMC. Refer to the Product Documentation. An EMC data sheet is available giving detailed information. The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used.

1 Safety information

1.1 Warnings, Cautions and Notes

WARNING

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

CAUTION

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

NOTE

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

1.2 Electrical safety - general warning

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

Specific warnings are given at the relevant places in this *Control 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 *Control 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 the *Power Installation 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 the relevant *Power Installation Guide*.

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.

The *Power Installation 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:

Safety of Machinery 2006/42/EC.
Electromagnetic Compatibility (EMC) Directive 2014/30/EU.

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 **00.006** 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.

1.12 Hazard

1.12.1 Falling hazard

The drive presents a falling or toppling hazard. This can cause injury to personnel and therefore should be handled with care.

2 Product information

2.1 Introduction

Open loop AC drive

Unidrive M400 delivers maximum machine performance with open loop vector and sensorless induction motor control, for dynamic and efficient machine operation.

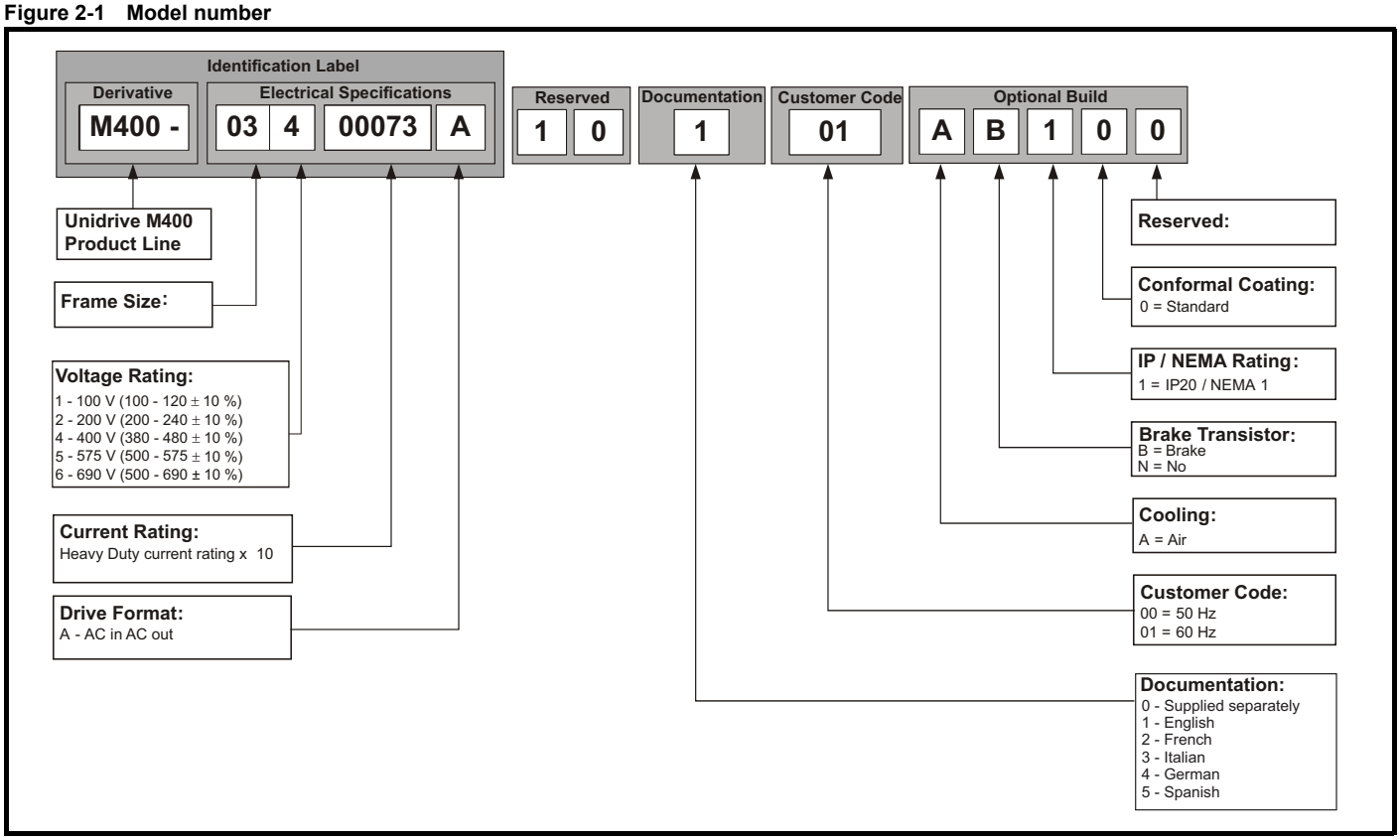
Features

- Fast set-up and diagnosis with real-text display
- Onboard IEC 61131-3 programmable automation
- NV Media Card for parameter copying and data storage
- 24 Vdc Back-up supply (optional)
- EIA 485 serial communications interface (optional)
- Dual channel Safe Torque Off (STO) input

2.2 Model number

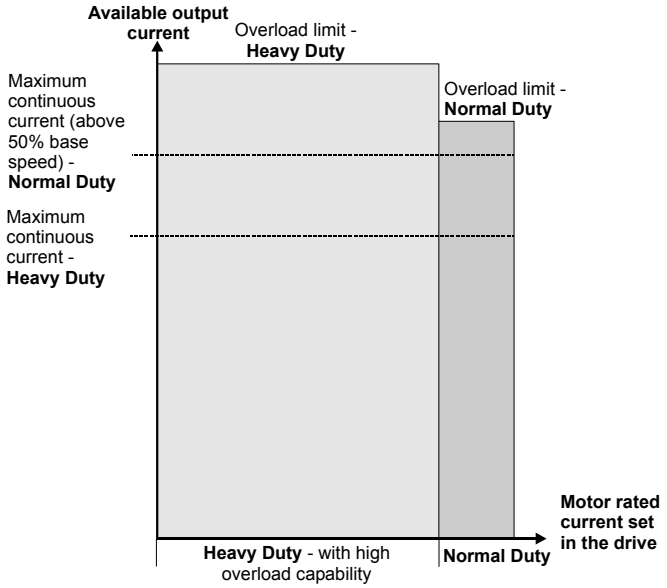
The way in which the model numbers for the Unidrive M range are formed is illustrated below:

Figure 2-1 Model number



2.3 Ratings

The size 1 to 4 drive is Heavy Duty rated only.
The size 5 to 9 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)

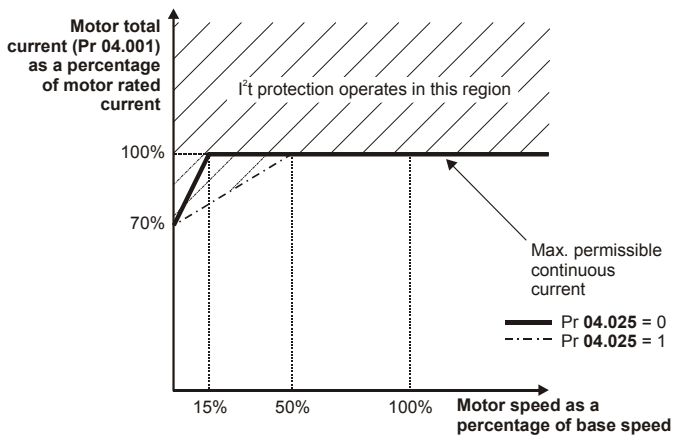
For constant torque applications or applications which require a high overload capability, or full torque is required at low speeds (e.g. winders, hoists).
The thermal protection is set to protect force ventilated induction motors by default.

NOTE

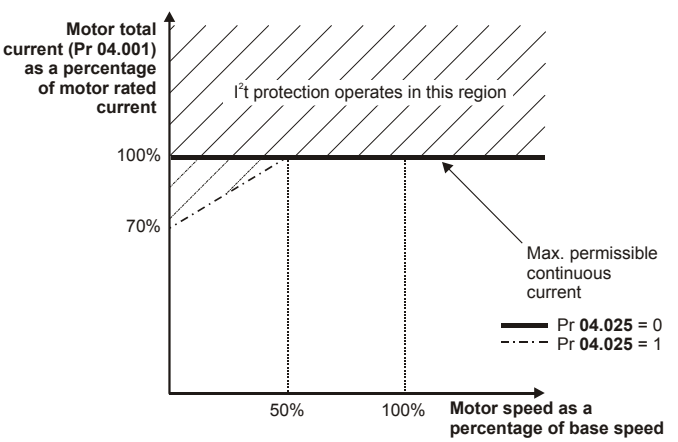
If the application uses a self ventilated (TENV/TEFC) induction motor and increased thermal protection is required for speeds below 50 % base speed, then this can be enabled by setting *Low Speed Thermal Protection Mode* (04.025) = 1.

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



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)
   - Square V/F mode (V/Hz)
2. RFC - A
   - Without 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.

Square 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

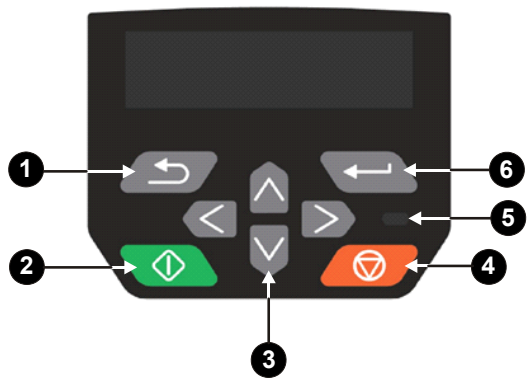
Rotor Flux Control for Asynchronous (induction) motors (RFC-A) encompasses closed loop vector control without a position feedback device.

Rotor flux control provides closed loop control without the need for position feedback by using current, voltages and key motor parameters to estimate the motor speed. It can eliminate instability traditionally associated with open loop control for example when operating large motors with light loads at low frequencies.

2.5 Keypad and display

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

Figure 2-2 CI-Keypad



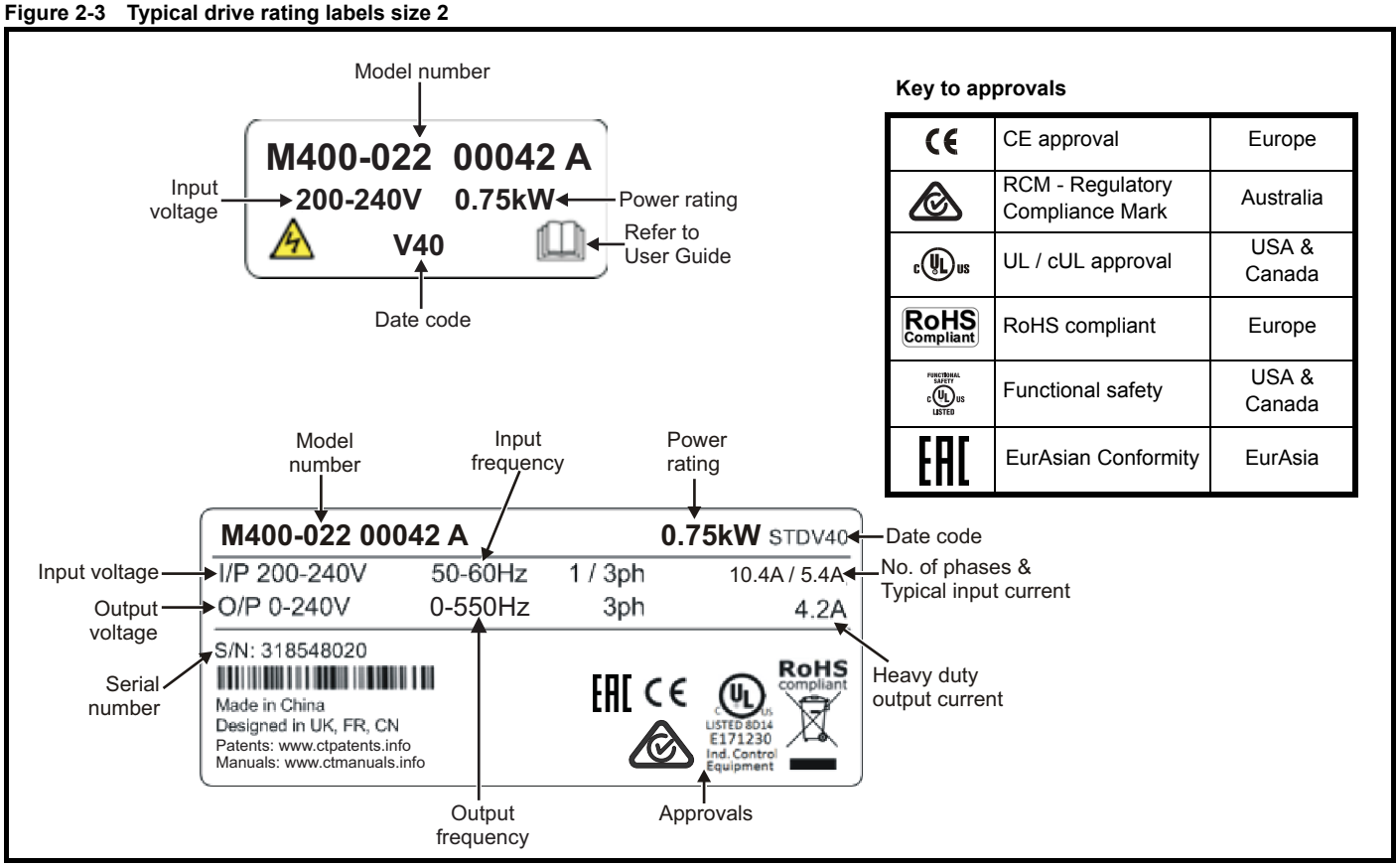
1. Escape button
2. Start button (Green)
3. Navigation keys (x4)
4. Stop / Reset button (red)
5. Status LED
6. Enter button

NOTE

The keypad is not supplied with the drive.

2.6 Nameplate description

Figure 2-3 Typical drive rating labels size 2



Refer to Figure 2-1 *Model number* on page 11 for further information relating to the labels.

NOTE

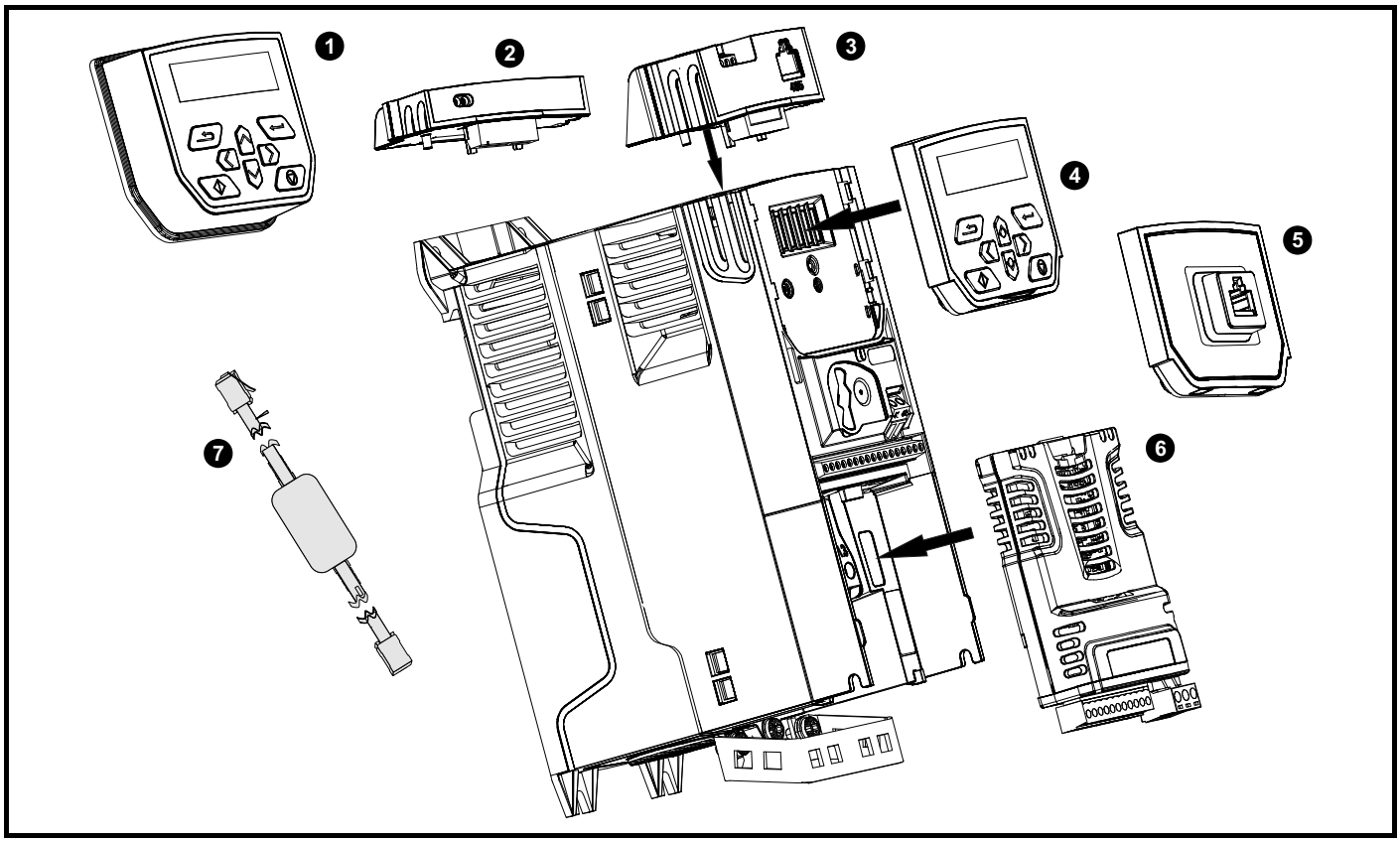
Date code format

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

Example:
A date code of **W28** would correspond to week 28 of year 2013.

2.7 Options

Figure 2-4 Options available with the drive



1. Remote mountable LCD keypad
2. AI-Backup adaptor
3. AI-485 Adaptor
4. Compact Interface (CI) keypad
5. CI-485 Adaptor interface
6. System Integration (SI) module
7. CT USB Comms cable

Table 2-1 System Integration (SI) option module identification

Type	Option module	Color	Name	Further details
Fieldbus		Purple	SI-PROFIBUS	**Profibus option** PROFIBUS adaptor for communications with the drive
		Medium Grey	SI-DeviceNet	**DeviceNet option** DeviceNet adaptor for communications with the drive
		Light Grey	SI-CANopen	**CANopen option** CANopen adaptor for communications with the drive
		Yellow Green	SI-PROFINET V2	**PROFINET V2 option** PROFINET V2 adapter for communications with the drive
		Beige	SI-Ethernet	External Ethernet module that supports EtherNet/IP, Modbus TCP/IP and RTMoE. The module can be used to provide global connectivity and integration with IT network technologies, such as wireless networking
		Brown Red	SI-EtherCAT	**EtherCAT option** EtherCAT adapter for communications with the drive
Automation (I/O expansion)		Orange	SI-I/O	**Extended I/O** Increases the I/O capability by adding the following combinations: • Digital I/O • Digital Inputs • Analog Inputs (differential or single ended) • Relays

Table 2-2 Adaptor Interface (AI) option module identification

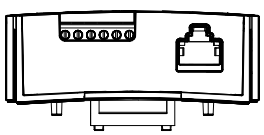
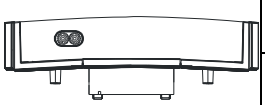
Type	Option module	Name	Further details
Communications		AI-485 adaptor	**EIA 485 serial communications option** Provides a EIA 485 serial communications interface via an RJ45 connector or alternative screw terminals.
Backup		AI-Backup adaptor	**+24 V Backup and SD card interface** Provides a +24 V Backup supply input and SD card interface
		AI-Smart adaptor	**+24 V Backup and SD card interface** Supplied with 4 GB SD Card for parameter copying and application programs, and an input for 24 V Backup

Table 2-3 Keypad identification

Type	Keypad	Name	Further Details
Keypad		Remote-Keypad	**Remote LCD keypad option** Remote Keypad with a LCD display
		CI-Keypad	**LCD keypad option** Keypad with a LCD display
		Remote-Keypad RTC	**Remote LCD keypad option** Remote Keypad with a LCD display and real time clock

Table 2-4 Compact Interface (CI) option module identification

Type	Option	Name	Further Details
Communications		CI-485 Adaptor	**EIA 485 serial communications option** Provides a EIA 485 serial communications interface via an RJ45 connector.

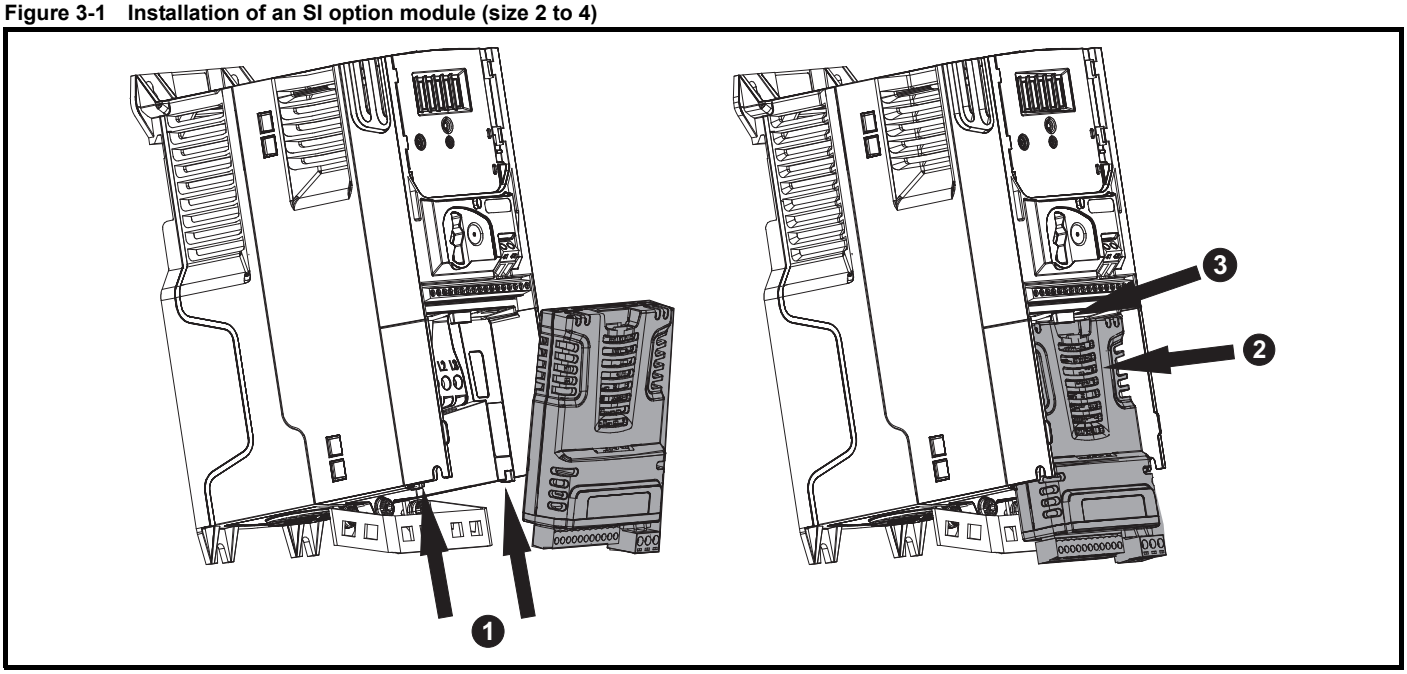
3 Mechanical installation

3.1 Installing / removing options and keypad

CAUTION

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

Figure 3-1 Installation of an SI option module (size 2 to 4)

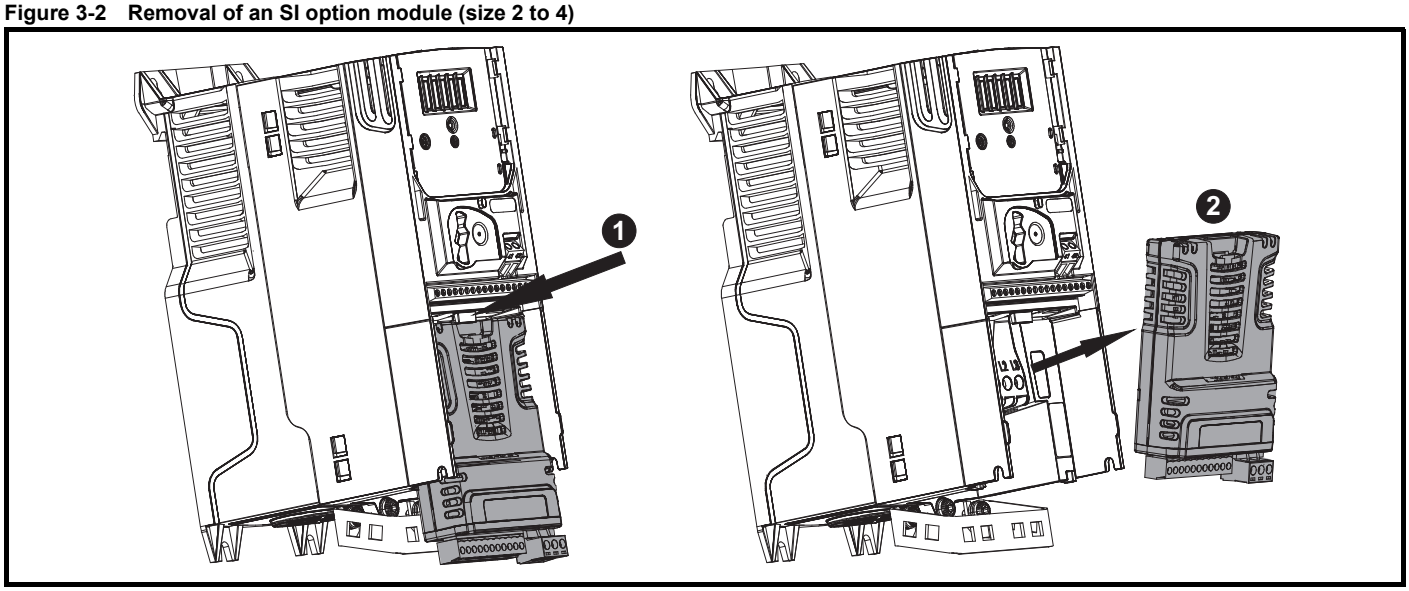


- With the option module tilted slightly backwards, align and locate the two holes in the rear of the option module onto the two tabs (1) on the drive.
- Press the option module onto the drive as shown in (2) until the connector mates with the drive, ensuring that the tab (3) retains the option module in place.

NOTE

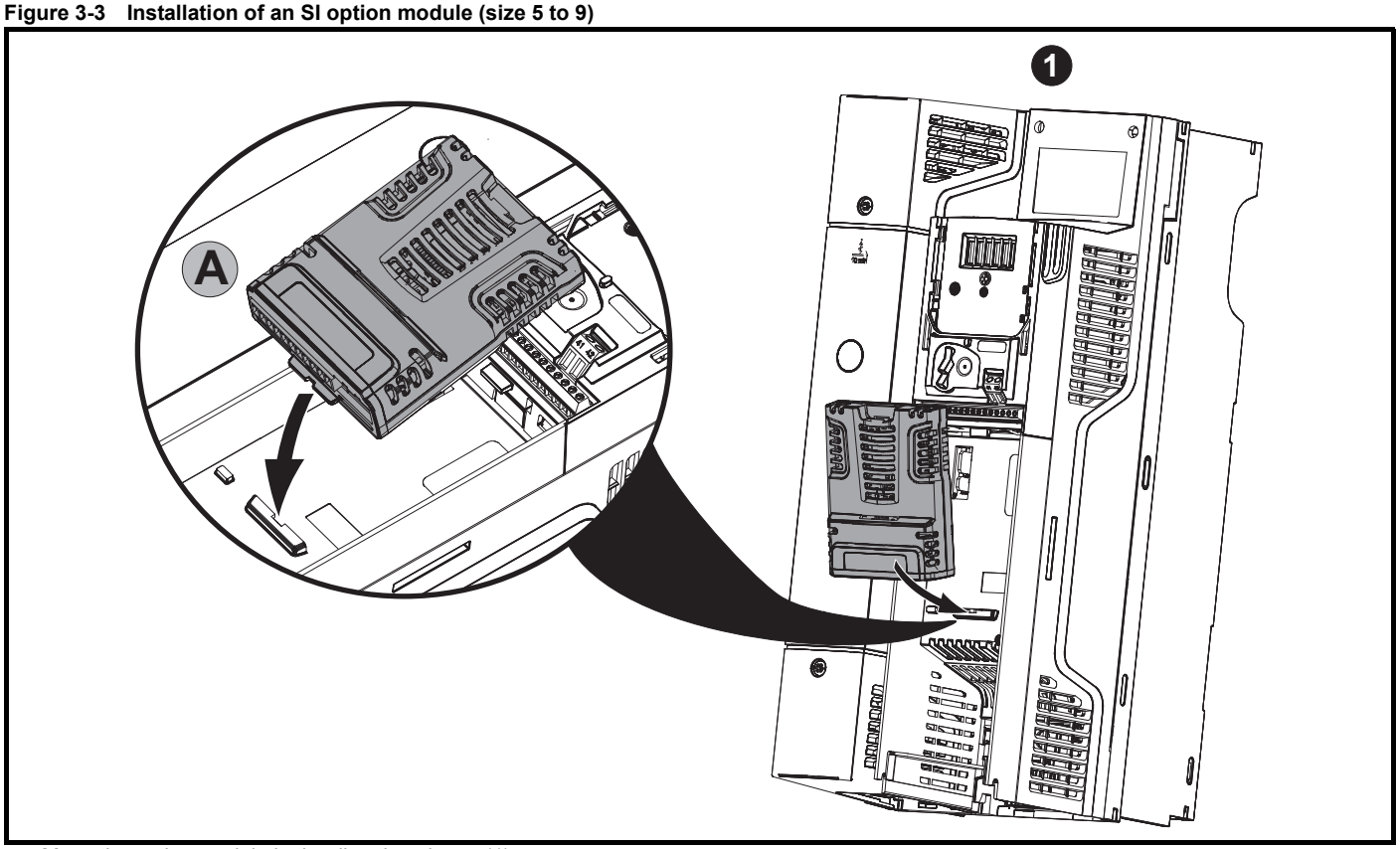
Check that the option module is securely located on the drive. Always ensure that the terminal cover is always replaced before use as this ensures that the option module is firmly secured.

Figure 3-2 Removal of an SI option module (size 2 to 4)



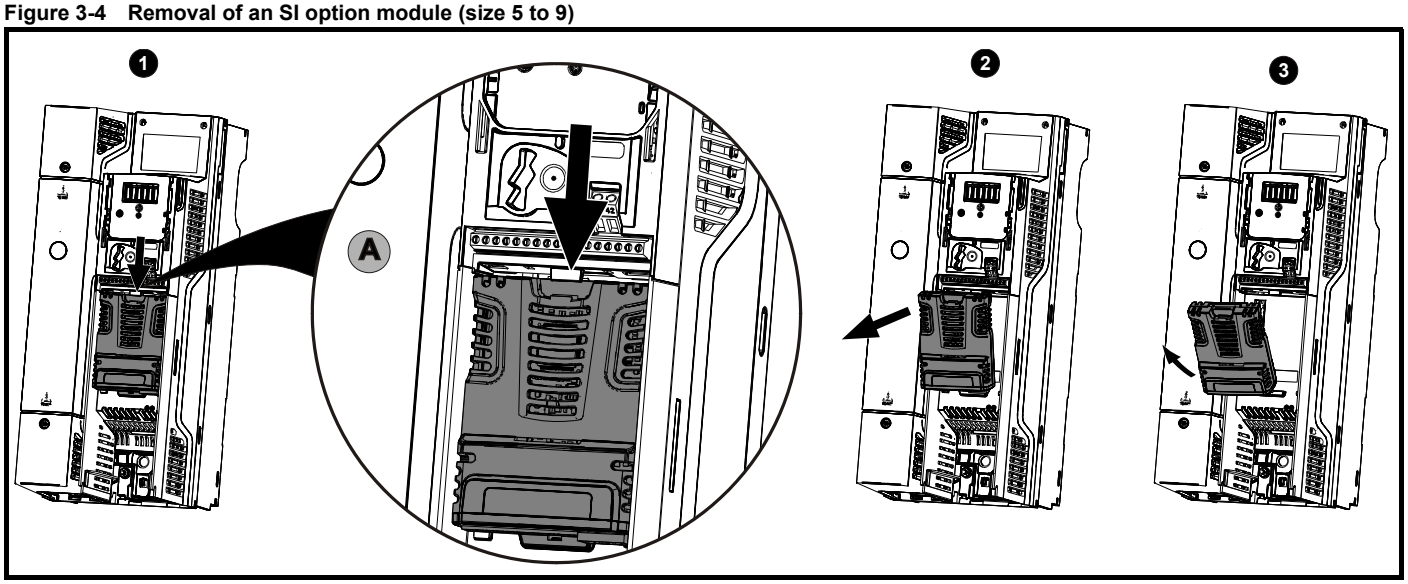
- Press down on the tab (1) to release the option module from the drive housing as shown.
- Tilt the option module slightly towards you and pull away from the drive housing (2).

Figure 3-3 Installation of an SI option module (size 5 to 9)



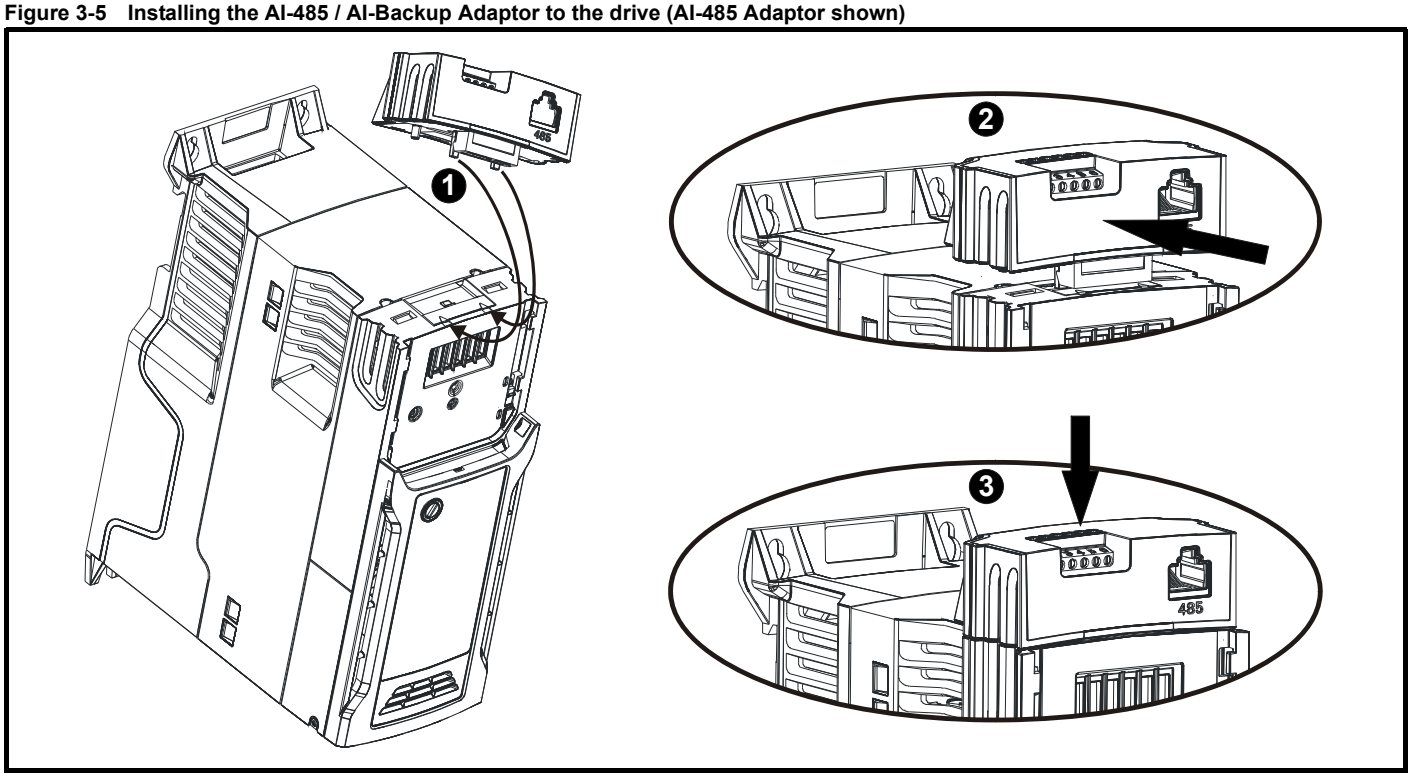
- Move the option module in the direction shown (1).
- Align and insert the option module tab into the slot provided. This is shown in the detailed view (A).
- Press down on the option module until it locks into place.

Figure 3-4 Removal of an SI option module (size 5 to 9)



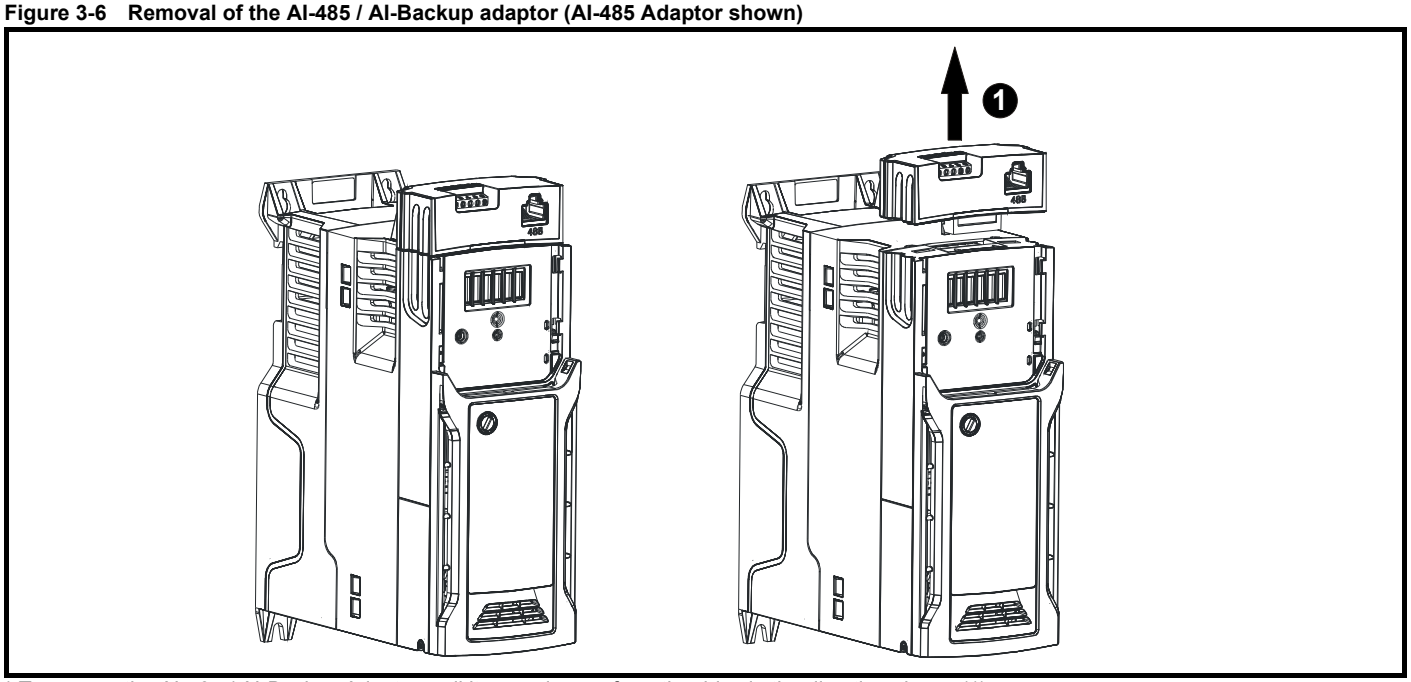
- To release the option module from the drive housing, press down on the tab (1) as shown in detailed view (A).
- Tilt the option module towards you as shown in (2).
- Remove the option module by lifting away from the drive as shown in (3).

Figure 3-5 Installing the AI-485 / AI-Backup Adaptor to the drive (AI-485 Adaptor shown)



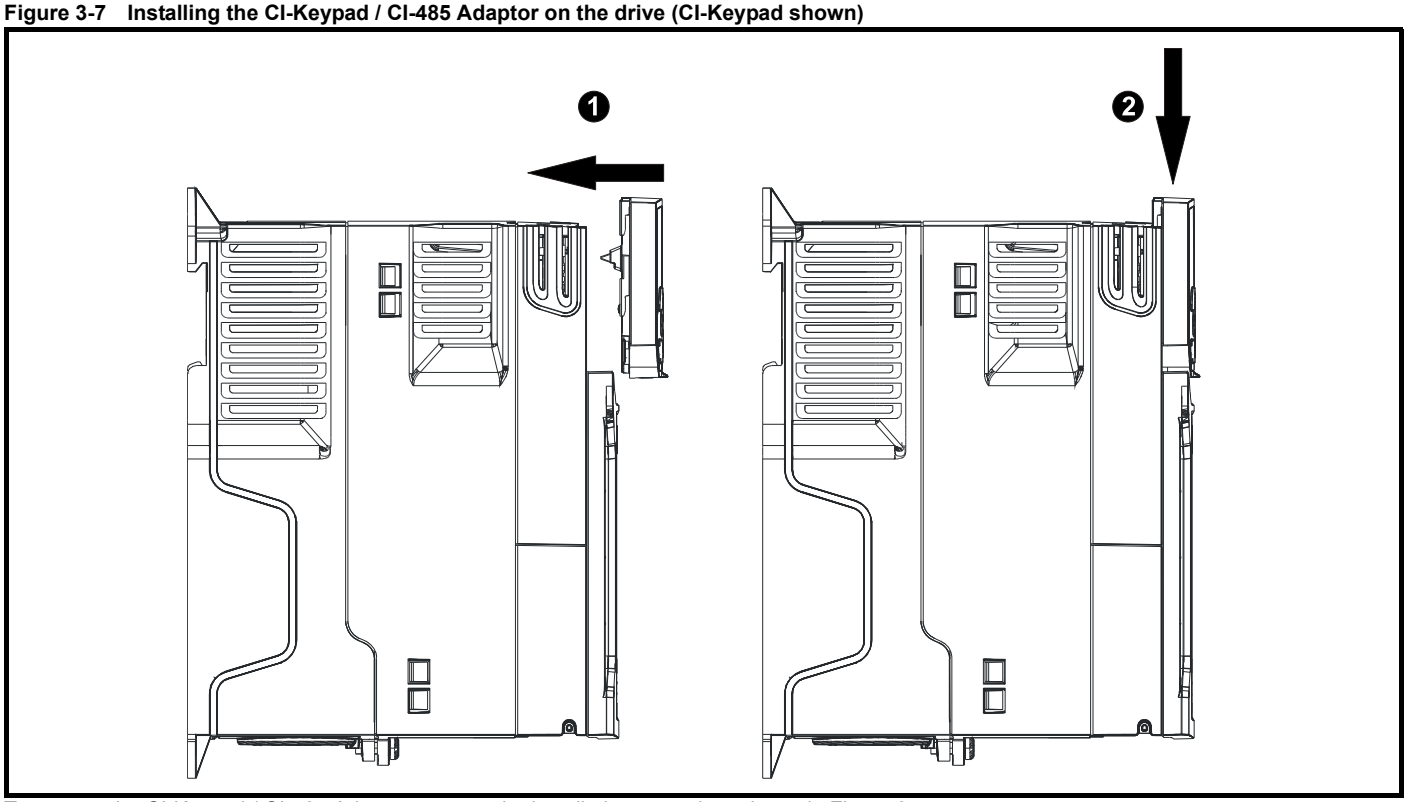
1. Identify the two plastic fingers on the underside of the AI-485 / AI-Backup Adaptor (1) - then insert the two fingers into the corresponding slots in the spring loaded sliding cover on the top of the drive.
2. Hold the adaptor firmly and push the spring loaded protective cover towards the back of the drive to expose the connector block (2) below.
3. Press the adaptor downwards (3) until the adaptor connector locates into the drive connection below.

Figure 3-6 Removal of the AI-485 / AI-Backup adaptor (AI-485 Adaptor shown)



* To remove the AI-485 / AI-Backup Adaptor, pull it up and away from the drive in the direction shown (1)

Figure 3-7 Installing the CI-Keypad / CI-485 Adaptor on the drive (CI-Keypad shown)



To remove the CI-Keypad / CI-485 Adaptor, reverse the installation procedure shown in Figure 3-7.

NOTE

The CI-Keypad / CI-485 Adaptor can be installed / removed while the drive is powered up and running motor, providing that the drive is not operating in keypad mode.

3.2 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 3-8 Remote Keypad RTC (rear view)

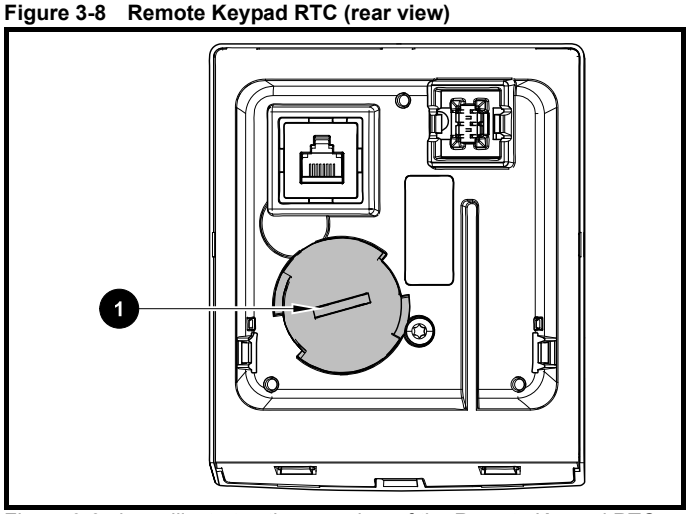


Figure 3-8 above illustrates the rear view of the Remote Keypad RTC.

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.

4 Electrical installation

4.1 24 Vdc supply

The 24 Vdc supply connected to the +24 V supply terminals on the AI-Backup adaptor provides the following functions:

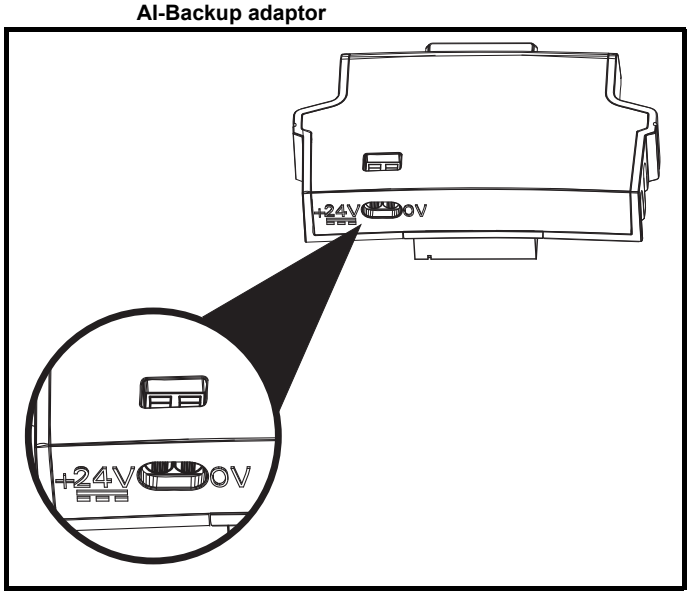
- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules or serial communications to continue to operate. If the line power supply is re-applied, then the normal operation can carry on after the drive automatically re-initializes the power board parameters.
- It can be used to clone or load parameters and user programs in order to pre-configure drives when the line power supply is not available. The keypad can be used to setup parameters if required. However, the drive will be in the Under Voltage state unless the line power supply 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).

The working voltage range of the 24 V back-up power supply is as follows:

0 V	**0 V (connected internally to 0V common - Control Terminal 1)**
+ 24 V	**+ 24 V Backup supply input**
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	19.2 V
Maximum continuous operating voltage	30.0 V
Minimum start up voltage	12.0 V
Minimum power supply requirement at 24 V	20 W
Recommended fuse	1 A, 50 Vdc

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

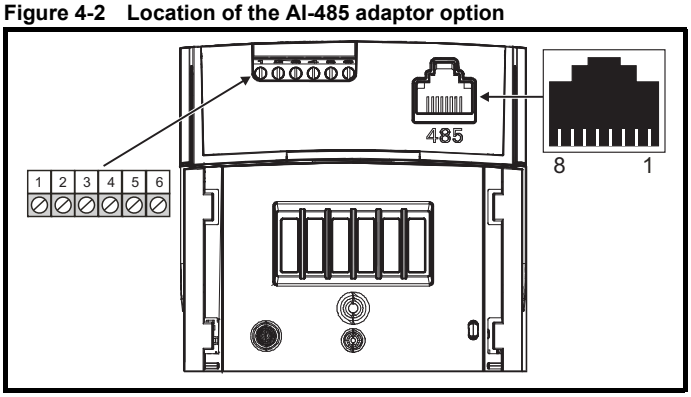
Figure 4-1 Location of the 24 Vdc power supply connection on the AI-Backup adaptor



4.2 Communication connections

Installing an AI-485 adaptor provides the drive with a 2 wire EIA 485 serial communications interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller as required.

Figure 4-2 Location of the AI-485 adaptor option



4.2.1 EIA 485 serial communications

The drive only supports Modbus RTU protocol. See Table 4-1 for the connection details.

NOTE

Standard Ethernet cables **must not be used** when connecting drives on a EIA 485 network as they do not have the correct twisted pairs for the pinout of the serial comms port.

Table 4-1 Serial communication port pin-outs (RJ45)

Pin	Function
1	120 Ω Termination resistor
2	RX TX
3	0 V
4	+24 V (100 mA) output
5	Not connected
6	TX enable
7	RX\ TX\
8	RX\ TX\ (if termination resistors are required, link to pin 1)

Minimum number of connections are 2, 3, 7 and shield.

Table 4-2 Serial communication port pin-outs (screw terminal block)

Pin	Function
1	0 V
2	RX\ TX\ (if termination resistor required, link to pin 4)
3	RX TX
4	120 Ω Termination resistor
5	TX Enable
6	+24 V (100 mA) output

NOTE

The connections on the RJ45 connector and terminal block are in parallel.

4.2.2 Isolation of the EIA 485 serial communication port

The serial communication port is single insulated and meets the requirements for ELV.

WARNING

When using the communications port with a personal computer or centralised controller e.g. PLC, an isolation device must be included with a rated voltage at least equal to the drive supply voltage. Ensure that the correct fuses are installed at the drive input, and that the drive is connected to the correct supply voltage.
If a serial communications converter other than the CT Comms cable is used to connect to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to a personal computer), then a safety isolating barrier must be included to maintain the SELV classification.

An isolated serial communications lead has been designed to connect the drive to IT equipment (such as laptop computers), and is available from the supplier of the drive. See below for details:

Table 4-3 Isolated serial comms lead details

Part number	Description
4500-0096	CT USB Comms cable

The “isolated serial communications” lead has reinforced insulation as defined in IEC60950 for altitudes up to 3,000 m.

4.3 Control connections

4.3.1 General

Table 4-4 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Single ended analog input	2	Mode, offset, invert, scaling, destination	2, 3, 5
Analog output	2	Source, mode, scaling	7, 8
Digital input	6	Destination, invert, logic select	5, 12, 13, 14, 15, 16
Digital input / output	2	Input / output mode select, destination / source, invert, logic select	10, 11
Digital output	2	Source, mode	7, 8
Frequency input	1	Maximum reference, input limit, scaling, destination	15
AB Encoder input	1	Rotary lines per revolution, filter, frequency feedback, maximum frequency feedback, position scaling, position counter reset, input limit, frequency reference scaling	15, 16
PWM or Frequency output	1	Source scaling, maximum output frequency, mode	10
Motor thermistor input	1	Mode, type, trip threshold, reset threshold	14
Relay	1	Source, invert	41, 42
Drive enable (Safe Torque Off)	2		31, 34 (frame 1- 4) 31, 35 (frame 5 - 9)
+ 10 V User output	1		4
+ 24 V User output	2		9, 17
0V common	2		1, 6
0V Safe Torque Off	2		32, 33 (frame 1- 4) 32, 36 (frame 5 - 9)

NOTE

The 0V terminals on the Safe Torque Off are isolated from each other and the 0V common (size 1 to 4), the 0V terminals on the Safe Torque Off function on size 5 to 9 are common with the user 0V terminals.

Key:

Destination parameter:	Indicates the parameter which is being controlled by the terminal / function
Source parameter:	Indicates the parameter being output by the terminal
Mode parameter:	Analog - indicates the mode of operation of the terminal, i.e. voltage 0-10 V, current 4-20 mA etc. Digital - indicates the mode of operation of the terminal.

All analog terminal functions can be programmed in menu 7.

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

WARNING

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

WARNING

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

CAUTION

If any of the digital inputs (including the drive enable input) are connected in parallel with an inductive load (i.e. contactor 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.

WARNING

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 terminals are positive logic input only (see Figure 4-4 on page 24).

Figure 4-3 Default terminal functions

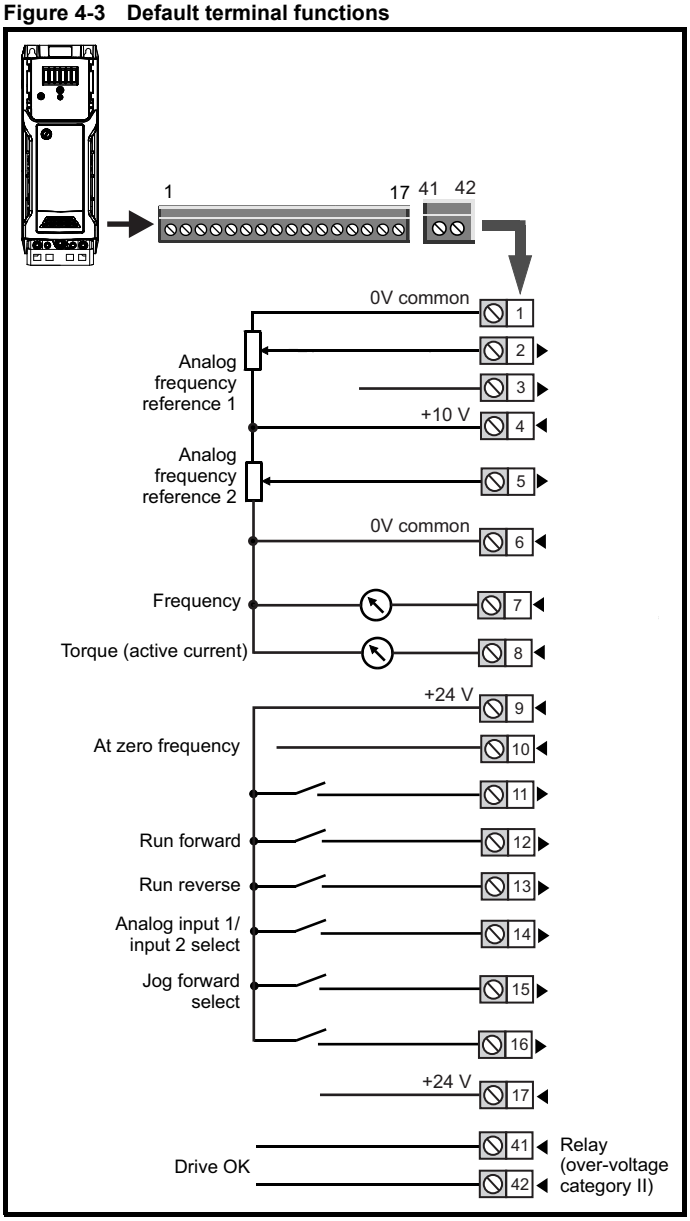


Figure 4-4 Safe Torque Off inputs (size 1 to 4)

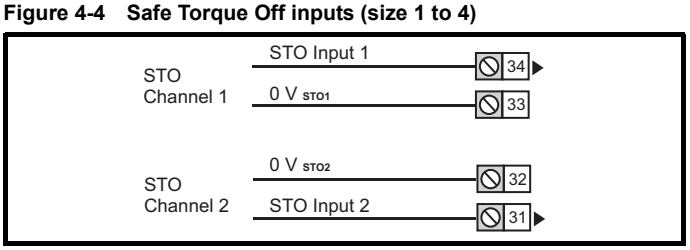
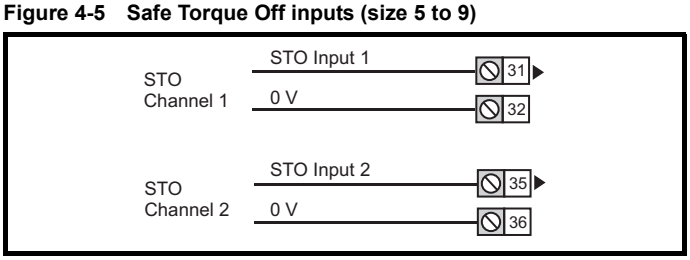


Figure 4-5 Safe Torque Off inputs (size 5 to 9)



4.3.2 Control terminal specification

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

2	Analog input 1
Default function	Frequency reference.
Type of input	Bipolar single-ended analog voltage or unipolar differential current.
Mode controlled by…	Pr **07.007**
Operating in voltage mode (default)	
Full scale voltage range	±10 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Input resistance	100 k Ω
Resolution	12 bits (11 bits plus sign)
Operating in current mode	
Current ranges	0 to 20 mA ±5 %, 20 to 0 mA ±5 %, 4 to 20 mA ±5 %, 20 to 4 mA ±5%
Maximum offset	250 µA
Common mode input voltage range	0V to +12 V
Resolution	11 bits
External fuse rating	80 mA
Common to all modes	
Sample rate	4 ms

WARNING

To avoid damage to the drive, a fuse or other over-current protection should be installed in the analog current input circuit.

When connecting a two wire sensor which has a 24 V input and a mA output, to the current input, the 24 V input can be connected to the +24 V terminal (9), while the mA output can be connected to the analog input 1 terminal (2). The analog input 1 return terminal (3) needs to be connected to the 0V terminal (1).

3	Analog input 1 return
Function	Return terminal for shunt resistor (current mode)

4	+10 V user output
Function	**Supply for external analog devices**
Nominal voltage	10.2 V
Voltage tolerance	±3 %
Maximum output current	5 mA

5	Analog input 2
Default function	**Frequency reference**
Type of input	Unipolar single-ended analog voltage, unipolar single-ended current or digital input (positive or negative logic).
Mode controlled by....	Pr **07.011**
Operating in voltage mode (default)	
Full scale voltage range	0 V to +10 V ±3 %
Maximum offset	±30 mV
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Input resistance	100 k Ω
Resolution	11 bits
Sample rate	4 ms
Operating in current mode	
Current ranges	0 to 20 mA ±4 %, 20 to 0 mA ±4 %, 4 to 20 mA ±4 %, 20 to 4 mA ±4 %
Maximum offset	250 µA
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Resolution	11 bits
Sample rate	4 ms
Operating in digital mode	
Logic mode controlled by…	Pr **08.010**
Absolute maximum voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 k Ω
Input threshold	10 V ±0.8 V (IEC 61131-2)
Sample rate	1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms.

6	0V common
Function	Common connection for all external devices

7	Analog output 1
8	Analog output 2
Terminal 7 default function	**Frequency output**
Terminal 8 default function	**Motor active current**
Type of output	Unipolar single-ended analog voltage, unipolar single-ended current or digital output.
Mode controlled by…	Pr 07.021, Pr 07.024
Operating in voltage mode (default)	
Voltage range	0 to +10 V ±5 %
Maximum offset	15 mV
Minimum load resistance	500 Ω
Protection	Short circuit relative to 0 V
Operating in current mode	
Current ranges	0 to 20 mA ±4 %, 4 to 20 mA ±4 %
Maximum load resistance	500 Ω
Operating in digital output mode	
Nominal maximum output current	50 mA
Voltage range	0 V to +24 V
Common to all modes	
Resolution	0.1 %
Sample rate	4 ms

9	+24 V user output
Function	**Supply for external digital devices**
Voltage tolerance	±20 %
Maximum output current	200 mA (total including all Digital Outputs)
Protection	Current limit and trip

10	Digital I/O 1
11	Digital I/O 2
Terminal 10 default function	**AT ZERO FREQUENCY output**
Terminal 11 default function	**None**
Type	Positive or negative logic digital inputs, positive logic voltage source outputs. PWM or frequency output modes can be selected on output 1.
Input / output mode controlled by …	Pr **08.031,** Pr **08.032**
Operating as in input	
Logic mode controlled by…	Pr **08.010**
Absolute maximum applied voltage range	-8 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V (IEC 61131-2)
Operating as an output	
Nominal maximum output current	50 mA
Maximum output current	200 mA (total including +24 Vout)
Common to all modes	
Voltage range	0 V to +24 V
Sample rate	1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms.

12	Digital Input 3
13	Digital Input 4
Terminal 12 default function	**RUN FORWARD input**
Terminal 13 default function	**RUN REVERSE input**
Type	Negative or positive logic digital inputs
Logic mode controlled by…	Pr **08.010**
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V (IEC 61131-2)
Sample rate	1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms.

14	Digital Input 5
Terminal 14 default function	**Analog INPUT 1 / INPUT 2 select**
Type	Negative or positive logic digital input or motor thermistor input (bias for DIN44081 ptc, KTY84, PT1000, PT2000 and other types) mode can be selected.
Input mode controlled by…	Pr **08.035**
Operating as digital input	
Logic mode controlled by…	Pr **08.010**
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V (IEC 61131-2)
Sample rate	1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms.

15	Digital Input 6
16	Digital Input 7
Terminal 15 default function	**JOG SELECT input**
Terminal 16 default function	**None**
Type	Negative or positive logic digital inputs, frequency input (digital input 6) or AB encoder input (digital input 6 and 7).
Input mode controlled by...	Pr **08.036**
Operating as digital input	
Logic mode controlled by…	Pr **08.010**
Operating as frequency or AB encoder input	
Maximum input frequency	100 kHz
Common to all modes	
Voltage range	0 V to +24 V
Absolute maximum applied voltage range	-18 V to +30 V relative to 0 V
Impedance	6.8 kΩ
Input threshold	10 V ±0.8 V (IEC 61131-2)
Sample rate	1 ms when routed to destinations Pr **06.035** or Pr **06.036**, otherwise 4 ms.

NOTE

To use an encoder on the AB encoder input with 5 V encoder signals, a 5 V to 24 V level converter e.g. Motrona PU210, will be required.

17	+24 V user output
Function	**Supply for external digital devices.**
Voltage tolerance	±20 %
Maximum output current	200 mA (total including all Digital Outputs)
Protection	Current limit trip.

31 34	Safe Torque Off function (drive enable) (frame size 1 to 4)
Type	Positive logic only digital input
Voltage range	0 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, <15 mA @30 V (IEC 61131-2, type 1)
Low state maximum current for disable to SIL3 and PL e	0.5 mA
Response time	Nominal: 12 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.	

32	0V STO2 (frame size 1 to 4)
Function	Common connection for STO2

33	0V STO1 (frame size 1 to 4)
Function	Common connection for STO1

31 35	Safe Torque Off function (drive enable) (frame size 5 to 9)
Type	Positive logic only digital input
Voltage range	0 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 (IEC 61131-2, type 1, 3.3 kΩ)
Low state maximum current for disable to SIL3 and PL e	0.5 mA
Response time	Nominal: 6 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
Contact minimum recommended rating	12 V 100 mA
Contact type	Normally open
Default contact condition	Closed when power applied and drive OK
Update rate	1 ms

WARNING

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

4.3.3 Accuracy and resolution

Frequency:

The absolute frequency accuracy depends on the accuracy of the oscillator used with the drive microprocessor. The accuracy of the oscillator is ± 0.02 % , and so the absolute frequency accuracy is ± 0.02 % of the reference, when a preset frequency 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 & closed loop resolution:

Preset frequency reference: 0.01 Hz

Analog input 1: 11 bit plus sign

Analog input 2: 11 bit

Current:

The resolution of the current feedback is 10 bit plus sign.

Accuracy: typical 2 %

worst case 5 %

4.4 Safe Torque Off (STO)

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

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

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

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

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

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

Machinery Applications

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

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

Type examination certificate number	Date of issue	Model	Frame sizes
01/205/5387.01/15	2015-01-29	M400	5 to 9
01/205/5383.02/15	2015-04-21	M400	1 to 4

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

Safety Parameters as verified by TüV Rheinland:

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

Type	Value	Percentage of SIL 3 allowance	Frame sizes
Proof test interval	20 years		All
High demand or a continuous mode of operation			
PFH (1/h)	9.61×10^{-11} 1/h	<1 %	1 to 4
PFH (1/h)	4.16×10^{-11} 1/h	<1 %	5 to 9
Low demand mode of operation (not EN 61800-5-2)			
PFDavg	8.4×10^{-6}	< 1 %	1 to 4
PFDavg	3.64×10^{-6}	< 1 %	5 to 9

According to EN ISO 13849-1

Type	Value	Classification
Category	4	
Performance Level (PL)	e	
$MTTF_D$ (ST01)	>2500 years	High
$MTTF_D$ (ST02)	>2500 years	High
$MTTF_D$ (Single channel STO)	>2500 years	High
DC_{avg}	≥99 %	High
Mission time	20 years	

NOTE

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

Lift (Elevator) Applications

The Safe Torque Off function has been independently assessed for use as a safety component in lift (elevator) applications by Notified Body, TüV Nord:

The Unidrive M drives series with Safe Torque Off (STO) function if applied according to the "Conditions of application" fulfil the safety requirements of the standards EN81-1, EN81-2, EN 81-50 and EN60664-1and are in conformity with all relevant requirements of the Directive 95/16/EC.

Certificate of Conformity number	Date of issue	Models
44799 13196202	04-08-2015	M400

The Safe Torque Off function can be used to eliminate electro-mechanical contactors, including special safety contactors, which would otherwise be required for safety applications.

For further information contact the supplier of the drive.

UL Approval

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

Safety Parameters as verified by UL:

According to IEC 61508-1 to 7

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

According to EN ISO 13849-1

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

Two-channel Safe Torque Off

The M400 models have dual channel STO.

The dual channel STO has two fully independent channels.

Each input meets the requirements of the standards as defined above.

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 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.

Under these conditions, 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 > 5 V could 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.

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.

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.

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 0V conductors which should be connected to terminals 32 and 33 (sizes 1 to 4) and terminals 32 and 36 (sizes 5 to 9) at the drive.

Safe Torque Off over-ride

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

5 Getting started

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

5.1 Understanding the display

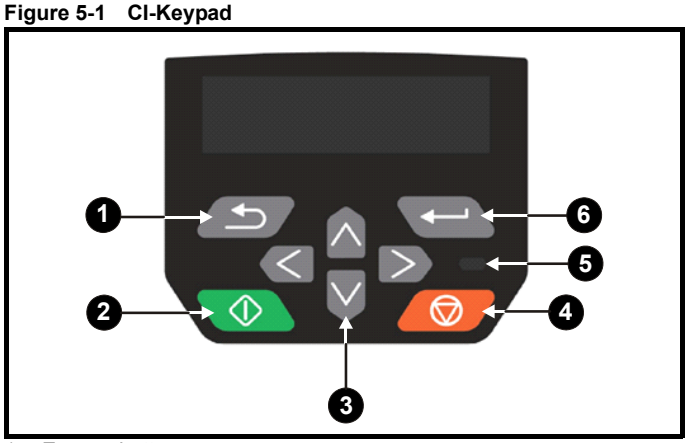
5.1.1 CI-Keypad

The keypad can only be mounted on the drive.

The CI-Keypad display consists of up to four rows of text. The upper two rows show the drive status or the menu and parameter number currently being viewed. When in status mode, an area one character wide and four lines high on the right-hand side of the display, is reserved for displaying actions that are active on the drive. The possible active actions are given in Table 5-2.

The keypad powers up into the status state. The value of any two parameters can be permanently displayed on the bottom two rows of the screen in the status state. To do this enter the desired parameter numbers into Pr **11.018** (*Status Mode Parameter 1*) and Pr **11.019** (*Status Mode Parameter 2*).

Figure 5-1 CI-Keypad



1. Escape button
2. Start button (Green)
3. Navigation keys (x4)
4. Stop / Reset button (red)
5. Status LED
6. Enter button

NOTE

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

The parameter value is correctly displayed on the keypad display as shown in the below table.

Table 5-1 Keypad display formats

Display formats	Value
IP Address	127. 0. 0. 0
MAC Address	01ABCDEF2345
Time	12:34:56
Date	31-12-13 or 12-31-13
Version number	01.02.00.00
Character	ABCD
32 bit number with decimal point	21474836.47
16 bit binary number	0100001011100101
Text	A1 A2
Number	10.00 Hz

Table 5-2 Active action icon

Active action icon	Description
	Alarm active
	NV media card being accessed
	Drive security active
	User security unlocked
	Motor map 2 active
	User program running
	Keypad reference active

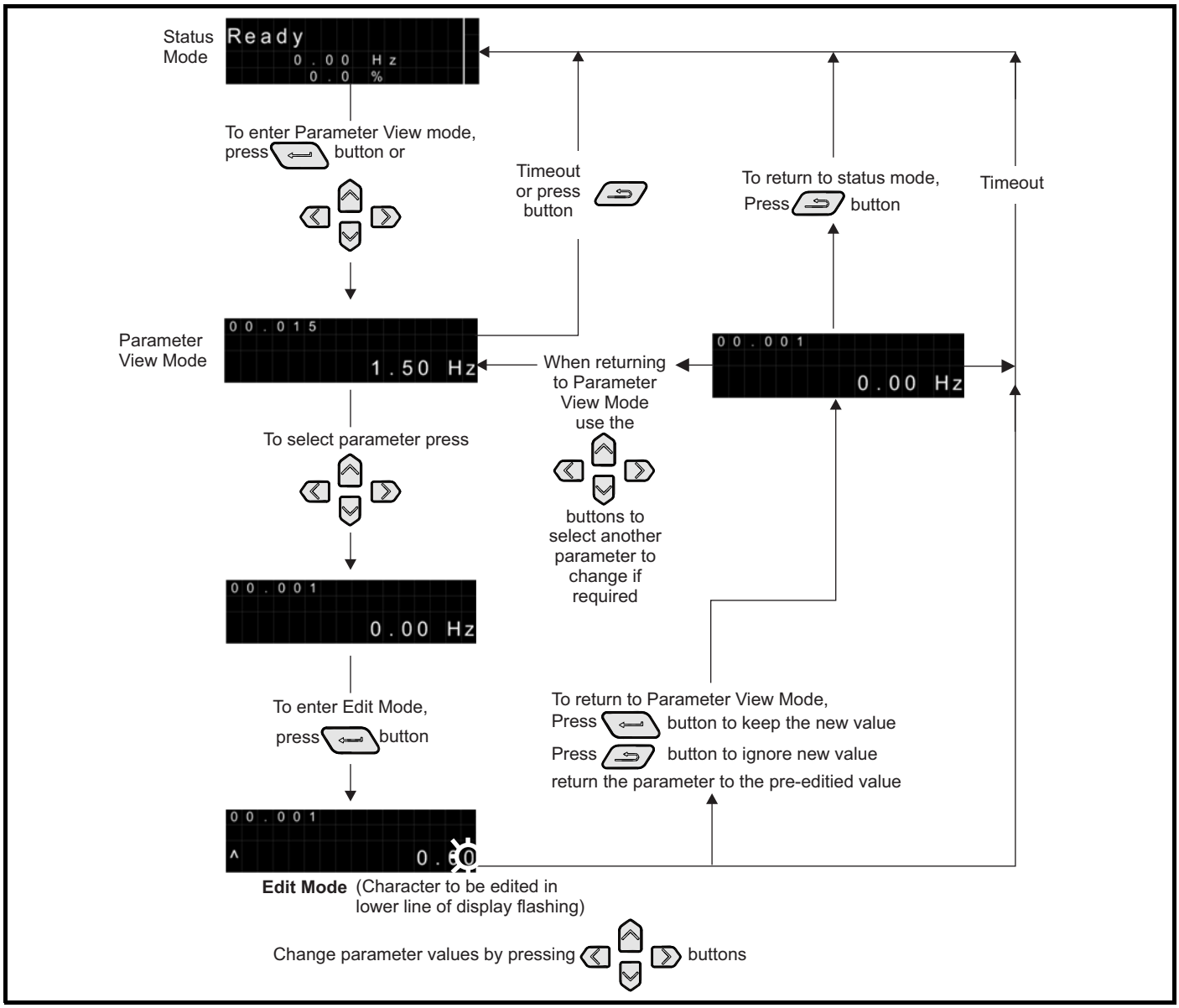
5.2 Keypad operation

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 change between parameter edit and view mode, as well as entering data.
- 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 button Used to provide a 'Run' command if keypad mode is selected.
- Stop / Reset button Used to reset the drive. In keypad mode can be used for 'Stop'.

Figure 5-2 Display modes



NOTE

The navigation buttons can only be used to move between menus if Pr **00.010** has been set to show 'All Menus'. Refer to section 5.8 *Parameter access level and security* on page 33.

NOTE

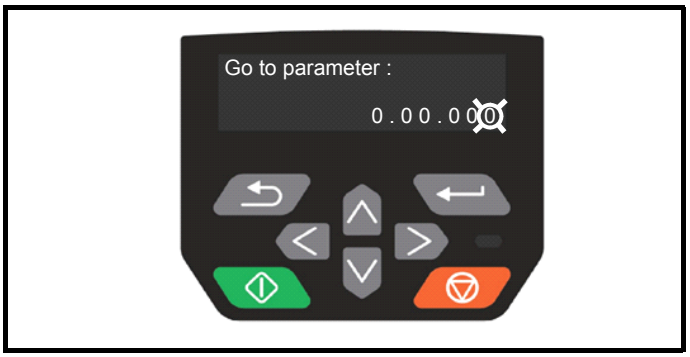
If the Escape button is held down for 1 second, the display returns to status mode.

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 view mode'.

Figure 5-3 Quick access mode



5.2.3 Keypad shortcuts

In 'parameter view 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, e.g. Pr **05.005** being viewed, when the above buttons pressed together will jump to Pr **05.000**.

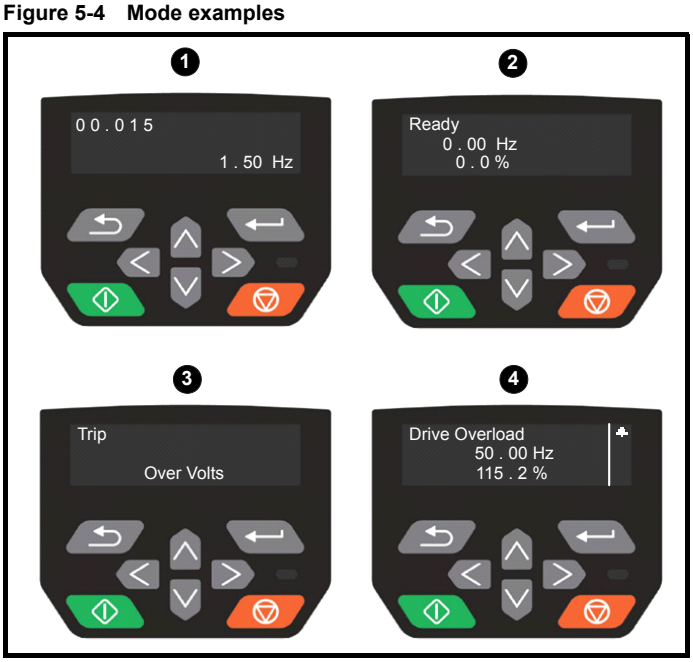
If the left and right keypad buttons are pressed together, then the keypad display will jump to the last viewed parameter in Menu 0.

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 12-2 *Trip indications* on page 139.

4. **Status mode: Alarm status**

During an 'alarm' condition the upper row of the display alternates 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

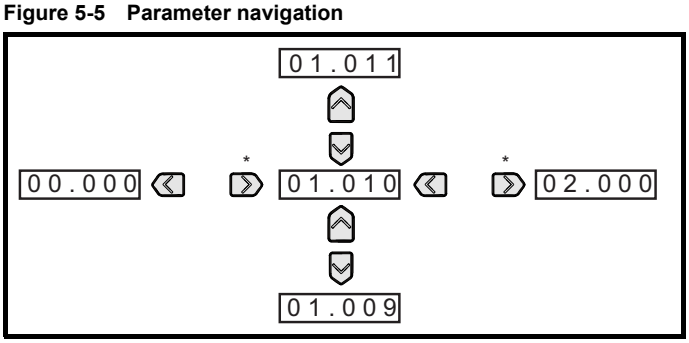
New parameter values must be saved to ensure that the new values apply after the drive has been power cycled. Refer to section 5.6 *Saving parameters* on page 33.

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 **00.010** has been set to 'All Menus', the left and right buttons are used to navigate between menus. For further information, refer to section 5.8 *Parameter access level and security* on page 33.

Figure 5-5 Parameter navigation



* Can only be used to move between menus if all menus have been enabled (Pr **00.010**). Refer to section 5.8 *Parameter access level and security* on page 33.

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.

5.3.1 CI-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 5-3 CI-Keypad set-up parameters

Parameters		Range	Type
Keypad.00	Language	English, French, German, Italian, Spanish and Chinese	RW
Keypad.01	Show Units	Off or On	RW
Keypad.02	Backlight Level	0 to 100 %	RW
Keypad.05	Show Raw Text Parameter Values	Off or On	RW
Keypad.06	Software Version	00.00.00.00 to 99.99.99.99	RO
Keypad.07	Language version	00.00.00.00 to 99.99.99.99	RO
Keypad.08	Font version	0 to 99	RO

NOTE

The languages available will depend on the keypad software version.

* Keypad.08 will depend on the keypad software version.

NOTE

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

5.4 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. Menus 0 to 30 can be viewed on the Keypad.

The option module menu (1.mm.ppp) is only displayed if the option module is installed. Where 1 signifies the option module slot number and the mm.ppp signifies the menu and parameter number of the option module's internal menus and parameters.

Table 5-4 Advanced menu descriptions

Menu	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Frequency reference
2	Ramps
3	Frequency control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	Analog I/O
8	Digital I/O
9	Programmable logic, motorized pot, binary sum, timers and scope
10	Status and trips
11	Drive set-up and identification, serial communications
12	Threshold detectors and variable selectors
14	User PID controller
15	Option module slot 1 set-up menu
18	General option module application menu 1
20	General option module application menu 2
21	Second motor parameters
22	Menu 0 set-up
24	Option module slot 1 application menu
30	Onboard user programming application menu
Slot 1	Slot 1 option menus*

* Only displayed when the option module is installed.

5.4.1 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 signals are not applied to the 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 frequency.	Enabled
Run	The drive is active and running.	Enabled
Supply Loss	Supply loss condition has been detected	Enabled
Deceleration	The motor is being decelerated to zero frequency because the final drive run has been deactivated.	Enabled
dc Injection	The drive is applying dc injection braking.	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled
Heat	The motor pre-heat function is active	Enabled

5.4.2 Alarm indications

An alarm is an indication given on the display by alternating the alarm string with the drive status string on the display. Alarms strings are not displayed when a parameter is being edited.

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 %.
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.
Option Slot 1	Option slot alarm.
Low AC	Low voltage mode. See *Low AC Alarm* (10.107).
Current Limit	Current limit active. See *Current Limit Active* (10.009).
24V Backup Lost	24V Backup not present. See *24V Alarm Loss Enable* (11.098)

5.5 Changing the operating mode

Procedure

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

1. Ensure the drive is not enabled, i.e. drive is in Inhibit or Under Voltage State.
2. Change the setting of Pr **00.079** as follows:

Pr **00.079** setting		Operating mode
00.079 ^ Open-loop	1	Open-loop
00.079 v RFC-A	2	RFC-A

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

NOTE

When the operating mode is changed, a parameter save is carried out.

3. Either:

Press the red reset button

Carry out a drive reset through serial communications by setting Pr **10.038** to 100.

5.6 Saving parameters

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

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

Procedure

1. Select 'Save parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**)
2. Either:

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

5.7 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drives memory. *User security status* (00.010) and *User security code* (00.025) are not affected by this procedure).

Procedure

1. Ensure the drive is not enabled, i.e. drive is in Inhibit or Under Voltage State.
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
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

5.8 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 30) 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 5-7.

Table 5-7 Parameter access level and security

User security status (00.010)	Access level	User security (00.025)	Menu 0 status	Advanced menu status
0	Menu 0	None	RW	Not visible
1	All Menus	None	RW	RW
2	Read-only Menu 0	Open	RW	Not visible
		Closed	RO	Not visible
3	Read-only	Open	RW	RW
		Closed	RO	RO
4	Status only	Open	RW	RW
		Closed	Not visible	Not visible
5	No access	Open	RW	RW
		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.

5.8.1 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* (00.010); these are shown in the table below.

User Security Status (Pr 00.010)	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 interface

5.8.2 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **00.010** or Pr **11.044**. The Security Level can be changed through the keypad even if the User Security Code has been set.

5.8.3 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 9999 in Pr **00.025** 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 **00.010**. 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 **00.025** 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 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, and the display will revert to parameter view mode.

Disabling User Security

Unlock the previously set security code as detailed above. Set Pr **00.025** 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.

5.9 Displaying parameters with non-default values only

By selecting 'Show non-default' in Pr **mm.000** (Alternatively, enter 12000 in Pr **mm.000**), the only parameters that will be visible to the user will be those containing a non-default value. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **mm.000** and select 'No action' (alternatively enter a value of 0). Please note that this function can be affected by the access level enabled, refer to section 5.8 *Parameter access level and security* on page 33 for further information regarding access level.

5.10 Displaying destination parameters only

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

Please note that this function can be affected by the access level enabled, refer to section 5.8 *Parameter access level and security* on page 33 for further information regarding access level.

5.11 Communications

Installing an AI-485 adaptor provides the drive with a 2 wire EIA 485 serial communications interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller as required.

5.11.1 EIA 485 Serial communications

Communication is via the RJ45 connector or screw terminals (parallel connection). The drive only supports Modbus RTU protocol.

The communications port applies a 1.25 unit load to the communications network.

USB to EIA 485 Communications

An external USB hardware interface such as a PC cannot be used directly with the 2-wire EIA485 interface of the drive. Therefore a suitable converter is required.

A suitable USB to EIA485 isolated converter is available from Control Techniques as follows:

- CT USB Comms cable (CT Part No. 4500-0096)

When using the above converter or any other suitable converter with the drive, it is recommended that no terminating resistors be connected on the network. It may be necessary to 'link out' the terminating resistor within the converter depending on which type is used. The information on how to link out the terminating resistor will normally be contained in the user information supplied with the converter.

Serial communications set-up parameters

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

Serial communications set-up parameters		
Serial Mode (11.024)	8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 1 EP (8), 7 1 OP (9), 7 1 EP M (10), 7 1 OP M (11)	The drive only supports the Modbus RTU protocol and is always a slave. This parameter defines the supported data formats used by the EIA 485 comms port (if installed) on the drive. This parameter can be changed via the drive keypad, via a option module or via the comms interface itself.
Serial Baud Rate (00.043)	600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600(8), 76800(9), 115200 (10)	This parameter can be changed via the drive keypad, via a option module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20 ms before sending a new message using the new baud rate.
Serial Address (00.044)	1 to 247	This parameter defines the serial address and an addresses between 1 and 247 are permitted.
Reset Serial Communications (00.045)	Off (0) or On (1)	When the above parameters are modified the changes do not have an immediate effect on the serial communication system. The new values are used after the next power up or if Reset Serial Communications is set to 1.

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

Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum value 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

For more information please see section 11.1 *Parameter ranges and Variable minimum/maximums:* on page 76.

6.1 Menu 0: Basic parameters

Parameter			Range(⇳)		Default(⇨)		Type					
			OL	RFC-A	OL	RFC-A						
00.001	Minimum Reference Clamp	**{01.007}**	VM_NEGATIVE_REF_CLAMP1 Hz		0.00 Hz		RW	Num				US
00.002	Maximum Reference Clamp	**{01.006}**	± 500.00 Hz		50 Hz default: 50.00 Hz 60 Hz default: 60.00 Hz		RW	Num				US
00.003	Acceleration Rate 1	**{02.011}**	0.0 to VM_ACCEL_RATE s/100 Hz		5.0 s/100 Hz		RW	Num				US
00.004	Deceleration Rate 1	**{02.021}**	0.0 to VM_ACCEL_RATE s/100 Hz		10.0 s/100 Hz		RW	Num				US
00.005	Drive Configuration	**{11.034}**	AV (0), AI (1), AV Preset (2), AI Preset (3), Preset (4), Keypad (5), Keypad Ref (6), Electronic Pot (7), Torque Control (8), Pid Control (9)		AV (0)		RW	Txt			PT	US
00.006	Motor Rated Current	**{05.007}**	0.00 to VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032) A		RW	Num		RA		US
00.007	Motor Rated Speed	**{05.008}**	0.0 to 33000.0 rpm		50 Hz default: 1500.0 rpm 60 Hz default: 1800.0 rpm	50 Hz default: 1450.0 rpm 60 Hz default: 1750.0 rpm	RW	Num				US
00.008	Motor Rated Voltage	**{05.009}**	0 to VM_AC_VOLTAGE_SET V		110 V drive: 230 V 200 V drive: 230 V 400 V drive 50 Hz: 400 V 400 V drive 60 Hz: 460 V 575 V drive: 575 V 690 V drive: 690 V		RW	Num		RA		US
00.009	Motor Rated Power Factor*	**{05.010}**	0.00 to 1.00		0.85		RW	Num		RA		US
00.010	User Security Status	**{11.044}**	Menu 0 (0), All Menus (1), Read only Menu 0 (2), Read only (3), Status Only (4), No Access (5)		Menu 0 (0)		RW	Txt	ND	NC	PT	
00.012	Input Logic Polarity	**{08.010}**	Negative Logic (0) or Positive Logic (1)		Positive Logic (1)		RW	Txt				US
00.015	Jog Reference	**{01.005}**	0.00 to 300.00 Hz		1.50 Hz		RW	Num				US
00.016	Analog Input 1 Mode	**{07.007}**	4-20 mA Stop (-6), 20-4 mA Stop (-5), 4-20 mA Low (-4), 20-4 mA Low (-3), 4-20 mA Hold (-2), 20-4 mA Hold (-1), 0-20 mA (0), 20-0 mA (1), 4-20 mA Trp (2), 20-4 mA Trp (3), 4-20 mA (4), 20-4 mA (5), Voltage (6)		Voltage (6)		RW	Txt				US
00.017	Bipolar Reference Enable	**{01.010}**	Off (0) or On (1)		Off (0)		RW	Bit				US
00.018	Preset Reference 1	**{01.021}**	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
00.025	User Security Code	**{11.030}**	0 to 9999		0		RW	Num	ND	NC	PT	US
00.027	Power-up Keypad Control Mode Reference	**{01.051}**	Reset (0), Last (1), Preset (2)		Reset (0)		RW	Txt				US
00.028	Ramp Mode Select	**{02.004}**	Fast (0), Standard (1), Std boost (2), Fast boost (3)		Standard (1)		RW	Txt				US
00.029	Ramp Enable	**{02.002}**		Off (0) or On (1)		On (1)	RW	Bit				US
00.030	Parameter Cloning	**{11.042}**	None (0), Read (1), Program (2), Auto (3), Boot (4)		None (0)		RW	Txt		NC		US
00.031	Stop Mode	**{06.001}**	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5)	Coast (0), Ramp (1), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5), No Ramp (6)	Ramp (1)		RW	Txt				US
00.032	Dynamic V to F Select	**{05.013}**	0 to 1		0		RW	Num				US
	Flux Optimisation Select	**{05.013}**		0 to 1		0	RW	Num				US
00.033	Catch A Spinning Motor	**{06.009}**	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)		RW	Txt				US
00.034	Digital Input 5 Select	**{08.035}**	Input (0), Therm Short Cct (1), Thermistor (2), Therm No Trip (3)		Input (0)		RW	Txt				US
00.035	Digital Output 1 Control	**{08.091}**	0 to 21		0		RW					US
00.036	Analog Output 1 Control	**{07.055}**	0 to 15		0		RW					US
00.037	Maximum Switching Frequency	**{05.018}**	0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz	2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz	3 (3) kHz		RW	Txt				US
00.038	Auto-tune	**{05.012}**	0 to 2	0 to 3	0		RW	Num		NC		US

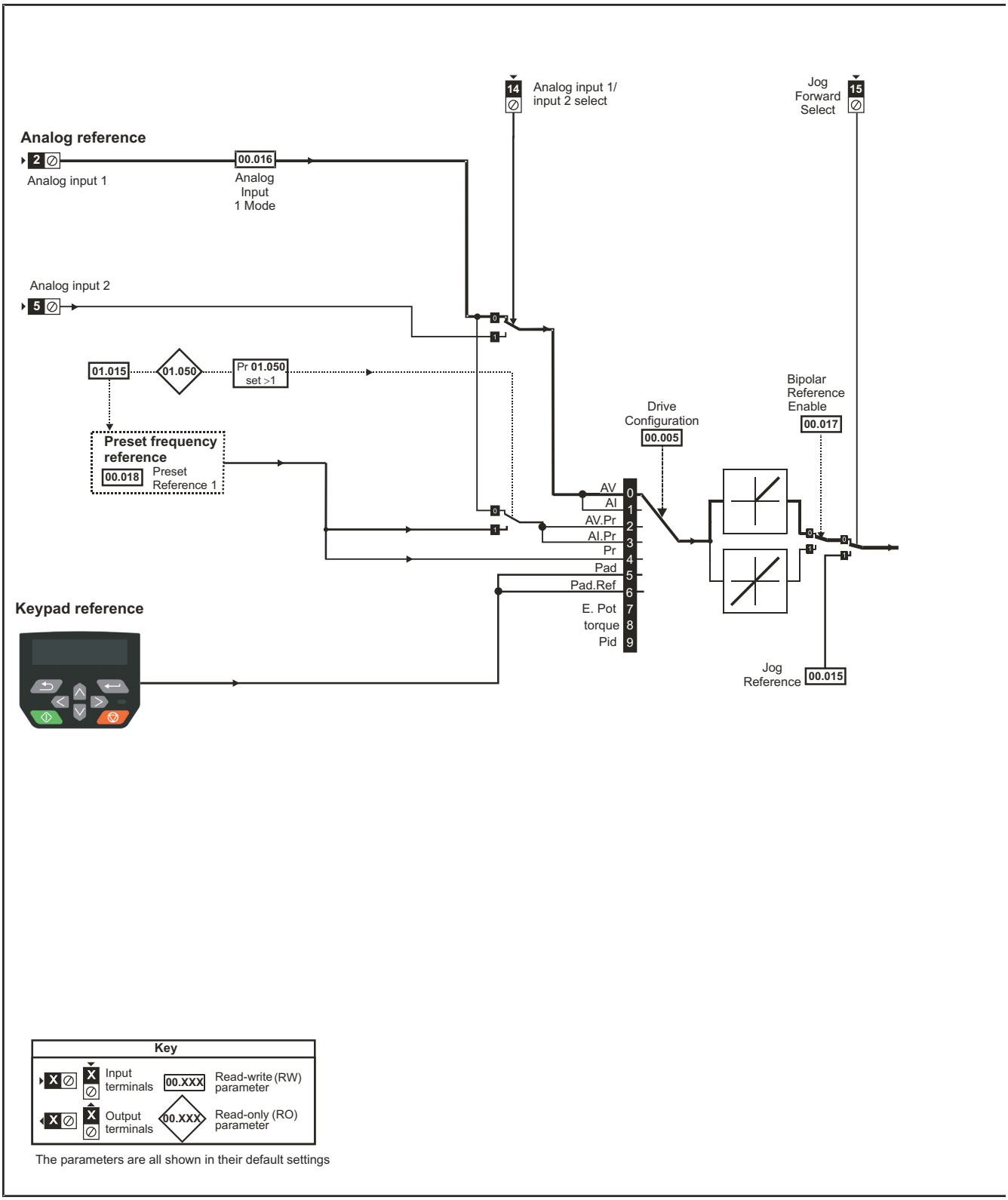
Parameter			Range(⇳)		Default(⇨)		Type					
			OL	RFC-A	OL	RFC-A						
00.039	Motor Rated Frequency	**{05.006}**	0.00 to 550.00 Hz		50Hz: 50.00 Hz 60Hz: 60.00 Hz		RW	Num		RA		US
00.040	Number of Motor Poles**	**{05.011}**	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				US
00.041	Control Mode	**{05.014}**	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Fixed Tapered (6)		Ur I (4)		RW	Txt				US
00.042	Low Frequency Voltage Boost	**{05.015}**	0.0 to 25.0 %		3.0 %		RW	Num				US
00.043	Serial Baud Rate	**{11.025}**	600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)		19200 (6)		RW	Txt				US
00.044	Serial Address	**{11.023}**	1 to 247		1		RW	Num				US
00.045	Reset Serial Communications	**{11.020}**	Off (0) or On (1)		Off (0)		RW	Bit	ND	NC		
00.046	Brake Controller: Upper Current Threshold	**{12.042}**	0 to 200 %		50 %		RW	Num				US
00.047	Brake Controller: Lower Current Threshold	**{12.043}**	0 to 200 %		10 %		RW	Num				US
00.048	BC Brake Release Frequency	**{12.044}**	0.00 to 20.00 Hz		1.00 Hz		RW	Num				US
00.049	BC Brake Apply Frequency	**{12.045}**	0.00 to 20.00 Hz		2.00 Hz		RW	Num				US
00.050	BC Brake Delay	**{12.046}**	0.0 to 25.0 s		1.0 s		RW	Num				US
00.051	BC Post-brake Release Delay	**{12.047}**	0.0 to 25.0 s		1.0 s		RW	Num				US
00.053	BC Initial Direction	**{12.050}**	Ref (0), Forward (1), Reverse (2)		Ref (0)		RW	Txt				US
00.054	BC Brake Apply Through Zero Threshold	**{12.051}**	0.00 to 25.00 Hz		1.00 Hz		RW	Num				US
00.055	BC Enable	**{12.041}**	Disable (0), Relay (1), Digital IO (2), User (3)		Disable (0)		RW	Txt				US
00.059	OUP Enable	**{11.047}**	Stop (0) or Run (1)		Run (1)		RW	Txt				US
00.065	Frequency Controller Proportional Gain Kp1	**{03.010}**		0.000 to 200.000 s/rad		0.100 s/rad	RW	Num				US
00.066	Frequency Controller Integral Gain Ki1	**{03.011}**		0.00 to 655.35 s^2/rad		0.10 s^2/rad	RW	Num				US
00.067	Sensorless Mode Filter	**{03.079}**		4 (0), 5 (1), 6 (2), 8 (3), 12 (4), 20 (5) ms		4 (0) ms	RW	Txt				US
00.069	Spin Start Boost	**{05.040}**	0.0 to 10.0		1.0		RW	Num				US
00.076	Action on Trip Detection	**{10.037}**	00000 to 11111		00000		RW	Bin				US
00.077	Maximum Heavy Duty Current Rating	**{11.032}**	0.00 to 9999.99 A				RO	Num	ND	NC	PT	
00.078	Software Version	**{11.029}**	00.00.00.00 to 99.99.99.99				RO	Num	ND	NC	PT	
00.079	User Drive Mode	**{11.031}**	Open loop (1), RFC A (2)		Open-loop (1)		RW	Txt	ND	NC	PT	US

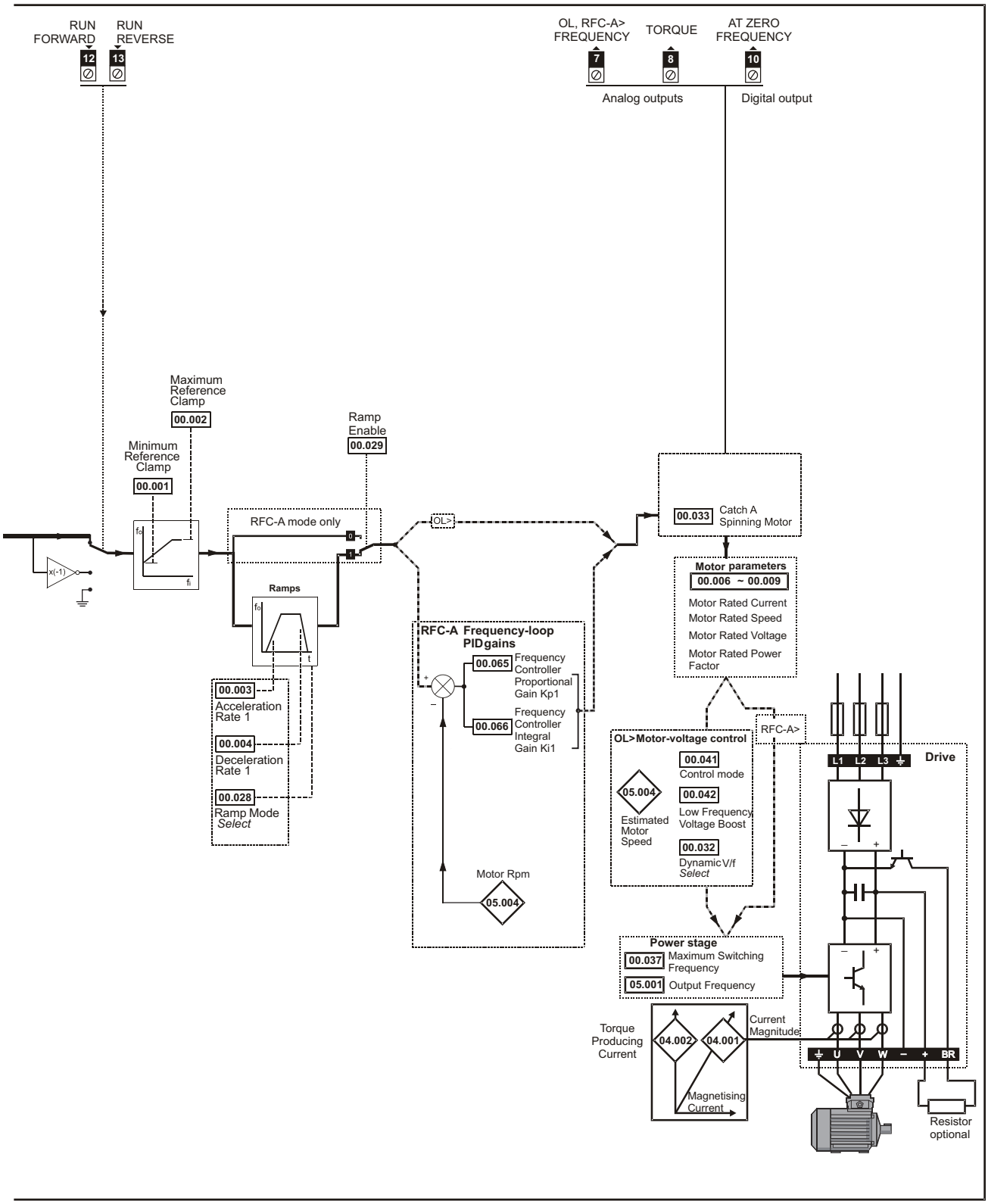
* Following a rotating autotune Pr **00.009** {05.010} is continuously written by the drive, calculated from the value of *Stator Inductance* (Pr **05.025**). To manually enter a value into Pr **00.009** {05.010}, Pr **05.025** will need to be set to 0. Please refer to the description of Pr **05.010** in the *Parameter Reference Guide* for further details.

** If this parameter is read via serial communications, it will show pole pairs.

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

Figure 6-1 Menu 0 logic diagram




RUN FORWARD
12
RUN REVERSE
13
OL, RFC-A> FREQUENCY
7
TORQUE
8
AT ZERO FREQUENCY
10
Analog outputs
Digital output
Maximum Reference Clamp
00.002
Minimum Reference Clamp
00.001
Ramp Enable
00.029
RFC-A mode only
OL>
00.033
Catch A Spinning Motor
Motor parameters
00.006 ~ 00.009
Motor Rated Current
Motor Rated Speed
Motor Rated Voltage
Motor Rated Power Factor
Ramps
00.003
Acceleration Rate 1
00.004
Deceleration Rate 1
00.028
Ramp Mode Select
RFC-A Frequency-loop PID gains
00.065
Frequency Controller Proportional Gain Kp1
00.066
Frequency Controller Integral Gain Ki1
Motor Rpm
05.004
OL>Motor-voltage control
00.041
Control mode
05.004
Estimated Motor Speed
00.042
Low Frequency Voltage Boost
00.032
Dynamic V/f Select
RFC-A>
Drive
L1 L2 L3
Power stage
00.037
Maximum Switching Frequency
05.001
Output Frequency
Torque Producing Current
04.002
04.001
Current Magnitude
Magnetising Current
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 4001 in Pr **mm.000** to store drive parameters on an NV media card.

Table 6-1 Commonly used functions in xx.000

Value	Equivalent value	String	Action
0	0	**No Action**	No action
1001	1	**Save Parameters**	Save drive parameters to non-volatile memory
6001	2	**Load file 1**	Load the data from file 1 on a non-volatile media card into the drive provided it is a parameter file
4001	3	**Save to file 1**	Store the drive parameters in file 1 on a non-volatile media card
6002	4	**Load file 2**	Load the data from file 2 on a non-volatile media card into the drive provided it is a parameter file
4002	5	**Save to file 2**	Store the drive parameters in file 2 on a non-volatile media card
6003	6	**Load file 3**	Load the data from file 3 on a non-volatile media card into the drive provided it is a parameter file
4003	7	**Save to file 3**	Store the drive parameters in file 3 on a non-volatile media card
12000	8	**Show non-default**	Only display parameters that are different from their default value
12001	9	**Destinations**	Only display parameters that are used to set-up destinations
1233	10	**Reset 50 Hz defs**	Load 50 Hz defaults
1244	11	**Reset 60 Hz defs**	Load 60 Hz defaults
1070	12	**Reset modules**	Reset option module

Table 6-2 Functions in Pr mm.000

Value	Action
1000	Save parameters when *Under Voltage Active* (Pr **10.016**) is not active.
1001	Save parameters under all conditions
1070	Reset option module
1233	Load standard (50 Hz) defaults
1234	Load standard (50 Hz) defaults to all menus except option module menu 15
1244	Load US (60 Hz) defaults
1245	Load US (60 Hz) defaults to all menus except option module menu 15
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 yyy
5yyy	NV media card: Transfer the onboard user program to onboard user program file yyy
59999**	Delete onboard user program
6yyy*	NV media card: Load the drive parameters from parameter file yyy or the onboard user program from onboard user program file yyy
7yyy*	NV media card: Erase file yyy
8yyy*	NV Media card: Compare the data in the drive with file yyy
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
12000***	Only display parameters that are different from their default value. This action does not require a drive reset.
12001***	Only display parameters that are used to set-up destinations (i.e. DE format bit is 1). This action does not require a drive reset.

* See Chapter 9 *NV Media Card Operation* on page 67 for more information on these functions.
** Program cannot be deleted if the drive is active or if the user program is running.

*** These functions do not require a drive reset to become active.
All other functions require a drive reset to initiate the function. Equivalent values and strings are also provided in the table above.

6.3 Control terminal configurations and wiring

00.005		Drive Configuration							
RW		Txt						PT	US
OL	⇳	AV (0), AI (1), AV Preset (2), AI Preset (3), Preset (4), Keypad (5), Keypad Ref (6), Electronic Pot (7), Torque Control (8), Pid Control (9)	⇨	AV (0)					
RFC-A									

Table 6-3 Parameter changes when drive configuration is changed

Parameter number	Description	Drive Configuration									
		AV	**AI**	**AV Preset**	**AI Preset**	**Preset**	**Keypad**	**Keypad Ref**	**Electronic Pot**	**Torque Control**	**Pid Control**
01.014	Reference select	0	0	1	1	3	4	6	3	0	1
06.004	Start/stop logic	5	5	5	5	5	5	5	5	5	5
07.007	Analog input 1 mode	6	4	6	4	6	6	6	6	4	4
07.010	Analog input 1 destination	01.036	01.036	01.036	01.036	01.036	01.036	01.036	01.036	01.036	0.000
07.011	Analog input 2 mode	6	6	7	7	7	6	6	7	6	6
07.014	Analog input 2 destination	01.037	01.037	01.046	01.046	01.046	01.037	01.037	09.027	04.008	0.000
07.051	Analog input 1 control	0	0	0	0	0	0	0	0	0	0
07.052	Analog input 2 control	0	0	0	0	0	0	0	0	0	0
08.022	Digital input 2 destination	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
08.025	Digital input 5 destination	01.041	01.041	01.045	01.045	01.045	01.041	01.041	09.026	04.011	14.008
08.085	DI 5 Control	0	0	0	0	0	0	0	0	0	0
09.025	Motorized pot destination	0.000	0.000	0.000	0.000	0.000	0.000	0.000	01.021	0.000	0.000
14.003	PID 1 reference source	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	07.002
14.004	PID 1 feedback source	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	07.001
14.016	PID 1 destination	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	01.036

The setting of Pr **00.005** automatically sets the drive configuration

Value	Text	Description
0	AV	Analog input 1 (voltage) Analog input 2 (voltage) selected by terminal (Local/Remote)
1	AI	Analog input 1 (current) or Analog input 2 (voltage) selected by terminal (Local/Remote)
2	AV Preset	Analog input 1 (voltage) or 3 presets selected by terminal
3	AI Preset	Analog input 1 (current) or 3 presets selected by terminal
4	Preset	Four presets selected by terminal
5	Keypad	Keypad reference
6	Keypad Ref	Keypad reference with terminal control
7	Electronic Pot	Electronic Potentiometer
8	Torque Control	Torque mode, Analog input 1 (current frequency reference) or Analog input 2 (voltage torque reference) selected by terminal
9	Pid Control	PID mode, Analog input 1 (current feedback source) and Analog input 2 (voltage reference source)

Action will only occur if the drive is inactive, and no User Actions are running. Otherwise, the parameter will return to its pre altered value on exit from edit mode. All parameters are saved if this parameter changes.

Figure 6-2 Pr 00.005 = AV (50 and 60 Hz)

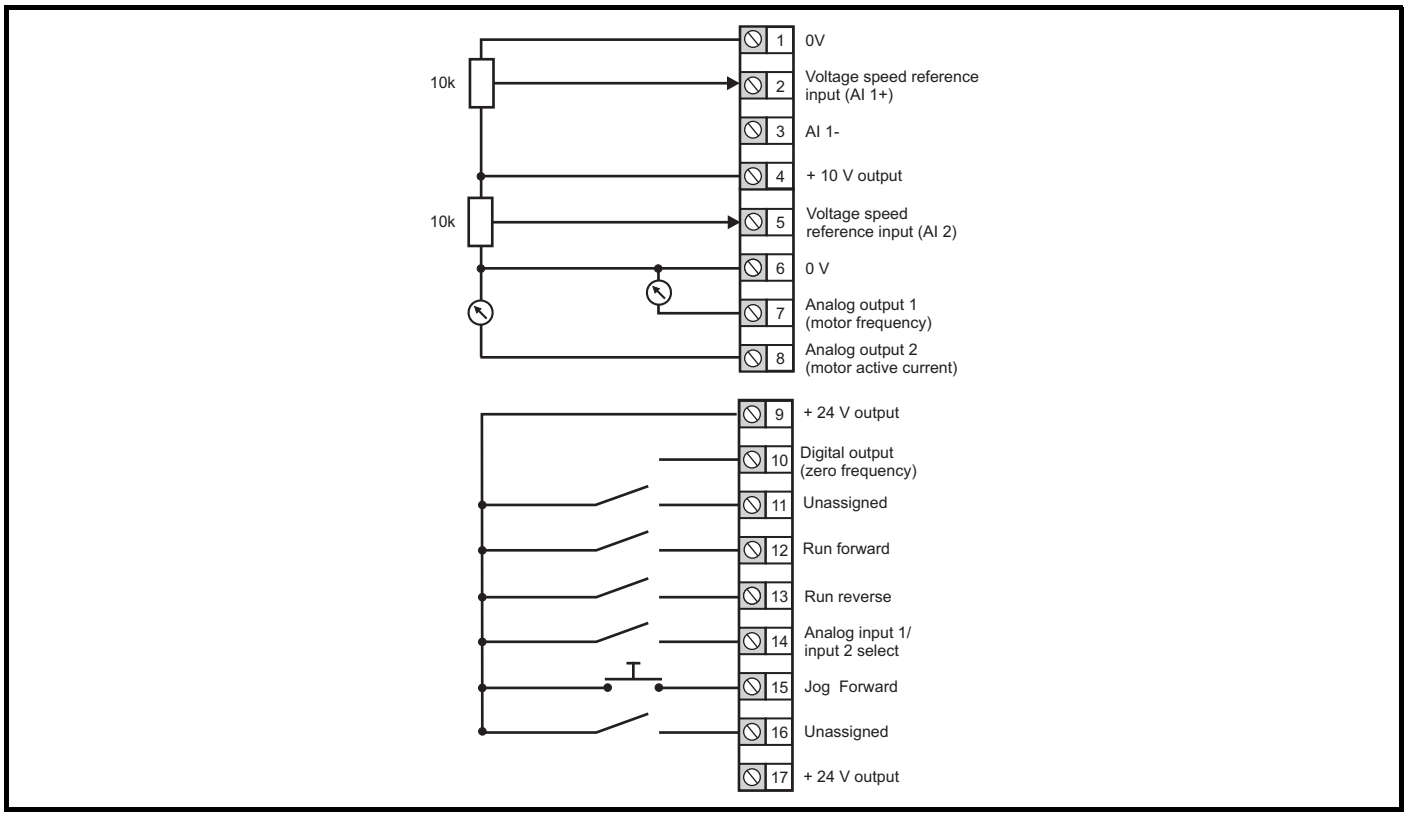


Figure 6-3 Pr 00.005 = AI (50 and 60 Hz)

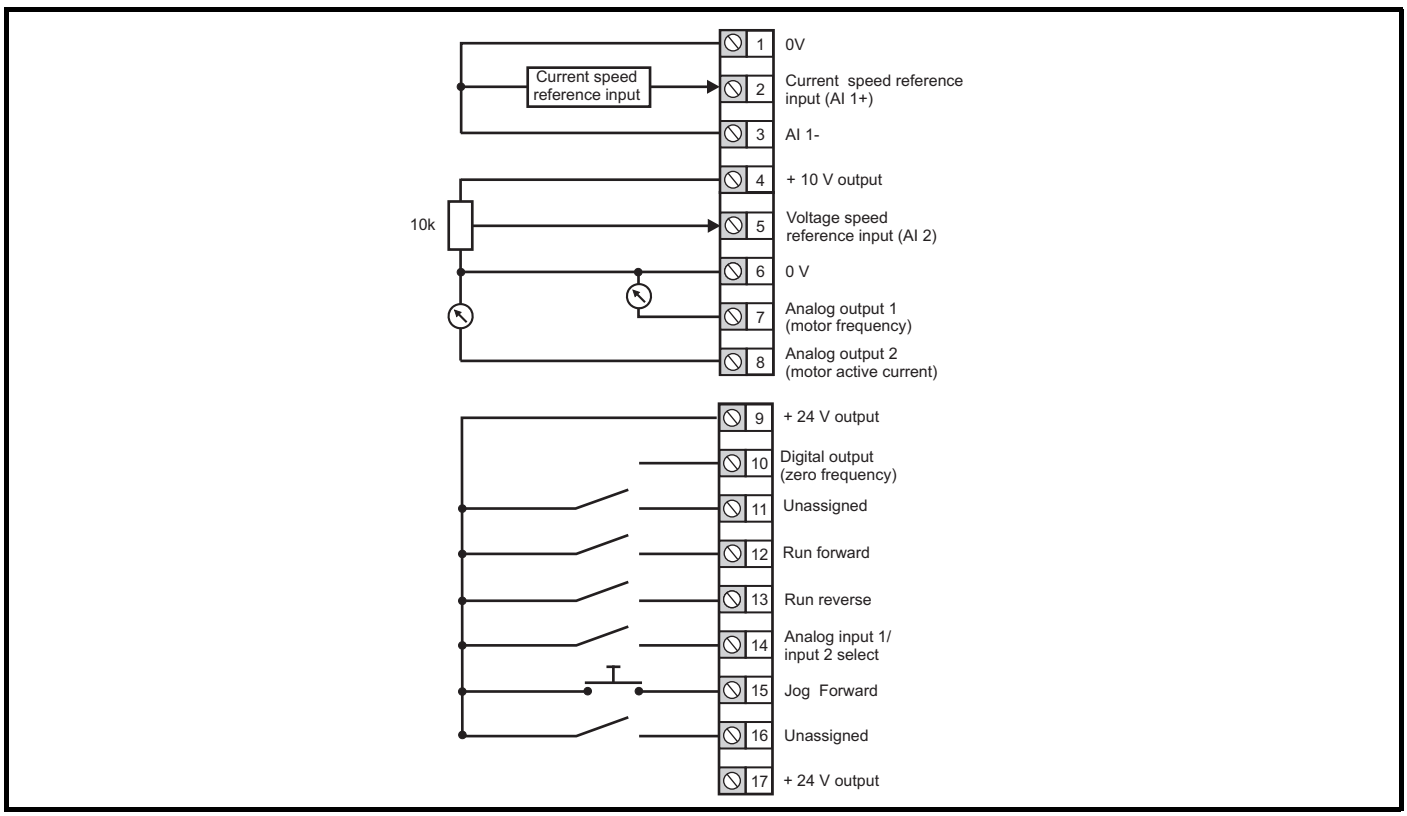
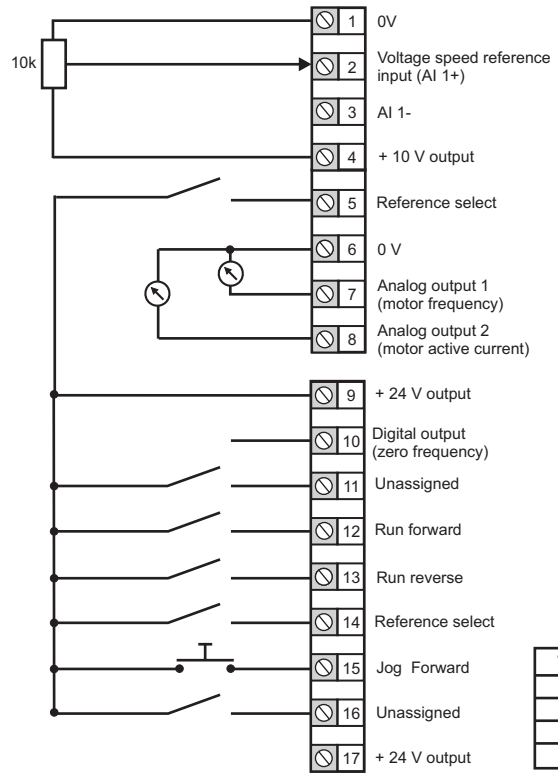
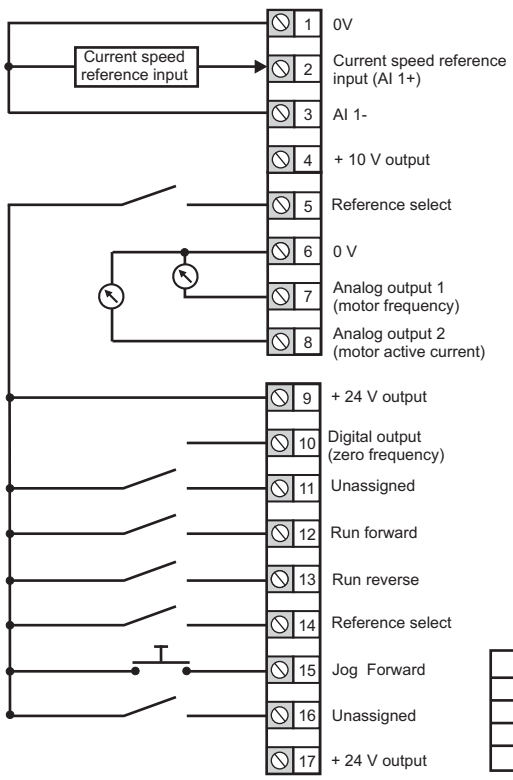


Figure 6-4 Pr 00.005 = AV Preset (50 and 60 Hz)



Terminal 5	Terminal 14	Reference selected
0	0	Analog reference 1*
0	1	Preset speed 2*
1	0	Preset speed 3*
1	1	Preset speed 4*

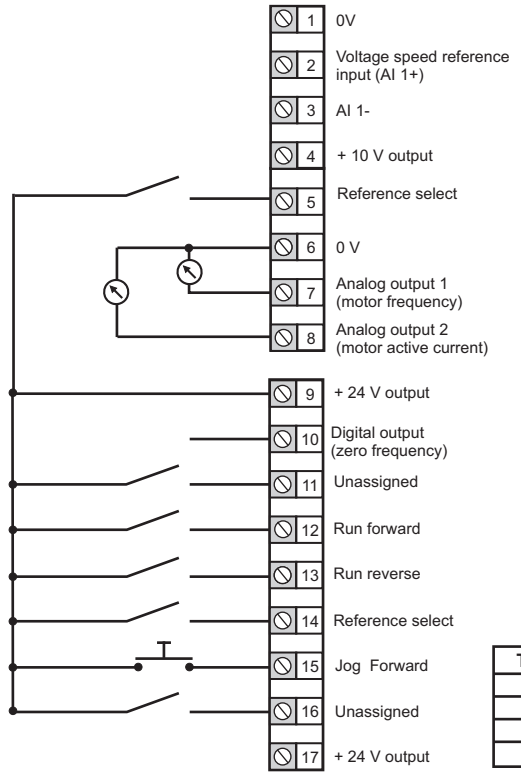
Figure 6-5 Pr 00.005 = AI Preset (50 and 60 Hz)



Terminal 5	Terminal 14	Reference selected
0	0	Analog reference 1*
0	1	Preset speed 2*
1	0	Preset speed 3*
1	1	Preset speed 4*

* Refer to section 11.2 *Menu 1: Frequency reference* on page 82.

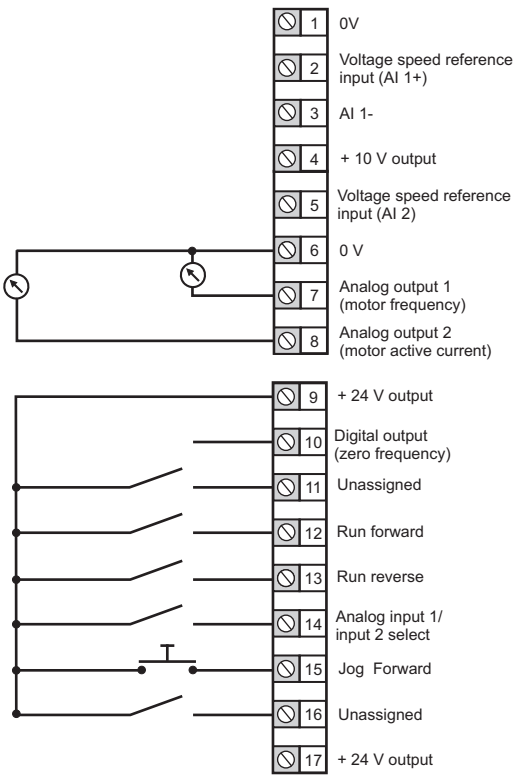
Figure 6-6 Pr 00.005 = Preset (50 and 60 Hz)



Terminal 5	Terminal 14	Reference selected
0	0	Preset speed 1*
0	1	Preset speed 2*
1	0	Preset speed 3*
1	1	Preset speed 4*

* Refer to section 11.2 *Menu 1: Frequency reference* on page 82.

Figure 6-7 Pr 00.005 = Keypad (50 and 60 Hz)



When Pr **00.005** is set to Keypad, to run in reverse:

- Set Pr **00.017** to On

The Keypad reference can now be set to a negative frequency to run the motor in the reverse direction.

Figure 6-8 Pr 00.005 = Keypad Ref (50 and 60 Hz)

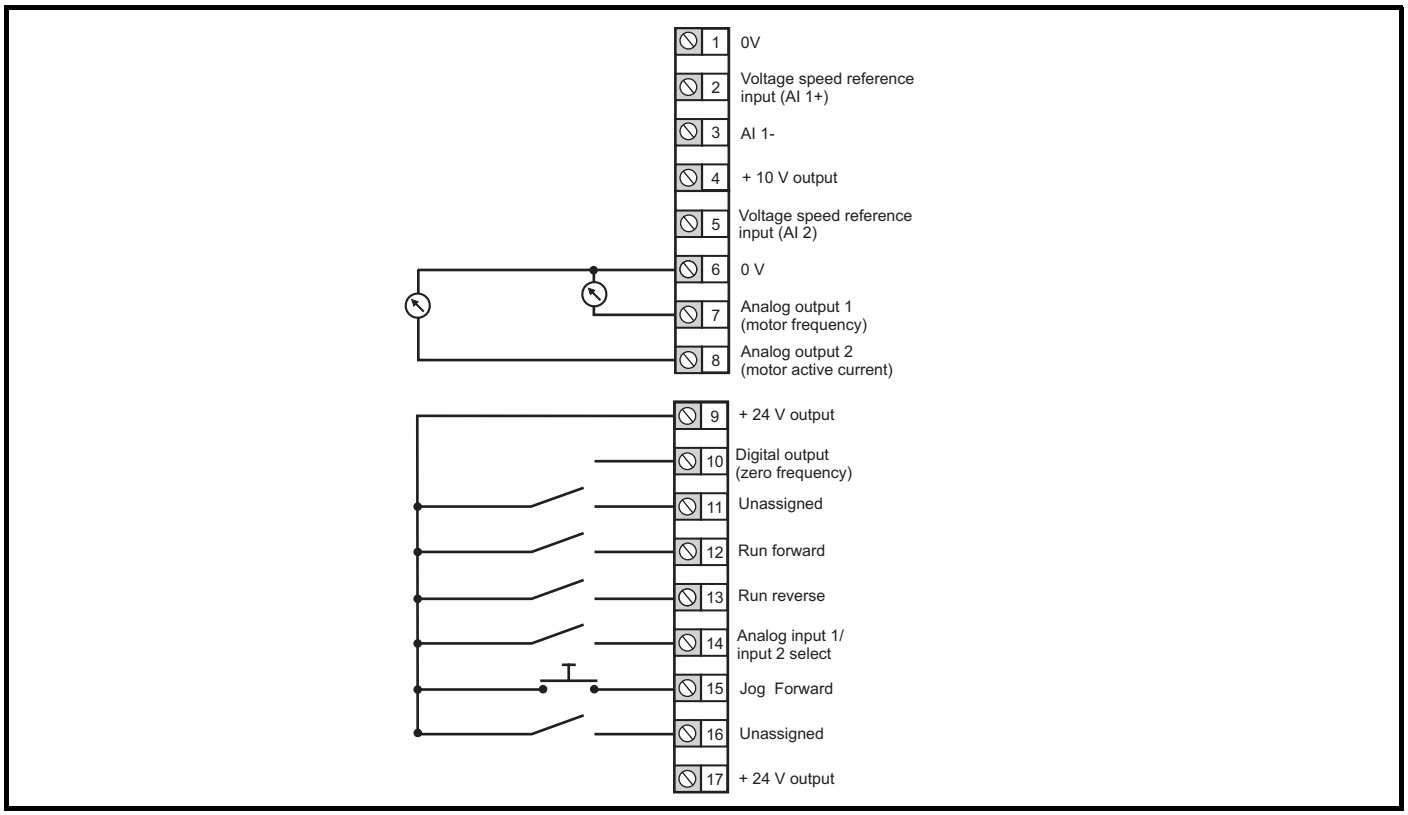
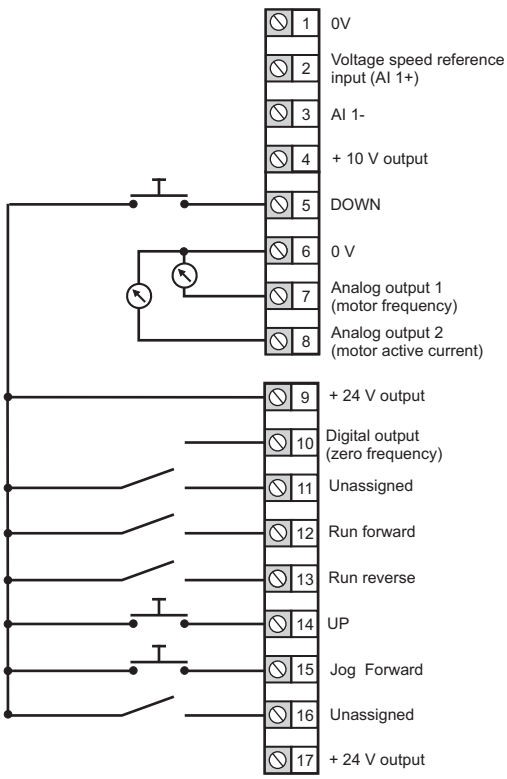


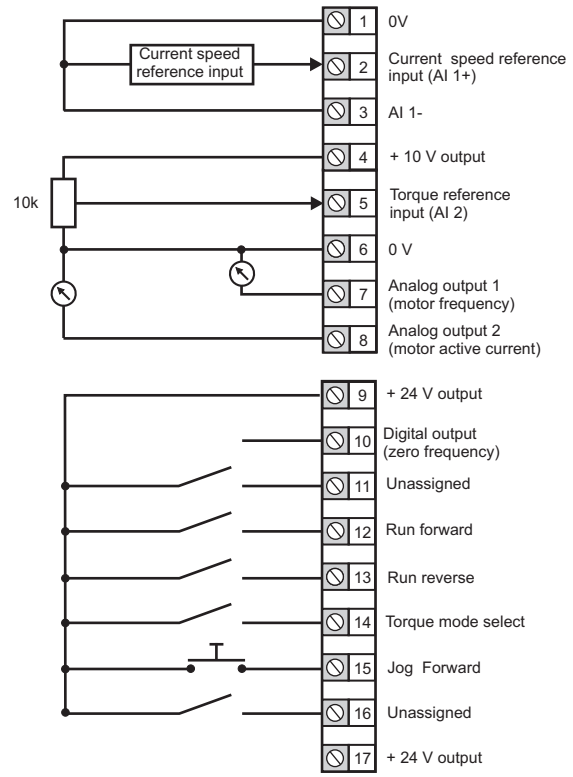
Figure 6-9 Pr 00.005 = Electronic Pot (50 and 60 Hz)



When Pr **00.005** is set to Electronic Pot, the following parameters may need to be adjusted:

- Pr **09.023**: Motorized pot up/down rate (s/100 %)
- Pr **09.022**: Motorized pot bipolar select (0 = unipolar, 1 = bipolar)
- Pr **09.021**: Motorized pot mode: 0 = zero at power-up, 1 = last value at power-up, 2 = zero at power-up and only change when drive is running,
  3 = last value at power-up and only change when drive is running, 4 = zero at power-up and drive disabled, only change when drive is running.

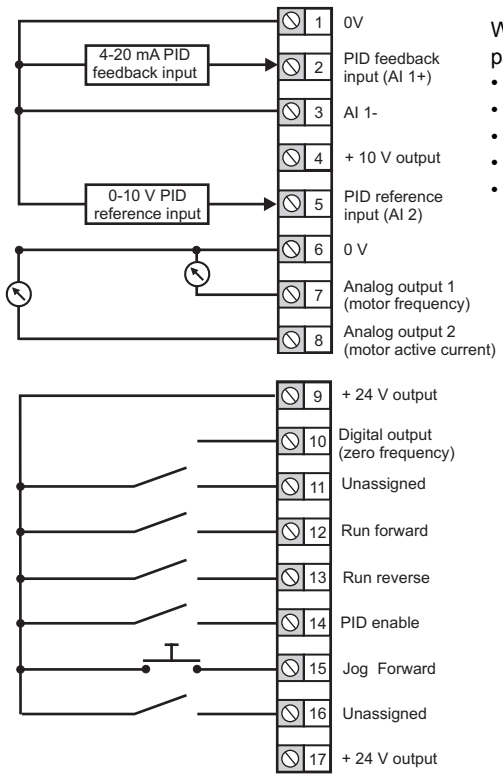
Figure 6-10 Pr 00.005 = Torque Control (50 and 60 Hz)



WARNING

When torque mode is selected and the drive is connected to an unloaded motor, the motor speed may increase rapidly to the maximum speed (Pr **00.002** +10 %)

Figure 6-11 Pr 00.005 = PID Control (50 and 60 Hz)



When Pr **00.005** is set to Pid, the following parameters may need to be adjusted:

- Pr **14.010**: PID proportional gain*
- Pr **14.011**: PID integral gain*
- Pr **14.006**: PID feedback invert*
- Pr **14.013**: PID output upper limit (%)*
- Pr **14.014**: PID output lower limit (%)*

* Refer to section 11.14 *Menu 14: User PID controller* on page 128.

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 54*.

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 **00.006** *Motor 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 52.

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
Serial communications	Drive enable Serial communications link

7.2 Changing the operating mode

Procedure

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

1. Ensure the drive is not enabled, i.e. drive is in Inhibit or Under Voltage State.
2. Change the setting of **Pr 00.079** as follows:

Pr **00.079** setting		Operating mode
00.079 ^ Open-loop	1	Open-loop
00.079 v RFC-A	2	RFC-A

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

3. Either:

- Press the red  reset button
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100.

NOTE

When the operating mode is changed, a parameter save is carried out.

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

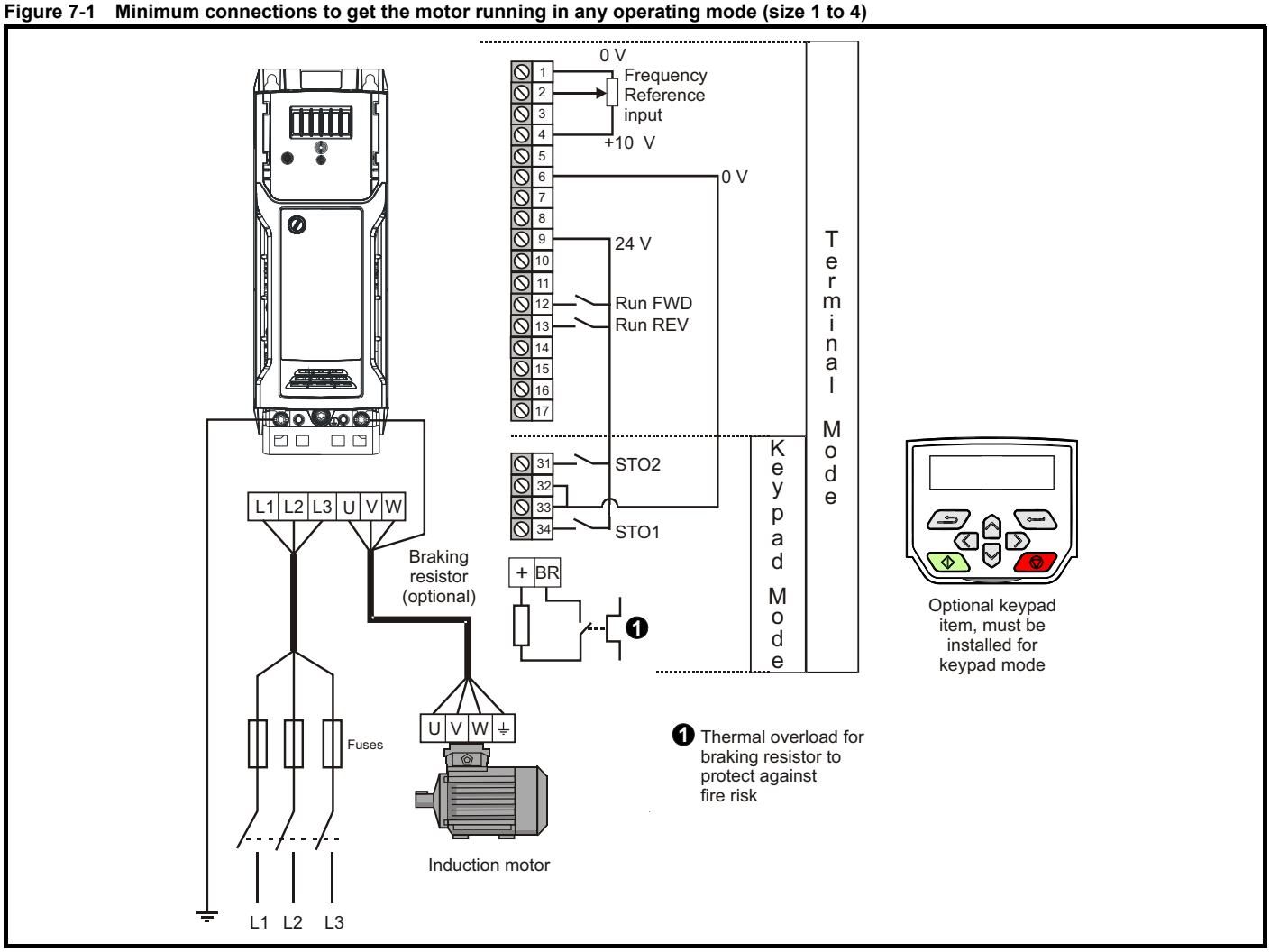


Figure 7-2 Minimum connections required to get the motor running in any mode (size 5)

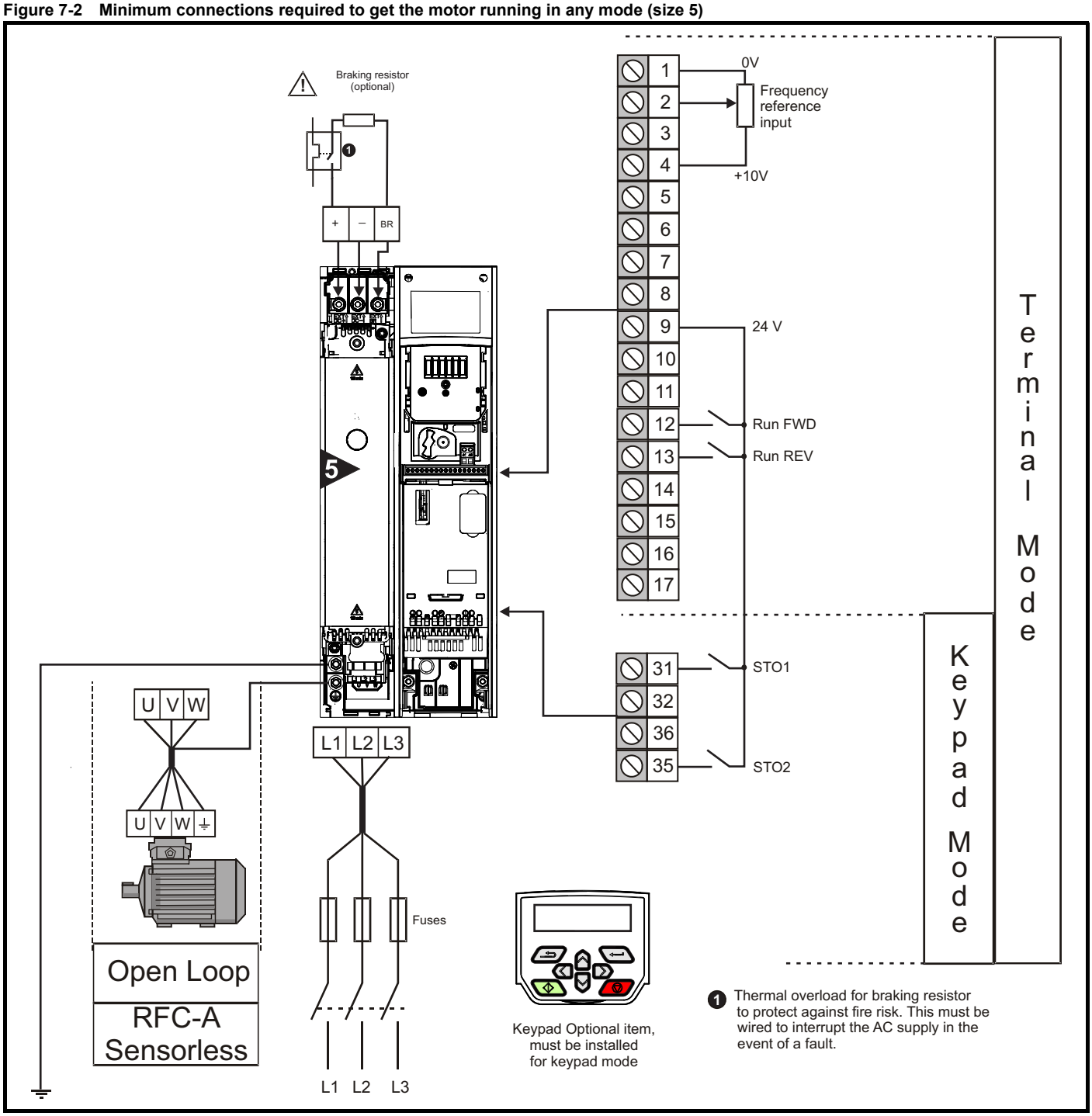


Figure 7-3 Minimum connections required to get the motor running in any operating mode (size 6)

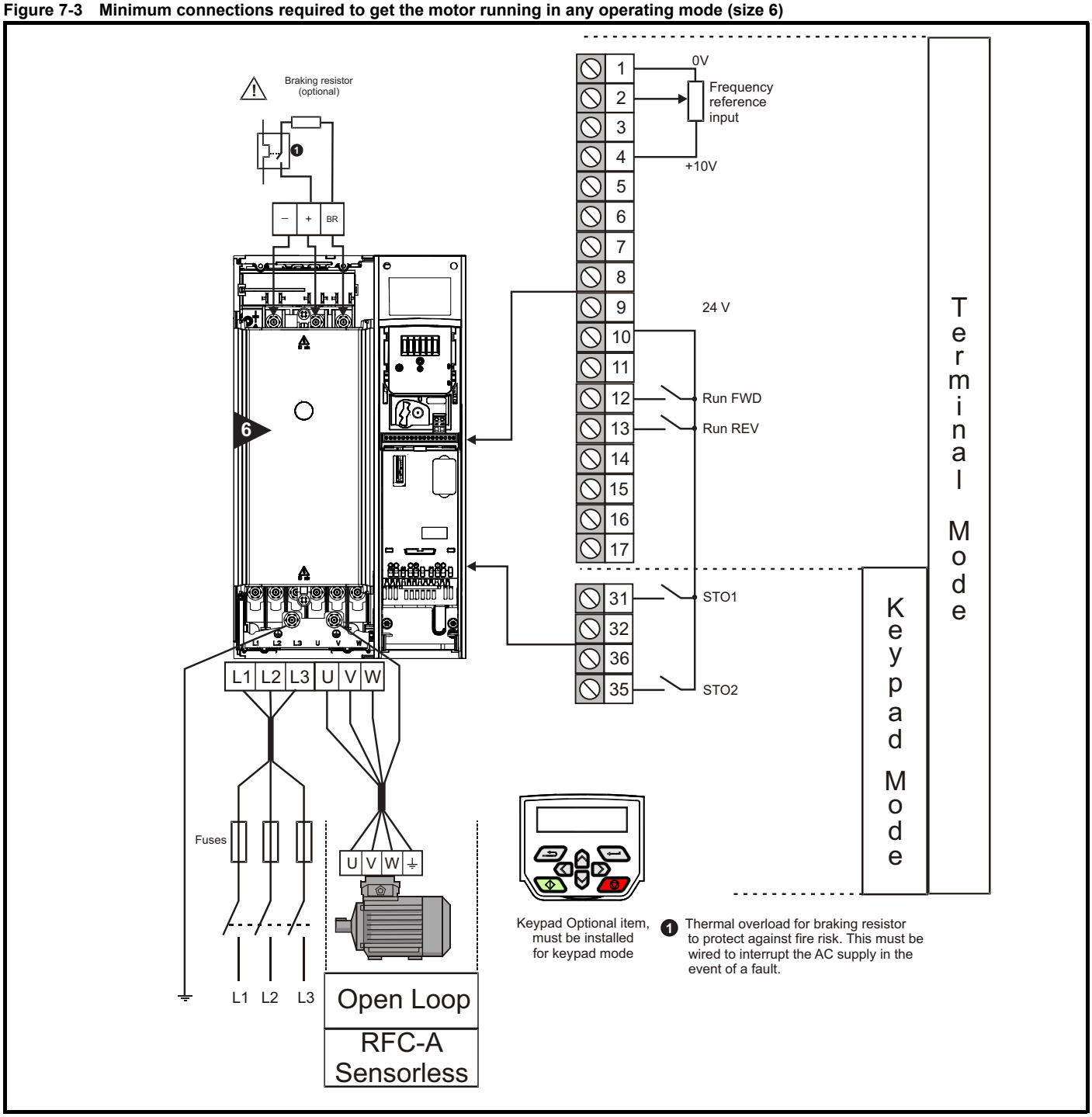
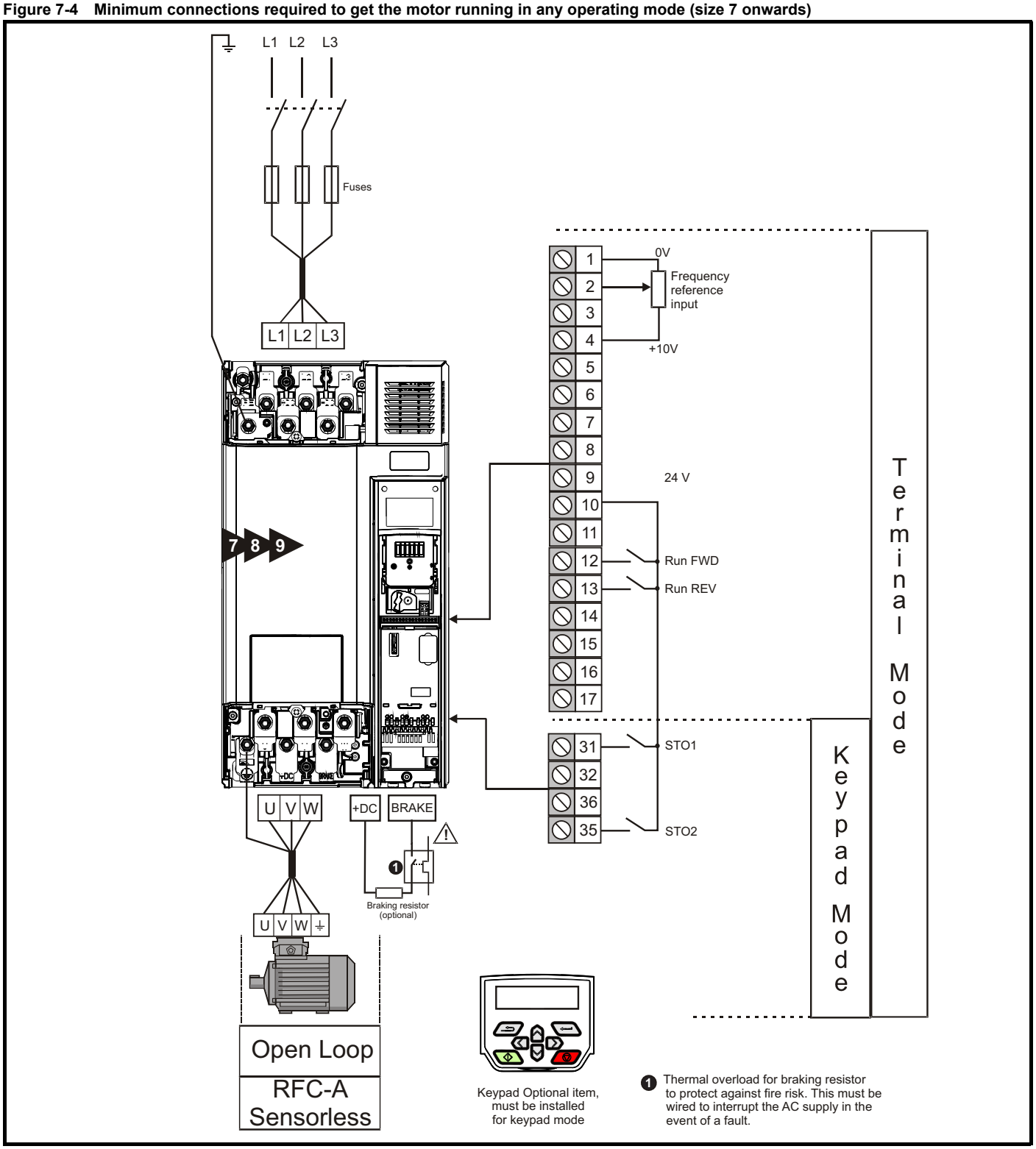
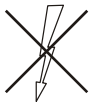
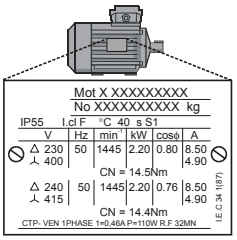
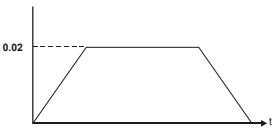
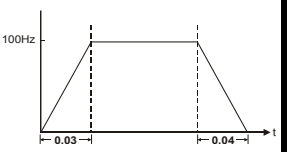
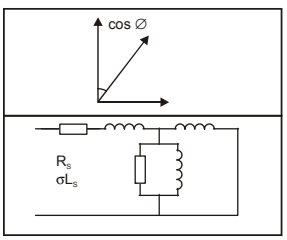


Figure 7-4 Minimum connections required to get the motor running in any operating mode (size 7 onwards)

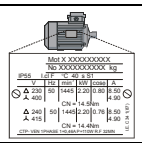
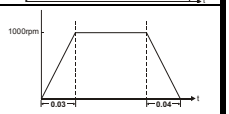
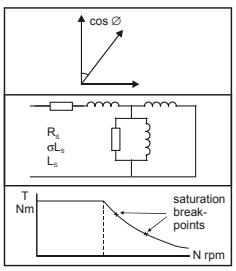


7.3 Quick start commissioning / start-up

7.3.1 Open loop

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) • 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 5.5 *Changing the operating mode* on page 33. Ensure: • Drive displays 'Inhibit' If the drive trips, see section 12 *Diagnostics* on page 137.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.039** (Hz) • Motor rated current in Pr **00.006** (A) • Motor rated speed in Pr **00.007** (rpm) • Motor rated voltage in Pr **00.008** (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 is installed, set Pr **00.028** = 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).	
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 dead time compensation for 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 **00.009**. • 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 **00.038** = 1 for a stationary autotune or set Pr **00.038** = 2 for a rotating autotune • Close the Drive Enable signal (apply +24 V to terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9). The drive will display 'ready'. • Close the run signal (apply +24 V to terminal 12 or 13). The display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 12 *Diagnostics* on page 137. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press the red  reset button.	
Run	Drive is now ready to run	

7.3.2 RFC - A mode

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) • Run signal is not given	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.5 *Changing the operating mode* on page 33. Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 12 *Diagnostics* on page 137.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.039** (Hz) • Motor rated current in Pr **00.006** (A) • Motor rated speed in Pr **00.007** (rpm)* • Motor rated voltage in Pr **00.008** (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 is installed, set Pr **00.028** = 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).	
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 **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 **00.009**. • 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 **00.038** = 1 for a stationary autotune or set Pr **00.038** = 2 for a rotating autotune • Close the drive enable signal (apply +24 V to terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9). The drive will display 'ready'. • Close the run signal (apply +24 V to terminal 12 or 13). The display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Inhibit' and for the motor to come to a standstill If the drive trips, see Chapter 12 *Diagnostics* on page 137. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press red reset button.	
Run	The drive is now ready to run	

* Slip is required for RFC-A mode.

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

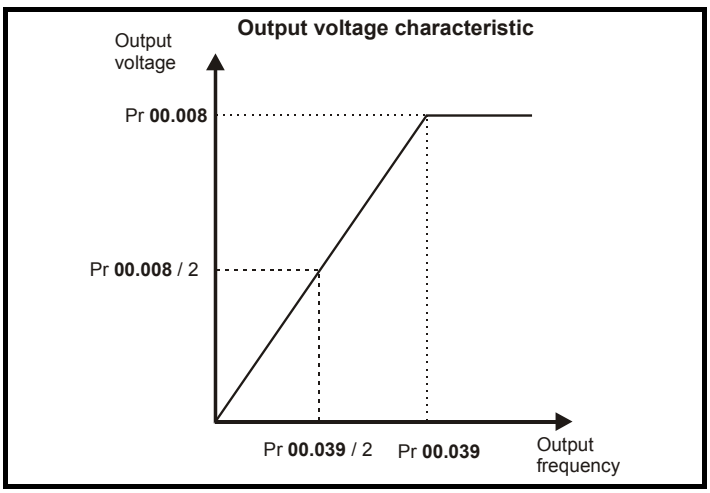
8.1.1 Open loop motor control

Pr 00.006 {05.007} *Motor Rated Current*	**Defines the maximum continuous motor current**

- The rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:
- Current limits (see section section 8.3 *Current limits* on page 60, for more information)
- Motor thermal overload protection (see section section 8.4 *Motor thermal protection* on page 60, for more information)
- Vector mode voltage control (see *Control Mode* later in this table)
- Slip compensation (see *Enable Slip Compensation* (05.027), later in this table)
- Dynamic V/F control

Pr 00.008 {05.009} *Motor Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.039 {05.006} *Motor Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Motor Rated Voltage* (00.008) and the *Motor Rated Frequency* (00.039) are used to define the voltage to frequency characteristic applied to the motor (see *Control Mode*, 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*, later in this table).



Pr 00.007 {05.008} *Motor Rated Speed*	**Defines the full load rated speed of the motor**
Pr 00.040 {05.011} *Number of Motor Poles*	**Defines the number of motor poles**

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

Rated slip (Hz) = Motor rated frequency - (Number of pole pairs x [Motor rated speed / 60]) = **00.039** $= \left(\frac{\textbf{00.040}}{\textbf{2}} \times \frac{\textbf{00.007}}{\textbf{60}}\right)$

If Pr **00.007** 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 **00.040** is also used in the calculation of the motor speed display by the drive for a given output frequency. When Pr **00.040** is set to 'Automatic', the number of motor poles is automatically calculated from the rated frequency Pr **00.039**, and the motor rated speed Pr **00.007**.

Number of poles = 120 x (*Rated Frequency* (00.039) / *Rated Speed* (00.007)) rounded to the nearest even number.

Pr 00.043 {05.010} *Motor 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 *Motor Rated Current* (00.006), 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 **00.038**), below).

Pr 00.038 {05.012} *Auto-tune*

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), *Maximum Deadtime Compensation* (05.059) and *Current At Maximum Deadtime Compensation* (05.060) which are required for good performance in vector control modes (see *Control Mode* 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 **00.009**. To perform a Stationary autotune, set Pr **00.038** to 1, and provide the drive with both an enable signal (on terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminals 12 or 13).

- 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 *Motor Rated Frequency* (00.039) 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 *Motor Rated Power Factor* (00.009). To perform a Rotating autotune, set Pr **00.038** to 2, and provide the drive with both an enable signal (on terminals 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminals 12 or 13).

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 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9, 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 00.041 {05.014} *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*, 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 *Motor Rated Power Factor* (00.009), *Stator Resistance* (05.017), *Maximum Deadtime Compensation* (05.059) and current at *Maximum Deadtime Compensation* (05.060) are all required to be set up accurately. The drive can be made to measure these by performing an autotune (see Pr **00.038** *Autotune*). The drive can also be made to measure the stator resistance automatically every time the drive is enabled or the first time the drive is enabled after it is powered up, by selecting one of the vector control voltage modes.

(0) **Ur S** = The stator resistance is measured and the 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 value of stator resistance is not automatically saved to the drive's EEPROM.

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

(1) **Ur** = The stator resistance 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.

(3) **Ur_Auto**= The stator resistance is measured once, the first time the drive is made to run. After the test has been completed successfully the *Control Mode* (00.041) is changed to Ur mode. The *Stator Resistance* (05.017) parameter is written to, and along with the *Control Mode* (00.041), 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

The stator resistance is not used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by Pr **00.042**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are three settings of fixed boost available:

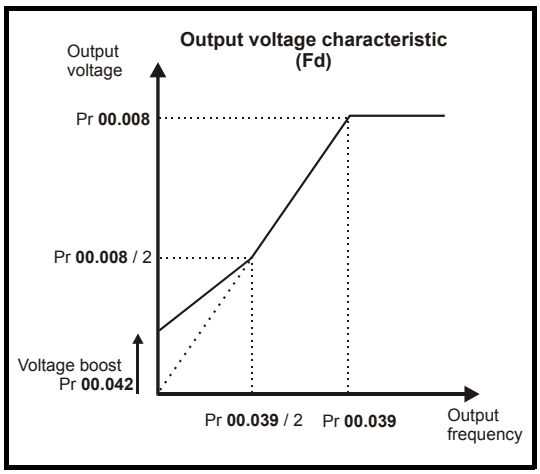
(2) **Fixed** = This mode provides the motor with a linear voltage characteristic from 0 Hz to *Motor Rated Frequency* (00.039), and then a constant voltage above rated frequency.

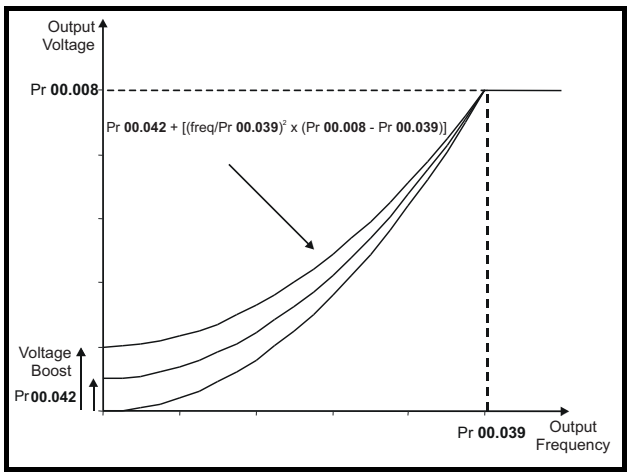
(5) **Square** = This mode provides the motor with a square law voltage characteristic from 0 Hz to *Motor Rated Frequency* (00.039), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of the speed of the motor shaft. This mode should not be used if a high starting torque is required.

(6) **Fixed Tapered** = This mode provides the motor with a linear voltage characteristic with a tapered slip limit.

Pr 00.041 {05.014} *Control Mode (cont)*

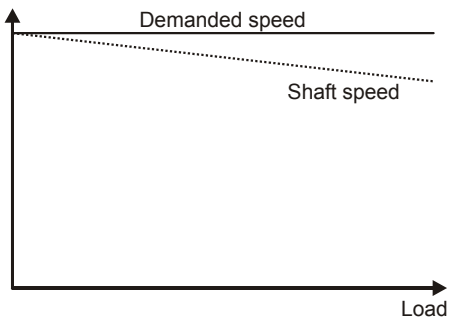
For mode 2 and 5, at low frequencies (from 0 Hz to ½ x Pr **00.039**) a voltage boost is applied as defined by Pr **00.042** as shown below:





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 100 % (this is the default setting), and the motor rated speed must be entered in Pr **00.007** (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 **00.007**, slip compensation will be disabled. If too small a value is entered in Pr **00.007**, 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

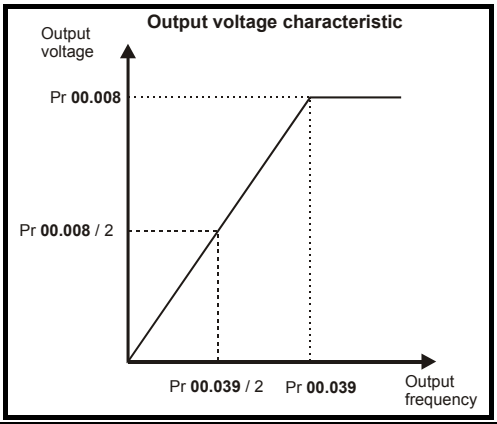
Pr 00.006 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

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

- Current limits (see section 8.3 *Current limits* on page 60, for more information).
- Motor thermal overload protection (see section 8.4 *Motor thermal protection* on page 60, for more information)
- Vector control algorithm

Pr 00.008 {05.009} *Motor Rated Voltage*	**Defines the voltage applied to the motor at rated frequency**
Pr 00.039 {05.006} *Motor Rated Frequency*	**Defines the frequency at which rated voltage is applied**

The *Motor Rated Voltage* (00.008) and the *Motor Rated Frequency* (00.039) are used to define the voltage to frequency characteristic applied to the motor (see *Control Mode* (00.041), 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* (00.007), later in this table).



Pr 00.007 {05.008} *Motor Rated Speed*	**Defines the full load rated speed of the motor and slip**
Pr 00.040 {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. A fixed value can be entered in this parameter.

When Pr **00.040** is set to 'Automatic', the number of motor poles is automatically calculated from the *Motor Rated Frequency* (00.039), and the *Motor Rated Speed* (00.007).

Number of poles = 120 x (Motor *Rated Frequency* (00.039 / Motor *Rated Speed* (00.007) rounded to the nearest even number.

Pr 00.009 {5.10} *Motor 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* (00.006) 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 **00.038**), later in this table).

Pr 00.038 {05.012} *Autotune*

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

NOTE

It is highly recommended that a rotating autotune is performed (Pr **00.038** 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 **00.009**. To perform a Stationary autotune, set Pr **00.038** to 1, and provide the drive with both an enable signal (on terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminal 12 or 13).
- 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 *Motor Rated Frequency* (00.039) 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 **05.062** 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 **00.038** to 2, and provide the drive with both an enable signal (on terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminal 12 or 13).
- The mechanical load test can measure the total inertia of the load and the motor. A series of progressively larger torque levels are applied to the motor (20 %, 40 % … 100 % of rated torque) to accelerate the motor up to ¾ x *Motor Rated Speed* (00.007) to determine the inertia from the acceleration/deceleration time. The test attempts to reach the required speed within 5s, but if this fails, the next torque level is used. When 100 % torque is used, the test allows 60 s for the required speed to be reached, but if this is unsuccessful, an Autotune 1 trip is initiated. To reduce the time taken for the test, it is possible to define the level of torque to be used for the test by setting *Mechanical Load Test Level* (05.021) to a non-zero value. When the test level is defined, the test is only carried out at the defined test level and 60 s is allowed for the motor to reach the required speed. It should be noted that if the maximum speed allows for flux weakening then it may not be possible to achieve the required torque level to accelerate the motor fast enough. If this is the case, the maximum speed reference should be reduced.
    1. The motor must be stationary at the start of the test.
    2. The motor is accelerated in the required direction up to ¾ of the maximum speed reference and then decelerated to zero speed.
    3. The test is repeated with progressively higher torque until the required speed is reached.

    To perform a mechanical load test autotune, set Pr **00.038** to 3, and provide the drive with both an enable signal (on terminal 31 & 34 on size 1 to 4 or terminals 31 & 35 on size 5 to 9) and a run signal (on terminal 12 or 13). 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, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

{04.013} / {04.014} *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. 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 **00.038**, 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.

Frequency Loop Gains
(00.065 {03.010}, Pr 00.066 {03.011})

The frequency loop gains control the response of the frequency controller to a change in frequency demand. The frequency 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 frequency controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **03.010** to Pr **03.012**) 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.

Frequency Controller Proportional Gain (Kp), Pr **00.065** {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 frequency error to produce a torque reference. Therefore as the motor load increases there will be a difference between the reference and actual frequencies. This effect, called regulation, depends on the level of the proportional gain, the higher the gain the smaller the frequency error for a given load. If the proportional gain is too high either the acoustic noise produced by numerical quantization becomes unacceptable, or the stability limit is reached.

Frequency Controller Integral Gain (Ki), Pr **00.066** {03.011} and Pr **03.014**

The integral gain is provided to prevent frequency regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any frequency error. Increasing the integral gain reduces the time taken for the frequency 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 **03.012** and Pr **03.015**

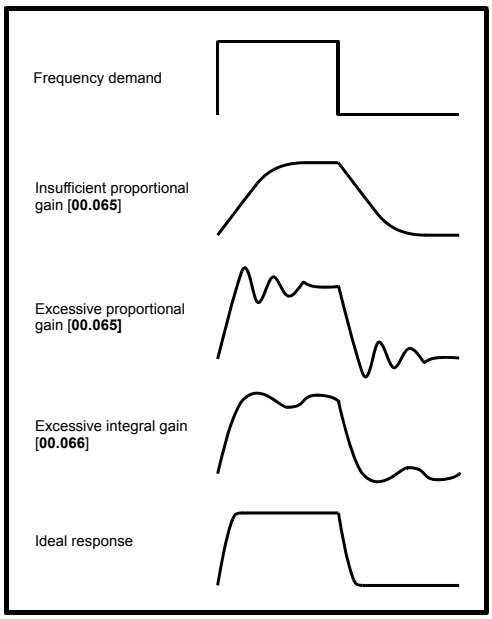
The differential gain is provided in the feedback of the frequency controller to give additional damping. The differential term is implemented in a way that does not introduce excessive noise normally associated with this type of function. Increasing the differential term reduces the overshoot produced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

Gain Change Threshold, Pr **03.017**

If the Frequency Controller Gain Select (03.016) = 2, gains Kp1, Ki1 and Kd1 (Pr **03.010** to Pr **03.012**) are used while the modulus of the frequency demand is less than the value held by Gain Change Threshold (**03.017**), else gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) will be used.

Tuning the frequency loop gains:

This involves the connecting of an oscilloscope to analog output 1 to monitor the frequency feedback. Give the drive a step change in frequency 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 frequency overshoots and then reduced slightly. The integral gain (Ki) should then be increased up to the point where the frequency 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 approaches the ideal response as shown. The diagram shows the effect of incorrect P and I gain settings as well as the ideal response.



8.2 Maximum motor rated current

Size 1 to 4:

The maximum motor rated current is the *Maximum Heavy Duty Current Rating* (00.077).

The values for the Heavy Duty rating can be found in the *Power Installation Guide*.

Size 5 onwards:

The maximum motor rated current allowed by the drive is greater than the *Maximum Heavy Duty Current Rating* (00.077). The ratio between the Normal Duty rating and the *Maximum Heavy Duty Current Rating* (00.077) varies between drive sizes. The values for the Normal and Heavy Duty rating can be found in the *Power Installation Guide*. If the *Motor Rated Current* (00.006) is set above the *Maximum Heavy Duty Current Rating* (00.077), the current limits and the motor thermal protection scheme are modified (see section 8.3 *Current limits* and section 8.4 *Motor thermal protection* below for further information).

8.3 Current limits

The default setting for the current limit parameters is:

- 165 % x motor rated torque producing current for open loop mode.
- 175 % x motor rated torque producing current for RFC-A mode.

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.

With size 5 upwards, increasing the motor rated current (Pr **00.006** / Pr **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 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]

Where:

Load related losses = $[I / (K_1 \times I_{Rated})]^2$

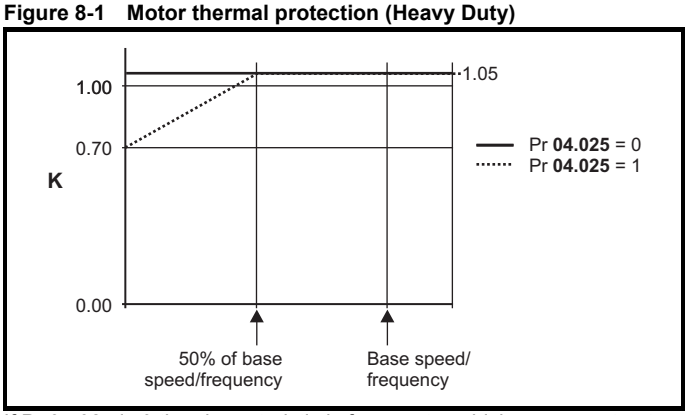
Where:

I = *Current Magnitude* (04.001)

I_{Rated} = *Motor Rated Current* (00.006)

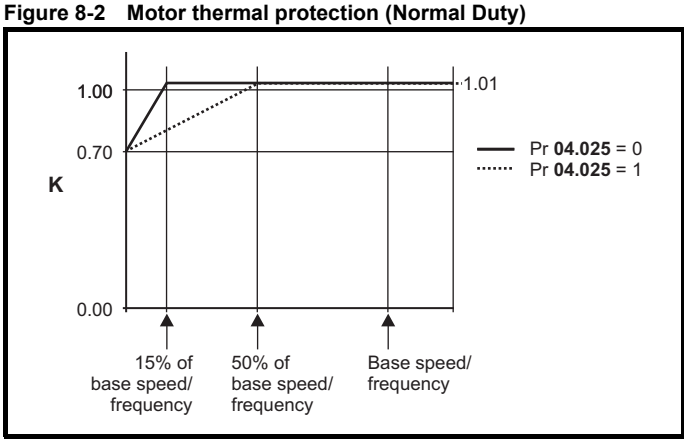
If *Motor Rated Current* (00.006) ≤ *Maximum Heavy Duty Current* (00.077)

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 accumulates the temperature of the motor while the drive remains powered-up. By default, the accumulator is set to the power down value at power up. If the rated current defined by Pr **00.006** is altered, the accumulator is reset to zero.

The default setting of the thermal time constant (Pr **04.015**) is 179 s which is equivalent to an overload of 150 % for 120 s from cold.

8.5 Switching frequency

The default switching frequency is 3 kHz, however this can be increased up to a maximum of 16 kHz by Pr **00.037**.

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 the *Power Installation Guide*.
2. Reduced heating of the motor - due to improved output waveform quality.
3. Reduced acoustic noise generated by the motor.
4. Increased sample rate on the speed and current controllers. A trade off must be made between motor heating, drive heating and the demands of the application with respect to the sample time required.

NOTE

Lowest switching frequency in RFC-A mode is 2 kHz.

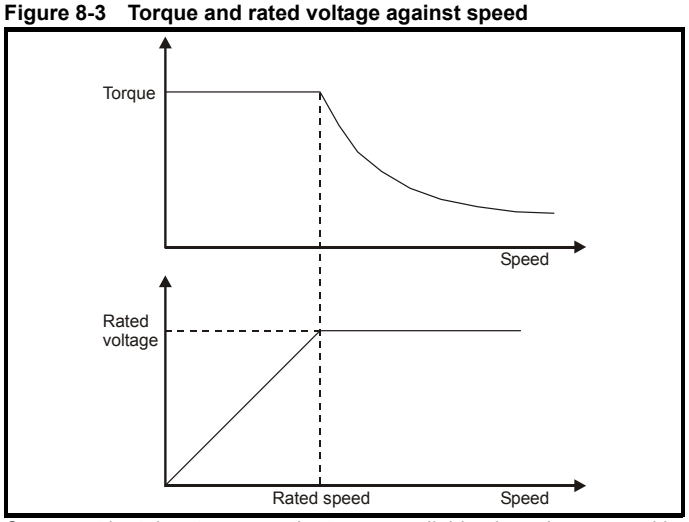
Table 8-1 Sample rates for various control tasks at each switching frequency

	0.667 1 kHz	3, 6, 12 kHz	2, 4, 8, 16 kHz	Open loop	RFC-A
Level 1	250 µs	167 µs	2 kHz = 250 µs 4 kHz = 125 µs 8 kHz = 125 µs 16 kHz = 125 µs	Peak limit	Current controllers
Level 2	250 µs			Current limit and ramps	Speed controller and ramps
Level 3	1 ms			Voltage controller	
Level 4	4 ms			Time critical user interface	
Background				Non-time critical user interface	

8.5.1 Field weakening (constant power) operation

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).

8.5.2 Maximum frequency

In all operating modes the maximum output frequency is limited to 550 Hz.

8.5.3 Over-modulation (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** (Over-modulation 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.

This can be used for example:

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

or

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

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

8.5.4 Switching frequency

With a default switching frequency of 3 kHz, the maximum output frequency should be limited to 250 Hz. Ideally, a minimum ratio of 12:1 should be maintained between the switching frequency and the output frequency. This ensures the number of switchings per cycle is sufficient to ensure the output waveform quality is maintained at a minimum level.

8.6 CT Modbus RTU specification

This section describes the adaptation of the MODBUS RTU protocol offered on Control Techniques' products. The portable software class which implements this protocol is also defined.

MODBUS RTU is a master slave system with half-duplex message exchange. The Control Techniques (CT) implementation supports the core function codes to read and write registers. A scheme to map between MODBUS registers and CT parameters is defined. The CT implementation also defines a 32 bit extension to the standard 16 bit register data format.

8.6.1 MODBUS RTU

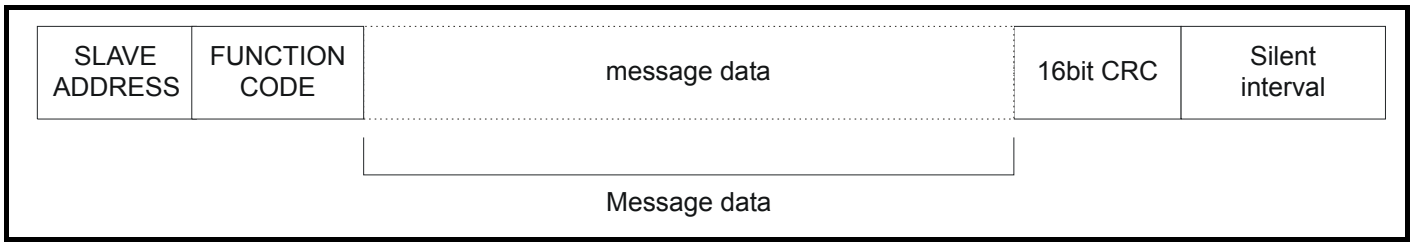
Physical layer

Attribute	Description
Normal physical layer for multi-drop operation	EIA485 2 wire
Bit stream	Standard UART asynchronous symbols with Non Return to Zero (NRZ)
Symbol	Each symbol consists of:- 1 start bit 8 data bits (transmitted least significant bit first) 2 stop bits*
Baud rates	600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200

* The drive will accept a packet with 1 or 2 stop bits but will always transmit 2 stop bits

RTU framing

The frame has the following basic format

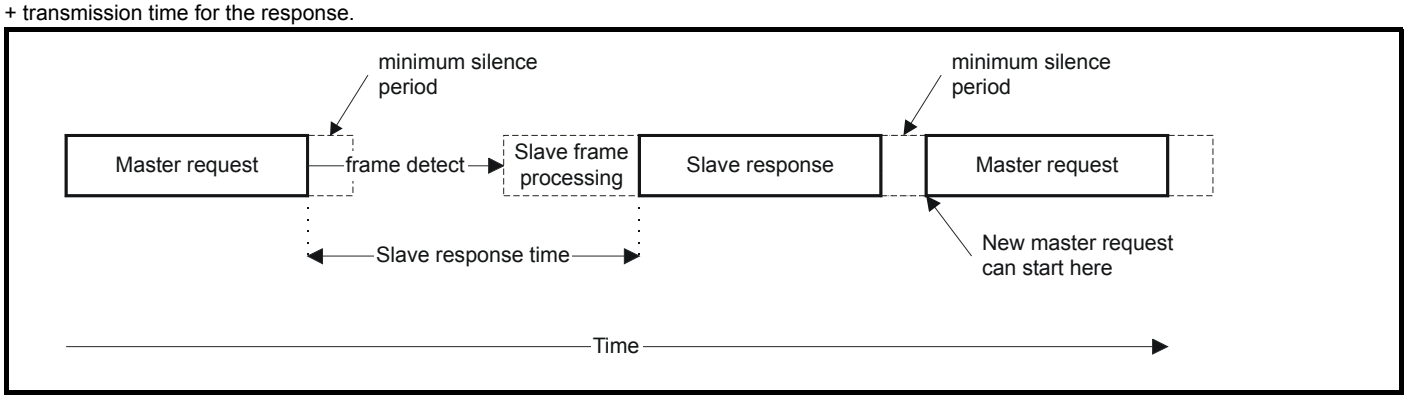


The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without any gaps greater or equal to the silence period. If an erroneous gap is inserted then receiving nodes may start frame processing early in which case the CRC will fail and the frame will be discarded.

MODBUS RTU is a master slave system. All master requests, except broadcast requests, will lead to a response from an individual slave. The slave will respond (i.e. start transmitting the response) within the quoted maximum slave response time (this time is quoted in the data sheet for all Control Techniques products). The minimum slave response time is also quoted but will never be less that the minimum silent period defined by 3.5 character times.

If the master request was a broadcast request then the master may transmit a new request once the maximum slave response time has expired.

The master must implement a message time out to handle transmission errors. This time out period must be set to the maximum slave response time + transmission time for the response.



8.6.2 Slave address

The first byte of the frame is the slave node address. Valid slave node addresses are 1 through 247 decimal. In the master request this byte indicates the target slave node; in the slave response this byte indicates the address of the slave sending the response.

Global addressing

Address zero addresses all slave nodes on the network. Slave nodes suppress the response messages for broadcast requests.

8.6.3 MODBUS registers

The MODBUS register address range is 16 bit (65536 registers) which at the protocol level is represented by indexes 0 through 65535.

PLC registers

Modicon PLCs typically define 4 register 'files' each containing 65536 registers. Traditionally, the registers are referenced 1 through 65536 rather than 0 through 65535. The register address is therefore decremented on the master device before passing to the protocol.

File type	Description
1	Read only bits ("coil")
2	Read / write bits ("coil")
3	Read only 16bit register
4	Read / write 16bit register

The register file type code is NOT transmitted by MODBUS and all register files can be considered to map onto a single register address space. However, specific function codes are defined in MODBUS to support access to the "coil" registers.

All standard CT drive parameters are mapped to register file '4' and the coil function codes are not required.

CT parameter mapping

The Modbus register address is 16 bits in size, of which the upper two bits are used for data type selection leaving 14 bits to represent the parameter address, taking into account the slave increments the address value by 1, this results in a theoretical maximum parameter address of 163.84 (limited to 162.99 in software) when the default standard addressing mode (see *Serial Mode* (11.024)) is used.

To access a parameter number above 99 in any drive menu then the modified addressing mode must be used (see *Serial Mode* (11.024)), this will allow access to parameter numbers up to 255 but also limit the maximum menu number to 63.

The Modbus slave device increments the register address by 1 before processing the command, this effectively prevents access to parameter Pr 00.000 in the drive or option module.

The table below shows how the start register address is calculated for both addressing modes.

Parameter	Addressing mode	Protocol register			
0.mm.ppp	Standard	mm x 100 + ppp - 1			
	Modified	mm x 256 + ppp - 1			
Examples					
		16-bit		**32-bit**	
		Decimal	**Hex (0x)**	**Decimal**	**Hex (0x)**
0.01.021	Standard	120	00 78	16504	40 78
	Modified	276	01 14	16660	41 14
0.01.000	Standard	99	00 63	16483	40 63
	Modified	255	00 FF	16639	40 FF
0.03.161	Standard	N/A	N/A	N/A	N/A
	Modified	928	03 A0	17312	43 A0

Data types

The MODBUS protocol specification defines registers as 16 bit signed integers. All CT devices support this data size.

Refer to the section 8.6.7 *Extended data types* on page 65 for detail on accessing 32 bit register data.

8.6.4 Data consistency

All CT devices support a minimum data consistency of one parameter (16 bit or 32 bit data). Some devices support consistency for a complete multiple register transaction.

8.6.5 Data encoding

MODBUS RTU uses a 'big-endian' representation for addresses and data items (except the CRC, which is 'little-endian'). This means that when a numerical quantity larger than a single byte is transmitted, the MOST significant byte is sent first. So for example

16 - bits	0x1234	would be	0x12	0x34		
32 - bits	0x12345678	would be	0x12	0x34	0x56	0x78

8.6.6 Function codes

The function code determines the context and format of the message data. Bit 7 of the function code is used in the slave response to indicate an exception.

The following function codes are supported:

Code	Description
3	Read multiple 16 bit registers
6	Write single register
16	Write multiple 16 bit registers
23	Read and write multiple 16 bit registers

FC03 Read multiple

Read a contiguous array of registers. The slave imposes an upper limit on the number of registers, which can be read. If this is exceeded the slave will issue an exception code 2.

Table 8-2 Master request

Byte	Description
0	Slave destination node address 1 through 247, 0 is global
1	Function code 0x03
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers MSB
5	Number of 16 bit registers LSB
6	CRC LSB
7	CRC MSB

Table 8-3 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x03
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

FC06 Write single register

Writes a value to a single 16 bit register. The normal response is an echo of the request, returned after the register contents have been written. The register address can correspond to a 32 bit parameter but only 16 bits of data can be sent.

Table 8-4 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

Table 8-5 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x06
2	Register address MSB
3	Register address LSB
4	Register data MSB
5	Register data LSB
6	CRC LSB
7	CRC MSB

FC16 Write multiple

Writes a contiguous array of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 8-6 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers MSB
5	Number of 16 bit registers LSB
6	Length of register data to write (in bytes)
7	Register data 0 MSB
8	Register data 0 LSB
7+byte count	CRC LSB
8+byte count	CRC MSB

Table 8-7 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x10
2	Start register address MSB
3	Start register address LSB
4	Number of 16 bit registers written MSB
5	Number of 16 bit registers written LSB
6	CRC LSB
7	CRC MSB

FC23 Read/Write multiple

Writes and reads two contiguous arrays of registers. The slave imposes an upper limit on the number of registers which can be written. If this is exceeded the slave will discard the request and the master will time out.

Table 8-8 Master request

Byte	Description
0	Slave node address 1 through 247, 0 is global
1	Function code 0x17
2	Start register address to read MSB
3	Start register address to read LSB
4	Number of 16 bit registers to read MSB
5	Number of 16 bit registers to read LSB
6	Start register address to write MSB
7	Start register address to write LSB
8	Number of 16 bit registers to write MSB
9	Number of 16 bit registers to write LSB
10	Length of register data to write (in bytes)
11	Register data 0 MSB
12	Register data 0 LSB
11+byte count	CRC LSB
12+byte count	CRC MSB

Table 8-9 Slave response

Byte	Description
0	Slave source node address
1	Function code 0x17
2	Length of register data in read block (in bytes)
3	Register data 0 MSB
4	Register data 0 LSB
3+byte count	CRC LSB
4+byte count	CRC MSB

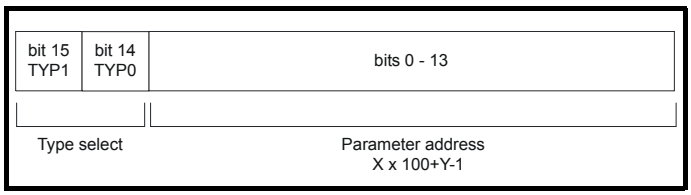
8.6.7 Extended data types

Standard MODBUS registers are 16bit and the standard mapping maps a single #X.Y parameter to a single MODBUS register. To support 32 bit data types (integer and float) the MODBUS multiple read and write services are used to transfer a contiguous array of 16bit registers.

Slave devices typically contain a mixed set of 16 bit and 32 bit registers. To permit the master to select the desired 16 bit or 32 bit access the top two bits of the register address are used to indicate the selected data type.

NOTE

The selection is applied for the whole block access.



The 2bit type field selects the data type according to the table below:

Type field bits 15-14	Selected data type	Comments
00	INT16	backward compatible
01	INT32	
10	Float32	IEEE754 standard Not supported on all slaves
11	Reserved	

If a 32 bit data type is selected then the slave uses two consecutive 16 bit MODBUS registers (in 'big endian'). The master must also set the correct 'number of 16 bit registers'.

Example, read Pr **20.021** through Pr **20.024** as 32 bit parameters using FC03 from node 8:

Table 8-10 Master request

Byte	Value	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x47	Start register address Pr **20.021** (16384 + 2021 - 1) = 18404 = 0x47E4
3	0xE4	
4	0x00	Number of 16bit registers to read Pr **20.021** through Pr **20.024** is 4x32 bit registers = 8x16 bit registers
5	0x08	
6	CRC LSB	
7	CRC MSB	

Table 8-11 Slave response

Byte	Value	Description
0	0x08	Slave destination node address
1	0x03	FC03 multiple read
2	0x10	Length of data (bytes) = 4x32 bit registers = 16 bytes
3-6		Pr **20.021** data
7-10		Pr **20.022** data
11-14		Pr **20.023** data
15-18		Pr **20.024** data
19	CRC LSB	
20	CRC MSB	

Reads when actual parameter type is different from selected

The slave will send the least significant word of a 32 bit parameter if that parameter is read as part of a 16 bit access.

The slave will sign extend the least significant word if a 16 bit parameter is accessed as a 32 bit parameter. The number of 16 bit registers must be even during a 32 bit access.

Example, If Pr **01.028** is a 32 bit parameter with a value of 0x12345678, Pr **01.029** is a signed 16 bit parameter with a value of 0xABCD, and Pr **01.030** is a signed 16 bit parameter with a value of 0x0123.

Read	Start register address	Number of 16 bit registers	Response	Comments
Pr **01.028**	127	1	0x5678	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
Pr **01.028**	16511*	2	0x12345678	Full 32 bit access
Pr **01.028**	16511*	1	Exception 2	Number of words must be even for 32 bit access
Pr **01.029**	128	1	0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of data
Pr **01.029**	16512*	2	0xFFFFABCD	32 bit access to a 16 bit register will return 32 bit sign extended data
Pr **01.030**	16513*	2	0x00000123	32 bit access to a 16 bit register will return 32 bit sign extended data
Pr **01.028** to Pr **01.029**	127	2	0x5678, 0xABCD	Standard 16 bit access to a 32 bit register will return low 16 bit word of truncated data
Pr **01.028** to Pr **01.029**	16511*	4	0x12345678, 0xFFFFABCD	Full 32 bit access

* Bit 14 is set to allow 32 bit access.

Writes when actual parameter type is different from selected

The slave will allow writing a 32 bit value to a 16 bit parameter as long as the 32 bit value is within the normal range of the 16 bit parameter.

The slave will allow a 16 bit write to a 32 bit parameter. The slave will sign extend the written value, therefore the effective range of this type of write will be -32768 to +32767.

Examples, if Pr **01.028** has a range of ±100000, and Pr **01.029** has a range of ±10000.

Write	Start register address	Number of 16 bit registers	Data	Comments
Pr **01.028**	127	1	0x1234	Standard 16 bit write to a 32bit register. Value written = 0x00001234
Pr **01.028**	127	1	0xABCD	Standard 16 bit write to a 32 bit register. Value written = 0xFFFFABCD
Pr **01.028**	16511	2	0x00001234	Value written = 0x00001234
Pr **01.029**	128	1	0x0123	Value written = 0x0123
Pr **01.029**	16512	2	0x00000123	Value written = 0x00000123

* Bit 14 is set to allow 32 bit access

8.6.8 Exceptions

The slave will respond with an exception response if an error is detected in the master request. If a message is corrupted and the frame is not received or the CRC fails then the slave will not issue an exception. In this case the master device will time out. If a write multiple (FC16 or FC23) request exceeds the slave maximum buffer size then the slave will discard the message. No exception will be transmitted in this case and the master will time out.

Exception message format

The slave exception message has the following format.

Byte	Description
0	Slave source node address
1	Original function code with bit 7 set
2	Exception code
3	CRC LSB
4	CRC MSB

Exception codes

The following exception codes are supported.

Code	Description
1	Function code not supported
2	Register address out of range, or request to read too many registers

Parameter over range during block write FC16

The slave processes the write block in the order the data is received. If a write fails due to an out of range value then the write block is terminated. However, the slave does not raise an exception response, rather the error condition is signalled to the master by the number of successful writes field in the response.

Parameter over range during block read/write FC23

There will be no indication that there has been a value out of range during a FC23 access.

8.6.9 CRC

The CRC is a 16bit cyclic redundancy check using the standard CRC-16 polynomial x16 + x15 + x2 + 1. The 16 bit CRC is appended to the message and transmitted LSB first.

The CRC is calculated on ALL the bytes in the frame.

8.6.10 Device compatibility parameters

All devices have the following compatibility parameters defined:

Parameter	Description
Device ID	Unique device identification code
Minimum slave response time	The minimum delay between the end of a message from the master and the time at which the master is ready to receive a response from the slave.
Maximum slave response time	When global addressing, the master must wait for this time before issuing a new message. In a network of devices, the slowest time must be used
Baud rate	Baud rate used by Modbus RTU
32 bit float data type supported	If this data type is not supported then an over range error will be raised if this data type is used
Maximum buffer size	Determines the maximum block size.

9 NV Media Card Operation

9.1 Introduction

The Non-Volatile Media Card feature enables simple configuration of parameters, parameter back-up and drive cloning using an SD card.

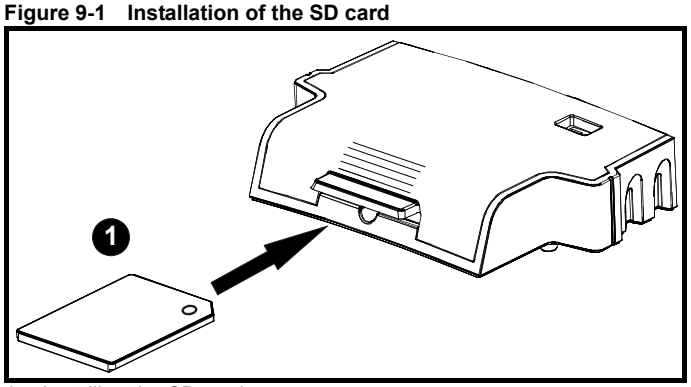
The SD card can be used for:

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

The NV Media Card (SD card) is located in the AI-Backup Adaptor.

The card is not hot swappable, but the AI-Backup Adaptor is 'hot swapped' only if  on display is off.

Figure 9-1 Installation of the SD card



1. Installing the SD card

NOTE

A flat bladed screwdriver or similar tool is required in order to insert / remove the SD card fully into / from the AI-Backup adaptor.

Before inserting / removing the SD card into / from the AI-Backup adaptor, the AI-Backup adaptor must be removed from the drive.

9.2 SD card support

An SD memory card can be inserted in the AI-Backup adaptor in order to transfer data to the drive, however the following limitations should be noted:

If a parameter from the source drive does not exist in the target drive then no data is transferred for that parameter.

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.

If the target drive has a different rating to the source drive then the normal rules for this type of transfer apply as described later.

No checking is possible to determine if the source and target product types are the same, and so no warning is given if they are different.

If an SD card is used then the drive will recognise the following file types through the drive parameter interface.

File Type	Description
Parameter file	A file that contains all copied user save parameters from the drive menus (1 to 30) in difference from default format
Macro file	The same as a parameter file, but defaults are not loaded before the data is transferred from the card

These files can be created on a card by the drive and then transferred to any other drive including derivatives. If the Drive Derivative (11.028) is different between the source and target drives then the data is transferred but a {Card Product} trip is initiated.

It is possible for other data to be stored on the card, but this should not be stored in the <MCDF> folder and it will not be visible via the drive parameter interface.

9.2.1 Changing the drive mode

If the source drive mode is different from the target drive mode then the mode will be changed to the source drive mode before the parameters are transferred. If the required drive mode is outside the allowed range for the target then a {Card Drive Mode} trip is initiated and no data is transferred.

9.2.2 Different voltage ratings

If the voltage rating of the source and target drives is different then all parameters except those that are rating dependent (i.e. attribute RA=1) are transferred to the target drive. The rating dependent parameters are left at their default values. After the parameters have been transferred and saved to non-volatile memory a {Card Rating} trip is given as a warning. The table below gives a list of the rating dependent parameters.

Parameters
Standard Ramp Voltage (02.008)
Motoring Current Limit (04.005)
M2 Motoring Current Limit (21.027)
Regenerating Current Limit (04.006)
M2 Regenerating Current Limit (21.028)
Symmetrical Current Limit (04.007)
M2 Symmetrical Current Limit (21.029)
User Current Maximum Scaling (04.024)
Motor Rated Current (05.007)
M2 Motor Rated Current (21.007)
Motor Rated Voltage (05.009)
M2 Motor Rated Voltage (21.009)
Motor Rated Power Factor (05.010)
M2 Motor Rated Power Factor (21.010)
Stator Resistance (05.017)
M2 Stator Resistance (21.012)
Maximum Switching Frequency (05.018)
Transient Inductance /Ld (05.024)
M2 Transient Inductance /Ld (21.014)
Stator Inductance (05.025)
M2 Stator Inductance (21.024)
Injection Braking Level (06.006)
Supply Loss Detection Level (06.048)

9.2.3 Different option modules installed

If the Option ID Code (15.001) is different for any option module installed to the source drive compared to the destination drive then the parameters for the set-up for that option module are not transferred, but the parameters are set to their default values. After the parameters have been transferred and saved to non-volatile memory a {Card Option} trip is given as a warning.

9.2.4 Different current ratings

If any of the current rating parameters (Maximum Heavy Duty Rating (11.032), Maximum Rated Current (11.060) or Full Scale Current Kc (11.061)) are different between the source and target then all parameters are still written to the target drive, but some may be limited by their allowed range. To give similar performance in the target compared to the source drive the frequency and current controller gains are modified as shown below. Note that this does not apply if the file identification number is larger than 500.

Gains	Multiplier
Frequency Controller Proportional Gain Kp1 (03.010) *Frequency Controller Integral Gain Ki1* (03.011) *Frequency Controller Proportional Gain Kp2* (03.013) *Frequency Controller Integral Gain Ki2* (03.014) *M2 Frequency Controller Proportional Gain Kp* (21.017) *M2 Frequency Controller Integral Gain Ki* (21.018)	[Source *Full Scale Current Kc* (11.061)] / [Target *Full Scale Current Kc* (11.061)]
Current Controller Kp Gain (04.013) *Current Controller Ki Gain* (04.014) *M2 Current Controller Kp Gain* (21.022) *M2 Current Controller Ki Gain* (21.023)	[Source *Full Scale Current Kc* (11.061)] / [Target *Full Scale Current Kc* (11.061)]

9.2.5 Different variable maximums

It should be noted that if ratings of the source and target drives are different, or the option module installed to the source and target drives are different, it is possible that some parameters with variable maximums may be limited and not have the same values as in the source drive.

9.2.6 Macro files

Macro files are created in the same way as parameter files except that *NV Media Card Create Special File* (11.072) must be set to 1 before the file is created on the NV media card. *NV Media Card Create Special File* (11.072) is set to zero after the file has been created or the transfer fails. When a macro file is transferred to a drive, the drive mode is not changed even if the actual mode is different to that in the file, and defaults are not loaded before the parameters are copied from the file to the drive.

The table below gives a summary of the values used in Pr **mm.000** for NV media card operations. The yyy represents the file identification number.

Table 9-1 Functions in Pr mm.000

Value	Action
2001	Transfer the drive parameters to parameter file 001 and sets the block as bootable. This will include the parameters from any attached option module.
4yyy	Transfer the drive parameters to parameter file yyy. This will include the parameters from any attached option module.
5yyy	Transfer the onboard user program to onboard user program file yyy.
59999*	Delete onboard user program
6yyy	Load the drive parameters from parameter file yyy or the onboard user program from onboard user program file yyy.
7yyy	Erase file yyy.
8yyy	Compare the data in the drive with the file yyy. The data in the drive is compared to the data in the file yyy. If the files are the same then Pr **mm.000** is simply reset to 0 when the compare is complete. If the files are different a {Card Compare} trip is initiated. All other NV media card trips also apply.
9555	Clear the warning suppression flag.
9666	Set the warning suppression flag.
9777	Clear the read-only flag.
9888	Set the read-only flag.

* Program cannot be deleted if the drive is active or if the user program is running.

9.2.7 Writing to the NV Media Card

4yyy - Writes defaults differences to the NV Media Card

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

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

Writing a parameter set to the NV Media Card (Pr 00.030 =Program (2))

Setting Pr **00.030** to Program (2) and resetting the drive will save the parameters to the NV Media Card, i.e. this is equivalent to writing 4001 to Pr **mm.000**. All NV Media Card trips apply except 'Card Change'. If the data block already exists it is automatically overwritten. When the action is complete this parameter is automatically reset to None (0).

9.2.8 Reading from the NV Media Card

6yyy - Reading from NV Media Card

When the data is transferred back to the drive, using 6yyy in Pr **mm.000**, it is transferred to the drive RAM and the EEPROM. A parameter save is not required to retain the data after-power down. Set up data for any option module installed stored on the card are transferred to the drive. If the option module installed is different between source and destination drives, the menu for the option module slot where the option module category is different is not updated from the card and will contain its 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. If the data is being transferred to the drive with different voltage or current rating a 'Card Rating' trip will occur.

The following drive rating dependant parameters (RA coding bit set) will not be transferred to the destination drive by a NV Media Card when the voltage rating of the destination drive is different from the source drive and the file is a parameter file.

However, drive rating dependent parameters will be transferred if only the current rating is different. If drive rating dependant parameters are not transferred to the destination drive they will contain their default values.

Pr **02.008** Standard Ramp Voltage

Pr **04.005** to Pr **04.007** and Pr **21.027** to Pr **21.029** *Motoring Current Limits*

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

Pr **04.041** *User Over Current Trip Level*

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 **06.073** *Braking IGBT Lower Threshold*

Pr **06.074** *Braking IGBT Upper Threshold*

Pr **06.075** *Low Voltage Braking IGBT Threshold*

Reading a parameter set from the NV Media Card (Pr 00.030 = Read (1))

Setting Pr **00.030** to Read (1) and resetting the drive will transfer the parameters from the card into the drive parameter set and the drive EEPROM, i.e. this is equivalent to writing 6001 to Pr **mm.000**.

All NV Media Card trips apply. Once the parameters are successfully copied this parameter is automatically reset to None (0). Parameters are saved to the drive EEPROM after this action is complete.

9.2.9 Auto saving parameter changes (Pr 00.030 = Auto (3))

This setting causes the drive to automatically save any changes made to menu 0 parameters on the drive to the NV Media Card. The latest menu 0 parameter set in the drive is therefore always backed up on the NV Media Card. Changing Pr **00.030** to Auto (3) and resetting the drive will immediately save the complete parameter set from the drive to the card, i.e. all parameters except parameters with the NC coding bit set. Once the whole parameter set is stored only the individual modified menu 0 parameter setting is updated.

Advanced parameter changes are only saved to the NV Media Card when Pr **mm.000** is set to 'Save Parameters' or a 1001 and the drive reset.

All NV Media Card trips apply, except 'Card Change'. If the data block already contains information it is automatically overwritten.

If the card is removed when Pr **00.030** is set to 3, Pr **00.030** is then automatically set to None (0).

When a new NV Media Card is installed Pr **00.030** must be set back to Auto (3) by the user and the drive reset so the complete parameter set is rewritten to the new NV Media Card if auto mode is still required.

When Pr **00.030** is set to Auto (3) and the parameters in the drive are saved, the NV Media Card is also updated, and therefore the NV Media Card becomes a copy of the drives stored configuration.

At power up, if Pr **00.030** is set to Auto (3), the drive will save the complete parameter set to the NV Media Card. The drive will display 'Card Write' during this operation. This is done to ensure that if a user puts a new NV Media Card in during power down the new NV Media Card will have the correct data.

NOTE

When Pr **00.030** is set to Auto (3) the setting of Pr **00.030** itself is saved to the drive EEPROM but not the NV Media Card.

9.2.10 Booting up from the NV Media Card on every power up (Pr 00.030 = Boot (4))

When Pr **00.030** is set to Boot (4) the drive operates the same as Auto mode except when the drive is powered-up. The parameters on the NV Media Card will be automatically transferred to the drive at power up if the following are true:

- A card is inserted in the drive
- Parameter data block 1 exists on the card
- The data in block 1 is type 1 to 4 (as defined in Pr **11.038**)
- Pr **00.030** on the card set to Boot (4)

The drive will display 'Booting Parameters' during this operation. If the drive mode is different from that on the card, the drive gives a 'Card Drive Mode' trip and the data is not transferred.

If 'Boot' mode is stored on the copying NV Media Card this makes the copying NV Media Card the master device. This provides a very fast and efficient way of re-programming a number of drives.

'Boot' mode is saved to the card, but when the card is read, the value of Pr **00.030** is not transferred to the drive.

9.2.11 Booting up from the NV Media Card on every power up (Pr mm.000 = 2001)

It is possible to create a bootable parameter data block by setting Pr **mm.000** to 2001 and initiating a drive reset. This data block is created in one operation and is not updated when further parameter changes are made.

Setting Pr **mm.000** to 2001 will overwrite the data block 1 on the card if it already exists.

9.2.12 8yyy - Comparing the drive full parameter set with the NV Media Card values

Setting 8yyy in Pr **mm.000**, will compare the NV Media Card file with the data in the drive. If the compare is successful Pr **mm.000** is simply set to 0. If the compare fails a 'Card Compare' trip is initiated.

9.2.13 7yyy - Erasing data from the NV Media Card values

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

- Setting 7yyy in Pr **mm.000** will erase NV Media Card data block yyy

9.2.14 9666 / 9555 - Setting and clearing the NV Media Card warning suppression flag

If the option module installed to the source and destination drive are different 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 or drive ratings are different between the source and destination drives. The option 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

9.2.15 9888 / 9777 - Setting and clearing the NV Media Card read only flag

The NV Media Card may be protected from writing or erasing by setting the read only flag. If an attempt is made to write or erase a data block when the read only flag is set, a 'Card Read Only' trip is initiated. When the read only flag is set only codes 6yyy or 9777 are effective.

- Setting 9888 in Pr **mm.000** will set the read only flag
- Setting 9777 in Pr **mm.000** will clear the read only flag

9.3 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	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 an SD card 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** and Pr **11.039**.

11.038	NV Media Card File Type					
RO	Txt	ND	NC	PT		
⇳	0 to 5			⇨	0	

Displays the type of data block selected with Pr **11.037**.

Pr 11.038	String	Type
0	None	No file selected
1	Open-loop	Open-loop mode parameter file
2	RFC-A	RFC-A mode parameter file
3	Reserved	Reserved
4	Reserved	Reserved
5	User Program	Onboard user program 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**.

11.042 {00.030}	Parameter Cloning					
RW	Txt		NC			US
⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)			⇨	0	

9.4 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 12 *Diagnostics* on page 137 for more information on NV Media Card trips.

9.5 Data block header information

Each data block stored on a NV Media Card has header information detailing the following:

- *NV Media Card File Number* (11.037)
- *NV Media Card File Type* (11.038)
- *NV Media Card File Version* (11.039)

The header information for each data block which has been used can be viewed in Pr **11.038** to Pr **11.039** 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.

10 Onboard PLC

10.1 Onboard PLC and Machine Control Studio

The drive has the ability to store and execute a 16 kB (less 4 kB of proxy) Onboard PLC user program without the need for additional hardware in the form of an option module.

Machine Control Studio is an IEC61131-3 development environment designed for use with Unidrive M and compatible application modules. Machine Control 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 Machine Control 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

Machine Control Studio provides a complete environment for the development of user programs. Programs can be created, compiled and downloaded to a Unidrive M 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 Machine Control 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 Machine Control Studio form the first level of functionality in a range of programmable options for Unidrive M.

Machine Control Studio can be downloaded from www.controltechniques.com.

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

10.2 Benefits

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

Machine Control 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 Machine Control 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
- Sequence 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 16 ms to 262 s in multiples of 16 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 256 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

Machine Control 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 Machine Control 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

The Onboard PLC user program has the following limitations:

- The flash memory allocated to the Onboard PLC is 16 kB which includes the user program and its header which results in a maximum user program size of about 12 kB
- The Onboard PLC is provided with 2 kB of RAM.
- 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 16 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.

1 - Run the User Program

The user program will execute. Background task starts from the beginning.

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.

0: Stopped

1: Running

2: Exception

3: No user program present

11.049	Onboard User Program: Programming Events					
RO	Uni		NC	PT	PS	
⇳	0 to 65535			⇨		

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 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 262128 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 12 *Diagnostics* on page 137 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.*

WARNING

These advanced parameters are listed for reference purposes only. The lists in this chapter do not include sufficient information for adjusting these parameters. Incorrect adjustment can affect the safety of the system, and damage the drive and or external equipment. Before attempting to adjust any of these parameters, refer to the *Parameter reference guide*.

Table 11-1 Menu descriptions

Menu	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Frequency reference
2	Ramps
3	Frequency control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	Analog I/O
8	Digital I/O
9	Programmable logic, motorized pot, binary sum, timers and scope
10	Status and trips
11	Drive set-up and identification, serial communications
12	Threshold detectors and variable selectors
14	User PID controller
15	Option module slot 1 set-up menu
18	General option module application menu 1
20	General option module application menu 2
21	Second motor parameters
22	Menu 0 set-up
24	Option module slot 1 application menu
30	Onboard user programming application menu
Slot 1	Slot 1 option menus**

** Only displayed when the option module is installed.

Operation mode abbreviations:

Open-loop: Sensorless control for induction motors

RFC-A: Asynchronous Rotor Flux Control for induction 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.

In some cases, the function or range of a parameter is affected by the setting of another parameter. The information in the lists relates to the default condition of any parameters affected in this way.

Table 11-2 Key to parameter table coding

Coding	Attribute
RW	Read/Write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'Off' on the display
Num	Number: can be uni-polar or bi-polar
Txt	Text: the parameter uses text strings instead of numbers.
Bin	Binary parameter
IP	IP Address parameter
Mac	Mac Address parameter
Date	Date parameter
Time	Time parameter
Chr	Character parameter
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will be transferred to the destination drive by non-volatile storage media when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the values will be transferred if only the current rating is different and the file is a difference from default type file.
ND	No default: The parameter is not modified when defaults are loaded
NC	Not copied: not transferred to or from non-volatile media during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) state occurs.

Table 11-3 Feature look-up table

Feature	Related parameters (Pr)												
Acceleration rates	02.010	02.011 to 02.019		02.032	02.033	02.034	02.002						
Analog reference 1	01.036	07.010	07.001	07.007	07.008	07.009	07.028	07.051	07.030	07.061	07.062	07.063	07.064
Analog reference 2	01.037	07.014	01.041	07.002	07.011	07.012	07.013	07.032	07.031	07.065	07.066	07.067	07.068
Analog I/O	Menu 7												
Analog input 1	07.001	07.007	07.008	07.009	07.010	07.028	07.051	07.030	07.061	07.062	07.063	07.064	
Analog input 2	07.002	07.011	07.012	07.013	07.014	07.028	07.031	07.052	07.065	07.066	07.067	07.068	
Analog output 1	07.019	07.020			07.055	07.099							
Analog output 2	07.022	07.023	07.024	07.056	07.102								
Application menu	Menu 18				Menu 20								
At frequency 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		05.017	05.021	05.024	05.025	05.010	05.029	05.030	05.062	05.063	05.059	05.060
Binary sum	09.029	09.030	09.031	09.032	09.033	09.034							
Bipolar reference	01.010												
Brake control	12.040 to 12.047			12.050	12.051								
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 11.039											
Cost - per kWh electricity	06.016	06.017	06.024	06.025	06.026		06.027						
Current controller	04.013	04.014											
Current feedback	04.001	04.002	04.017	04.004		04.020		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 T10	08.001	08.011	08.021	08.031	08.081	08.091	08.121						
Digital I/O T11	08.002	08.012	08.022		08.082	08.122							
Digital I/O T12	08.003	08.013	08.023		08.083	08.123							
Digital input T13	08.004	08.014	08.024	08.084	08.124								
Digital input T14	08.005	08.015	08.025		08.035	08.085	08.125						
Digital input T15	08.006	08.016	08.026	08.036	08.086	08.126							
Digital input T16	08.007	08.017	08.027	08.036	08.087	08.127							
Direction	10.013	06.030	06.031	01.003	10.014	02.001	03.002	08.003	08.004	10.040			
Drive active	10.002	10.040											
Drive derivative	11.028												
Drive OK	10.001	08.028	08.008	08.018	10.036	10.040							
Dynamic performance	05.026												
Dynamic V/F	05.013												
Enable	06.015	08.039		08.040	06.038								
External trip	10.032												
Fan speed	06.045												
Field weakening - induction motor	05.029	05.030	01.006	05.028	05.062	05.063							
Filter change	06.019	06.018	06.021	06.022	06.023								
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		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							
Limit switches	06.035	06.036											
Line power supply loss	06.003	10.015	10.016	05.005	06.046	06.048	06.051						
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					

Feature	Related parameters (Pr)												
Maximum frequency	01.006												
Menu 0 set-up				Menu 22									
Minimum frequency	01.007	10.004											
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	09.003				
Offset reference	01.004	01.038	01.009										
Onboard PLC	11.047 to 11.051			11.055									
Open loop vector mode	05.014	05.017	05.088										
Operating mode		11.031		05.014									
Output	05.001	05.002	05.003	05.004									
Over frequency threshold	03.008												
Over modulation enable	05.020												
PID controller	Menu 14												
Positive logic	08.010												
Power up parameter	11.022												
Preset speeds	01.015	01.021 to 01.028				01.014	01.042	01.045 to 01.047			01.050		
Programmable logic	Menu 9												
Ramp (accel / decel) mode	02.004	02.008	06.001	02.002	02.003	10.030	10.031	10.039					
Regenerating	10.010	10.011	10.030	10.031	06.001	02.004	02.002	10.012	10.039	10.040			
Relay output	08.008	08.018	08.028										
Reset	10.033			10.034	10.035	10.036	10.001	10.038					
RFC mode (encoder less CLV mode)				05.040									
Scope	09.055 to 09.073												
S ramp	02.006	02.007											
Sample rates	05.018												
Safe Torque Off input			08.039	08.040									
Security code	11.030	11.044											
Serial comms	11.023 to 11.027			11.099	11.020								
Skip speeds	01.029	01.030	01.031	01.032	01.033	01.034	01.035						
Slip compensation	05.027	05.008	05.033	05.036	05.084								
NV media card	11.036 to 11.039			11.042									
Firmware version	11.029	11.035											
Frequency controller	03.010 to 03.017												
Estimated frequency	03.002	03.003	03.004										
Reference selection	01.014	01.015	01.049	01.050	01.001								
Status word	10.040												
Supply	05.005	06.003	06.046	06.048	06.051	06.058	06.059						
Switching frequency	05.018	05.035	05.038	07.034	07.035								
Thermal protection - drive	05.018	05.035	07.004	07.005			07.035	10.018					
Thermal protection - motor	04.015	05.007	04.019	04.016	04.025		08.035						
Thermistor input	07.046	07.047	07.048	07.049	07.050	08.035							
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	06.021	06.022	06.023								
Time - powered up log	06.020			06.019	06.017	06.018	06.084						
Time - run log				06.019	06.017	06.018	06.084						
Torque	04.003	04.026	05.032										
Torque mode	04.008	04.011											
Trip detection	10.037	10.038	10.020 to 10.029										
Trip log	10.020 to 10.029			10.041 to 10.060				10.070 to 10.079					
Under voltage	05.005	10.016	10.015	10.068									
V/F mode	05.015	05.014											
Variable selector 1	12.008 to 12.016												
Variable selector 2	12.028 to 12.036												
Voltage controller	05.031												
Voltage mode	05.014	05.017		05.015									
Voltage rating	11.033	05.009	05.005										
Voltage supply		06.046	05.005										
Warning	10.019	10.012	10.017	10.018	10.040								
Zero frequency indicator bit	03.005	10.003											

11.1 Parameter ranges and Variable minimum/maximums:

Some parameters in the drive have a variable range with a variable minimum and a variable maximum values which is dependent on one of the following:

- The settings of other parameters
- The drive rating
- The drive mode
- Combination of any of the above

The tables below give the definition of variable minimum/maximum and the maximum range of these.

VM_AC_VOLTAGE	Range applied to parameters showing AC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 930
Definition	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE[MIN] = 0

VM_AC_VOLTAGE_SET	Range applied to the AC voltage set-up parameters
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 765
Definition	VM_AC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_AC_VOLTAGE_SET[MIN] = 0

VM_ACCEL_RATE	Maximum applied to the ramp rate parameters
Units	s / 100 Hz, s/1000 Hz, s/Max Frequency
Range of [MIN]	Open-loop: 0.0 RFC-A: 0.0
Range of [MAX]	Open-loop: 0.0 to 3200.0 RFC-A: 0.0 to 3200.0
Definition	A maximum needs to be applied to the ramp rate parameters because the units are a time for a change of speed from zero to a defined level or to maximum speed. If the change of speed is to the maximum speed then changing the maximum speed changes the actual ramp rate for a given ramp rate parameter value. The variable maximum calculation ensures that longest ramp rate (parameter at its maximum value) is not slower than the rate with the defined level, i.e. 3200.0 s/100 Hz. The maximum frequency is taken from *Maximum Reference Clamp* (01.006) if *Select Motor 2 Parameters* (11.045) = 0, or *M2 Maximum Reference Clamp* (21.001) if *Select Motor 2 Parameters* (11.045) = 1. VM_ACCEL_RATE[MIN] = 0.0 If Ramp Rate Units (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 Otherwise: VM_ACCEL_RATE[MAX] = 3200.0 x Maximum frequency / 100.00

VM_DC_VOLTAGE	Range applied to parameters showing DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1190
Definition	VM_DC_VOLTAGE[MAX] is the full scale d.c. 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 1150
Definition	VM_DC_VOLTAGE_SET[MAX] is drive voltage rating dependent. See Table 11-4 VM_DC_VOLTAGE_SET[MIN] = 0

VM_DRIVE_CURRENT	Range applied to parameters showing current in A
Units	A
Range of [MIN]	-9999.99 to 0.00
Range of [MAX]	0.00 to 9999.99
Definition	VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) for the drive and is given by *Full Scale Current Kc* (11.061). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]

VM_FREQ	Range applied to parameters showing frequency
Units	Hz
Range of [MIN]	-1100.00
Range of [MAX]	1100.00
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_FREQ[MIN] = 2 x VM_SPEED_FREQ_REF[MIN] VM_FREQ[MAX] = 2 x VM_SPEED_FREQ_REF[MAX]

VM_MAX_SWITCHING_FREQUENCY	Range applied to the maximum switching frequency parameters
Units	User units
Range of [MIN]	Open-loop: 0 (0.667 kHz) RFC-A: 2 (2 kHz)
Range of [MAX]	Open-loop: 8 (16kHz) RFC-A: 8 (16kHz)
Definition	VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent VM_SWITCHING_FREQUENCY[MIN] = 0 This variable maximum is used by the *Minimum Switching Frequency* (05.038) to define the minimum frequency limit used if the inverter thermal model is actively reducing the switching frequency due to temperature. Note that parameter *Maximum Switching Frequency* (05.018) takes priority over parameter *Minimum Switching Frequency* (05.038) so is not limited by parameter *Minimum Switching Frequency* (05.038). The actual minimum switching frequency limit used is the lower of *Maximum Switching Frequency* (05.018) and *Minimum Switching Frequency* (05.038).

VM_MOTOR1_CURRENT_LIMIT	Range applied to current limit parameters (motor 1)
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR1_CURRENT_LIMIT[MAX] is dependent on the drive rating and motor set-up parameters. VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0 **Open-loop** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ 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). $$\textbf{MOTOR1\_CURRENT\_LIMIT\_MAX} = \frac{\sqrt{\left[\left[\frac{\textbf{Maximum current}}{\textbf{Motor rated current}}\right]^2 + (\textbf{PF})^2 - \textbf{1}\right]}}{\textbf{PF}} \times \textbf{100\%}$$ Where: Motor rated current is given by Pr **05.007** PF is motor rated power factor given by Pr **05.010** (MOTOR2_CURRENT_LIMIT_MAX is calculated from the motor map 2 parameters) The Maximum current is (1.5 x Rated drive current) when the rated current set by Pr **05.007** (or Pr **21.007** if motor map 2 is selected) is less than or equal to the Maximum Heavy Duty current rating specified in Pr **11.032**, otherwise it is (1.1 x Maximum motor rated current). For example, with a motor of the same rating as the drive and a power factor of 0.85, the maximum current limit is 165.2%. The rated active and rated magnetising currents are calculated from the power factor (Pr **05.010**) and motor rated current (Pr **05.007**) as: rated active current = power factor x motor rated current rated magnetising current = $\sqrt{(1 - \text{power factor}^2)}$ x motor rated current **RFC-A** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ 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). 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_MOTOR2_CURRENT_LIMIT	Range applied to current limit parameters (motor 2)
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR2_CURRENT_LIMIT[MAX] is dependent on the drive rating and motor set-up parameters. VM_MOTOR2_CURRENT_LIMIT[MIN] = 0.0 Refer to VM_MOTOR1_CURRENT_LIMIT for more information. 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	Limits applied to the negative frequency clamp (motor 1)
Units	Hz
Range of [MIN]	-550.00 to 0.00
Range of [MAX]	0.00 to 550.00
Definition	This variable maximum/minimum defines the range of the negative frequency clamp associated with motor map 1 (*Minimum Reference Clamp* (01.007)). The minimum and maximum are affected by the settings of the *Negative Reference Clamp Enable* (01.008), *Bipolar Reference Enable* (01.010) and *Maximum Reference Clamp* (01.006) as shown in the table below.

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_NEGATIVE_REF_ CLAMP1[MIN]**	**VM_NEGATIVE_REF_ CLAMP1[MAX]**
0	0	0.00	Pr **01.006**
0	1	0.00	0.00
1	X	-VM_POSITIVE_REF_CLAMP[MAX]	0.00

VM_NEGATIVE_REF_CLAMP2	Limits applied to the negative frequency clamp (motor 2)
Units	Hz
Range of [MIN]	-550.00 to 0.00
Range of [MAX]	0.00 to 550.00
Definition	This variable maximum/minimum defines the range of the negative frequency clamp associated with motor map 2 (*M2 Minimum Reference Clamp* (21.002)). It is defined in the same way as VM_NEGATIVE_REF_CLAMP1 except that the *M2 Maximum Reference Clamp* (21.001) is used instead of *Maximum Reference Clamp* (01.006).

VM_POWER	Range applied to parameters that either set or display power
Units	kW
Range of [MIN]	-9999.99 to 0.00
Range of [MAX]	0.00 to 9999.99
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 AC output voltage, at maximum controlled current and unity power factor. VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000 VM_POWER[MIN] = -VM_POWER[MAX]

VM_RATED_CURRENT	Range applied to rated current parameters
Units	A
Range of [MIN]	0.00
Range of [MAX]	0.00 to 9999.99
Definition	VM_RATED_CURRENT [MAX] = *Maximum Rated Current* (11.060) and is dependent on the drive rating. VM_RATED_CURRENT [MIN] = 0.00

VM_SPEED_FREQ_REF	Range applied to the frequency reference parameters
Units	Hz
Range of [MIN]	-550.00 to 0.00
Range of [MAX]	0.00 to 550.00
Definition	This variable minimum/maximum is applied throughout the frequency and speed reference system so that the references can vary in the range from the minimum to maximum clamps. VM_SPEED_FREQ_REF[MIN] = -VM_SPEED_FREQ_REF[MAX].

***Negative Reference Clamp Enable* (01.008)**	**VM_SPEED_FREQ_REF[MAX] if *Select Motor 2 Parameters* (11.045) = 0**	**VM_SPEED_FREQ_REF[MAX] if *Select Motor 2 Parameters* (11.045) = 1**
0	*Maximum Reference Clamp* (01.006)	*M2 Maximum Reference Clamp* (21.001)
1	*Maximum Reference Clamp* (01.006) or |*Minimum Reference Clamp* (01.007)| whichever the larger	*M2 Maximum Reference Clamp* (21.001) or |M2 *Minimum Reference Clamp* (21.002)| whichever the larger

VM_SPEED_FREQ_USER_REFS	Range applied to analog reference parameters
Units	Hz
Range of [MIN]	-550.00 to 550.00
Range of [MAX]	0.00 to 550.00
Definition	This variable maximum is applied to *Analog Reference 1* (01.036), *Analog Reference 2* (01.037) and *Keypad Reference* (01.017). The maximum applied to these parameters is the same as other frequency reference parameters. VM_SPEED_FREQ_USER_REFS [MAX] = VM_SPEED_FREQ_REF[MAX] However the minimum is dependent on *Negative Reference Clamp Enable* (01.008) and *Bipolar Reference Enable* (01.010).

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_SPEED_FREQ_USER_REFS[MIN]**
0	0	If *Select Motor 2 Parameters* (11.045) = 0 *Minimum Reference Clamp* (01.007), otherwise *M2 Minimum Reference Clamp* (21.002)
0	1	-VM_SPEED_FREQ_REF[MAX]
1	0	0.00
1	1	-VM_SPEED_FREQ_REF[MAX]

VM_SUPPLY_LOSS_LEVEL	Range applied to the supply loss threshold
Units	V
Range of [MIN]	0 to 1150
Range of [MAX]	0 to 1150
Definition	VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX] VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 11-4

VM_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	VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]

***Select Motor 2 Parameters* (11.045)**	**VM_TORQUE_CURRENT[MAX]**
0	VM_MOTOR1_CURRENT_LIMIT[MAX]
1	VM_MOTOR2_CURRENT_LIMIT[MAX]

VM_TORQUE_CURRENT_UNIPOLAR	Unipolar version of VM_TORQUE_CURRENT
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX] VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0 *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT which is applied to *Percentage Load* (04.020) and *Torque Reference* (04.008). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

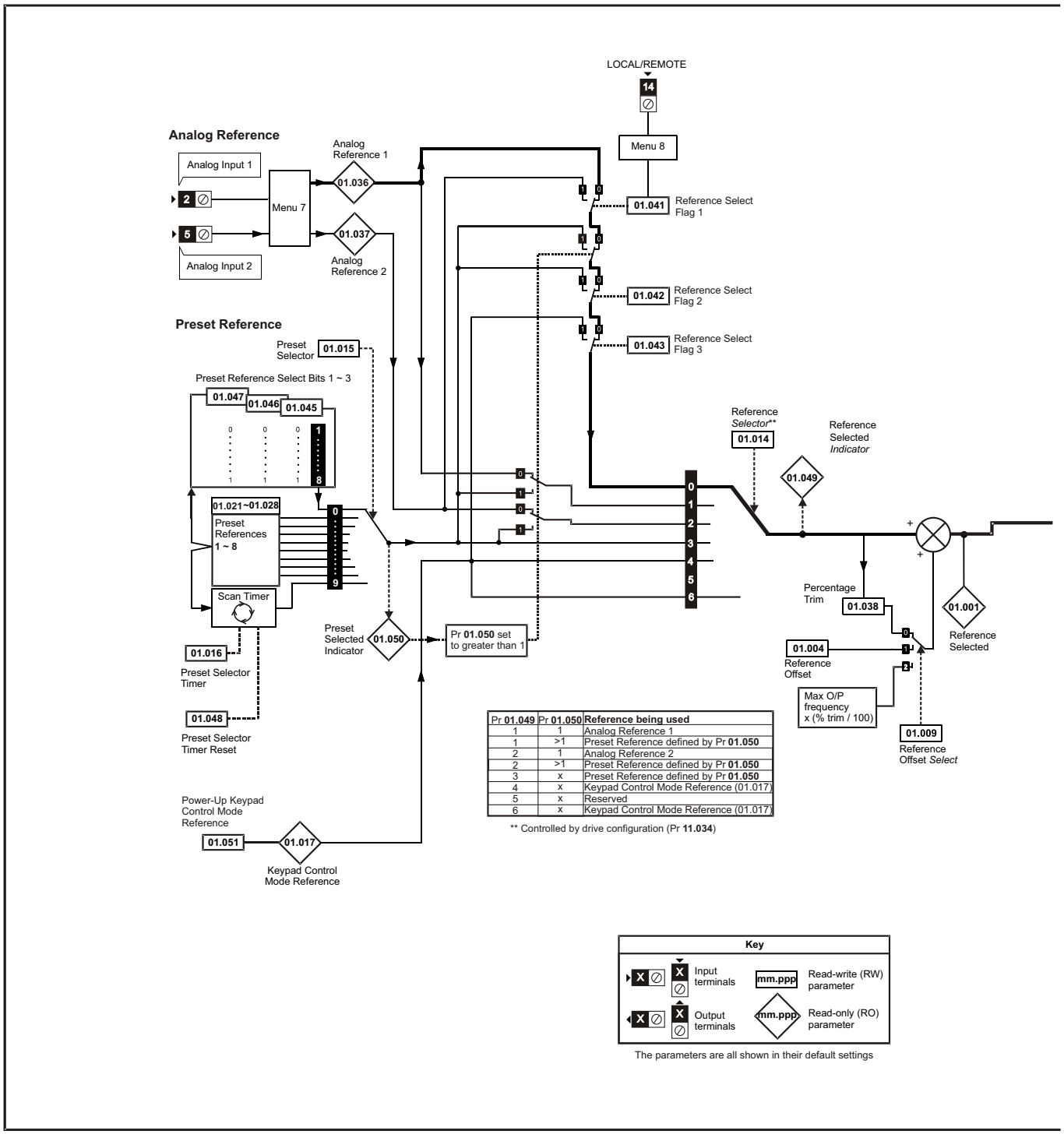
VM_USER_CURRENT	Range applied to torque reference and percentage load parameters with one decimal place
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024) VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX] *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT which is applied to *Percentage Load* (04.020) and *Torque Reference* (04.008). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. This maximum is subject to a limit of MOTOR1_CURRENT_LIMIT or MOTOR2_CURRENT_LIMIT depending on which motor map is currently active. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

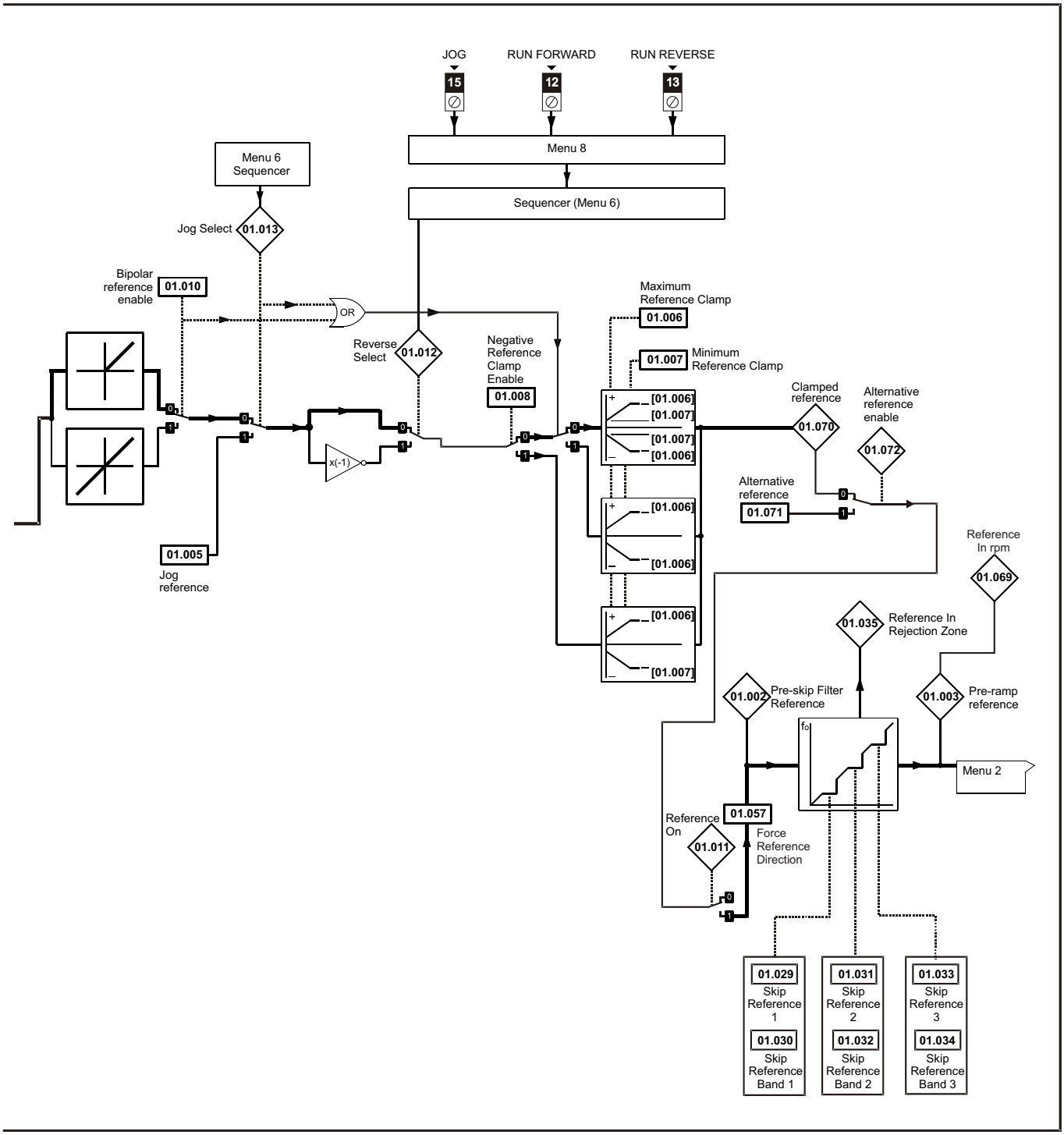
Table 11-4 Voltage ratings dependant values

Variable min/max	Voltage level				
	100 V	**200 V**	**400 V**	**575 V**	**690 V**
VM_DC_VOLTAGE_SET(MAX]	400		800	955	1150
VM_DC_VOLTAGE(MAX] Frame 1 to 4	510		870	N/A	N/A
VM_DC_VOLTAGE(MAX] Frame 5 to 9	415		830	990	1190
VM_AC_VOLTAGE_SET(MAX] Frame 1 to 4	240		480	N/A	N/A
VM_AC_VOLTAGE_SET(MAX] Frame 5 to 9	265		530	635	765
VM_AC_VOLTAGE[MAX]	325		650	780	930
VM_STD_UNDER_VOLTS[MIN]	175		330	435	435
VM_SUPPLY_LOSS_LEVEL{MIN]	205		410	540	540

11.2 Menu 1: Frequency reference

Figure 11-1 Menu 1 logic diagram



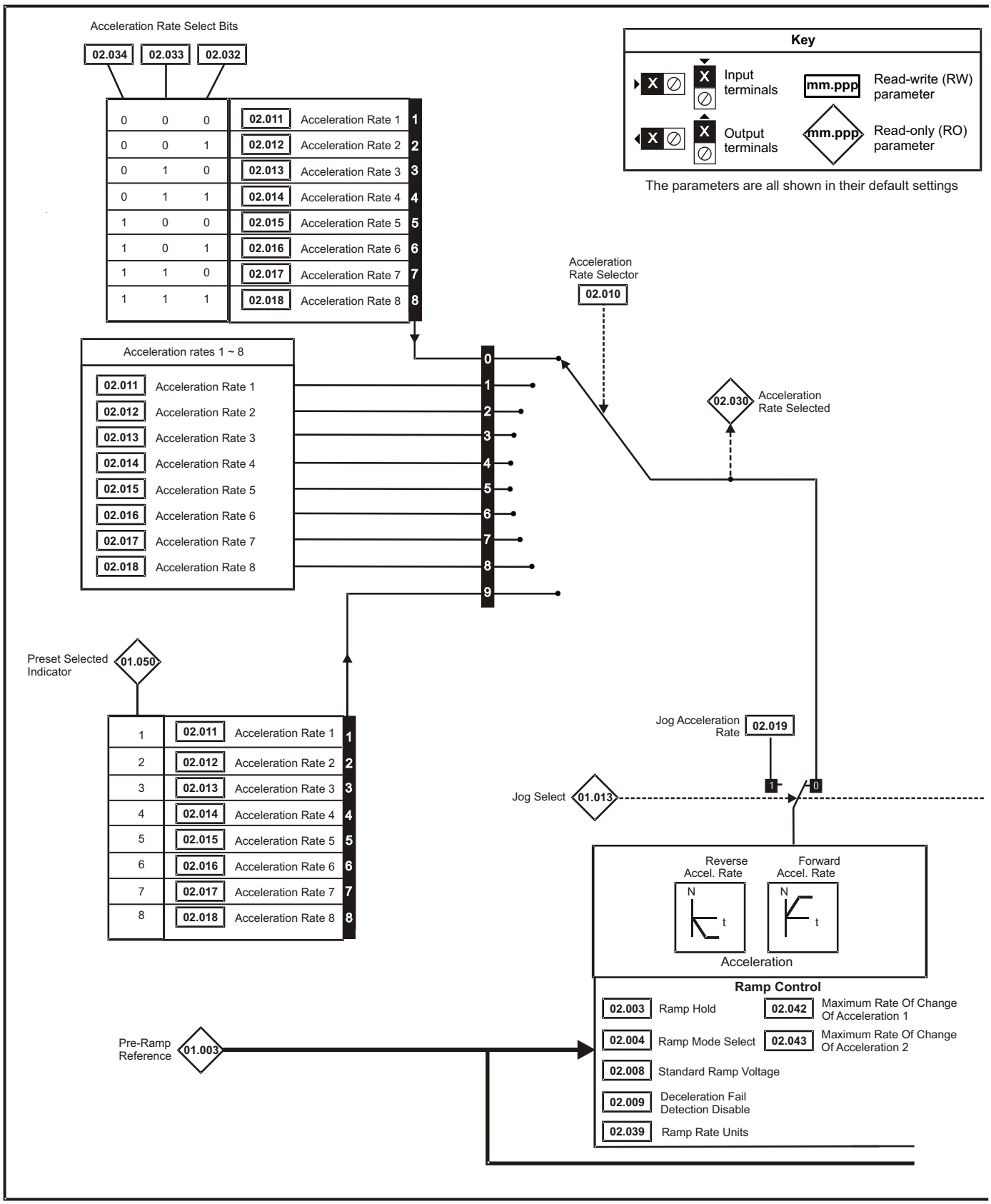

JOG
RUN FORWARD
RUN REVERSE
15
12
13
Menu 8
Sequencer (Menu 6)
Menu 6 Sequencer
Jog Select 01.013
Bipolar reference enable 01.010
OR
Reverse Select 01.012
Negative Reference Clamp Enable 01.008
Maximum Reference Clamp 01.006
01.007 Minimum Reference Clamp
[01.006]
[01.007]
[01.007]
[01.006]
[01.006]
[01.006]
[01.006]
[01.006]
[01.007]
x(-1)
Clamped reference 01.070
Alternative reference enable 01.072
Alternative reference 01.071
01.005 Jog reference
Reference In rpm 01.069
01.035 Reference In Rejection Zone
01.002 Pre-skip Filter Reference
01.003 Pre-ramp reference
Menu 2
Reference On 01.011
01.057 Force Reference Direction
01.029 Skip Reference 1
01.030 Skip Reference Band 1
01.031 Skip Reference 2
01.032 Skip Reference Band 2
01.033 Skip Reference 3
01.034 Skip Reference Band 3

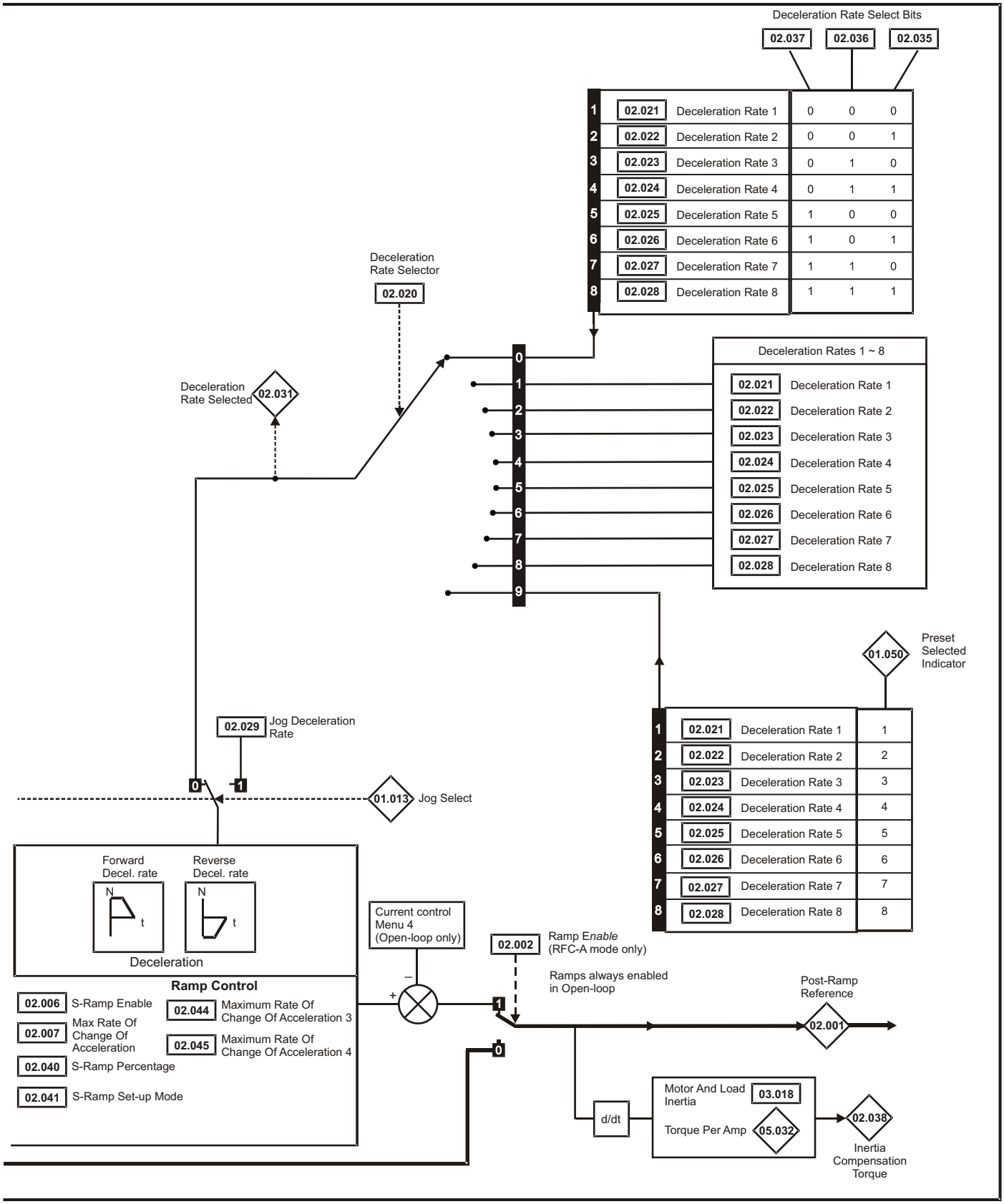
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
01.001	Reference Selected	VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.002	Pre-skip Filter Reference	VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.003	Pre-ramp Reference	VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.004	Reference Offset	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.005	Jog Reference	0.00 to 300.00 Hz		1.50 Hz		RW	Num				US
01.006	Maximum Reference Clamp	±550.00 Hz		50 Hz: 50.00 Hz 60 Hz: 60.00 Hz		RW	Num				US
01.007	Minimum Reference Clamp	VM_NEGATIVE_REF_CLAMP1 Hz		0.00 Hz		RW	Num				US
01.008	Negative Reference Clamp Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
01.009	Reference Offset Select	0 to 2		0		RW	Num				US
01.010	Bipolar Reference Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
01.011	Reference On	Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.012	Reverse Select	Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.013	Jog Select	Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.014	Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Reserved (5), Keypad Ref (6)		A1 A2 (0)		RW	Txt				US
01.015	Preset Selector	0 to 9		0		RW	Num				US
01.016	Preset Selector Timer	0.0 to 400.0 s		10.0 s		RW	Num				US
01.017	Keypad Control Mode Reference	VM_SPEED_FREQ_USER_REFS Hz		0.00 Hz		RO	Num		NC	PT	PS
01.021	Preset Reference 1	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.022	Preset Reference 2	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.023	Preset Reference 3	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.024	Preset Reference 4	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.025	Preset Reference 5	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.026	Preset Reference 6	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.027	Preset Reference 7	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.028	Preset Reference 8	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
01.029	Skip Reference 1	0.00 to 550.00 Hz		0.00 Hz		RW	Num				US
01.030	Skip Reference Band 1	0.00 to 25.00 Hz		0.50 Hz		RW	Num				US
01.031	Skip Reference 2	0.00 to 550.00 Hz		0.00 Hz		RW	Num				US
01.032	Skip Reference Band 2	0.00 to 25.00 Hz		0.50 Hz		RW	Num				US
01.033	Skip Reference 3	0.00 to 550.00 Hz		0.00 Hz		RW	Num				US
01.034	Skip Reference Band 3	0.00 to 25.00 Hz		0.50 Hz		RW	Num				US
01.035	Reference In Rejection Zone	Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.036	Analog Reference 1	VM_SPEED_FREQ_USER_REFS Hz		0.00 Hz		RO	Num		NC		
01.037	Analog Reference 2	VM_SPEED_FREQ_USER_REFS Hz		0.00 Hz		RO	Num		NC		
01.038	Percentage Trim	±100.00 %		0.00 %		RW	Num		NC		
01.041	Reference Select Flag 1	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.042	Reference Select Flag 2	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.043	Reference Select Flag 3	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.045	Preset Select Flag 1	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.046	Preset Select Flag 2	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.047	Preset Select Flag 3	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.048	Preset Selector Timer Reset	Off (0) or On (1)		Off (0)		RW	Bit		NC		
01.049	Reference Selected Indicator	1 to 6				RO	Num	ND	NC	PT	
01.050	Preset Selected Indicator	1 to 8				RO	Num	ND	NC	PT	
01.051	Power-up Keypad Control Mode Reference	Reset (0), Last (1), Preset (2)		Reset (0)		RW	Txt				US
01.057	Force Reference Direction	None (0), Forward (1), Reverse (2)		None (0)		RW	Txt				
01.069	Reference in rpm	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.070	Clamped Reference	VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
01.071	Alternative Reference	VM_SPEED_FREQ_REF Hz		0.00 Hz		RO	Num		NC		
01.072	Alternative Reference Enable	Off (0) or On (1)				RO	Bit	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

11.3 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram




Deceleration Rate Select Bits
02.037
02.036
02.035
1 02.021 Deceleration Rate 1 0 0 0
2 02.022 Deceleration Rate 2 0 0 1
3 02.023 Deceleration Rate 3 0 1 0
4 02.024 Deceleration Rate 4 0 1 1
5 02.025 Deceleration Rate 5 1 0 0
6 02.026 Deceleration Rate 6 1 0 1
7 02.027 Deceleration Rate 7 1 1 0
8 02.028 Deceleration Rate 8 1 1 1
Deceleration Rate Selector
02.020
Deceleration Rate Selected
02.031
0 1 2 3 4 5 6 7 8 9
Deceleration Rates 1 ~ 8
02.021 Deceleration Rate 1
02.022 Deceleration Rate 2
02.023 Deceleration Rate 3
02.024 Deceleration Rate 4
02.025 Deceleration Rate 5
02.026 Deceleration Rate 6
02.027 Deceleration Rate 7
02.028 Deceleration Rate 8
01.050
Preset Selected Indicator
1 02.021 Deceleration Rate 1 1
2 02.022 Deceleration Rate 2 2
3 02.023 Deceleration Rate 3 3
4 02.024 Deceleration Rate 4 4
5 02.025 Deceleration Rate 5 5
6 02.026 Deceleration Rate 6 6
7 02.027 Deceleration Rate 7 7
8 02.028 Deceleration Rate 8 8
02.029 Jog Deceleration Rate
0 1
01.013 Jog Select
Forward Decel. rate
Reverse Decel. rate
N t
Deceleration
Ramp Control
02.006 S-Ramp Enable
02.007 Max Rate Of Change Of Acceleration
02.040 S-Ramp Percentage
02.041 S-Ramp Set-up Mode
02.044 Maximum Rate Of Change Of Acceleration 3
02.045 Maximum Rate Of Change Of Acceleration 4
Current control Menu 4 (Open-loop only)
02.002
Ramp Enable (RFC-A mode 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	OL	RFC-A						
02.001	Post Ramp Reference	VM_SPEED_FREQ_REF Hz				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 Select	Fast (0), Standard (1), Std boost (2), Fast boost (3)		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	Max Rate Of Change Of Acceleration	0.0 to 300.0 s²/100Hz		3.1 s²/100Hz		RW	Num				US
02.008	Standard Ramp Voltage	0 to VM_DC_VOLTAGE_SET V		110V drive: 375 V, 200V drive: 375 V 400V drive 50Hz: 750 V, 400V drive 60Hz: 775 V 575V drive: 895 V, 690V drive: 1075 V		RW	Num		RA		US
02.009	Deceleration Fail Detection Disable	Off (0) or On (1)		Off (0)		RW	Bit				US
02.010	Acceleration Rate Selector	0 to 9		0		RW	Num				US
02.011	Acceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz		5.0 s/100 Hz		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	0.0 to VM_ACCEL_RATE s/100 Hz		0.2 s/100 Hz		RW	Num				US
02.020	Deceleration Rate Selector	0 to 9		0		RW	Num				US
02.021	Deceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz		10.0 s/100 Hz		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	0.0 to VM_ACCEL_RATE s/100 Hz		0.2 s/100 Hz		RW	Num				US
02.030	Acceleration Rate Selected	0 to 8				RO	Num	ND	NC	PT	
02.031	Deceleration Rate Selected	0 to 8				RO	Num	ND	NC	PT	
02.032	Acceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.033	Acceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.034	Acceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.035	Deceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.036	Deceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.037	Deceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)		RW	Bit		NC		
02.038	Inertia Compensation Torque		±1000.0 %			RO	Num	ND	NC	PT	
02.039	Ramp Rate Units	0 (s/100 Hz), 1 (s/maximum frequency), 2 (s/1000 Hz)		0 (s/100 Hz)		RW	Num				US
02.040	S Ramp Percentage	0.0 to 50.0 %		0.0 %		RW	Num				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 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.043	Maximum Rate Of Change Of Acceleration 2	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.044	Maximum Rate Of Change Of Acceleration 3	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		RW	Num				US
02.045	Maximum Rate Of Change Of Acceleration 4	0.0 to 300.0 s²/100Hz		0.0 s²/100Hz		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

11.4 Menu 3: Frequency control

Figure 11-3 Menu 3 Open-loop logic diagram

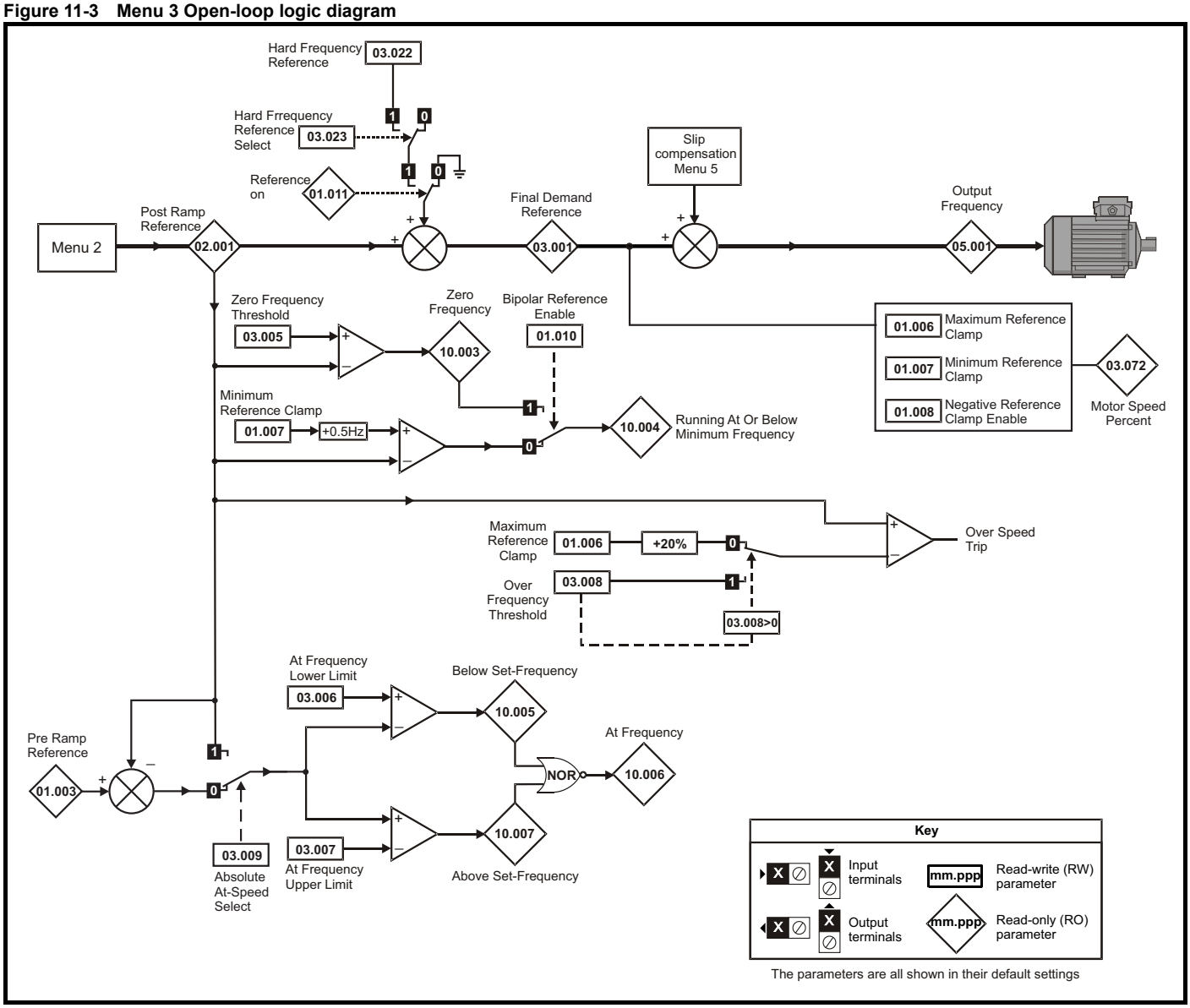
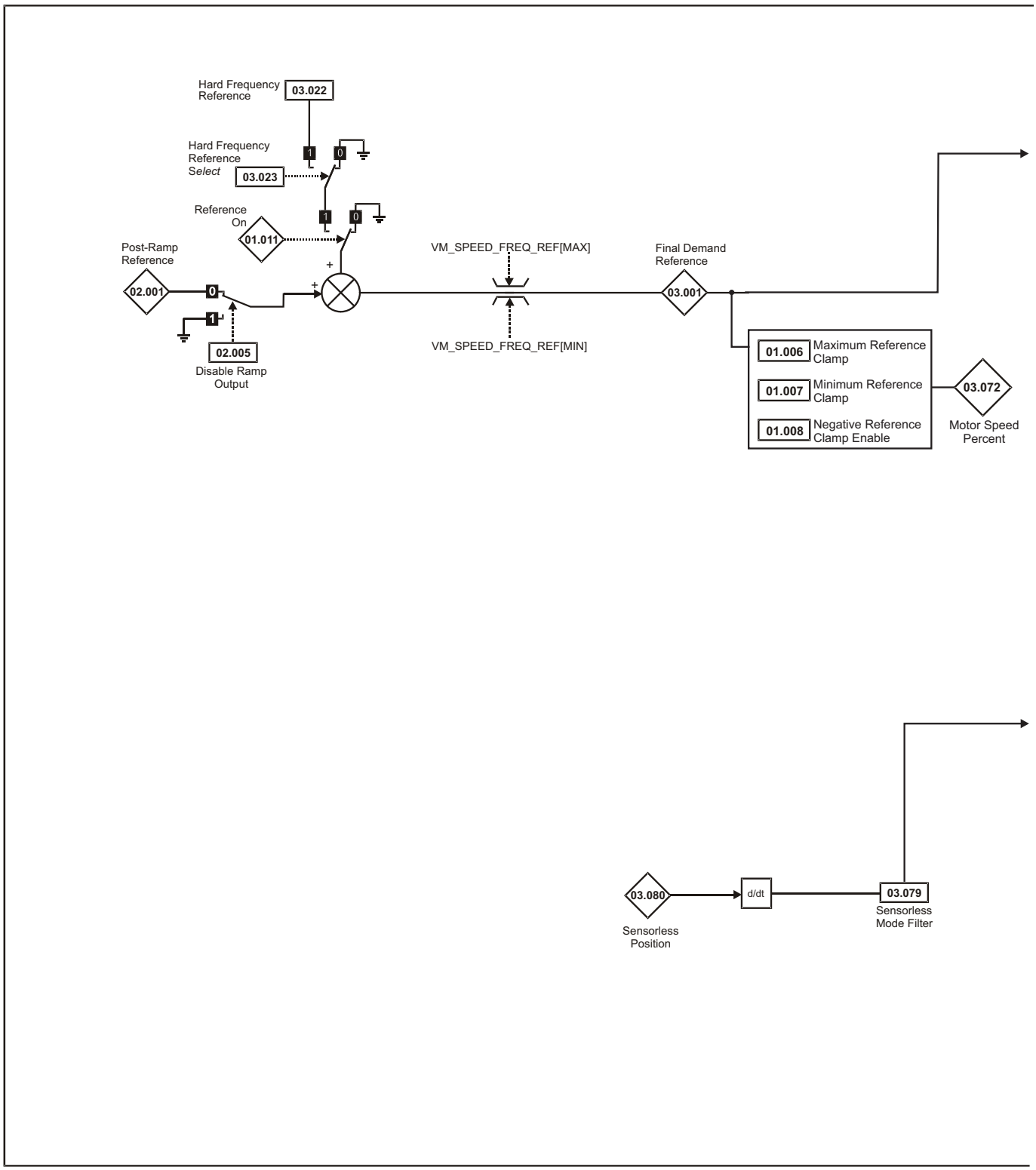


Figure 11-4 Menu 3 RFC-A logic diagram



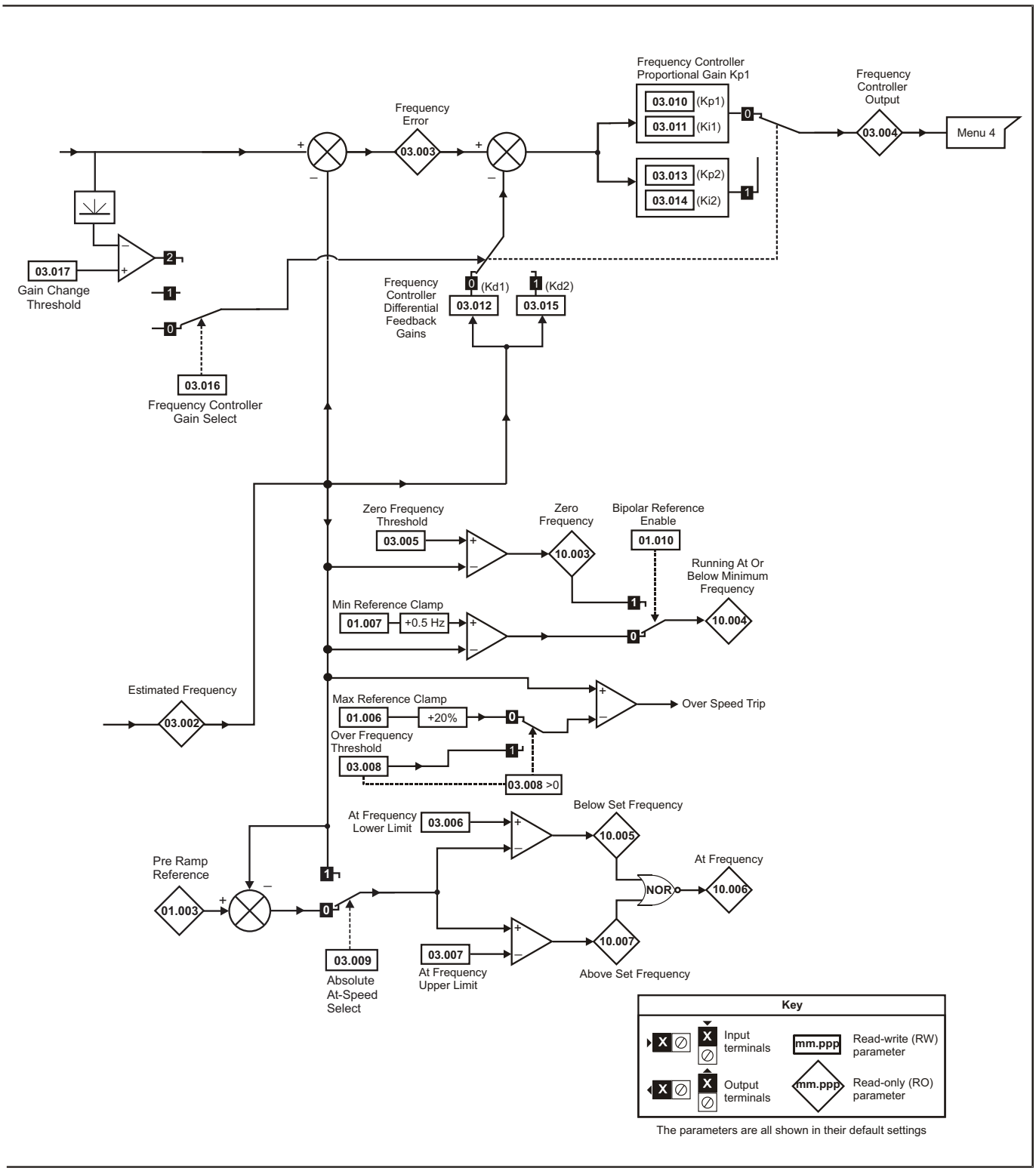
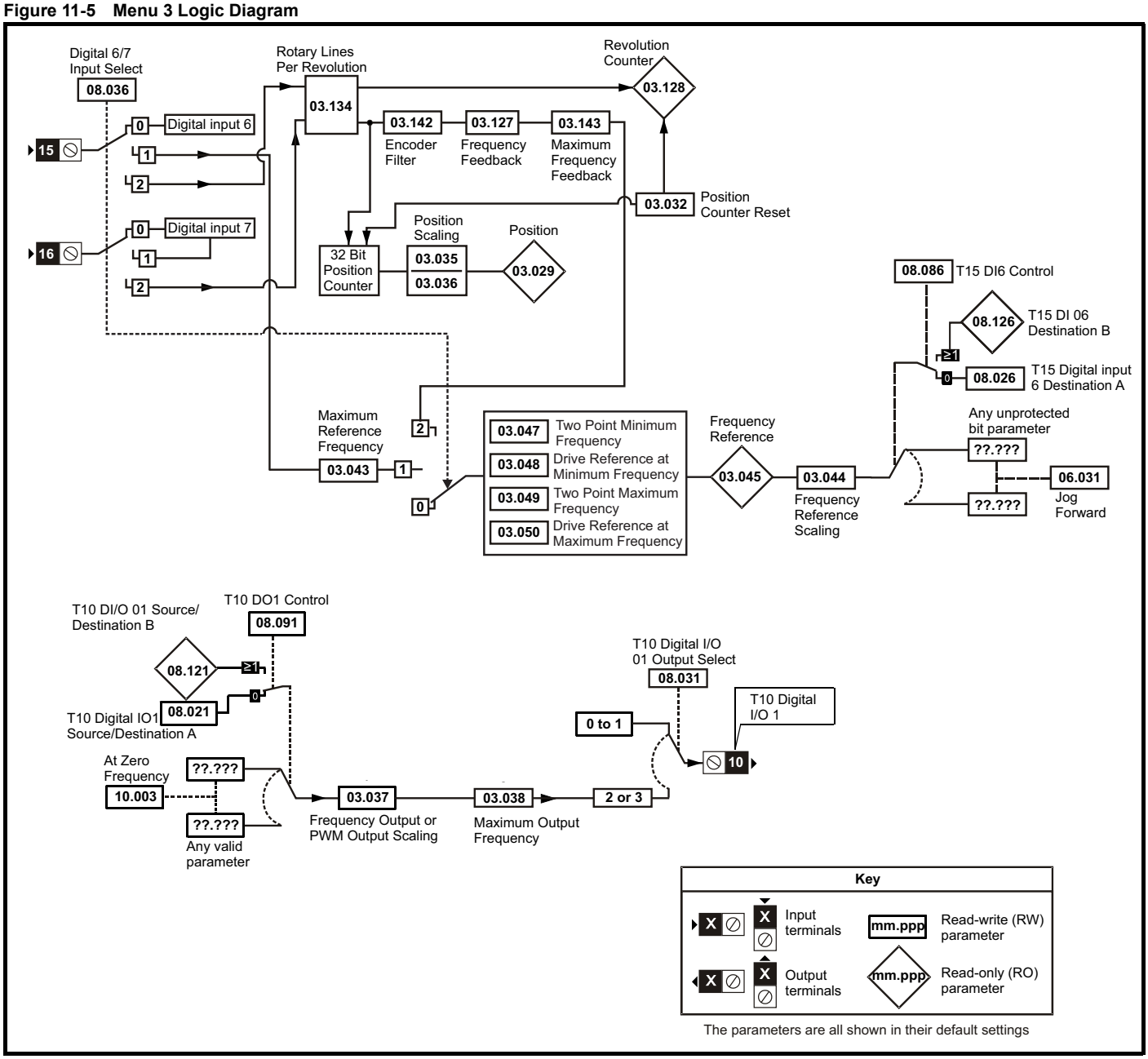

Frequency Controller Proportional Gain Kp1
03.010 (Kp1)
03.011 (Ki1)
03.013 (Kp2)
03.014 (Ki2)
Frequency Controller Output
03.004
Menu 4
Frequency Error
03.003
03.017
Gain Change Threshold
03.016
Frequency Controller Gain Select
Frequency Controller Differential Feedback Gains
03.012 (Kd1)
03.015 (Kd2)
Zero Frequency Threshold
03.005
Zero Frequency
10.003
Bipolar Reference Enable
01.010
Running At Or Below Minimum Frequency
10.004
Min Reference Clamp
01.007
+0.5 Hz
Estimated Frequency
03.002
Max Reference Clamp
01.006
+20%
Over Speed Trip
Over Frequency Threshold
03.008
03.008 >0
At Frequency Lower Limit
03.006
Below Set Frequency
10.005
At Frequency
10.006
NOR
Pre Ramp Reference
01.003
03.009
Absolute At-Speed Select
03.007
At Frequency Upper Limit
10.007
Above Set Frequency
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 Menu 3 Logic Diagram

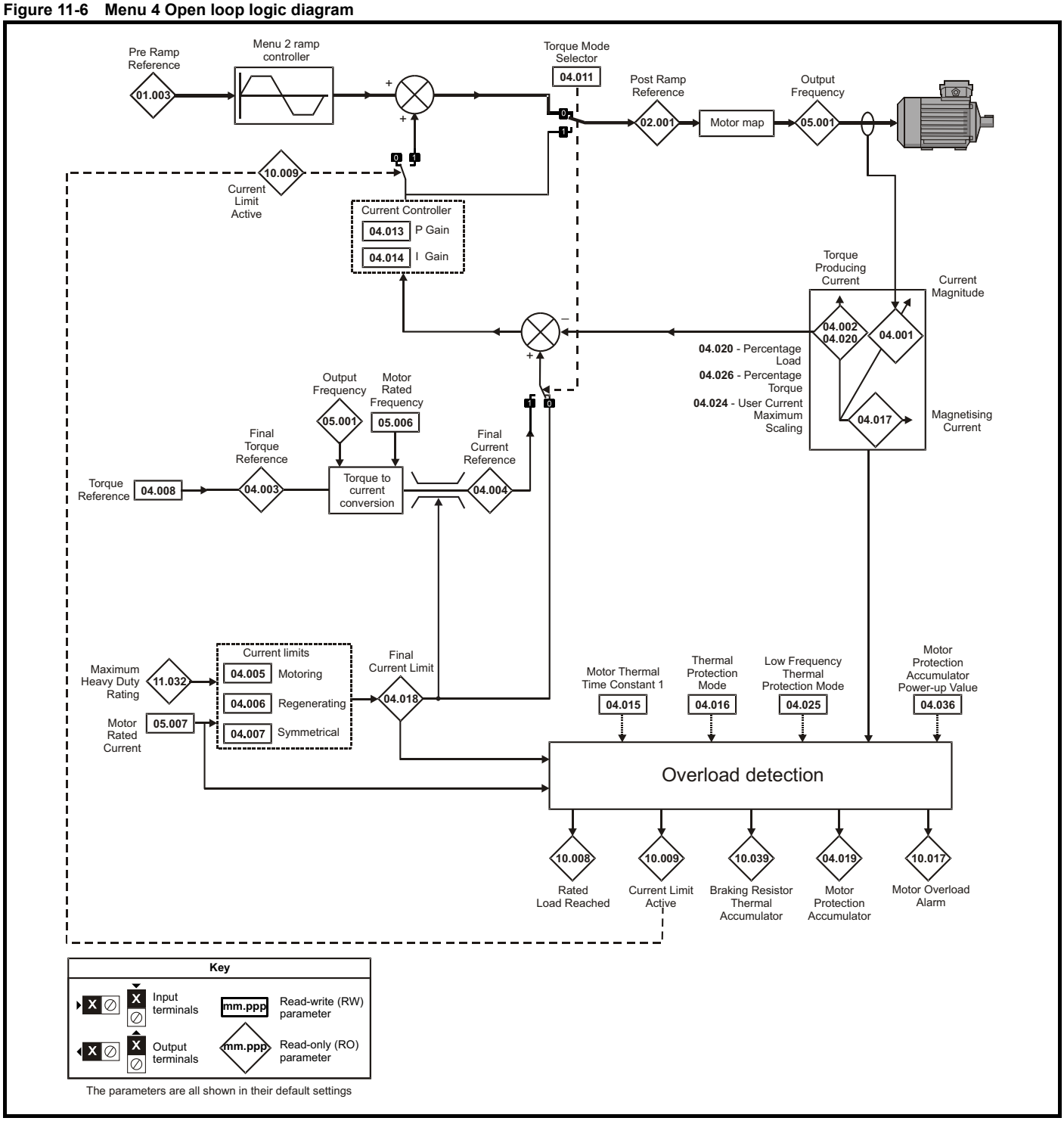


Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
03.001	Final Demand Reference	VM_FREQ Hz				RO	Num	ND	NC	PT	FI
03.002	Estimated Frequency		VM_FREQ Hz			RO	Num	ND	NC	PT	FI
03.003	Frequency Error		VM_FREQ Hz			RO	Num	ND	NC	PT	FI
03.004	Frequency Controller Output		VM_TORQUE_ CURRENT %			RO	Num	ND	NC	PT	FI
03.005	Zero Frequency Threshold	0.00 to 20.00 Hz		2.00 Hz		RW	Num				US
03.006	At Frequency Lower Limit	0.00 to 550.00 Hz		1.00 Hz		RW	Num				US
03.007	At Frequency Upper Limit	0.00 to 550.00 Hz		1.00 Hz		RW	Num				US
03.008	Over Frequency Threshold	0.00 to 550.00 Hz		0.00 Hz		RW	Num				US
03.009	Absolute At Frequency Select	Off (0) or On (1)		Off (0)		RW	Bit				US
03.010	Frequency Controller Proportional Gain Kp1		0.000 to 200.000 s/rad		0.100 s/rad	RW	Num				US
03.011	Frequency Controller Integral Gain Ki1		0.00 to 655.35 s²/rad		0.10 s²/rad	RW	Num				US
03.012	Frequency Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad		0.00000 1/rad	RW	Num				US
03.013	Frequency Controller Proportional Gain Kp2		0.000 to 200.000 s/rad		0.100 s/rad	RW	Num				US
03.014	Frequency Controller Integral Gain Ki2		0.00 to 655.35 s²/rad		0.10 s²/rad	RW	Num				US
03.015	Frequency Controller Differential Feedback Gain Kd2		0.00000 to 0.65535 1/rad		0.00000 1/rad	RW	Num				US
03.016	Frequency Controller Gain Select		0 to 2		0	RW	Num				US
03.017	Gain Change Threshold		0.00 to 550.00 Hz		0.00 Hz	RW	Num				US
03.018	Motor and Load Inertia		0.00 to 1000.00 kgm²		0.00 kgm²	RW	Num				US
03.022	Hard Frequency Reference	VM_SPEED_FREQ_REF Hz		0.00 Hz		RW	Num				US
03.023	Hard Frequency Reference Select	Off (0) or On (1)		Off (0)		RW	Bit				US
03.029	Position (T15/16)	0 to 65535				RO	Num	ND	NC	PT	FI
03.032	Position Counter Reset (T15/16)	Off (0) or On (1)		Off (0)		RW	Bit		NC		
03.035	Position Scaling Numerator (T15/16)	0.000 to 1.000		1.000		RW	Num				US
03.036	Position Scaling Denominator (T15/16)	0.000 to 100.000		1.000		RW	Num				US
03.037	Frequency Output or PWM Output Scaling (T10)	0.000 to 4.000		1.000		RW	Num				US
03.038	Maximum Output Frequency (T10)	1 (0), 2 (1), 5 (2), 10 (3)		5 (2)		RW	Txt				US
03.042	Frequency Input High Precision	Off (0) or On (1)		Off (0)		RW	Bit				US
03.043	Maximum Reference Frequency (T15)	0.00 to 100.00 kHz		10.00 kHz		RW	Num				US
03.044	Frequency Reference Scaling (T15/16)	0.000 to 4.000		1.000		RW	Num				US
03.045	Frequency Reference (T15/16)	±100.00 %				RO	Num	ND	NC	PT	FI
03.047	Two Point Minimum Frequency (T15/16)	±100.00 %		-100.00 %		RW	Num				US
03.048	Drive Reference at Minimum Frequency (T15/16)	±100.00 %		-100.00 %		RW	Num				US
03.049	Two Point Maximum Frequency (T15/16)	0.00 to 100.00 %		100.00 %		RW	Num				US
03.050	Drive Reference at Maximum Frequency (T15/16)	0.00 to 100.00 %		100.00 %		RW	Num				US
03.072	Motor speed percent	±150.0 %				RO	Num	ND	NC	PT	FI
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		0 to 65535			RO	Num	ND	NC	PT	
03.127	Frequency Feedback	0.00 to VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	
03.128	Revolution Counter	0 to 65535				RO	Num	ND	NC	PT	FI
03.134	Rotary Lines Per Revolution	512 (0), 1024 (1), 2048 (2),4096 (3)		1024 (1)		RW	Txt				US
03.142	Encoder Filter	1 to 31 ms		3 ms		RW					US
03.143	Maximum Frequency Feedback	VM_SPEED_FREQ_REF Hz		50 Hz: 50 Hz: 60 Hz: 60 Hz		RW					US

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

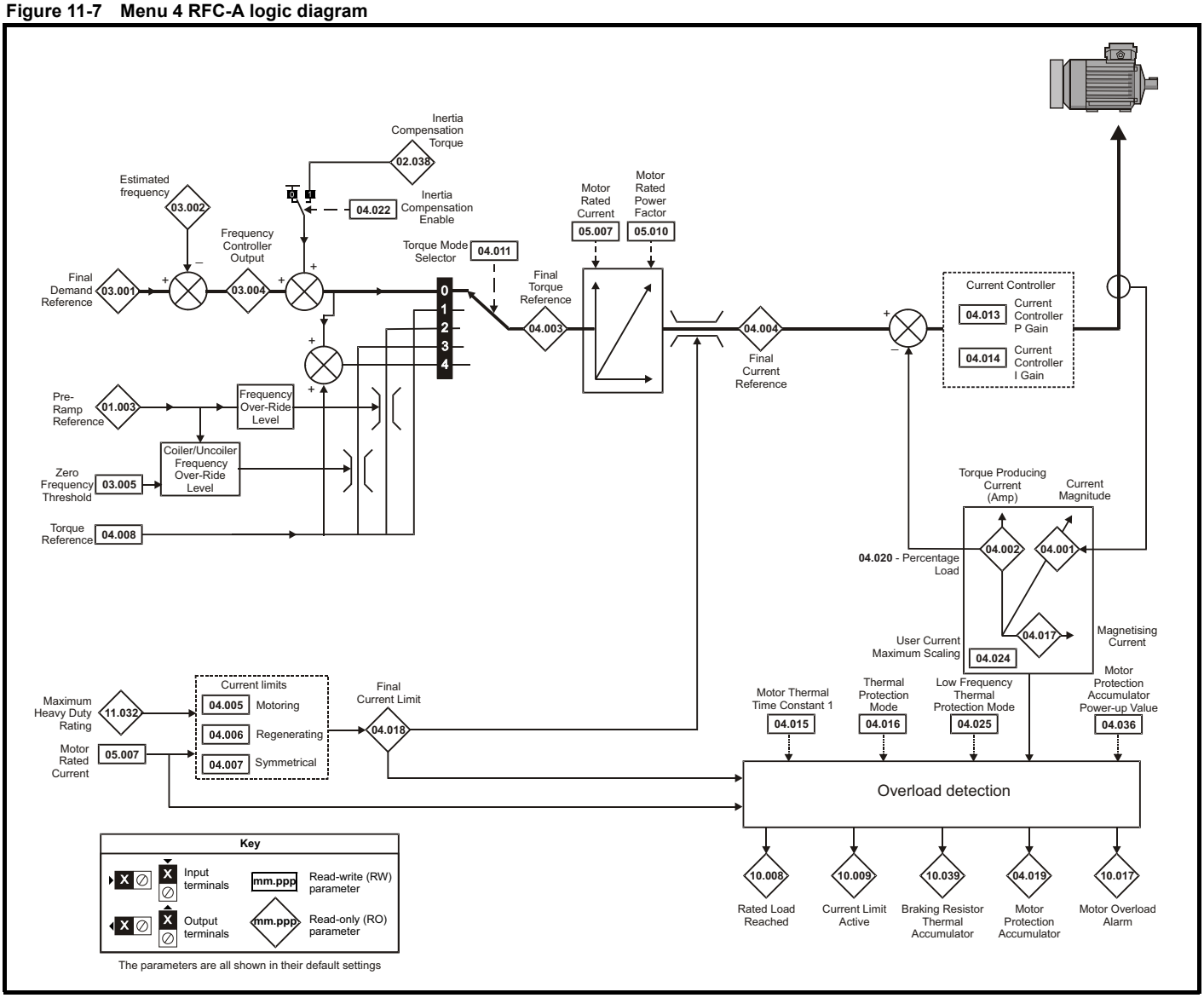
11.5 Menu 4: Torque and current control

Figure 11-6 Menu 4 Open loop logic diagram



The parameters are all shown in their default settings

Figure 11-7 Menu 4 RFC-A logic diagram



Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
04.001	Current Magnitude	VM_DRIVE_CURRENT A				RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current	VM_DRIVE_CURRENT A				RO	Num	ND	NC	PT	FI
04.003	Final Torque Reference	VM_TORQUE_CURRENT %				RO	Num	ND	NC	PT	FI
04.004	Final Current Reference	VM_TORQUE_CURRENT %				RO	Num	ND	NC	PT	FI
04.005	Motoring Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165.0 %*	175.0 %**	RW	Num		RA		US
04.006	Regenerating Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165.0 %*	175.0 %**	RW	Num		RA		US
04.007	Symmetrical Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165.0 %*	175.0 %**	RW	Num		RA		US
04.008	Torque Reference	VM_USER_CURRENT %		0.0 %		RW	Num				US
04.011	Torque Mode Selector	0 to 1	0 to 5	0		RW	Num				US
04.013	Current Controller Kp Gain	0.00 to 4000.00		20.00		RW	Num				US
04.014	Current Controller Ki Gain	0.000 to 600.000		40.000		RW	Num				US
04.015	Motor Thermal Time Constant 1	1 to 3000 s		179 s		RW	Num				US
04.016	Thermal Protection Mode	00 to 11		00		RW	Bin				US
04.017	Magnetising Current	VM_DRIVE_CURRENT A				RO	Num	ND	NC	PT	FI
04.018	Final Current Limit	VM_TORQUE_CURRENT %				RO	Num	ND	NC	PT	
04.019	Motor Protection Accumulator	0.0 to 100.0 %				RO	Num	ND	NC	PT	PS
04.020	Percentage Load	VM_USER_CURRENT %				RO	Num	ND	NC	PT	FI
04.022	Inertia Compensation Enable		Off (0) or On (1)		Off (0)	RW	Bit				US
04.024	User Current Maximum Scaling	0.0 to VM_TORQUE_CURRENT_UNIPOLAR %		165.0 %*	175.0 %**	RW	Num		RA		US
04.025	Low Frequency Thermal Protection Mode	0 to 1		0		RW	Num				US
04.026	Percentage Torque	VM_USER_CURRENT %				RO	Num	ND	NC	PT	FI
04.036	Motor Protection Accumulator Power-up Value	Power down (0), Zero (1), Real time (2)		Power down (0)		RW	Txt				US
04.041	User Over Current Trip Level	0 to 100 %		100 %		RW	Num		RA		US

* For size 9 the default is 141.9 %

** For size 9 the default is 150.0 %

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

11.6 Menu 5: Motor control

Figure 11-8 Menu 5 Open-loop logic diagram

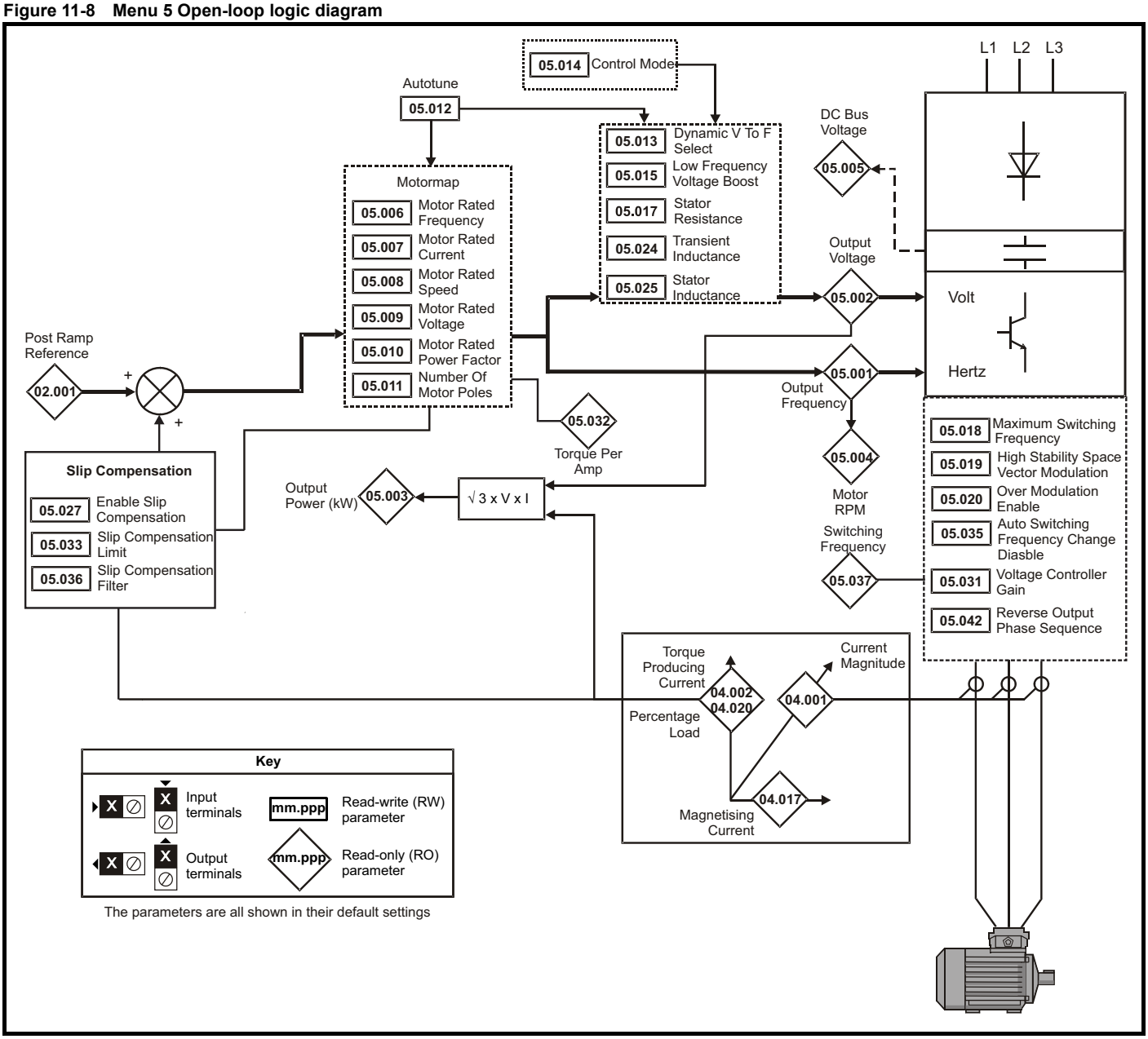
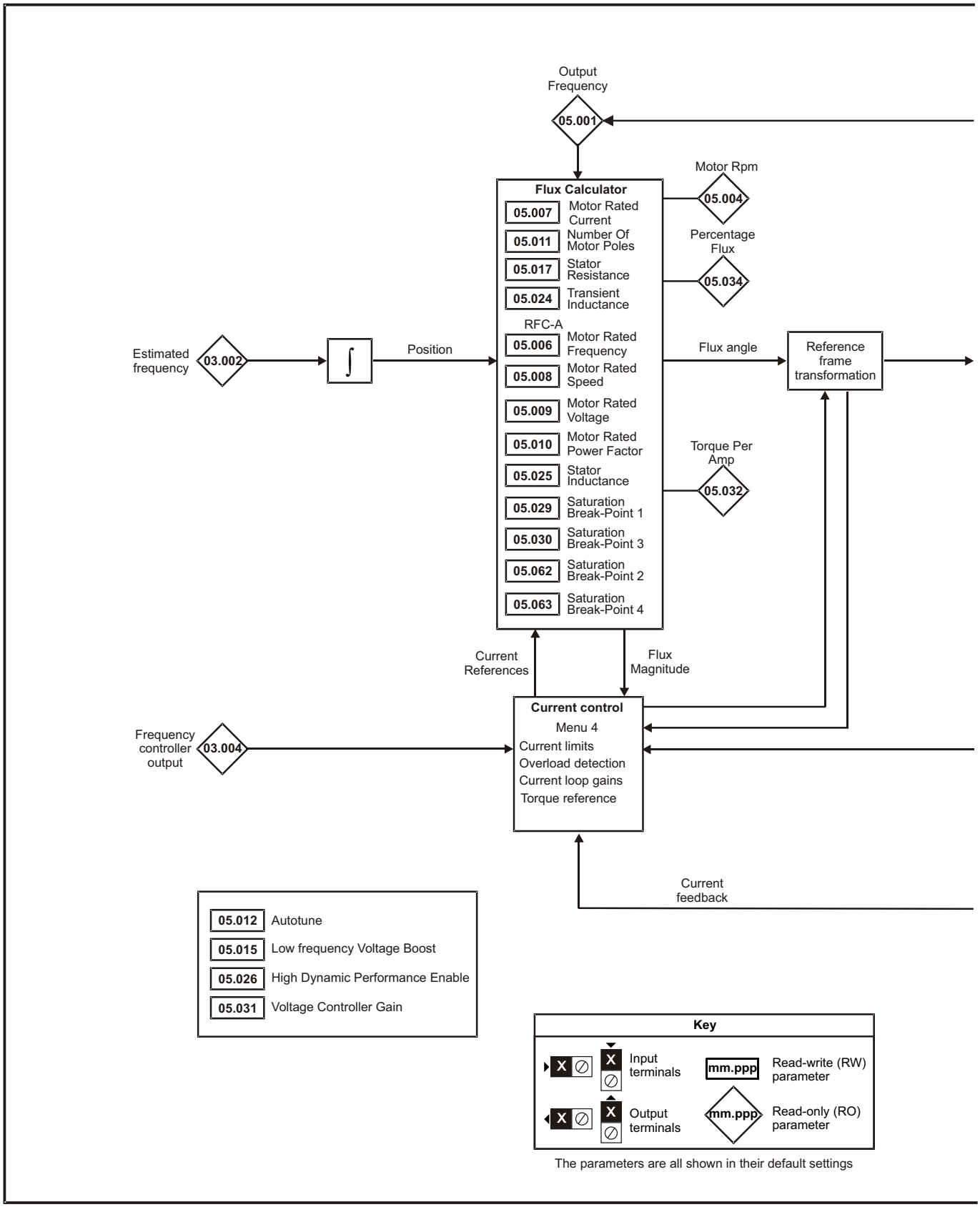
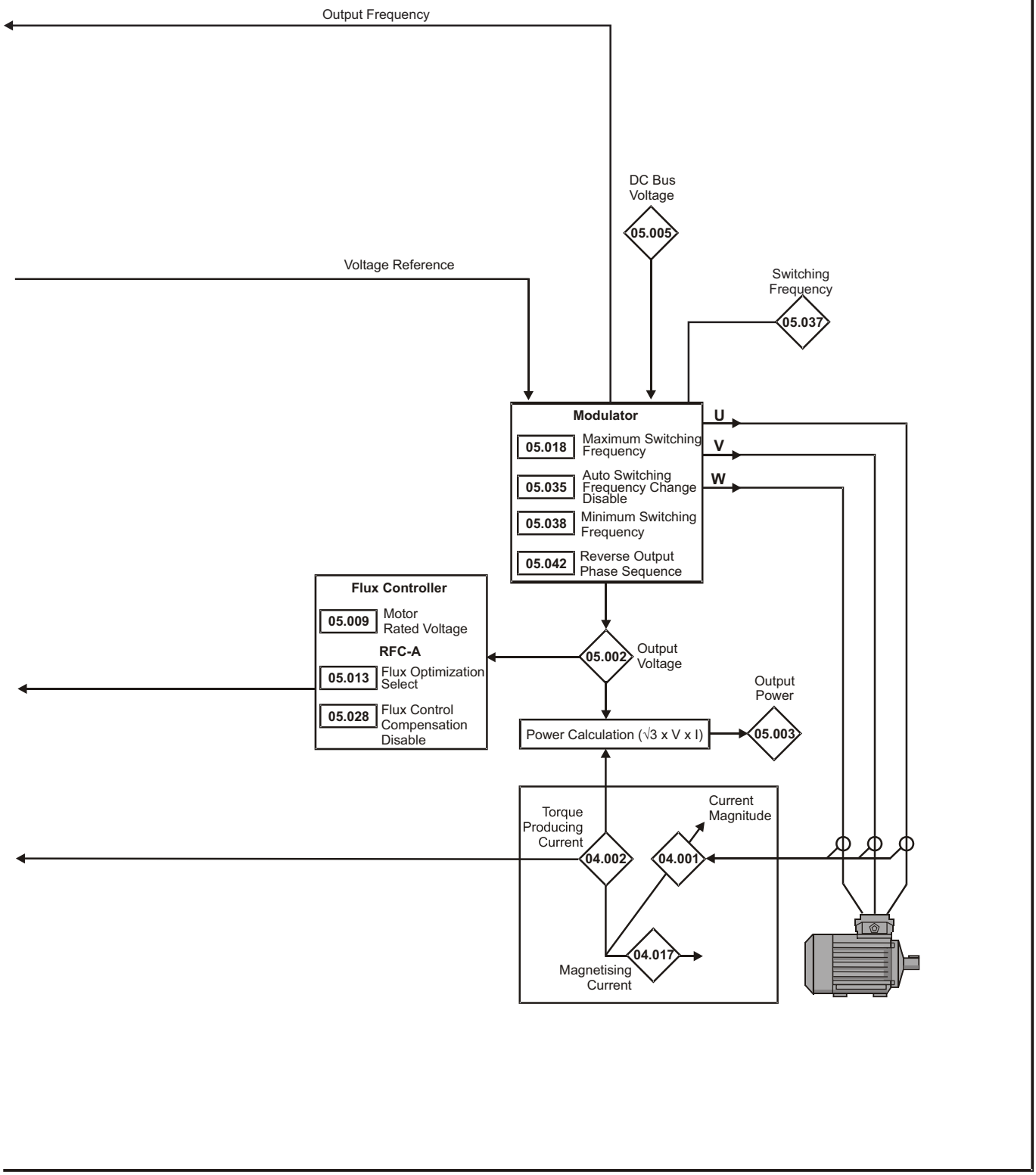


Figure 11-9 Menu 5 RFC-A, logic diagram




Output Frequency
DC Bus Voltage
05.005
Voltage Reference
Switching Frequency
05.037
Modulator
05.018 Maximum Switching Frequency
05.035 Auto Switching Frequency Change Disable
05.038 Minimum Switching Frequency
05.042 Reverse Output Phase Sequence
U
V
W
Flux Controller
05.009 Motor Rated Voltage
RFC-A
05.013 Flux Optimization Select
05.028 Flux Control Compensation Disable
05.002 Output Voltage
Output Power
Power Calculation (√3 x V x I)
05.003
Torque Producing Current
Current Magnitude
04.002
04.001
04.017
Magnetising Current

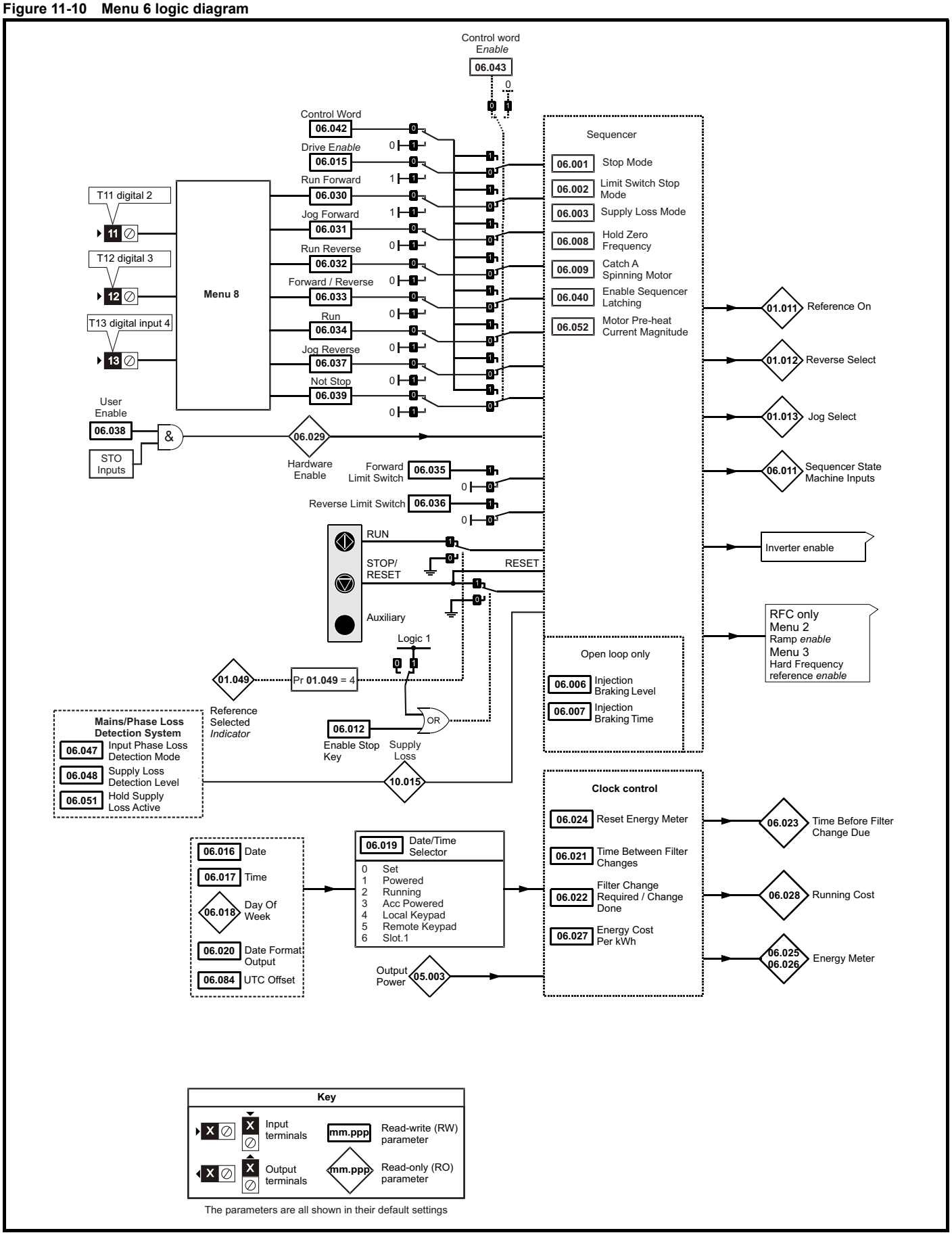
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
05.001	Output Frequency	VM_SPEED_FREQ_REF Hz				RO	Num	ND	NC	PT	FI
05.002	Output Voltage	0 to VM_AC_VOLTAGE V				RO	Num	ND	NC	PT	FI
05.003	Output Power	VM_POWER kW				RO	Num	ND	NC	PT	FI
05.004	Motor Rpm	±33000.0 rpm				RO	Num	ND	NC	PT	FI
05.005	D.C. Bus Voltage	0 to VM_DC_VOLTAGE V				RO	Num	ND	NC	PT	FI
05.006	Motor Rated Frequency	0.00 to 550.00 Hz		50Hz: 50.00 Hz, 60Hz: 60.00 Hz		RW	Num				US
05.007	Motor Rated Current	0.00 to VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032)		RW	Num		RA		US
05.008	Motor Rated Speed	0.0 to 33000.0 rpm		50 Hz: 1500.0 rpm 60 Hz: 1800.0 rpm	50 Hz: 1450.0 rpm 60 Hz: 1750.0 rpm	RW	Num				US
05.009	Motor Rated Voltage	0 to VM_AC_VOLTAGE_SET V		110 V drive: 230 V, 200 V drive: 230 V 400 V drive 50 Hz: 400 V, 400 V drive 60 Hz: 460 V 575 V drive: 575 V, 690 V drive: 690 V		RW	Num		RA		US
05.010	Motor Rated Power Factor	0.00 to 1.00		0.85		RW	Num		RA		US
05.011	Number Of Motor Poles*	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				US
05.012	Auto-tune	0 to 2	0 to 3	0		RW	Num		NC		
05.013	Dynamic V To F Select	0 to 1		0		RW	Num				US
	Flux Optimization Select		0 to 1		0 to 1	RW	Num				US
05.014	Control Mode	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5), Fixed Tapered (6)		Ur I (4)		RW	Txt				US
05.015	Low Frequency Voltage Boost	0.0 to 25.0 %		3.0 %		RW	Num				US
05.017	Stator Resistance	0.0000 to 99.9999 Ω		0.0000 Ω		RW	Num		RA		US
05.018	Maximum Switching Frequency	0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz	2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz	3 (3) kHz		RW	Txt		RA		US
05.019	High Stability Space Vector Modulation	Off (0) or On (1)		Off (0)		RW	Bit				US
05.020	Over Modulation Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
05.021	Mechanical Load Test Level		0 to 100 %		0 %	RW	Bit				US
05.024	Transient Inductance	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	±150.0 %		100.0 %		RW	Num				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		0.0 to 100.0 %		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	
05.033	Slip Compensation Limit	0.00 to 10.00 Hz		10.00 Hz		RW	Num				US
05.034	Percentage Flux		0.0 to 150.0 %			RO	Num	ND	NC	PT	
05.035	Auto-switching Frequency Change Disable	0 to 2		0		RW	Num				US
05.036	Slip Compensation Filter	64 (0), 128 (1), 256 (2), 512 (3) ms		128 (1) ms		RW	Txt				US
05.037	Switching Frequency	0.667 (0), 1 (1), 2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz	2 (2), 3 (3), 4 (4), 6 (5), 8 (6), 12 (7), 16 (8) kHz			RO	Txt	ND	NC	PT	
05.038	Minimum Switching Frequency	0 to VM_MAX_SWITCHING_ FREQUENCY kHz		0.667 (0) kHz		RW	Txt		RA		
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
05.059	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
05.061	Disable Deadtime Compensation	Off (0) or On (1)		Off (0)		RW	Bit				US
05.062	Saturation Breakpoint 2		0.0 to 100.0 %		0.0 %	RW	Num				US
05.063	Saturation Breakpoint 4		0.0 to 100.0 %		0.0 %	RW	Num				US
05.074	Boost End Voltage	0.0 to 100.0 %		50.0 %		RW	Num				US
05.075	Boost End Frequency	0.0 to 100.0 %		50.0 %		RW	Num				US
05.076	Second Point Voltage	0.0 to 100.0 %		55.0 %		RW	Num				US
05.077	Second Point Frequency	0.0 to 100.0 %		55.0 %		RW	Num				US
05.078	Third point voltage	0.0 to 100.0 %		75.0 %		RW	Num				US
05.079	Third point frequency	0.0 to 100.0 %		75.0 %		RW	Num				US
05.080	Low acoustic noise enable	Off (0) or On (1)		Off (0)		RW	Bit				US
05.081	Change to maximum drive switching frequency at low output current	Off (0) or On (1)		Off (0)		RW	Bit				US
05.083	Voltage Shelving Disable	Off (0) or On (1)		Off (0)		RW	Bit				US
05.084	Low Frequency Slip Boost	0.0 to 100.0 %		0.0 %		RW	Num				US
	Low Frequency Estimator Threshold		0.0 to 100.0 %		0.0 %	RW	Num				US
05.088	Ur Mode Pre-Flux Delay	0.0 to 0.7 s		0.5 s		RW	Num				US

* If this parameter is read via serial communications, it will show pole pairs.

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

11.7 Menu 6: Sequencer and clock

Figure 11-10 Menu 6 logic diagram



The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
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), Ramp dc I (2), dc I (3), Timed dc I (4), Disable (5), No Ramp (6)	Ramp (1)		RW	Txt				US
06.002	Limit Switch Stop Mode	Stop (0), Ramp (1)		Ramp (1)		RW	Txt				US
06.003	Supply Loss Mode	Disable (0), Ramp Stop (1), Ride Thru (2), Limit Stop (3)		Disable (0)		RW	Txt				US
06.004	Start/Stop Logic Select	0 to 6		5		RW	Num				US
06.006	Injection Braking Level	0.0 to 150.0 %		100.0 %		RW	Num		RA		US
06.007	Injection Braking Time	0.0 to 100.0 s		1.0 s		RW	Num				US
06.008	Hold Zero Frequency	Off (0) or On (1)		Off (0)		RW	Bit				US
06.009	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)		RW	Txt				US
06.010	Enable Conditions	000000000000 to 111111110111				RO	Bin	ND	NC	PT	
06.011	Sequencer State Machine Inputs	0000000 to 1111111				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 (1), Run Reverse (2)		Disabled (0)		RW	Txt				US
06.014	Disable Auto Reset On Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
06.015	Drive Enable	Off (0) or On (1)		On (1)		RW	Bit				US
06.016	Date	00-00-00 to 31-12-99				RW	Date	ND	NC	PT	
06.017	Time	00:00:00 to 23:59:59				RW	Time	ND	NC	PT	
06.018	Day Of Week	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)				RO	Txt	ND	NC	PT	
06.019	Date/Time Selector	Set (0), Powered (1), Running (2), Acc Powered (3), Local Keypad. (4), Remote Keypad (5), Slot 1 (6)		Powered (1)		RW	Txt				US
06.020	Date Format	Std (0), 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 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		NC		
06.030	Run Forward	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.031	Jog Forward	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.032	Run Reverse	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.033	Forward/Reverse	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.034	Run	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.035	Forward Limit Switch	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.036	Reverse Limit Switch	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.037	Jog Reverse	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.038	User Enable	Off (0) or On (1)		On (1)		RW	Bit		NC		
06.039	Not Stop	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.040	Enable Sequencer Latching	Off (0) or On (1)		Off (0)		RW	Bit				US
06.041	Drive Event Flags	00 to 11		00		RW	Bin		NC		
06.042	Control Word	000000000000000 to 111111111111111		000000000000000		RW	Bin		NC		
06.043	Control Word Enable	0 to 1		0		RW	Num		NC		US
06.045	Cooling Fan control	0 to 5		2		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	0 to VM_SUPPLY_LOSS_LEVEL V		110V drive: 205 V, 200V drive: 205 V 400V drive: 410 V, 575V drive: 540 V 690V drive: 540 V		RW	Num		RA		US
06.051	Hold Supply Loss Active	Off (0) or On (1)		Off (0)		RW	Bit		NC		
06.052	Motor Pre-heat Current Magnitude	0 to 100 %		0 %		RW	Num				US
06.058	Output Phase Loss Detection Time	0.5 (0), 1.0 (1), 2.0 (2), 4.0 (3) s		0.5 (0) s		RW	Txt				US
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	0000 to 1111		0000		RW	Bin				US
06.071	Slow Rectifier Charge Rate Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
06.073	Braking IGBT Lower Threshold	0 to VM_DC_VOLTAGE_SET V		110V drive: 390 V, 200V drive: 390 V 400V drive: 780 V, 575V drive: 930 V 690V drive: 1120 V		RW	Num		RA		US
06.074	Braking IGBT Upper Threshold	0 to VM_DC_VOLTAGE_SET V		110V drive: 390 V, 200V drive: 390 V 400V drive: 780 V, 575V drive: 930 V 690V drive: 1120 V		RW	Num		RA		US
06.075	Low Voltage Braking IGBT Threshold	0 to VM_DC_VOLTAGE_SET V		0 V		RW	Num		RA		US
06.076	Low Voltage Braking IGBT Threshold Select	Off (0) or On (1)		Off (0)		RW	Bit				
06.077	Low DC Link Operation	Off (0) or On (1)		Off (0)		RW	Bit				US
06.084	UTC Offset	± 24.00 Hours		0.00 Hours		RW	Num				US
06.089	DC Injection Active	Off (0) or On (1)				RO	Bit		NC	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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.8 Menu 7: Analog I/O

Figure 11-11 Menu 7 logic diagram

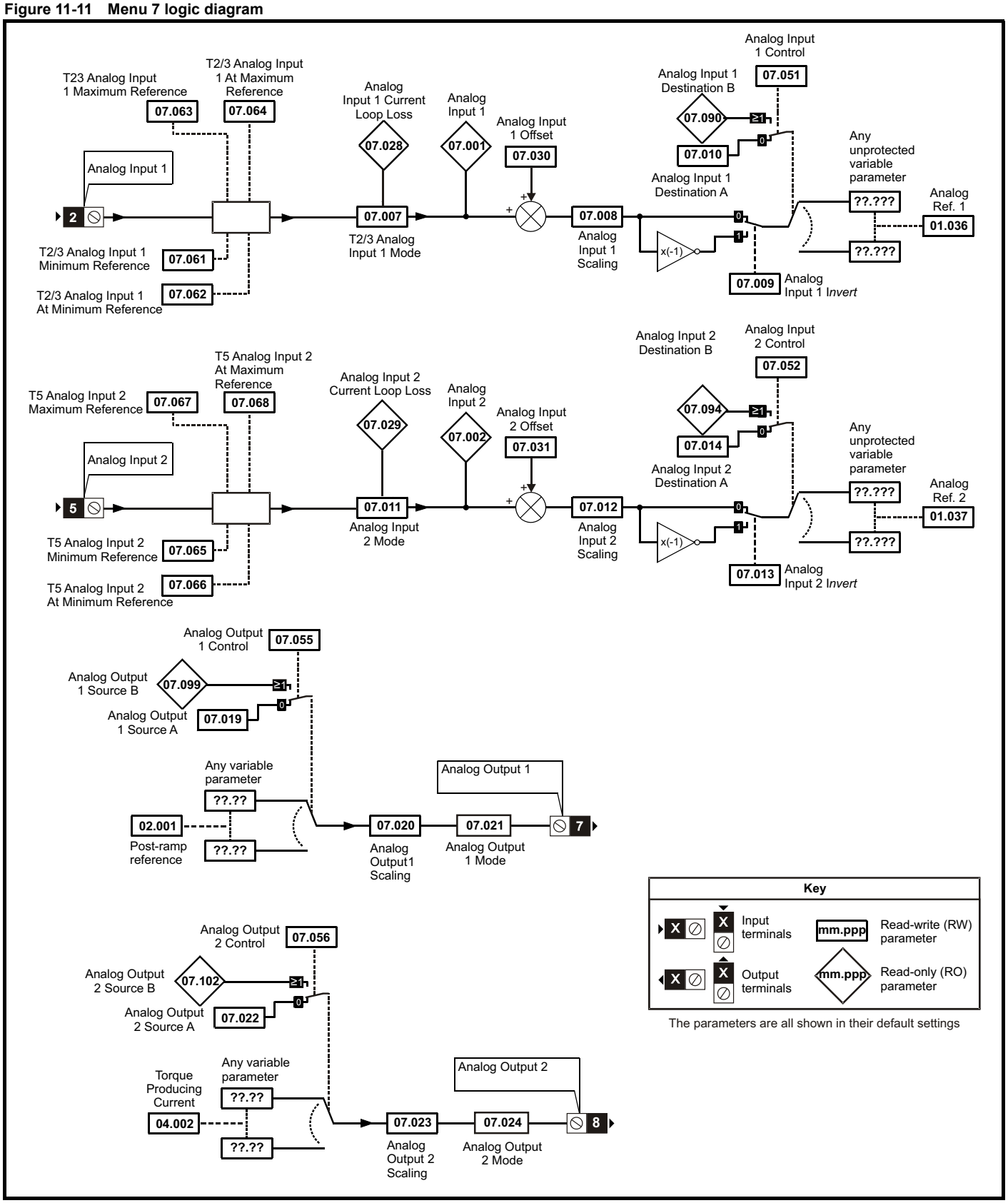
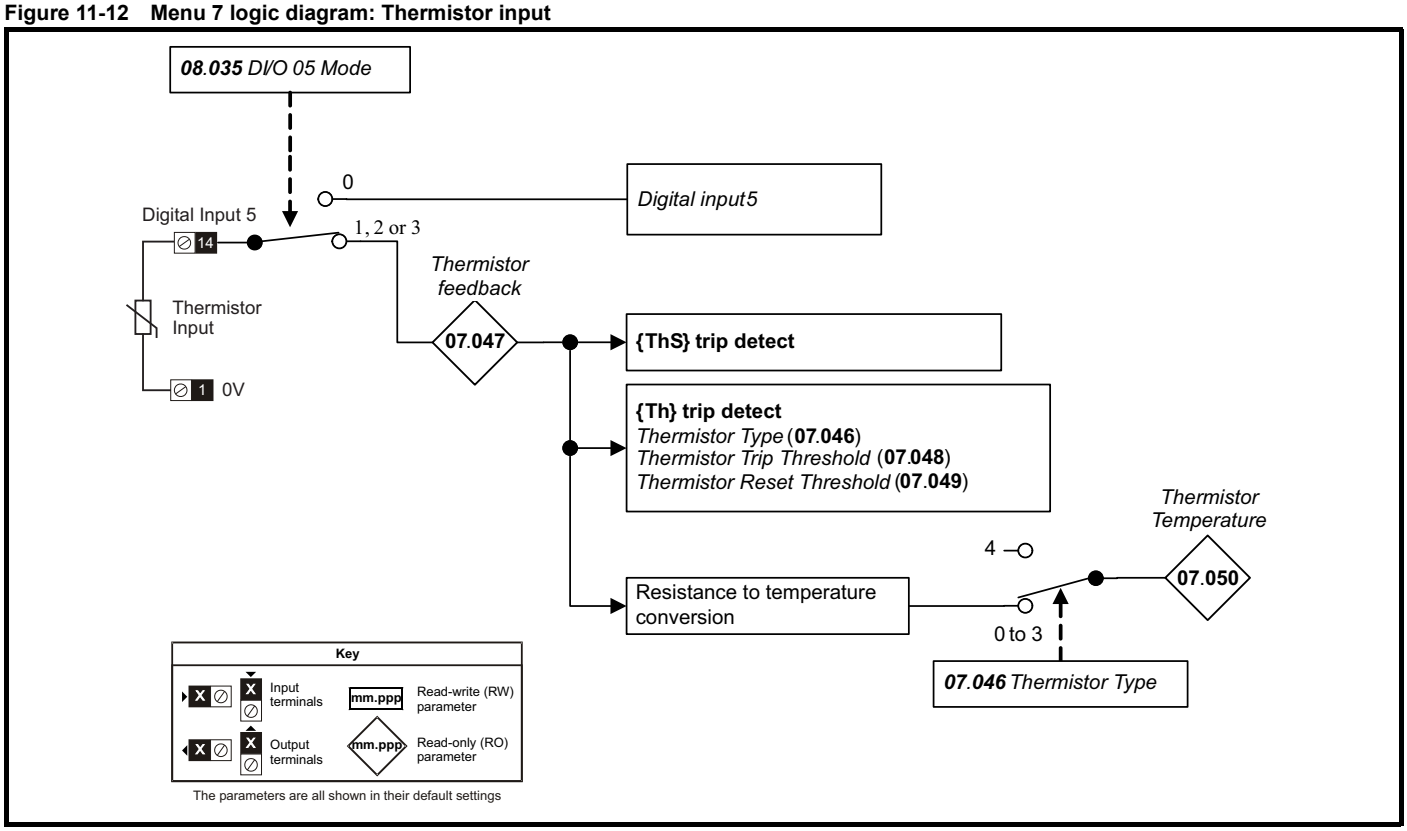


Figure 11-12 Menu 7 logic diagram: Thermistor input

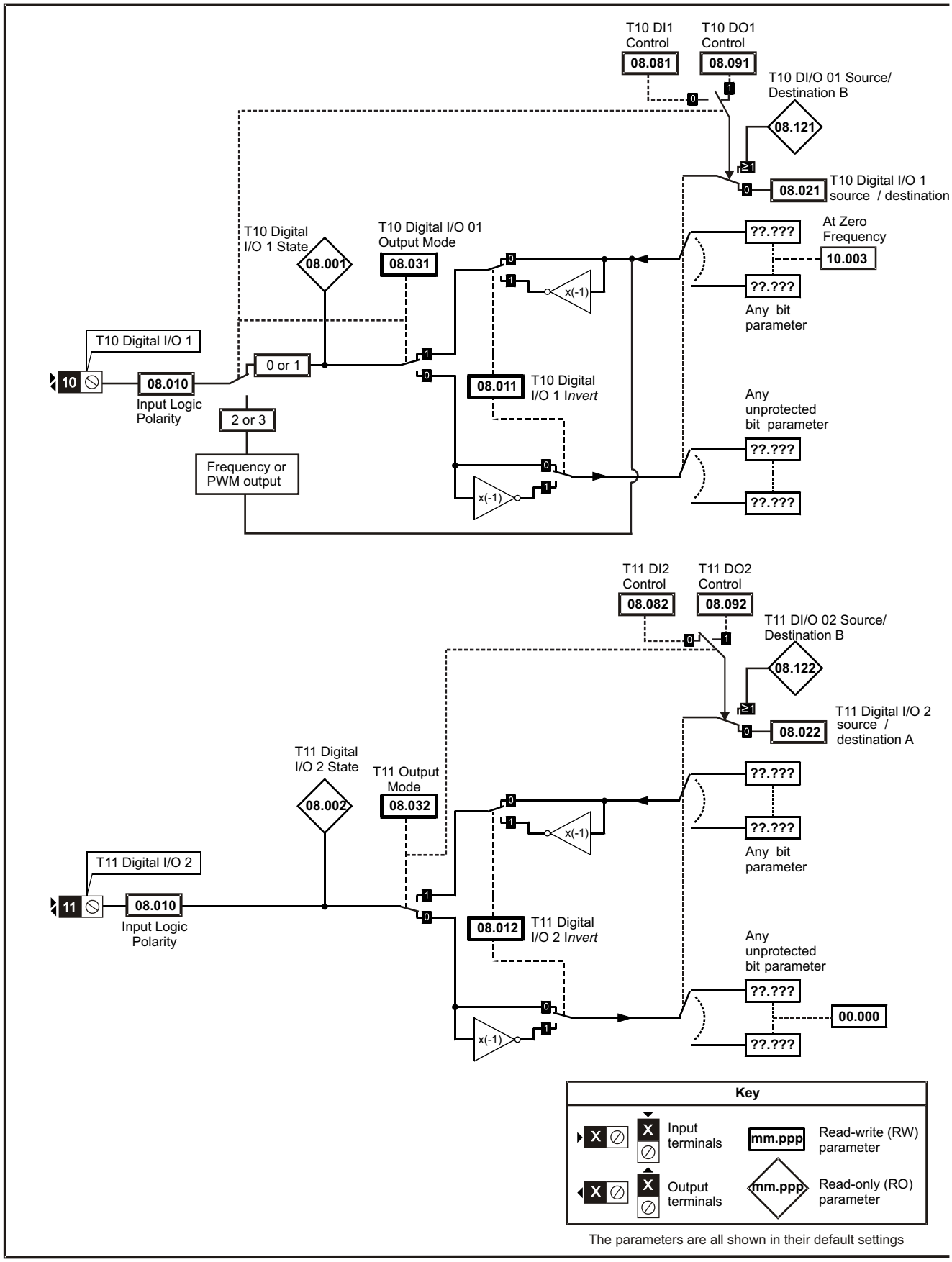


Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
07.001	Analog Input 1 (T2/3)	±100.00 %				RO	Num	ND	NC	PT	FI
07.002	Analog Input 2 (T5)	0.00 to 100.00 %				RO	Num	ND	NC	PT	FI
07.004	Stack Temperature	±250 °C				RO	Num	ND	NC	PT	
07.005	Auxiliary Temperature	±250 °C				RO	Num	ND	NC	PT	
07.007	Analog Input 1 Mode (T2/3)	4-20mA Stop (-6), 20-4mA Stop (-5), 4-20mA Low (-4), 20-4mA Low (-3), 4-20mA Hold (-2), 20-4mA Hold (-1), 0-20mA (0), 20-0mA (1), 4-20mA Trp (2), 20-4mA Trp (3), 4-20mA (4), 20-4mA (5), Voltage (6)		Voltage (6)		RW	Txt				US
07.008	Analog Input 1 Scaling (T2/3)	0.000 to 10.000		1.000		RW	Num				US
07.009	Analog Input 1 Invert (T2/3)	Off (0) or On (1)		Off (0)		RW	Bit				US
07.010	Analog Input 1 Destination A (T2/3)	0.000 to 30.999		1.036		RW	Num	DE		PT	US
07.011	Analog Input 2 Mode (T5)	4-20mA Stop (-6), 20-4mA Stop (-5), 4-20mA Low (-4), 20-4mA Low (-3), 4-20mA Hold (-2), 20-4mA Hold (-1), 0-20mA (0), 20-0mA (1), 4-20mA Trp (2), 20-4mA Trp (3), 4-20mA (4), 20-4mA (5), Voltage (6), Digital (7)		Voltage (6)		RW	Txt				US
07.012	Analog Input 2 Scaling (T5)	0.000 to 10.000		1.000		RW	Num				US
07.013	Analog Input 2 Invert (T5)	Off (0) or On (1)		Off (0)		RW	Bit				US
07.014	Analog Input 2 Destination A (T5)	0.000 to 30.999		1.037		RW	Num	DE		PT	US
07.019	Analog Output 1 Source A (T7)	0.000 to 30.999		2.001		RW	Num			PT	US
07.020	Analog Output 1 Scaling (T7)	0.000 to 40.000		1.000		RW	Num				US
07.021	Analog Output 1 Mode (T7)	Voltage (0), 0-20mA (1), 4-20mA (2), Digital (3)		Voltage (0)		RW	Txt				US
07.022	Analog Output 2 Source A (T8)	0.000 to 30.999		4.002		RW	Num			PT	US
07.023	Analog Output 2 Scaling (T8)	0.000 to 40.000		1.000		RW	Num				US
07.024	Analog Output 2 Mode (T8)	Voltage (0), 0-20mA (1), 4-20mA (2), Digital (3)		Voltage (0)		RW	Txt				US
07.026	Analog Input 1 Preset on Current Loss (T2/3)	4.00 to 20.00		4.00		RW	Num				US
07.027	Analog Input 2 Preset on Current Loss (T5)	4.00 to 20.00		4.00		RW	Num				US
07.028	Analog Input 1 Current Loop Loss (T2/3)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
07.029	Analog Input 2 Current Loop Loss (T5)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
07.030	Analog Input 1 Offset (T2/3)	±100.00 %		0.00 %		RW	Num				US
07.031	Analog Input 2 Offset (T5)	±100.00 %		0.00 %		RW	Num				US
07.034	Inverter Temperature	±250 °C				RO	Num	ND	NC	PT	
07.035	Percentage Of d.c. Link Thermal Trip Level	0 to 100 %				RO	Num	ND	NC	PT	
07.036	Percentage Of Drive Thermal Trip Level	0 to 100 %				RO	Num	ND	NC	PT	
07.037	Temperature Nearest To Trip Level	0 to 29999				RO	Num	ND	NC	PT	
07.046	Thermistor Type	DIN44081 (0), KTY84 (1), PT1000 (2), PT2000 (3), Other (4)		DIN44081 (0)		RW	Txt				US
07.047	Thermistor Feedback	0 to 4000 Ω				RO	Num	ND	NC	PT	FI
07.048	Thermistor Trip Threshold	0 to 4000 Ω		3300 Ω		RW	Num				US
07.049	Thermistor Reset Threshold	0 to 4000 Ω		1800 Ω		RW	Num				US
07.050	Thermistor Temperature	-50 to 300 °C				RO	Num	ND	NC	PT	FI
07.051	Analog Input 1 Control (T2/3)	0 to 5		0		RW	Num				US
07.052	Analog Input 2 Control (T5)	0 to 5		0		RW	Num				US
07.055	Analog Output 1 Control (T7)	0 to 15		0		RW	Num				US
07.056	Analog Output 2 Control (T8)	0 to 15		0		RW	Num				US
07.061	Analog Input 1 Minimum Reference (T2/3)	±100.00 %		-100.00 %		RW	Num				US
07.062	Analog Input 1 At Minimum Reference (T2/3)	±100.00 %		-100.00 %		RW	Num				US
07.063	Analog Input 1 Maximum Reference (T2/3)	±100.00 %		100.00 %		RW	Num				US
07.064	Analog Input 1 At Maximum Reference (T2/3)	±100.00 %		100.00 %		RW	Num				US
07.065	Analog Input 2 Minimum Reference (T5)	0.00 to 100.00 %		0.00 %		RW	Num				US
07.066	Analog Input 2 At Minimum Reference (T5)	±100.00 %		0.00 %		RW	Num				US
07.067	Analog Input 2 Maximum Reference (T5)	0.00 to 100.00 %		100.00 %		RW	Num				US
07.068	Analog Input 2 At Maximum Reference (T5)	±100.00 %		100.00 %		RW	Num				US
07.090	Analog Input 1 Destination B (T2/3)	0.000 to 30.999				RO	Num	DE		PT	US
07.094	Analog Input 2 Destination B (T5)	0.000 to 30.999				RO	Num	DE		PT	US
07.099	Analog Output 1 Source B (T7)	0.000 to 30.999				RO	Num			PT	US
07.102	Analog Output 2 Source B (T8)	0.000 to 30.999				RO	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	

11.9 Menu 8: Digital I/O

Figure 11-13 Menu 8 logic diagram



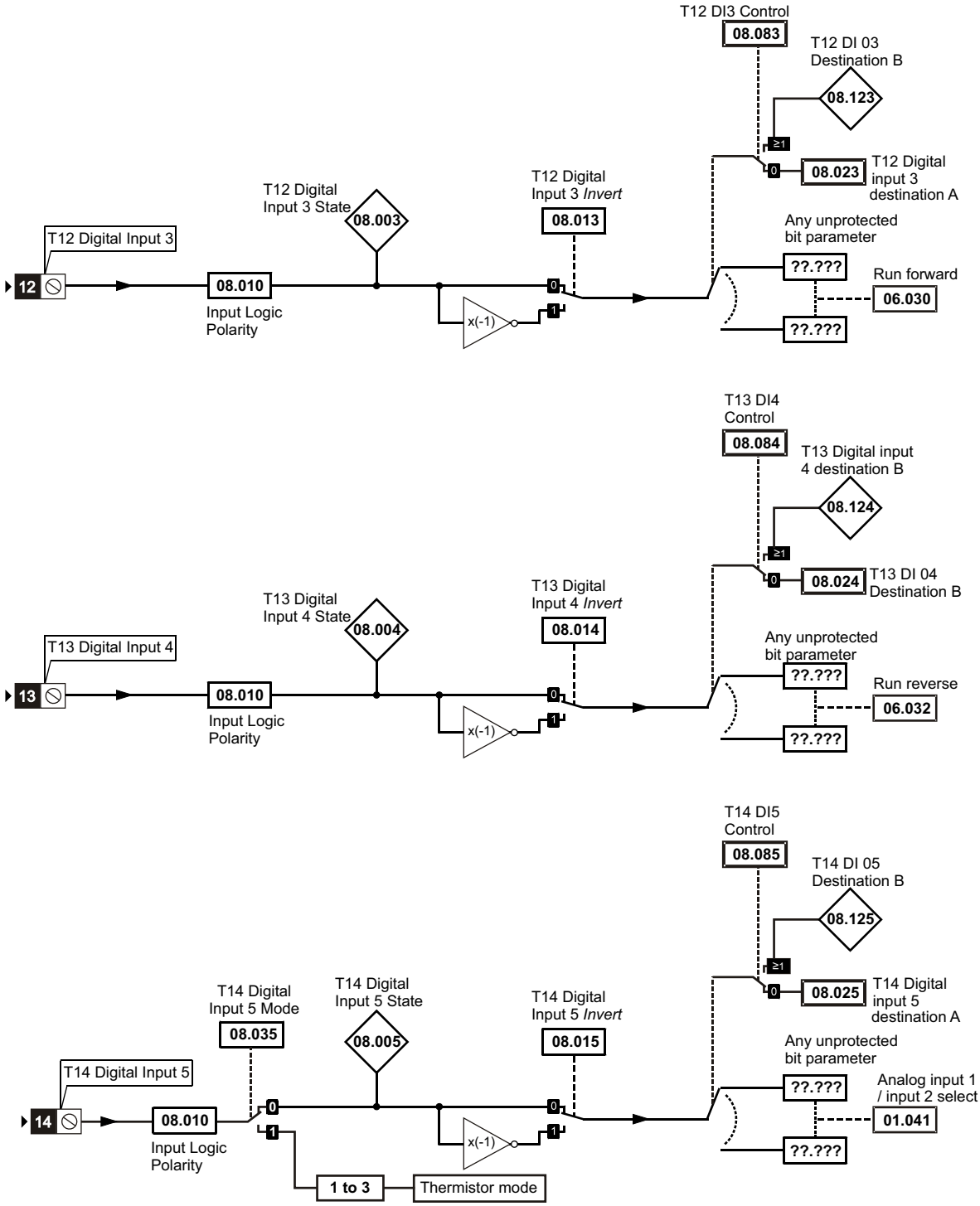

T12 DI3 Control
08.083
T12 DI 03 Destination B
08.123
≥1
0
08.023
T12 Digital input 3 destination A
T12 Digital Input 3 State
08.003
T12 Digital Input 3 Invert
08.013
Any unprotected bit parameter
??.???
Run forward
06.030
??.???
T12 Digital Input 3
12
08.010
Input Logic Polarity
x(-1)
0
1
T13 DI4 Control
08.084
T13 Digital input 4 destination B
08.124
≥1
0
08.024
T13 DI 04 Destination B
T13 Digital Input 4 State
08.004
T13 Digital Input 4 Invert
08.014
Any unprotected bit parameter
??.???
Run reverse
06.032
??.???
T13 Digital Input 4
13
08.010
Input Logic Polarity
x(-1)
0
1
T14 DI5 Control
08.085
T14 DI 05 Destination B
08.125
≥1
0
08.025
T14 Digital input 5 destination A
T14 Digital Input 5 Mode
08.035
T14 Digital Input 5 State
08.005
T14 Digital Input 5 Invert
08.015
Any unprotected bit parameter
??.???
Analog input 1 / input 2 select
01.041
??.???
T14 Digital Input 5
14
08.010
Input Logic Polarity
0
1
x(-1)
0
1
1 to 3
Thermistor mode

Figure 11-14 Menu 8 logic diagram (cont)

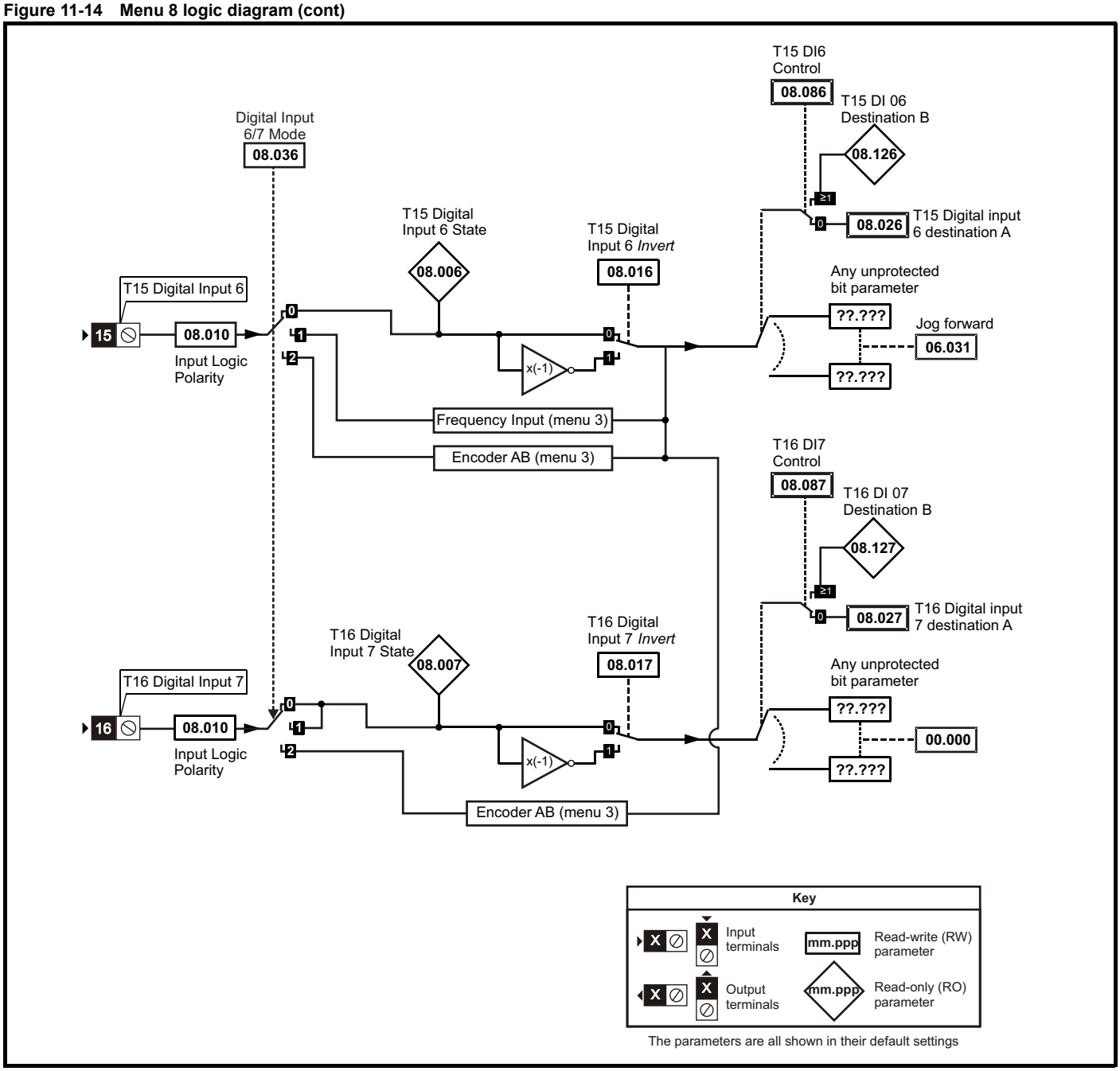


Figure 11-15 Menu 8 logic (relay)

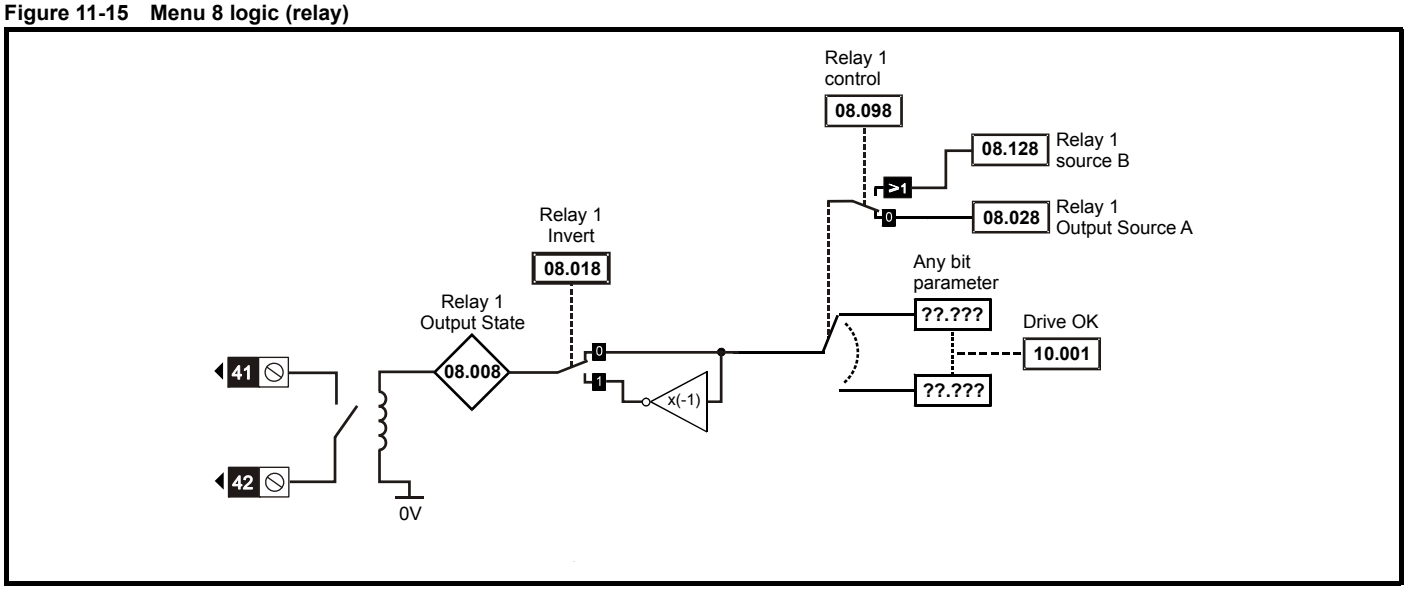


Figure 11-16 Safe Torque Off logic diagram (frame 1 to 4)

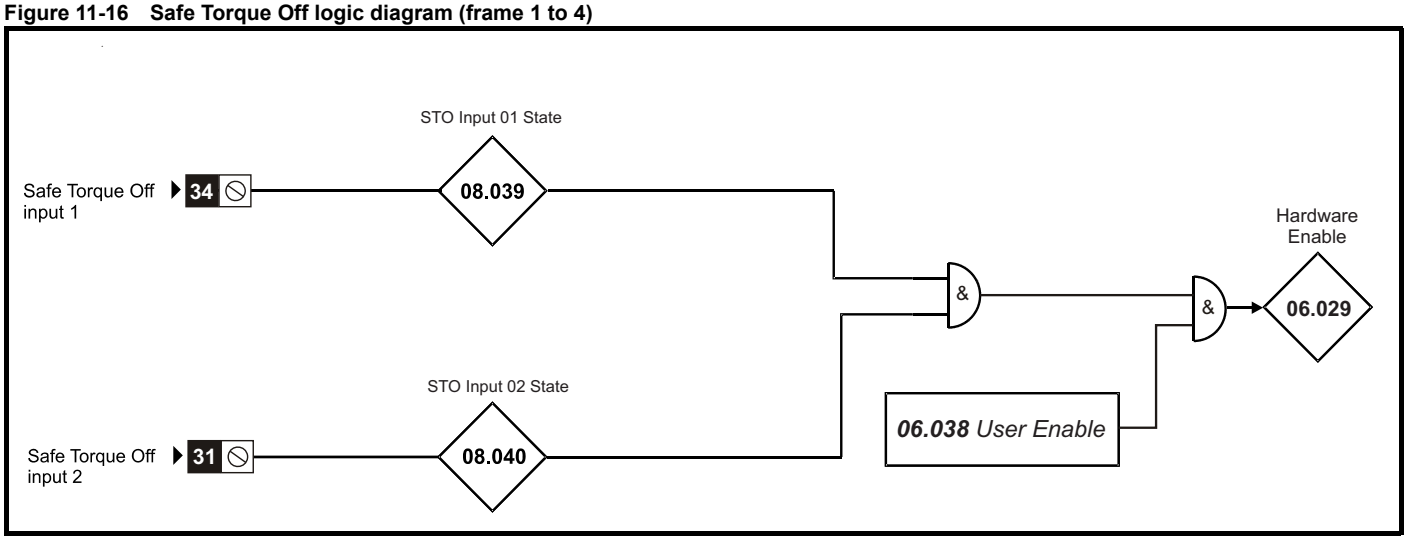


Figure 11-17 Safe Torque Off logic diagram (frame 5 to 9)

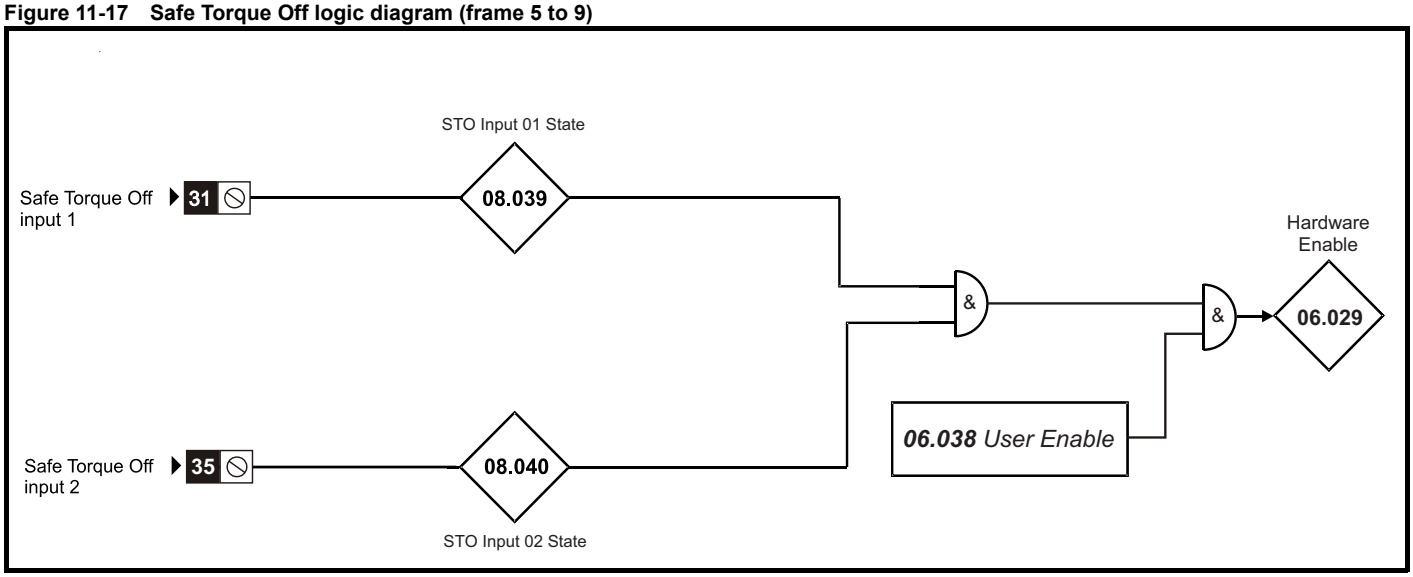
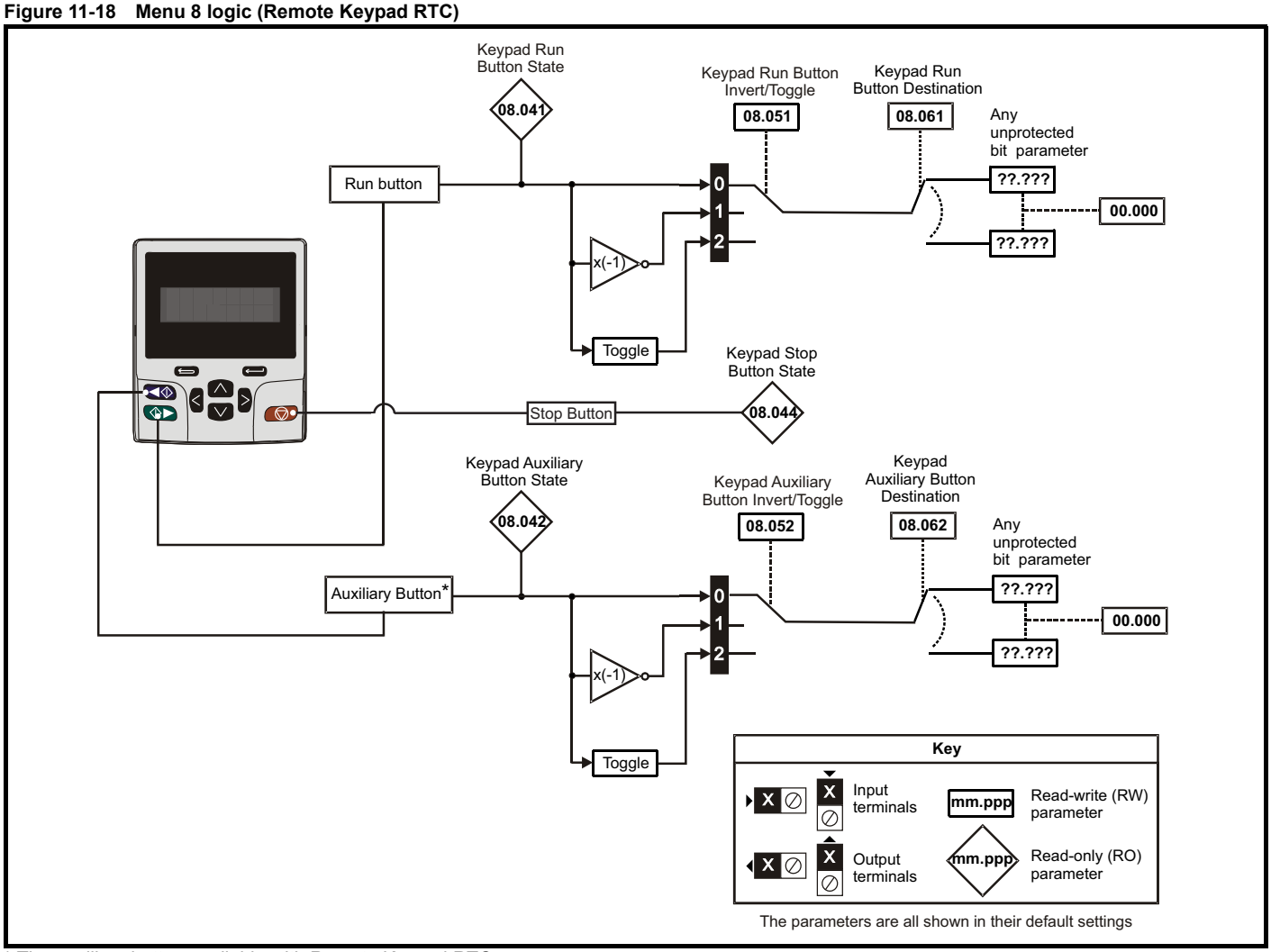
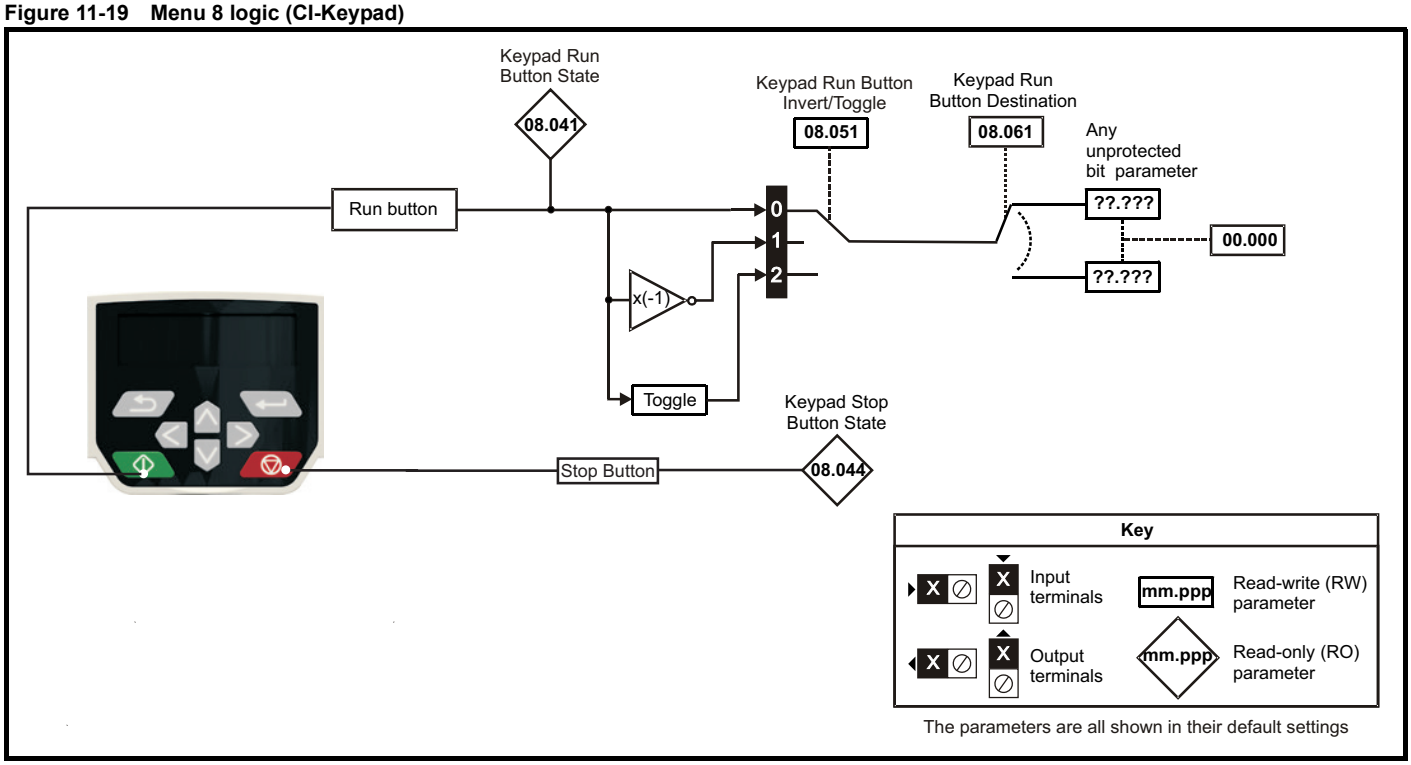


Figure 11-18 Menu 8 logic (Remote Keypad RTC)



* The auxiliary button available with Remote Keypad RTC.

Figure 11-19 Menu 8 logic (CI-Keypad)

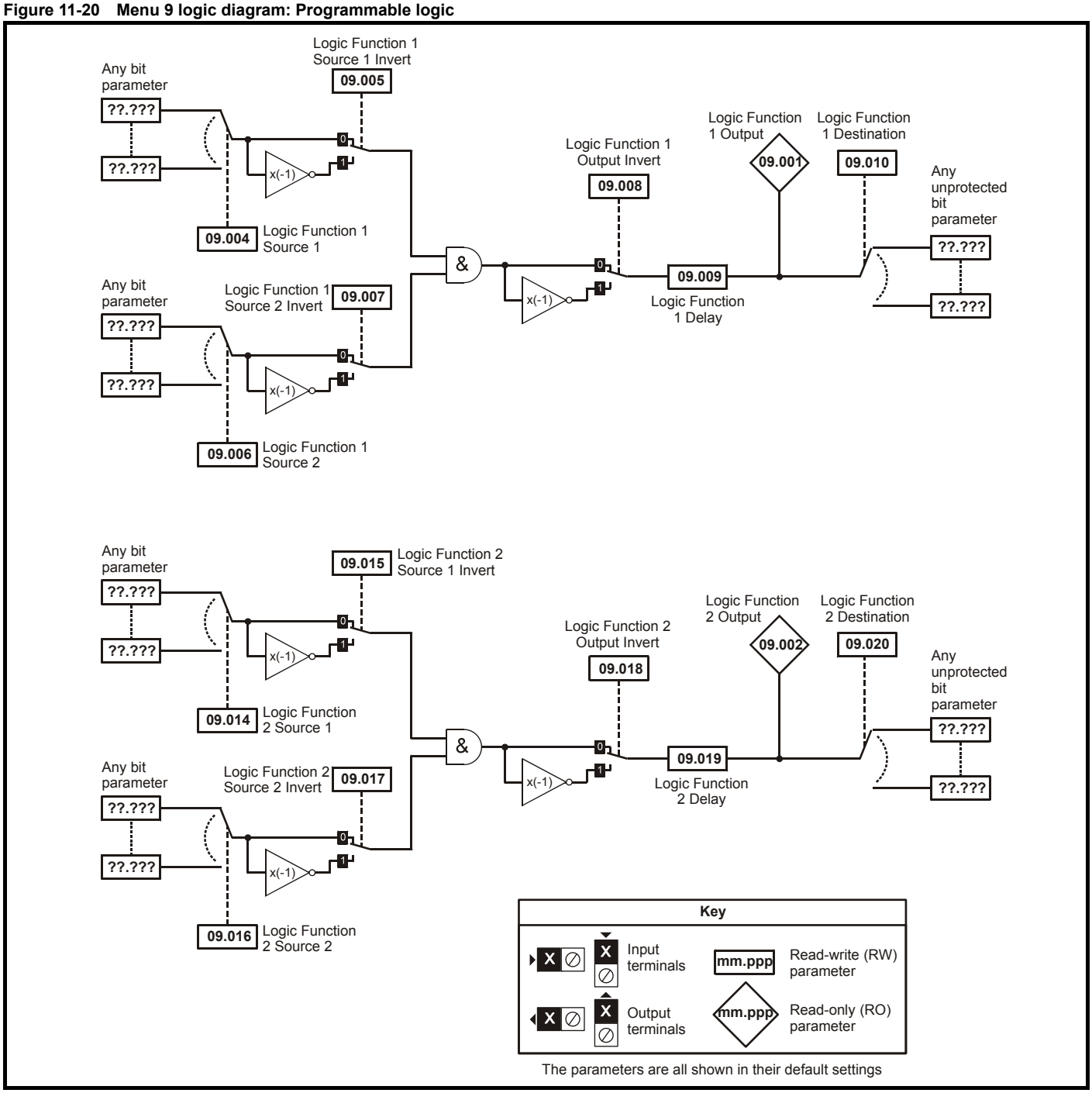


Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
08.001	Digital I/O 1 State (T10)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.002	Digital I/O 2 State (T11)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.003	Digital Input 3 State (T12)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.004	Digital Input 4 State (T13)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.005	Digital Input 5 State (T14)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.006	Digital Input 6 State (T15)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.007	Digital Input 7 State (T16)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.008	Relay 1 Output State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.010	Input Logic Polarity	Negative Logic (0), Positive Logic (1)		Positive Logic (1)		RW	Txt				US
08.011	Digital I/O 1 Invert (T10)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.012	Digital I/O 2 Invert (T11)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.013	Digital Input 3 Invert (T12)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.014	Digital Input 4 Invert (T13)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.015	Digital Input 5 Invert (T14)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.016	Digital Input 6 Invert (T15)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.017	Digital Input 7 Invert (T16)	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.018	Relay 1 Invert	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.020	Digital I/O Read Word	000000000000 to 111111111111				RO	Bin	ND	NC	PT	
08.021	Digital IO1 Source/Destination A (T10)	0.000 to 30.999		10.003		RW	Num	DE		PT	US
08.022	Digital IO2 Source/Destination A (T11)	0.000 to 30.999		0.000		RW	Num	DE		PT	US
08.023	Digital Input 03 Destination A (T12)	0.000 to 30.999		6.030		RW	Num	DE		PT	US
08.024	Digital Input 04 Destination A (T13)	0.000 to 30.999		6.032		RW	Num	DE		PT	US
08.025	Digital Input 05 Destination A (T14)	0.000 to 30.999		1.041		RW	Num	DE		PT	US
08.026	Digital Input 06 Destination A (T15)	0.000 to 30.999		6.031		RW	Num	DE		PT	US
08.027	Digital Input 07 Destination A (T16)	0.000 to 30.999		0.000		RW	Num	DE		PT	US
08.028	Relay 1 Output Source A	0.000 to 30.999		10.001		RW	Num			PT	US
08.031	Digital I/O 01 Output Mode (T10)	Input (0), Output (1), Frequency output (2), PWM output (3)		Output (1)		RW	Txt				US
08.032	Digital I/O 02 Output Mode (T11)	Input (0), Output (1)		Input (0)		RW	Txt				US
08.035	Digital Input 5 Mode (T14)	Input (0), Therm Short Cct (1), Thermistor (2), Therm No Trip (3)		Input (0)		RW	Txt				US
08.036	Digital Input 6/7 Mode (T15/16)	Digital Input (0), Frequency (1), Encoder AB (2)		Digital Input (0)		RW	Txt				US
08.039	STO Input 01 State (T34)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.040	STO Input 02 State (T31)	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.041	Keypad Run Button State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.042	Keypad Auxiliary Button State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.043	24V Supply Input State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.044	Keypad Stop Button State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.051	Keypad Run Button Invert/Toggle	Not Invert (0), Invert (1), Toggle (2)		Not Invert (0)		RW	Txt				US
08.052	Keypad Auxiliary Button Invert/Toggle	Not Invert (0), Invert (1), Toggle (2)		Not Invert (0)		RW	Txt				US
08.053	24V Supply Input Invert	Not Invert (0), Invert (1)		Not Invert (0)		RW	Txt				US
08.061	Keypad Run Button Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
08.062	Keypad Auxiliary Button Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
08.063	24V Supply Input Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
08.081	DI1 Control (T10)	0 to 26		0		RW	Num				US
08.082	DI2 Control (T11)	0 to 26		0		RW	Num				US
08.083	DI3 Control (T12)	0 to 26		0		RW	Num				US
08.084	DI4 Control (T13)	0 to 26		0		RW	Num				US
08.085	DI5 Control (T14)	0 to 26		0		RW	Num				US
08.086	DI6 Control (T15)	0 to 26		0		RW	Num				US
08.087	DI7 Control (T16)	0 to 26		0		RW	Num				US
08.091	DO1 Control (T10)	0 to 21		0		RW	Num				US
08.092	DO2 Control (T11)	0 to 21		0		RW	Num				US
08.098	Relay 1 Control	0 to 21		0		RW	Num				US
08.121	DI/O 01 Source/Destination B (T10)	0.000 to 30.999				RO	Num	DE		PT	US
08.122	DI/O 02 Source/Destination B (T11)	0.000 to 30.999				RO	Num	DE		PT	US
08.123	DI 03 Destination B (T12)	0.000 to 30.999				RO	Num	DE		PT	US
08.124	DI 04 Destination B (T13)	0.000 to 30.999				RO	Num	DE		PT	US
08.125	DI 05 Destination B (T14)	0.000 to 30.999				RO	Num	DE		PT	US
08.126	DI 06 Destination B (T15)	0.000 to 30.999				RO	Num	DE		PT	US
08.127	DI 07 Destination B (T16)	0.000 to 30.999				RO	Num	DE		PT	US
08.128	Relay 01 Source B	0.000 to 30.999		0.000		RW	Num			PT	US

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

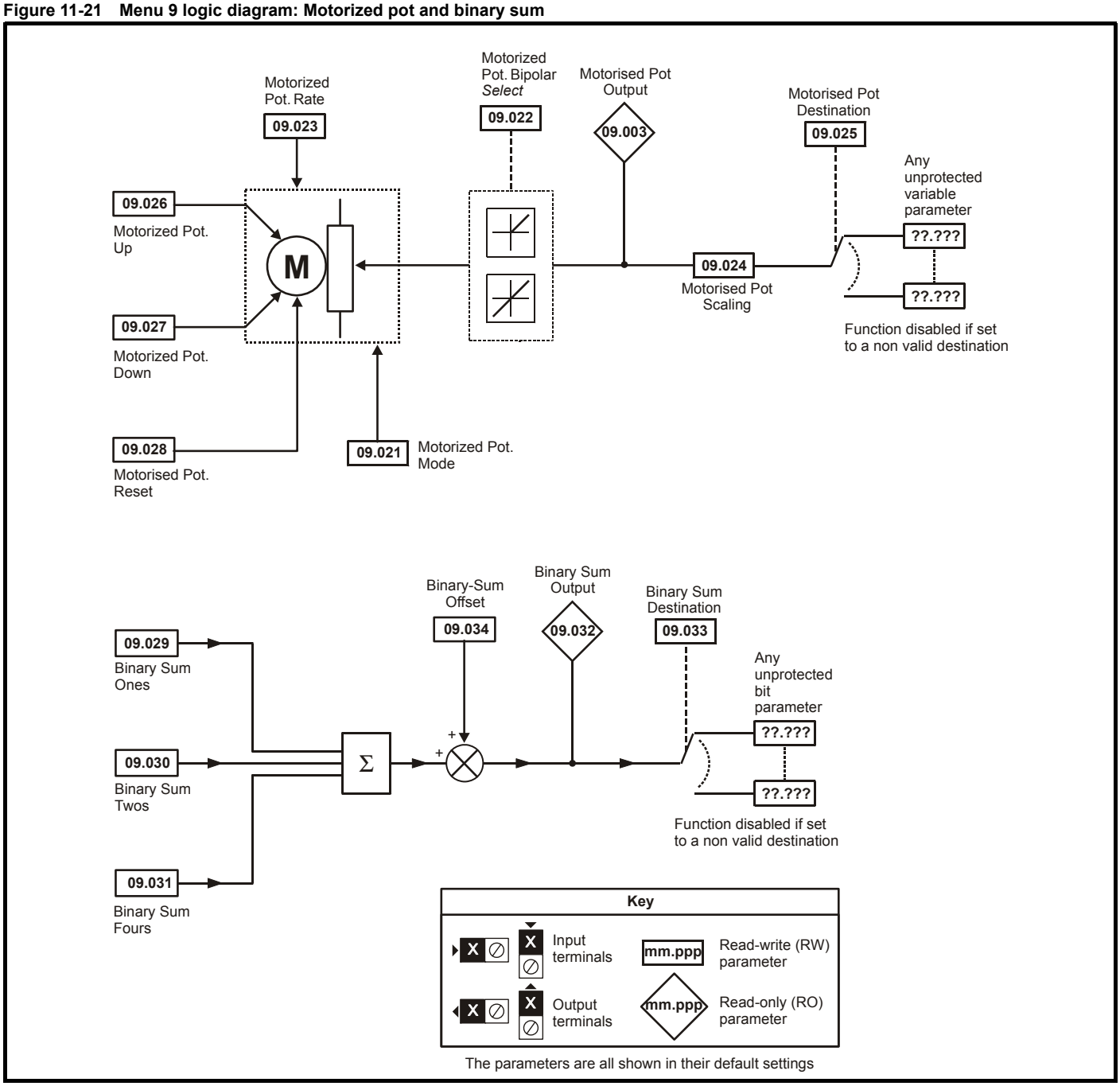
11.10 Menu 9: Programmable logic, motorized pot, binary sum and timers

Figure 11-20 Menu 9 logic diagram: Programmable logic



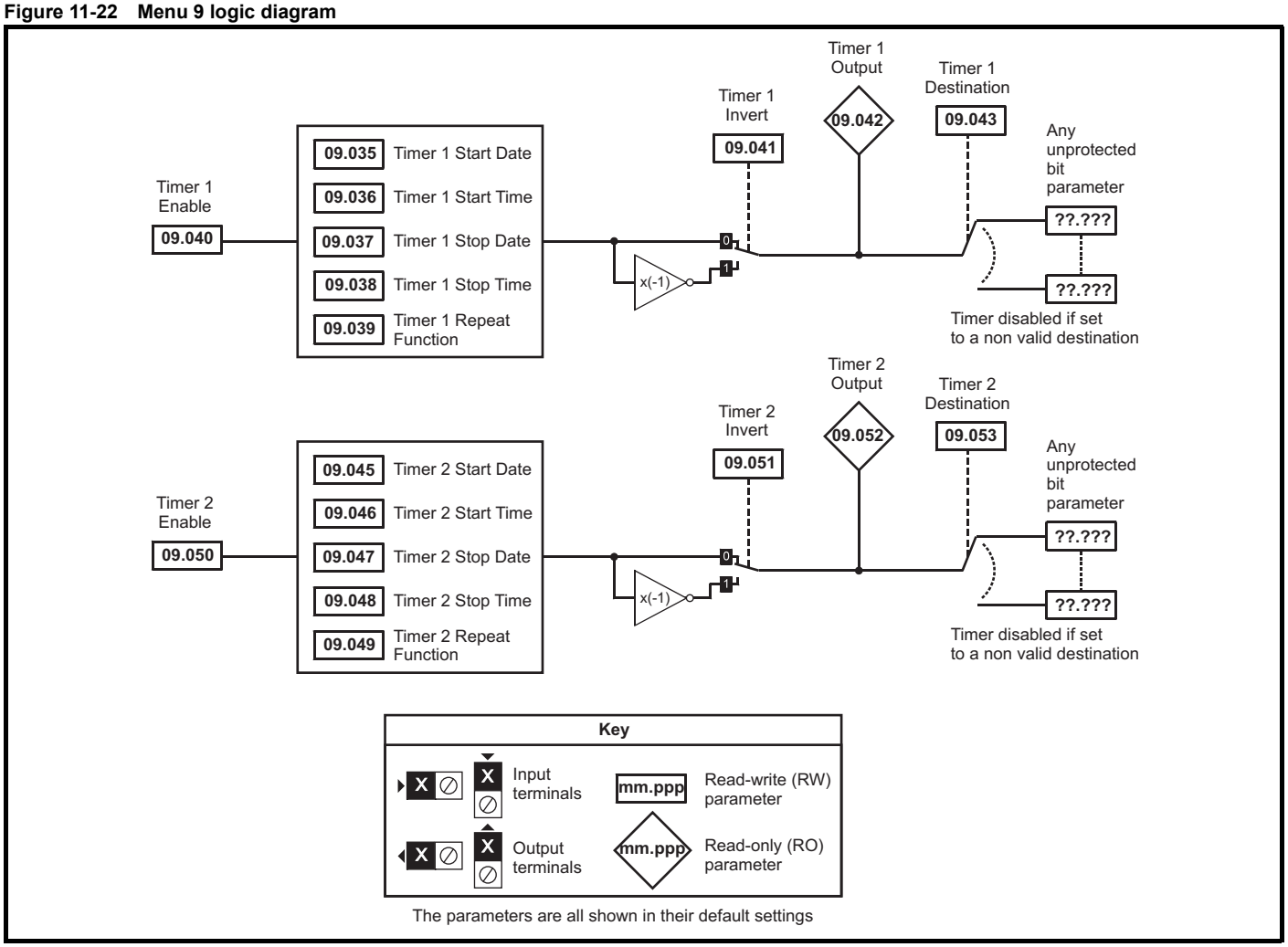
The parameters are all shown in their default settings

Figure 11-21 Menu 9 logic diagram: Motorized pot and binary sum



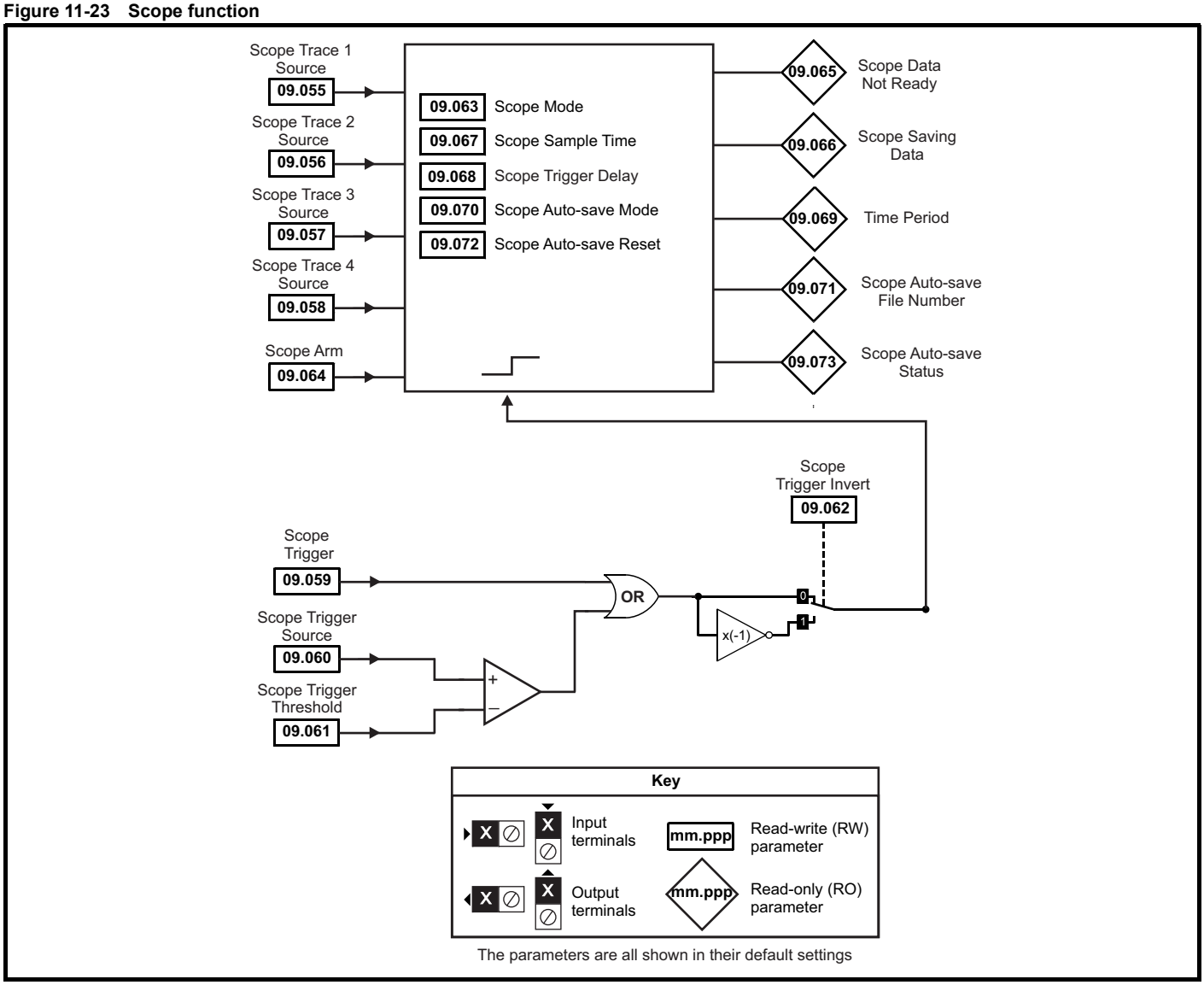
The parameters are all shown in their default settings

Figure 11-22 Menu 9 logic diagram



The parameters are all shown in their default settings

Figure 11-23 Scope function



The parameters are all shown in their default settings

Parameter		Range (⇕)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
09.001	Logic Function 1 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.002	Logic Function 2 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.003	Motorised Pot Output	±100.00 %				RO	Num	ND	NC	PT	PS
09.004	Logic Function 1 Source 1	0.000 to 30.999		0.000		RW	Num			PT	US
09.005	Logic Function 1 Source 1 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.006	Logic Function 1 Source 2	0.000 to 30.999		0.000		RW	Num			PT	US
09.007	Logic Function 1 Source 2 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.008	Logic Function 1 Output Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.009	Logic Function 1 Delay	±25.0 s		0.0 s		RW	Num				US
09.010	Logic Function 1 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.014	Logic Function 2 Source 1	0.000 to 30.999		0.000		RW	Num			PT	US
09.015	Logic Function 2 Source 1 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.016	Logic Function 2 Source 2	0.000 to 30.999		0.000		RW	Num			PT	US
09.017	Logic Function 2 Source 2 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.018	Logic Function 2 Output Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.019	Logic Function 2 Delay	±25.0 s		0.0 s		RW	Num				US
09.020	Logic Function 2 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.021	Motorised Pot Mode	0 to 4		0		RW	Num				US
09.022	Motorised Pot Bipolar Select	Off (0) or On (1)		Off (0)		RW	Bit				US
09.023	Motorised Pot Rate	0 to 250 s		20 s		RW	Num				US
09.024	Motorised Pot Scaling	0.000 to 4.000		1.000		RW	Num				US
09.025	Motorised Pot Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.026	Motorised Pot Up	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.027	Motorised Pot Down	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.028	Motorised Pot Reset	Off (0) or On (1)		Off (0)		RW	Bit		NC		
09.029	Binary Sum Ones	Off (0) or On (1)		Off (0)		RW	Bit				
09.030	Binary Sum Twos	Off (0) or On (1)		Off (0)		RW	Bit				
09.031	Binary Sum Fours	Off (0) or On (1)		Off (0)		RW	Bit				
09.032	Binary Sum Output	0 to 255				RO	Num	ND	NC	PT	
09.033	Binary Sum Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.034	Binary Sum Offset	0 to 248		0		RW	Num				US
09.035	Timer 1 Start Date	00-00-00 to 31-12-99		00-00-00		RW	Date				US
09.036	Timer 1 Start Time	00:00:00 to 23:59:59		00:00:00		RW	Time				US
09.037	Timer 1 Stop Date	00-00-00 to 31-12-99		00-00-00		RW	Date				US
09.038	Timer 1 Stop Time	00:00:00 to 23:59:59		00:00:00		RW	Time				US
09.039	Timer 1 Repeat Function	None (0), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (7)		None (0)		RW	Txt				US
09.040	Timer 1 Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
09.041	Timer 1 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.042	Timer 1 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.043	Timer 1 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.045	Timer 2 Start Date	00-00-00 to 31-12-99		00-00-00		RW	Date				US
09.046	Timer 2 Start Time	00:00:00 to 23:59:59		00:00:00		RW	Time				US
09.047	Timer 2 Stop Date	00-00-00 to 31-12-99		00-00-00		RW	Date				US
09.048	Timer 2 Stop Time	00:00:00 to 23:59:59		00:00:00		RW	Time				US
09.049	Timer 2 Repeat Function	None (0), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (7)		None (0)		RW	Txt				US
09.050	Timer 2 Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
09.051	Timer 2 Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
09.052	Timer 2 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.053	Timer 2 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
09.055	Scope Trace 1 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.056	Scope Trace 2 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.057	Scope Trace 3 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.058	Scope Trace 4 Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.059	Scope Trigger	Off (0) or On (1)		Off (0)		RW	Bit				
09.060	Scope Trigger Source	0.000 to 30.999		0.000		RW	Num			PT	US
09.061	Scope Trigger Threshold	-2147483648 to 2147483647		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	Off (0) or On (1)				RO	Bit	ND	NC	PT	
09.067	Scope Sample Time	1 to 200 ms		1 ms		RW	Num				US
09.068	Scope Trigger Delay	0 to 100 %		0 %		RW	Num				US

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
09.069	Scope Time Period	0.00 to 200000.00 ms				RO	Bit	ND	NC	PT	
09.070	Scope Auto-save Mode	Disabled (0), Overwrite (1), Keep (2)		Disabled (0)		RW	Txt				US
09.071	Scope Auto-save File Number	0 to 99		0		RO	Num				PS
09.072	Scope Auto-save Reset	Off (0) or On (1)		Off (0)		RW	Bit				
09.073	Scope Auto-save Status	Disabled (0), Active (1), Stopped (2), Failed (3)		Disabled (0)		RO	Txt				PS

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

11.11 Menu 10: Status and trips

Parameter		Range (⇕)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
10.001	Drive Healthy	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.002	Drive Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.003	Zero Frequency	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.004	Running At Or Below Minimum Frequency	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.005	Below Set Frequency	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.006	At Frequency	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.007	Above Set Frequency	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.008	Rated Load Reached	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.009	Current Limit Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.010	Regenerating	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.011	Braking IGBT Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.012	Braking Resistor Alarm	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.013	Reverse Direction Commanded	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.014	Reverse Direction Running	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.015	Supply Loss	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.016	Under Voltage Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.017	Motor Overload Alarm	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.018	Drive Over-temperature Alarm	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.019	Drive Warning	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.020	Trip 0	0 to 255				RO	Txt	ND	NC	PT	PS
10.021	Trip 1	0 to 255				RO	Txt	ND	NC	PT	PS
10.022	Trip 2	0 to 255				RO	Txt	ND	NC	PT	PS
10.023	Trip 3	0 to 255				RO	Txt	ND	NC	PT	PS
10.024	Trip 4	0 to 255				RO	Txt	ND	NC	PT	PS
10.025	Trip 5	0 to 255				RO	Txt	ND	NC	PT	PS
10.026	Trip 6	0 to 255				RO	Txt	ND	NC	PT	PS
10.027	Trip 7	0 to 255				RO	Txt	ND	NC	PT	PS
10.028	Trip 8	0 to 255				RO	Txt	ND	NC	PT	PS
10.029	Trip 9	0 to 255				RO	Txt	ND	NC	PT	PS
10.030	Braking Resistor Rated Power	0.0 to 99999.9 kW		0.0 kW		RW	Num				US
10.031	Braking Resistor Thermal Time Constant	0.00 to 1500.00 s		0.00 s		RW	Num				US
10.032	External Trip	Off (0) or On (1)		Off (0)		RW	Bit		NC		
10.033	Drive Reset	Off (0) or On (1)		Off (0)		RW	Bit		NC		
10.034	Number Of Auto-reset Attempts	None (0), 1 (1), 2 (2), 3 (3), 4 (4), 5 (5), Infinite (6)		None (0)		RW	Txt				US
10.035	Auto-reset Delay	0.0 to 600.0 s		1.0 s		RW	Num				US
10.036	Auto-reset Hold Drive Healthy	Off (0) or On (1)		Off (0)		RW	Bit				US
10.037	Action On Trip Detection	00000 to 11111		00000		RW	Bin				US
10.038	User Trip	0 to 255				RW	Num	ND	NC		
10.039	Braking Resistor Thermal Accumulator	0.0 to 100.0 %				RO	Num	ND	NC	PT	
10.040	Status Word	000000000000000 to 111111111111111				RO	Bin	ND	NC	PT	
10.041	Trip 0 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.042	Trip 0 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.043	Trip 1 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.044	Trip 1 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.045	Trip 2 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.046	Trip 2 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.047	Trip 3 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.048	Trip 3 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.049	Trip 4 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.050	Trip 4 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.051	Trip 5 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.052	Trip 5 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.053	Trip 6 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.054	Trip 6 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.055	Trip 7 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.056	Trip 7 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.057	Trip 8 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.058	Trip 8 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.059	Trip 9 Date	00-00-00 to 31-12-99				RO	Date	ND	NC	PT	PS
10.060	Trip 9 Time	00:00:00 to 23:59:59				RO	Time	ND	NC	PT	PS
10.061	Braking Resistor Resistance	0.00 to 10000.00 Ω		0.00 Ω		RW	Num				US
10.064	Remote Keypad Battery Low	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.065	Auto-tune Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.066	Limit Switch Active	Off (0) or On (1)				RO	Bit	ND	NC	PT	

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
10.068	Hold Drive Healthy On Under Voltage	Off (0) or On (1)		Off (0)		RW	Bit				US
10.069	Additional Status Bits	0000000000 to 1111111111				RO	Bin	ND	NC	PT	
10.070	Trip 0 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.071	Trip 1 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.072	Trip 2 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.073	Trip 3 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.074	Trip 4 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.075	Trip 5 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.076	Trip 6 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.077	Trip 7 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.078	Trip 8 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.079	Trip 9 Sub-trip Number	0 to 65535				RO	Num	ND	NC	PT	PS
10.080	Stop Motor	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.081	Phase Loss	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.090	Drive Ready	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.101	Drive Status	Inhibit (0), Ready (1), Stop (2), Reserved (3), Run (4), Supply Loss (5), Deceleration (6), dc Injection (7), Reserved (8), Trip (9), Active (10), 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	-2147483648 to 2147483647 ms				RO	Num	ND	NC	PT	
10.104	Active Alarm	None (0), Brake Resistor (1), Motor Overload (2), Reserved (3), Drive Overload (4), Auto Tune (5), Limit Switch (6), Reserved (8), Option Slot 1 (9), Reserved (10), Reserved (11), Reserved (12), Low AC (13), Current limit (14), 24V Backup Lost (15)				RO	Txt	ND	NC	PT	
10.107	Low AC Alarm	Off (0) or On (1)				RO	Bit	ND	NC	PT	
10.106	Potential Drive Damage Conditions	00 to 11		00		RO	Bin	ND	NC	PT	
10.108	Reversed cooling fan detected	Off (0) or On (1)				RO	Bit	ND		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
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time parameter	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.12 Menu 11: General drive set-up

Parameter		Range (⇕)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
11.018	Status Mode Parameter 1	0.000 to 30.999		2.001		RW	Num			PT	US
11.019	Status Mode Parameter 2	0.000 to 30.999		4.020		RW	Num			PT	US
11.020	Reset Serial Communications	Off (0) or On (1)				RW	Bit	ND	NC		
11.021	Customer defined 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			PT	US
11.023	Serial Address	1 to 247		1		RW	Num				US
11.024	Serial Mode	8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 1 EP (8), 7 1 OP (9), 7 1 EP M (10), 7 1 OP M (11)		8 2 NP (0)		RW	Txt				US
11.025	Serial Baud Rate	600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)		19200 (6)		RW	Txt				US
11.026	Minimum Comms Transmit Delay	0 to 250 ms		2 ms		RW	Num				US
11.027	Silent Period	0 to 250 ms		0 ms		RW	Num				US
11.028	Drive Derivative	0 to 255				RO	Num	ND	NC	PT	
11.029	Software Version	00.00.00.00 to 99.99.99.99				RO	Ver	ND	NC	PT	
11.030	User Security Code	0 to 9999				RW	Num	ND	NC	PT	US
11.031	User Drive Mode	Open-loop (1), RFC-A (2)				RW	Txt	ND	NC	PT	
11.032	Maximum Heavy Duty Rating	0.00 to 9999.99 A				RO	Num	ND	NC	PT	
11.033	Drive Rated Voltage	110V (0), 200V (1), 400V (2), 575V (3), 690V (4)				RO	Txt	ND	NC	PT	
11.034	Drive Configuration	AV (0), AI (1), AV Preset (2), AI Preset (3), Preset (4), Keypad (5), Keypad Ref (6), Electronic Pot (7), Torque Control (8), Pid Control (9)		AV (0)		RW	Txt			PT	US
11.035	Power Software Version	00.00.00.00 to 99.99.99.99				RO	Ver	ND	NC	PT	
11.036	NV Media Card File Previously Loaded	0 to 999		0		RO	Num		NC	PT	
11.037	NV Media Card File Number	0 to 999		0		RW	Num				
11.038	NV Media Card File Type	None (0), Open-loop (1), RFC-A (2), User Program (5)				RO	Txt	ND	NC	PT	
11.039	NV Media Card File Version	0 to 9999				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)		None (0)		RW	Txt		NC		
11.044	User Security Status	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)				RW	Txt	ND		PT	
11.045	Select Motor 2 Parameters	Motor 1 (0), 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), Run (1)		Run (1)		RW	Txt				US
11.048	Onboard User Program: Status	-2147483648 to 2147483647				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	0 to 65535				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	000000 to 999999				RO	Num	ND	NC	PT	
11.053	Serial Number MS	0 to 999999				RO	Num	ND	NC	PT	
11.054	Drive Date Code	0000 to 9999				RO	Num	ND	NC	PT	
11.055	Onboard User Program: Clock Task Schedule Rate	0 to 262128				RO	Num	ND	NC	PT	
11.060	Maximum Rated Current	0.000 to 999.999 A				RO	Num	ND	NC	PT	
11.061	Full Scale Current Kc	0.000 to 999.999 A				RO	Num	ND	NC	PT	
11.063	Product Type	0 to 255				RO	Num	ND	NC	PT	
11.064	Product Identifier Characters	M400				RO	Chr	ND	NC	PT	
11.065	Frame size and voltage code	000 to 999				RO	Num	ND	NC	PT	
11.066	Power Stage Identifier	0 to 255				RO	Num	ND	NC	PT	
11.067	Control Board Identifier	0 to 255				RO	Num	ND	NC	PT	
11.068	Drive current rating	00000 to 32767				RO	Num	ND	NC	PT	
11.070	Core Parameter Database Version	0.00 to 99.99				RO	Num	ND	NC	PT	
11.072	NV Media Card Create Special File	0 to 1		0		RW	Num		NC		
11.073	NV Media Card Type	None (0), Reserved (1), SD Card (2)				RO	Txt	ND	NC	PT	
11.075	NV Media Card Read-only Flag	Off (0) or On (1)				RO	Bit	ND	NC	PT	
11.076	NV Media Card Warning Suppression Flag	Off (0) or On (1)				RO	Bit	ND	NC	PT	
11.077	NV Media Card File Required Version	0 to 9999				RW	Num	ND	NC	PT	
11.079	Drive Name Characters 1-4	□□□□ (-2147483648) to □□□□ (2147483647)		---- (757935405)		RW	Chr			PT	US
11.080	Drive Name Characters 5-8	□□□□ (-2147483648) to □□□□ (2147483647)		---- (757935405)		RW	Chr			PT	US
11.081	Drive Name Characters 9-12	□□□□ (-2147483648) to □□□□ (2147483647)		---- (757935405)		RW	Chr			PT	US
11.082	Drive Name Characters 13-16	□□□□ (-2147483648) to □□□□ (2147483647)		---- (757935405)		RW	Chr			PT	US
11.084	Drive Mode	Open-loop (1), RFC-A (2)				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), All Menus (1)				RO	Txt	ND	NC	PT	PS

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
11.090	Keypad Port Serial Address	1 to 16		1		RW	Num				US
11.091	Additional Identifier Characters 1	□□□□ (-2147483648) to □□□□ (2147483647)				RO	Chr	ND	NC	PT	
11.092	Additional Identifier Characters 2	□□□□ (-2147483648) to □□□□ (2147483647)				RO	Chr	ND	NC	PT	
11.093	Additional Identifier Characters 3	□□□□ (-2147483648) to □□□□ (2147483647)				RO	Chr	ND	NC	PT	
11.097	AI ID Code	None (0), SD Card (1), RS-485 (2), boot (3), RS-485 (4)				RO	Txt	ND	NC	PT	
11.098	24V Alarm Loss Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
11.099	Modbus Parameter Conversion	0000 to 1111		0000		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	SMP	Slot,menu,parameter	Chr	Character parameter	Ver	Version number

11.13 Menu 12: Threshold detectors, variable selectors and brake control function

Figure 11-24 Menu 12 logic diagram

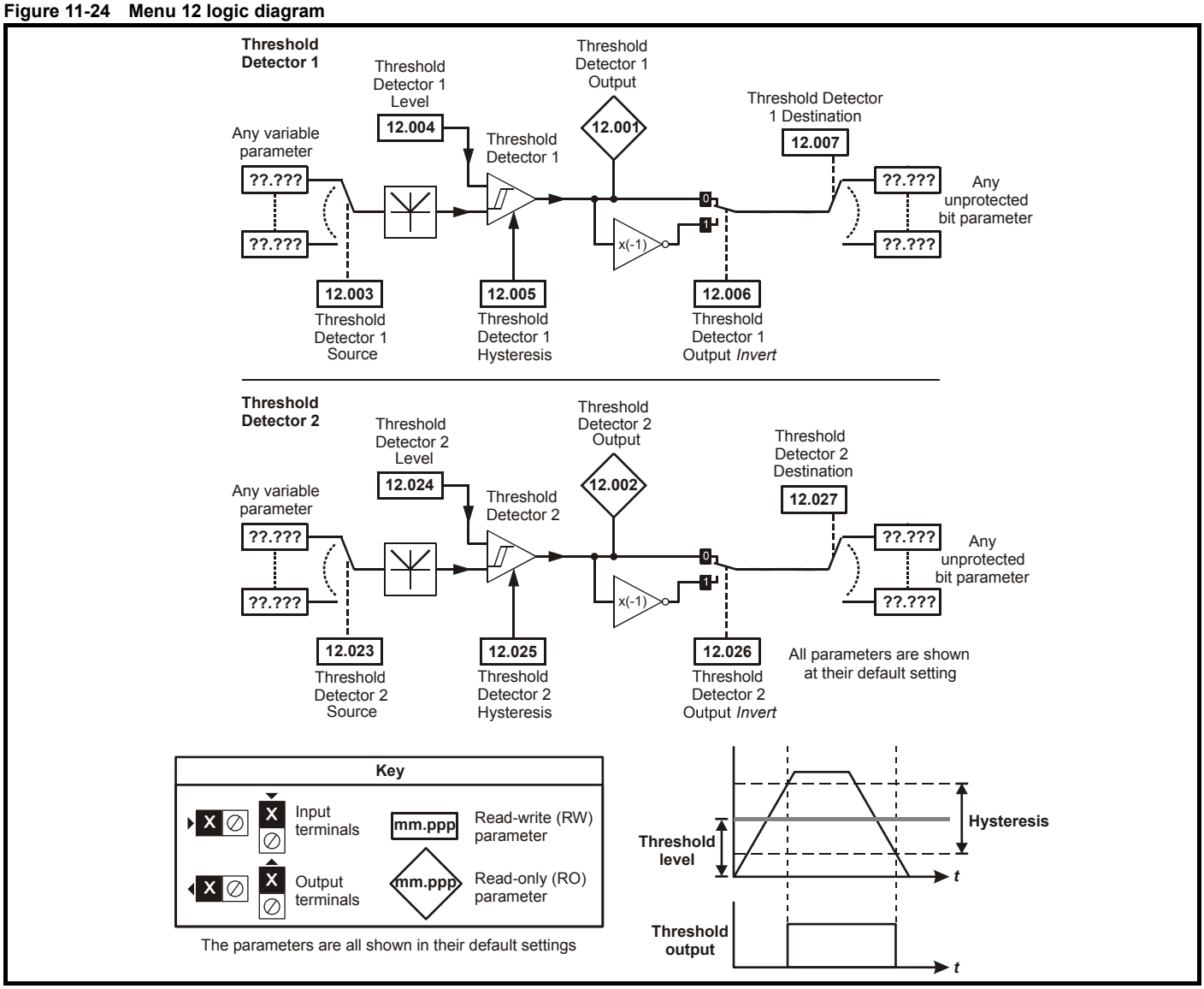
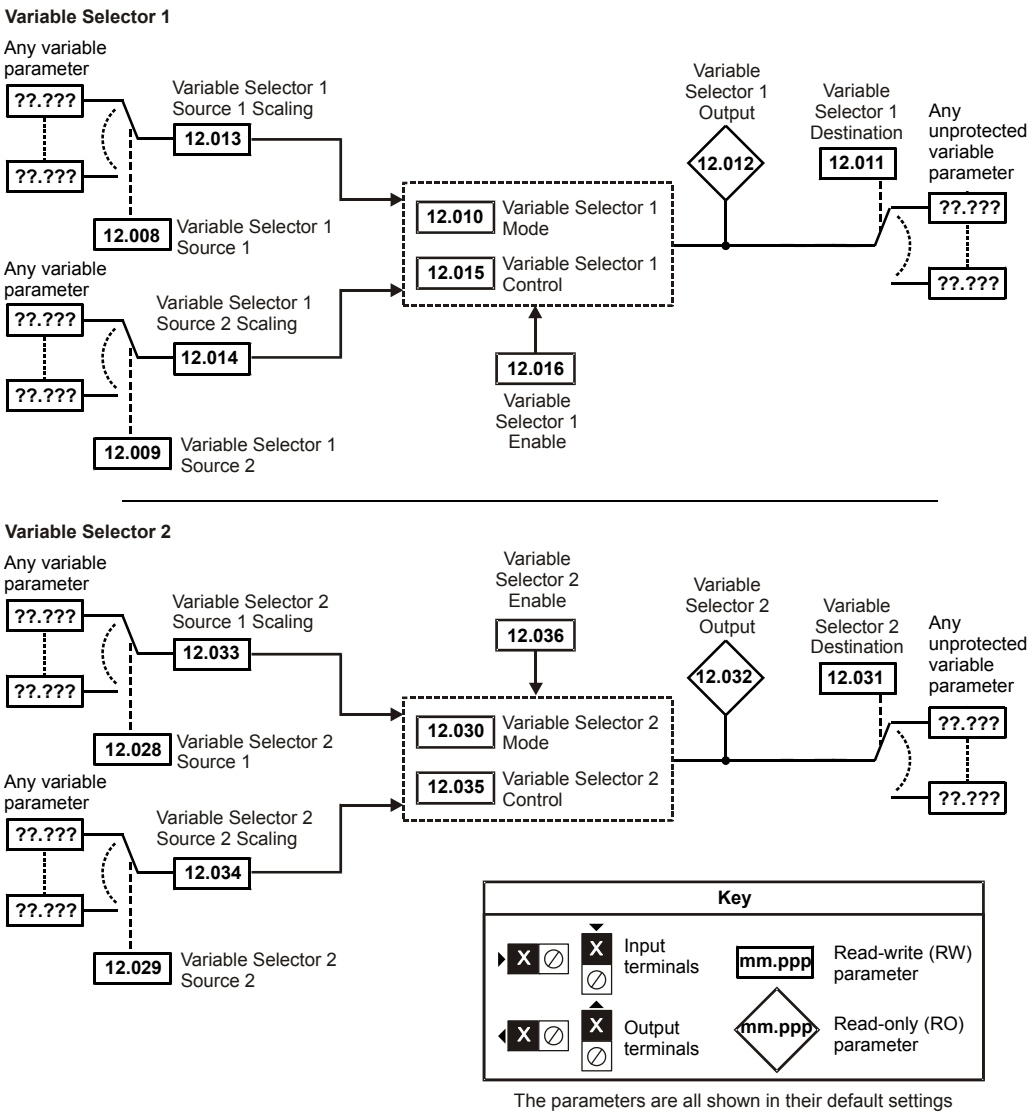


Figure 11-25 Menu 12 logic diagram (continued)



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 an NV media card in boot mode can ensure drive parameters are immediately programmed to avoid this situation.

Figure 11-26 Open loop brake function

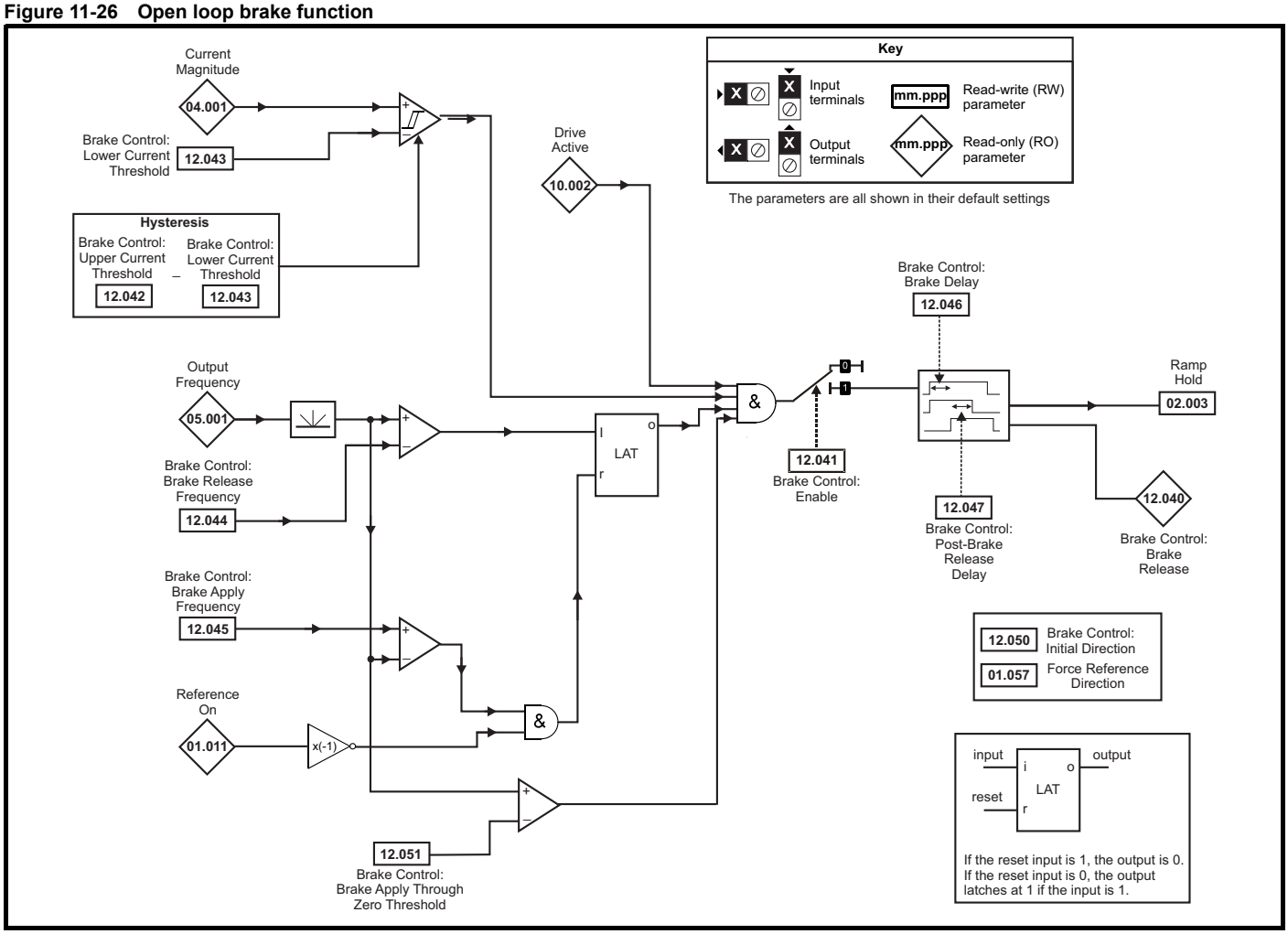


Figure 11-27 Brake sequence

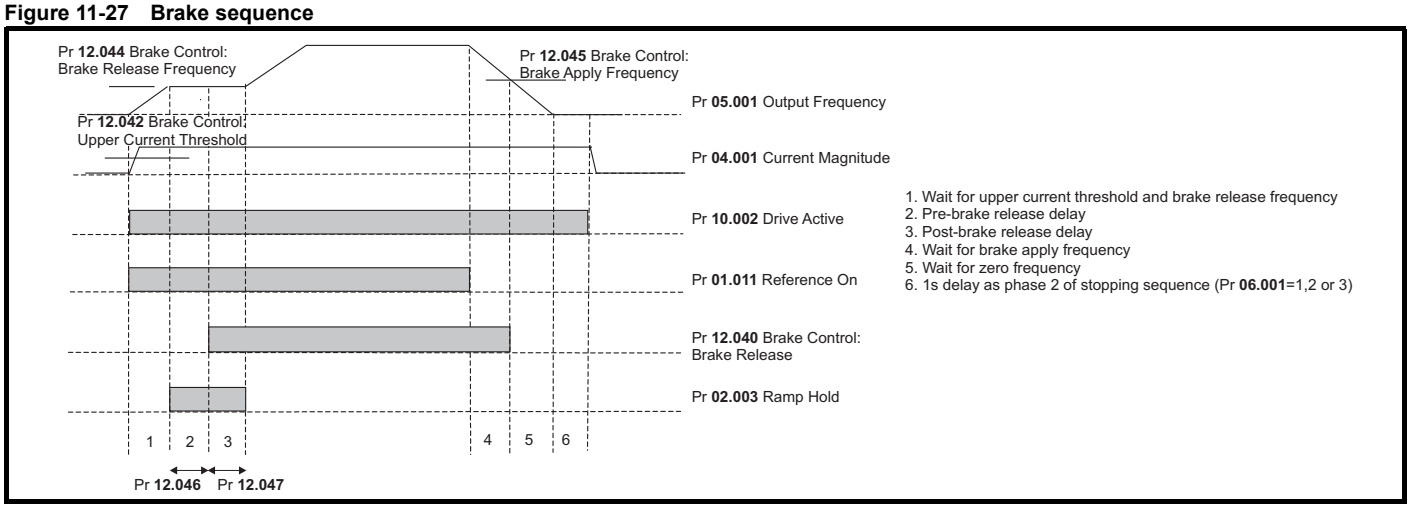
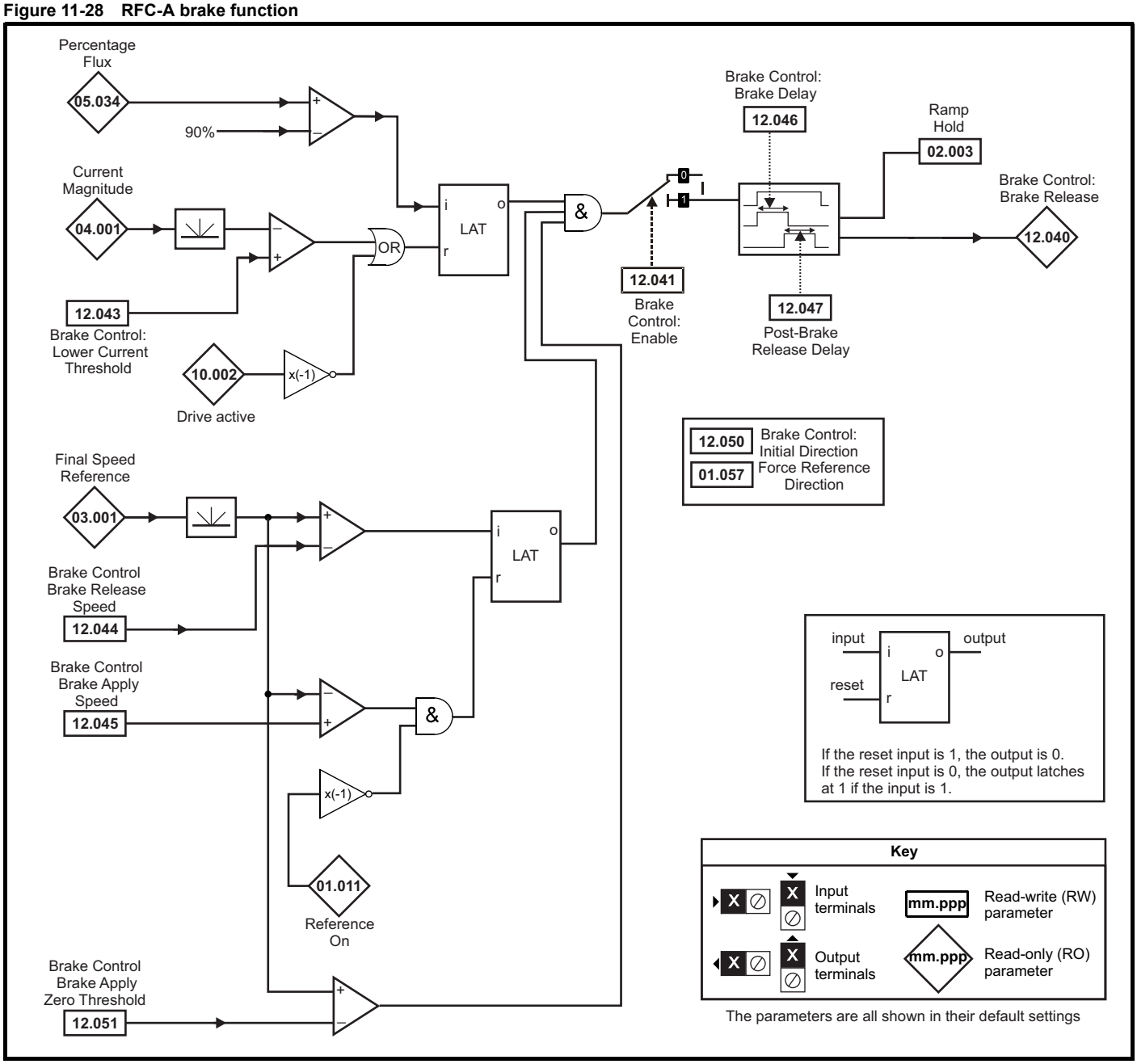


Figure 11-28 RFC-A brake function

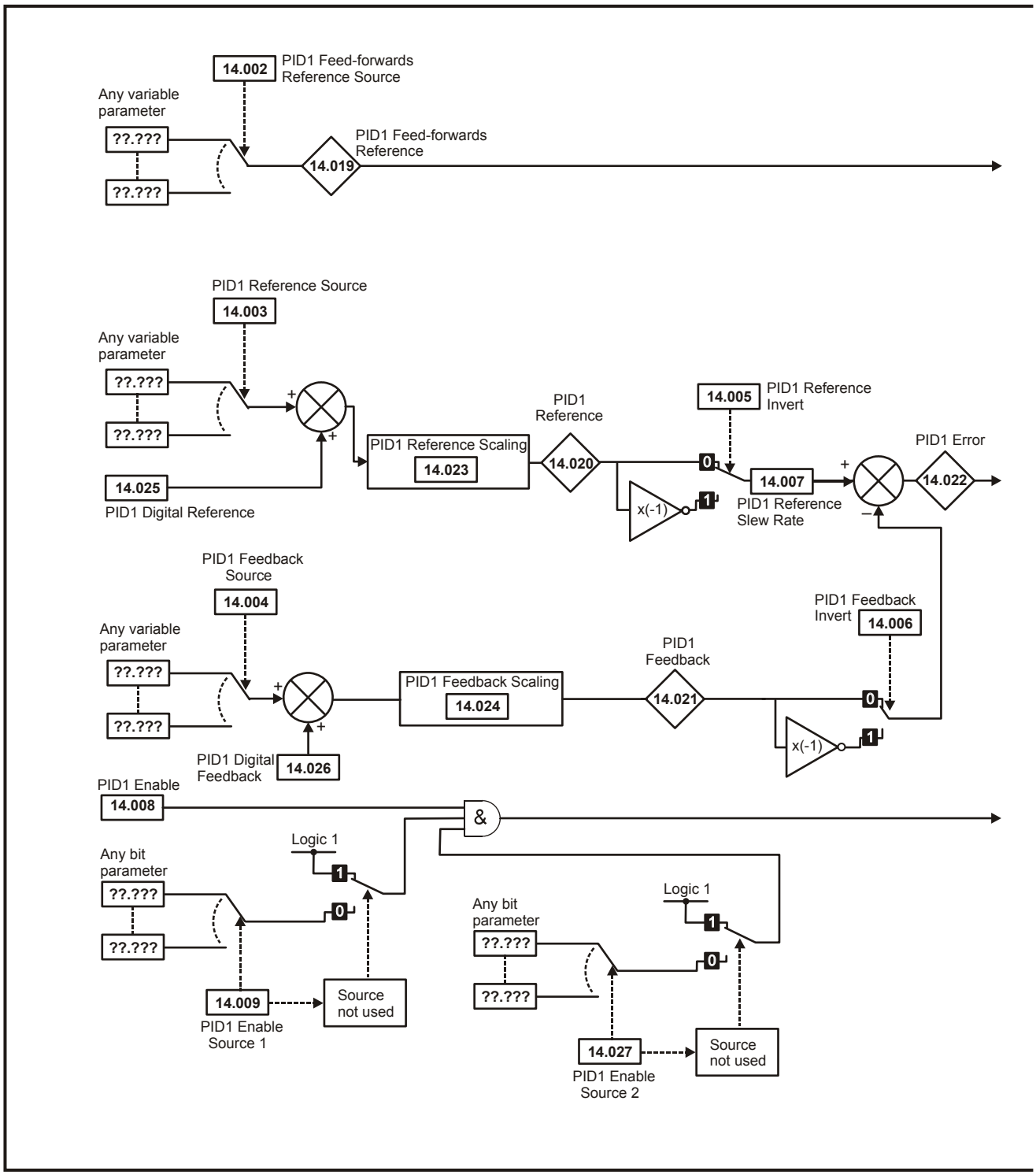


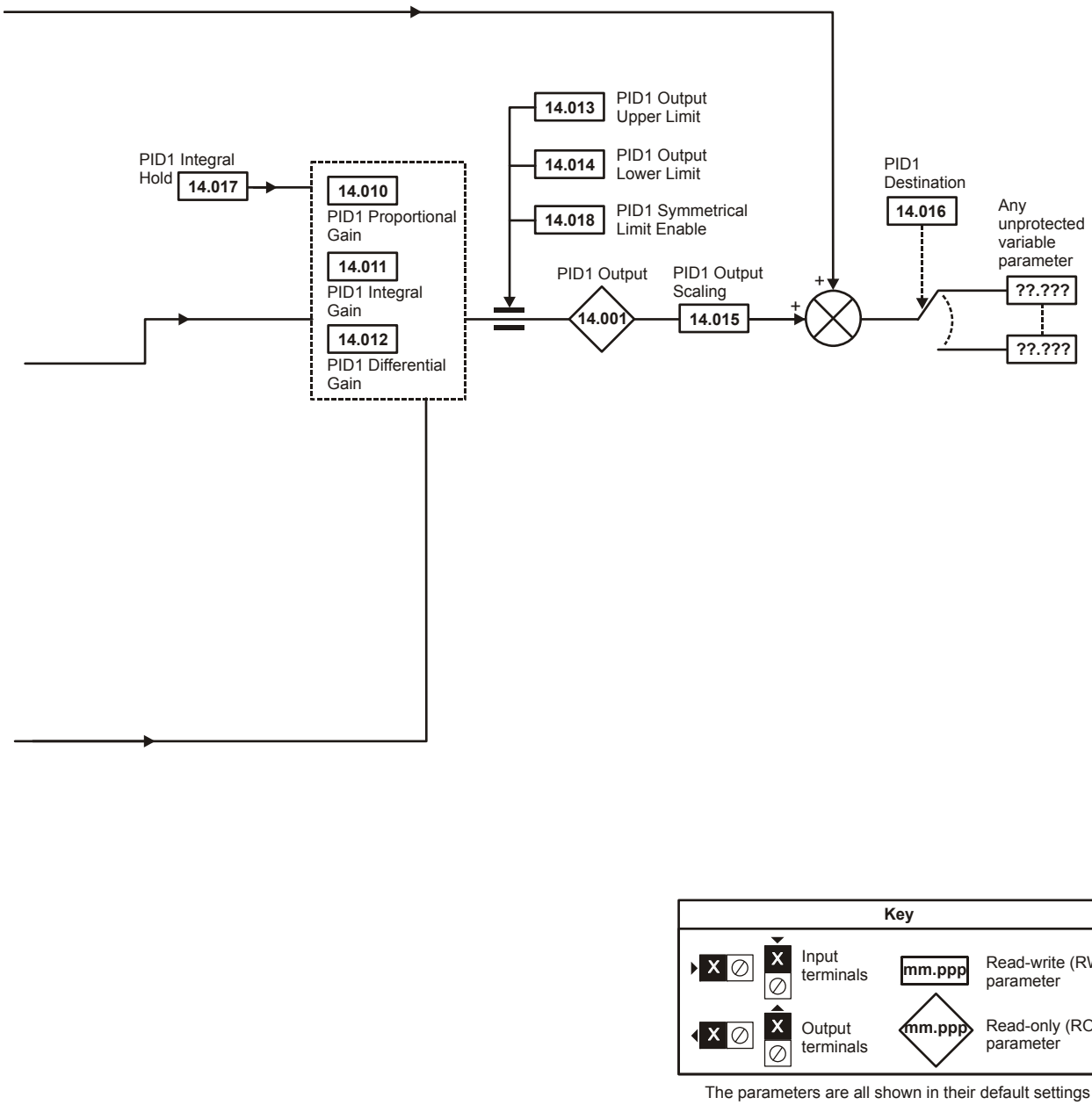
Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
12.001	Threshold Detector 1 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output	Off (0) or On (1)				RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source	0.000 to 30.999		0.000		RW	Num			PT	US
12.004	Threshold Detector 1 Level	0.00 to 100.00 %		0.00 %		RW	Num				US
12.005	Threshold Detector 1 Hysteresis	0.00 to 25.00 %		0.00 %		RW	Num				US
12.006	Threshold Detector 1 Output Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
12.007	Threshold Detector 1 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
12.008	Variable Selector 1 Source 1	0.000 to 30.999		0.000		RW	Num			PT	US
12.009	Variable Selector 1 Source 2	0.000 to 30.999		0.000		RW	Num			PT	US
12.010	Variable Selector 1 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9)		Input 1 (0)		RW	Txt				US
12.011	Variable Selector 1 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
12.012	Variable Selector 1 Output	±100.00 %				RO	Num	ND	NC	PT	
12.013	Variable Selector 1 Source 1 Scaling	±4.000		1.000		RW	Num				US
12.014	Variable Selector 1 Source 2 Scaling	±4.000		1.000		RW	Num				US
12.015	Variable Selector 1 Control	0.00 to 100.00		0.00		RW	Num				US
12.016	Variable Selector 1 Enable	Off (0) or On (1)		On (1)		RW	Bit				US
12.023	Threshold Detector 2 Source	0.000 to 30.999		0.000		RW	Num			PT	US
12.024	Threshold Detector 2 Level	0.00 to 100.00 %		0.00 %		RW	Num				US
12.025	Threshold Detector 2 Hysteresis	0.00 to 25.00 %		0.00 %		RW	Num				US
12.026	Threshold Detector 2 Output Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
12.027	Threshold Detector 2 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
12.028	Variable Selector 2 Source 1	0.000 to 30.999		0.000		RW	Num			PT	US
12.029	Variable Selector 2 Source 2	0.000 to 30.999		0.000		RW	Num			PT	US
12.030	Variable Selector 2 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9)		Input 1 (0)		RW	Txt				US
12.031	Variable Selector 2 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
12.032	Variable Selector 2 Output	±100.00 %				RO	Num	ND	NC	PT	
12.033	Variable Selector 2 Source 1 Scaling	±4.000		1.000		RW	Num				US
12.034	Variable Selector 2 Source 2 Scaling	±4.000		1.000		RW	Num				US
12.035	Variable Selector 2 Control	0.00 to 100.00		0.00		RW	Num				US
12.036	Variable Selector 2 Enable	Off (0) or On (1)		On (1)		RW	Bit				US
12.040	BC Brake Release	Off (0) or On (1)				RO	Bit	ND	NC	PT	
12.041	BC Enable	Disable (0), Relay (1), Digital IO (2), User (3)		Disable (0)		RW	Txt				US
12.042	BC Upper Current Threshold	0 to 200 %		50 %		RW	Num				US
12.043	BC Lower Current Threshold	0 to 200 %		10 %		RW	Num				US
12.044	BC Brake Release Frequency	0.00 to 20.00 Hz		1.00 Hz		RW	Num				US
12.045	BC Brake Apply Frequency	0.00 to 20.00 Hz		2.00 Hz		RW	Num				US
12.046	BC Brake Delay	0.0 to 25.0 s		1.0 s		RW	Num				US
12.047	BC Post-brake Release Delay	0.0 to 25.0 s		1.0 s		RW	Num				US
12.050	BC Initial Direction	Ref (0), Forward (1), Reverse (2)		Ref (0)		RW	Txt				US
12.051	BC Brake Apply Through Zero Threshold	0.00 to 25.00 Hz		1.00 Hz		RW	Num				US

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

11.14 Menu 14: User PID controller

Figure 11-29 Menu 14 Logic diagram





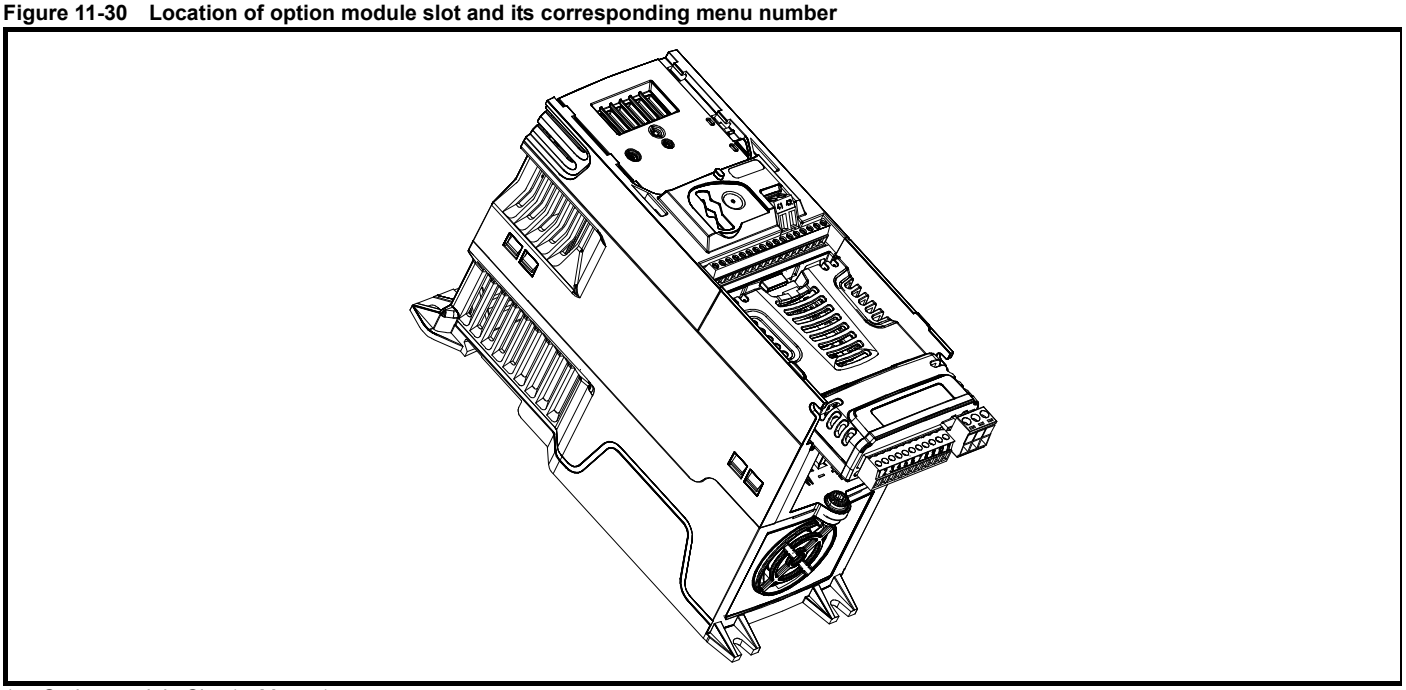
The parameters are all shown in their default settings

Parameter		Range (⇳)		Default (⇨)		Type					
		Open-Loop	RFC-A	Open-Loop	RFC-A						
14.001	PID1 Output	±100.00 %				RO	Num	ND	NC	PT	
14.002	PID1 Feed-forwards Reference Source	0.000 to 30.999		0.000		RW	Num			PT	US
14.003	PID1 Reference Source	0.000 to 30.999		0.000		RW	Num			PT	US
14.004	PID1 Feedback Source	0.000 to 30.999		0.000		RW	Num			PT	US
14.005	PID1 Reference Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
14.006	PID1 Feedback Invert	Off (0) or On (1)		Off (0)		RW	Bit				US
14.007	PID1 Reference Slew Rate	0.0 to 3200.0 s		0.0 s		RW	Num				US
14.008	PID1 Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
14.009	PID1 Enable Source 1	0.000 to 30.999		0.000		RW	Num			PT	US
14.010	PID1 Proportional Gain	0.000 to 4.000		1.000		RW	Num				US
14.011	PID1 Integral Gain	0.000 to 4.000		0.500		RW	Num				US
14.012	PID1 Differential Gain	0.000 to 4.000		0.000		RW	Num				US
14.013	PID1 Output Upper Limit	0.00 to 100.00 %		100.00 %		RW	Num				US
14.014	PID1 Output Lower Limit	±100.00 %		-100.00 %		RW	Num				US
14.015	PID1 Output Scaling	0.000 to 4.000		1.000		RW	Num				US
14.016	PID1 Destination	0.000 to 30.999		0.000		RW	Num	DE		PT	US
14.017	PID1 Integral Hold	Off (0) or On (1)		Off (0)		RW	Bit				
14.018	PID1 Symmetrical Limit Enable	Off (0) or On (1)		Off (0)		RW	Bit				US
14.019	PID1 Feed-forwards Reference	±100.00 %				RO	Num	ND	NC	PT	
14.020	PID1 Reference	±100.00 %				RO	Num	ND	NC	PT	
14.021	PID1 Feedback	±100.00 %				RO	Num	ND	NC	PT	
14.022	PID1 Error	±100.00 %				RO	Num	ND	NC	PT	
14.023	PID1 Reference Scaling	0.000 to 4.000		1.000		RW	Num				US
14.024	PID1 Feedback Scaling	0.000 to 4.000		1.000		RW	Num				US
14.025	PID1 Digital Reference	±100.00 %		0.00 %		RW	Num				US
14.026	PID1 Digital Feedback	±100.00 %		0.00 %		RW	Num				US
14.027	PID1 Enable Source 2	0.000 to 30.999		0.000		RW	Num			PT	US

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

11.15 Menu 15: Option module set-up

Figure 11-30 Location of option module slot and its corresponding menu number



1. Option module Slot 1 - Menu 15

11.15.1 Parameters common to all categories

Parameter		Range(⇳)	Default(⇨)	Type					
15.001	Module ID	0 to 65535		RO	Num	ND	NC	PT	
15.002	Software Version	00.00.00.00 to 99.99.99.99		RO	Ver	ND	NC	PT	
15.003	Hardware Version	0.00 to 99.99		RO	Num	ND	NC	PT	
15.004	Serial Number LS	0 to 99999999		RO	Num	ND	NC	PT	
15.005	Serial Number MS			RO	Num	ND	NC	PT	
15.006	Module Status	Bootldr - Update (-2) to Error (3)		RO	Txt	ND	NC	PT	
15.007	Module Reset	Off (0) or On (1)	Off (0)	RW	Bit		NC		

The option module ID indicates the type of module that is installed in the corresponding slot. See the relevant option module user guide for more information regarding the module.

Option module ID	Module	Category
0	No module installed	
209	SI-I/O	Automation (I/O Expansion)
431	SI-EtherCAT	Fieldbus
433	SI-Ethernet	
434	SI-PROFINET V2	
443	SI-PROFIBUS	
447	SI-DeviceNet	
448	SI-CANopen	

11.16 Menu 18: Application menu 1

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
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	-32768 to 32767				RO	Num	ND	NC		
18.003	Application Menu 1 Read-only Integer 3	-32768 to 32767				RO	Num	ND	NC		
18.004	Application Menu 1 Read-only Integer 4	-32768 to 32767				RO	Num	ND	NC		
18.005	Application Menu 1 Read-only Integer 5	-32768 to 32767				RO	Num	ND	NC		
18.006	Application Menu 1 Read-only Integer 6	-32768 to 32767				RO	Num	ND	NC		
18.007	Application Menu 1 Read-only Integer 7	-32768 to 32767				RO	Num	ND	NC		
18.008	Application Menu 1 Read-only Integer 8	-32768 to 32767				RO	Num	ND	NC		
18.009	Application Menu 1 Read-only Integer 9	-32768 to 32767				RO	Num	ND	NC		
18.010	Application Menu 1 Read-only Integer 10	-32768 to 32767				RO	Num	ND	NC		
18.011	Application Menu 1 Read-write Integer 11	-32768 to 32767		0		RW	Num				US
18.012	Application Menu 1 Read-write Integer 12	-32768 to 32767		0		RW	Num				US
18.013	Application Menu 1 Read-write Integer 13	-32768 to 32767		0		RW	Num				US
18.014	Application Menu 1 Read-write Integer 14	-32768 to 32767		0		RW	Num				US
18.015	Application Menu 1 Read-write Integer 15	-32768 to 32767		0		RW	Num				US
18.016	Application Menu 1 Read-write Integer 16	-32768 to 32767		0		RW	Num				US
18.017	Application Menu 1 Read-write Integer 17	-32768 to 32767		0		RW	Num				US
18.018	Application Menu 1 Read-write Integer 18	-32768 to 32767		0		RW	Num				US
18.019	Application Menu 1 Read-write Integer 19	-32768 to 32767		0		RW	Num				US
18.020	Application Menu 1 Read-write Integer 20	-32768 to 32767		0		RW	Num				US
18.021	Application Menu 1 Read-write Integer 21	-32768 to 32767		0		RW	Num				US
18.022	Application Menu 1 Read-write Integer 22	-32768 to 32767		0		RW	Num				US
18.023	Application Menu 1 Read-write Integer 23	-32768 to 32767		0		RW	Num				US
18.024	Application Menu 1 Read-write Integer 24	-32768 to 32767		0		RW	Num				US
18.025	Application Menu 1 Read-write Integer 25	-32768 to 32767		0		RW	Num				US
18.026	Application Menu 1 Read-write Integer 26	-32768 to 32767		0		RW	Num				US
18.027	Application Menu 1 Read-write Integer 27	-32768 to 32767		0		RW	Num				US
18.028	Application Menu 1 Read-write Integer 28	-32768 to 32767		0		RW	Num				US
18.029	Application Menu 1 Read-write Integer 29	-32768 to 32767		0		RW	Num				US
18.030	Application Menu 1 Read-write Integer 30	-32768 to 32767		0		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	Off (0) or On (1)		Off (0)		RW	Bit				US
18.033	Application Menu 1 Read-write bit 33	Off (0) or On (1)		Off (0)		RW	Bit				US
18.034	Application Menu 1 Read-write bit 34	Off (0) or On (1)		Off (0)		RW	Bit				US
18.035	Application Menu 1 Read-write bit 35	Off (0) or On (1)		Off (0)		RW	Bit				US
18.036	Application Menu 1 Read-write bit 36	Off (0) or On (1)		Off (0)		RW	Bit				US
18.037	Application Menu 1 Read-write bit 37	Off (0) or On (1)		Off (0)		RW	Bit				US
18.038	Application Menu 1 Read-write bit 38	Off (0) or On (1)		Off (0)		RW	Bit				US
18.039	Application Menu 1 Read-write bit 39	Off (0) or On (1)		Off (0)		RW	Bit				US
18.040	Application Menu 1 Read-write bit 40	Off (0) or On (1)		Off (0)		RW	Bit				US
18.041	Application Menu 1 Read-write bit 41	Off (0) or On (1)		Off (0)		RW	Bit				US
18.042	Application Menu 1 Read-write bit 42	Off (0) or On (1)		Off (0)		RW	Bit				US
18.043	Application Menu 1 Read-write bit 43	Off (0) or On (1)		Off (0)		RW	Bit				US
18.044	Application Menu 1 Read-write bit 44	Off (0) or On (1)		Off (0)		RW	Bit				US
18.045	Application Menu 1 Read-write bit 45	Off (0) or On (1)		Off (0)		RW	Bit				US
18.046	Application Menu 1 Read-write bit 46	Off (0) or On (1)		Off (0)		RW	Bit				US
18.047	Application Menu 1 Read-write bit 47	Off (0) or On (1)		Off (0)		RW	Bit				US
18.048	Application Menu 1 Read-write bit 48	Off (0) or On (1)		Off (0)		RW	Bit				US
18.049	Application Menu 1 Read-write bit 49	Off (0) or On (1)		Off (0)		RW	Bit				US
18.050	Application Menu 1 Read-write bit 50	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

11.17 Menu 20: Application menu 2

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
20.021	Application Menu 2 Read-write Long Integer 21	-2147483648 to 2147483647		0		RW	Num				
20.022	Application Menu 2 Read-write Long Integer 22	-2147483648 to 2147483647		0		RW	Num				
20.023	Application Menu 2 Read-write Long Integer 23	-2147483648 to 2147483647		0		RW	Num				
20.024	Application Menu 2 Read-write Long Integer 24	-2147483648 to 2147483647		0		RW	Num				
20.025	Application Menu 2 Read-write Long Integer 25	-2147483648 to 2147483647		0		RW	Num				
20.026	Application Menu 2 Read-write Long Integer 26	-2147483648 to 2147483647		0		RW	Num				
20.027	Application Menu 2 Read-write Long Integer 27	-2147483648 to 2147483647		0		RW	Num				
20.028	Application Menu 2 Read-write Long Integer 28	-2147483648 to 2147483647		0		RW	Num				
20.029	Application Menu 2 Read-write Long Integer 29	-2147483648 to 2147483647		0		RW	Num				
20.030	Application Menu 2 Read-write Long Integer 30	-2147483648 to 2147483647		0		RW	Num				

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

11.18 Menu 21: Second motor parameters

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
21.001	M2 Maximum Reference Clamp	±550.00 Hz		50 Hz: 50.00 Hz 60 Hz: 60.00 Hz		RW	Num				US
21.002	M2 Minimum Reference Clamp	VM_NEGATIVE_REF_CLAMP2 Hz		0.00 Hz		RW	Num				US
21.003	M2 Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Reserved (5), Keypad Ref (6)		A1 A2 (0)		RW	Txt				US
21.004	M2 Acceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz		5.0 s/100 Hz		RW	Num				US
21.005	M2 Deceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz		10.0 s/100 Hz		RW	Num				US
21.006	M2 Motor Rated Frequency	0.00 to 550.00 Hz		50 Hz: 50.00 Hz 60 Hz: 60.00 Hz		RW	Num				US
21.007	M2 Motor Rated Current	0.00 to VM_RATED_CURRENT A		Maximum Heavy Duty Rating (11.032)		RW	Num		RA		US
21.008	M2 Motor Rated Speed	0.0 to 33000.0 rpm		50 Hz: 1500.0 rpm 60 Hz: 1800.0 rpm	50 Hz: 1450.0 rpm 60 Hz: 1750.0 rpm	RW	Num				US
21.009	M2 Motor Rated Voltage	0 to VM_AC_VOLTAGE_SET V		110V drive: 230 V, 200V drive: 230 V 400V drive 50 Hz: 400 V, 400V drive 60 Hz: 460 V 575 V drive: 575 V, 690V drive: 690 V		RW	Num		RA		US
21.010	M2 Motor Rated Power Factor	0.00 to 1.00		0.85		RW	Num		RA		US
21.011	M2 Number of Motor Poles*	Automatic (0) to 32 (16) Poles		Automatic (0) Poles		RW	Txt				US
21.012	M2 Stator Resistance	0.0000 to 99.9999 Ω		0.0000 Ω		RW	Num		RA		US
21.014	M2 Transient Inductance	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 to 3000 s		179 s		RW	Num				US
21.017	M2 Frequency Controller Proportional Gain Kp1		0.000 to 200.000 s/rad		0.100 s/rad	RW	Num				US
21.018	M2 Frequency Controller Integral Gain Ki1		0.00 to 655.35 s²/rad		0.10 s²/rad	RW	Num				US
21.019	M2 Frequency Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad		0.00000 1/rad	RW	Num				US
21.022	M2 Current Controller Kp Gain	0.00 to 4000.00		20.00		RW	Num				US
21.023	M2 Current Controller Ki Gain	0.000 to 600.000		40.000		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		0.0 to 100.0 %		75.0 %	RW	Num				US
21.027	M2 Motoring Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %		165.0 %**	175.0 %***	RW	Num		RA		US
21.028	M2 Regenerating Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %		165.0 %**	175.0 %***	RW	Num		RA		US
21.029	M2 Symmetrical Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %		165.0 %**	175.0 %***	RW	Num		RA		US
21.033	M2 Low Frequency Thermal Protection Mode	0 to 1		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		0.0 to 100.0 %		0.0 %	RW	Num				US

* When read via serial communications, this parameter will show pole pairs.

** For size 9 the default is 141.9 %

*** For size 9 the default is 150.0 %

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

11.19 Menu 22: Additional Menu 0 set-up

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
22.001	Parameter 00.001 Set-up	0.000 to 30.999		1.007		RW	Num			PT	US
22.002	Parameter 00.002 Set-up	0.000 to 30.999		1.006		RW	Num			PT	US
22.003	Parameter 00.003 Set-up	0.000 to 30.999		2.011		RW	Num			PT	US
22.004	Parameter 00.004 Set-up	0.000 to 30.999		2.021		RW	Num			PT	US
22.005	Parameter 00.005 Set-up	0.000 to 30.999		11.034		RW	Num			PT	US
22.006	Parameter 00.006 Set-up	0.000 to 30.999		5.007		RW	Num			PT	US
22.007	Parameter 00.007 Set-up	0.000 to 30.999		5.008		RW	Num			PT	US
22.008	Parameter 00.008 Set-up	0.000 to 30.999		5.009		RW	Num			PT	US
22.009	Parameter 00.009 Set-up	0.000 to 30.999		5.010		RW	Num			PT	US
22.010	Parameter 00.010 Set-up	0.000 to 30.999		11.044		RW	Num			PT	US
22.011	Parameter 00.011 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.012	Parameter 00.012 Set-up	0.000 to 30.999		8.010		RW	Num			PT	US
22.013	Parameter 00.013 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.014	Parameter 00.014 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.015	Parameter 00.015 Set-up	0.000 to 30.999		1.005		RW	Num			PT	US
22.016	Parameter 00.016 Set-up	0.000 to 30.999		7.007		RW	Num			PT	US
22.017	Parameter 00.017 Set-up	0.000 to 30.999		1.010		RW	Num			PT	US
22.018	Parameter 00.018 Set-up	0.000 to 30.999		1.021		RW	Num			PT	US
22.019	Parameter 00.019 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.020	Parameter 00.020 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.021	Parameter 00.021 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.022	Parameter 00.022 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.023	Parameter 00.023 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.024	Parameter 00.024 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.025	Parameter 00.025 Set-up	0.000 to 30.999		11.030		RW	Num			PT	US
22.026	Parameter 00.026 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.027	Parameter 00.027 Set-up	0.000 to 30.999		1.051		RW	Num			PT	US
22.028	Parameter 00.028 Set-up	0.000 to 30.999		2.004		RW	Num			PT	US
22.029	Parameter 00.029 Set-up	0.000 to 30.999		2.002		RW	Num			PT	US
22.030	Parameter 00.030 Set-up	0.000 to 30.999		11.042		RW	Num			PT	US
22.031	Parameter 00.031 Set-up	0.000 to 30.999		6.001		RW	Num			PT	US
22.032	Parameter 00.032 Set-up	0.000 to 30.999		5.013		RW	Num			PT	US
22.033	Parameter 00.033 Set-up	0.000 to 30.999		6.009		RW	Num			PT	US
22.034	Parameter 00.034 Set-up	0.000 to 30.999		8.035		RW	Num			PT	US
22.035	Parameter 00.035 Set-up	0.000 to 30.999		8.091		RW	Num			PT	US
22.036	Parameter 00.036 Set-up	0.000 to 30.999		7.055		RW	Num			PT	US
22.037	Parameter 00.037 Set-up	0.000 to 30.999		5.018		RW	Num			PT	US
22.038	Parameter 00.038 Set-up	0.000 to 30.999		5.012		RW	Num			PT	US
22.039	Parameter 00.039 Set-up	0.000 to 30.999		5.006		RW	Num			PT	US
22.040	Parameter 00.040 Set-up	0.000 to 30.999		5.011		RW	Num			PT	US
22.041	Parameter 00.041 Set-up	0.000 to 30.999		5.014		RW	Num			PT	US
22.042	Parameter 00.042 Set-up	0.000 to 30.999		5.015		RW	Num			PT	US
22.043	Parameter 00.043 Set-up	0.000 to 30.999		11.025		RW	Num			PT	US
22.044	Parameter 00.044 Set-up	0.000 to 30.999		11.023		RW	Num			PT	US
22.045	Parameter 00.045 Set-up	0.000 to 30.999		11.020		RW	Num			PT	US
22.046	Parameter 00.046 Set-up	0.000 to 30.999		12.042		RW	Num			PT	US
22.047	Parameter 00.047 Set-up	0.000 to 30.999		12.043		RW	Num			PT	US
22.048	Parameter 00.048 Set-up	0.000 to 30.999		12.044		RW	Num			PT	US
22.049	Parameter 00.049 Set-up	0.000 to 30.999		12.045		RW	Num			PT	US
22.050	Parameter 00.050 Set-up	0.000 to 30.999		12.046		RW	Num			PT	US
22.051	Parameter 00.051 Set-up	0.000 to 30.999		12.047		RW	Num			PT	US
22.052	Parameter 00.052 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.053	Parameter 00.053 Set-up	0.000 to 30.999		12.050		RW	Num			PT	US
22.054	Parameter 00.054 Set-up	0.000 to 30.999		12.051		RW	Num			PT	US
22.055	Parameter 00.055 Set-up	0.000 to 30.999		12.041		RW	Num			PT	US
22.056	Parameter 00.056 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.057	Parameter 00.057 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.058	Parameter 00.058 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.059	Parameter 00.059 Set-up	0.000 to 30.999		11.047		RW	Num			PT	US
22.060	Parameter 00.060 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.061	Parameter 00.061 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.062	Parameter 00.062 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.063	Parameter 00.063 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.064	Parameter 00.064 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.065	Parameter 00.065 Set-up	0.000 to 30.999		3.010		RW	Num			PT	US

Parameter		Range (⇳)		Default (⇨)		Type					
		OL	RFC-A	OL	RFC-A						
22.066	Parameter 00.066 Set-up	0.000 to 30.999		3.011		RW	Num			PT	US
22.067	Parameter 00.067 Set-up	0.000 to 30.999		3.079		RW	Num			PT	US
22.068	Parameter 00.068 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.069	Parameter 00.069 Set-up	0.000 to 30.999		5.040		RW	Num			PT	US
22.070	Parameter 00.070 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.071	Parameter 00.071 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.072	Parameter 00.072 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.073	Parameter 00.073 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.074	Parameter 00.074 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.075	Parameter 00.075 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US
22.076	Parameter 00.076 Set-up	0.000 to 30.999		10.037		RW	Num			PT	US
22.077	Parameter 00.077 Set-up	0.000 to 30.999		11.032		RW	Num			PT	US
22.078	Parameter 00.078 Set-up	0.000 to 30.999		11.029		RW	Num			PT	US
22.079	Parameter 00.079 Set-up	0.000 to 30.999		11.031		RW	Num			PT	US
22.080	Parameter 00.080 Set-up	0.000 to 30.999		0.000		RW	Num			PT	US

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

12 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:

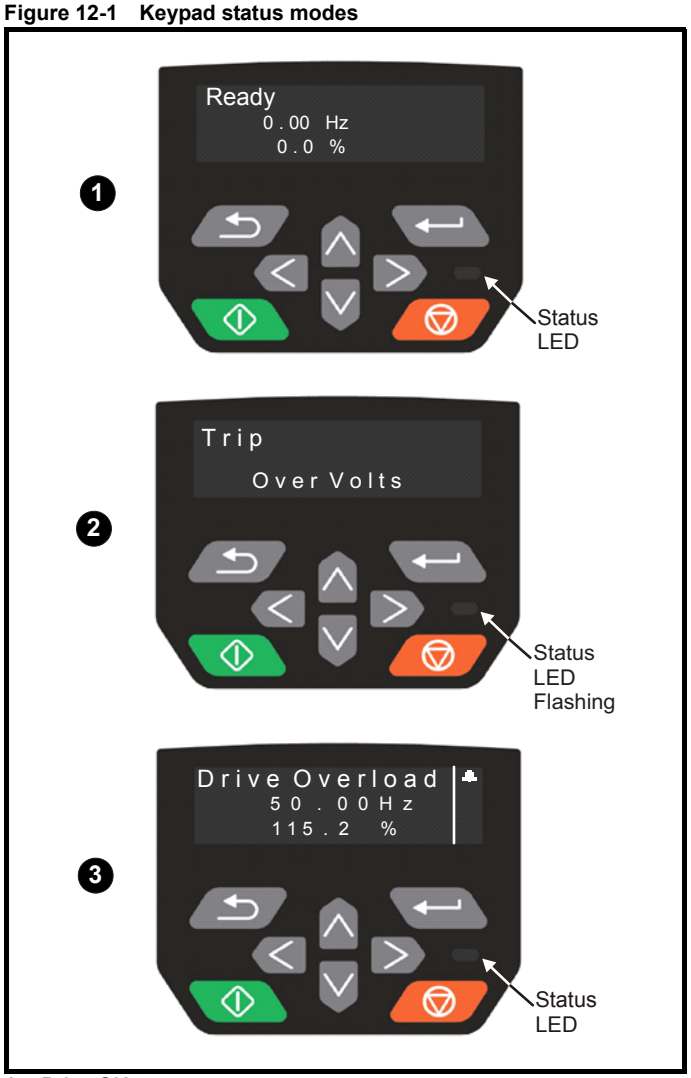
- Trip indications
- Alarm indications
- Status indications

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.

12.1 Status modes (Keypad and LED status)

Figure 12-1 Keypad status modes



1 Drive OK status

2 Trip status

3 Alarm status

12.2 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.

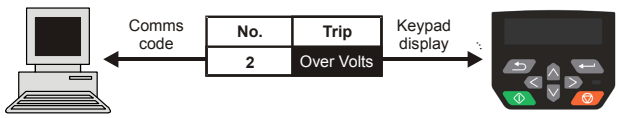
During a trip condition, where a CI-Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will show the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip number, 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 point.

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 12-2 *Key to sub-trip number* .

Trips are listed alphabetically in Table 12-2 *Trip indications* on page 139 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 HF23) do not have trip numbers (except HF08, HF11, HF12 and HF18 which have sub-trip number/s). The trip number must be checked in Table 12-2 to identify the specific trip.

Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 12-3 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 12-2.
4. Perform checks detailed under *Diagnosis*.

12.3 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 12-1 is in the form xxyzz and used to identify the source of the trip.

Table 12-1 Trips associated with xxyzz sub-trip number

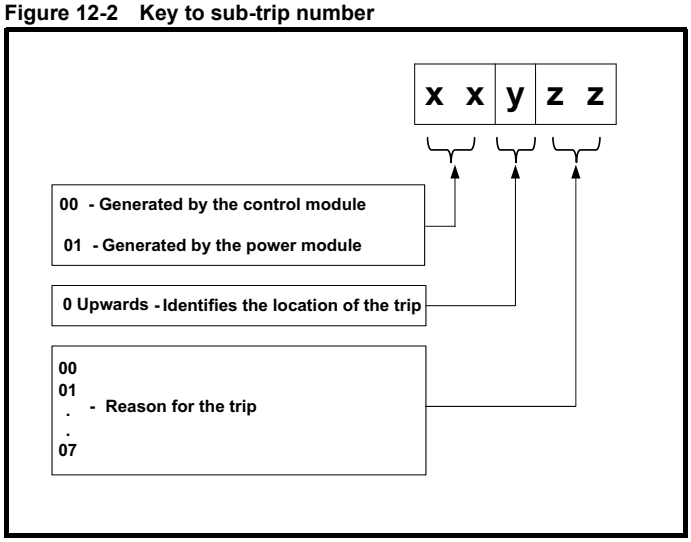
Over Volts	Phase Loss
PSU	OI Snubber
OHt Inverter	Temp Feedback
OHt Power	Power Data
OHt dc bus	

The digits xx are 00 for a trip generated by the control system. For a 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.

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 12-2 Key to sub-trip number



12.4 Trips, Sub-trip numbers

Table 12-2 Trip indications

Trip	Diagnosis
An Input 1 Loss	**Analog input 1 current loss**
28	The *An Input 1 Loss* trip indicates that a current loss was detected in current mode on Analog input 1 (Terminal 2). 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 1 OI	**Analog input 1 over-current**
189	Current input on analog input 1 exceeds 24mA.
An Input 2 Loss	**Analog input 2 current loss**
29	The *An Input 2 Loss* trip indicates that a current loss was detected in current mode on Analog input 2 (Terminal 5). In 4-20 mA and 20-4 mA modes loss of input is detected if the current falls below 3 mA. Recommend 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 Input 2 OI	**Analog input 2 over-current**
190	Current input on analog input 2 exceeds 24 mA.
Autotune 1	**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** 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 is released • Ensure *Mechanical Load Test Level* (05.021) is set correctly
Autotune 3	**Measured inertia has exceeded the parameter range (RFC-A mode only)**
13	The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number. **Sub-trip** / **Reason** 1 / Measured inertia has exceeded the parameter range during a mechanical load measurement 3 / The mechanical load test has been unable to identify the motor inertia **Recommended actions:** • Check motor cable wiring is correct
Autotune Stopped	**Autotune test stopped before completion**
18	The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed. **Recommended actions:** • Check the drive enable signal (Terminal 31 & 34 on size 1 to 4, or terminal 31 & 35 on size 5 to 9) were active during the autotune. • Check the run command was active in Digital input 3 or 4 state (Pr **08.003** or Pr **08.004**) during the autotune.
Brake R Too Hot	**Braking resistor overload timed out (I^2t)**
19	The *Brake R Too Hot* trip 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 the *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. • Check resistor value and power rating • If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr **10.030**, Pr **10.031** or Pr **10.061** to 0 to disable the trip.

Card Access	**NV Media Card Write fail**
185	The *Card Access* trip indicates that the drive was unable to access the NV Media Card. If the trip occurs during the data transfer to the card then the file being written may be corrupted. If the trip occurs when the data being transferred to the drive then the data transfer may be incomplete. If a parameter file is transferred to the drive and this trip occurs during the transfer, the parameters are not saved to non-volatile memory, and so the original parameters can be restored by powering the drive down and up again. **Recommended actions:** • Check NV Media Card is installed / located correctly • Replace the NV Media Card
Card Busy	**NV Media Card cannot be accessed as it is being accessed by an option module**
178	The *Card Busy* trip indicates that an attempt has been made to access a file on NV Media Card, but the NV Media Card is already being accessed by an Option Module. No data is transferred. **Recommended actions:** • Wait for the option module to finish accessing the NV Media Card and re-attempt the required function
Card Compare	**NV Media Card file/data is different to the one in the drive**
188	A compare has been carried out between a file on the NV Media Card and the drive, a *Card Compare* trip is initiated if the parameters on the NV Media Card are different to the drive. **Recommended actions:** • Set Pr **mm.000** to 0 and reset the trip • Check to ensure the correct data block on the NV Media Card has been used for the compare
Card Data Exists	**NV Media Card data location already contains data**
179	The *Card Data Exists* trip indicates that an attempt has been made to store data on a NV Media Card in a data block which already contains data. **Recommended actions:** • Erase the data in data location • Write data to an alternative data location
Card Drive Mode	**NV Media Card parameter set not compatible with current drive mode**
187	The *Card Drive Mode* trip is produced during a compare if the drive mode in the data block on the NV Media Card is different from the current drive mode. This trip is also produced if an attempt is made to transfer parameters from a NV Media Card to the drive if the operating mode in the data block is outside the allowed range of operating modes, for the target drive. **Recommended actions:** • Ensure the destination drive supports the drive operating mode in the parameter file. • Clear the value in Pr **mm.000** and reset the drive • Ensure destination drive operating mode is the same as the source parameter file
Card Error	**NV Media Card data structure error**
182	The *Card Error* trip indicates that an attempt has been made to access the 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. On an SD card, whilst this trip is still present, missing directories will be created, and if the header file is missing it will be created. The cause of the trip can be identified by the sub-trip. **Sub-trip** / **Reason** 1 – The required folder and file structure is not present 2 – The 000.DAT file is corrupted 3 – Two or more files in the <MCDF\> folder have the same file identification number **Recommended actions:** • Erase all the data block and re-attempt the process • Ensure the card is located correctly • Replace the NV Media Card
Card Full	**NV Media Card full**
184	The *Card Full* trip indicates that an attempt has been made to create a data block on a NV Media Card, but there is not enough space left on the card. No data is transferred. **Recommended actions:** • Delete a data block or the entire NV Media Card to create space • Use a different NV Media Card
Card No Data	**NV Media Card data not found**
183	The *Card No Data* trip indicates that an attempt has been made to access a non-existent file on the NV Media Card. No data is transferred. **Recommended actions:** • Ensure data file number is correct

Card Option	**NV Media Card trip; option module installed is different between source drive and destination drive**
180	The *Card Option* trip indicates that parameter data is being transferred from the NV Media Card to the drive, but the option module category is different between the source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the option module that is different will be set to the default values and not the values from the card. This trip also applies if a compare is performed between the data block on the card and the drive, and the option module installed is different between the source and target. **Recommended actions:** • Ensure the correct option module is installed. • Press the red reset button to acknowledge that the parameters for the option module installed will be at their default values • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.
Card Product	**NV Media Card data blocks are not compatible with the drive derivative**
175	The *Card Product* trip is initiated either at power-up or when the card is accessed, If *Drive Derivative* (11.028) or *Product Type* (11.063) are 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. **Sub-trip** / **Reason** 1 – If *Drive Derivative* (11.028) is different between the source and target drives, this trip is initiated either at power-up or when the SD Card is accessed. This trip can be reset and data can be transferred in either direction between the drive and the card. 2 – If *Product Type* (11.063) is different between the source and target drives or the file is corrupted or incompatible. This trip is initiated either at power-up or when the SD card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card. **Recommended actions:** • Use a different NV Media Card • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive, if sub-trip 1. • Choose a file compatible between the source and target drives, if sub-trip 2.
Card Rating	**NV Media Card Trip; The voltage and / or current rating of the source and destination drives are different**
186	The *Card Rating* trip indicates that parameter data is being transferred from the 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 performed between the data block on a NV Media Card and the drive. The Card Rating trip does not stop the data transfer but is a warning that rating specific parameters with the RA attribute may not be transferred to the destination drive. **Recommended actions:** • Reset the drive to clear the trip • Ensure that the drive rating dependent parameters have transferred correctly. • This trip can be suppressed by setting Pr **mm.000** to 9666 and resetting the drive.
Card Read Only	**NV Media Card has the Read Only bit set**
181	The *Card Read Only* trip indicates that an attempt has been made to modify data on a read-only NV Media Card or to modify 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
Card Slot	**NV Media Card trip; Option module file transfer has failed**
174	The Card Slot trip is initiated, if the transfer of an option module file to or from a module failed because the option module does not respond correctly. If this happens this trip is produced with the sub-trip number indicating the option module slot number.
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 large 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. The user actions that change drive parameters are loading defaults, changing drive mode, or transferring data from an NV memory card to the drive. The file system actions that will cause this trip to be initiated if the drive is enabled during the transfer are writing a parameter or macro file to the drive, or transferring a user program to the drive. It should be noted that none of these actions can be started if the drive is active, and so the trip only occurs if the action is started and then the drive is enabled. **Recommended actions:** • Ensure the drive is not enabled when one of the following is being carried out: Loading defaults Transferring user program Changing drive mode Transferring data from NV Media Card
DCCT Ref	**DCCT Reference out of range for size 5 upwards only**
110	**Recommended actions:** • Hardware fault - Contact the supplier of the drive
Derivative ID	**Derivative file error**
246	Derivative file error with sub-trips: **Sub-trip** / **Reason** / **Comments** 1 / The derivative file is missing or is invalid / Occurs when the drive powers-up. Load valid derivative file matching the control board hardware. 2 / The derivative file does not match the control board hardware / Occurs when the drive powers-up. Load valid derivative file matching the control board hardware. 3 / The derivative file has been changed for a file with a different derivative number. / Occurs when the drive powers-up or the file is programmed. The file tasks will not run. **Recommended actions:** • Contact the supplier of the drive

Derivative Image

Derivative product image error

248

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.

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 an 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	Reduce code in timed task or power down repeat rate
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
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

Destination

Two or more parameters are writing to the same destination parameter

199

The *Destination* trip indicates that destination parameters of two or more functions (Menus 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 config

Drive configuration

232

The hardware ID does not match the user software ID.

Sub-trip	Reason
1	The hardware ID does not match the user software ID (size 5 upwards only)
2	Invalid hardware ID
3	The hardware ID does not match the user software ID (Size 1-4)

Recommended actions:

- Hardware fault - Contact the supplier of the drive

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	Reserved
7	Reserved
8	The control board hardware has changed
9	The checksum on the non-parameter area of the EEPROM has failed

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

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

Recommended actions:

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

External Trip — **An External trip is initiated**

6

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

Sub-trip	Reason
3	*External Trip* (10.032) = 1

Recommended actions:

- 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

Fan Fail — **Fan fail**

173

This trip cannot be reset until 10 s after the trip was initiated.

Recommended actions:

- Check that the fan is installed and connected correctly.
- Check that the fan is not obstructed.
- Contact the supplier of the drive to replace the fan.

File changed — **File changed**

247

Recommended action:

- Power cycle the drive.

FW incompatible — Firmware incompatibility

237

The *FW incompatible* trip indicates that the user firmware is incompatible with the power firmware.

Recommended actions:

- Re-program the drive with the latest version of the drive firmware for Unidrive M400, using Unidrive M Connect.

HF01 — **Data processing error: CPU hardware fault**

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

HF02 — **Data processing error: CPU memory management fault**

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

Recommended actions:

- Hardware fault – Contact the supplier of the drive

HF03 — **Data processing error: CPU has detected a bus fault**

The *HF03* trip indicates that a bus fault has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:

- Hardware fault – Contact the supplier of the drive

HF04 — **Data processing error: CPU has detected a usage fault**

The *HF04* trip indicates that a usage fault 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 — **Reserved**

HF06 — **Reserved**

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. The crash level is indicated by the sub-trip number.

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 — **Reserved**

HF11 — **Data processing error: Non-volatile memory comms error**

The *HF11* trip indicates that a non-volatile memory comms error has occurred. The crash level is indicated by the sub-trip number. This trip indicates that the control PCB on the drive has failed.

Sub-trip	Reason	Recommended action
1	Non-volatile memory comms error.	Hardware fault – contact the supplier of the drive.
2	EEPROM size is incompatible with the user firmware.	Re-program drive with compatible user firmware.

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	User program or derivative background stack overflow
2	User program or derivative timed stack overflow
3	Main system interrupt stack overflow
4	Main system background stack overflow

Recommended actions:

- Hardware fault - Contact the supplier of the drive

HF13 — **Reserved**

HF14 — **Reserved**

HF15 — **Reserved**

HF16 — **Data processing error: RTOS error**

The *HF16* trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed.

Recommended actions:

- Hardware fault – Contact the supplier of the drive

HF17 — **Reserved**

HF18 — **Data processing error: Internal flash memory has failed**

The HF18 trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	Programming error while writing menu in flash
2	Erase flash block containing setup menus failed
3	Erase flash block containing application menus failed

Recommended actions:

- Hardware fault - Contact the supplier of the drive

HF19 — **Data processing error: CRC check on the firmware has failed**

HF19 trip indicates that the CRC check on the drive firmware has failed.The drive is now in its Bootloader and is waiting for a new image to be downloaded using Unidrive M Connect. Once a new image is downloaded, the drive can run normally.

Recommended actions:

- Re-program the drive with latest control and power firmware using Unidrive M Connect.
- Hardware fault - Contact the supplier of the drive

HF23 — **Hardware fault**

Recommended actions:

- If this trip occurs, contact the supplier of the drive

Hot Rect/Brake — **Hot rectifier/brake**

Over-temperature detected on input rectifier or braking IGBT.

250

Recommended actions:

Increase ventilation by setting *Cooling Fan Control* (06.045) > 0

I cal. range — **Current calibration range**

Current calibration range error.

231

Recommended actions:

- Hardware fault - Contact the supplier of the drive

I/O Overload — **Digital output overload**

This trip indicates that the total current drawn from the AI adaptor 24 V or from the digital output has exceeded the limit.

Sub-trip	Reason
1	Digital output or 24 V supply load on control terminal is too high.
2	AI adaptor 24 V load is too high

26

Recommended actions:

- Check total loads on digital outputs and 24 V
- Check control wiring is correct
- Check output wiring is undamaged

Keypad Mode — **Keypad has been removed when the drive is receiving the reference from the keypad**

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.

34

Recommended actions:

- Re-install keypad and reset
- Change *Reference Selector* (01.014) to select the reference from another source

LF Power Comms — **Communication has been lost / errors detected between power, control and rectifier modules**

This 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.
Control system	00	0	02: Excessive communication errors between the control system and power system.
Power system	01	1	00: Excessive communications errors detected by the rectifier module.

90

Recommended actions:

- Hardware fault - contact the supplier of the drive.

Motor Too Hot	**Output current overload timed out (I^2t)**
20	The *Motor Too Hot* trip indicates a motor thermal overload based on the *Motor Rated Current* (Pr **05.007**) and *Motor Thermal Time Constant* (Pr **04.015**). Pr **04.019** displays the motor temperature as a percentage of the maximum value. The drive will trip on *Motor Too Hot* when Pr **04.019** gets to 100 %. **Recommended actions:** • Ensure the load is not jammed / sticking • Check the load on the motor has not changed • Tune the motor rated speed parameter (Pr **5.008**) (RFC-A mode only) • Ensure the motor rated current is not zero
No power board	**No power board**
236	No communication between the power and control boards. **Recommended actions**: • Hardware fault - contact the supplier of the drive.
OHt Control	**Control stage over temperature**
219	This trip indicates that a control stage over-temperature has been detected if *Cooling Fan Control* (06.045) = 0. This trip causes the option module to go to standby and *Potential Drive Damage Conditions* (10.106) Bit 1 to be set. **Recommended actions:** • Increase ventilation by setting *Cooling Fan Control* (06.045) > 0
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 **05.019** = 1) – (Open loop)
  - Disconnect the load and complete a rotating auto-tune (Pr **05.012**)
  - Reduce frequency loop gains (Pr **03.010**, Pr **03.011**, Pr **03.012**) – (RFC-A)

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. The *OHt Inverter* trip is initiated when the temperature based on the thermal model reaches 145 °C. The trip reset temperature is 139 °C.

Source	xx	y	zz	Description
Control system	00	1	00	Inverter thermal model gives {OHt Inverter} trip with sub-trip 100

Recommended actions:

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

OHt Power

Power stage over temperature

22

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

Source	xx	y	zz	Description
Power system	01	0	zz	Thermistor location in the drive defined by zz

Drive size	Trip temperature (°C)	Trip reset temperature (°C)
1 to 4	95	90
5	115	110
06200XXX	115	110
06400XXX	125	120
06500XXX	120	115

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
- Increase acceleration / deceleration rates
- Use *S Ramp Enable* (02.006)
- 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

OI ac

Instantaneous output over current detected

3

The instantaneous drive output current has exceeded Pr **11.061**.

This trip cannot be reset until 10 s after the trip was initiated.

Recommended actions/checks:

- Increase acceleration/deceleration rate
- 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
- Is the motor cable length within limits for the frame size?
- Reduce the values in the frequency loop gain parameters - (Pr **03.010**, **03.011**, **03.012**) or (Pr **03.013**, **03.014**, **03.015**)
- Reduce the values in the current loop gain parameters - (Pr **04.013,** Pr **04.014**)

OI Snubber

Snubber over-current detected

92

This trip indicates that an over-current condition has been detected in the rectifier snubbing circuit, The exact cause of the trip can be identified by the sub-trip number.

Source	xx	y	zz
Power system	01	1	00: Rectifier snubber over current trip detected

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.

OI Brake

Braking IGBT over current detected: short circuit protection for the braking IGBT activated

4

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

Recommended actions:

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

Out Phase Loss

98

Output phase loss detected

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

A test can be made for output phase loss when the drive is enabled or the output phase loss condition can be detected while the drive is running as defined by *Output Phase Loss Detection Enable* (06.059).

Sub-trip	Reason
1	U phase detected as disconnected when drive enabled to run.
2	V phase detected as disconnected when drive enabled to run.
3	W phase detected as disconnected when drive enabled to run.
4	The drive output frequency is above 4 Hz and a phase is disconnected for the time specified by *Output Phase Loss Detection Time* (06.058)

NOTE

If Pr **05.042** = 1 the physical output phases are reversed, and so sub-trip 3 refers to physical output phase V and sub-trip 2 refers to physical output phase W.

Recommended actions:

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

Output phase s/c

228

Output phase short-circuit

Over-current detected on drive output when enabled. Possible motor ground fault.

Recommended actions:

- Check for short circuit on the output cabling
- Check integrity of the motor insulation using an insulation tester
- Is the motor cable length within limits for the frame size?

Over Speed

7

Motor frequency has exceeded the over frequency threshold

In open loop mode, if the *Post-ramp Reference* (02.001) exceeds the threshold set in the *Over Frequency Threshold* (03.008) in either direction an Over Speed trip is produced. In RFC-A mode, if the *Estimated Frequency* (03.002) exceeds the Over Frequency Threshold in Pr **03.008** in either direction an Over Speed trip is produced. If Pr **03.008** is set to 0.00 the threshold is then equal to 1.2 x the value set in Pr **01.006**.

Recommended actions:

- Check that the motor is not being driven by another part of the system.
- Reduce the *Frequency Controller Proportional Gain* (03.010) to reduce the frequency overshoot (RFC-A mode only).

Over Volts

2

DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds

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] Frame 1 to 4	VM_DC_VOLTAGE[MAX] Frame 5 to 9	VM_DC_VOLTAGE_SET[MAX]
100	510	415	400
200	510	415	400
400	870	830	800
575	N/A	990	955
690	N/A	1190	1150

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	01	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 an insulation tester

Phase Loss

32

Supply phase loss

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	01	0	00: Phase loss has been detected by the rectifier module.

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
- Check for mechanical resonance with the load
- Reduce the duty cycle
- Reduce the motor load
- Disable the phase loss detection, set Pr **06.047** to 2.

Power Board HF

235

Power board HF

Power processor hardware fault. The sub-trip number is the HF code.

Recommended action:

- Hardware fault - Contact the supplier of the drive

Power Boot Mode

245

Power board is in bootloader mode

Power board is in bootloader mode

Recommended actions:

- Send power board firmware file to reprogram the power board using Unidrive M Connect and power cycle drive

Power Comms

93

Communication has been lost / errors detected between control and power board

The *Power Comms* trip is initiated if there is no communications between the control board processor and the power board processor. The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	PLL operating range out of lock
2	Power board lost communications with user board
3	User board lost communication with power board
4	Communication CRC error

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Power Data

Power system configuration data error

220

This trip can be generated from either the drive control system or from the power system.

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

The trip is related to the table uploaded from the power system at power-up.

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.
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.
Control system	0	0	07	The power data table failed to be stored in the power board.
Power system	01	0	00	The power data table used internally by the power module has an error.
Power system	01	0	01	The power data table that is uploaded to the control system on power up has an error.
Power system	01	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

Power Down Save

Power down save error

37

The *Power Down Save* trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory.

Recommended actions:

- Perform a 1001 save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up.

PSU

Internal power supply fault

5

The *PSU* trip indicates that one or more internal power supply rails are outside limits or overloaded.

Source	xx	y	zz	Description
Control system	00	0	00	Internal power supply overload.
Power system	01	1		

Recommended actions:

- Remove the option module and perform a reset
- There is a hardware fault within the drive – return the drive to the supplier

Reserved

Reserved trips

01
09
12
14-17
23, 38, 39
91,
94 - 95, 99
101 - 109, 111
168 - 172, 176
191 - 198
205 - 217
222 - 224
229 - 230
233
238 - 244
251 - 254

These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.

Trip Number	Description
01, 09, 12, 14 -17, 23, 38, 39	Reserved resettable trip
91, 94 -95, 99	Reserved resettable trip
101 - 109, 111	Reserved resettable trip
168 - 172, 176	Reserved resettable trip
191 – 198	Reserved resettable trip
205 - 217	Reserved resettable trip
222 - 224	Reserved non-resettable trip
229 - 230, 233	Reserved non-resettable trip
238 - 244	Reserved non-resettable trip
251 - 254	Reserved non-resettable trip

Resistance — **Measured resistance has exceeded the parameter range**

33

The *Resistance* trip indicates that the measured stator resistance of the motor during an auto-tune test has exceeded the maximum possible value of *Stator Resistance* (05.017).

If the measured value or a value written to this parameter by the user exceeds ($V_{FS}/\sqrt{2}$) / *Full Scale Current Kc* (11.061), where V_{FS} is the full scale DC bus voltage then this trip is initiated.

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.

If the value is the result of a measurement made by the drive then sub-trip 0 is applied, or if it is because the parameter has been changed by the user then sub-trip 3 is applied. During the stator resistance section of auto-tuning an additional test is performed to measure the drive inverter characteristics to provide the compensation necessary for dead-times. If the inverter characteristic measurement fails then sub-trip 2 is applied.

The reason for the trip can be identified by the sub-trip number.

Sub-trip	Reason
0	*Stator Resistance* (05.017/21.012) test failed during Autotune or measured stator resistance value is out of range.
1	Reserved
2	*Transient Inductance* (05.024/21.014) test failed during Autotune or measured stator resistance value is out of range.
3	The value of Stator Resistance (05.017/21.012) is too large when the parameter is edited.
4	*Stator Resistance* (05.017/21.012) test successful during Autotune but Pr **05.017**/Pr **21.012** is too large for this drive current and voltage rating.

Recommended actions:

- Check that a value has not been entered in the Stator Resistance for the presently selected motor map that exceeds the allowed range.
- Check the motor cable / connections
- Check the integrity of the motor stator winding using an insulation tester
- Check the motor phase to phase resistance at the drive terminals
- Check the motor phase to phase resistance at the motor terminals
- Ensure the stator resistance of the motor falls within the range of the drive model
- Select fixed boost mode (Pr **05.014** = Fd) and verify the output current waveforms with an oscilloscope
- Replace the motor

Slot 1 Different — **Option module in option slot 1 has changed**

204

The *Slot 1 Different* trip indicates that the option module in option slot 1 on the drive is a different type to that installed when parameters were last saved on the drive. The reason for the trip can be identified by the sub-trip number.

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

Recommended actions:

- Turn off the power, ensure the correct option module is installed in the option slot 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.**

Slot 1 Error — **Option module in option slot 1 has detected a fault**

202

The *Slot 1 Error* trip indicates that the option module in option slot 1 on the drive has detected an error. The reason for the error can be identified by the sub-trip number. As default the sub-trip number is shown as a number on the display. However, it is possible for the option module to supply sub-trip number strings which will be displayed instead of the number if available.

Recommended actions:

- See relevant *option module User Guide* for details of the trip

Slot 1 HF — **Option module 1 hardware fault**

200

The *Slot 1 HF* trip indicates that the option module in option slot 1 has indicated a fault. The possible causes of the trip can be identified by the sub-trip number.

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

Recommended actions:

- Ensure the option module is installed correctly
- Replace the option module
- Replace the drive

Slot 1 Not Fitted — **Option module in option slot 1 has been removed**

203

The *Slot 1 Not Fitted* trip indicates that the option module in option slot 1 on the drive has been removed since the last power up. The sub-trip number gives the ID code of the option module that has been removed.

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**.

Slot 1 Watchdog — **Option module watchdog function service error**

201

The *Slot 1 Watchdog* trip indicates that the option module installed in Slot 1 has started the option watchdog function and then failed to service the watchdog correctly.

Recommended actions:

- Replace the option module

Soft Start — **Soft start relay failed to close, soft start monitor failed**

226

The *Soft Start* trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed. The cause of the trip can be identified by the sub-trip number.

Sub-trip	Reason
1	Soft-start failure
2	DC bus capacitor failure on 110 V drive (size 2 only)

Recommended actions:

- Hardware fault – Contact the supplier of the drive

STO Error — **No Safe Torque Off board fitted**

234

STO board not fitted.

Recommended actions:

Hardware fault – Contact the supplier of the drive

Stored HF — **Hardware trip has occurred during last power down**

221

The *Stored HF* trip indicates that a hardware trip (HF01 –HF18) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip.

Recommended actions:

- Enter 1299 in Pr **mm.000** and press reset to clear the trip

Sub-array RAM

227

RAM allocation error

The *Sub-array RAM* trip indicates that an option module derivative 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	1
8 bit	2
16 bit	3
32 bit	4
64 bit	5

Parameter type	Value
Volatile	0
User save	1
Power-down save	2

Derivatives can customize menus 18 and 20.

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

Temp Feedback

218

Internal thermistor has failed

The *Temp Feedback* trip indicates that an internal thermistor has failed in the drive (i.e. open circuit or short circuit). The thermistor location can be identified by the sub-trip number.

Source	xx	y	zz
Power system	01	0	Thermistor location defined by zz in the power system
Power system	01	1	Thermistor location defined by zz in the rectifier

Recommended actions:

- Hardware fault – Contact the supplier of the drive

Th Brake Res

10

Brake resistor over temperature

The *Th Brake Res* trip is initiated if the 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

25

Motor thermistor short circuit

The *Th Short Circuit* trip indicates that the motor thermistor connected to terminal 14 (digital input 5) on the control connections, is short circuit or low impedance (<50 Ω).

Recommended actions:

- Check thermistor continuity
- Replace motor / motor thermistor

Thermistor

24

Motor thermistor over-temperature

The *Thermistor* trip indicates that the motor thermistor connected to terminal 14 (digital input 5) on the control connections has indicated a motor over temperature. If *Digital Input 5 Mode* (08.035) is 2 then a thermistor trip is initiated if the feedback value is higher than *Thermistor Trip Threshold* (07.048).

Recommended actions:

- Check Threshold Level (Pr **07.048**)
- Check motor temperature
- Check thermistor continuity

User OI ac

8

User OI ac

A *User OI ac* trip is initiated if the output current of the drive exceeds the trip level set by User Over Current Trip Level (Pr **04.041**).

User Prog Trip

96

Trip generated by an onboard user program

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 Program	On board user program error

249

An error has been detected in the onboard user program image. The sub-trip indicated the reason for the trip.

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 an 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 user program image has been changed for an image with a different user program number.	As 30.
40	The timed task has not completed in time and has been suspended.	*Onboard User Program: Enable* (11.047) is reset to zero when the trip is initiated.
41	Undefined function called, i.e. a function in the host system vector table that has not been assigned.	As 40.
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 user program menu and the trip will keep occurring until drive parameters are saved.
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	
100	Image has detected and prevented attempted pointer access outside of the IEC task's heap area.	
101	Image has detected and prevented misaligned pointer usage.	
102	Image has detected an array bounds violation and prevented its access.	
103	Image has attempted to convert a data type to or from an unknown data type, has failed and has shut itself down.	
104	Image has attempted to use an unknown user service function.	
200	User program has invoked a "divide" service with a denominator of zero. (Note that this is raised by the downloaded image and has therefore been given a distinct error code despite being the same fundamental problem as sub-trip 1.)	
201	Parameter access is not supported. An attempt to read database other than the host drive.	
202	Parameter does not exist. Database was host drive but the specified parameter does not exist.	
203	Parameter is read-only.	
204	Parameter is write-only.	
205	Unknown parameter error.	
206	Invalid bit present in parameter. The parameter does not contain the specified bit.	
207	Parameter format lookup failed. Failed to get parameter information data.	
208	An over-range write has been attempted.	

The following table shows the differences when compared to the derivative product image.

Sub-trip	Difference
40,41	Onboard User Program: Enable (11.047) is reset to zero when the trip is initiated.
51	Not applicable as core menu Customization not allowed.
6x	Not applicable as option module restrictions not allowed.
7x	Not applicable as option module restrictions not allowed.
100	Image has detected and prevented attempted pointer access outside of the IEC task's heap area.
101	Image has detected and prevented misaligned pointer usage.
102	Image has detected an array bounds violation and prevented its access.
103	Image has attempted to convert a data type to or from an unknown data type, has failed and has shut itself down.
104	Image has attempted to use an unknown user service function.
200	User program has invoked a "divide" service with a denominator of zero. (Note that this is raised by the downloaded image and has therefore been given a distinct error code despite being the same fundamental problem as sub-trip 1)

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 - 167**	These trips are not generated by the drive and are to be used by the user to trip the drive through an application program. **Recommended actions:** • Check the user program
Watchdog	**Control word watchdog has timed out**
30	The *Watchdog* trip indicates that the control word has been enabled and has timed out **Recommended actions:** Once Pr **06.042** bit 14 has been changed from 0 to 1 to enable the watchdog, this must be repeated every 1s or a Watchdog trip will be initiated. The watchdog is disabled when the trip occurs and must be re-enabled if required when the trip is reset.

Table 12-3 Serial communications look up table

No	Trip	No	Trip	No	Trip
1	**Reserved**	90	**LF Power Comms**	199	**Destination**
2	**Over Volts**	91	**Reserved**	200	**Slot 1 HF**
3	**OI ac**	92	**OI Snubber**	201	**Slot 1 Watchdog**
4	**OI Brake**	93	**Power Comms**	202	**Slot 1 Error**
5	**PSU**	94 - 95	**Reserved**	203	**Slot 1 Not Fitted**
6	**External Trip**	96	**User Prog Trip**	204	**Slot 1 Different**
7	**Over Speed**	97	**Data Changing**	205 - 214	**Reserved**
8	**User OI ac**	98	**Out Phase Loss**	215	**Reserved**
9	**Reserved**	99	**Reserved**	216 - 217	**Reserved**
10	**Th Brake Res**	100	**Reset**	218	**Temp Feedback**
11	**Autotune 1**	101	**Reserved**	219	**OHt Control**
12	**Reserved**	102	**Reserved**	220	**Power Data**
13	**Autotune 3**	103 - 108	**Reserved**	221	**Stored HF**
14 - 17	**Reserved**	109	**Reserved**	222	**Reserved**
18	**Autotune Stopped**	110	**DCCT Ref**	223 - 224	**Reserved**
19	**Brake R Too Hot**	111	**Reserved**	225	**Current Offset**
20	**Motor Too Hot**	112 - 167	**t112 - t167**	226	**Soft Start**
21	**OHt Inverter**	168 - 172	**Reserved**	227	**Sub-array RAM**
22	**OHt Power**	173	**Fan Fail**	228	**Output phase s/c**
23	**Reserved**	174	**Card Slot**	229	**Reserved**
24	**Thermistor**	175	**Card Product**	230	**Reserved**
25	**Th Short Circuit**	176	**Reserved**	231	**I cal. range**
26	**I/O Overload**	177	**Reserved**	232	**Drive config**
27	**OHt dc bus**	178	**Card Busy**	233	**Reserved**
28	**An Input 1 Loss**	179	**Card Data Exists**	234	**STO Error**
29	**An Input 2 Loss**	180	**Card Option**	235	**Power Board HF**
30	**Watchdog**	181	**Card Read Only**	236	**No power board**
31	**EEPROM Fail**	182	**Card Error**	237	**FW incompatible**
32	**Phase Loss**	183	**Card No Data**	238 - 244	**Reserved**
33	**Resistance**	184	**Card Full**	245	**Power Boot Mode**
34	**Keypad Mode**	185	**Card Access**	246	**Derivative ID**
35	**Control Word**	186	**Card Rating**	247	**File changed**
36	**User Save**	187	**Card Drive Mode**	248	**Derivative Image**
37	**Power Down Save**	188	**Card Compare**	249	**User Program**
38	**Reserved**	189	**An Input 1 OI**	250	**Hot Rect/Brake**
39	**Reserved**	190	**An Input 2 OI**	252 - 254	**Reserved**
40 - 89	**t040 - t089**	191 - 198	**Reserved**	255	**Reset logs**

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 12-4 Trip categories

Priority	Category	Trips	Comments
1	Internal faults	HFxx	These indicate internal problems and cannot be reset. All drive features are inactive after any of these trips occur.
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, {Slot 1 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	{PSU}	Rectifier 24 V
5	Trips with extended reset times	{OI.ac}, {OI Brake} and {Fan Fail}	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} 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	

12.5 Internal / Hardware trips

Trips {HF01} to {HF23} are internal faults that do not have trip numbers, except HF08, HF11, HF12 and HF18. 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 (the sub-trip number indicates the HF fault code). Enter 1299 in **mm.000** to clear the Stored HF trip.

12.6 Alarm indications

In any mode, an alarm is an indication given on the display by alternating the alarm string with the drive status string display. If an action is not taken to eliminate any alarm except "Auto Tune", “Limit Switch" and 24V Backup Lost” the drive may eventually trip. Alarms are not displayed when a parameter is being edited.

Table 12-5 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* (4.019) 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.
Option Slot 1	Option slot alarm
Low AC	Low voltage mode. See *Low AC Alarm* (10.107).
Current limit	Current limit active. See *Current Limit Active* (10.009).
24V Backup Lost	24V Backup not present. See *24V Alarm Loss Enable* (11.098)

12.7 Status indications

Table 12-6 Status indications

Upper row string	Description	Drive output stage
Inhibit	The drive is inhibited and cannot be run. The Safe Torque Off signals are not applied to the 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 frequency.	Enabled
Run	The drive is active and running.	Enabled
Supply Loss	Supply loss condition has been detected.	Enabled
Deceleration	The motor is being decelerated to zero frequency because the final drive run has been deactivated.	Enabled
dc Injection	The drive is applying dc injection braking.	Enabled
Trip	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
Under Voltage	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled
Heat	The motor pre-heat function is active	Enabled

Table 12-7 Option module and other status indications at power-up

First row string	Second row string	Status
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	**Option**	Waiting for an option module
The drive is waiting for the option module to respond after power-up		
Uploading From	**Option**	Loading parameter database
At power-up it may be necessary to update the parameter database held in the drive because an option module has changed. This may involve data transfer between the drive and option module. During this period 'Uploading From Option' is displayed.		
Awaiting	**Image**	Bootloading drive firmware
The drive is waiting for the bootloader file to be transferred to the processor.		

12.8 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 12-2 is the value transmitted.

NOTE

The trip logs can be reset by writing a value of 255 in Pr **10.038** (via serial communications only).

12.9 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 diagnose the cause of the trip.

Parameter	Description
01.001	Frequency reference
01.002	Pre-skip filter reference
01.003	Pre-ramp reference
01.069	Reference in rpm
01.070	Clamped reference
02.001	Post-ramp reference
03.001	Final demand ref
03.002	Estimated frequency
03.003	Frequency error
03.004	Frequency controller output
03.045	Frequency reference
04.001	Current magnitude
04.002	Active current
04.017	Reactive current
05.001	Output frequency
05.002	Output voltage
05.003	Power
05.005	DC bus voltage
07.001	Analog input 1
07.002	Analog input 2

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

13 UL information

13.1 UL file reference

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

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

13.2 Option modules, kits and accessories

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

13.3 Enclosure ratings

Drives are UL Open Type as supplied.

Drives fitted with a conduit box are UL Type 1.

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

Remote Keypads are UL Type 12.

13.4 Mounting

Drives can be mounted directly onto a vertical surface. This is known as 'surface' or 'standard' mounting. Refer to relevant *Power Installation Guide* for further information.

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

Some drives can be mounted on their side. This is known as 'tile' mounting. Suitable tile mounting kits are available from Emerson Industrial Automation. Refer to relevant *Power Installation Guide* for further information.

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

Some drives may be through-hole mounted. Mounting brackets and sealing kits are available from Emerson Industrial Automation. Refer to relevant *Power Installation Guide* for further information.

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

13.5 Environment

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

All drives are capable of delivering full rated output current at surrounding air temperatures up to 40 °C.

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

13.6 Electrical Installation

TERMINAL TORQUE

Terminals must be tightened to the rated torque as specified in the Installation Instructions. Refer to relevant *Power Installation Guide* for further information.

WIRING TERMINALS

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

UL Listed closed-loop connectors sized according to the field wiring shall be used for all field wiring connections. Refer to relevant *Power Installation Guide* for further information.

BRANCH CIRCUIT PROTECTION

The fuses and circuit breakers required for branch circuit protection are contained in the Installation Instructions. Refer to relevant *Power Installation Guide* for further information.

OPENING OF BRANCH CIRCUIT

Opening of the branch-circuit protective device may be an indication that a fault has been interrupted. To reduce the risk of fire or electric shock, the equipment should be examined and replaced if damaged. If burnout of the current element of an overload relay occurs, the complete overload relay must be replaced.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local "codes".

DYNAMIC BRAKING

Drives with model numbers beginning M100, M101, M200, M201, M300 or M400 have been evaluated for dynamic braking applications.

13.7 Motor overload protection and thermal memory retention

All drives incorporate internal overload protection for the motor load that does not require the use of an external or remote overload protection device.

The protection level is adjustable and the method of adjustment is provided in section 8.4 *Motor thermal protection* on page 60. Maximum current overload is dependent on the values entered into the current limit parameters (motoring current limit, regenerative current limit and symmetrical current limit entered as percentage) and the motor rated current parameter (entered in amperes).

The duration of the overload is dependent on motor thermal time constant The time constant is programmable. The default overload protection is typically set to 150 % of the motor rated current for 120 seconds.

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

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

All models are provided with thermal memory retention.

13.8 Electrical supply

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

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

13.9 External Class 2 supply

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

13.10 Requirement for Transient Surge Suppression

This requirement applies to drives with rated input voltage = 575 V, Frame Size 7 only.

TRANSIENT SURGE SUPPRESSION SHALL BE INSTALLED ON THE LINE SIDE OF THIS EQUIPMENT AND SHALL BE RATED 575 Vac (PHASE TO GROUND), 575 Vac (PHASE TO PHASE), SUITABLE FOR OVERVOLTAGE CATEGORY III, AND SHALL PROVIDE PROTECTION FOR A RATED IMPULSE VOLTAGE TO WITHSTAND VOLTAGE PEAK OF 6 kV AND A CLAMPING VOLTAGE OF MAXIMUM 2400 V.

13.11 Group Installation and Modular Drive Systems

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

Alternatively, the inverters may be supplied by converters from the Unidrive-M range manufactured by Emerson Industrial Automation.

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

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

Index

0478-0349-01