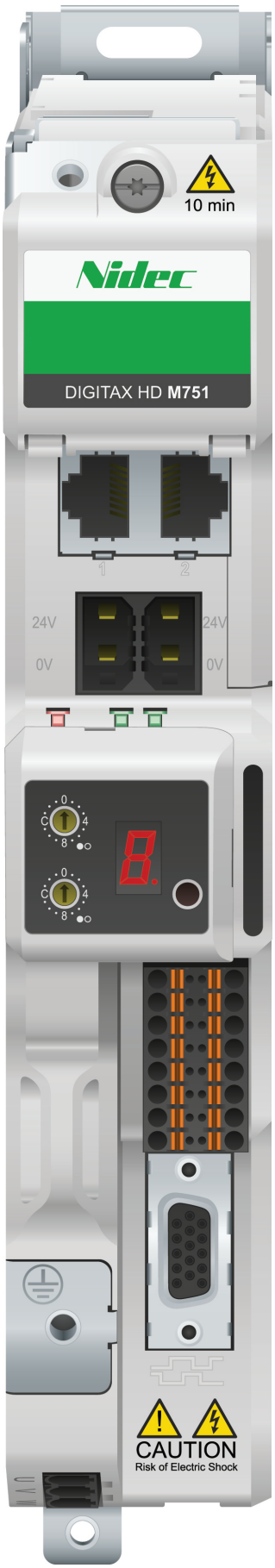

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Control User Guide

Digitax HD M751 Series

Variable Speed AC drive for Servo and Induction motors

Part Number: 0478-0460-03
Issue: 3

Original Instructions

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

Documentation

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

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

Warranty and Liability

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

Environmental policy

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

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

Restriction of Hazardous Substances (RoHS)

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

Disposal and Recycling (WEEE)

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

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

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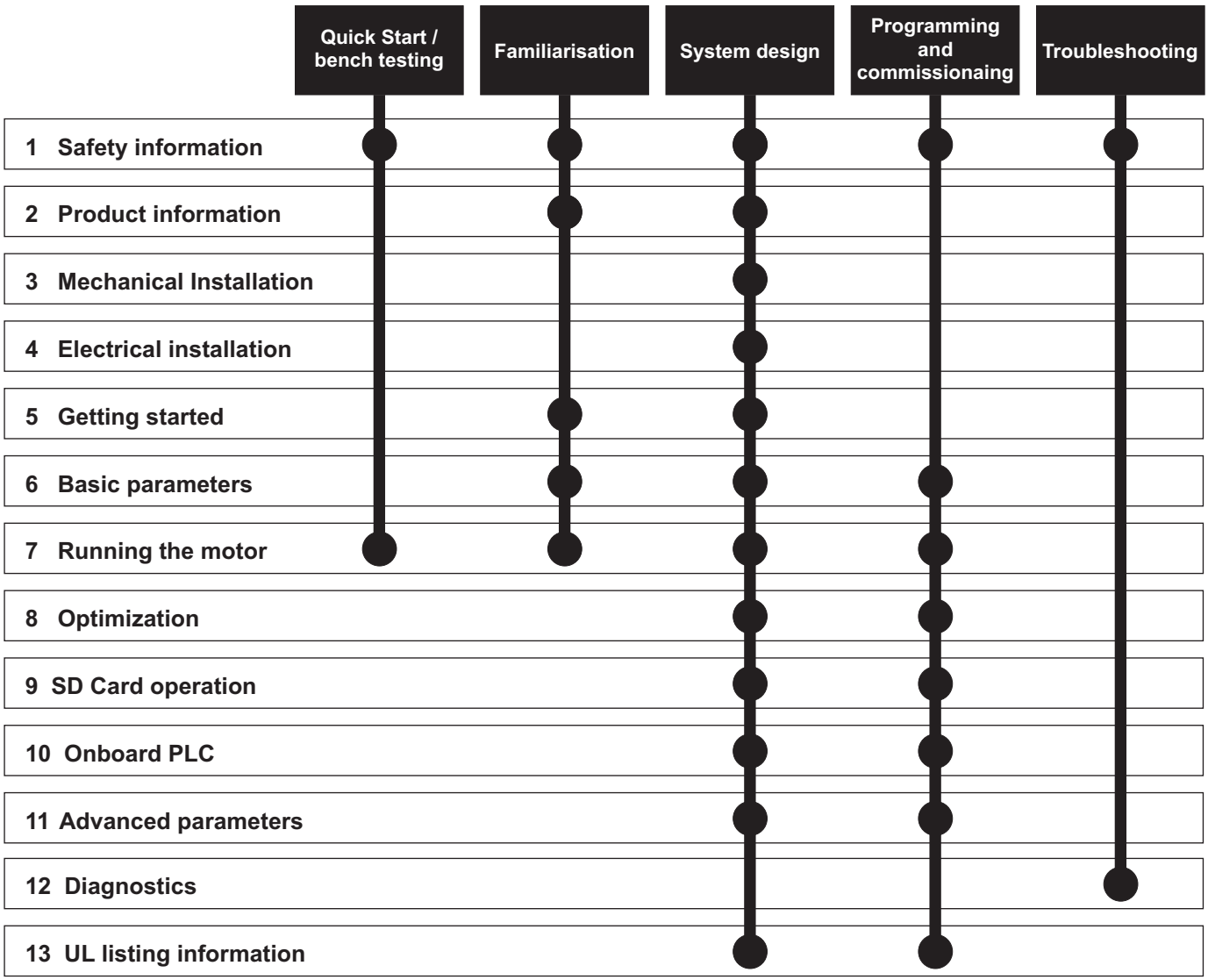
How to use this guide

This guide is intended to be used in conjunction with the *Digitax HD M75X Series Installation and Technical Guide*. The *Installation and Technical Guide* gives information necessary to 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:



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EU Declaration of Conformity

Nidec Control Techniques Ltd,

The Gro,

Newtown,

Powys,

SY16 3BE,

UK.

This declaration is issued under the sole responsibility of the manufacturer. The object of the declaration is in conformity with the relevant European 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, M708, M709, M751, M753, M754, 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).

Jonathan Holman-White

Director, Technology

Date: 14th May 2018

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

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

EU Declaration of Conformity (including 2006 Machinery Directive)

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SY16 3BE

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	M600, M700, M701, M702, M708, M709, M751, M753, M754, F300, H300, E200, E300, 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

Notified body identification number: 0035
The harmonized standards used are shown below:
EC type-examination certificate numbers:
01/205/5270.02/17 dated 2017-08-28

EN 61800-5-2:2016	Adjustable speed electrical power drive systems - Part 5-2: Safety requirements - Functional
EN 61800-5-1:2016 (in extracts)	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
EN 61800-3: 2004+A1:2012	Adjustable speed electrical power drive systems - Part 3: EMC requirements and specific test methods
EN ISO 13849-1:2015	Safety of Machinery, Safety-related parts of control systems, General principles for design
EN 62061:2005 + AC:2010 + A1:2013 + A2:2015	Safety of machinery, Functional safety of safety related electrical, electronic and programmable electronic control systems
IEC 61508 Parts 1 - 7:2010	Functional safety of electrical/ electronic/programmable electronic safety-related systems

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

DoC authorised by:

Jonathan Holman-White
Director, Technology
Date: 14th May 2018

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. It is the responsibility of the installer to ensure that the design of the complete machine, including its safety-related control system, is carried out in accordance with the requirements of the Machinery Directive and any other relevant legislation. The use of a safety-related drive in itself does not ensure the safety of the machine. Compliance with safety and EMC regulations depends upon installing and configuring drives correctly, including using the specified input filters. The drive must be installed only by professional installers who are familiar with requirements for safety and EMC. The assembler is responsible for ensuring that the end product or system complies with all relevant laws in the country where it is to be used. For more information regarding Safe Torque Off, refer to the Product Documentation.

1 Safety information

1.1 Warnings, Cautions and Notes

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

WARNING

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

CAUTION

NOTE

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

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

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

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

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

1.3 Responsibility

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

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

1.4 Compliance with regulations

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

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

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

2006/42/EC Safety of machinery.

2014/30/EU: Electromagnetic Compatibility.

1.5 Electrical hazards

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

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

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

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

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

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

1.6 Stored electrical charge

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

1.7 Mechanical hazards

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

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

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

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

1.8 Access to equipment

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

1.9 Environmental limits

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

1.10 Hazardous environments

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

1.11 Motor

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

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

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

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

1.12 Mechanical brake control

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

1.13 Adjusting parameters

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

1.14 Electromagnetic compatibility (EMC)

Installation instructions for a range of EMC environments are provided in the *Digitax HD M75X Series Installation and Technical Guide*. If the installation is poorly designed or other equipment does not comply with suitable standards for EMC, the product might cause or suffer from disturbance due to electromagnetic interaction with other equipment. It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the relevant EMC legislation in the place of use.

2 Product information

The *Digitax HD M75X series* is a range of high performance servo drives used as a standalone single axis or easily configured for multi-axis systems. Functionality also allows for this range of drives to be reconfigured for high performance universal AC motor control.

2.1 Introduction

Servo and Universal AC drive

This product family consists of the following variants:

- Digitax HD M751 Base
- Digitax HD M753 EtherCAT

Common features (Digitax HD M751 and M753)

- Universal high performance open and closed loop control for induction, servo, permanent magnet and linear motors using Unidrive M motor control algorithms.
- Onboard IEC 61131-3 programmable automation and motion control.
- Flexibility with speed and position measurement, supporting multiple devices and all common interfaces.
- SD Media Card slot for parameter copying and data storage.
- Dual channel Safe Torque Off (STO) input.
- Simplified wiring and networking for multi-axis arrangements.
- Connect support for quick start commissioning/start up (downloadable from controltechniques.com).
- Option module connectable.

Variant description summary (Digitax HD M751 and M753)

Digitax HD M751 Base

- EIA-485 serial communications interface
- Option module support as standard for configuration and flexibility

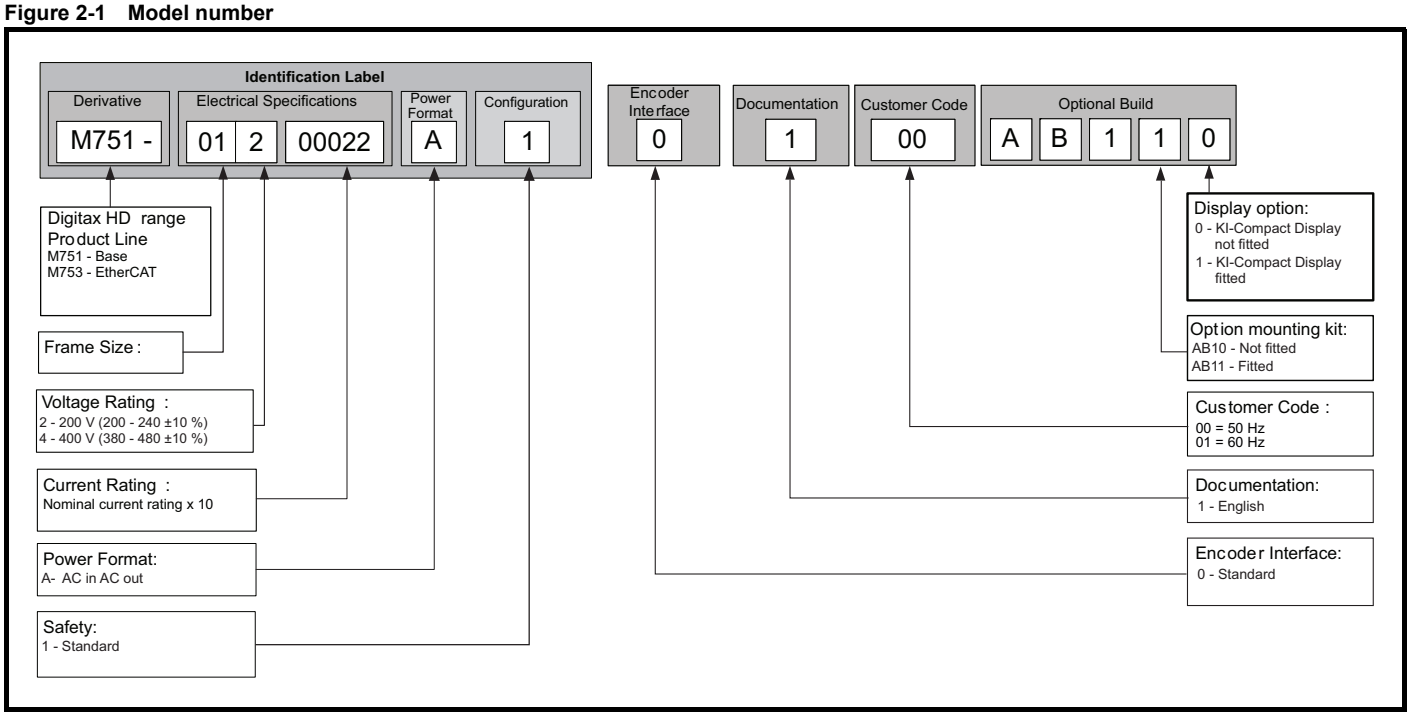
Digitax HD M753 EtherCAT

- Onboard EtherCAT slave for centralized motion control and accurate synchronization applications.
- 2 integrated EtherCAT ports

2.2 Model number

The way in which the model numbers for the Digitax HD M75X series product range are formed is illustrated below:

Figure 2-1 Model number



2.3 Operating modes

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

1. RFC - S
   - With position feedback sensor
   - Without position feedback sensor (Sensorless)
2. Open loop mode
   - Open loop vector mode
   - Fixed V/F mode (V/Hz)
   - Quadratic V/F mode (V/Hz)
3. RFC - A
   - With position feedback sensor
   - Without position feedback sensor (Sensorless)

As a range of high performance servo drives, the Digitax HD M75X series are initially factory configured for RFC-S mode. The operating mode will need to be re-configured for AC induction motor control (open loop or RFC-A mode).

2.3.1 RFC- S

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

With position feedback

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

The drive directly controls the speed of the motor using the feedback device to ensure the rotor speed is exactly as demanded.

Absolute position information is required from the feedback device to ensure the output voltage is accurately matched to the back EMF of the motor. Full torque is available across the entire speed range.

Without position feedback (Sensorless)

For permanent magnet brushless motor control without a feedback device, using current, voltages and key motor parameters for motor control.

2.3.2 Open loop mode

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

Open loop vector mode

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

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

Fixed V/F mode

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

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

Quadratic V/F mode

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

2.3.3 RFC-A mode

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

With position feedback

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

Without position feedback (Sensorless)

Sensorless mode 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 such as operating large motors with light loads at low frequencies.

2.4 Compatible position feedback devices

Table 2-1 Supported feedback devices

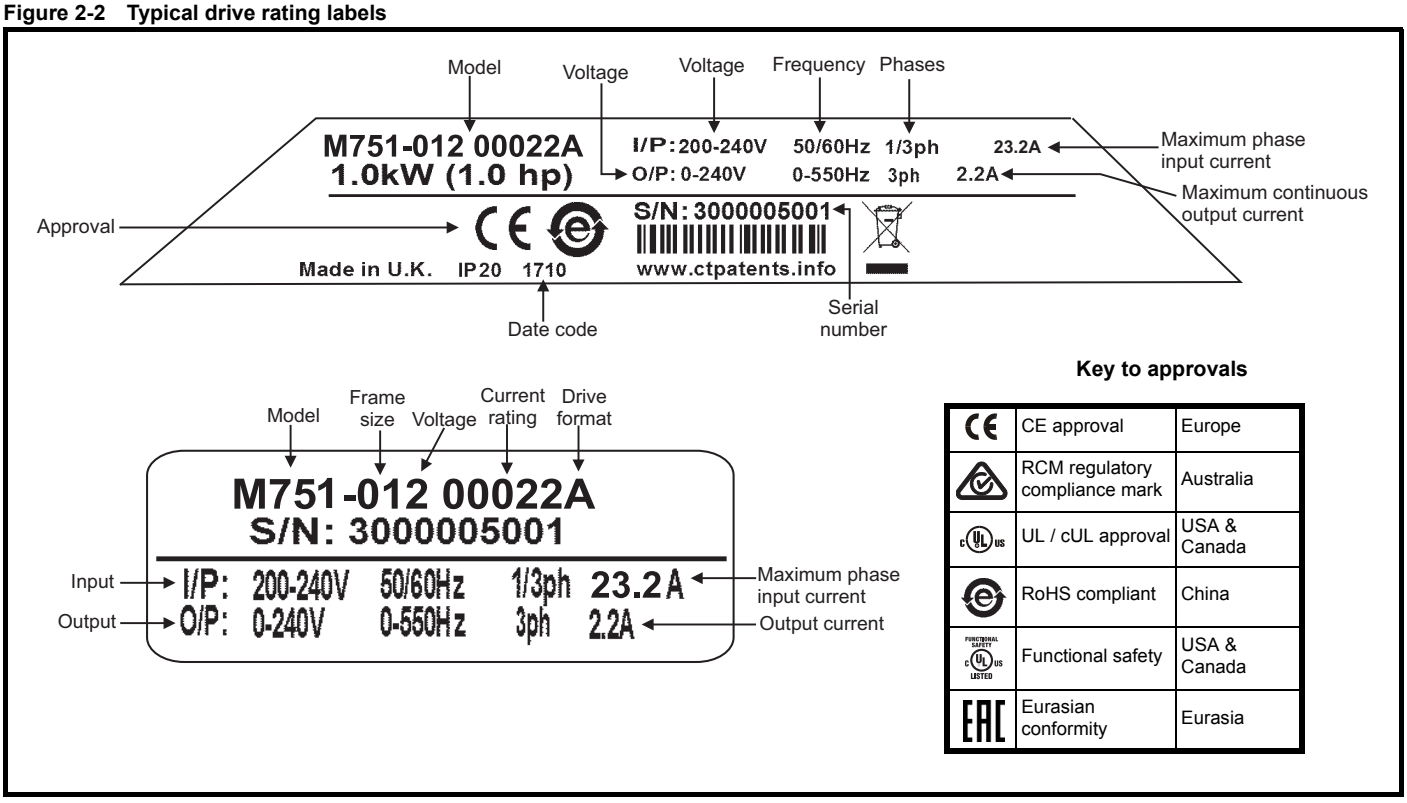
Encoder type	Pr 3.038 setting
Quadrature incremental encoders with or without marker pulse	AB (0)
Quadrature incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	AB Servo (3)
Forward / reverse incremental encoders with or without marker pulse	FR (2)
Forward / reverse incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FR Servo (5)
Frequency and direction incremental encoders with or without marker pulse	FD (1)
Frequency and direction incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FD Servo (4)
Sincos incremental encoders	SC (6)
Sincos incremental with commutation signals	SC Servo (12)
Heidenhain sincos encoders with EnDat comms for absolute position	SC EnDat (9)
Stegmann sincos encoders with Hiperface comms for absolute position	SC Hiperface (7)
Sincos encoders with SSI comms for absolute position	SC SSI (11)
Sincos incremental with absolute position from single sin and cosine signals	SC SC (15)
SSI encoders (Gray code or binary)	SSI (10)
EnDat communication only encoders	EnDat (8)
BiSS	BiSS (13)
Resolver	Resolver (14)
UVW commutation only encoders*	Commutation only (16)
SC BiSS	SC BiSS (17)

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

2.5 Nameplate description

The following labels are attached to the drive.

Figure 2-2 Typical drive rating labels



NOTE

Date code format

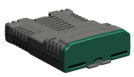
The date code is four numbers. The first two numbers indicate the year and the remaining numbers indicate the week of the year in which the drive was built.

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

2.6 Options

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

Table 2-2 Option module identification

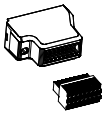
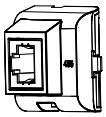
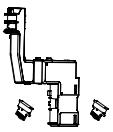
Type	Option module*	Color	Name	Further Details
Fieldbus		Purple	SI-PROFIBUS	**PROFIBUS option** PROFIBUS adapter for communications with the drive
		Medium Grey	SI-DeviceNet	**DeviceNet option** DeviceNet adapter for communications with the drive
		Light Grey	SI-CANopen	**CANopen option** CANopen adapter for communications with the drive
		Beige	SI-Ethernet	External Ethernet module that supports EtherNet/IP, Modbus TCP/IP and RTMoE. The module can be used to provide high speed drive access, global connectivity and integration with IT network technologies, such as wireless networking
		Yellow Green	SI-PROFINET V2	**PROFINET V2 option** PROFINET V2 adapter for communications with the drive Note: PROFINET V2 replaces PROFINET RT.
		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) • Analog Output • Relays
Feedback		Light Brown	SI-Encoder	Incremental encoder input interface module.
		Dark Brown	SI-Universal Encoder	Additional combined encoder input and output interface supporting Incremental, SinCos, HIPERFACE, EnDAT and SSI encoders.
Automation (Applications)		Moss Green	MCi200	**Machine Control Studio Compatible Applications Processor** 2nd processor for running pre-defined and/or customer created application software.
		Moss Green	MCi210	**Machine Control Studio Compatible Applications Processor (with Ethernet communications)** 2nd processor for running pre-defined and/or customer created application software with Ethernet communications.

*Additional SI option mounting kit required when connecting option modules where not already fitted.

Table 2-3 Display / Keypad identification

Type	Keypad	Name	Further Details
Display		KI-Compact display	**Single segment display option** Compact display with single character code drive status representation, node address setting and a push button reset
Keypad		Remote-Keypad RTC	**Remote LCD keypad option** Remote Keypad with a LCD display and a real time clock

Table 2-4 Additional options

Type	Option	Name	Further Details
Feedback		Encoder breakout kit (82700000020200)	**Drive encoder breakout kit** Provides screw terminal interface for encoder wiring.
Accessory		KI-Compact 485 adaptor (82700000020300)	**KI-Compact 485 adaptor** The M75X Remote Keypad Adaptor provides an EIA-485 port for permanent connection to a KI-Remote Keypad or the temporary attachment for PC tool connection
Accessory		SI-Option Mounting kit (9500-1055)	**SI-Option Mounting kit** When connecting SI-Option modules, an additional SI-Option Mounting kit is required, when the drive is not supplied with a SI-Option Mounting kit fitted.

3 Mechanical installation

3.1 SI-Option module installation

CAUTION

Remove the AC/DC power as well as the 24 Vdc supply to the drive before installing / removing the option module. Failure to do so may result in damage to the product.

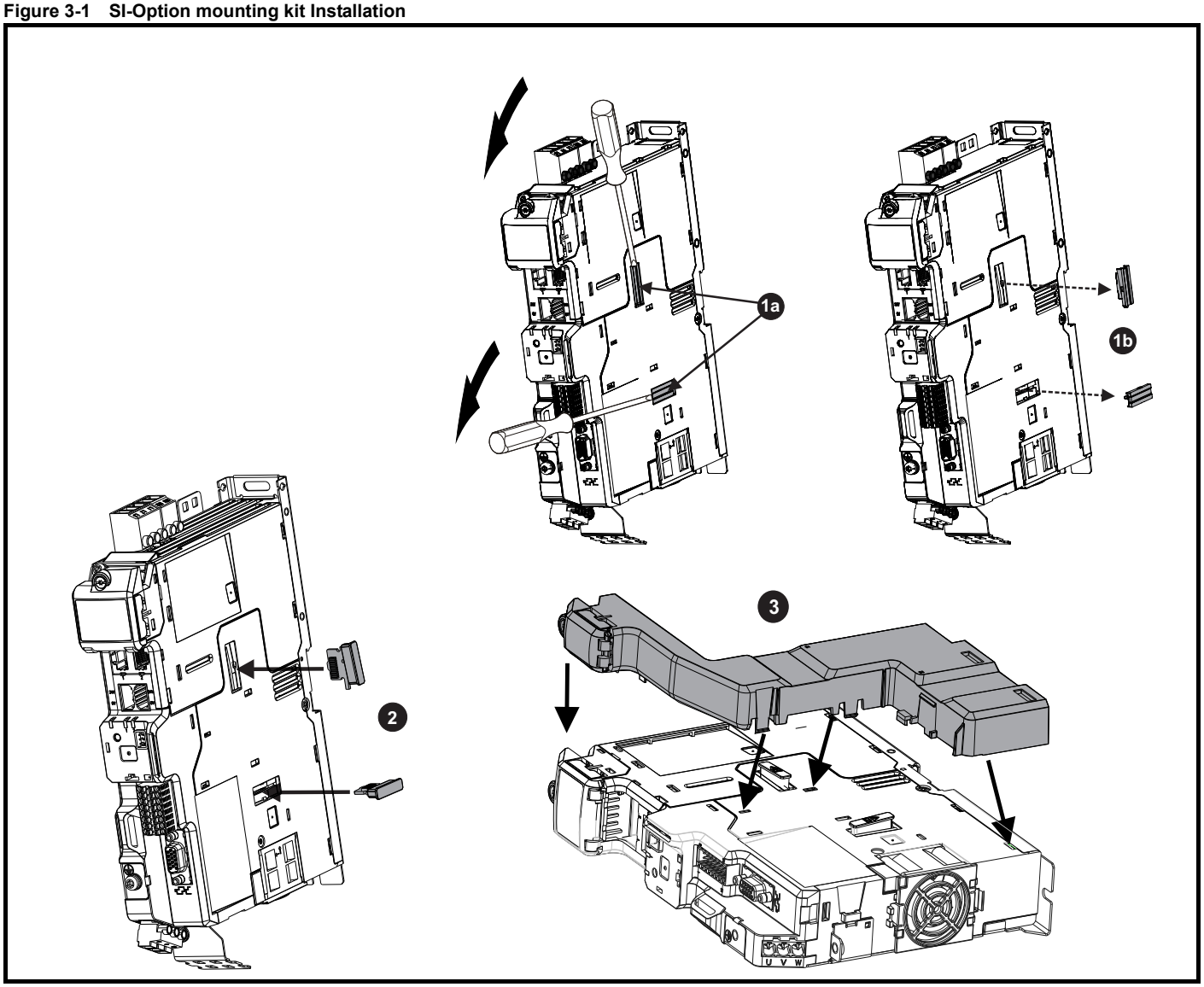
CAUTION

Care must be taken when handling the option module interface card to avoid contaminating the gold contacts. Gold contacts must not be touched directly, handle the interface card using the protective cover provided in the mounting kit.

When connecting SI-option modules, an additional SI-Option mounting kit is required. If the drive is not supplied with a mounting kit fitted, it can be ordered from the supplier of the drive. Refer to Table 2-4 on page 14.

For fitting instructions, refer to Figure 3-1.

Figure 3-1 SI-Option mounting kit Installation

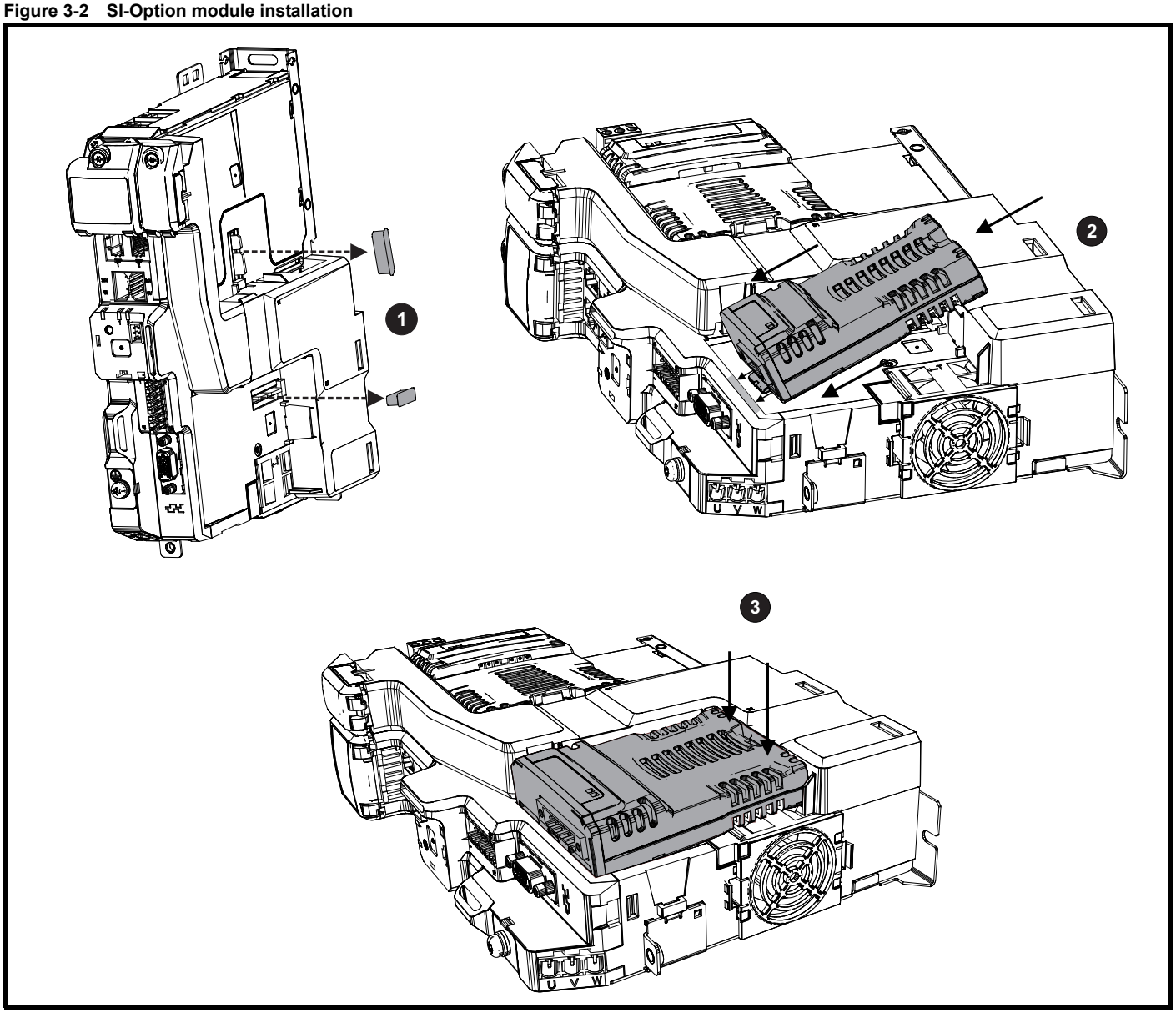


1a. Insert a flat head terminal screwdriver underneath the option module slot covers and prise both out in the direction shown as highlighted (**1b**).

2. Install the interface card into the option module slot (do not remove the protective cover). The interface card will remain at an angle with respect to the plastic.

3. Line up and clip the SI-option module support mounting frame to the drive in the direction shown.

Figure 3-2 SI-Option module installation



1. Remove the protective interface card cover.

2. Align and insert the option module tab into the slot on the drive plastic.

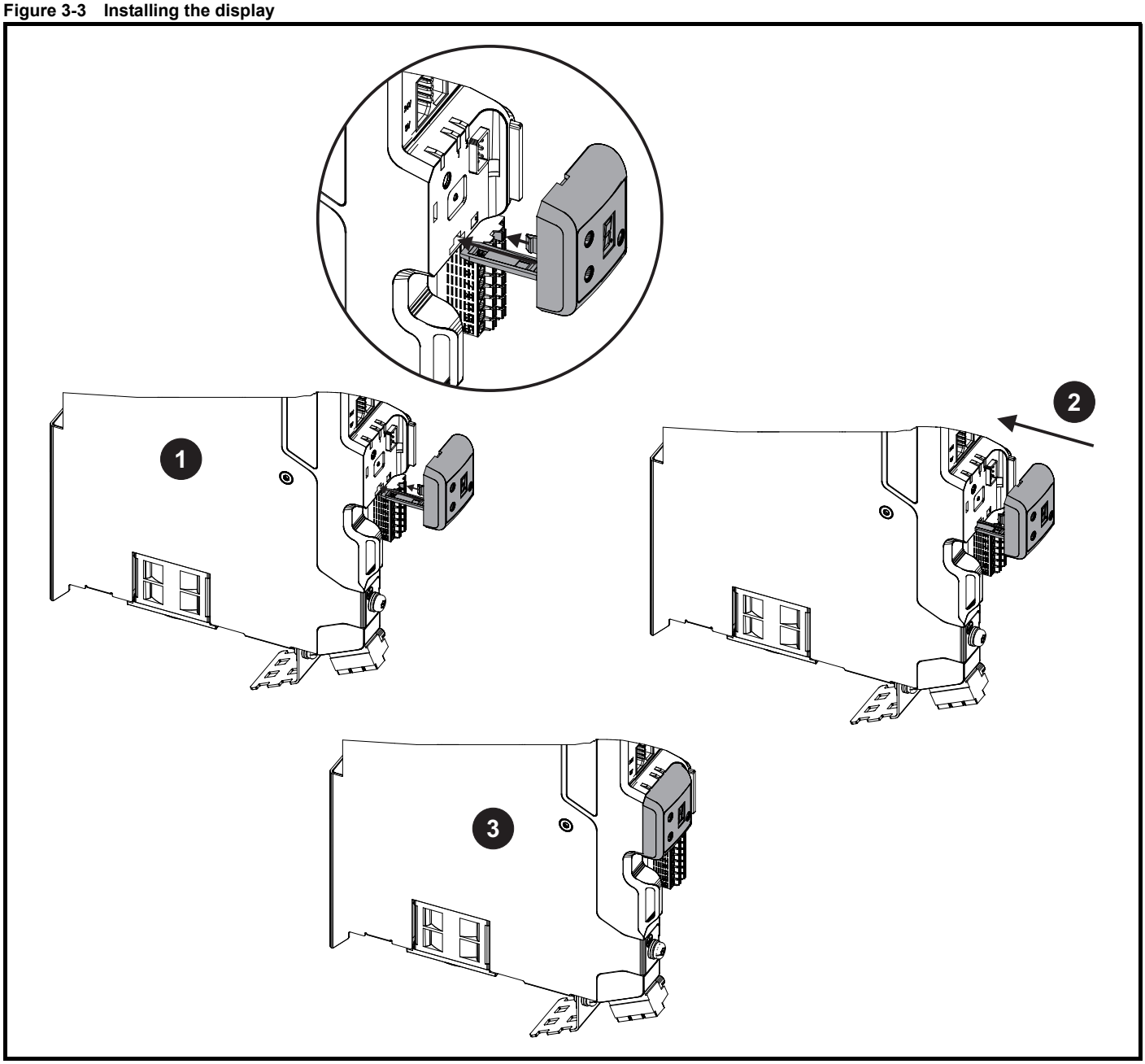
3. Once the option module tab is located into the slot on the drive, push down at the rear of the option module until it clicks into place.

NOTE

Once fitted, the SI-option module remains at an angle with respect to the drive.

3.2 KI-Compact Display installation

Figure 3-3 Installing the display



1. Align display tether with slot.

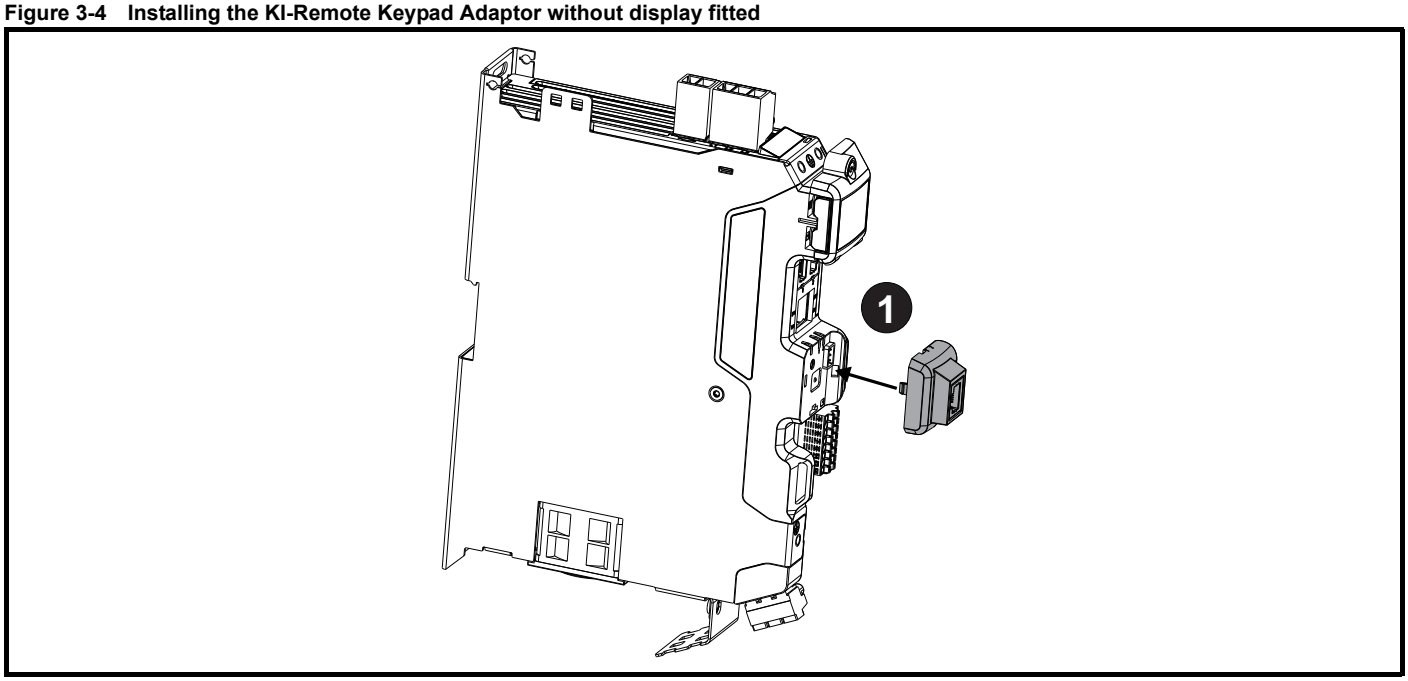
2. Slide the display and tether in the direction shown.

3. Push display until it clicks into position.

3.3 KI-Remote Keypad Adaptor installation

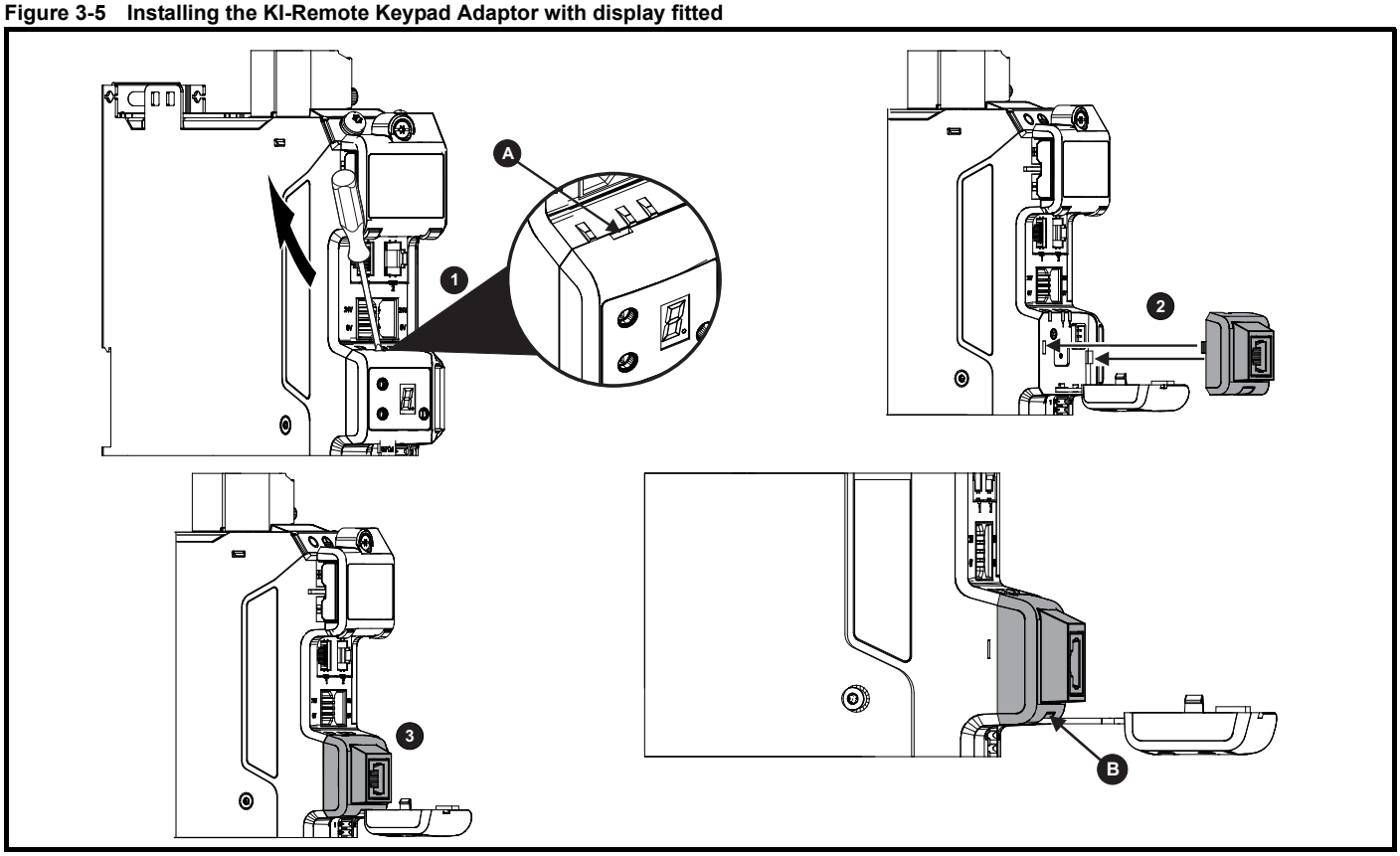
The M75X Remote Keypad Adaptor provides an EIA-485 port for permanent connection to a KI-Remote Keypad or the temporary attachment for PC tool connection. The KI-Remote Keypad Adaptor is available from the supplier of the drive. Refer to Table 2-4 *Additional options* on page 14.

Figure 3-4 Installing the KI-Remote Keypad Adaptor without display fitted



1. Align the KI-Remote Keypad Adaptor to the display housing and push on until it clicks into place.

Figure 3-5 Installing the KI-Remote Keypad Adaptor with display fitted



1. Unclip and pull the display away from the front cover. The tether keeps the display associated to the drive and should not be removed. A small terminal screwdriver maybe required to unclip the display. A slot in the drive plastic is provided for this purpose (**A**).

2. Align the Remote Keypad Adaptor with the display housing noting the position of the notch (See view **B** above). Install the Remote Keypad Adaptor over the display tether.

3. Push the Remote Keypad Adaptor into the housing until it clicks into place.

4 Electrical installation

4.1 External 24 Vdc supply

The drive will power down and reset if the external 24 Vdc is removed.

An external 24 Vdc supply is required to power all the low voltage circuits within the drive.

The cable length between the 24 Vdc power supply and the drive should not exceed 10 m.

The 0V connection of the external 24 Vdc power supply should be connected to the same ground connection as the drive. Where this is not possible the 0V connection of the 24 Vdc power supply should be floating.

The working voltage range of the drive 24 V power circuit is as follows:

Table 4-1 Working voltage range of the 24 Vdc supply

1	**0V common**
2	**+24 Vdc**
All frame sizes	
Nominal operating voltage	24.0 Vdc
Minimum continuous operating voltage	20.4 V
Maximum continuous operating voltage	28.8 V
Minimum start up voltage	20.4 V
Maximum fuse rating	30 A

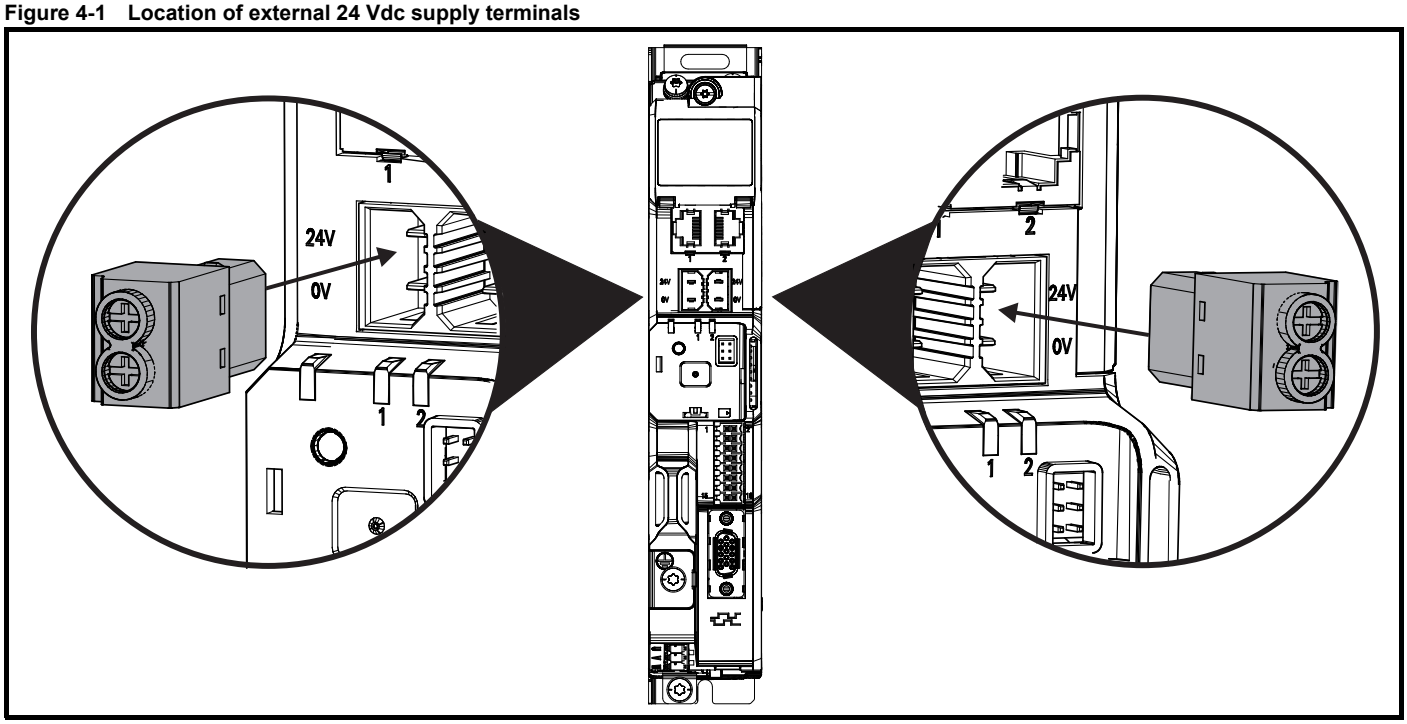
Table 4-2 24 Vdc typical input current and power requirements

Model / Option / Feature	Frame size	Typical input current (mA) @ 24 V	Typical input power (W)
Digitax HD M75X drive module	1, 2	894	21.5
	3	1039	25
SI-option module	Per module	450	11
High current brake output	All	1200	28.8
KI-Compact display	All	10	0.24
KI-Remote LCD keypad	All	73	1.75

NOTE

During start up of the external 24 Vdc supply, allow for an additional 1 A for 300 ms.

Figure 4-1 Location of external 24 Vdc supply terminals



NOTE

The 24 Vdc supply connector has been designed to allow wiring from either the left or right hand side of the drive. The same plug should be used but attention is required to the polarity of the wiring. If it is reversed, the drive will not power up but will not be damaged.

For stand alone drives connection to either terminal is permissible.

4.2 Low voltage operation

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

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

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

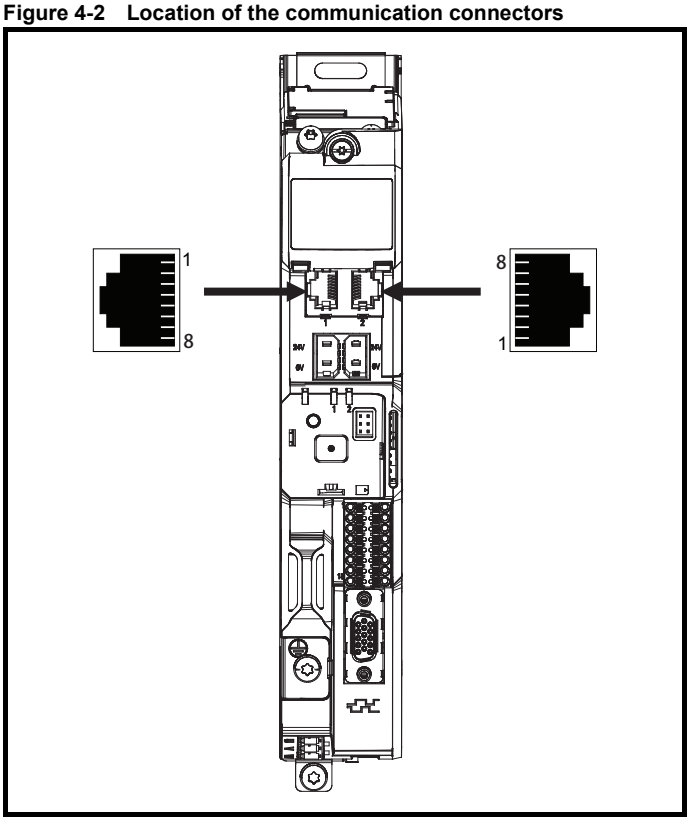
The working voltage range of the low voltage DC power supply is as follows:

Minimum continuous operating voltage:	26 Vdc
Minimum start up voltage:	32 Vdc
Maximum over voltage trip threshold:	230 Vac drives: 415 Vdc
	400 Vac drives: 830 Vdc

4.3 Communication connections

The *Digitax HD M751* drive offers a 2 wire EIA-485 interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller if required.

Figure 4-2 Location of the communication connectors



4.3.1 *Digitax HD M751* EIA-485 serial communications

The EIA-485 interface provides two parallel RJ45 connectors allowing easy daisy chaining, refer to Figure 4-2 Location of the communication connectors. The drive only supports Modbus RTU protocol. See Table 4-3 for the connection details.

NOTE

Standard Ethernet cables are not recommended for use 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.

CAUTION

If an Ethernet network adaptor is inadvertently connected to a *Digitax HD M751* EIA-485 drive, a low impedance load across the EIA-485 24 V is applied and if connected for a significant period of time can introduce the potential risk of damage.

Table 4-3 Serial communication port pin-outs

Pin	Function
1	120 Ω Termination resistor
2	RX TX
3	Isolated 0V
4	+24 V (100 mA) output
5	Isolated 0V
6	TX enable
7	RX\ TX\
8	RX\ TX\ (if termination resistors are required, link to pin 1)
Shell	Isolated 0V

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

4.3.2 *Digitax HD M751* Isolation of the EIA-485 serial communications port

The serial communications port is double insulated from the high voltage drive circuits and meets the requirements for PELV (Protective Extra Low Voltage) according to IEC61800-5-1. The communications ports remain referenced to other PELV rated circuits within the drive (including the control, feedback and digital I/O). Where further isolation from these PELV rated circuits is required and additional external isolation barrier will be required.

WARNING

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

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 4-4 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.

4.3.3 Communication networks and cabling

Any isolated signal circuit has the capability to become live through accidental contact with other conductors; as such they should always be double-insulated from live parts. The routing of network and signal wires should be done so as to avoid close proximity to mains voltage cabling.

4.4 Control connections

4.4.1 *Digitax HD M75X* control connections

Table 4-5 The control connections consist of:

Function	Qty	Control parameters available	Terminal number
Differential analog input	1	Offset, invert, scaling	9, 10
Digital input	2	Destination, invert, logic select	11, 13
Digital output	2	Source, invert, logic select	14, 16
Drive enable (Safe Torque Off)	2		2, 6
+24 V User output	1	Source, invert	12
0V common	7		1, 3, 4, 5, 7, 8, 15

Key:

Destination parameter:	Indicates the parameter which is being controlled by the terminal / function
Source parameter:	Indicates the parameter being output by the terminal

All analog terminal functions can be programmed in menu 7.

All digital terminal functions 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.

NOTE

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

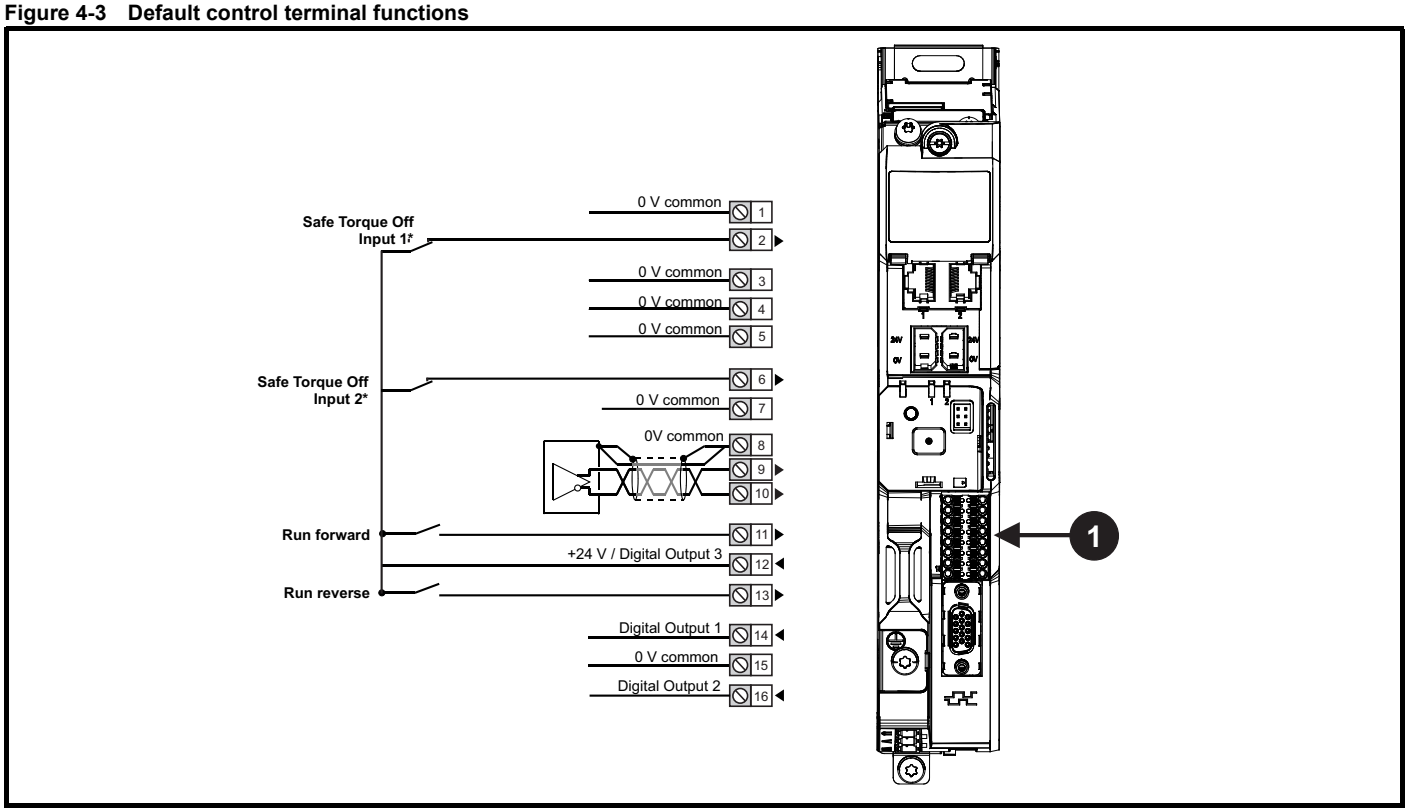
NOTE

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

NOTE

The control circuits are isolated from the power circuits in the drive by reinforced insulation.

Figure 4-3 Default control terminal functions



1. Polarized signal connections.

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

4.4.2 *Digitax HD M75X* control terminal specification

1	**0V common**
3	**0V common**
4	**0V common**
5	**0V common**
7	**0V common**
8	**0V common**
15	**0V common**
Function	**Common connection for all external devices. Internally connected to ground.**

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

Refer to section 4.6 *Safe Torque Off (STO)* on page 30 for further information.

Analog input	
9	**Inverting input**
10	**Non-inverting input**
Default function	**Frequency/speed reference**
Type of input	Bipolar differential analog voltage
Mode controlled by:	Pr **07.007**
Operating in Voltage mode	
Full scale voltage range	±10 V ±2 %
Maximum offset	±10 mV
Absolute maximum voltage range	±36 V relative to 0V
Absolute maximum differential input voltage	±36 V
Working common mode voltage range	±13 V relative to 0V
Input resistance	≥100 kΩ
Monotonic	Yes (including 0V)
Dead band	None (including 0V)
Jumps	None (including 0V)
Maximum offset	20 mV
Maximum non linearity	0.3 % of input
Maximum gain asymmetry	0.5 %
Input filter bandwidth single pole	~3 kHz
Resolution	12 bits (11 bits plus sign)
Sample / update period	250 µs with destinations Pr **01.036**, Pr **01.037**, Pr **03.022** or Pr **04.008** in RFC-A and RFC-S modes. 4 ms for open loop mode and all other destinations in RFC-A or RFC-S modes.

11	**Digital Input 4**
13	**Digital Input 5**
Terminal 11 default function	**RUN FORWARD input**
Terminal 13 default function	**RUN REVERSE input**
Type	Negative or positive logic digital inputs
Logic mode controlled by...	Pr **08.029**
Voltage range	0V to +24 V
Absolute maximum applied voltage range	-3 V to +30 V
Impedance	>2 mA @15 V (IEC 61131-2, type 1)
Input thresholds	10 V ±0.8 V (IEC 61131-2, type 1)
Sample / Update period	250 µs when configured as an input with destinations Pr **06.035** or Pr **06.036**. 600 µs when configured as an input with destination Pr **06.029**. 2 ms in all other cases.

12	**+24 V user output / Digital Output 3 (selectable)**
Terminal 12 default function	**+24 V user output**
Programmability	Can be switched on or off to act as a third digital output (positive logic only) by setting the source Pr **08.028** and source invert Pr **08.018**
Nominal output current	100 mA
Maximum output current	100 mA 200 mA (total including DO1)
Protection	Current limit and trip
Sample / update period	2 ms when configured as an output (output will only change at the update rate of the source parameter if slower)

14	Digital Output 1
Terminal 14 default function	**AT ZERO SPEED output**
Type	Positive logic voltage source outputs
Operating as an output	
Nominal maximum output current	100 mA
Maximum output current	200 mA (combined with +24 V user output/ DO3)
Voltage range	0V to +24 V
Sample / Update period	2 ms (output will only change at the update rate of the source parameter

16	Digital Output 2
Terminal 16 default function	**High current motor brake output**
Type	Positive logic voltage source outputs
Operating as an output	
Nominal output current	1 A (1.3 A max)
Voltage range	0V to +24 V
Sample / Update period	2 ms (output will only change at the update rate of the source parameter

4.5 Position feedback connections

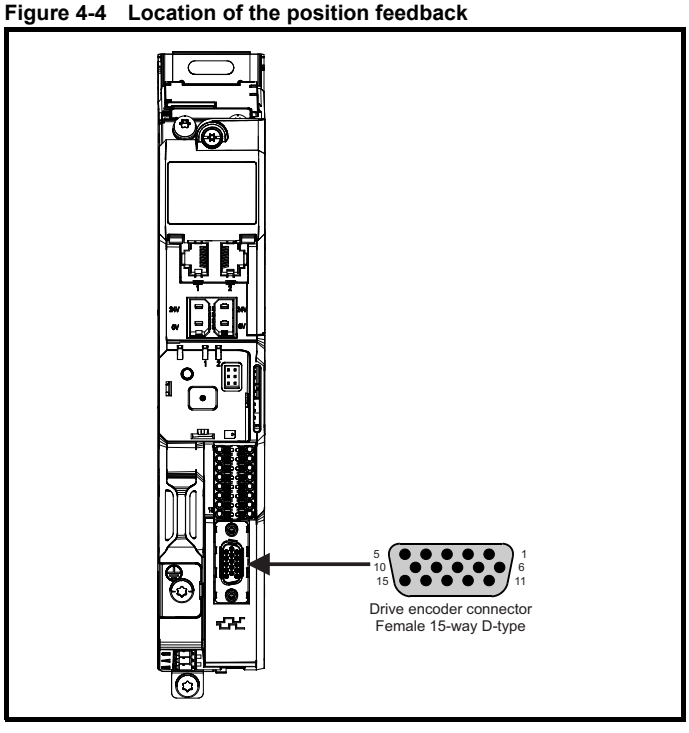
The following functions are provided via the 15-way high density D-type connector on the drive:

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

The P1 position interface is always available but the availability of the P2 position interface and the encoder simulation output depends on the position feedback device used on the P1 position interface, as shown in Table 4-8.

4.5.1 Location of position feedback connector

Figure 4-4 Location of the position feedback



4.5.2 Compatible position feedback devices

Table 4-6 Supported feedback devices on the P1 position interface

Encoder type	Pr 03.038 setting
Quadrature incremental encoders with or without marker pulse	AB (0)
Quadrature incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	AB Servo (3)
Forward / reverse incremental encoders with or without marker pulse	FR (2)
Forward / reverse incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FR Servo (5)
Frequency and direction incremental encoders with or without marker pulse	FD (1)
Frequency and direction incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	FD Servo (4)
Sincos incremental encoders	SC (6)
Sincos incremental with commutation signals	SC Servo (12)
Heidenhain sincos encoders with EnDat comms for absolute position	SC EnDat (9)
Stegmann sincos encoders with Hiperface comms for absolute position	SC Hiperface (7)
Sincos encoders with SSI comms for absolute position	SC SSI (11)
Sincos incremental with absolute position from single sin and cosine signals	SC SC (15)
SSI encoders (Gray code or binary)	SSI (10)
EnDat communication only encoders	EnDat (8)
Resolver	Resolver (14)
UVW commutation only encoders*	Commutation only (16)
BiSS communication only encoders	BiSS (13)
Sincos encoders with BiSS communications	SC BiSS (17)

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

Table 4-7 Supported feedback devices on the P2 position interface

Encoder type	Pr 03.138 setting
Quadrature incremental encoders with or without marker pulse	AB (1)
Frequency and direction incremental encoders with or without marker pulse	FD (2)
Forward / reverse incremental encoders with or without marker pulse	FR (3)
EnDat communication only encoders	EnDat (4)
SSI encoders (Gray code or binary)	SSI (5)
BiSS communication only encoders	BiSS (6)

Table 4-8 shows the possible combinations of position feedback device types connected to the P1 and P2 position interfaces and the availability of the encoder simulation output.

Table 4-8 Availability of the P2 position feedback interface and the encoder simulation output

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

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

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

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

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

NOTE

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

4.5.3 Position feedback connection details

Table 4-9 P1 Position feedback connection details

P1 Position feedback interface Pr 03.038	Connections														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
AB (0)	A	A\	B	B\	Z	Z\									
FD (1)	F	F\	D	D\	Z	Z\									
FR (2)	F	F\	R	R\	Z	Z\									
AB Servo (3)	A	A\	B	B\	Z	Z\	U	U\	V	V\	W	W\			
FD Servo (4)	F	F\	D	D\	Z	Z\	U	U\	V	V\	W	W\			
FR Servo (5)	F	F\	R	R\	Z	Z\	U	U\	V	V\	W	W\			
SC (6)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\									
SC Hiperface (7)	Cos	Cosref	Sin	Sinref	DATA	DATA\									
EnDat (8)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
SC EnDat (9)	A	A\	B	B\	DATA	DATA\					CLK	CLK\	+V	0V	Th
SSI (10)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
SC SSI (11)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	DATA	DATA\					CLK	CLK\			
SC Servo (12)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\	U	U\	V	V\	W	W\			
BiSS (13)	DATA	DATA\	CLK	CLK\	Freeze	Freeze\									
Resolver (14)	Cos H	Cos L	Sin H	Sin L	Ref H	Ref L									
SC SC (15)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Z	Z\	C*1	C*1	D*2	D*2	Freeze2	Freeze2\			
Commutation Only (16)							U	U\	V	V\	W	W\			
SC BiSS (17)	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	DATA	DATA\					CLK	CLK\			

*1 - One cosine wave per revolution

*2 - One sine wave per revolution

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

NOTE

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

Table 4-10 P2 Position feedback and encoder simulation output connection details

P1 Position feedback interface Pr 03.038	P2 Position feedback interface Pr 03.138	Encoder Simulation Output	Connections							
			5	6	7	8	9	10	11	12
AB (0) FD (1) FR (2) SC (6) SC Hiperface (7) Resolver (14)	AB (1)	Disabled*1			A	A\	B	B\	Z	Z\
	FD (2)				F	F\	D	D\	Z	Z\
	FR (3)				F	F\	R	R\	Z	Z\
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\	Freeze2	Freeze2\
	None (0)	AB			Asim	Asim\	Bsim	Bsim\	Zsim	Zsim\
		FD			Fsim	Fsim\	Dsim	Dsim\	Zsim	Zsim\
		FR			Fsim	Fsim\	Rsim	Rsim\	Zsim	Zsim\
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
SC EnDat (9) SC SSI (11) SC BiSS (17)	AB (1)	Disabled*1			A	A\	B	B\		
	FD (2)				F	F\	D	D\		
	FR (3)				F	F\	R	R\		
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\		
	None (0)	AB			Asim	Asim\	Bsim	Bsim\		
		FD			Fsim	Fsim\	Dsim	Dsim\		
		FR			Fsim	Fsim\	Rsim	Rsim\		
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
EnDat (8) SSI (10) BiSS (13)	AB (1)	Disabled*1			A	A\	B	B\	Z	Z\
	FD (2)				F	F\	D	D\	Z	Z\
	FR (3)				F	F\	R	R\	Z	Z\
	EnDat (4) SSI (5) BiSS (6)				DATA	DATA\	CLK	CLK\	Freeze2	Freeze2\
	None (0)	AB			Asim	Asim\	Bsim	Bsim\	Zsim	Zsim\
		FD			Fsim	Fsim\	Dsim	Dsim\	Zsim	Zsim\
		FR			Fsim	Fsim\	Rsim	Rsim\	Zsim	Zsim\
		SSI			DATAsim	DATAsim\	CLKsim	CLKsim\		
EnDat (8) SSI (10) BiSS (13) (with no Freeze inputs)	EnDat (4) SSI (5) BiSS (6)	AB	DATA	DATA\	Asim	Asim\	Bsim	Bsim\	CLK	CLK\
		FD	DATA	DATA\	Fsim	Fsim\	Dsim	Dsim\	CLK	CLK\
		FR	DATA	DATA\	Fsim	Fsim\	Rsim	Rsim\	CLK	CLK\
		SSI	DATA	DATA\	DATAsim	DATAsim\	CLKsim	CLKsim\	CLK	CLK\

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

NOTE

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

4.5.4 Position feedback terminal specifications

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

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

SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15), SC BiSS (17)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-11.
Maximum applied differential voltage and common mode voltage range	±4 V

Resolution: The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-11 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port.

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

Resolver (14)	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 - 8 kHz
Input voltage	0.6 Vrms
Minimum impedance	85 Ω

Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

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

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

SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15), SC BiSS (17)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-11.
Maximum applied differential voltage and common mode voltage range	±4 V

Resolution: The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-11 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port.

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

Resolver (14)	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 – 8 kHz
Input voltage	0.6 Vrms
Minimum impedance	85 Ω

Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

NOTE

The position feedback input will accept 5 V TTL differential signals.

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

AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5), SC SC (15)	
Type	EIA-485 differential receivers
Maximum input frequency	512 kHz
Line loading	< 2 unit loads
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC BiSS (17)	
Type	EIA-485 differential receivers
Maximum input frequency	4 MHz
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
EnDat (8), SSI (10)	
Type	EIA-485 differential receivers
Maximum input frequency	4 MHz
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
Resolver (14)	
Type	Differential voltage
Nominal voltage	0 – 2 Vrms depending on turns ratio
Operating frequency	6 - 8 KHz
Minimum impedance	85 Ω
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

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

AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA-485 differential receivers
Maximum input frequency	512 kHz
Line loading	1 unit load
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-11.
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

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

AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA-485 differential receivers
Maximum input frequency	512 kHz
Line loading	1 unit load
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
SC SC (15)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-11.
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

11	**W, Clock, Not used, Not used**
12	**W\, Clock\, Not used, Not used**
AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)	
Type	EIA-485 differential receivers
Maximum input frequency	512 kHz
Line loading	1 unit load
Line termination components	120 Ω (switchable)
Working common mode range	–7 V to +12 V
SC EnDat (9), SC SSI (11)	
Type	Differential voltage
Maximum Signal level	1.25 V peak to peak (sin with regard to sinref and cos with regard to cosref)
Maximum input frequency	See Table 4-11.
Maximum applied differential voltage and common mode voltage range	±4 V
EnDat (8), SSI (10), BiSS (13)	
Not used	
Resolver (14)	
Not used	
Common to All	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

Common to all Feedback types

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

14	**0V Common**

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

Sincos encoder resolution

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

Table 4-11 Feedback resolution based on frequency and voltage level

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

4.6 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.

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 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 is suitable for use as a safety component of a machine:

Safety Parameters

According to IEC 61508-1 to 7 / EN 61800-5-2 / EN 62061

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

According to EN ISO 13849-1

Type	Value	Classification
Category	4	
Performance Level (PL)	e	
$MTTF_D$ (STO1)	>2500 years	High
$MTTF_D$ (STO2)	>2500 years	High
MTTFD (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.

Two-channel Safe Torque Off

The *Digitax HD M75X series* has dual channel Safe Torque Off.

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.

One-channel Safe Torque Off (Including Two- channel Safe Torque off with the inputs connected together).

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

It is important to note that a single short-circuit from the Safe Torque Off input to a DC supply of > 5V 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 (0V of the Drive) 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.

WARNING

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

WARNING

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

WARNING

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

WARNING

It is essential to observe the maximum permitted voltage of 5 V for a safe low (disabled) state of Safe Torque Off. The connections to the drive must be arranged so that voltage drops in the 0 V wiring cannot exceed this value under any loading condition. It is strongly recommended that the Safe Torque Off circuit be provided with a dedicated 0 V conductor which should be connected to either terminals 1, 3, 4, 5, 7 or 15 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.

Lift (Elevator) Applications

The Safe Torque Off function is suitable for use as a safety component in lift (elevator) applications:

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

For further information, contact the supplier of the drive.

5 Getting started

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

5.1 Display and Keypad operation

The drive can be directly fitted with a KI-Compact Display.

Or

A Remote-Keypad RTC connected to the drive either via a KI-Remote keypad adaptor or one of the drive's RS485 ports (M751 only) and a suitable Cat 5E patch cord.

5.1.1 KI-Compact Display

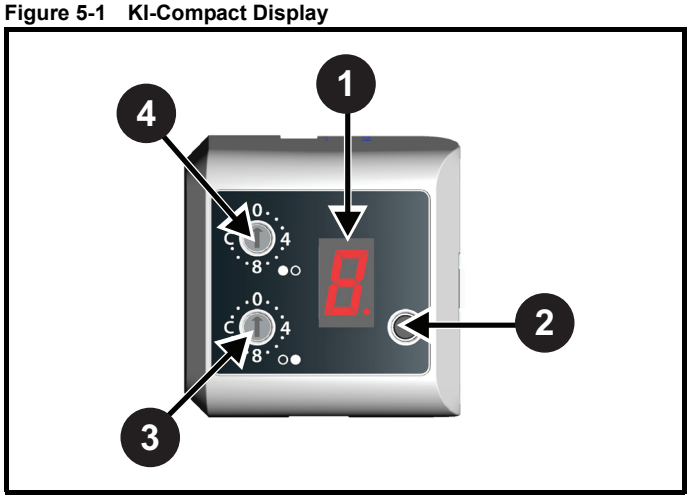
The M75X display provides the following features:

- Displays drive status information.
- Allows the drive node address to be set via dials on the front of the display.
- A push button to reset drive trips.

If not already fitted, the display can be ordered from the supplier of the drive. Refer to Table 2-3 *Display / Keypad identification* on page 13.

5.1.2 Drive state representation

Figure 5-1 KI-Compact Display



1. Single Character display.
2. Reset switch.
3. Rotary dial for node address setting (least significant).
4. Rotary dial for node address setting (Most significant).

The display provides the following drive status information:

A single character code is used to indicate non tripped drive states as a non flashing display, refer to Table 5-1 for further information.

Table 5-1 Single character status indication codes (non tripped drive state)

Display character	Drive status LED	Description	Drive output stage
	Non flashing (RED)	Inhibit state	Disabled
	Flashing (RED)	Communications to drive lost for > 10 seconds	N/A
	Non flashing (RED)	Ready state	Disabled
	Non flashing (RED)	Under the following status indicators: Stop Scan Run Supply Loss Deceleration DC injection Position Active Heat Phasing	Enabled
	Non flashing (RED)	Under voltage	Disabled

The decimal point on the display is used to alert the user of the following situations:

- The SD card is being accessed.
  The decimal point on the display will be illuminated constantly whenever the drive is accessing the SD card.
- The drive has an active alarm.
  The decimal point will flash if the drive has an active alarm.

5.1.3 Node address setting

The KI-Compact Display rotary dials allow for the drive node address to be configured from 0 to 247.

The most significant nibble is set by adjusting the top dial and least significant nibble is set by the bottom dial (see Figure 5-1 *KI-Compact Display*).

Dial settings and equivalent decimal values are shown in Figure 5-2.

Table 5-2 Dial settings and equivalent decimal value

Most significant nibble		Least significant nibble	
Dial setting	**Decimal value**	**Dial setting**	**Decimal value**
1	16	1	1
2	32	2	2
3	48	3	3
4	64	4	4
5	80	5	5
6	96	6	6
7	112	7	7
8	128	8	8
9	144	9	9
A	160	A	10
B	176	B	11
C	192	C	12
D	208	D	13
E	224	E	14
F	240	F	15

The node address will be set to the sum of the most significant nibble and the least significant nibble (in decimal).

As the dials are adjusted each setting is shown on the display. Once the dials are set to the desired configurations the display will confirm the dial settings in hexadecimal followed by the node address setting in decimal, dial settings and node address are separated with a hyphen (-).

Serial address (Pr **11.023**) and Keypad defined node address (Pr **11.017**) are then updated.

Example:

To set a node address of 55 via the display, with reference to table 5-2, set the most significant dial to 3 (decimal 48) and the least significant dial to 7 (decimal 7).

NOTE

The node address setting can be configured from the rotary dials of the KI-Compact Display with no power applied to the drive (with the exception of a zero value setting). Non zero configured settings will be transferred to the drive on the next power up.

NOTE

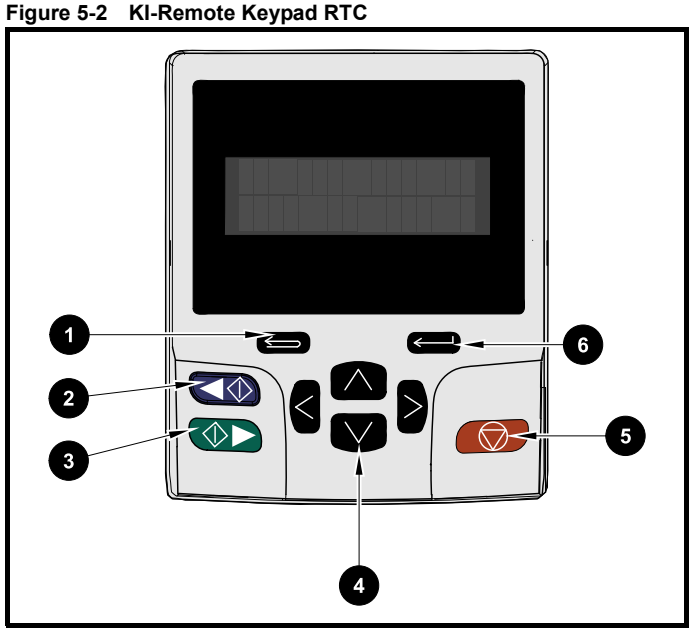
The KI-Compact Display can be installed/removed while the drive is powered. A delay of 10 seconds should be maintained following power up or following a node address dial adjustment before the KI-Compact Display can be removed from the drive, to ensure correct transfer of node address data.

5.1.4 KI-Remote Keypad RTC

The KI-Remote Keypad RTC display consists of two rows of text. The upper row shows the drive status or the menu and parameter number currently being viewed. The lower row of the display line shows the parameter value or the specific trip type. The last two characters on the first row may display special indications. If more than one of these indications is active then the indications are prioritized as shown in Table 5-4.

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

Figure 5-2 KI-Remote Keypad RTC



1. Escape button
2. Start reverse (Auxiliary button)
3. Start forward
4. Navigation keys (x4)
5. Stop / Reset (red) button
6. Enter button

NOTE

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

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

Table 5-3 Keypad display formats

Display formats	Value
IP Address	127.000.000.000
MAC Address	01ABCDEF2345
Time	12:34:56
Date	31-12-11 or 12-31-11
Version number	01.02.02.00
Character	ABCD
32 bit number with decimal point	21474836.47
16 bit binary number	0100001011100101
Text	M600
Number	1.5 Hz

Table 5-4 Active action icon

Active action icon	Description	Row (1=top)	Priority in row
	Accessing non-volatile media card	1	1
	Alarm active	1	2
	Keypad real-time clock battery low	1	3
or	Drive security active and locked or unlocked	1	4
	Motor map 2 active	2	1
	User program running	3	1
	Keypad reference active	4	1
	No entry - read only parameter cannot be edited	1	1

5.2 KI-Remote Keypad operation

5.2.1 Control buttons

The keypad consists of:

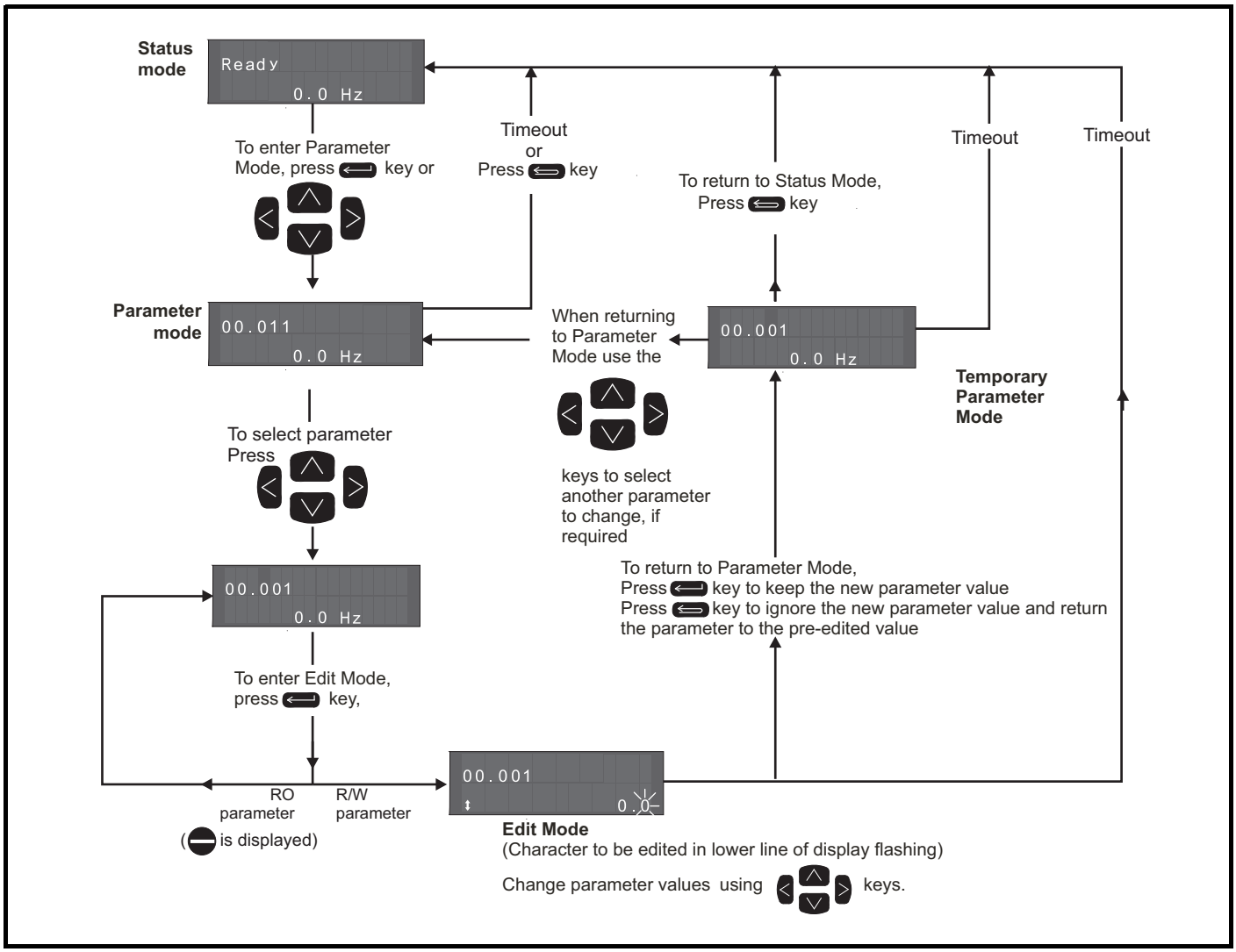
- Navigation Keys - Used to navigate the parameter structure and change parameter values.
- Enter / Mode button - Used to toggle between parameter edit and view mode.
- Escape / Exit button - Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the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

NOTE

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

Figure 5-3 overleaf shows an example on moving between menus and editing parameters.

Figure 5-3 Display modes



NOTE

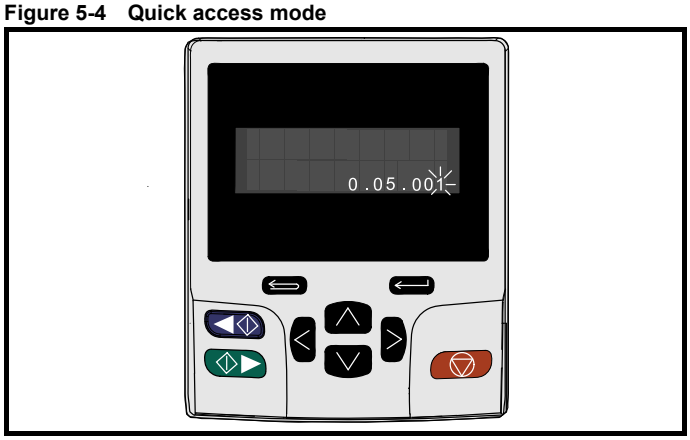
The navigation keys can only be used to move between menus if Pr **00.049** has been set to show 'All Menus'. Refer to section 5.9 *Parameter access level and security* on page 39.

5.2.2 Quick access mode

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

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

Figure 5-4 Quick access mode



5.2.3 KI-Remote Keypad shortcuts

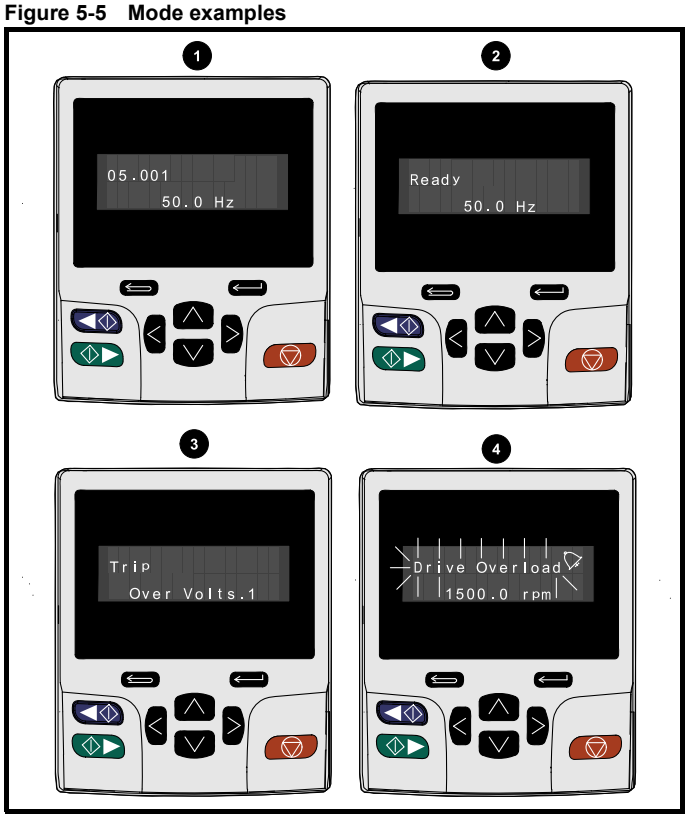
In 'parameter mode':

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

In 'parameter edit mode':

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

Figure 5-5 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 12-4 *Trip indications* on page 195**.**

4. **Status mode: Alarm status**

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

WARNING

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

NOTE

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

NOTE

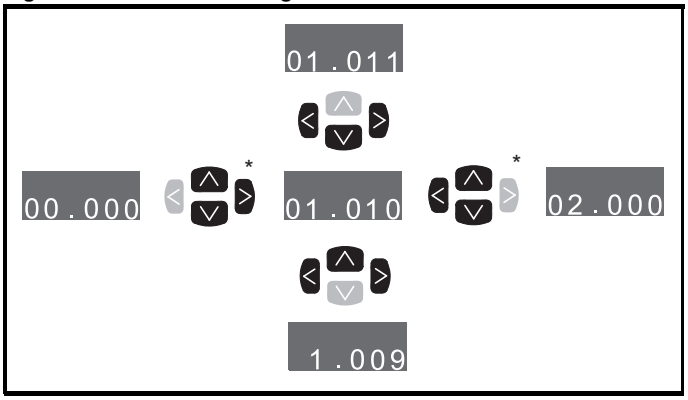
For new parameter-values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *KI-Remote Keypad saving parameters* on page 39.

5.3 Menu structure

The drive parameter structure consists of menus and parameters.

The drive initially powers up so that only Menu 0 can be viewed. The up and down arrow buttons are used to navigate between parameters and once Pr **00.049** has been set to 'All Menus' the left and right buttons are used to navigate between menus. For further information, refer to section 5.9 *Parameter access level and security* on page 39.

Figure 5-6 Parameter navigation



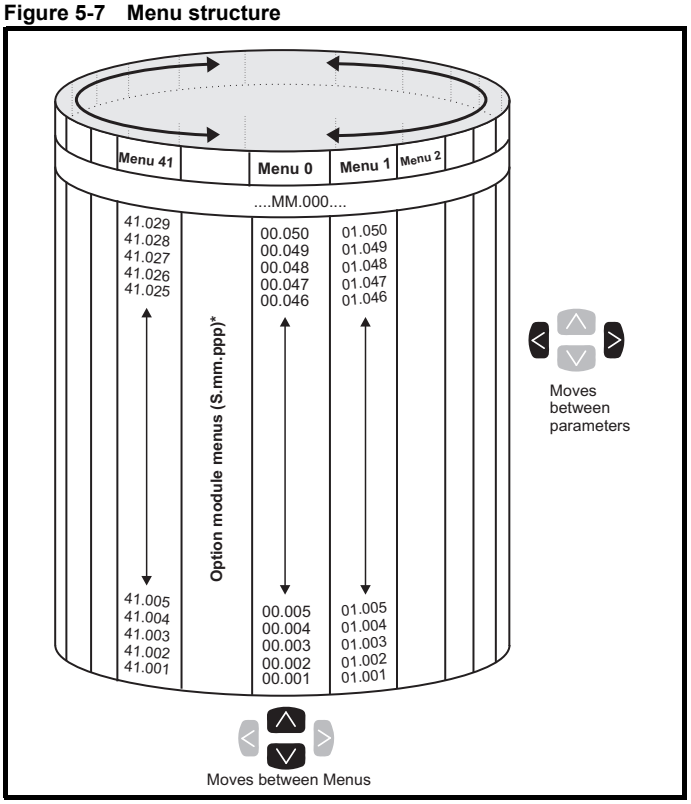
* Can only be used to move between menus if all menus have been enabled (Pr **00.049**). Refer to section 5.9 *Parameter access level and security* on page 39.

The menus and parameters roll over in both directions.

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

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

Figure 5-7 Menu structure



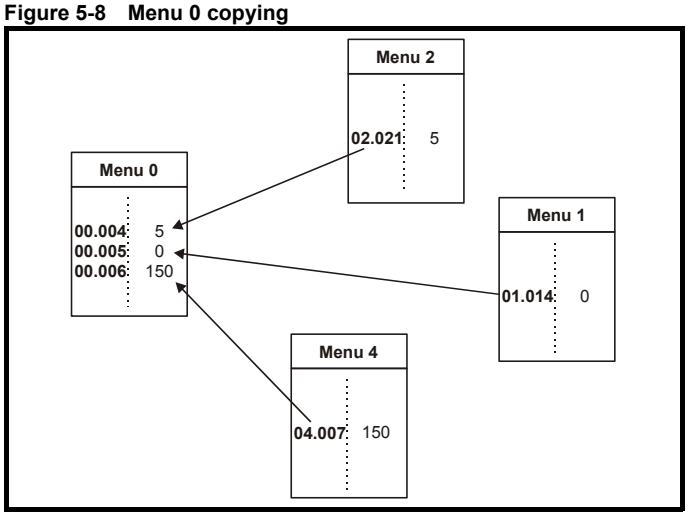
* The option module menus (S.mm.ppp) are only displayed if option modules are installed. Where S signifies the option module slot number and the mm.ppp signifies the menu and the parameter number of the option module's internal menus and parameter.

5.4 Menu 0

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

For further information, refer to Chapter 6 *Basic parameters* on page 42.

Figure 5-8 Menu 0 copying



5.5 Advanced menus

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

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

Table 5-5 Advanced menu descriptions

Menu	Description
0	Commonly used basic set up parameters for quick / easy programming
1	Frequency / Speed reference
2	Ramps
3	Frequency slaving, speed feedback and speed 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
13	Standard motion control
14	User PID controller
15	Option module slot 1 set-up menu
16	Option module slot 2 set-up menu
17	Option module slot 3 set-up menu
18	General option module application menu 1
19	General option module application menu 2
20	General option module application menu 3
21	Second motor parameters
22	Menu 0 set-up
23	Not allocated
25	Option module slot 1 application parameters
26	Option module slot 2 application parameters
27	Option module slot 3 application parameters
29	Reserved menu
30	Onboard user programming application menu
31-41	Advanced motion controller set-up parameters
Slot 1	Slot 1 option menus*
Slot 2	Slot 2 option menus*

* Only displayed when the option modules are installed.

5.5.1 KI-Remote 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 5-6 KI-Remote Keypad RTC set-up parameters

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

NOTE

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

5.5.2 KI-Remote Keypad alarm indications

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

Table 5-7 Alarm indications

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

5.5.3 KI-Remote Keypad display messages

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

Table 5-8 Status indications

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

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

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

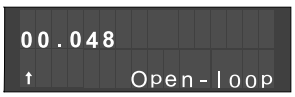
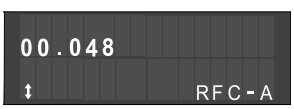
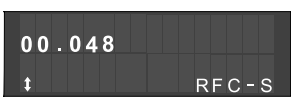
5.6 KI-Remote Keypad changing the operating mode

Changing the operating mode returns all parameters to their default value, including the motor parameters. *User security status* (00.049) and *User security code* (00.034) are not affected by this procedure).

Procedure

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

1. Ensure the drive is not enabled, i.e. terminals 2 and 6 are open or Pr **06.015** is Off (0)
2. Enter either of the following values in Pr **mm.000**, as appropriate:
   1253 (50 Hz AC supply frequency)
   1254 (60 Hz AC supply frequency)
3. Change the setting of Pr **0.048** as follows:

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

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

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

NOTE

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

5.7 KI-Remote Keypad saving parameters

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

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

Procedure

1. Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**)
2. Either:
- Press the red reset button
- Toggle the reset digital input, or
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

5.8 Restoring parameter defaults

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

Procedure

1. Ensure the drive is not enabled, i.e. terminal 2 and 6 are open or Pr **06.015** is Off (0)
2. Select 'Reset 50 Hz Defs' or 'Reset 60 Hz Defs' in Pr **mm.000**. (alternatively, enter 1233 (50 Hz settings) or 1244 (60 Hz settings) in Pr **mm.000**).
3. Either:
- Press the red reset button on the KI-Compact Display or KI-Remote Keypad.
- Toggle the reset digital input.
- Carry out a drive reset through serial communications by setting Pr **10.038** to 100

5.9 Parameter access level and security

The parameter access level determines whether the user has access to Menu 0 only or to all the advanced menus (Menus 1 to 41) in addition to Menu 0.

The User Security determines whether the access to the user is read only or read write.

Both the User Security and Parameter Access Level can operate independently of each other as shown in Table 5-10.

Table 5-10 Parameter access level and security

User security status (00.049)	Access level	User security (00.034)	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.

5.9.1 User Security Level / Access Level

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

User Security Status (Pr 00.049)	Description
Menu 0 (0)	All writable parameters are available to be edited but only parameters in Menu 0 are visible.
All menus (1)	All parameters are visible and all writable parameters are available to be edited.
Read- only Menu 0 (2)	Access is limited to Menu 0 parameters only. All parameters are read-only.
Read-only (3)	All parameters are read-only however all menus and parameters are visible.
Status only (4)	The keypad remains in status mode and no parameters can be viewed or edited.
No access (5)	The keypad remains in status mode and no parameters can be viewed or edited. Drive parameters cannot be accessed via a comms/ fieldbus interface in the drive or any option module.

5.9.2 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **00.049** or Pr **11.044**. The Security Level can be changed through the KI-Remote Keypad even if the User Security Code has been set.

5.9.3 User Security Code

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

Setting User Security Code

Enter a value between 1 and 2147483647 in Pr **00.034** and press the ⟵ button; the security code has now been set to this value. In order to activate the security, the Security level must be set to desired level in Pr **00.049**. When the drive is reset, the security code will have been activated and the drive returns to Menu 0 and the 🔒 symbol is displayed in the right hand corner of the keypad display. The value of Pr **00.034** will return to 0 in order to hide the security code.

Unlocking User Security Code

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

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

Disabling User Security

Unlock the previously set security code as detailed above. Set Pr **00.034** to 0 and press the ⟵ button. The User Security has now been disabled, and will not have to be unlocked each time the drive is powered up to allow read / write access to the parameters.

5.10 Displaying parameters with non-default values only

By selecting 'Show non-default' in Pr **mm.000** (Alternatively, enter 12000 in Pr **mm.000**), the only parameters that will be visible to the user will be those containing a non-default value. This function does not require a drive reset to become active. In order to deactivate this function, return to Pr **mm.000** and select 'No action' (alternatively enter a value of 0). Please note that this function can be affected by the access level enabled, refer to section 5.9 *Parameter access level and security* on page 39 for further information regarding access level.

5.11 Displaying destination parameters only

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

Please note that this function can be affected by the access level enabled, refer to section 5.9 *Parameter access level and security* on page 39 for further information regarding access level.

5.12 Communications

The *Digitax HD M751* drive offers a 2 wire EIA-485 interface. This enables the drive set-up, operation and monitoring to be carried out with a PC or controller if required.

5.12.1 *Digitax HD M751* - EIA-485 Serial communications

The EIA-485 option provides two parallel RJ45 connectors allowing easy daisy chaining. The drive only supports Modbus RTU protocol.

The serial communications port of the drive is a RJ45 socket, which is isolated from the power stage and the other control terminals (see section 4.3 *Communication connections* on page 21 for connection and isolation details).

The communications port applies a 2 unit load to the communications network.

USB/EIA-232 to EIA-485 Communications

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

As suitable USB to EIA-485 isolated converter is available from the supplier of the drive:

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

NOTE

When using the EIA-232 Comms cable the available baud rate is limited to 19.2 k baud.

When using one of the above converters or any other suitable converter with the drive, it is recommended that no terminating resistors be connected on the network. It may be necessary to '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 (00.035)	8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 2 NP (8), 7 1 NP (9), 7 1 EP (10), 7 1 OP (11), 7 2 NP M (12), 7 1 NP M (13), 7 1 EP M (14), 7 1 OP M (15)	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 (00.036)	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600(8), 76800(9), 115200 (10)	This parameter can be changed via the drive keypad, via a option module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20 ms before sending a new message using the new baud rate.
Serial Address (00.037)	1 to 247	This parameter defines the serial address and an addresses between 1 and 247 are permitted.
Reset Serial Communications (00.052)	0 to 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 {…}). Menus 22 can be used to configure the parameters in Menu 0.

6.1 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, refer to section 11.1 *Parameter ranges and Variable minimum/maximums* on page 109.

6.2 Menu 0: Basic parameters

Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.001	Minimum Reference Clamp	**{01.007}**	VM_NEGATIVE_REF_CLAMP1 Hz / rpm			0.0 Hz	0.0 rpm		RW	Num				US
00.002	Maximum Reference Clamp	**{01.006}**	VM_POSITIVE_REF_CLAMP1 Hz / rpm			50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz	50 Hz default: 1500.0 rpm 60 Hz default: 1800.0 rpm	3000.0 rpm	RW	Num				US
00.003	Acceleration Rate 1	**{02.011}**	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm		5.0 s/100 Hz	2.000 s/1000 rpm	0.200 s/1000 rpm	RW	Num				US
00.004	Deceleration Rate 1	**{02.021}**	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm		10.0 s/100 Hz	2.000 s/1000 rpm	0.200 s/1000 rpm	RW	Num				US
00.005	Reference Selector	**{01.014}**	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Precision (5), Keypad Ref (6)			A1 Preset (1)			RW	Txt				US
00.006	Symmetrical Current Limit	**{04.007}**	0.0 to VM_MOTOR1_CURRENT_LIMIT %			165 %	250 %		RW	Num		RA		US
00.007	Open-loop Control Mode	**{05.014}**	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5)			Ur I (4)			RW	Txt				US
	Speed Controller Proportional Gain Kp1	**{03.010}**		0.0000 to 200.000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
00.008	Low Frequency Voltage Boost	**{05.015}**	0.0 to 25.0 %			1 %			RW	Num				US
	Speed Controller Integral Gain Ki1	**{03.011}**		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
00.009	Dynamic V to F Select	**{05.013}**	Off (0) or On (1)			Off (0)			RW	Bit				US
	Speed Controller Differential Feedback Gain Kd 1	**{03.012}**		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
00.010	Motor Rpm	**{05.004}**	±180000 rpm						RO	Bit				US
	Speed Feedback	**{03.002}**		VM_SPEED rpm					RO	Num	ND	NC	PT	FI
00.011	Output Frequency	**{05.001}**	VM_SPEED_FREQ_REF Hz	±2000.0 Hz					RO	Num	ND	NC	PT	FI
	P1 Position	**{03.029}**			0 to 65535				RO	Num	ND	NC	PT	FI
00.012	Current Magnitude	**{04.001}**	0.000 to VM_DRIVE_CURRENT_UNIPOLAR A						RO	Bit	ND	NC	PT	FI
00.013	Torque Producing Current	**{04.002}**	VM_DRIVE_CURRENT A						RO	Bit	ND	NC	PT	FI
00.014	Torque Mode Selector	**{04.011}**	0 or 1	0 to 5		0			RW	Num				US
00.015	Ramp Mode	**{02.004}**	Fast (0), Standard (1), Std boost (2)	Fast (0), Standard (1)		Standard (1)	Fast (0)		RW	Txt				US
00.016	Ramp Enable	**{02.002}**		Off (0) or On (1)			On (1)		RW	Bit				US
00.017	Current Reference Filter 1 Time Constant	**{04.012}**		0.0 to 25.0 ms			0.0 ms		RW	Num				US
00.018	P1 Thermistor Fault Detection	**{03.123}**	None (0), Temperature (1), Temp or Short (2)			None (0)		Temperature (1)	RW	Txt				US
00.022	Bipolar Reference Enable	**{01.010}**	Off (0) or On (1)			Off (0)	On (1)		RW	Bit				US
00.023	Jog Reference	**{01.005}**	0.0 to 400.0 Hz	0.0 to 4000.0 rpm		0.0			RW	Num				US
00.024	Preset Reference 1	**{01.021}**	VM_SPEED_FREQ_REF			0.0			RW	Num				US
00.025	Preset Reference 2	**{01.022}**	VM_SPEED_FREQ_REF			0.0			RW	Num				US
00.026	Preset Reference 3	**{01.023}**	VM_SPEED_FREQ_REF Hz			0.0			RW	Num				US
	Overspeed Threshold	**{03.008}**		0 to 40000 rpm			0.0		RW	Num				US
00.027	Preset Reference 4	**{01.024}**	VM_SPEED_FREQ_REF Hz			0.0			RW	Num				US
	P1 Rotary Lines Per Revolution	**{03.034}**		1 to 100000			1024	4096	RW	Num				US
00.028	Enable Auxiliary Key	**{06.013}**	Disabled (0), Forward/Reverse (1), Run Reverse (2)			Disabled (0)			RW	Txt				US
00.029	NV Media Card File Previously Loaded	**{11.036}**	0 to 999						RO	Num		NC	PT	

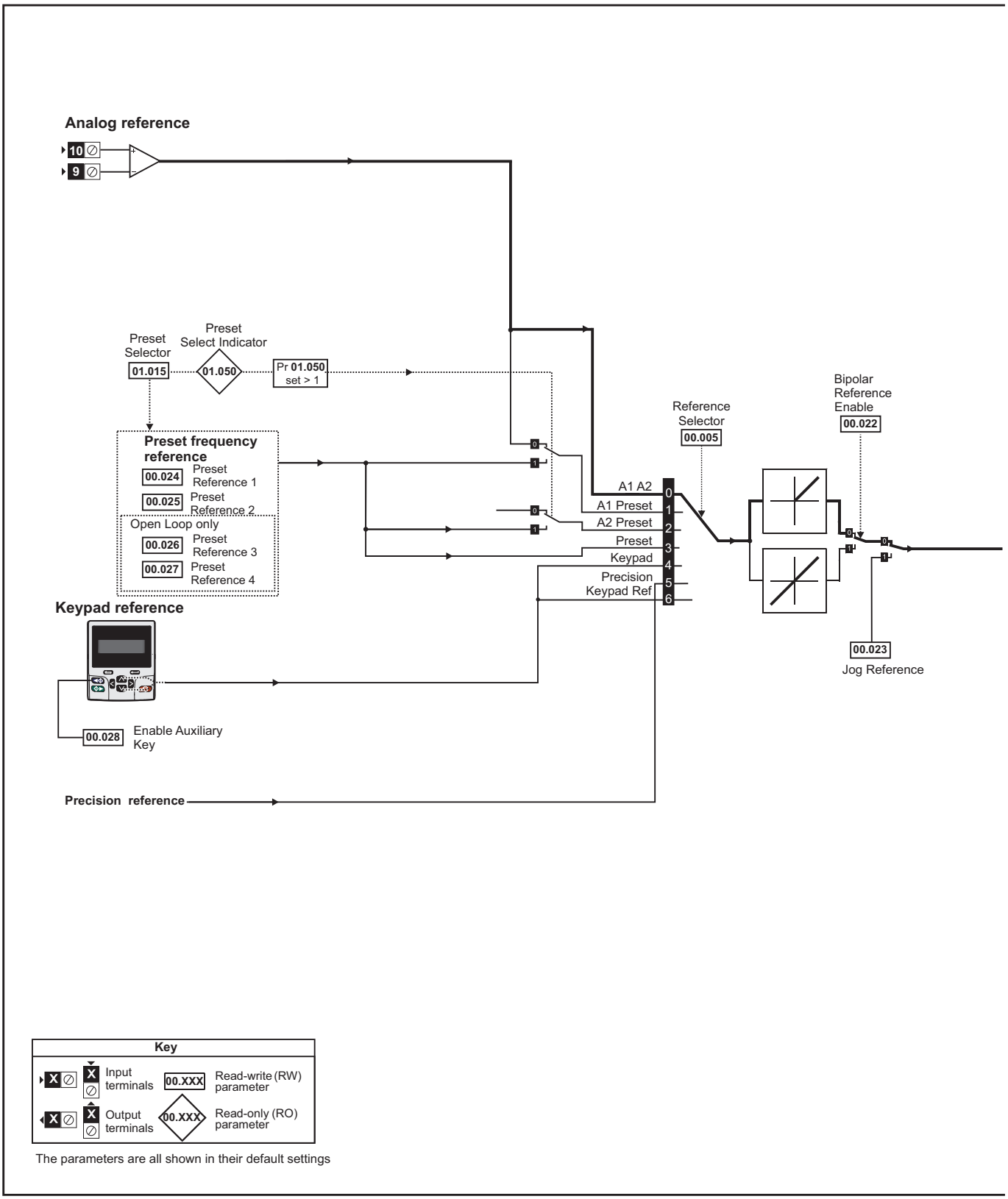
Parameter			Range			Default			Type					
			OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
00.030	Parameter Cloning	**{11.042}**	None (0), Read (1), Program (2), Auto (3), Boot (4)			None (0)			RW	Txt		NC		US
00.031	Drive Rated Voltage	**{11.033}**	200 V (0), 400 V (1)						RO	Txt	ND	NC	PT	
00.032	Maximum Heavy Duty Rating	**{11.032}**	0.000 to 99999.999 A						RO	Num	ND	NC	PT	
00.033	Catch A Spinning Motor	**{06.009}**	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)			Disable (0)			RW	Txt				US
	Rated Speed Optimisation Select	**{05.016}**		Disabled (0), Classic Slow (1), Classic Fast (2), Combined (3), VARs Only (4), Voltage Only (5)			Disabled (0)		RW	Txt				US
00.034	User Security Code	**{11.030}**	0 to 2^{31}-1			0			RW	Num	ND	NC	PT	US
00.035	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 2 NP (8), 7 1 NP (9), 7 1 EP (10), 7 1 OP (11), 7 2 NP M (12), 7 1 NP M (13), 7 1 EP M (14), 7 1 OP M (15)			8 2 NP (0)			RW	Txt				US
00.036	Serial Baud Rate*	**{11.025}**	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)			19200 (6)			RW	Txt				US
00.037	Serial Address*	**{11.023}**	1 to 247			1			RW	Num				US
00.038	Current Controller Kp Gain	**{04.013}**	0 to 30000			20	150		RW	Num				US
00.039	Current Controller Ki Gain	**{04.014}**	0 to 30000			40	2000		RW	Num				US
00.040	Auto-tune	**{05.012}**	0 to 2	0 to 5	0 to 6	0			RW	Num		NC		
00.041	Maximum Switching Frequency	**{05.018}**	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)			8 kHz (4)			RW	Txt		RA		US
00.042	Number Of Motor Poles	**{05.011}**	Automatic (0) to 480 Poles (240)			Automatic (0)		6 Poles (3)	RW	Num				US
00.043	Rated Power Factor**	**{05.010}**	0.000 to 1.000			0.850			RW	Num		RA		US
	Position Feedback Phase Angle	**{03.025}**			0.0 to 359.9°			0.0°	RW	Num	ND			US
00.044	Rated Voltage	**{05.009}**	0 to VM_AC_VOLTAGE_SET V			200 V drive: 230 V 50 Hz default 400V drive: 400 V 60 Hz default 400V drive: 460 V			RW	Num		RA		US
00.045	Rated Speed	**{05.008}**	0 to 33000 rpm	0.00 to 33000.00 rpm		50 Hz default: 1500 rpm 60 Hz default: 1800rpm	50 Hz default: 1450.00 rpm 60 Hz default: 1750.00 rpm	3000.00 rpm	RW	Num				US
00.046	Rated Current	**{05.007}**	0.000 to VM_RATED_CURRENT A			Maximum Heavy Duty Rating (11.032)			RW	Num		RA		US
00.047	Rated Frequency	**{05.006}**	0.0 to 550.0 Hz			50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz			RW	Num				US
	Volts Per 1000 rpm	**{05.033}**			0 to 10,000 V			98	RW	Num				US
00.048	User Drive Mode	**{11.031}**	Open-loop (1), RFC-A (2), RFC-S (3)			Open-loop (1)	RFC-A (2)	RFC-S (3)	RW	Txt	ND	NC	PT	
00.049	User Security Status	**{11.044}**	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)			Menu 0 (0)			RW	Txt	ND		PT	
00.050	Software Version	**{11.029}**	0 to 99999999						RO	Num	ND	NC	PT	
00.051	Action On Trip Detection	**{10.037}**	0 to 31			0			RW	Bin				US
00.052	Reset Serial Communications*	**{11.020}**	Off (0) or On (1)			Off (0)			RW	Bit	ND	NC		
00.053	Motor Thermal Time Constant 1	**{04.015}**	1.0 to 3000.0 s			89.0 s			RW	Num				US

* Only applicable to *Digitax HD M751.*

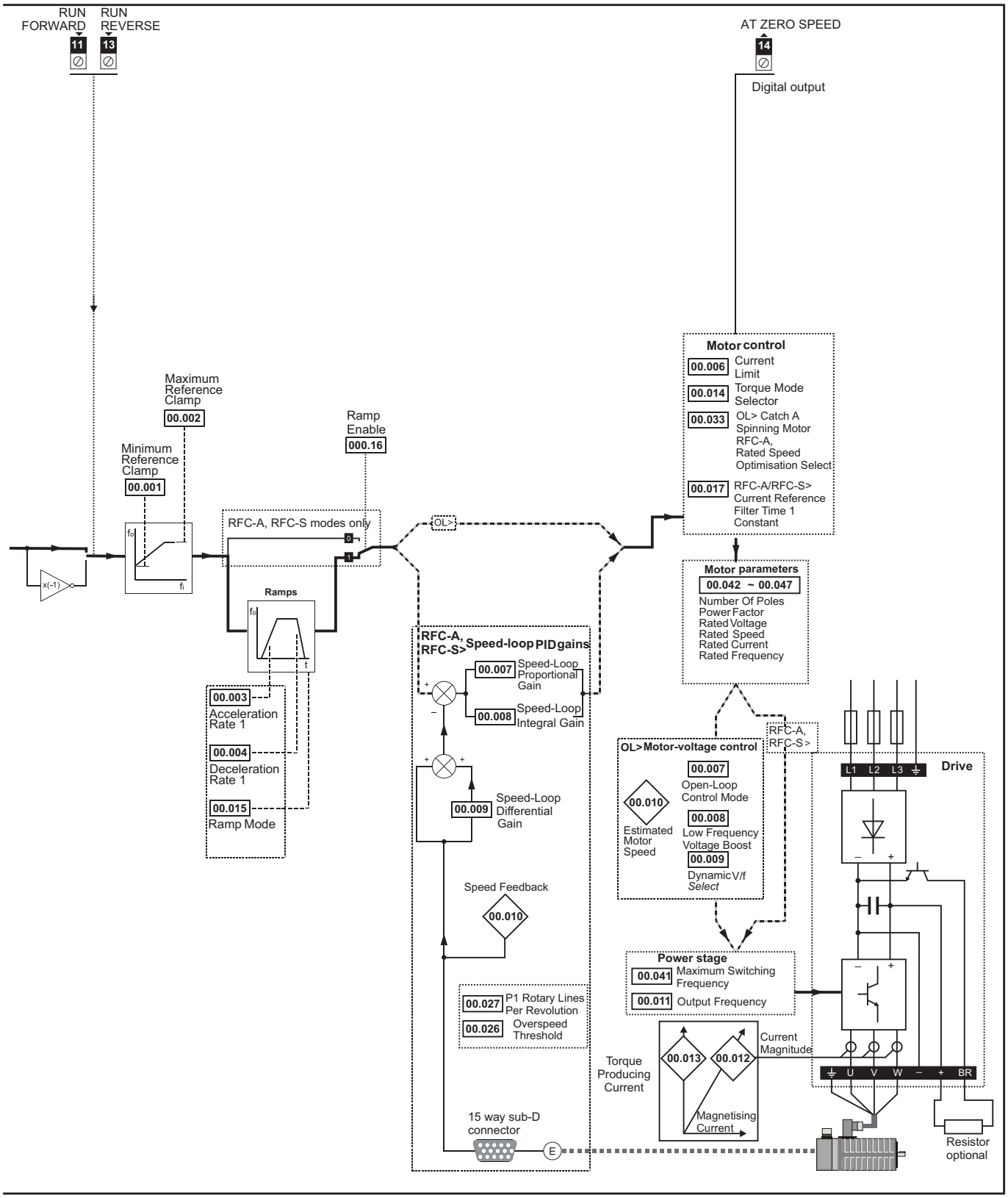
** Following a rotating autotune Pr **00.043** {05.010} is continuously written by the drive, calculated from the value of Stator Inductance (Pr **05.025**). To manually enter a value into Pr **00.043** {05.010}, Pr **05.025** will need to be set to 0. Please refer to the description of Pr **05.010** in the *Parameter Reference Guide* for further details.

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

Figure 6-1 Menu 0 logic diagram



The parameters are all shown in their default settings


RUN FORWARD
11
RUN REVERSE
13
AT ZERO SPEED
14
Digital output
Motor control
00.006 Current Limit
00.014 Torque Mode Selector
00.033 OL> Catch A Spinning Motor RFC-A, Rated Speed Optimisation Select
00.017 RFC-A/RFC-S> Current Reference Filter Time 1 Constant
Maximum Reference Clamp
00.002
Minimum Reference Clamp
00.001
Ramp Enable
000.16
RFC-A, RFC-S modes only
OL>
Ramps
00.003 Acceleration Rate 1
00.004 Deceleration Rate 1
00.015 Ramp Mode
Motor parameters
00.042 ~ 00.047
Number Of Poles
Power Factor
Rated Voltage
Rated Speed
Rated Current
Rated Frequency
RFC-A, RFC-S> Speed-loop PID gains
00.007 Speed-Loop Proportional Gain
00.008 Speed-Loop Integral Gain
00.009 Speed-Loop Differential Gain
Speed Feedback
00.010
00.027 P1 Rotary Lines Per Revolution
00.026 Overspeed Threshold
15 way sub-D connector
OL> Motor-voltage control
00.007 Open-Loop Control Mode
00.010 Estimated Motor Speed
00.008 Low Frequency Voltage Boost
00.009 Dynamic V/f Select
RFC-A, RFC-S>
Power stage
00.041 Maximum Switching Frequency
00.011 Output Frequency
Drive
L1 L2 L3
U V W – + BR
Torque Producing Current
00.013
00.012
Current Magnitude
Magnetising Current
Resistor optional

6.3 Parameter descriptions

6.3.1 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 SD Card.

Table 6-1 Commonly used functions in xx.000

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

Table 6-2 Functions in Pr mm.000

Value	Action
1000	Save parameters when *Under Voltage Active* (Pr **10.016**) is not active and *Low Under Voltage Threshold Select* mode (Pr **06.067** = Off) is not active.
1001	Save parameters under all conditions
1070	Reset all option modules
1233	Load standard (50 Hz) defaults
1234	Load standard (50 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1244	Load US (60 Hz) defaults
1245	Load US (60 Hz) defaults to all menus except option module menus (i.e 15 to 20 and 24 to 28)
1253	Change drive mode and load standard (50 Hz) defaults
1254	Change drive mode and load US (60 Hz) defaults
1255	Change drive mode and load standard (50 Hz) defaults except for menus 15 to 20 and 24 to 28
1256	Change drive mode and load US (60 Hz) defaults except for menus 15 to 20 and 24 to 28
1299	Reset {Stored HF} trip.
2001*	Create a boot file on a non-volatile media card based on the present drive parameters including all Menu 20 parameters
4yyy*	SD card: Transfer the drive parameters to parameter file xxx
5yyy*	SD card: Transfer the onboard user program to onboard user program file xxx
6yyy*	SD card: Load the drive parameters from parameter file xxx or the onboard user program from onboard user program file xxx
7yyy*	SD card: Erase file xxx
8yyy*	SD card: Compare the data in the drive with file xxx
9555*	SD card: Clear the warning suppression flag
9666*	SD card: Set the warning suppression flag
9777*	SD card: Clear the read-only flag
9888*	SD card: Set the read-only flag
59999	Delete onboard user program
110S0	Transfer electronic nameplate motor object parameters from the drive to an encoder connected to the drive or an option module.
110S1	Transfer electronic nameplate motor objects parameters from an encoder connected to the drive or option module to the drive parameters.
110S2	As 110S0, but for performance object 1
110S3	As 110S1, but for performance object 1
110S4	As 110S0, but for performance object 2
110S5	As 110S1, but for performance object 2
110S6	Transfer electronic nameplate motor object parameters from the drive to an encoder connected to the drive or an option module in the Unidrive SP format.
12000**	Only display parameters that are different from their default value. This action does not require a drive reset.
12001**	Only display parameters that are used to set-up destinations (i.e. DE format bit is 1). This action does not require a drive reset.
15xxx*	Transfer the user program in an option module installed in slot 1 to a non-volatile media card file xxx
16xxx*	Transfer the user program in an option module installed in slot 2 to a non-volatile media card file xxx
17xxx*	Transfer the user program in an option module installed in slot 3 to a non-volatile media card file xxx
18xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 1.
19xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 2.
20xxx*	Transfer the user program from file xxx in a non-volatile media card to an option module installed in slot 3.

* See Chapter 9 *SD Card Operation* on page 100 for more information on these functions.

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

6.4 Full descriptions

Table 6-3 Key to parameter table coding

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

6.4.1 Parameter x.00

00.000 {mm.000}	**Parameter zero**								
RW	Num				ND	NC	PT		
⇳	0 to 65,535				⇨				

6.4.2 Speed limits

00.001 {01.007}	**Minimum Reference Clamp**								
RW	Num							US	
OL	⇳	VM_NEGATIVE_REF_ CLAMP1 Hz / rpm					⇨	0.0 Hz	
RFC-A								0.0 rpm	
RFC-S									

(When the drive is jogging, [**00.001**] has no effect.)

Open-loop

Set Pr **00.001** at the required minimum output frequency of the drive for both directions of rotation. The drive speed reference is scaled between Pr **00.001** and Pr **00.002**. [**00.001**] is a nominal value; slip compensation may cause the actual frequency to be higher.

RFC-A / RFC-S

Set Pr **00.001** at the required minimum motor speed for both directions of rotation. The drive speed reference is scaled between Pr **00.001** and Pr **00.002**.

00.002 {01.006}	**Maximum Reference Clamp**								
RW	Num							US	
OL	⇳	VM_POSITIVE_REF_ CLAMP1 Hz / rpm					⇨	50Hz default: 50.0 Hz 60Hz default: 60.0 Hz	
RFC-A								50Hz default:1500.0 rpm 60Hz default:1800.0 rpm	
RFC-S								3000.0 rpm	

(The drive has additional over-speed protection).

Open-loop

Set Pr **00.002** at the required maximum output frequency for both directions of rotation. The drive speed reference is scaled between Pr **00.001** and Pr **00.002**. [**00.002**] is a nominal value; slip compensation may cause the actual frequency to be higher.

RFC-A / RFC-S

Set Pr **00.002** at the required maximum motor speed for both directions of rotation. The drive speed reference is scaled between Pr **00.001** and Pr **00.002**.

For operating at high speeds see section 8.5 *High speed operation* on page 93.

6.4.3 Ramps, speed reference selection, current limit

00.003 {02.011}	**Acceleration Rate 1**								
RW	Num							US	
OL	⇳	0.0 to VM_ACCEL_RATE s/100 Hz					⇨	5.0 s/100 Hz	
RFC-A		0.000 to VM_ACCEL_RATE s/1000 rpm						2.000 s/1000 rpm	
RFC-S								0.200 s/1000 rpm	

Set Pr **00.003** at the required rate of acceleration.

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

00.004 {02.021}	**Deceleration Rate 1**								
RW	Num							US	
OL	⇳	0.0 to VM_ACCEL_RATE s/100 Hz					⇨	10.0 s/100 Hz	
RFC-A		0.000 to VM_ACCEL_RATE s/1000 rpm						2.000 s/1000 rpm	
RFC-S								0.200 s/1000 rpm	

Set Pr **00.004** at the required rate of deceleration.

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

00.005 {01.014}	**Reference Selector**								
RW	Txt							US	
OL	⇳	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Precision (5), Keypad Ref (6)					⇨	A1 Preset (1)	
RFC-A									
RFC-S									

Use Pr **00.005** to select the required frequency/speed reference as follows:

Setting		Description
A1 A2	0	Analog input 1 OR analog input 2 selectable by digital input, terminal 28
A1 Preset	1	Analog input 1 OR preset frequency/speed
A2 Preset	2	Analog input 2 OR preset frequency/speed
Preset (3)	3	Pre-set frequency/speed
Keypad (4)	4	Keypad mode
Precision (5)	5	Precision reference
Keypad Ref (6)	6	Keypad Reference

00.006 {04.007}		Symmetrical Current Limit		
RW		Num		US
OL	⇳	0.0 to VM_MOTOR1_CURRENT_LIMIT %	⇨	165 %
RFC-A				250 %
RFC-S				

Pr **00.006** limits the maximum output current of the drive (and hence maximum motor torque) to protect the drive and motor from overload.

Set Pr **00.006** at the required maximum torque as a percentage of the rated torque of the motor, as follows:

$$[\mathbf{00.006}] = \frac{T_R}{T_{RATED}} \times \mathbf{100\ (\%)}$$

Where:

T_R Required maximum torque

T_{RATED} Motor rated torque

Alternatively, set Pr **00.006** at the required maximum active (torque-producing) current as a percentage of the rated active current of the motor, as follows:

$$[\mathbf{00.006}] = \frac{I_R}{I_{RATED}} \times \mathbf{100\ (\%)}$$

Where:

I_R Required maximum active current

I_{RATED} Motor rated active current

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

00.007 {05.014}		Open-loop Control Mode (OL)		
00.007 {03.010}		Speed Controller Proportional Gain Kp1 (RFC)		
RW		Txt / Num		US
OL	⇳	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5)	⇨	Ur I (4)
RFC-A	⇳	0.0000 to 200.000 s/rad	⇨	0.0300 s/rad
RFC-S				0.0100 s/rad

Open-loop

There are six voltage modes available, which fall into two categories, vector control and fixed boost. For further details, refer to section *Pr 00.007 {05.014} Open Loop Control Mode* on page 83.

RFC-A/ RFC-S

Pr **00.007** (**03.010**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-4 on page 126 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 77.

00.008 {05.015}		Low Frequency Voltage Boost (OL)		
00.008 {03.011}		Speed Controller Integral Gain Ki1 (RFC)		
RW		Num		US
OL	⇳	0.0 to 25.0 %	⇨	3.0 %
RFC-A	⇳	0.00 to 655.35 s^2/rad	⇨	0.10 s^2/rad
RFC-S				1.00 s^2/rad

Open-loop

When *Open-loop Control Mode* (00.007) is set at **Fd** or **SrE**, set Pr **00.008** (**05.015**) at the required value for the motor to run reliably at low speeds.

Excessive values of Pr **00.008** can cause the motor to be overheated.

RFC-A/ RFC-S

Pr **00.008** (**03.011**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-4 on page 126 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 77.

00.009 {05.013}		Dynamic V to F Select (OL)		
00.009 {03.012}		Speed Controller Differential Feedback Gain Kd 1 (RFC)		
RW		Bit		US
OL	⇳	Off (0) or On (1)	⇨	Off (0)
RFC-A	⇳	0.00000 to 0.65535 1/rad	⇨	0.00000 1/rad
RFC-S				

Open-loop

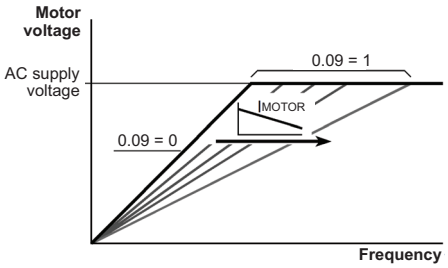
Set Pr **00.009** (**05.013**) at 0 when the V/f characteristic applied to the motor is to be fixed. It is then based on the rated voltage and frequency of the motor.

Set Pr **00.009** at 1 when reduced power dissipation is required in the motor when it is lightly loaded. The V/f characteristic is then variable resulting in the motor voltage being proportionally reduced for lower motor currents. Figure 6-2 shows the change in V/f slope when the motor current is reduced.

RFC-A / RFC-S

Pr **00.009** (**03.012**) operates in the feedback path of the speed-control loop in the drive. See Figure 11-4 *Menu 3 RFC-A, RFC-S logic diagram* on page 126 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 77.

Figure 6-2 Fixed and variable V/f characteristics



6.4.5 Monitoring

00.010 {05.004}	Motor Rpm									
RO		Bit							US	
OL	⇳	±180000 rpm						⇨		

Open-loop

Pr **00.010** (**05.004**) indicates the value of motor speed that is estimated from the following:

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

00.010 {03.002}	Speed Feedback									
RO		Num	FI			ND	NC	PT		
RFC-A RFC-S	⇳	VM_SPEED rpm				⇨				

RFC-A / RFC-S

Pr **00.010** (**03.002**) indicates the value of motor speed that is obtained from the speed feedback.

00.011 {05.001}	Output Frequency (OL)									
00.011 {03.029}	P1 Position (RFC)									
RO		Num	FI			ND	NC	PT		
OL RFC-A	⇳	VM_SPEED_FREQ_ REF Hz				⇨				
RFC-S	⇳	0 to 65535				⇨				

Open-loop and RFC-A

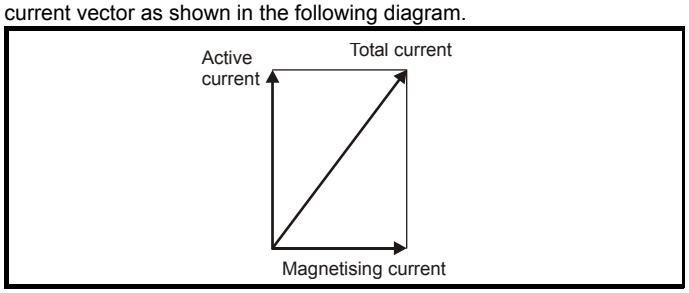
Pr **00.011** displays the frequency at the drive output.

RFC-S

Pr **00.011** displays the position of the encoder in mechanical values of 0 to 65,535. There are 65,536 units to one mechanical revolution.

00.012 {04.001}	Current Magnitude									
RO		Bit	FI			ND	NC	PT		
OL RFC-A RFC-S	⇳	0.000 to VM_DRIVE_CURRENT_ UNIPOLAR A				⇨				

Pr **00.012** displays the rms value of the output current of the drive in each of the three phases. The phase currents consist of an active component and a reactive component, which can form a resultant current vector as shown in the following diagram.



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

00.013 {04.002}	Torque Producing Current									
RO		Bit	FI			ND	NC	PT		
OL RFC-A RFC-S	⇳	VM_DRIVE_CURRENT A				⇨				

When the motor is being driven below its rated speed, the torque is proportional to [**00.013**].

6.4.6 Jog reference, Ramp mode selector, Stop and torque mode selectors

Pr **00.014** is used to select the required control mode of the drive as follows:

00.014 {04.011}	Torque Mode Selector									
RW		Num							US	
OL	⇳	0 or 1				⇨	0			
RFC-A RFC-S	⇳	0 to 5				⇨	0			

Setting	Open-Loop	RFC-A/S
0	Frequency control	Speed control
1	Torque control	Torque control
2		Torque control with speed override
3		Coiler/uncoiler mode
4		Speed control with torque feed-forward
5		Bi-directional torque control with speed override

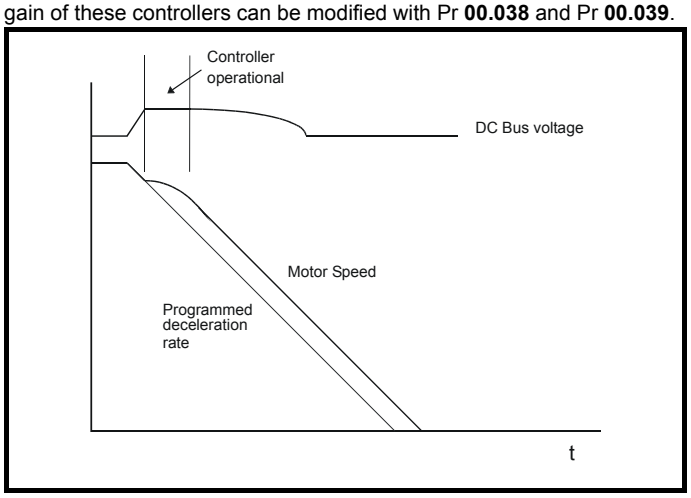
00.015 {02.004}	Ramp Mode Select									
RW		Txt							US	
OL	⇳	Fast (0), Standard (1), Std boost (2)				⇨	Standard (1)			
RFC-A RFC-S	⇳	Fast (0), Standard (1)				⇨	Fast (0)			

Pr **00.015** sets the ramp mode of the drive as shown below:

0: Fast ramp
Fast ramp is used where the deceleration follows the programmed deceleration rate subject to current limits. This mode must be used if a braking resistor is connected to the drive.

1: Standard ramp
Standard ramp is used. During deceleration, if the voltage rises to the standard ramp level (Pr **02.008**) it causes a controller to operate, the output of which changes the demanded load current in the motor. As the controller regulates the link voltage, the motor deceleration increases as the speed approaches zero speed. When the motor deceleration rate reaches the programmed deceleration rate the controller ceases to operate and the drive continues to decelerate at the programmed rate. If the standard ramp voltage (Pr **02.008**) is set lower than the nominal DC bus level the drive will not decelerate the motor, but it will coast to rest.

The output of the ramp controller (when active) is a current demand that is fed to the frequency changing current controller (Open-loop modes) or the torque producing current controller (RFC-A or RFC-S modes). The gain of these controllers can be modified with Pr **00.038** and Pr **00.039**.



2: Standard ramp with motor voltage boost

This mode is the same as normal standard ramp mode except that the motor voltage is boosted by 20 %. This increases the losses in the motor, dissipating some of the mechanical energy as heat giving faster deceleration.

00.016 {02.002}	**Ramp Enable**									
RW	Bit								US	
OL	⇳				⇨					
RFC-A	⇳	Off (0) or On (1)			⇨	On (1)				
RFC-S										

Setting Pr **00.016** to 0 allows the user to disable the ramps. This is generally used when the drive is required to closely follow a speed reference which already contains acceleration and deceleration ramps.

00.017 {04.012}	**Current Reference Filter Time Constant**									
RW	Num								US	
RFC-A	⇳	0.0 to 25.0 ms			⇨	0.0 ms				
RFC-S										

RFC-A / RFC-S

A first order filter, with a time constant defined by Pr **00.017**, is provided on the current demand to reduce acoustic noise and vibration produced as a result of position feedback quantisation noise. The filter introduces a lag in the speed loop, and so the speed loop gains may need to be reduced to maintain stability as the filter time constant is increased.

00.018 {03.123}	**P1 Thermistor Fault Detection**									
RW										
OL	⇳	None (0), Temperature (1), Temp and short (2)			⇨	None (0)				
RFC-A										
RFC-S						Temperature (1)				

Defines the fault detection for the P1 thermistor input:

***P1 Thermistor Fault Detection* (03.123)**	**Fault detection**
0: None	No detection active
1: Temperature	Over temperature detection
2: Temp and short	Over temperature and short circuit detection

If over temperature detection is enabled a *Thermistor*.001 trip is initiated if *P1 Thermistor Feedback* (03.119) is above the level defined by *P1 Thermistor Trip Threshold* (03.120). The trip cannot be reset until *P1 Thermistor Feedback* (03.119) is below *P1 Thermistor Reset Threshold* (03.121).

If short circuit detection is enabled then a *Th Short Circuit*.001 is initiated if *P1 Thermistor Feedback* (03.119) is below 50 Ohms.

00.022 {01.010}	**Bipolar Reference Enable**									
RW	Bit								US	
OL	⇳	OFF (0) or On (1)			⇨	OFF (0)				
RFC-A										
RFC-S										

Pr **00.022** determines whether the reference is uni-polar or bi-polar as follows:

Pr 00.022	**Function**	
0	Unipolar speed/frequency reference	
1	Bipolar speed/frequency reference	

00.023 {01.005}	**Jog Reference**									
RW	Num								US	
OL	⇳	0.0 to 400.0 Hz			⇨	0.0				
RFC-A	⇳	0.0 to 4000.0 rpm			⇨	0.0				
RFC-S										

Enter the required value of jog frequency/speed.

The frequency/speed limits affect the drive when jogging as follows:

Frequency-limit parameter	**Limit applies**
Pr **00.001** Minimum reference clamp	No
Pr **00.002** Maximum reference clamp	Yes

00.024 {01.021}	**Preset Reference 1**									
RW	Num								US	
OL	⇳	VM_SPEED_FREQ_REF			⇨	0.0				
RFC-A										
RFC-S										

00.025 {01.022}	**Preset Reference 2**									
RW	Num								US	
OL	⇳	VM_SPEED_FREQ_REF			⇨	0.0				
RFC-A										
RFC-S										

00.026 {01.023}	Preset Reference 3 (OL)									
00.026 {03.008}	Overspeed Threshold (RFC)									
RW		Num							US	
OL	⇳	VM_SPEED_FREQ_REF Hz							⇨	0.0
RFC-A	⇳	0 to 40000 rpm							⇨	0.0
RFC-S	⇳	0 to 40000 rpm							⇨	0.0

Open-loop

If the preset reference has been selected (see Pr **00.005**), the speed at which the motor runs is determined by these parameters.

RFC-A / RFC-S

If the speed feedback (Pr **00.010**) exceeds this level in either direction, an overspeed trip is produced. If this parameter is set to zero, the overspeed threshold is automatically set to 120 % x SPEED_FREQ_MAX.

00.027 {01.024}	Preset Reference 4 (OL)									
00.027 {03.034}	P1 Rotary Lines Per Revolution (RFC)									
RW		Num							US	
OL	⇳	VM_SPEED_FREQ_REF Hz							⇨	0.0
RFC-A	⇳	1 to 100000							⇨	1024
RFC-S	⇳	1 to 100000							⇨	4096

Open-loop

Refer to Pr **00.024** to Pr **00.026**.

RFC-A / RFC-S

Enter in Pr **00.027** the number of lines per revolution of the drive encoder.

00.028 {06.013}	Enable Auxiliary Key									
RW		Txt							US	
OL	⇳	Disabled (0), Forward/Reverse (1), Run Reverse (2)							⇨	Disabled (0)
RFC-A	⇳	Disabled (0), Forward/Reverse (1), Run Reverse (2)							⇨	Disabled (0)
RFC-S	⇳	Disabled (0), Forward/Reverse (1), Run Reverse (2)							⇨	Disabled (0)

When a keypad is installed, this parameter enables the forward/reverse key.

00.029 {11.036}	NV Media Card File Previously Loaded									
RO		Num					NC	PT		
OL	⇳	0 to 999							⇨	
RFC-A	⇳	0 to 999							⇨	
RFC-S	⇳	0 to 999							⇨	

This parameter shows the number of the data block last transferred from an SD Card to the drive.

00.030 {11.42}	Parameter Cloning									
RW		Txt					NC		US*	
OL	⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)							⇨	None (0)
RFC-A	⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)							⇨	None (0)
RFC-S	⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)							⇨	None (0)

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

NOTE

If Pr **00.030** is equal to 1 or 2 this value is not transferred to the EEPROM or the drive. If Pr **00.030** is set to a 3 or 4 the value is transferred.

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

For further information, please refer to Chapter 9 *SD Card Operation* on page 100.

00.031 {11.033}	Drive Rated Voltage									
RO		Txt					ND	NC	PT	
OL	⇳	200 V (0), 400 V (1)							⇨	
RFC-A	⇳	200 V (0), 400 V (1)							⇨	
RFC-S	⇳	200 V (0), 400 V (1)							⇨	

Pr **00.031** indicates the voltage rating of the drive.

00.032 {11.032}	Maximum Heavy Duty Rating									
RO		Num					ND	NC	PT	
OL	⇳	0.000 to 99999.999 A							⇨	
RFC-A	⇳	0.000 to 99999.999 A							⇨	
RFC-S	⇳	0.000 to 99999.999 A							⇨	

Pr **00.032** indicates the maximum continuous Heavy Duty current rating.

00.033 {06.009}	Catch A Spinning Motor (OL)									
00.033 {05.016}	Rated Speed Optimisation Select (RFC-A)									
RW		Txt							US	
OL	⇳	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)							⇨	Disable (0)
RFC-A	⇳	Disabled (0), Classic Slow (1), Classic Fast (2), Combined (3), VARs Only (4), Voltage Only (5)							⇨	Disabled (0)

Open-loop

When the drive is enabled with Pr **00.033** = 0, the output frequency starts at zero and ramps to the required reference. When the drive is enabled when Pr **00.033** has a non-zero value, the drive performs a start-up test to determine the motor speed and then sets the initial output frequency to the synchronous frequency of the motor.

Restrictions may be placed on the frequencies detected by the drive as follows:

Pr 00.033	Pr string	Function
0	Disable	Disabled
1	Enable	Detect all frequencies
2	Fwd only	Detect positive frequencies only
3	Rev only	Detect negative frequencies only

RFC-A

The *Rated Frequency* (00.047) and *Rated Speed* (00.045) are used to define the rated slip of the motor. The rated slip is used in sensorless mode (*Sensorless Mode Active* (03.078) = 1) to correct the motor speed with load. When this mode is active *Rated Speed Optimisation Select* (00.033) has no effect.

If sensorless mode is not active (*Sensorless Mode Active* (03.078) = 0) the rated slip is used in the motor control algorithm and an incorrect value of slip can have a significant effect on the motor performance. If *Rated Speed Optimisation Select* (00.033) = 0 then the adaptive control system is disabled. However, if *Rated Speed Optimisation Select* (00.033) is set to a non-zero value the drive can automatically adjust the *Rated Speed* (00.045) to give the correct value of rated slip.

Rated Speed (00.045) is not saved at power-down, and so when the drive is powered-down and up again it will return to the last value saved by the user. The rate of convergence and the accuracy of the adaptive controller reduces at low output frequency and low load. The minimum frequency is defined as a percentage of *Rated Frequency* (00.047) by *Rated Speed Optimisation Minimum Frequency* (05.019). The minimum load is defined as a percentage of rated load by *Rated Speed Optimisation Minimum Load* (05.020). The adaptive controller is enabled when a motoring or regenerative load rises above *Rated Speed Optimisation Minimum Load* (05.020) + 5 %, and is disabled again when it falls below *Rated Speed Optimisation Minimum Load* (05.020). For best optimisation results the correct values of *Stator Resistance* (05.017), *Transient Inductance* (05.024), *Stator Inductance* (05.025), *Saturation Breakpoint 1* (05.029), *Saturation Breakpoint 2* (05.062), *Saturation Breakpoint 3* (05.030) and *Saturation Breakpoint 4* (05.063) should be used.

00.034 {11.030}	**User security code**								
RW	Num				ND	NC	PT	US	
OL									
RFC-A	⇳	0 to 2^{31}-1			⇨	0			
RFC-S									

If any number other than 0 is programmed into this parameter, user security is applied so that no parameters except Pr **00.049** can be adjusted with the keypad. When this parameter is read via a keypad it appears as zero. For further details refer to section 5.9.3 *User Security Code* on page 40.

00.035 {11.024}	**Serial Mode**								
RW	Txt							US	
OL		8 2 NP (0), 8 1 NP (1), 8 1 EP (2), 8 1 OP (3), 8 2 NP M (4), 8 1 NP M (5), 8 1 EP M (6), 8 1 OP M (7), 7 2 NP (8), 7 1 NP (9), 7 1 EP (10), 7 1 OP (11), 7 2 NP M (12), 7 1 NP M (13), 7 1 EP M (14), 7 1 OP M (15)							
RFC-A	⇳				⇨	8 2 NP (0)			
RFC-S									

This parameter defines the communications protocol used by the EIA485 comms port on the drive. This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original protocol. The master should wait at least 20 ms before send a new message using the new protocol. (Note: ANSI uses 7 data bits, 1 stop bit and even parity; Modbus RTU uses 8 data bits, 2 stops bits and no parity).

Pr Value	Pr String
0	8 2 NP
1	8 1 NP
2	8 1 EP
3	8 1 OP
4	8 2 NP M
5	8 1 NP M
6	8 1 EP M
7	8 1 OP M
8	7 2 NP
9	7 1 NP
10	7 1 EP
11	7 1 OP
12	7 2 NP M
13	7 1 NP M
14	7 1 EP M
15	7 1 OP M

The core drive always uses the Modbus rtu protocol and is always a slave. *Serial Mode* (00.035) defines the data format used by the serial comms interface. The bits in the value of *Serial Mode* (00.035) define the data format as follows. Bit 3 is always 0 in the core product as 8 data bits are required for Modbus rtu. The parameter value can be extended in derivative products which provide alternative communications protocols if required.

Bits	3	2	1 and 0
Format	Number of data bits 0 = 8 bits 1 = 7 bits	Register mode 0 = Standard 1 = Modified	Stop bits and Parity 0 = 2 stop bits, no parity 1 = 1 stop bit, no parity 2 = 1 stop bit, even parity 3 = 1 stop bit, odd parity

Bit 2 selects either standard or modified register mode. The menu and parameter numbers are derived for each mode as given in the following table. Standard mode is compatible with Unidrive SP. Modified mode is provided to allow register numbers up to 255 to be addressed. If any menus with numbers above 63 should contain more than 99 parameters, then these parameters cannot be accessed via Modbus rtu.

Register mode	Register address
Standard	(mm x 100) + ppp - 1 where mm ≤ 162 and ppp ≤ 99
Modified	(mm x 256) + ppp - 1 where mm ≤ 63 and ppp ≤ 255

Changing the parameters does not immediately change the serial communications settings. See *Reset Serial Communications* (11.020) for more details.

00.036 {11.025}	**Serial Baud Rate**								
RW	Txt							US	
OL		300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)							
RFC-A	⇳				⇨	19200 (6)			
RFC-S									

This parameter can be changed via the drive keypad, via a Solutions 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 send a new message using the new baud rate.

00.037 {11.023}		Serial Address								
RW		Num							US	
OL	⇳	1 to 247				⇨	1			
RFC-A										
RFC-S										

Used to define the unique address for the drive for the serial interface. The drive is always a slave address 0 is used to globally address all slaves, and so this address should not be set in this parameter

00.038 {04.013}		Current Controller Kp Gain								
RW		Num							US	
OL	⇳	0 to 30000				⇨	20			
RFC-A							150			
RFC-S										

00.039 {04.014}		Current Controller Ki Gain								
RW		Num							US	
OL	⇳	0 to 30000				⇨	40			
RFC-A						⇨	2000			
RFC-S										

These parameters control the proportional and integral gains of the current controller used in the open loop drive. The current controller either provides current limits or closed loop torque control by modifying the drive output frequency. The control loop is also used in its torque mode during line power supply loss, or when the controlled mode standard ramp is active and the drive is decelerating, to regulate the flow of current into the drive.

00.040 {05.012}		Auto-tune								
RW		Num					NC			
OL	⇳	0 to 2				⇨	0			
RFC-A	⇳	0 to 4				⇨				
RFC-S	⇳	0 to 5				⇨				

Open-Loop

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

- 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 *Open Loop Control Mode* (00.007), later in this table). The stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 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 *Rated Frequency* (05.006) x 2/3, and the frequency is maintained at that level for 4 seconds. *Stator Inductance* (05.025) is measured and this value is used in conjunction with other motor parameters to calculate *Rated Power Factor* (00.043). To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 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 terminal 2 and 6, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the *Control Word* (06.042) and *Control Word Enable* (06.043).

RFC-A

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

NOTE

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

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary autotune measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 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 *Rated Frequency* (00.047) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (05.025), and the motor saturation breakpoints (Pr **05.029**, Pr **05.030**, Pr **06.062** and Pr **05.063**) are modified by the drive. The *Motor Rated Power Factor* (00.043) is also modified by the *Stator Inductance* (05.025). The No-Load motor core losses are measured and written to *No-Load Core Loss* (04.045). To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 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 terminal 2 and 6, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

RFC-S

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

- *Stationary Autotune*

The stationary autotune can be used when the motor is loaded and it is not possible uncouple the load from motor shaft. This test can be used to measure all the necessary parameters for basic control. During the stationary autotune, a test is performed to locate the flux axis of the motor. However this test may not be able to calculate such an accurate value for the Position Feedback Phase Angle (00.043) as compared to rotating autotune. A stationary test is performed to measure *Stator Resistance* (05.017), *Ld* (05.024), *Maximum Deadtime Compensation* (05.059), *Current At Maximum Deadtime Compensation* (05.060),

No Load Lq (05.072). If *Enable Stator Compensation* (05.049) = 1 then *Stator Base Temperature* (05.048) is made equal to *Stator Temperature* (05.046). The *Stator Resistance* (05.017) and the *Ld* (05.024) are then used to set up *Current controller Kp Gain* (00.038) and *Current Controller Ki Gain* (00.039). If sensorless mode is not selected then *Position Feedback Phase Angle* (00.043) is set up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).

- *Rotating Autotune*

The rotating autotune must be performed on unloaded motor. This test can be used to measure all the necessary parameters for the basic control and parameters for cancelling the effects of the cogging torque. During the rotating autotune, *Rated Current* (00.046) is applied and the motor is rotated by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the required direction. If sensorless mode is not selected then the *Position Feedback Phase Angle* (00.043) is set-up for the position from the position feedback interface selected with *Motor Control* revolutions) in the required direction. If sensorless mode is not selected then the *Position Feedback Phase Angle* (00.043) is set-up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). A stationary test is then performed to measure *Stator Resistance* (05.017), Ld (05.024), *Maximum Deadtime Compensation* (05.059), *Current At Maximum Deadtime Compensation* (05.060) and *No Load Lq* (05.072). *Stator Resistance* (05.017) and *Ld* (05.024) are used to set up *Current Controller Kp Gain* (00.038) and *Current Controller Ki Gain* (00.039). This is only done once during the test, and so the user can make further adjustments to the current controller gains if required. To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).

00.041 {05.018}	**Maximum Switching Frequency**									
RW	Txt					RA	NC			
OL	⇳	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)				⇨	8 kHz (4)			
RFC-A										
RFC-S										

This parameter defines the required switching frequency. The drive may automatically reduce the actual switching frequency (without changing this parameter) if the power stage becomes too hot. A thermal model of the IGBT junction temperature is used based on the heatsink temperature and an instantaneous temperature drop using the drive output current and switching frequency. The estimated IGBT junction temperature is displayed in Pr **07.034**. If the temperature exceeds 135 °C the switching frequency is reduced if this is possible (i.e >3 kHz). Reducing the switching frequency reduces the drive losses and the junction temperature displayed in Pr **07.034** also reduces. If the load condition persists the junction temperature may continue to rise again above 145 °C and the drive cannot reduce the switching frequency further the drive will initiate an 'OHt Inverter' trip. Every second the drive will attempt to restore the switching frequency to the level set in Pr **00.041**.

See section 8.4 *Switching frequency* on page 93, for the maximum available switching frequency for each drive rating.

6.4.7 Motor parameters

00.042 {05.011}	**Number Of Motor Poles**									
RW	Num							US		
OL	⇳	Automatic (0) to 480 Poles (240)				⇨	Automatic (0)			
RFC-A										
RFC-S						⇨	6 Poles (3)			

Open-loop

This parameter is used in the calculation of motor speed, and in applying the correct slip compensation. When Automatic (0) is selected, the number of motor poles is automatically calculated from the *Rated Frequency* (00.047) and the *Rated Speed* rpm (00.045). The number of poles = 120 * rated frequency / rpm rounded to the nearest even number.

RFC-A

This parameter must be set correctly for the vector control algorithms to operate correctly. When Automatic (0) is selected, the number of motor poles is automatically calculated from the *Rated Frequency* (00.047) and the *Rated Speed* (00.045) rpm. The number of poles = 120 * rated frequency / rpm rounded to the nearest even number.

RFC-S

This parameter must be set correctly for the vector control algorithms to operate correctly. When Automatic (0) is selected the number of poles is set to 6.

00.043 {05.010}	**Rated Power Factor (OL)**									
00.043 {03.025}	**Position Feedback Phase Angle (RFC)**									
RW	Num							US		
OL	⇳	0.000 to 1.000				⇨	0.850			
RFC-A	⇳	0.000 to 1.000				⇨	0.850			
RFC-S	⇳	0.0 to 359.9 °				⇨	0.0 °			

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current.

Open-loop

The power factor is used in conjunction with the motor rated current (Pr **00.046**) to calculate the rated active current and magnetizing current of the motor. The rated active current is used extensively to control the drive, and the magnetizing current is used in vector mode Rs compensation. It is important that this parameter is set up correctly.

This parameter is obtained by the drive during a rotational autotune. If a stationary autotune is carried out, then the nameplate value should be entered in Pr **00.043**.

RFC-A

If the stator inductance (Pr **05.025**) contains a non-zero value, the power factor used by the drive is continuously calculated and used in the vector control algorithms (this will not update Pr **00.043**).

If the stator inductance is set to zero (Pr **05.025**) then the power factor written in Pr **00.043** is used in conjunction with the motor rated current and other motor parameters to calculate the rated active and magnetizing currents which are used in the vector control algorithm.

This parameter is obtained by the drive during a rotational autotune. If a stationary autotune is carried out, then the nameplate value should be entered in Pr **00.043**.

RFC-S

The phase angle between the rotor flux in a servo motor and the encoder position is required for the motor to operate correctly. If the phase angle is known it can be set in this parameter by the user. Alternatively the drive can automatically measure the phase angle by performing a phasing test (see autotune in RFC-S mode Pr **00.040**). When the test is complete the new value is written to this parameter. The encoder phase angle can be modified at any time and becomes effective immediately. This parameter has a factory default value of 0.0 °, but is not affected when defaults are loaded by the user.

00.044 {05.009}	**Rated Voltage**								
RW	Num				RA			US	

OL **RFC-A** **RFC-S**	⇳	0 to VM_AC_VOLTAGE_SET	⇨	200 V drive: 230 V 50Hz default 400 V drive: 400 V 60Hz default 400 V drive: 460 V

Enter the value from the rating plate of the motor.

00.045 {05.008}	**Rated Speed**									
RW		Num							US	
OL	⇳	0 to 33000 rpm						⇨	50 Hz default: 1500 rpm 60 Hz default: 1800 rpm	
RFC-A	⇳	0.00 to 33000.00 rpm						⇨	50 Hz default: 1450.00 rpm 60 Hz default: 1750.00 rpm	
RFC-S	⇳							⇨	3000.00 rpm	

Open-loop

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

Slip compensation is disabled if Pr **00.045** is set to 0 or to synchronous speed, or if Pr **05.027** is set to 0.

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

RFC-A

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

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

The nameplate value is normally the value for a hot machine, however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate.
The rated speed rpm can be optimized by the drive (For further information, refer to section 8.1.4 *RFC-A mode* on page 85).

RFC-S

Rated Speed (00.045) is used as follows:

1. Operation without position feedback, i.e. Sensorless Mode Active (03.078) = 1.
2. Where the motor operates above this speed and flux weakening is active.
3. In the motor thermal model.

The units for *Rated Speed* (00.045) are always rpm even if a linear motor is used and *Linear Speed Select* (01.055) = 1.

00.046 {05.007}	**Rated Current**								
RW	Num				RA			US	

OL **RFC-A** **RFC-S**	⇳	0.000 to VM_RATED_CURRENT	⇨	Maximum Heavy Duty Rating (00.032)

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

00.047 {05.006}	**Rated Frequency (OL, RFC-A)**								
00.047 {05.033}	**Volts per 1000 rpm (RFC-S)**								
RW		Num						US	
OL	⇳	0.0 to 550.0 Hz					⇨	50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz	
RFC-A	⇳	0.0 to 550.0 Hz							
RFC-S	⇳	0 to 10000 V / 1000 rpm					⇨	98 V / 1000 rpm	

Open-loop and RFC-A

Enter the value from the rating plate of the motor.

6.4.8 Operating-mode selection

00.048 {11.031}	**User Drive Mode**								
RW		Txt				ND	NC	PT	
OL	⇳	Open-loop (1), RFC-A (2), RFC-S (3)				⇨	Open-loop (1)		
RFC-A						⇨	RFC-A (2)		
RFC-S						⇨	RFC-S (3)		

The settings for Pr 00.048 are as follows:

Setting	Operating mode
1	Open-loop
2	RFC-A
3	RFC-S

This parameter defines the drive operating mode. Pr **mm.000** must be set to '1253' (European defaults) or '1254' (USA defaults) before this parameter can be changed. When the drive is reset to implement any change in this parameter, the default settings of all parameters will be set according to the drive operating mode selected and saved in memory.

6.4.9 Status information

00.049 {11.044}	**User Security Status**								
RW		Txt					ND	PT	
OL **RFC-A** **RFC-S**	⇳	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)				⇨	Menu 0 (0)		

This parameter controls access via the drive keypad as follows:

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

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

00.050 {11.029}	**Software Version**									
RO		Num				ND	NC	PT		
OL	⇳	0 to 99999999				⇨				
RFC-A										
RFC-S										

The parameter displays the software version of the drive.

00.051 {10.037}	**Action On Trip Detection**									
RW		Bin							US	
OL	⇳	0 to 31				⇨	0			
RFC-A										
RFC-S										

Each bit in this parameter has the following functions:

Bit	Function
0	Stop on non-important trips
1	Disable braking resistor overload detection
2	Disable phase loss stop
3	Disable braking resistor temperature monitoring
4	Disable parameter freeze on trip

Example

Pr **00.051** =8 (1000_{binary}) Th Brake Res trip is disabled

Pr **00.051** =12 (1100_{binary}) Th Brake Res and phase loss trip is disabled

Stop on non-important trips

If bit 0 is set to one the drive will attempt to stop before tripping if any of the following trip conditions are detected: I/O Overload, An Input 1 Loss, An Input 2 Loss or Keypad Mode.

Disable braking resistor overload detection

For details of braking resistor overload detection mode see Pr **10.030**.

Disable phase loss trip

Normally the drive will stop when the input phase loss condition is detected. If this bit is set to 1 the drive will continue to run and will only trip when the drive is brought to a stop by the user.

Disable braking resistor temperature monitoring

Size 3, 4 and 5 drives have an internal user install braking resistor with a thermistor to detect overheating of the resistor. As default bit 3 of Pr **00.051** is set to zero, and so if the braking resistor and its thermistor is not installed the drive will produce a trip (Th Brake Res) because the thermistor appears to be open-circuit. This trip can be disabled so that the drive can run by setting bit 3 of Pr **00.051** to one. If the resistor is installed then no trip is produced unless the thermistor fails, and so bit 3 of Pr **00.051** can be left at zero. This feature only applies to size 3, 4 and 5 drives. For example if Pr **00.051** = 8, then Th Brake Res trip will be disabled.

Disable parameter freeze on trip

If this bit is 0 then the parameters listed below are frozen on trip until the trip is cleared. If this bit is 1 then this feature is disabled.

Open-loop mode	RFC-A and RFC-S modes
Reference Selected (01.001)	*Reference Selected* (01.001)
Pre-skip Filter Reference (01.002)	*Pre-skip Filter Reference* (01.002)
Pre-ramp Reference (01.003)	*Pre-ramp Reference* (01.003)
Post Ramp Reference (02.001)	*Post Ramp Reference* (02.001)
Frequency Slaving Demand (03.001)	*Final Speed Reference* (03.001)
	Speed Feedback (00.010)
	Speed Error (03.003)
	Speed Controller Output (03.004)
Current Magnitude (00.012)	*Current Magnitude* (00.012)
Torque Producing Current (00.013)	*Torque Producing Current* (00.013)
Magnetising Current (04.017)	*Magnetising Current* (04.017)
Output Frequency (00.011)	*Output Frequency* (00.011)
Output Voltage (05.002)	*Output Voltage* (05.002)
Output Power (05.003)	*Output Power* (05.003)
D.c. Bus Voltage (05.005)	*D.c. Bus Voltage* (05.005)
Analog Input 1 (07.001)	*Analog Input 1* (07.001)

00.052 {11.020}	**Reset Serial Communications**									
RW		Bit					ND	NC		
OL	⇳	Off (0) or On (1)				⇨	Off (0)			
RFC-A										
RFC-S										

When *Serial Address* (00.037), *Serial Mode* (00.035), *Serial Baud Rate* (00.036), *Minimum Comms Transmit Delay* (11.026) or *Silent Period* (11.027) are modified the changes do not have an immediate effect on the serial communications system. The new values are used after the next power-up or if *Reset Serial Communications* (00.052) is set to one. *Reset Serial Communications* (00.052) is automatically cleared to zero after the communications system is updated.

00.053 {04.015}	**Motor Thermal Time Constant**									
RW		Num							US	
OL	⇳	1.0 to 3000.0 s				⇨	89.0 s			
RFC-A										
RFC-S										

Pr **00.053** is the motor thermal time constant of the motor, and is used (along with the motor rated current Pr **00.046**, and total motor current Pr **00.012**) in the thermal model of the motor in applying thermal protection to the motor.

For further details, refer to section 8.3 *Motor thermal protection* on page 92.

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 77.

WARNING

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

CAUTION

The values of the motor parameters affect the protection of the motor.
The default values in the drive should not be relied upon.
It is essential that the correct value is entered in Pr **00.046** *Rated Current*. This affects the thermal protection of the motor.

CAUTION

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

WARNING

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

7.1 Quick start connections

7.1.1 Basic requirements

This section shows the basic connections which must be made for the drive to run in the required mode. For minimal parameter settings to run in each mode please see the relevant part of section 7.3 *Quick start commissioning / start-up* on page 60.

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

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

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

Speed feedback
Suitable devices are:

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

Speed and position feedback
Suitable devices are:

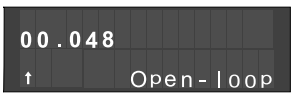
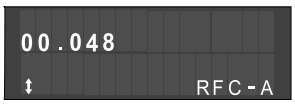
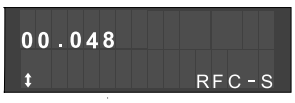
- Incremental encoder (A, B or F, D with or without Z) with commutation signals (U, V, W).
- Incremental encoder with forward and reverse outputs (F, R with or without Z) and commutation outputs (U, V, W).
- SINCOS encoder (with Stegmann Hiperface, EnDat, BiSS or SSI communications protocols)
- EnDat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

7.2 Changing the operating mode

Changing the operating mode returns all parameters to their default value, including the motor parameters. *User Security Status* (Pr **00.049**) and *User Security Code* (Pr **00.034**) are not affected by this procedure).

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

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

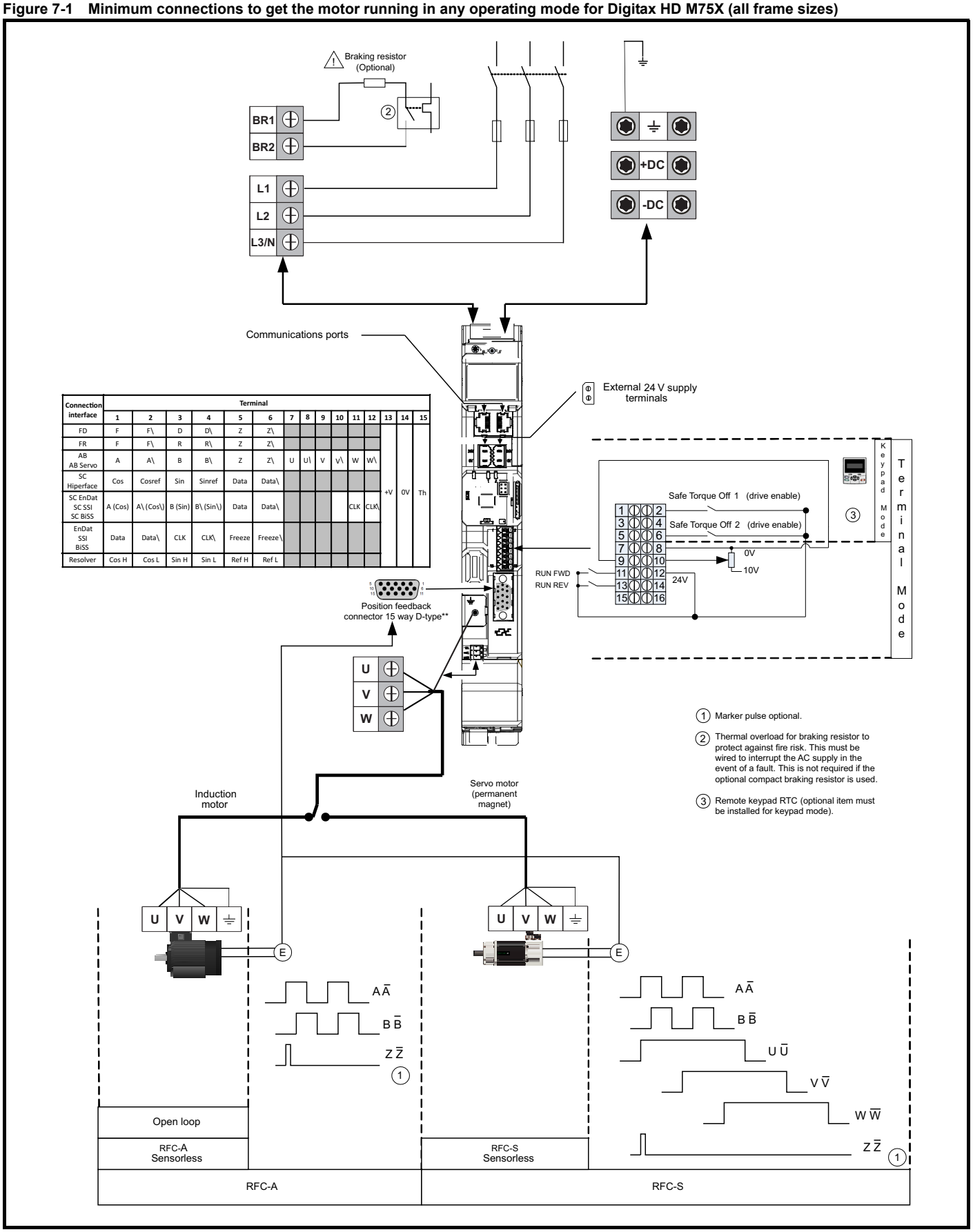
Pr 00.048 setting		Operating mode
	1	Open-loop
	2	RFC-A
	3	RFC-S

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

3. Either:

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

Figure 7-1 Minimum connections to get the motor running in any operating mode for Digitax HD M75X (all frame sizes)



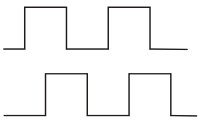
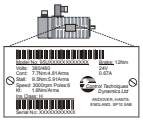
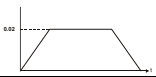
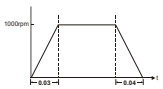
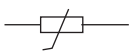
Connection interface	Terminal 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
FD	F	F\	D	D\	Z	Z\									
FR	F	F\	R	R\	Z	Z\									
AB AB Servo	A	A\	B	B\	Z	Z\	U	U\	V	V\	W	W\			
SC Hiperface	Cos	Cosref	Sin	Sinref	Data	Data\							+V	0V	Th
SC EnDat SC SSI SC BiSS	A (Cos)	A\ (Cos\)	B (Sin)	B\ (Sin\)	Data	Data\				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

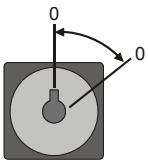
7.3 Quick start commissioning / start-up

7.3.1 RFC-S mode (with position feedback)

Permanent magnet motor with position feedback

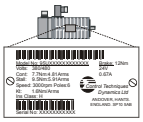
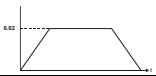
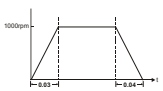
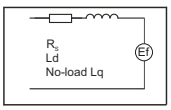
For simplicity only an incremental quadrature encoder with commutation outputs will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section 7.5 *Setting up a feedback device* on page 69.

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 2 & 6). • Run signal is not given. • Motor and feedback device are connected.	
Power-up the drive	Verify that RFC-S mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *KI-Remote Keypad changing the operating mode* on page 39. Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 12 *Diagnostics* on page 192.	
Set motor feedback parameters	**Incremental encoder basic set-up** Enter: • Drive encoder type in Pr. **03.038** = AB Servo (3): Quadrature encoder with commutation outputs. • Encoder power supply in Pr. **03.036** = 5 V (0), 8 V (1) or 15 V (2). **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled Pr **03.039** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. • Drive encoder Pulses Per Revolution in Pr **03.034** (set according to encoder) • Drive encoder termination resistor setting in Pr **03.039**: **0** = A-A\, B-B\, Z-Z\ termination resistors disabled **1** = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled **2** = A-A\, B-B\, Z-Z\ termination resistors enabled	
Enter motor nameplate details	Enter: • Motor rated current in Pr **00.046** (A) Ensure that this equal to or less than the Heavy Duty rating of the drive otherwise 'Motor Too Hot' trips may occur during the autotune. • Number of poles in Pr **00.042** • Motor rated voltage in Pr **00.044** (V)	
Set maximum speed	Enter: • Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000 rpm) • Deceleration rate in Pr **00.004** (s/1000 rpm) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118). Motor thermistor fault detection is enabled as default, it can be deselected in Pr **03.123**. Refer to Pr **03.123** for further information.	

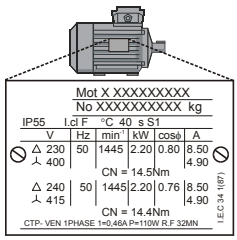
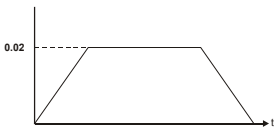
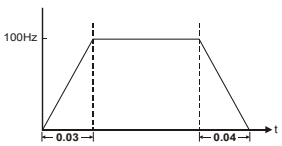
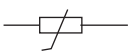
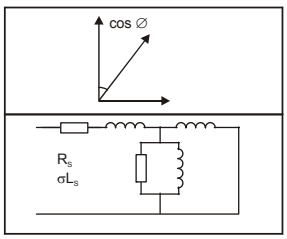
Action	Detail	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive.The drive is able to perform a stationary, rotating, mechanical load measurement or locked rotor test autotune. The motor must be at a standstill before an autotune is enabled. It is suggested that a rotating auto tune is used for accurate measurement for position feedback phase angle. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. A stationary autotune is performed to locate the flux axis of the motor. The stationary autotune measures the stator resistance, inductance in flux axis, maximum deadtime compensation, inductance in torque axis with no load on the motor and current at maximum deadtime compensation of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. If Sensorless mode is not selected then *Position Feedback Phase Angle* (00.043) is set-up for the selected position feedback. • A rotating autotune should only be used if the motor is uncoupled. The rotating autotune will rotate the motor by up to 2 mechanical revolutions in the direction selected, regardless of the reference provided to obtain the position feedback phase angle. A stationary autotune is then performed to obtain stator resistance, inductance in flux axis, maximum deadtime compensation, inductance in torque axis with no load on the motor and current at maximum deadtime compensation of the motor. From the above obtained parameters the current loop gains are calculated, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. **WARNING** The rotating autotune will rotate the motor by up to 2 mechanical revolutions in the direction selected, regardless of the reference provided. After a short delay, the motor is further rotated through a electrical revolution. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune, Pr **00.040** = 2 for a rotating autotune. • Close the run signal (terminal 11 or 13). • Close the drive enable signal (terminal 2 & 6). The upper row of the display will flash 'Auto Tune' while the drive is performing the test. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips it cannot be reset until the drive enable signal (terminal 2 & 6) has been removed. See section 12 *Diagnostics* on page 192. • Remove the drive enabled and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **MM.000** (alternatively enter a value of 1001 in Pr **MM.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.3.2 RFC-S mode (Sensorless control)

Permanent magnet motor without position feedback

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 2 & 6). • Run signal is not given. • Motor is connected.	
Power-up the drive	Verify that RFC-S mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *KI-Remote Keypad changing the operating mode* on page 39, otherwise restore parameter defaults (see section 5.8 *Restoring parameter defaults* on page 39). Ensure: • Drive displays 'inhibit' If the drive trips, see Chapter 12 *Diagnostics* on page 192.	
Select RFC-S (Sensorless control) mode and disable encoder wire-break trip	• Set Pr **03.024** = 1 or 3 to select RFC-S Sensorless mode • Set Pr **03.040** = 0000 to disable the wire break	
Enter motor nameplate details	Enter: • Motor rated current in Pr **00.046** (A) Ensure that this equal to or less than the Heavy Duty rating of the drive otherwise 'Motor Too Hot' trips may occur during the autotune. • Number of poles in Pr **00.042** • Motor rated voltage in Pr **00.044** (V)	
Set maximum speed	Enter: • Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000 rpm). It is recommended that the ramp rates are increased from the default value of 0.200 s/1000 rpm. • Deceleration rate in Pr **00.004** (s/1000 rpm) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Set stop mode	Enter: • Set Stop Mode to Ramp in Pr **06.001**	
Set hold zero speed	Enter: • Set Hold Zero Speed to Off (0) in Pr **06.008**.	
Autotune	The drive is able to perform a stationary autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance. • A stationary autotune is performed to locate the flux axis of the motor. The stationary autotune measures the stator resistance, inductance in flux axis, inductance in torque axis with no load on the motor and values relating to deadtime compensation from the drive. Measured values are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. To perform an autotune: • Set Pr **00.040** = 1 or 2 for a stationary autotune. (Both perform the same tests). • Close the run signal (terminal 11 or 13). • Close the drive enable signal (terminal 2 & 6). The upper row of the display will flash 'Auto Tune' while the drive is performing the test. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips it cannot be reset until the drive enable signal (terminal 2 & 6) has been removed. See Chapter 12 *Diagnostics* on page 192. • Remove the drive enabled and run signal from the drive.	
Check Saliency	In sensorless mode, when the motor speed is below Pr **00.045** / 10, a special low speed algorithm must be used to control the motor. There are two modes available, with the mode chosen based on the saliency of the motor. The ratio No-load Lq (Pr **00.056**) / Ld (Pr **05.024**) provides a measure of the saliency. If this value is > 1.1, then Injection (0) mode may be used. Current (2) mode may be used (but with limitations). If this value is < 1.1, then Current (2) mode must be used (this is the default of Pr **05.064**).	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

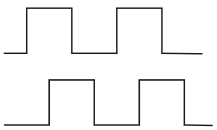
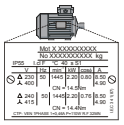
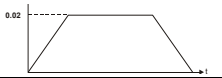
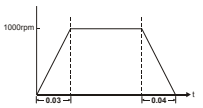
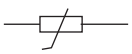
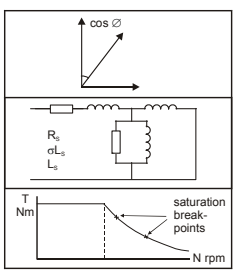
7.3.3 Open loop

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 2 & 6). • Run signal is not given. • Motor is connected.	
Power-up the drive	Verify that Open Loop mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *KI-Remote Keypad changing the operating mode* on page 39. Ensure: • Drive displays 'Inhibit' If the drive trips, see section 12 *Diagnostics* on page 192.	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.047** (Hz) • Motor rated current in Pr **00.046** (A) • Motor rated speed in Pr **00.045** (rpm) • Motor rated voltage in Pr **00.044** (V) - check if ⅄ or △ connection	
Set maximum frequency	Enter: • Maximum frequency in Pr **00.002** (Hz)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/100 Hz) • Deceleration rate in Pr **00.004** (s/100 Hz) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030** and Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118). The motor thermistor can be selected in Pr **03.123**. Refer to Pr **03.123** for further information.	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive. **WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. A stationary autotune measures the stator resistance and the transient inductance in the motor. These are required for good performance in vector control modes. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^2/_3$ base speed in the direction selected. The rotating autotune measures the power factor of the motor. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune or set Pr **00.040** = 2 for a rotating autotune • Close the Drive Enable signal (terminal 2 & 6). The drive will display 'Ready'. • Close the run signal (terminal 11 or 13). The upper row of the display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 12 *Diagnostics* on page 192. • Remove the drive enable and run signal from the drive.	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press the red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.3.4 RFC - A mode (with position feedback)

Induction motor with position feedback

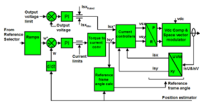
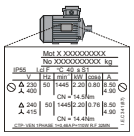
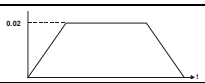
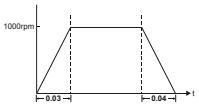
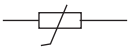
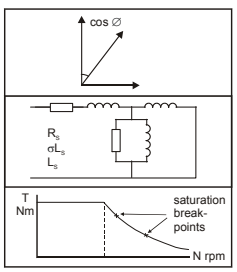
For simplicity only an incremental quadrature encoder will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section 7.5 *Setting up a feedback device* on page 69.

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 2 & 6). • Run signal is not given • Motor and feedback device are connected	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *KI-Remote Keypad changing the operating mode* on page 39. Ensure: • Drive displays 'Inhibit' If the drive trips, see Chapter 12 *Diagnostics* on page 192.	
Set motor feedback parameters	**Incremental encoder basic set-up** Enter: • Drive encoder type in Pr **03.038** = AB (0): Quadrature encoder • Encoder power supply in Pr. **03.036** = 5 V (0), 8 V (1) or 15 V (2). **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled Pr **03.039** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. • Drive encoder Lines Per Revolution (LPR) in Pr **03.034** (set according to encoder) • Drive encoder termination resistor setting in Pr **03.039**: **0** = A-A\, B-B\, Z-Z\ termination resistors disabled **1** = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled **2** = A-A\, B-B\, Z-Z\ termination resistors enabled	
Enter motor nameplate details	• Motor rated frequency in Pr **00.047** (Hz) • Motor rated current in Pr **00.046** (A) • Motor rated speed in Pr **00.045** (rpm) • Motor rated voltage in Pr **00.044** (V) - check if ⅄ or △ connection	
Set maximum speed	Enter: Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000 rpm) • Deceleration rate in Pr **00.004** (s/1000 rpm) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118). The motor thermistor can be selected in Pr **03.123**. Refer to Pr **03.123** for further information.	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. **WARNING** A rotating autotune will cause the motor to accelerate up to $^{2}/_{3}$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. The stationary autotune measures the stator resistance and transient inductance of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at $^{2}/_{3}$ base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune or set Pr **00.040** = 2 for a rotating autotune • Close the drive enable signal (terminal 2 & 6). The drive will display 'Ready'. • Close the run signal (terminal 11 or 13). The upper row of the display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill If the drive trips, see Chapter 12 *Diagnostics* on page 192. • Remove the drive enable and run signal from the drive.	

Action	Detail	
Save parameters	Select 'Save Parameters' in Pr **mm.000** (alternatively enter a value of 1001 in Pr **mm.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.3.5 RFC-A mode (Sensorless control)

Induction motor with sensorless control

Action	Detail	
Before power-up	Ensure: • The drive enable signal is not given (terminal 2 & 6). • Run signal is not given • Motor is connected	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 *KI-Remote Keypad changing the operating mode* on page 39. Ensure: • Drive displays 'Inhibit' If the drive trips, see Chapter 12 *Diagnostics* on page 192.	
Select RFC-A (Sensorless control) mode and disable encoder wire-break trip	• Set Pr **03.024** = 1 or 3 to select RFC-A Sensorless mode • Set Pr **03.040** = 0000 to disable the wire break	
Enter motor nameplate details	Enter: • Motor rated frequency in Pr **00.047** (Hz) • Motor rated current in Pr **00.046** (A) • Motor rated speed in Pr **00.045** (rpm) • Motor rated voltage in Pr **00.044** (V) - check if ⅄ or △ connection	
Set maximum speed	Enter: • Maximum speed in Pr **00.002** (rpm)	
Set acceleration / deceleration rates	Enter: • Acceleration rate in Pr **00.003** (s/1000rpm) • Deceleration rate in Pr **00.004** (s/1000rpm) (If braking resistor installed, set Pr **00.015** = Fast. Also ensure Pr **10.030**, Pr **10.031** and Pr **10.061** are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in *P1 Thermistor Type* (03.118). The motor thermistor can be selected in Pr **03.123**. Refer to Pr **03.123** for further information.	
Select or deselect catch a spinning motor mode	If catch a spinning motor mode is not required then set Pr **06.009** to 0. If catch a spinning motor mode is required then leave Pr **06.009** at the default of 1, but depending on the size of the motor the value in Pr **05.040** may need to be adjusted. Pr **05.040** defines a scaling function used by the algorithm that detects the speed of the motor. The default value of Pr **05.040** is 1 which is suitable for small motors (<4 kW). For larger motors the value in Pr **05.040** will need to be increased. Approximate values of Pr **05.040** for different motor sizes are as follows, 2 for 11 kW, 3 for 55 kW and 5 for 150 kW. If the value of Pr **05.040** is too large the motor may accelerate from standstill when the drive is enabled. If the value of this parameter is too small the drive will detect the motor speed as zero even if the motor is spinning.	
Autotune	The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. **NOTE** It is highly recommended that a rotating autotune is performed (Pr **00.040** set to 2). **WARNING** A rotating autotune will cause the motor to accelerate up to $^2/_3$ base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable. • A stationary autotune can be used when the motor is loaded and it is not possible to uncouple the load from the motor shaft. The stationary autotune measures the stator resistance and transient inductance of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. • A rotating autotune should only be used if the motor is uncoupled. A rotating autotune first performs a stationary autotune before rotating the motor at 2/3 base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor. To perform an autotune: • Set Pr **00.040** = 1 for a stationary autotune or set Pr **00.040** = 2 for a rotating autotune • Close the drive enable signal (terminal 2 & 6). The drive will display 'Ready' or 'Inhibit'. • Close the run signal (terminal 11or 13). The upper row of the display will flash 'Auto Tune' while the drive is performing the autotune. • Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill. If the drive trips, see Chapter 12 *Diagnostics* on page 192. • Remove the drive enable and run signal from the drive.	

Action	Detail	
Save parameters	Select 'Save Parameters' in Pr **MM.000** (alternatively enter a value of 1001 in Pr **MM.000**) and press red reset button or toggle the reset digital input.	
Run	Drive is now ready to run	

7.4 Quick start commissioning / start-up using Connect

Connect is a Windows™ based software commissioning / start-up tool for Digitax HD.

Connect can be downloaded from **http://www.drive-setup.com/ctdownloads**

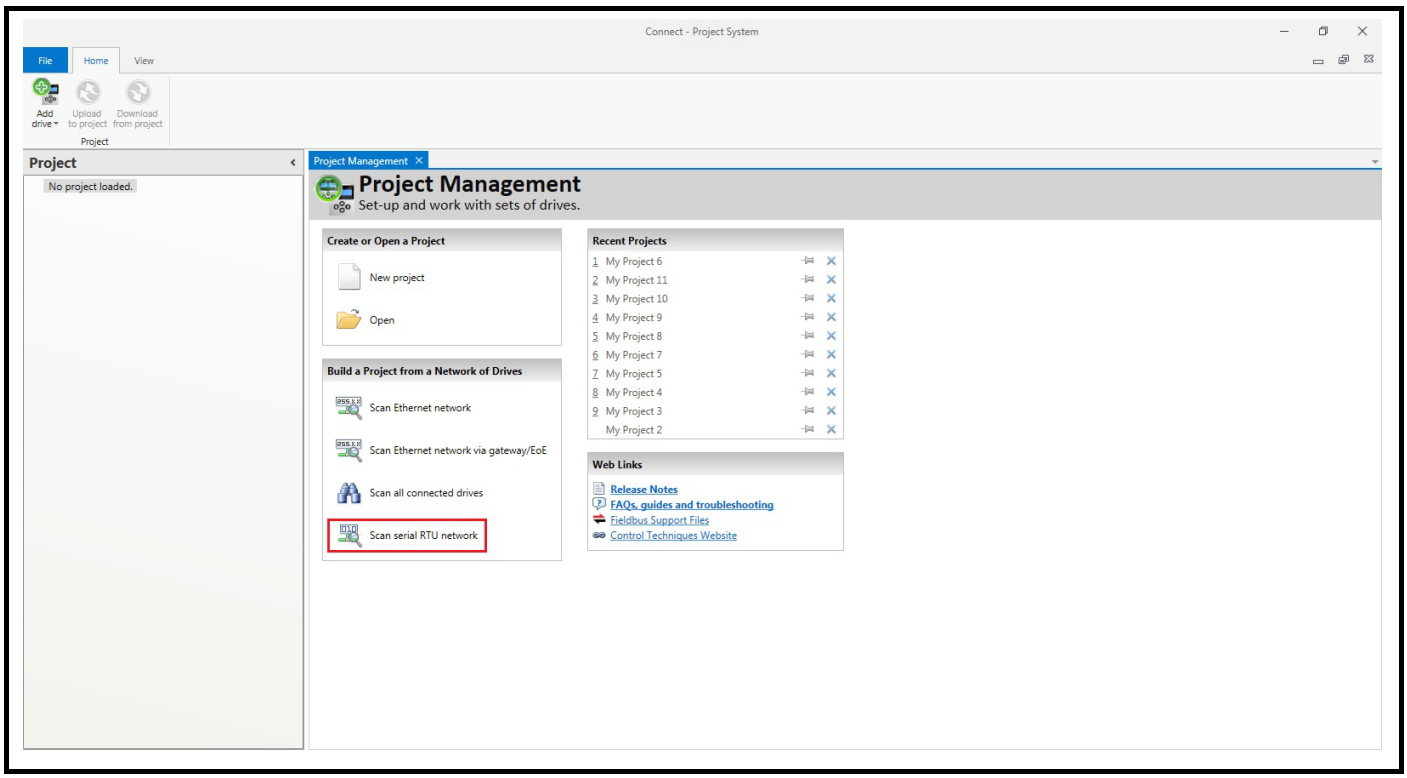
Connect system requirements

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

Any previous copy of Connect should be uninstalled before proceeding with the installation (existing projects will not be lost).

7.4.1 Power-up the drive

1. Start Connect, and on the 'Project Management' screen select 'Scan serial RTU network' (M751 only when connected to the drive communication port or all variants when connecting via the KI-Compact 485 adaptor), 'Scan Ethernet network' (M750 only or M753 when using Ethernet over EtherCAT protocol) or 'Scan all connected drives'. This example uses the 'Scan serial RTU network' option.



Select the discovered drive.

1. Select the 'Online' icon to connect with the drive. When a successful connection is made the icon will be highlighted blue.
2. Select 'Set mode and region'.

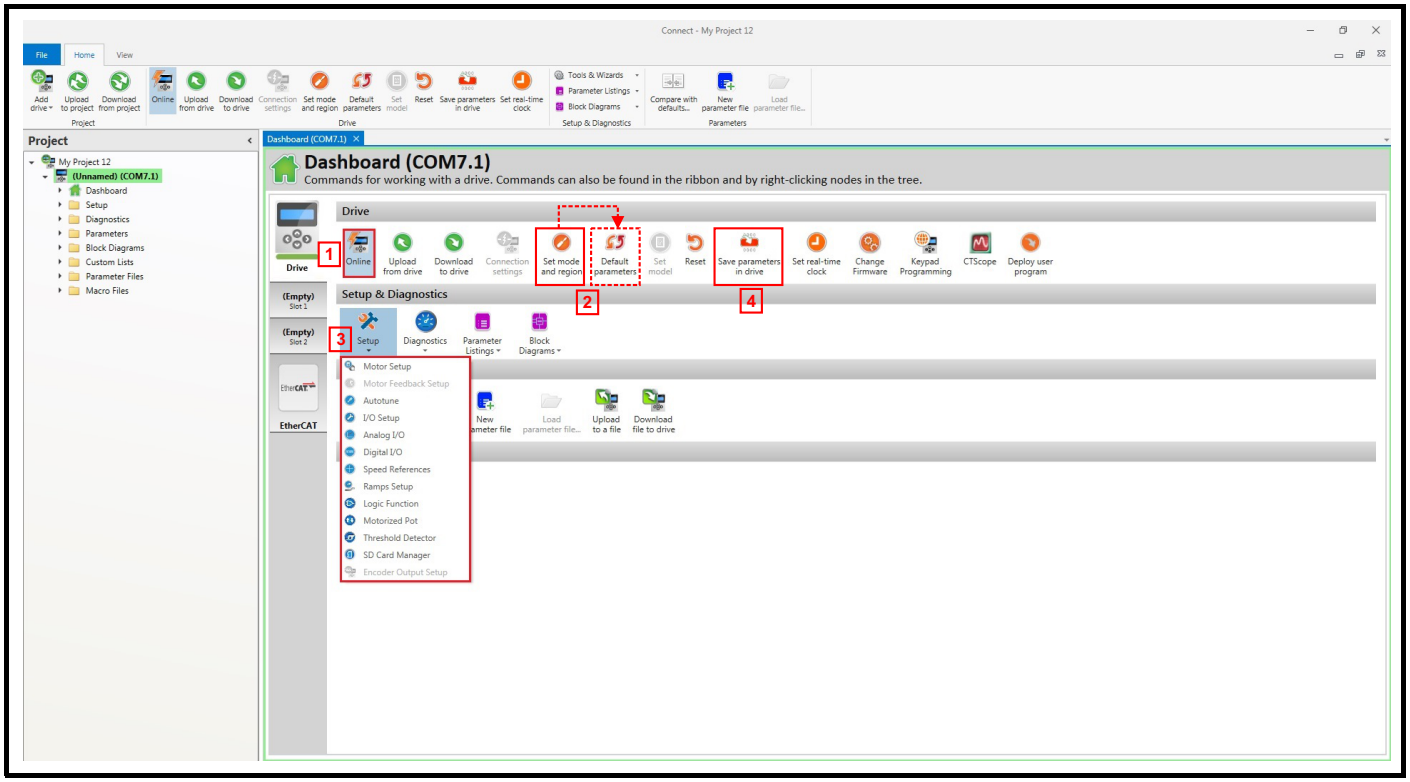
   If the required control mode is highlighted in the 'Drive Settings' dialog, then:

   - Change the supply frequency if required and select 'Apply', otherwise select 'Cancel'.

   If the required control mode is not highlighted in the 'Drive Settings' dialog then:

   - Select the required mode and supply frequency.
   - Select 'Apply'.

   Select 'Default parameters' from the Dashboard and in the 'Default Parameters' dialog, select 'Apply'.



3. Select 'Setup' and perform the steps highlighted:

Action	Detail
Motor set-up	Connect contains a database for induction motors and permanent magnet motors. Provision is also made to enter motor nameplate data.
Motor feedback set-up	This only needs to be performed in RFC-S and RFC-A (with feedback) modes. Enter the encoder type and encoder configuration data as prompted on screen. **NOTE** If output voltage from the encoder is > 5 V, then the termination resistors must be disabled Pr **03.039** to 0. **CAUTION** Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.
Speed references	Enter preset speeds or a jog reference if required.
Ramps set-up	Enter the required Acceleration rate and Deceleration rate. Note: If a braking resistor is installed, set 'Ramp mode' to '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.
I/O set-up	Map I/O terminals to parameters (where non default configuration is required).
Analog I/O	Configure Analog input 1 and thermal monitoring parameters (where non default configuration is required).
Digital I/O	Allocate non default digital control functions to digital terminals where necessary.
Autotune	Follow the Autotune set up wizard to automatically tune the drive to the motor. **NOTE** Not required when using data from the motor database for a Leroy Somer LSRPM motor used in RFC-S Sensorless mode.

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

7.5 Setting up a feedback device

7.5.1 P1 position interface

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

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

Parameter	AB, FD, FR, AB Servo, SC, SC Servo, SC SC FD Servo, FR Servo	SC Hiperface	SC EnDat	SC BiSS	SC SSI	SSI	EnDat	BiSS	Resolver
P1 Marker Mode (03.031)	✓								
P1 Rotary Turns Bits (03.033)		●	●	●	✓	✓	●	●	
P1 Rotary Lines Per Revolution (03.034)	✓	●	●	●	✓				
P1 Comms Bits (03.035)		●	●	●	✓	✓	●	●	
P1 Supply Voltage (03.036)*	✓	✓	✓	✓	✓	✓	✓	✓	
P1 Comms Baud Rate (03.037)			✓	✓	✓	✓	✓	✓	
P1 Device Type (03.038)	✓	✓	✓	✓	✓	✓	✓	✓	✓
P1 Auto–configuration Select (03.041)		✓	✓	✓			✓	✓	
P1 SSI Binary Mode (03.048)					✓	✓			
P1 Calculation time (03.060)							✓	✓	
P1 Resolver Poles (03.065)									✓
P1 Resolver Excitation (03.066)									✓
P1 Additional Configuration (03.074)				●				●	

✓ Information required to be entered by the user.

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

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

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

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

Standard quadrature encoder with or without commutation signals (A, B, Z or A, B, Z, U, V, W), or Sincos encoder with or without UVW commutation signals Sincos encoder with absolute position from single sin and cosine signals

Device Type (03.038)	**AB** (0) for a quadrature encoder without commutation signals * **AB Servo** (3) for a quadrature encoder with commutation signals **SC** (6) for a Sincos encoder without commutation signals * **SC Servo** (12) for a Sincos encoder with commutation signals **SC SC** (15) for a Sincos encoder with absolute position from single sin and cosine signals
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If output voltage from the encoder is >5 V, then the termination resistors must be disabled. Set Pr **03.039** to 0.
Rotary Line Per Revolution (03.034)	Set to the number of lines or sine waves per revolution of the encoder.
Termination Select (03.039) (AB or AB Servo only)	**0** = A, B, Z termination resistors disabled **1** = A, B termination resistors enabled and Z termination resistors disabled **2** = A, B, Z termination resistors enabled
Marker Mode (03.031)	See table below
Error Detection Level (03.040)	See table below

Bit 3	Bit 2	Bit 1	Bit 0	Description
x	x	x	1	No action is taken unless marker flag is zero before marker event occurs
x	x	1	x	Pr **03.028** and Pr **03.058** are set to zero
x	1	x	x	Pr **03.028**, Pr **03.029**, Pr **03.030** and the related part of Pr **03.058** are not reset. Pr **03.058** is transferred to Pr **03.059** and Pr **03.032** is set to 1.
1	x	x	x	Undefined state region range is reduced from -30 mV to 30 mV. The marker pulse is only recognized if the pulse is 10 μs wide.

Bit 3	Bit 2	Bit 1	Bit 0	Description
x	x	x	1	Enable wire break detection
1	x	x	x	Disable trips *Encoder 1* to *Encoder 6*

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

Incremental encoder with Frequency and Direction (F and D) or Forward and Reverse (CW and CCW) signals with or without commutation signals.

Device Type (03.038)	**FD** (1) for frequency and direction signals without commutation signals* **FR** (3) for forward and reverse signals without commutation signals* **FD** Servo (4) for frequency and direction signals with commutation signals **FR** Servo (5) for forward and reverse signals with commutation signals
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2) **NOTE** If output voltage from the encoder is > 5 V, then the termination resistors must be disabled. Set Pr **03.039** to 0.
Rotary Line Per Revolution (03.034)	Set to the number of pulses per revolution of the encoder divided by 2.
Termination Select (03.039)	0 = F or CW, D or CCW, Z termination resistors disabled 1 = F or CW, D or CCW termination resistors enabled and Z termination resistors disabled 2 = For CW, D or CCW, Z termination resistors enabled
Marker Mode (03.031)	**Bit** 3 2 1 0 / **Description** x x x 1 — No action is taken unless marker flag is zero before marker event occurs x x 1 x — Pr **03.028** and Pr **03.058** are set to zero x 1 x x — Pr **03.028**, Pr **03.029**, Pr **03.030** and the related part of Pr **03.058** are not reset. Pr **03.058** is transferred to Pr **03.059** and Pr **03.032** is set to 1. 1 x x x — Undefined state region range is reduced from -30 mV to 30 mV. The marker pulse is only recognized if the pulse is 10 μs wide.
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection 1 x x x — Disable trips *Encoder 1* to *Encoder 7*

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

Absolute Sincos encoder with Hiperface, EnDat or BiSS serial communication, or Absolute EnDat or BiSS communication only encoder

Device Type (03.038)	**SC Hiperface** (7) for a Sincos encoder with Hiperface serial communications **EnDat** (8) for an EnDat communications only encoder **SC EnDat** (9) for a Sincos encoder with EnDat serial communications **BiSS** (13) for an BiSS communications only encoder **SC BiSS** (17) for a Sincos encoder with BiSS serial communications
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2)
Auto-configuration Select (03.041)	Auto-configuration is enabled at default and automatically sets up the following parameters. *Rotary Turns Bits* (03.033) *Rotary Lines Per Revolutions* (03.034) *Comms Bits* (03.035) These parameters can be entered manually when Pr 03.041 is set to Disabled (0).
Comms Baud Rate (03.037)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.040)	**Bit** 3 2 1 0 / **Description** x x x 1 — Enable wire break detection x x 1 x — Enable phase error detection 1 x x x — Disable trips *Encoder 1* to *Encoder 6* So for example, to enable the wire break and phase error detection, set Pr **03.040** to 0011.

Absolute SSI communications only encoder, or Absolute Sincos encoder with SSI communications	
Device Type (03.038)	**SSI** (10) for a SSI communications only encoder. **SC SSI** (11) for a Sincos encoder with SSI serial communications.
Supply Voltage (03.036)	**5 V** (0), **8 V** (1) or **15 V** (2)
Rotary Line Per Revolution (03.034)	Set the number of sine waves per revolution of the encoder.
SSI Binary Mode (03.048)	Off = Gray Code On = Binary Mode
Rotary Turns Bits (03.033)	Set to the number of turns bits for the encoder (this is normally 12 bits for a SSI encoder)
Comms Bits (03.035)	Total number of bits of position information (this is usually 25 bits for a SSI encoder)
Comms Baud Rate (03.037)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.040)	**Bit 3 2 1 0** / **Description** x x x 1 — Enable wire break detection x x 1 x — Enable phase error detection x 1 x x — Enable SSI power supply alarm bit monitor 1 x x x — Disable trips *Encoder 1* to *Encoder 6* So for example, to enable the wire break and phase error detection, set Pr **03.040** to 0011.

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

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

Due to the low resolution of UVW communication only encoders, it is recommended that the *P1 Feedback Filter* (03.042) is set to its maximum value. A value of 1 ms to 2 ms may also be required in the *Current Reference Filter* (00.017) and it is also recommended that the speed loop gains are set to a low value to obtain stable operation.

Resolver	
Device Type (03.038)	Resolver (14)
Resolver Poles (03.065)	Set number of Resolver poles 2 poles (1) to 20 poles (10)
Resolver Excitation (03.066)	Set Resolver excitation voltage and frequency 6 kHz 3V (0), 8 kHz 3V (1), 6 kHz 2V (2), 8 kHz 2V (3)
Error Detection Level (03.040)	**Bit 3 2 1 0** / **Description** x x x 1 — Enable wire break detection 1 x x x — Disable trips *Encoder 1* to *Encoder 6* So for example, to enable the wire break error detection, set Pr **03.040** to 0001.

7.5.3 P2 position interface

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

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

Parameter	AB, FD, FR	EnDat	SSI	BiSS
P2 Marker Mode (03.131)	✓			
P2 Rotary Turns Bits (03.133)		•	•	•
P2 Rotary Lines Per Revolution (03.134)	✓	•	•	•
P2 Comms Bits (03.135)		•	•	•
P2 Comms Baud Rate (03.137)		✓	✓	✓
P2 Device Type (03.138)	✓	✓	✓	✓
P2 Auto–configuration Select (03.141)		✓		✓

✓ Information required to be entered by the user.

• Parameter can be set-up automatically by the drive through auto-configuration. Parameter must be set by the user if auto-configuration is disabled (i.e. Pr **03.141** = Disabled (0)).

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

NOTE

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

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

Standard quadrature encoder (A, B, Z)

Device Type (03.138)	**AB** (1) for a quadrature encoder
Rotary Line Per Revolution (03.134)	Set to the number of lines per revolution of the encoder
Marker Mode (03.131)	See table below

Bit 3	Bit 2	Bit 1	Bit 0	Description
x	x	x	1	No action is taken unless marker flag is zero before marker event occurs
x	x	1	x	Pr **03.128** and Pr **03.158** are set to zero
x	1	x	x	Pr **03.128**, Pr **03.129**, Pr **03.130** and the related part of Pr **03.158** are not reset. Pr **03.158** is transferred to Pr **03.159** and Pr **03.132** is set to 1.
1	x	x	x	This Bit in has no effect.

Incremental encoder with Frequency and Direction (F and D), or Forward and Reverse (CW and CCW) signals

Device Type (03.138)	**FD** (2) for frequency and direction signals without commutation signals **FR** (3) for forward and reverse signals without commutation signals
Rotary Line Per Revolution (03.134)	Set to the number of pulses per revolution of the encoder divided by 2.
Marker Mode (03.131)	See table below

Bit 3	Bit 2	Bit 1	Bit 0	Description
x	x	x	1	No action is taken unless marker flag is zero before marker event occurs.
x	x	1	x	Pr **03.128** and Pr **03.158** are set to zero.
x	1	x	x	Pr **03.128**, Pr **03.129**, Pr **03.130** and the related part of Pr **03.158** are not reset. Pr **03.158** is transferred to Pr **03.159** and Pr **03.132** is set to 1.
1	x	x	x	This Bit in has no effect.

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

Absolute SSI communications only encoder	
Device Type (03.138)	**SSI** (5) for a SSI communications only encoder
SSI Binary Mode (03.148)	**Off** (0) = Gray Code **On** (1) = Binary Mode
Rotary Turns Bits (03.133)	Set to the number of turns bits for the encoder (this is usually 12 bits for a multi-turn SSI encoder)
Comms Bits (03.135)	Total number of bits of position information for the encoder (this is usually 25 bits for a multi-turn SSI encoder)
Comms Baud Rate (03.137)	100 k, 200 k, 300 k, 400 k, 500 k, 1 M, 1.5 M, 2 M, 4 M
Error Detection Level (03.140)	**Bit** 3 2 1 0 / **Description** x 1 x x — *Enable SSI power supply alarm bit monitor* 1 x x x — Disable trips *Encoder 4* to *Encoder 6*

7.6 Encoder Simulation Output Set-up

The drive supports four modes of encoder simulation output.

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

The availability of the encoder simulation output on the 15-way D-type on the drive is dependent on the type of feedback device connected to the P1 position interface. See Table 4-8 on page 25 for more information on the availability of the encoder simulation output. The status of the encoder simulation output can be seen in *Encoder Simulation Status* (03.086) as follows:

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

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

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

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

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

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

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

Lines per revolution

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

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

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

Ratio

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

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

Software mode - Absolute SSI data

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

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

8 Optimization

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

8.1 Motor map parameters

8.1.1 RFC-S mode

Permanent magnet motor with Position feedback

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

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

- Current limits (see section 8.2 *Current limits* on page 92, for more information)
- Motor thermal overload protection (see section 8.3 *Motor thermal protection* on page 92, for more information)

Pr 00.042 {05.011} *Number Of Motor Poles*	**Defines the number of motor poles**

The number of motor poles parameter defines the number of electrical revolutions in one whole mechanical revolution of the motor. This parameter must be set correctly for the control algorithms to operate correctly. When Pr **00.042** is set to "Automatic" the number of poles is 6.

Pr 00.040 {05.012} *Autotune*

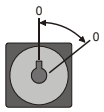
There are four autotune tests available in RFC-S mode, a stationary autotune, a rotating autotune, mechanical load measurement tests to measure load dependent parameters.

- *Stationary Autotune*

The stationary autotune can be used when the motor is loaded and it is not possible uncouple the load from motor shaft. This test can be used to measure all the necessary parameters for basic control. During the stationary autotune, a test is performed to locate the flux axis of the motor. However this test may not be able to calculate such an accurate value for the *Position Feedback Phase Angle* (00.043) as compared to rotating autotune. A stationary test is performed to measure *Stator Resistance* (05.017), *Ld* (05.024), *Maximum Deadtime Compensation* (05.059), *Current At Maximum Deadtime Compensation* (05.060), *No Load Lq* (05.072). If *Enable Stator Compensation* (05.049) = 1 then *Stator Base Temperature* (05.048) is made equal to *Stator Temperature* (05.046). The *Stator Resistance* (05.017) and the *Ld* (05.024) are then used to set up *Current controller Kp Gain* (00.038) and *Current Controller Ki Gain* (00.039). If sensorless mode is not selected then *Position Feedback Phase Angle* (00.043) is set up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).

- *Rotating Autotune*

The rotating autotune must be performed on unloaded motor. This test can be used to measure all the necessary parameters for the basic control and parameters for cancelling the effects of the cogging torque.
During the rotating autotune, *Rated Current* (00.046) is applied and the motor is rotated by 2 electrical revolutions (i.e. up to 2 mechanical revolutions) in the required direction. If sensorless mode is not selected then the *Position Feedback Phase Angle* (00.043) is set-up for the position from the position feedback interface selected with *Motor Control Feedback Select* (03.026). A stationary test is then performed to measure *Stator Resistance* (05.017), *Ld* (05.024), *Maximum Deadtime Compensation* (05.059), *Current At Maximum Deadtime Compensation* (05.060) and *No Load Lq* (05.072). *Stator Resistance* (05.017) and *Ld* (05.024) are used to set up *Current Controller Kp Gain* (00.038) and *Current Controller Ki Gain* (00.039). This is only done once during the test, and so the user can make further adjustments to the current controller gains if required. To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 or 13).



- *Mechanical load measurement test using signal injection*

The mechanical load measurement test using signal injection, measures the mechanical characteristic of the motor and load by rotating the motor at the speed defined by the present speed reference and injecting a series of speed test signals. This test should only be used provided all the basic control parameters (including *Torque Per Amp* (05.032)) have been set-up correctly and the speed controller parameters should be set to conservative levels, such as the default values, so that the motor is stable when it runs. The test measures the motor and load inertia, which can be used in automatic set-up of the speed controller gains and in producing a torque feed-forward term. If *Mechanical Load Test Level* (05.021) is left at its default value of zero then the peak level of the injection signal will be 1 % of the maximum speed reference subject to a maximum of 500 rpm. If a different test level is required then *Mechanical Load Test Level* (05.021) should be set to a non-zero value to define the level as a percentage of the maximum speed reference, again subject to a maximum of 500 rpm. The user defined speed reference which defines the speed of the motor should be set to a level higher than the test level, but not high enough for flux weakening to become active. In some cases, however it is possible to perform the test at zero speed provided the motor is free to move, but it may be necessary to increase the test signal from the default value. The test will give the correct results when there is a static load applied to the motor and in the presence of mechanical damping. This test should be used if possible, however for sensorless mode, or if the speed controller cannot be set up for stable operation an alternative test is provided (*Autotune* (00.040) = 4) where a series of torque levels are applied to accelerate and decelerate the motor to measure the inertia.

1. A rotating test is performed in which the motor is accelerated with the currently selected ramps up to the currently selected speed reference, and this speed is maintained for the duration of the test. *Motor And Load Inertia* (03.018) and *Inertia Times 1000* (04.033) are set up.

To perform this autotune test, set Pr **00.040** to 3 and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).

- *Mechanical load measurement using applied torque*

Auto-tune test 3 should normally be used for mechanical load measurement, but under some circumstances this test may be used as an alternative. This test is likely to give incorrect results if standard ramp mode is active. A series of progressively larger torque levels are applied to the motor (20 %, 40 % ... 100 % of rated torque) to accelerate the motor up to 3/4 x *Rated Speed* (00.045) 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, a 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 reached 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 is accelerated in the required direction up to 3/4 of the maximum speed reference and then decelerated to zero speed.
2. The test is repeated with progressively higher torques until the required speed is reached.
3. *Motor And Load Inertia* (03.018) and *Inertia Times 1000* (04.033) are set up. To perform this autotune test, set Pr 00.040 to 4 and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).

Pr 00.038 {04.013} / Pr 00.039 {04.014} *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The proportional gain (Pr 00.038) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr 00.040, earlier in this table) the drive measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor and calculates the current loop gains.

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

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

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009**) are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

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

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

Speed Controller Integral Gain (Ki), Pr **00.008** {**03.011**} and Pr **03.014**

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

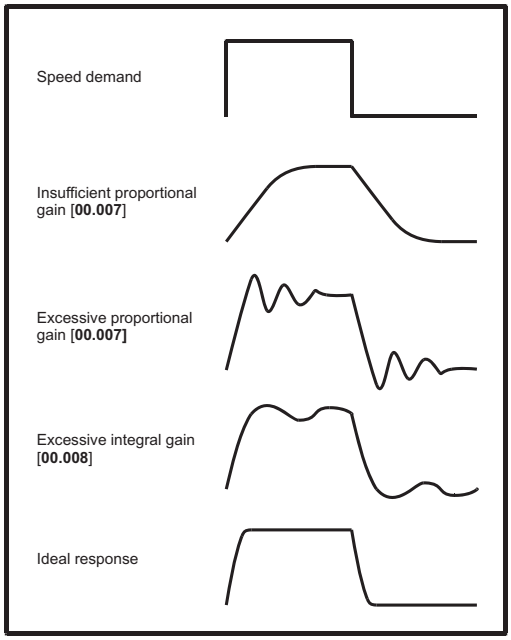
Differential Gain (Kd), Pr **00.009** {**03.012**} and Pr **03.015**

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

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

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

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



5. Pr **03.017** = 4 - 6
   If *Speed Controller Set-up Method* (03.017) is set to a value from 4 to 6 the *Speed Controller Proportional Gain Kp1* (03.010) and *Speed Controller Integral Gain Ki1* (03.011) are automatically set up to give the bandwidths given in the table below and a damping factor of unity. These settings give low, standard or high performance.

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

6. Pr **03.017** = 7
   If *Speed Controller Set-up Method* (03.017) = 7 then *Speed Controller Proportional Gain Kp1* (03.010), *Speed Controller Integral Gain Ki1* (03.011) and *Speed Controller Differential Feedback Gain Kd1* (03.012) are set up to give a closed-loop speed controller response that approximates to a first order system with a transfer function of $1 / (s\tau + 1)$, where $\tau = 1/\omega bw$ and $\omega bw = 2\pi$ x *Bandwidth* (03.020). In this case the damping factor is meaningless, and *Damping Factor* (03.021) and *Compliance Angle* (03.019) have no effect.

8.1.2 RFC-S Sensorless mode

Permanent magnet motor without Position feedback

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

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

- Current limits (see section 8.2 *Current limits* on page 92, for more information)
- Motor thermal overload protection (see section 8.3 *Motor thermal protection* on page 92, for more information)

Pr 00.042 {05.011} *Number Of Motor Poles*	**Defines the number of motor poles**

The number of motor poles parameter defines the number of electrical revolutions in one whole mechanical revolution of the motor. This parameter must be set correctly for the control algorithms to operate correctly. When Pr **00.042** is set to "Automatic" the number of poles is 6.

Pr 00.040 {05.012} *Autotune*

There are three autotune tests available in RFC-S sensorless mode, a stationary autotune and an inertia measurement test.

- Stationary Autotune (Pr **00.040** {**05.012**} = 1)

The stationary autotune can be used to measure all the necessary parameters for basic control. The tests measures *Stator Resistance* (05.017), *Ld* (05.024), *No Load Lq* Pr **00.056** {**05.072**}, *Maximum Deadtime Compensation* (05.059) and *Current At Maximum Deadtime Compensation* (05.060). If *Enable Stator Compensation* (05.049) = 1 then *Stator Base Temperature* (05.048) is made equal to *Stator Temperature* (05.046). *The Stator Resistance* (05.017) and *Ld* (05.024) are then used to set up *Current controller Kp Gain* Pr **00.038** {**04.013**} and *Current Controller Ki Gain* Pr **00.039** {**04.014**}. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 or 13).

- Rotating Autotune (Pr **00.040** {**05.012**} = 2)

In sensorless mode, if Rotating autotune is selected (Pr **00.040** = 2), then a stationary autotune is performed.

- Inertia measurement test (Pr **00.040** {**05.012**} = 4)

NOTE: It is not possible to perform this test if, after autotune, the ratio *No load Lq* Pr **00.056** {**05.072**} / *Ld* (05.024) < 1.1 and Pr **00.054 {05.064}** has been set to Non-salient.

The inertia measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains (see Speed loop gains) and to provide torque feed-forwards when required during acceleration. The test may give inaccurate results, if the motor rated speed is not set to the correct value for the motor, or if standard ramp mode is active. During the inertia measurement test a series of progressively larger torque levels are applied to the motor (20 %, 40 % ... 100 % of rated torque) to accelerate the motor up to 3/4 x *Rated Speed* Pr **00.045** {**05.008**} to determine the inertia from the acceleration/ deceleration time. The test attempts to reach the required speed within 5 s, 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 unsucessful an Autotune 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 quickly enough. If this is the case, the maximum speed reference should be reduced. To perform an Inertia measurement autotune, set Pr **00.040** to 4, and provide the drive with both an enable signal (on terminal 2 & 6) and a run signal (on terminal 11 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 terminal 2 & 6, setting the drive Enable Parameter (**06.015**) to Off (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

Pr 00.038 {04.013} / Pr 00.039 {04.014} *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The proportional gain Pr **00.038** {**04.013**} is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr **00.040**, earlier in this table) the drive measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor and calculates the current loop gains.

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

Speed Loop Gains (Pr 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {03.012})

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009)** are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

NOTE: In sensorless mode, the speed controller bandwidth may need to be limited to 10 Hz or less for stable operation.

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

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

Speed Controller Integral Gain (Ki), Pr **00.008** {**03.011**} and Pr **03.014**

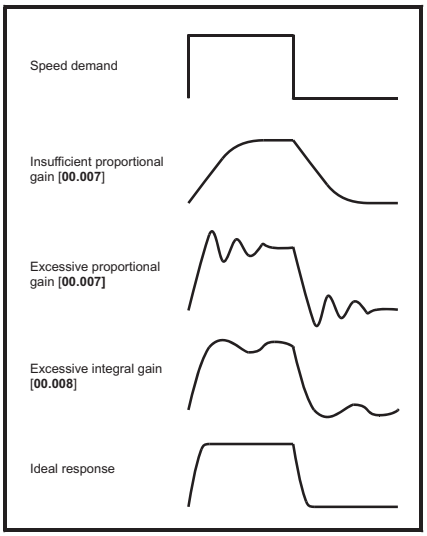
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of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

Differential Gain (Kd), Pr **00.009** {**0 3.012**} and Pr **03.015**

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

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

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



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

If *Speed Controller Set-up Method* (03.017) is set to a value from 4 to 6 the *Speed Controller Proportional Gain Kp1* Pr **00.007** {**03.010**} and *Speed Controller Integral Gain Ki1* Pr **00.008** {**03.011**} are automatically set up to give the bandwidths given in the table below and a damping factor of unity. These settings give low, standard or high performance.

Pr 03.017	Performance	Bandwidth
4	Low	5 Hz
5	Standard	25 Hz
6	High	100 Hz

6. Pr **03.017** = 7

If *Speed Controller Set-up Method* (03.017) = 7 then *Speed Controller Proportional Gain Kp1* Pr **00.007** {**03.010**}, *Speed Controller Integral Gain Ki1* Pr **00.008** {**03.011**} and *Speed Controller Differential Feedback Gain Kd1* Pr **00.009** {**03.012**} are set up to give a closed-loop speed controller response that approximates to a first order system with a transfer function of 1 / (st + 1), where t= 1/wbw and wbw = 2p x *Bandwidth* (03.020). In this case the damping factor is meaningless, and *Damping Factor* (03.021) and *Compliance Angle* (03.019) have no effect.

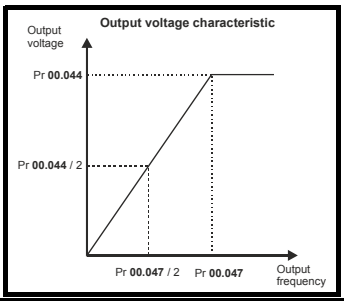
8.1.3 Open loop motor control

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

- The rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:
- Current limits (see section 8.2 *Current limits* on page 92, for more information)
- Motor thermal overload protection (see section 8.3 *Motor thermal protection* on page 92, for more information)
- Vector mode voltage control (see *Open Loop Control Mode* (00.007), later in this table)
- Slip compensation (see *Enable Slip Compensation* (05.027), later in this table)
- Dynamic V/F control

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

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



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

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

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

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

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

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

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

The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. The power factor is used in conjunction with the *Rated Current* (00.046), to calculate the rated active current and magnetising current of the motor. The rated active current is used extensively to control the drive, and the magnetising current is used in vector mode stator resistance compensation. It is important that this parameter is set up correctly. The drive can measure the motor rated power factor by performing a rotating autotune (see Autotune (Pr 00.040), overleaf).

Pr 00.040 {05.012} Autotune	

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

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary test measures the *Stator Resistance* (05.017), *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 *Open Loop Control Mode* (00.007), later in this table). The stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 *Rated Frequency* (05.006) x 2/3, and the frequency is maintained at that level for 4 seconds. *Stator Inductance* (05.025) is measured and this value is used in conjunction with other motor parameters to calculate *Rated Power Factor* (05.010). To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 terminal 2 & 6, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the *Control Word* (06.042) and *Control Word Enable* (06.043).

Pr 00.007 {05.014} *Open Loop Control Mode*

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

Vector control

Vector control mode provides the motor with a linear voltage characteristic from 0 Hz to motor *Rated Frequency* (00.047), and then a constant voltage above motor rated frequency. When the drive operates between motor rated frequency/50 and motor rated frequency/4, full vector based stator resistance compensation is applied. When the drive operates between motor rated frequency/4 and motor rated frequency/2 the stator resistance compensation is gradually reduced to zero as the frequency increases. For the vector modes to operate correctly the *Rated Power Factor* (00.043), *Stator Resistance* (05.017) are all required to be set up accurately. The drive can be made to measure these by performing an autotune (see Pr 00.040 *Autotune*). The drive can also be made to measure the stator resistance automatically every time the drive is enabled or the first time the drive is enabled after it is powered up, by selecting one of the vector control voltage modes.

(0) **Ur S** = The stator resistance is measured and the parameter for the selected motor map is 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.

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

(3) **Ur_Auto** = The stator resistance is measured once, the first time the drive is made to run. After the test has been completed successfully the *Open Loop Control Mode* (00.007) is changed to Ur mode. The *Stator Resistance* (05.017) parameter is written to, and along with the *Open Loop Control Mode* (00.007), are saved in the drive's EEPROM. If the test fails, the voltage mode changes to Ur mode but *Stator Resistance* (05.017) is not updated.

(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.

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

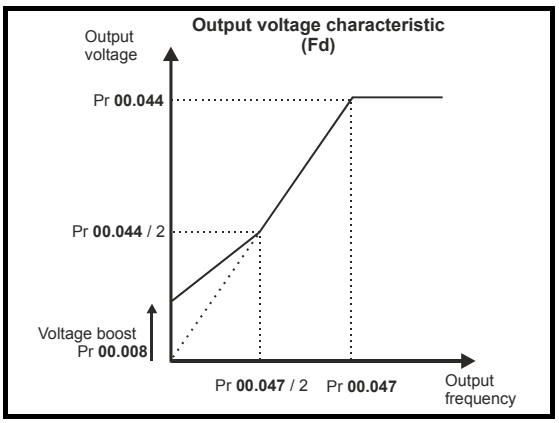
Fixed boost

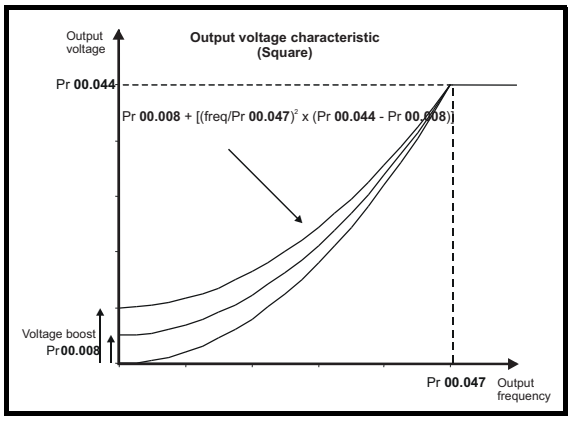
The stator resistance is not used in the control of the motor, instead a fixed characteristic with low frequency voltage boost as defined by parameter Pr **00.008**, is used. Fixed boost mode should be used when the drive is controlling multiple motors. There are two settings of fixed boost available:

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

(5) **Square** = This mode provides the motor with a square law voltage characteristic from 0 Hz to *Rated Frequency* (00.047), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of the speed of the motor shaft. This mode should not be used if a high starting torque is required.

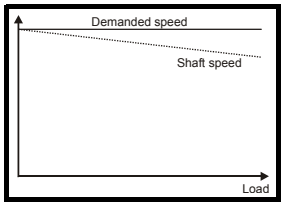
For both these modes, at low frequencies (from 0Hz to ½ x Pr **00.047**) a voltage boost is applied defined by Pr **00.008** as shown below:





Pr 05.027 *Enable Slip Compensation*

When a motor, being controlled in open loop mode, has load applied a characteristic of the motor is that the output speed droops in proportion to the load applied as shown:



In order to prevent the speed droop shown above slip compensation should be enabled. To enable slip compensation Pr **05.027** must be set to a 1 (this is the default setting), and the motor rated speed must be entered in Pr **00.045** (Pr **05.008**).

The motor rated speed parameter should be set to the synchronous speed of the motor minus the slip speed. This is normally displayed on the motor nameplate, i.e. for a typical 18.5 kW, 50 Hz, 4 pole motor, the motor rated speed would be approximately 1465 rpm. The synchronous speed for a 50 Hz, 4 pole motor is 1500 rpm, so therefore the slip speed would be 35 rpm. If the synchronous speed is entered in Pr **00.045**, slip compensation will be disabled. If too small a value is entered in Pr **00.045**, the motor will run faster than the demanded frequency. The synchronous speeds for 50 Hz motors with different numbers of poles are as follows:

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

8.1.4 RFC-A mode

Induction motor with Position feedback

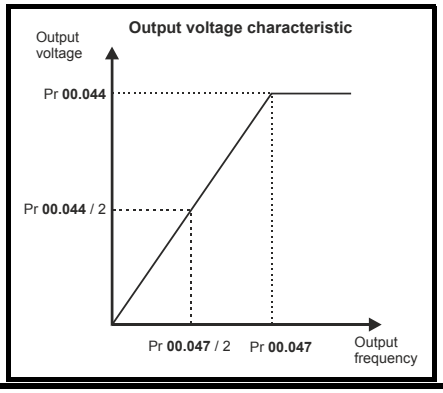
Pr 00.046 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

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

- Current limits (see section 8.2 *Current limits* on page 92, for more information).
- Motor thermal overload protection (see section 8.3 *Motor thermal protection* on page 92, for more information)
- Vector control algorithm

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

The *Rated Voltage* (00.044) and the *Rated Frequency* (00.047) are used to define the voltage to frequency characteristic applied to the motor (see *Open Loop Control Mode* (00.007), detailed in section 8.1.3). The motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see motor *Rated Speed (*00.045), later in this table).



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

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

Incorrect setting of this parameter has the following effects:

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

The nameplate value is normally the value for a hot motor; however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. Either a fixed value can be entered in this parameter or an optimization system may be used to automatically adjust this parameter (see *Rated Speed Optimisation Select* (00.033), later in this table).

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

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

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

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

Pr 00.040 {05.012} *Autotune*

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

NOTE

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

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary autotune measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. To perform a Stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 *Rated Frequency* (00.047) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (05.025), and the motor saturation breakpoints (Pr **05.029**, Pr **05.030**, Pr **06.062** and Pr **05.063**) are modified by the drive. The *Motor Rated Power Factor* (00.043) is also modified by the *Stator Inductance* (05.025). The No-Load motor core losses are measured and written to *No-Load Core Losses* (04.045). To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 or 13).
- Mechanical load measurement test using signal injection.
  This test measures the mechanical characteristic of the motor and load by rotating the motor at the speed defined by the present speed reference and injecting a series of speed test signals. This test should only be used provided all the basic control parameters have been set-up correctly and the speed controller parameters should be set to conservative levels, such as the default values, so that the motor is stable when it runs. The test measures the motor and load inertia, which can be used in automatic set-up of the speed controller gains and in producing a torque feed-forward term. If *Mechanical Load Test Level* (05.021) is left at its default value of zero then the peak level of the injection signal will be 1 % of the maximum speed reference subject to a maximum of 500 rpm. If a different test level is required then *Mechanical Load Test Level* (05.021) should be set to a non-zero value to define the level as a percentage of the maximum speed reference, again subject to a maximum of 500 rpm. The user defined speed reference which defines the speed of the motor should be set to a level higher than the test level, but not high enough for flux weakening to become active. In some cases however, it is possible to perform the test at zero speed provided the motor is free to move, but it may be necessary to increase the test signal from the default value. The test will give the correct results when there is a static load applied to the motor and in the presence of mechanical damping. This test should be used if possible, however for sensorless mode, or if the speed controller cannot be set up for stable operation an alternative test is provided (*Autotune* (00.040) = 4) where a series of torque levels are applied to accelerate and decelerate the motor to measure the inertia.
  1. A rotating test is performed in which the motor is accelerated with the currently selected ramps up to the currently selected speed reference, and this speed is maintained for the duration of the test. The *Motor And Load Inertia* (03.018) is set-up.

To perform this autotune test, set Pr **00.040** to 3 and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 or 13).

- *Mechanical load measurement test using applied torque*.

Auto-tune test 3 should normally be used for mechanical load measurement, but under some circumstances this test may be used as an alternative. This test will not give such accurate results as test 3 if the motor rated speed is not set to the correct value for the motor. Also this test is likely to give incorrect results if standard ramp mode is active. A series of progressively larger torque levels are applied to the motor (20 %, 40 % ... 100 % of rated torque) to accelerate the motor up to 3/4 x *Rated Speed* (00.045) to determine the inertia from the acceleration/deceleration time. The test attempts to reach the required speed within 5 s, 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 is accelerated in the required direction up to 3/4 of the maximum speed reference and then decelerated to zero speed.
2. The test is repeated with progressively higher torques until the required speed is reached.
3. *Motor And Load Inertia* (03.018) and *Inertia Times 1000* (04.033) are set up.

To perform this autotune test, set Pr **00.040** to 4 and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 terminal 2 & 6, setting the *Drive Enable* (06.015) to Off (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

Pr 00.033 {05.016} *Rated Speed Optimisation Select*

The *Rated Frequency* (00.047) and *Rated Speed* (00.045) are used to define the rated slip of the motor. The rated slip is used in sensorless mode (*Sensorless Mode Active* (03.078) = 1) to correct the motor speed with load. When this mode is active *Rated Speed Optimisation Select* (00.033) has no effect.

If sensorless mode is not active (*Sensorless Mode Active* (03.078) = 0) the rated slip is used in the motor control algorithm and an incorrect value of slip can have a significant effect on the motor performance. If *Rated Speed Optimisation Select* (00.033) = 0 then the adaptive control system is disabled. However, if *Rated Speed Optimisation Select* (00.033) is set to a non-zero value the drive can automatically adjust the *Rated Speed* (00.045) to give the correct value of rated slip. *Rated Speed* (00.045) is not saved at power-down, and so when the drive is powered-down and up again it will return to the last value saved by the user. The rate of convergence and the accuracy of the adaptive controller reduces at low output frequency and low load. The minimum frequency is defined as a percentage of *Rated Frequency* (00.047) by *Rated Speed Optimisation Minimum Frequency* (05.019). The minimum load is defined as a percentage of rated load by *Rated Speed Optimisation Minimum Load* (05.020). The adaptive controller is enabled when a motoring or regenerative load rises above *Rated Speed Optimisation Minimum Load* (05.020) + 5%, and is disabled again when it falls below *Rated Speed Optimisation Minimum Load* (05.020). For best optimisation results the correct values of *Stator Resistance* (05.017), *Transient Inductance* (05.024), *Stator Inductance* (05.025), *Saturation Breakpoint 1* (05.029), *Saturation Breakpoint 2* (05.062), *Saturation Breakpoint 3* (05.030) and *Saturation Breakpoint 4* (05.063) should be used.

Pr 00.038 {04.013} / Pr 00.039 {04.014} *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The *Current Controller Kp Gain* (00.038) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr 00.040, earlier in this table) the drive measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor and calculates the current loop gains.

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

Speed Loop Gains (Pr 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {03.012})

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009)** are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

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

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

Speed Controller Integral Gain (Ki), Pr **00.008** {**03.011**} and Pr **03.014**

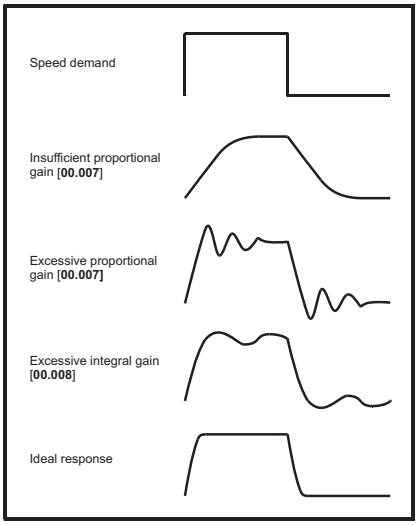
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of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

Differential Gain (Kd), Pr **00.009** {**0 3.012**} and Pr **03.015**

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

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

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



Pr **03.017** = 4 - 6

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

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

6. Pr **03.017** = 7

If *Speed Controller Set-up Method* (03.017) = 7 then *Speed Controller Proportional Gain Kp1* (03.010), *Speed Controller Integral Gain Ki1* (03.011) and *Speed Controller Differential Feedback Gain Kd1* (03.012) are set up to give a closed-loop speed controller response that approximates to a first order system with a transfer function of $1 / (s\tau + 1)$, where $\tau = 1/\omega bw$ and $\omega bw = 2\pi$ x *Bandwidth* (03.020). In this case the damping factor is meaningless, and *Damping Factor* (03.021) and *Compliance Angle* (03.019) have no effect.

8.1.5 RFC-A Sensorless mode

Induction motor without position feedback

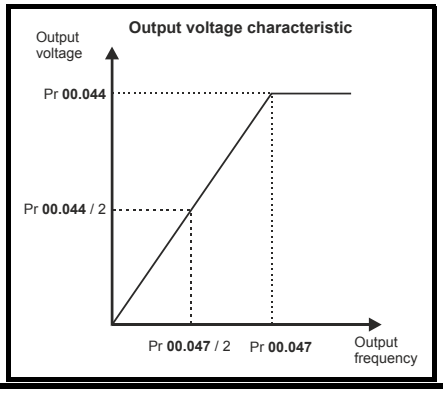
Pr 00.046 {05.007} *Motor Rated Current*	**Defines the maximum motor continuous current**

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

- Current limits (see section 8.2 *Current limits* on page 92, for more information).
- Motor thermal overload protection (see section 8.3 *Motor thermal protection* on page 92, for more information)
- Vector control algorithm

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

The *Rated Voltage* (00.044) and the *Rated Frequency* (00.047) are used to define the voltage to frequency characteristic applied to the motor (see *Open Loop Control Mode* (00.007), detailed in section 8.1.3). The motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see motor *Rated Speed* (00.045), later in this table).



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

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

Incorrect setting of this parameter has the following effects:

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

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

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

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

Pr 00.043 {5.010} *Rated Power Factor*	**Defines the angle between the motor voltage and current**

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

Pr 00.040 {05.012} *Autotune*

There are three autotune tests available in RFC-A mode, a stationary test, a rotating test and a mechanical load measurement test. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. A mechanical load measurement test should be performed separately to a stationary or rotating autotune.

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

- A stationary autotune can be used when the motor is loaded and it is not possible to remove the load from the motor shaft. The stationary autotune measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor. These are used to calculate the current loop gains, and at the end of the test the values in Pr **00.038** and Pr **00.039** are updated. *Maximum Deadtime Compensation* (05.059) and *Current At Maximum Deadtime Compensation* (05.060) for the drive are also measured. Additionally, if *Enable Stator Compensation* (05.049) = 1, then *Stator Base Temperature* (05.048) is made equal to *Stator Temperature* (05.046). A stationary autotune does not measure the power factor of the motor so the value on the motor nameplate must be entered into Pr **00.043**. To perform a stationary autotune, set Pr **00.040** to 1, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 in which the motor is accelerated with currently selected ramps up to a frequency of *Rated Frequency* (00.047) x 2/3, and the frequency is maintained at the level for up to 40 s. During the rotating autotune the *Stator Inductance* (05.025), and the motor saturation breakpoints (Pr **05.029**, Pr **05.030**, Pr **06.062** and Pr **05.063**) are modified by the drive. The power factor is also modified for user information only, but is not used after this point as the stator inductance is used in the vector control algorithm instead. To perform a Rotating autotune, set Pr **00.040** to 2, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 or 13).
- The mechanical load measurement test can measure the total inertia of the load and the motor. This is used to set the speed loop gains (see Speed loop gains) and to provide torque feed-forwards when required during acceleration.
  Applied torque (sensorless mode) This test may give inaccurate results, if the motor rated speed is not set to the correct value for the motor, or if standard ramp mode is active. During the mechanical load measurement test a series of progressively larger torque levels are applied to the motor (20 %, 40 % ... 100 % of rated torque) to accelerate the motor up to $^{3}/_{4}$ x *Rated Speed* (00.045) to determine the inertia from the acceleration/deceleration time. The test attempts to reach the required speed within 5 s, 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 quickly enough. If this is the case, the maximum speed reference should be reduced. To perform a mechanical load measurement autotune, set Pr **00.040** to 4, and provide the drive with both an enable signal (terminal 2 & 6) and a run signal (terminal 11 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 terminal 2 & 6, setting the *Drive Enable* (06.015) to OFF (0) or disabling the drive via the control word (Pr **06.042** & Pr **06.043**).

Pr 00.038 {04.013} / Pr 00.039 {04.014} *Current Loop Gains*

The current loop gains proportional (Kp) and integral (Ki) gains control the response of the current loop to a change in current (torque) demand. The default values give satisfactory operation with most motors. However, for optimal performance in dynamic applications it may be necessary to change the gains to improve the performance. The *Current Controller Kp Gain* (00.038) is the most critical value in controlling the performance. The values for the current loop gains can be calculated by performing a stationary or rotating autotune (see *Autotune* Pr **00.040**, earlier in this table) the drive measures the *Stator Resistance* (05.017) and *Transient Inductance* (05.024) of the motor and calculates the current loop gains.

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

Speed Loop Gains (Pr 00.007 {03.010}, Pr 00.008 {03.011}, Pr 00.009 {03.012})

The speed loop gains control the response of the speed controller to a change in speed demand. The speed controller includes proportional (Kp) and integral (Ki) feed forward terms, and a differential (Kd) feedback term. The drive holds two sets of these gains and either set may be selected for use by the speed controller with Pr **03.016**. If Pr **03.016** = 0, gains Kp1, Ki1 and Kd1 (Pr **00.007** to Pr **00.009)** are used, and if Pr **03.016** = 1, gains Kp2, Ki2 and Kd2 (Pr **03.013** to Pr **03.015**) are used. Pr **03.016** may be changed when the drive is enabled or disabled. If the load is predominantly a constant inertia and constant torque, the drive can calculate the required Kp and Ki gains to give a required compliance angle or bandwidth dependant on the setting of Pr **03.017**.

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

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

Speed Controller Integral Gain (Ki), Pr **00.008** {**03.011**} and Pr **03.014**

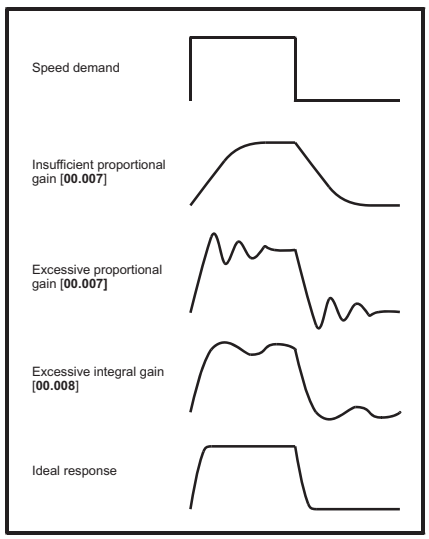
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of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

Differential Gain (Kd), Pr **00.009** {**0 3.012**} and Pr **03.015**

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

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

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



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

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

Pr 03.017	Performance	Bandwidth
4	Low	5 Hz
5	Standard	25 Hz
6	High	100 Hz

6. Pr **03.017** = 7

If *Speed Controller Set-up Method* (03.017) = 7 then *Speed Controller Proportional Gain Kp1* (03.010), *Speed Controller Integral Gain Ki1* (03.011) and *Speed Controller Differential Feedback Gain Kd1* (03.012) are set up to give a closed-loop speed controller response that approximates to a first order system with a transfer function of $1 / (s\tau + 1)$, where $\tau = 1/\omega bw$ and $\omega bw = 2\pi$ x *Bandwidth* (03.020). In this case the damping factor is meaningless, and *Damping Factor* (03.021) and *Compliance Angle* (03.019) have no effect.

8.2 Current limits

The default setting for the current limit parameters is:

- 165 % x motor rated torque producing current for open loop mode
- 250 % x motor rated torque producing current for RFC-A and RFC-S modes.

There are three parameters which control the current limits:

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

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

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

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 %.

8.3 Motor thermal protection

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

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

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

Where:

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

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

Where:

I = *Current Magnitude* (00.012)

I_{Rated} = *Rated Current* (00.046)

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

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

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

Where:

T = *Motor Protection Accumulator* (04.019)

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

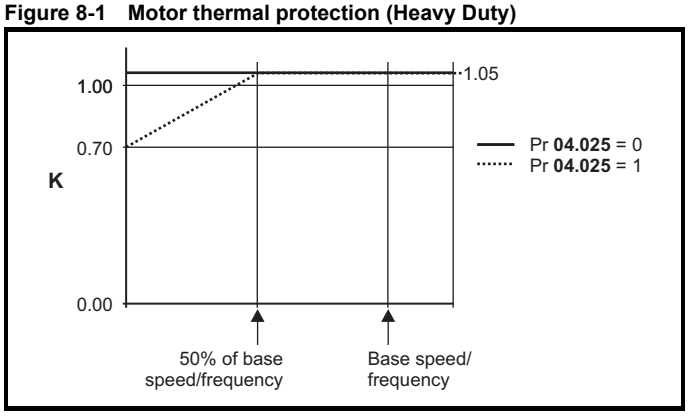
$\tau 1$ = *Motor Thermal Time Constant 1* (00.053)

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

K_1 = Varies, see below

If *Rated Current* (00.046) ≤ *Maximum Heavy Duty Current* (00.032)

Figure 8-1 Motor thermal protection (Heavy Duty)



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

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 **00.046** is altered, the accumulator is reset to zero.

The default setting of the thermal time constant (Pr **00.053**) is 89 s which is equivalent to an overload of 150 % for 100 s from cold.

8.4 Switching frequency

The default switching frequency is 8 kHz, however this can be increased up to a maximum of 16 kHz by Pr **00.041** (dependent on drive size). The available switching frequencies are shown below.

Table 8-1 Available switching frequencies

Drive size	Model	2 kHz	3 kHz	4 kHz	6 kHz	8 kHz	12 kHz	16 kHz
1	All	✓	✓	✓	✓	✓	✓	✓
2								
3								

If switching frequency is increased from 8 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 *Digitax HD M75X Series Installation and Technical Guide.*
2. Reduced heating of the motor - due to improved output waveform quality.
3. Reduced acoustic noise generated by the motor.
4. Increased sample rate on the speed and current controllers. A trade off must be made between motor heating, drive heating and the demands of the application with respect to the sample time required.

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

Level	3, 6, 12 kHz	2, 4, 8, 16 kHz	Open loop	RFC-A RFC-S
Level 1	3 kHz - 167µs 6 kHz - 83 µs 12 kHz - 83 µs	2 kHz - 250 µs 4 kHz - 125 µs 8 kHz - 62.5 µs 16 kHz - 62.5 µs	Peak limit	Current controllers
Level 2	250 µs	2 kHz - 500 µs 4 kHz - 250 µs 8 kHz - 250 µs 16 kHz - 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 High speed operation

8.5.1 Encoder feedback limits

The maximum encoder frequency should be prevented from exceeding 500 kHz. In RFC-A and RFC-S modes the maximum speed that can be entered in to the speed reference clamps (Pr **00.002** and Pr **00.001**) can be limited by the drive. This is defined by the following (subject to an absolute maximum of 33,000 rpm):

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

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

Where:

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

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

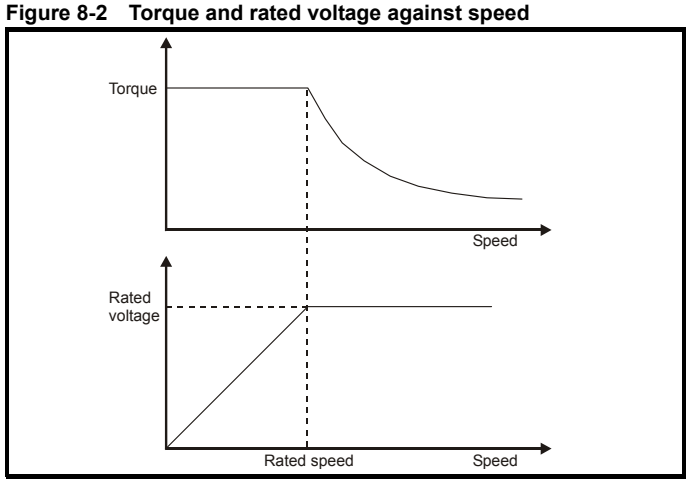
This maximum speed limit is defined by the device selected with the speed feedback selector (Pr **03.026**), and the ELPR set for the position feedback device. In RFC-A mode it is possible to disable this limit via Pr **03.024**, so that the drive can be switched between operation with and without feedback when the speed becomes too high for the feedback device.

8.5.2 Field weakening (constant power) operation

(Open loop and RFC-A mode only)

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

Figure 8-2 Torque and rated voltage against speed



Care must be taken to ensure the torque available above base speed is sufficient for the application to run satisfactorily. 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).

8.5.3 Permanent magnet motor high speed operation

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

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

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

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

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

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

8.5.4 Switching frequency

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. If this is not possible, quasi-square switching should be enabled (Pr **05.020** =1). The output waveform will be quasi square above base speed ensuring a symmetrical output waveform, which results in a better quality output than would otherwise result.

8.5.5 Maximum speed / frequency

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

8.5.6 Quasi-Square wave (open-loop only)

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

This can be used for example:

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

or

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

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

8.6 Modbus RTU specification (EIA-485)

This section describes the adaptation of the MODBUS RTU protocol. The portable software class which implements this protocol is also defined. MODBUS RTU is a master slave system with half-duplex message exchange. The core function codes to read and write registers are supported'. A scheme to map between MODBUS registers and parameters is defined. The implementation also defines a 32 bit extension to the standard 16 bit register data format

8.6.1 MODBUS RTU

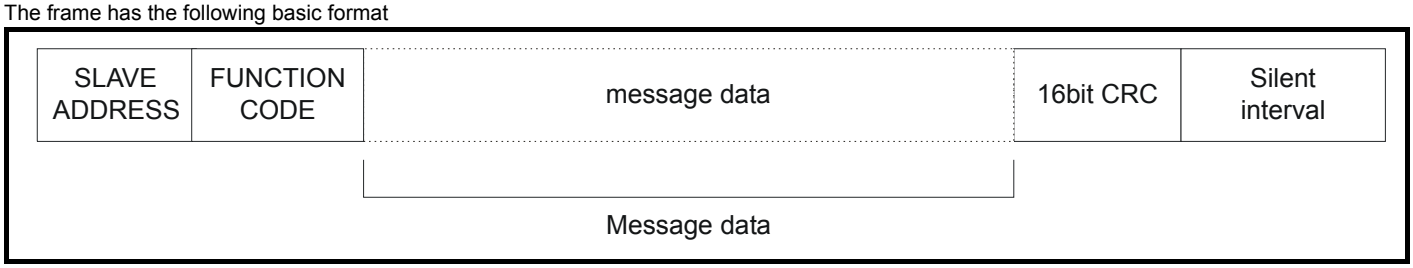
Physical layer

Attribute	Description
Normal physical layer for multi-drop operation	EIA-485 2 wire
Bit stream	Standard UART asynchronous symbols with Non Return to Zero (NRZ)
Symbol	Each symbol consists of:- 1 start bit 8 data bits (transmitted least significant bit first) 2 stop bits*
Baud rates	300, 600, 1200, 2400, 4800, 9600, 19200, 38400, 57600, 76800, 115200

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

RTU framing

The frame has the following basic format

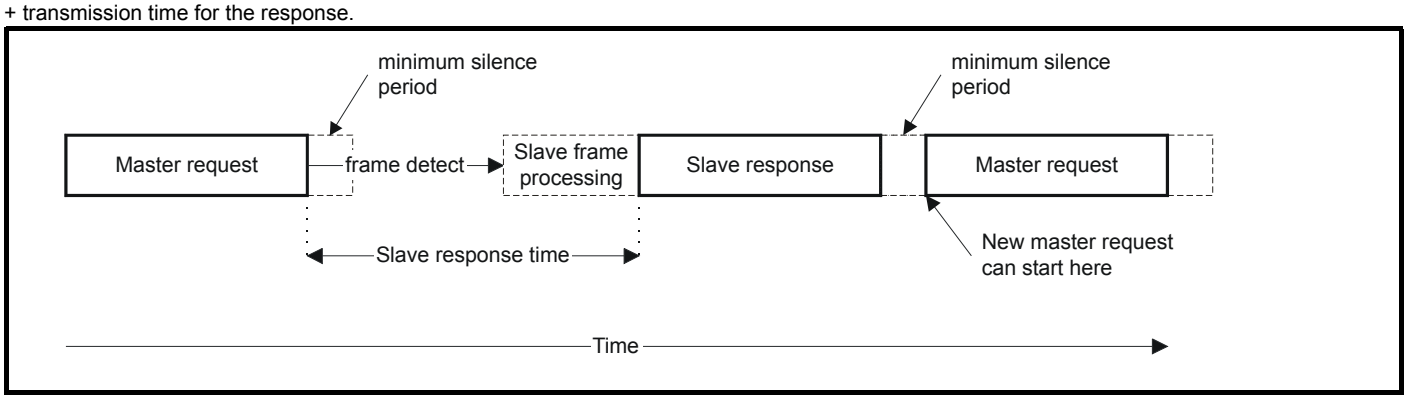


The frame is terminated with a minimum silent period of 3.5 character times (for example, at 19200 baud the minimum silent period is 2 ms). Nodes use the terminating silence period to detect the end of frame and begin frame processing. All frames must therefore be transmitted as a continuous stream without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

MODBUS RTU is a master slave system. All master requests, except broadcast requests, will lead to a response from an individual slave. The slave will respond (i.e. start transmitting the response) within the quoted maximum slave response time (this time is quoted in the data sheet for all 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	Supported
1	Read only bits ("coil")	Use register
2	Read / write bits ("coil")	Use register
3	Read only 16 bit register	Yes
4	Read / write 16 bit register	Yes

The register file type code is NOT transmitted by MODBUS and all register files can be considered to map onto a single register address space.

However, specific function codes are defined in MODBUS to support access to the "coil" registers.

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

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 devices support this data size.

Refer to the section 8.6.7 *Extended data types* on page 98 for detail on accessing 32 bit register data.

8.6.4 Data consistency

All 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 8-3 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 8-4 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 8-5 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 8-6 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 8-7 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 8-8 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 8-9 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 8-10 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

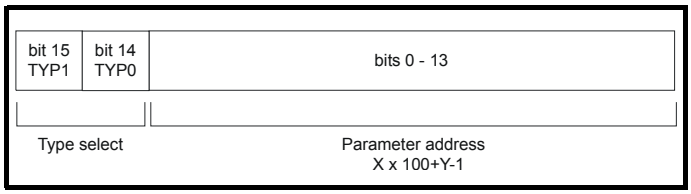
8.6.7 Extended data types

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	Not supported
11	Reserved	

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

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

Table 8-11 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	CRC
7	CRC MSB	CRC

Table 8-12 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	CRC
20	CRC MSB	CRC

Reads when actual parameter type is different from selected

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

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

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

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

* Bit 14 is set to allow 32 bit access.

Writes when actual parameter type is different from selected

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

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

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

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

* Bit 14 is set to allow 32 bit access

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

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

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. Refer to par 11-26.
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 SD Card Operation

9.1 Introduction

The Non-Volatile Media Card feature enables simple configuration of parameters, parameter back-up, storing / reading PLC programs and drive copying using an SD card storing / reading PLC programs.

The SD Card can be used for:

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

The SC Card slot is located at the middle of the module, adjacent to the drive compact display (if installed) on the right-hand side.

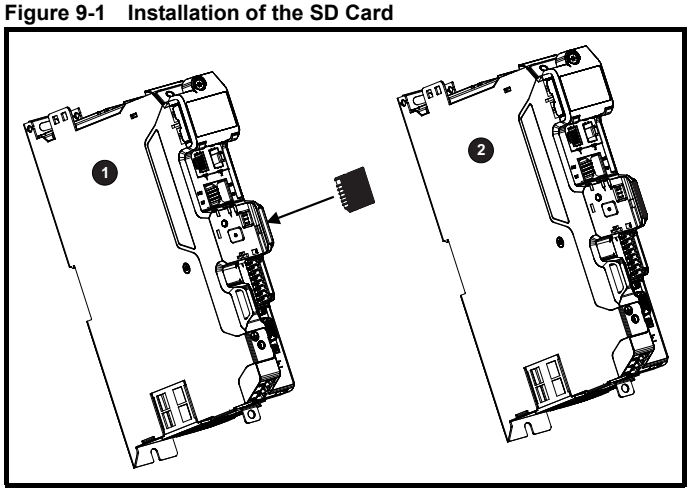
Ensure the SD Card is inserted with the contacts facing the left-hand side of the drive.

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

WARNING

Beware of possible live terminals when installing the SD Card.

Figure 9-1 Installation of the SD Card



1. Installing the SD Card
2. SD Card installed

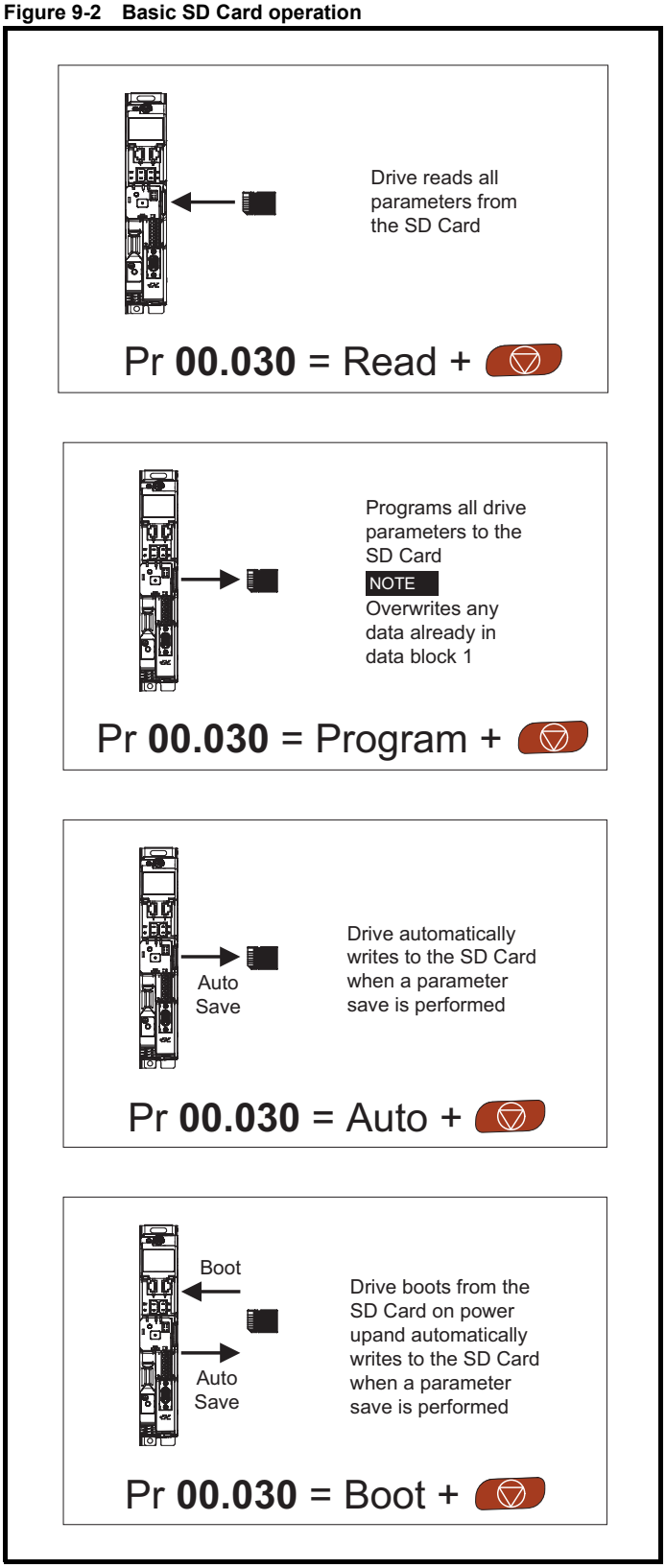
9.2 SD Card support

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

NOTE

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

Figure 9-2 Basic SD Card operation



The whole card may be protected from writing or erasing by setting the read-only flag as detailed section 9.3.9 *9888 / 9777 - Setting and clearing the SD Card read only flag* on page 102.

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

9.3 Transferring data

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

Table 9-1 SD card codes

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

Where yyy indicates the block number 001 to 999.

NOTE

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

9.3.1 Writing to the SD Card

4yyy - Writes defaults differences to the SD 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 SD Card. In addition to these parameters all menu 20 parameters (except Pr **20.000**), can be transferred to the SD Card.

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

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

9.3.2 Reading from the SD Card

6yyy - Reading from SD Card

When the data is transferred back to the drive, using 6yyy in Pr **mm.000**, it is transferred to the drive RAM and the EEPROM. A parameter save is not required to retain the data after-power down. Set up data for any option modules installed stored on the card are transferred to the drive. If the option modules installed are different between source and destination drives, the menus for the option module slots where the option module categories are different are not updated from the card and will contain their default values after the copying action. The drive will produce a 'Card Option' trip if the option module installed to the source and the destination drives are different or are in different slots. If the data is being transferred to the drive with different voltage or current rating a 'Card Rating' trip will occur.

The following drive rating dependant parameters (RA coding bit set) will not be transferred to the destination drive by a SD 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 **05.007**, Pr **21.007** *Rated Current*

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

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

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

Pr **05.018** *Maximum Switching Frequency*

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

Pr **05.025**, Pr **21.024** *Stator Inductance*

Pr **06.006** *Injection Braking Level*

Pr **06.048** *Supply Loss Detection Level*

Pr **06.065** *Standard Under Voltage Threshold*

Pr **06.066** *Low Under Voltage Threshold*

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

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

This setting causes the drive to automatically save any changes made to menu 0 parameters on the drive to the SD Card. The latest menu 0 parameter set in the drive is therefore always backed up on the SD 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 SD Card when Pr **mm.000** is set to 'Save Parameters' or a 1001 and the drive reset.

All SD 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 SD 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 SD 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 SD Card is also updated, and therefore the SD 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 SD Card. The drive will display 'Card Write' during this operation. This is done to ensure that if a user puts a new SD Card in during power down the new SD 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 SD Card.

9.3.4 Booting up from the SD 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 SD 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 SD Card this makes the copying SD Card the master device. This provides a very fast and efficient way of re-programming a number of drives.

NOTE

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

9.3.5 Booting up from the SD Card on every power up (Pr mm.000 = 2001)

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

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

9.3.6 8yyy - Comparing the drive full parameter set with the SD Card values

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

9.3.7 7yyy - Erasing data from the SD Card values

Data can be erased from the SD Card one block at a time.

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

9.3.8 9666 / 9555 - Setting and clearing the SD Card warning suppression flag

If the option modules installed to the source and destination drive are different or are in different slots the drive will produce a 'Card Option' trip.

If the data is being transferred to a drive of a different voltage or current rating a 'Card Rating' trip will occur. It is possible to suppress these trips by setting the warning suppression flag. If this flag is set the drive will not trip if the option module(s) or drive ratings are different between the source and destination drives. The options module or rating dependent parameters will not be transferred.

- Setting 9666 in Pr **mm.000** will set the warning suppression flag
- Setting 9555 in Pr **mm.000** will clear the warning suppression flag

9.3.9 9888 / 9777 - Setting and clearing the SD Card read only flag

The SD 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 eff.

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

9.4 Data block header information

Each data block stored on an SD Card has header information detailing the following:

- *NV Media Card File Number* (11.037)
- *NV Media Card File Type* (11.038)
- *NV Media Card File Version* (11.039)
- *NV Media Card File Checksum* (11.040)

The header information for each data block which has been used can be viewed in Pr **11.038** to Pr **11.040** by increasing or decreasing the data block number set in Pr **11.037**. If there is no data on the card Pr **11.037** can only have a value of 0.

9.5 SD Card parameters

Table 9-2 Key to parameter table coding

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

11.036 {00.029}	**NV Media Card File Previously Loaded**									
RO	Num					NC	PT			
OL										
RFC-A	⇳	0 to 999			⇨	0				
RFC-S										

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									
OL										
RFC-A	⇳	0 to 999			⇨	0				
RFC-S										

This parameter is used to select a data block file by its file identification number and can only be changed to values that correspond to files that are recognised by the drive on the SD card or a value of 0.
When *NV Media Card File Number* (Pr **11.037**) corresponds to the number of a data block file, Pr **11.038**, Pr **11.039** and Pr **11.040** are populated with data relating to that specific file number.

11.038	NV Media Card File Type									
RO	Txt				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6)			⇨					

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

Pr 11.038	String	Type / mode
0	None	No file selected
1	Open-loop	Open-loop mode parameter file
2	RFC-A	RFC-A mode parameter file
3	RFC-S	RFC-S mode parameter file
4	Regen	Regen mode parameter file
5	User Prog	Onboard user program file
6	Option App	Option module application file

11.039	NV Media Card File Version									
RO	Num				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	0 to 9999			⇨					

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

11.040	NV Media Card File Checksum									
RO	Num				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	-2147483648 to 2147483647			⇨					

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

11.042 {00.030}	Parameter Cloning									
RW	Txt					NC		US*		
OL / RFC-A / RFC-S	⇳	None (0), Read (1), Program (2), Auto (3), Boot (4)			⇨	None (0)				

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

NOTE

If Pr **11.042** is equal to 1 or 2, this value is not transferred to the drive or saved to the EEPROM. If Pr **11.042** is set to 3 or 4 the value is saved to the EEPROM

None (0) = Inactive

Read (1) = Read parameter set from the SD Card

Program (2) = Program a parameter set to the SD Card

Auto (3) = Auto save

Boot (4) = Boot mode

11.072	NV Media Card Create Special File									
RW	Num					NC				
OL / RFC-A / RFC-S	⇳	0 to 1			⇨	0				

If *NV Media Card Create Special File* (11.072) = 1 when a parameter file is transferred to an SD card the file is created as a macro file. *NV Media Card Create Special File* (11.072) is reset to 0 after the file is created or the transfer fails.

11.073	NV Media Card Type									
RO	Txt				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	None (0), SD Card (1)			⇨					

This will display the type of media card inserted; it will contain one of the following values:

"None" (0) - No SD Card has been inserted.

"SD Card" (1) - A FAT formatted SD card has been inserted.

11.075	NV Media Card Read-only Flag									
RO	Bit				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	Off (0) or On (1)			⇨					

NV Media Card Read-only Flag (11.075) shows the state of the read-only flag for the currently installed card.

11.076	NV Media Card Warning Suppression Flag									
RO	Bit				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	Off (0) or On (1)			⇨					

NV Media Card Warning Suppression Flag (11.076) shows the state of the warning flag for the currently installed card.

11.077	NV Media Card File Required Version									
RW	Num				ND	NC	PT			
OL / RFC-A / RFC-S	⇳	0 to 9999			⇨					

The value of *NV Media Card File Required Version* (11.077) is used as the version number for a file when it is created on an SD Card. *NV Media Card File Required Version* (11.077) is reset to 0 when the file is created or the transfer fails.

9.6 SD Card trips

After an attempt to read, write or erase data from an SD Card, a trip is initiated if there has been a problem with the command.

See Chapter 12 *Diagnostics* on page 192 for more information on SD Card trips.

10 Onboard PLC

10.1 Onboard PLC and Machine Control Studio

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

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

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 Digitax HD 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 Digitax HD.

Machine Control Studio can be downloaded from www.drive-setup.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 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
- Sequences routines
- Custom control words.

10.3 Features

The Digitax HD Onboard PLC user program has the following features:

10.3.1 Tasks

The Onboard PLC allows use of two tasks.

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

10.3.2 Variables

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

10.3.3 Custom menu

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 4 ms.
- The freewheeling background task runs at a low priority. The drive is prioritized to perform the clock task and its major functions first, e.g. motor control, and will use any remaining processing time to execute the freewheeling task as a background activity. As the drive's processor becomes more heavily loaded, less time is spent executing the freewheeling task.
- Breakpoints, single stepping and online program changes are not possible.
- The Graphing tool is not supported.
- The variable data types REAL (32 bit floating point), LWORD (64 bit integer) and WSTRING (Unicode string), and retained variables are not supported.

10.4 Onboard PLC parameters

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

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

This parameter stops and starts the user program.

0 - Stop the User Program

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

1 - Run the User Program

The user program will execute.

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

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

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 192 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 / Speed reference
2	Ramps
3	Frequency slaving, speed feedback and speed control
4	Torque and current control
5	Motor control
6	Sequencer and clock
7	Analog I/O / Temperature monitoring
8	Digital I/O
9	Programmable logic, motorized pot, binary sum, timers and scope
10	Status and trips
11	Drive set-up and identification, serial communications
12	Threshold detectors and variable selectors
13	Standard motion control
14	User PID controller
15	Option module slot 1 set-up menu
16	Option module slot 2 set-up menu
17	Option module slot 3 set-up menu
18	General option module application menu 1
19	General option module application menu 2
20	General option module application menu 3
21	Second motor parameters
22	Menu 0 set-up
23	Not allocated
25	Option module slot 1 application parameters
26	Option module slot 2 application parameters
27	Option module slot 3 application parameters
29	Reserved menu
30	Onboard user programming application menu
31-41	Advanced motion controller setup parameters
Slot 1	Slot 1 option menus*
Slot 2	Slot 2 option menus*
Slot 3	Slot 3 option menus*

* Only displayed when the option modules are installed.

Operation mode abbreviations:

Open-loop: Sensorless control for induction motors

RFC-A: Asynchronous Rotor Flux Control for induction motors

RFC-S: Synchronous Rotor Flux Control for synchronous motors including permanent magnet motors.

Default abbreviations:

Standard default value (50 Hz AC supply frequency)

USA default value (60 Hz AC supply frequency)

NOTE

Parameter numbers shown in brackets {...} are the equivalent Menu 0 parameters. Some Menu 0 parameters appear twice since their function depends on the operating mode.

The Range - RFC-A / S column applies to both RFC-A and RFC-S. For some parameters, this column applies to only one of these modes, this is indicated accordingly in the Default columns.

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

Table 11-2 Key to parameter table coding

Coding	Attribute
RW	Read/Write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter. 'On' or 'Off' on the display
Num	Number: can be uni-polar or bi-polar
Txt	Text: the parameter uses text strings instead of numbers.
Bin	Binary parameter
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 speed reference 1	01.036	07.010	07.001	07.007	07.008	07.009	07.025	07.026	07.030				
Analog I/O	Menu 7												
Analog input 1	07.001	07.007	07.008	07.009	07.010	07.025	07.026	07.030					
Application menu	Menu 18		Menu 19		Menu 20								
At speed indicator bit	03.006	03.007	03.009	10.006	10.005	10.007							
Auto reset	10.034	10.035	10.036	10.001									
Autotune	05.010	05.012	05.017	05.024	05.025	05.029	05.030	05.059	05.060	05.062			
Binary sum	09.029	09.030	09.031	09.032	09.033	09.034							
Bipolar speed	01.010												
Brake control	12.040 to 12.055												
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												
Comms	11.023 to 11.027												
Copying	11.042	11.036 to 11.040											
Cost - per kWh electricity	06.016	06.017	06.024	06.025	06.026	06.027	06.028						
Current controller	04.013	04.014											
Current feedback	04.001	04.002	04.017	04.004	04.012	04.020	04.023	04.024	04.026	10.008	10.009	10.017	
Current limits	04.005	04.006	04.007	04.018	04.015	04.019	04.016	05.007	05.010	10.008	10.009	10.017	
DC bus voltage	05.005	02.008											
DC injection braking	06.006	06.007	06.001										
Deceleration rates	02.020	02.021 to 02.029		02.004	02.035 to 02.037		02.002	02.008	06.001	10.030	10.031	10.039	02.009
Defaults	11.043	11.046											
Digital I/O	Menu 8												
Digital I/O read word	08.020												
Digital Output 1 T14	08.001	08.011	08.021	08.031									
Digital Output 2 T16	08.002	08.012	08.022	08.032									
Digital input 4 T11	08.004	08.014	08.024										
Digital input 5 T13	08.005	08.015	08.025										
Digital lock	13.010	13.001 to 13.009			13.011	13.012	13.016	03.022	03.023	13.019 to 13.023			
Digital output T12	08.008	08.018	08.028										
Direction	10.013	06.030	06.031	01.003	10.014	02.001	03.002		08.004	10.040			
Drive active	10.002	10.040											
Drive derivative	11.028												
Drive OK	10.001	08.027			10.036	10.040							
Dynamic performance	05.026												
Dynamic V/F	05.013												
Enable	06.015	08.009	08.040										
Encoder reference	03.043	03.044	03.045	03.046									
Encoder set-up	03.033	03.034 to 03.042			03.047	03.048							
External trip	10.032	08.010											
Fan speed	06.045												
Fast disable	06.029												
Field weakening - induction motor	05.029	05.030	01.006	05.028	05.062	05.063							
Field weakening - servo	05.022	01.006	05.009										
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							
Hard speed reference	03.022	03.023											
Heavy duty rating	05.007	11.032											
High stability space vector modulation	05.019												
I/O sequencer	06.030	06.031	06.032	06.033	06.034	06.042	06.043	06.041					
Inertia compensation	02.038	05.012	04.022	03.018									
Jog reference	01.005	02.019	02.029										
Keypad reference	01.017	01.014	01.043	01.051	06.012	06.013							
Kt	05.032												
Limit switches	06.035	06.036											
Line power supply loss	06.003	10.015	10.016	05.005	06.048								
Local position reference	13.020 to 13.023												
Logic function 1	09.001	09.004	09.005	09.006	09.007	09.008	09.009	09.010					

Feature	Related parameters (Pr)												
Logic function 2	09.002	09.014	09.015	09.016	09.017	09.018	09.019	09.020					
Low voltage supply	06.044												
Marker pulse	03.032	03.031											
Maximum speed	01.006												
Menu 0 set-up	11.018 to 11.022			Menu 22									
Minimum speed	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					
Offset speed reference	01.004	01.038	01.009										
Onboard PLC	11.047 to 11.051												
Open loop vector mode	05.014	05.017											
Operating mode	00.048	11.031	03.024	05.014									
Orientation	13.010	13.013 to 13.015											
Output	05.001	05.002	05.003	05.004									
Overspeed threshold	03.008												
Phase angle	03.025	05.012											
PID controller	Menu 14												
Position feedback - drive	03.028	03.029	03.030	03.050									
Power up parameter	11.022	11.021											
Precision reference	01.018	01.019	01.020	01.044									
Preset speeds	01.015	01.021 to 01.028			01.016	01.014	01.042	01.045 to 01.048			01.050		
Programmable logic	Menu 9												
Quasi square operation	05.020												
Ramp (accel / decel) mode	02.004	02.008	06.001	02.002	02.003	10.030	10.031	10.039					
Rated speed autotune	05.016	05.008											
Regenerating	10.010	10.011	10.030	10.031	06.001	02.004	02.002	10.012	10.039	10.040			
Relative jog	13.017 to 13.019												
Relay output	08.007	08.017	08.027										
Reset	10.033			10.034	10.035	10.036	10.001	10.038					
RFC mode (encoder less CLV mode)	03.024	03.042	04.012										
S ramp	02.006	02.007											
Sample rates	05.018												
Safe Torque Off input	08.009	08.040											
Security code	11.030	11.044											
Serial comms	11.023 to 11.027			11.020									
Skip speeds	01.029	01.030	01.031	01.032	01.033	01.034	01.035						
Slip compensation	05.027	05.008											
NV media card	11.036 to 11.040			11.042									
Firmware version	11.029	11.034	11.062										
Speed controller	03.010 to 03.017			03.019	03.020	03.021							
Speed feedback	03.002	03.003	03.004										
Speed feedback - drive	03.026	03.027	03.028	03.029	03.030	03.031	03.042						
Speed feed forward	01.039	01.040											
Speed reference selection	01.014	01.015	01.049	01.050	01.001								
Status word	10.040												
Supply	06.044	05.005											
Switching frequency	05.018	05.035	07.034	07.035									
Thermal protection - drive	05.018	05.035	07.004	07.005	07.006	07.034	07.035	07.036	10.018				
Thermal protection - motor	04.015	05.007	04.019	04.016	04.025	07.015							
Thermistor input	03.118 to 03.123												
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	06.019	06.020											
Time - run log	06.019												
Torque	04.003	04.026	05.032										
Torque mode	04.008	04.011	04.009	04.010									
Trip detection	10.037	10.038	10.020 to 10.029										
Trip log	10.020 to 10.029			10.041 to 10.060				10.070 to 10.079					
Under voltage	05.005	10.016	10.015										
V/F mode	05.015	05.014											
Variable selector 1	12.008 to 12.016												

Feature	Related parameters (Pr)											
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	06.044		05.005									
Warning	10.019	10.012	10.017	10.018	10.040							
Zero speed 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 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

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

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

VM_AC_VOLTAGE_SET	Range applied to the AC voltage set-up parameters
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 690
Definition	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 11-4. VM_AC_VOLTAGE[MIN] = 0

VM_ACCEL_RATE	Maximum applied to the ramp rate parameters
Units	s / 100 Hz, s / 1000 rpm, s / 1000 mm/s
Range of [MIN]	Open-loop: 0.0 RFC-A, RFC-S: 0.000
Range of [MAX]	Open-loop: 0.0 to 3200.0 RFC-A, RFC-S: 0.000 to 3200.000
Definition	Open-loop mode If *Ramp Rate Units* (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 If *Ramp Rate Units* (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.0 x Pr **01.006** / 100.0 VM_ACCEL_RATE[MIN] = 0.0 RFC-A, RFC-S modes If *Ramp Rate Units* (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.000 If *Ramp Rate Units* (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.000 x Pr **01.006** / 1000.0 VM_ACCEL_RATE[MIN] = 0.000 If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006**.

VM_AMC_JERK_UNIPOLAR	Range applied to the parameters showing the AMC jerk
Units	User units / ms / ms / ms
Range of [MIN]	0
Range of [MAX]	107374.1823
Definition	VM_AMC_JERK_UNIPOLAR[MAX] = 107374.1823 / *AMC Auto Resolution Scaling* (31.016) VM_AMC_JERK_UNIPOLAR[MIN] = 0

VM_AMC_POSITION	Range applied to the parameters showing the AMC position
Unit	User units
Range of [MIN]	-2147483648
Range of [MAX]	2147483647
Definition	VM_AMC_POSITION is modified by *AMC Auto Resolution Scaling* (31.016) and *AMC Roll Over Limit* (31.010). See the table below.

AMC Roll Over Limit (31.010)	**= 0**	**> 0**
VM_AMC_POSITION[MAX]	2147483647 / *AMC Auto Resolution Scaling* (31.016)	*AMC Roll Over Limit* (31.010) - 1
VM_AMC_POSITION[MIN]	-2147483648 / *AMC Auto Resolution Scaling* (31.016)	0

VM_AMC_POSITION_CAM	Range applied to the parameters showing the AMC cam position
Unit	User units
Range of [MIN]	-1073741824
Range of [MAX]	1073741823
Definition	VM_AMC_POSITION_CAM is modified by *AMC Auto Resolution Scaling* (31.016) and *AMC Roll Over Limit* (31.010). See the table below.

AMC Roll Over Limit (31.010)	**= 0**	**> 0**
VM_AMC_POSITION_CAM[MAX]	1073741823 / *AMC Auto Resolution Scaling* (31.016)	*AMC Roll Over Limit* (31.010) - 1
VM_AMC_POSITION_CAM[MIN]	-1073741824 / *AMC Auto Resolution Scaling* (31.016)	*-AMC Roll Over Limit* (31.010) + 1

VM_AMC_POSITION_CAM_UNIPOLAR	Unipolar version of VM_AMC_POSITION_CAM
Unit	User units
Range of [MIN]	0
Range of [MAX]	1073741823
Definition	VM_AMC_POSITION_CAM_UNIPOLAR is modified by *AMC Auto Resolution Scaling* (31.016) and *AMC Roll Over Limit* (31.010). See the table below. .

AMC Roll Over Limit (31.010)	**= 0**	**> 0**
VM_AMC_POSITION_CAM_UNIPOLAR[MAX]	1073741823 / *AMC Auto Resolution Scaling* (31.016)	*AMC Roll Over Limit* (31.010) - 1
VM_AMC_POSITION_CAM_UNIPOLAR[MIN]	0	0

VM_AMC_POSITION_REF	Range applied to the AMC position reference
Unit	User units
Range of [MIN]	-2147483648
Range of [MAX]	2147483647
Definition	VM_AMC_POSITION_REF is modified by *AMC Auto Resolution Scaling* (31.016), *AMC Roll Over Limit* (31.010) and *AMC Rotary Mode* (34.005). See the table below.

AMC Roll Over Limit (31.010)	**= 0**	**> 0**	**> 0**
AMC Rotary Mode (34.005)	**Not active**	**< 4**	**= 4**
VM_AMC_POSITION_REF[MAX]	2147483647 / *AMC Auto Resolution Scaling* (31.016)	*AMC Roll Over Limit* (31.010) - 1	1073741823 / *AMC Auto Resolution Scaling* (31.016)
VM_AMC_POSITION_REF[MIN]	-2147483648 / *AMC Auto Resolution Scaling* (31.016)	0	-1073741824 / *AMC Auto Resolution Scaling* (31.016)

VM_AMC_POSITION_UNIPOLAR	Unipolar version of VM_AMC_POSITION
Unit	User units
Range of [MIN]	0
Range of [MAX]	2147483647
Definition	VM_AMC_POSITION_UNIPOLAR is modified by *AMC Auto Resolution Scaling* (31.016) and *AMC Roll Over Limit* (31.010). See the table below.

AMC Roll Over Limit (31.010)	= 0	> 0
VM_AMC_POSITION_UNIPOLAR[MAX]	2147483647 / *AMC Auto Resolution Scaling* (31.016)	*AMC Roll Over Limit* (31.010) - 1
VM_AMC_POSITION_UNIPOLAR[MIN]	0	0

VM_AMC_RATE	Range applied to the parameters showing the AMC acceleration
Unit	User units / ms / ms
Range of [MIN]	1073742.824
Range of [MAX]	1073741.823
Definition	VM_AMC_RATE_UNIPOLAR[MAX] = 1073741.823 / *AMC Auto Resolution Scaling* (31.016) VM_AMC_RATE_UNIPOLAR[MIN] = 1073741.824 / AMC Auto Resolution Scaling (31.016)

VM_AMC_RATE_UNIPOLAR	Unipolar version of VM_AMC_RATE
Unit	User units / ms / ms
Range of [MIN]	0
Range of [MAX]	1073741.823
Definition	VM_AMC_RATE_UNIPOLAR[MAX] = 1073741.823 / *AMC Auto Resolution Scaling* (31.016) VM_AMC_RATE_UNIPOLAR[MIN] = 0

VM_AMC_ROLLOVER	Maximum applied to the AMC Rollover parameter
Unit	User units / ms / ms
Range of [MIN]	0
Range of [MAX]	1073741823
Definition	VM_AMC_ROLLOVER[MAX] = 1073741823 / *AMC Auto Resolution Scaling* (31.016) VM_AMC_ROLLOVER[MIN] = 0

VM_AMC_SPEED	Range applied to the parameters showing the AMC speed
Unit	User units / ms / ms
Range of [MIN]	-21474836.48
Range of [MAX]	21474836.47
Definition	VM_AMC_SPEED[MAX] = 21474836.47 / *AMC Auto Resolution Scaling* (31.016) VM_AMC_SPEED[MIN] = -21474836.48 / *AMC Auto Resolution Scaling* (31.016)

VM_AMC_SPEED_UNIPOLAR	Unipolar version of VM_AMC_SPEED
Unit	User units / ms
Range of [MIN]	0
Range of [MAX]	21474836.47
Definition	VM_SPEED_UNIPOLAR[MAX] = 21474836.47 / *AMC Auto Resolution Scaling* (31.016) VM_SPEED_UNIPOLAR[MIN] = 0

VM_DC_VOLTAGE	Range applied to parameters showing DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1190
Definition	VM_DC_VOLTAGE[MAX] is the full scale 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]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT[MAX] is equivalent to the full scale (over current trip level) for the drive and is given by *Full Scale Current Kc* (11.061). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]

VM_DRIVE_CURRENT_UNIPOLAR	Unipolar version of VM_DRIVE_CURRENT
Units	A
Range of [MIN]	0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_DRIVE_CURRENT_UNIPOLAR[MAX] = VM_DRIVE_CURRENT[MAX] VM_DRIVE_CURRENT_UNIPOLAR[MIN] = 0.000

VM_HIGH_DC_VOLTAGE	Range applied to parameters showing high DC voltage
Units	V
Range of [MIN]	0
Range of [MAX]	0 to 1500
Definition	VM_HIGH_DC_VOLTAGE[MAX] is the full scale d.c. link voltage feedback for the high d.c. link voltage measurement which can measure the voltage if it goes above the normal full scale value. See Table 11-4. VM_HIGH_DC_VOLTAGE[MIN] = 0

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

VM_MIN_SWITCHING_FREQUENCY	Range applied to the minimum switching frequency parameter
Units	User units
Range of [MIN]	0
Range of [MAX]	0 to 6
Definition	VM_MIN_SWITCHING_FREQUENCY[MAX] = *Maximum Switching Frequency* (05.018) VM_MIN_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes, or 1 for Regen mode (subject to the maximum)

VM_MOTOR1_CURRENT_LIMIT **VM_MOTOR2_CURRENT_LIMIT**	Range applied to current limit parameters
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0 **Open-loop** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos($\sin^{-1}$(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** sin ϕ I_{Trated} = Pr **05.007** x cos ϕ cos ϕ = Pr **05.010** I_{MaxRef} is 0.7 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty). **RFC-A** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{Tlimit} / I_{Trated}) x 100 % Where: I_{Tlimit} = I_{MaxRef} x cos($\sin^{-1}$(I_{Mrated} / I_{MaxRef})) I_{Mrated} = Pr **05.007** x sin ϕ_1 ITrated = Pr **05.007** x cos ϕ_1 ϕ_1 = cos-1 (Pr **05.010**) + ϕ_2. ϕ_1 is calculated during an autotune. See the variable minimum / maximum calculations in the *Parameter Reference Guide* for more information regarding ϕ_2. I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty). **RFC-S and Regen** VM_MOTOR1_CURRENT_LIMIT[MAX] = (I_{MaxRef} / Pr **05.007**) x 100 % Where: I_{MaxRef} is 0.9 x Pr **11.061** when the motor rated current set in Pr **05.007** is less than or equal to Pr **11.032** (i.e. Heavy duty). For VM_MOTOR2_CURRENT_LIMIT[MAX] use Pr **21.007** instead of Pr **05.007** and Pr **21.010** instead of Pr **05.010**.

VM_NEGATIVE_REF_CLAMP1 **VM_NEGATIVE_REF_CLAMP2**	Limits applied to the negative frequency or speed clamp
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.0 to 0.0 RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	See table below VM_NEGATIVE_REF_CLAMP2 is defined in the same way except that Pr **21.001** is used instead of Pr **01.006**.

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_NEGATIVE_REF_ CLAMP1[MIN]**	**VM_NEGATIVE_REF_ CLAMP1[MAX]**
0	0	0.0	Pr **01.006**
0	1	0.0	0.0
1	X	-VM_POSITIVE_REF_CLAMP1[MAX]	0.0

VM_POSITIVE_REF_CLAMP1 **VM_POSITIVE_REF_CLAMP2**	Limits applied to the positive frequency or speed reference clamp
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: 0.0 RFC-A, RFC-S: 0.0
Range of [MAX]	Open-loop: 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_POSITIVE_REF_CLAMP1[MAX] defines the range of the positive reference clamp, *Maximum Reference Clamp* (01.006), which in turn limit the references. In RFC-A and RFC-S modes a limit is applied so that the position feedback does not exceed the speed where the drive can no longer interpret the feedback signal correctly as given in the table below. The limit is based on the position feedback device selected with *Motor Control Feedback Select* (03.026). It is possible to disable this limit if the *RFC Feedback Mode* (03.024) ≥ 1 (i.e. VM_POSITIVE_REF_CLAMP1 = 50000.0), so that the motor can be operated at a speed above the level where the drive can interpret the feedback in sensorless mode. It should be noted that the position feedback device itself may have a maximum speed limit that is lower than those given in the table. Care should be taken not to exceed a speed that would cause damage to the position feedback device.

Feedback device	VM_POSITIVE_REF_CLAMP1[MAX]
AB, AB Servo	(500 kHz x 60 / rotary lines per revolution) rpm (500 kHz x linear line pitch in mm) mm/s
FD, FR, FD Servo, FR Servo	(500 kHz x 60 / rotary lines per revolution)/2 rpm (500 kHz x linear line pitch in mm)/2 mm/s
SC, SC Hiper, SC EnDat, SC SSI, SC Servo	(500 kHz x 60 / sine waves per revolution) rpm (500 kHz x linear line pitch in mm) mm/s
Resolver	(250 Hz x 60) rpm (250 Hz x pole pitch in mm) mm/s
Any other device	50000.0 rpm or mm/s

In open-loop mode VM_POSITIVE_REF_CLAMP1[MAX] is fixed at 550.0 Hz

In RFC mode a limit is applied to the speed reference of 550 x 60 / Motor pole pairs. Therefore, with a 4 pole motor the limit for VM_POSITIVE_REF_CLAMP1[MAX] will be 16,500 rpm.

VM_POSITIVE_REF_CLAMP1[MIN] = 0.0

VM_POSITIVE_REF_CLAMP2 is defined in the same way as VM_POSITIVE_REF_CLAMP1 except VM_POSITIVE_REF_CLAMP2[MAX] defines the range of the positive reference clamp, *M2 Maximum Reference Clamp* (21.001), which in turn limits the references.

VM_POWER	Range applied to parameters that either set or display power
Units	kW
Range of [MIN]	-99999.999 to 0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_POWER[MAX] is rating dependent and is chosen to allow for the maximum power that can be output by the drive with maximum a.c. output voltage, at maximum controlled current and unity power factor. VM_POWER[MAX] = √3 x VM_AC_VOLTAGE[MAX] x VM_DRIVE_CURRENT[MAX] / 1000 VM_POWER[MIN] = -VM_POWER[MAX]

VM_RATED_CURRENT	Range applied to rated current parameters
Units	A
Range of [MIN]	0.000
Range of [MAX]	0.000 to 99999.999
Definition	VM_RATED_CURRENT [MAX] = *Maximum Rated Current* (11.060) and is dependent on the drive rating. This is the Heavy Duty rating of the drive. VM_RATED_CURRENT [MIN] = 0.000

VM_REGEN_REACTIVE	Range applied to the reactive current reference in Regen mode
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_REGEN_REACTIVE[MAX] Applies a limit to the reactive current reference in Regen mode so that the total current reference does not exceed its maximum allowed level. VM_REGEN_REACTIVE[MIN] = - VM_REGEN_REACTIVE[MAX]

VM_SPEED	Range applied to parameters showing speed
Units	Open-loop, RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop, RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop, RFC-A, RFC-S: 0.0 to 50000.0
Definition	This variable minimum/maximum defines the range of speed monitoring parameters. To allow headroom for overshoot the range is set to twice the range of the speed references. VM_SPEED[MAX] = 2 x VM_SPEED_FREQ_REF[MAX] VM_SPEED[MIN] = 2 x VM_SPEED_FREQ_REF[MIN]

VM_SPEED_FREQ_KEYPAD_REF	Range applied to the keypad reference
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.0 to 550.0 RFC-A, RFC-S: -50000.0 to 50000.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	This variable maximum is applied to *Keypad Control Mode 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	0.0
1	1	-VM_SPEED_FREQ_REF[MAX]

VM_SPEED_FREQ_REF	Range applied to the frequency or speed reference parameters
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.0 to 0.0 RFC-A, RFC-S: -50000.0 to 0.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	If Pr **01.008** = 0: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** If Pr **01.008** = 1: VM_SPEED_FREQ_REF[MAX] = Pr **01.006** or |Pr **01.007**|, whichever is larger. If the second motor map is selected (Pr **11.045** = 1) Pr **21.001** is used instead of Pr **01.006** and Pr **21.002** instead of Pr **01.007**. VM_SPEED_FREQ_REF[MIN] = -VM_SPEED_FREQ_REF[MAX].

VM_SPEED_FREQ_REF_UNIPOLAR	Unipolar version of VM_SPEED_FREQ_REF
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: 0.0 RFC-A, RFC-S: 0.0
Range of [MAX]	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_SPEED_FREQ_REF_UNIPOLAR[MAX] = VM_SPEED_FREQ_REF[MAX] VM_SPEED_FREQ_REF_UNIPOLAR[MIN] = 0.0

VM_SPEED_FREQ_USER_REFS	Range applied to Analog reference parameters
Units	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s
Range of [MIN]	Open-loop: -550.00 to 550.00 RFC-A, RFC-S: -50000.0 to 50000.0
Range of [MAX]	Open-loop: 0.00 to 550.00 RFC-A, RFC-S: 0.0 to 50000.0
Definition	VM_SPEED_FREQ_USER_REFS= VM_SPEED_FREQ_REF[MAX]

***Negative Reference Clamp Enable* (01.008)**	***Bipolar Reference Enable* (01.010)**	**VM_SPEED_FREQ_USER_REFS [MIN]**
0	0	Pr **01.007**
0	1	-VM_SPEED_FREQ_REF[MAX]
1	0	0.0
1	1	-VM_SPEED_FREQ_REF[MAX]

If the second motor map is selected (Pr **11.045** = 1) Pr **21.002** is used instead of Pr **01.007**.

VM_STD_UNDER_VOLTS	Range applied to the standard under-voltage threshold
Units	V
Range of [MIN]	0 to 1150
Range of [MAX]	0 to 1150
Definition	VM_STD_UNDER_VOLTS[MAX] = VM_DC_VOLTAGE_SET / 1.1 VM_STD_UNDER_VOLTS[MIN] is voltage rating dependent. See Table 11-4.

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

VM_SWITCHING_FREQUENCY	Range applied to the maximum switching frequency parameters
Units	User units
Range of [MIN]	0
Range of [MAX]	0 to 6
Definition	VM_SWITCHING_FREQUENCY[MAX] = Power stage dependent VM_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes, or 1 for Regen mode (subject to the maximum)

VM_TORQUE_CURRENT	Range applied to torque and torque producing current parameters (where this is used in Regen mode it refers to the active current)
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	***Select Motor 2 Parameters* (11.045)** / **VM_TORQUE_CURRENT [MAX]** 0 / VM_MOTOR1_CURRENT_LIMIT[MAX] 1 / VM_MOTOR2_CURRENT_LIMIT[MAX] VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]

VM_TORQUE_CURRENT_UNIPOLAR	Unipolar version of VM_TORQUE_CURRENT
Units	%
Range of [MIN]	0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX] VM_TORQUE_CURRENT_UNIPOLAR[MIN] =0.0

VM_USER_CURRENT	Range applied to torque reference and percentage load parameters with one decimal place
Units	%
Range of [MIN]	-1000.0 to 0.0
Range of [MAX]	0.0 to 1000.0
Definition	VM_USER_CURRENT[MAX] = *User Current Maximum Scaling* (04.024) VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX] *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to *Percentage Load* (04.020), *Torque Reference* (04.008) and *Torque Offset* (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

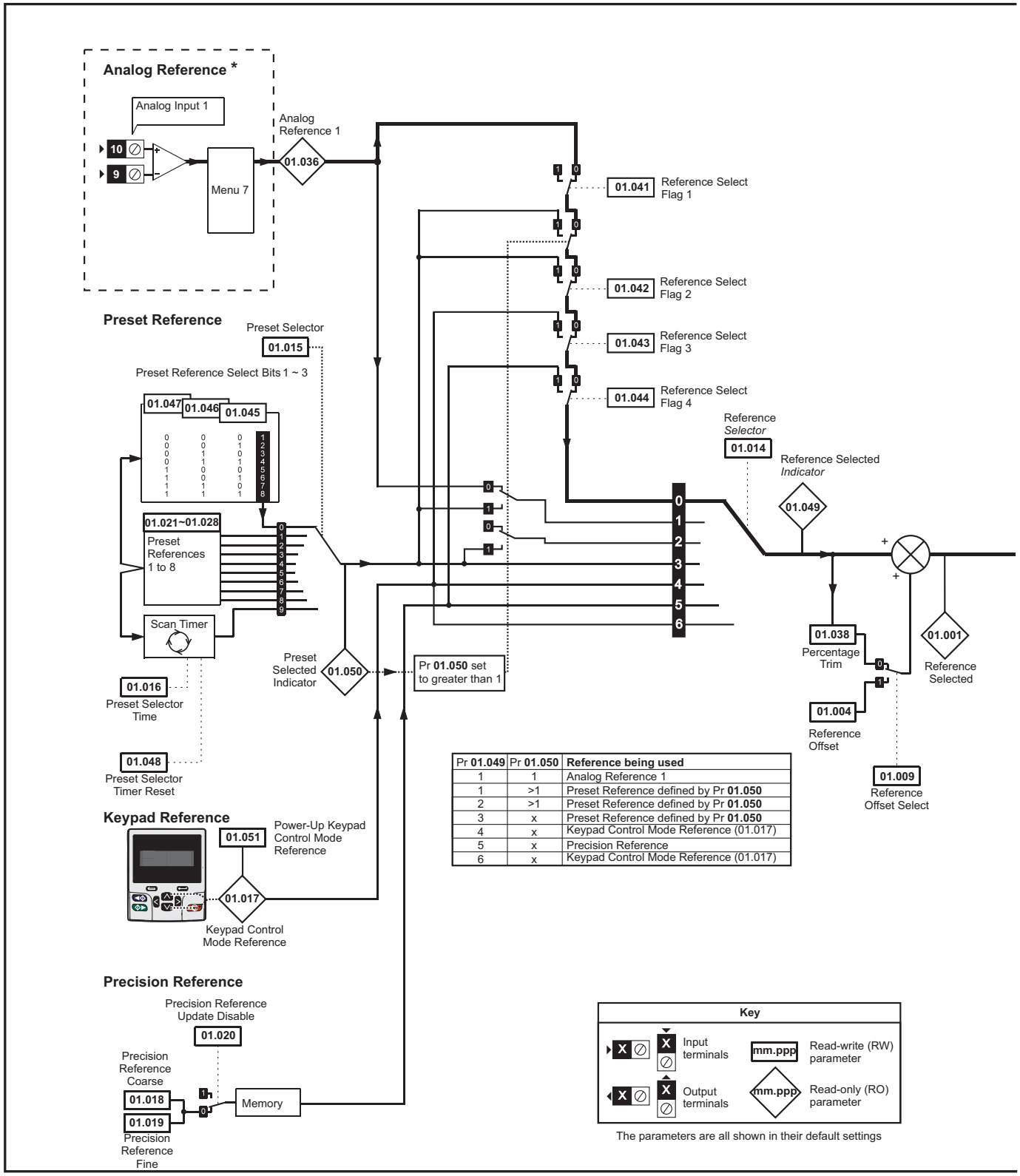
VM_USER_CURRENT_HIGH_RES	Range applied to torque reference and percentage load parameters with two decimal places
Units	%
Range of [MIN]	-1000.00 to 0.00
Range of [MAX]	0.00 to 1000.00
Definition	VM_USER_CURRENT_HIGH_RES[MAX] = *User Current Maximum Scaling* (04.024) with an additional decimal place VM_USER_CURRENT_HIGH_RES[MIN] = -VM_USER_CURRENT_HIGH_RES[MAX] *User Current Maximum Scaling* (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to *Percentage Load* (04.020), *Torque Reference* (04.008) and *Torque Offset* (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user. The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.

Table 11-4 Voltage ratings dependant values

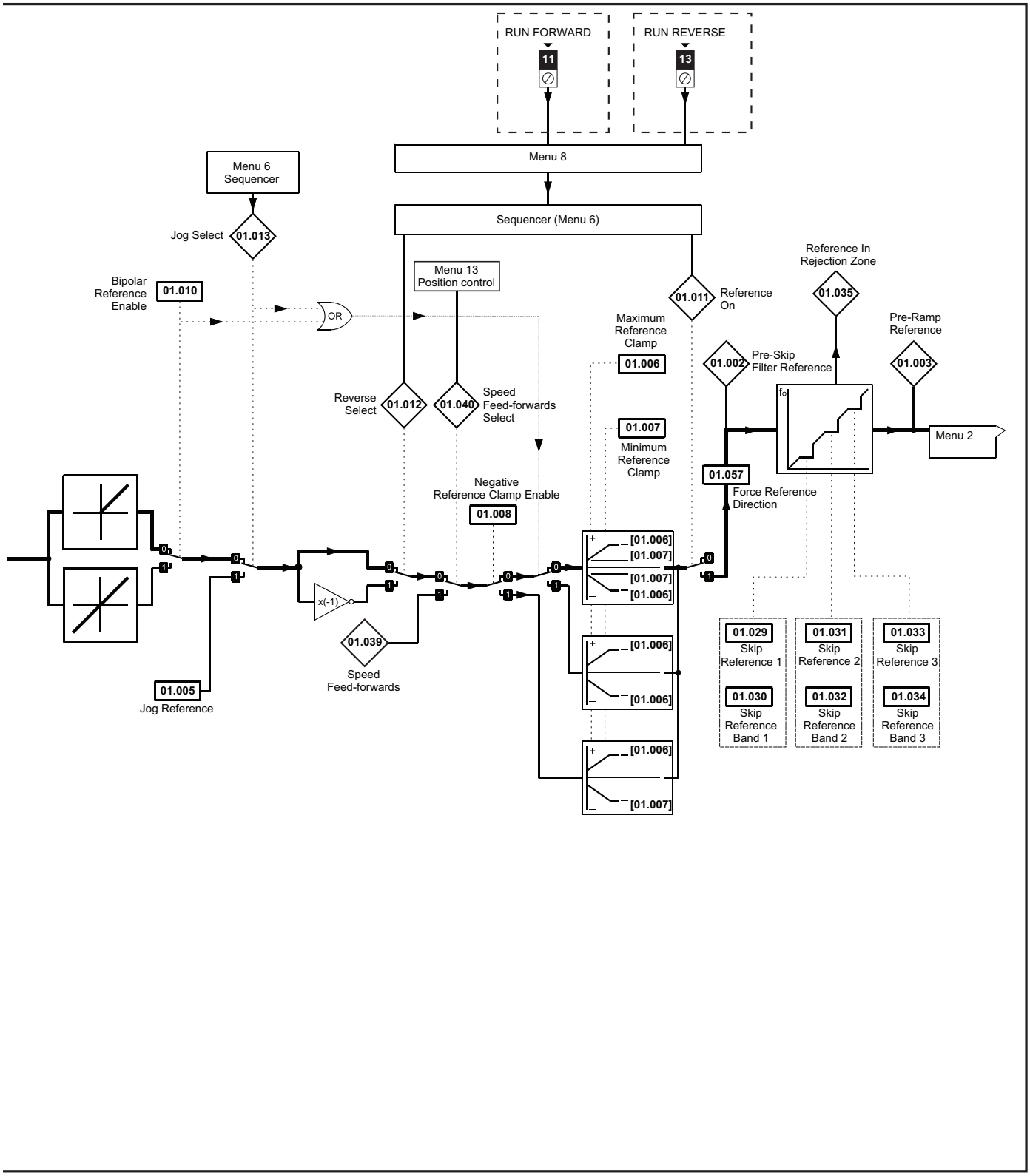
Variable min/max	**Voltage level (V)**	
	200 V	**400 V**
VM_DC_VOLTAGE_SET[MAX]	400	800
VM_DC_VOLTAGE[MAX]	415	830
VM_AC_VOLTAGE_SET[MAX]	265	530
VM_AC_VOLTAGE[MAX]	325	650
VM_STD_UNDER_VOLTS[MIN]	175	330
VM_SUPPLY_LOSS_LEVEL[MIN]	205	410
VM_HIGH_DC_VOLTAGE[MAX]	1500	1500

11.2 Menu 1: Frequency / speed reference

Figure 11-1 Menu 1 logic diagram



Pr **01.049**	Pr **01.050**	**Reference being used**
1	1	Analog Reference 1
1	>1	Preset Reference defined by Pr **01.050**
2	>1	Preset Reference defined by Pr **01.050**
3	x	Preset Reference defined by Pr **01.050**
4	x	Keypad Control Mode Reference (01.017)
5	x	Precision Reference
6	x	Keypad Control Mode Reference (01.017)

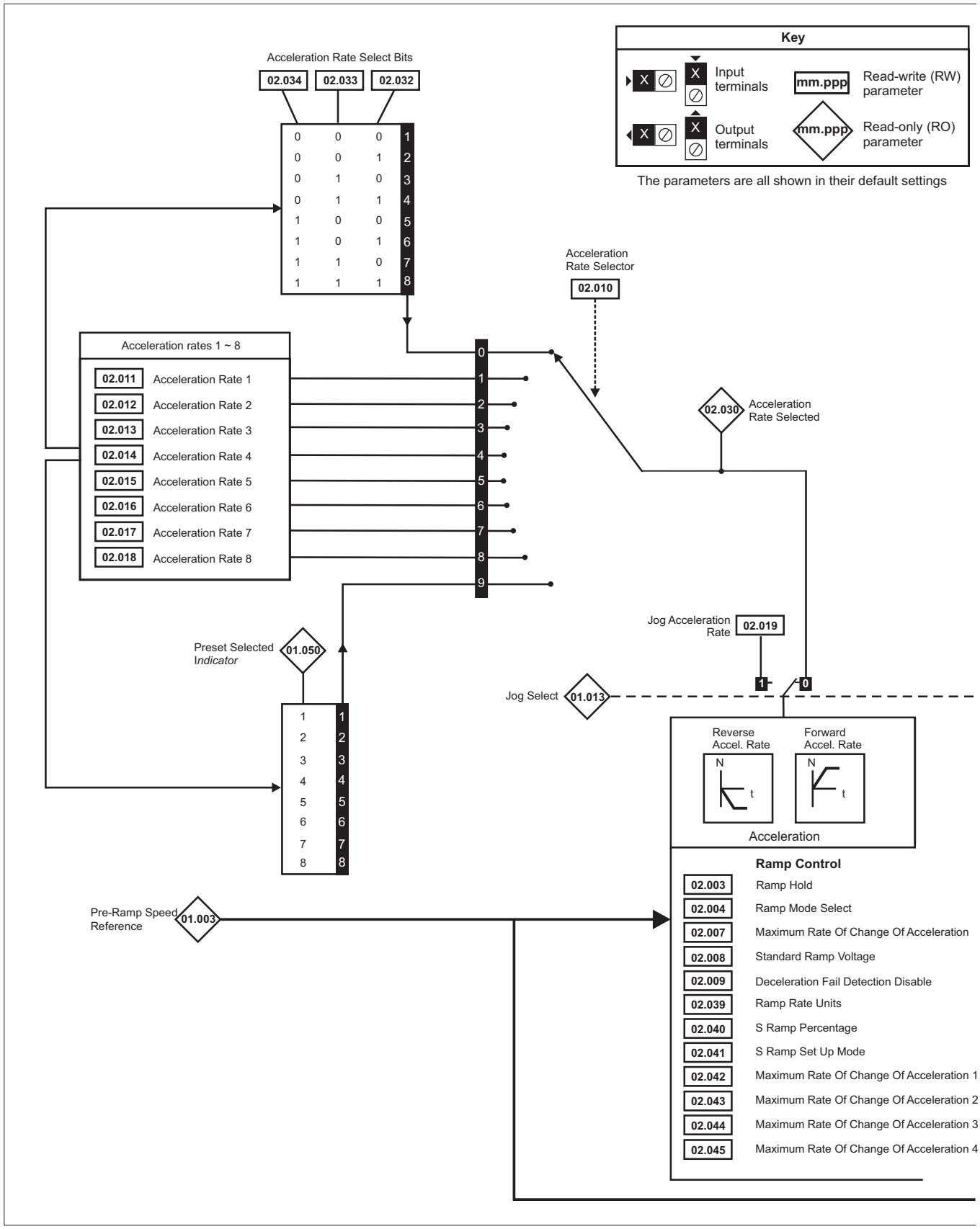

RUN FORWARD
11
RUN REVERSE
13
Menu 8
Sequencer (Menu 6)
Menu 6 Sequencer
Jog Select
01.013
Bipolar Reference Enable
01.010
OR
Menu 13 Position control
Reverse Select
01.012
01.040
Speed Feed-forwards Select
01.011
Reference On
Reference In Rejection Zone
01.035
Maximum Reference Clamp
01.006
01.002
Pre-Skip Filter Reference
Pre-Ramp Reference
01.003
01.007
Minimum Reference Clamp
Menu 2
01.057
Force Reference Direction
Negative Reference Clamp Enable
01.008
x(-1)
01.039
Speed Feed-forwards
01.005
Jog Reference
[01.006]
[01.007]
[01.007]
[01.006]
[01.006]
[01.006]
[01.006]
[01.007]
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

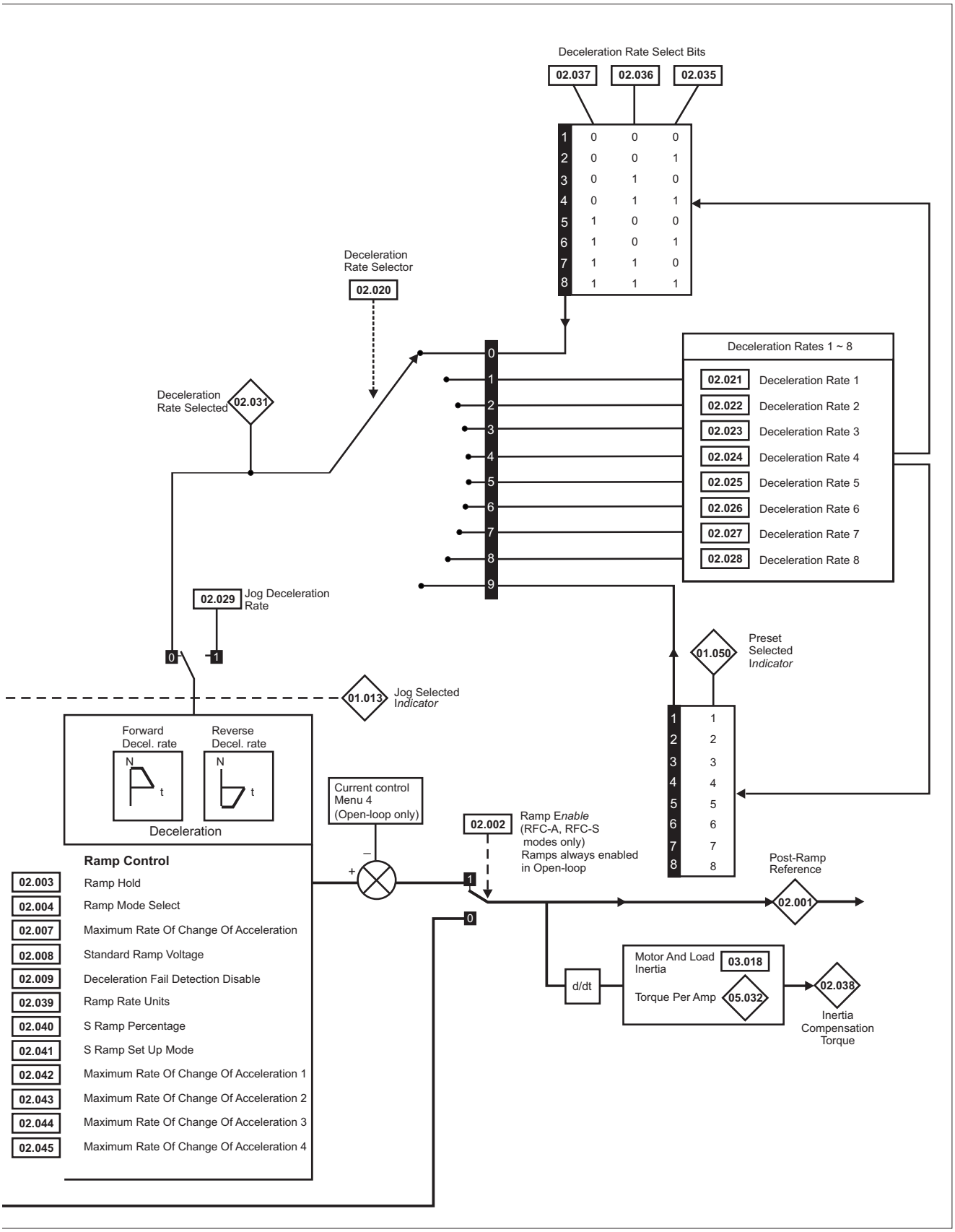
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
01.001	Reference Selected	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.002	Pre-Skip Filter Reference	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.003	Pre-Ramp Reference	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm				RO	Num	ND	NC	PT	
01.004	Reference Offset	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm	0.0			RW	Num				US
01.005	Jog Reference	0.0 to 400.0 Hz	0.0 to 4000.0 rpm	0.0			RW	Num				US
01.006	Maximum Reference Clamp	VM_POSITIVE_REF_ CLAMP1 Hz	VM_POSITIVE_REF_ CLAMP1 rpm	50 Hz: 50.0 60 Hz: 60.0	50Hz: 1500.0 60Hz: 1800.0	3000.0	RW	Num				US
01.007	Minimum Reference Clamp	VM_NEGATIVE_REF_ CLAMP1 Hz	VM_NEGATIVE_REF_ CLAMP1 rpm	0.0			RW	Num				US
01.008	Negative Reference Clamp Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
01.009	Reference Offset Select	Off (0) or On (1)		Off (0)			RW	Bit				US
01.010	Bipolar Reference Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
01.011	Reference On	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.012	Reverse Select	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.013	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), Precision (5), Keypad Ref (6)		A1 Preset (1)			RW	Txt				US
01.015	Preset Selector	0 to 9		0			RW	Num				US
01.016	Preset Selector Time	0.0 to 400.0 s		10.0 s			RW	Num				US
01.017	Keypad Control Mode Reference	VM_SPEED_FREQ_KEYPAD_REF		0.0			RO	Num		NC	PT	PS
01.018	Precision Reference Coarse	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.019	Precision Reference Fine	0.000 to 0.099 Hz	0.000 to 0.099 rpm	0.000			RW	Num				US
01.020	Precision Reference Update Disable	Off (0) or On (1)		Off (0)			RW	Bit		NC		
01.021	Preset Reference 1	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.022	Preset Reference 2	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.023	Preset Reference 3	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.024	Preset Reference 4	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.025	Preset Reference 5	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.026	Preset Reference 6	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.027	Preset Reference 7	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.028	Preset Reference 8	VM_SPEED_FREQ_REF		0.0			RW	Num				US
01.029	Skip Reference 1	0.0 to 550.0 Hz	0 to 33, 000 rpm	0.0	0		RW	Num				US
01.030	Skip Reference Band 1	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.031	Skip Reference 2	0.0 to 550.0 Hz	0 to 33, 000 rpm	0.0	0		RW	Num				US
01.032	Skip Reference Band 2	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.033	Skip Reference 3	0.0 to 550.0 Hz	0 to 33, 000 rpm	0.0	0		RW	Num				US
01.034	Skip Reference Band 3	0.0 to 25.0 Hz	0 to 250 rpm	0.0	0		RW	Num				US
01.035	Reference In Rejection Zone	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.036	Analog Reference 1	VM_SPEED_FREQ_USER_ REFS Hz	VM_SPEED_FREQ_USER_ REFS rpm	0.0			RO	Num		NC		
01.037	Analog Reference 2			0.0			RO	Num		NC		
01.038	Percentage Trim	±100.00 %		0.00 %			RW	Num		NC		
01.039	Speed Feed-forwards	VM_SPEED_FREQ_REF					RO	Num	ND	NC	PT	
01.040	Speed Feed-forwards Select	Off (0) or On (1)					RO	Bit	ND	NC	PT	
01.041	Reference Select Flag 1	Off (0) or On (1)		Off (0)			RW	Bit		NC		
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		
01.044	Reference Select Flag 4	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
01.055	Linear Speed Select		Off (0) or On (1)		Off (0)		RW	Bit				US
01.056	Linear Speed Selected		Off (0) or On (1)				RO	Bit	ND	NC	PT	
01.057	Force Reference Direction	None (0), Forward (1), Reverse (2)		None (0)			RW	Txt				

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

11.3 Menu 2: Ramps

Figure 11-2 Menu 2 logic diagram




Deceleration Rate Select Bits
02.037
02.036
02.035
1 0 0 0
2 0 0 1
3 0 1 0
4 0 1 1
5 1 0 0
6 1 0 1
7 1 1 0
8 1 1 1
Deceleration Rate Selector
02.020
Deceleration Rate Selected
02.031
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
02.029 Jog Deceleration Rate
01.050 Preset Selected Indicator
01.013 Jog Selected Indicator
Forward Decel. rate
Reverse Decel. rate
Deceleration
Current control Menu 4 (Open-loop only)
02.002 Ramp Enable (RFC-A, RFC-S modes only) Ramps always enabled in Open-loop
Post-Ramp Reference
02.001
Motor And Load Inertia 03.018
Torque Per Amp 05.032
d/dt
02.038 Inertia Compensation Torque
Ramp Control
02.003 Ramp Hold
02.004 Ramp Mode Select
02.007 Maximum Rate Of Change Of Acceleration
02.008 Standard Ramp Voltage
02.009 Deceleration Fail Detection Disable
02.039 Ramp Rate Units
02.040 S Ramp Percentage
02.041 S Ramp Set Up Mode
02.042 Maximum Rate Of Change Of Acceleration 1
02.043 Maximum Rate Of Change Of Acceleration 2
02.044 Maximum Rate Of Change Of Acceleration 3
02.045 Maximum Rate Of Change Of Acceleration 4

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
02.001	Post Ramp Reference	VM_SPEED_FREQ_ REF Hz	VM_SPEED_FREQ_ REF rpm				RO	Num	ND	NC	PT	
02.002	Ramp Enable		Off (0) or On (1)		On (1)		RW	Bit				US
02.003	Ramp Hold	Off (0) or On (1)		Off (0)			RW	Bit				US
02.004	Ramp Mode	Fast (0), Standard (1), Std boost (2)	Fast (0), Standard (1)	Standard (1)	Fast (0)		RW	Txt				US
02.005	Disable Ramp Output		Off (0) or On (1)		Off (0)		RW	Bit				US
02.006	S Ramp Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
02.007	Maximum Rate Of Change Of Acceleration	0.0 to 300.0 s^2/100 Hz	0.000 to 100.000 s^2/1000 rpm	3.1	1.500	0.030	RW	Num				US
02.008	Standard Ramp Voltage	0 to VM_DC_VOLTAGE_SET V		200 V drive: 375 V 50 Hz - 400 V drive: 750 V 60 Hz - 400 V drive: 775 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	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.012	Acceleration Rate 2	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.013	Acceleration Rate 3	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.014	Acceleration Rate 4	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.015	Acceleration Rate 5	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.016	Acceleration Rate 6	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.017	Acceleration Rate 7	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.018	Acceleration Rate 8	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	5.0 s	2.000 s	0.200 s	RW	Num				US
02.019	Jog Acceleration Rate	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	0.2 s	0.000 s		RW	Num				US
02.020	Deceleration Rate Selector	0 to 9		0			RW	Num				US
02.021	Deceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.022	Deceleration Rate 2	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.023	Deceleration Rate 3	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.024	Deceleration Rate 4	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.025	Deceleration Rate 5	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.026	Deceleration Rate 6	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.027	Deceleration Rate 7	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.028	Deceleration Rate 8	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	10.0 s	2.000 s	0.200 s	RW	Num				US
02.029	Jog Deceleration Rate	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/1000 rpm	0.2 s	0.000 s		RW	Num				US
02.030	Acceleration Rate Selected	0 to 8					RO	Num	ND	NC	PT	
02.031	Deceleration Rate Selected	0 to 8					RO	Num	ND	NC	PT	
02.032	Acceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.033	Acceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.034	Acceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.035	Deceleration Rate Select Bit 0	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.036	Deceleration Rate Select Bit 1	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.037	Deceleration Rate Select Bit 2	Off (0) or On (1)		Off (0)			RW	Bit		NC		
02.038	Inertia Compensation Torque		±1000.0 %				RO	Num	ND	NC	PT	
02.039	Ramp Rate Units	Off (0) or On (1)		Off (0)			RW	BIt				US
02.040	S Ramp Percentage	0.0 to 50.0 %		0.0 %			RW					US
02.041	S Ramp Set-up Mode	Single (0), Percentage (1), Independent (2)		Single (0)			RW	Txt				US
02.042	Maximum Rate Of Change Of Acceleration 1	0.0 to 300.0	0.000 to 100.000	0.0	0.000		RW	Num				US
02.043	Maximum Rate Of Change Of Acceleration 2	0.0 to 300.0	0.000 to 100.000	0.0	0.000		RW	Num				US
02.044	Maximum Rate Of Change Of Acceleration 3	0.0 to 300.0	0.000 to 100.000	0.0	0.000		RW	Num				US
02.045	Maximum Rate Of Change Of Acceleration 4	0.0 to 300.0	0.000 to 100.000	0.0	0.000		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 slaving, speed feedback and speed control

Figure 11-3 Menu 3 Open-loop logic diagram

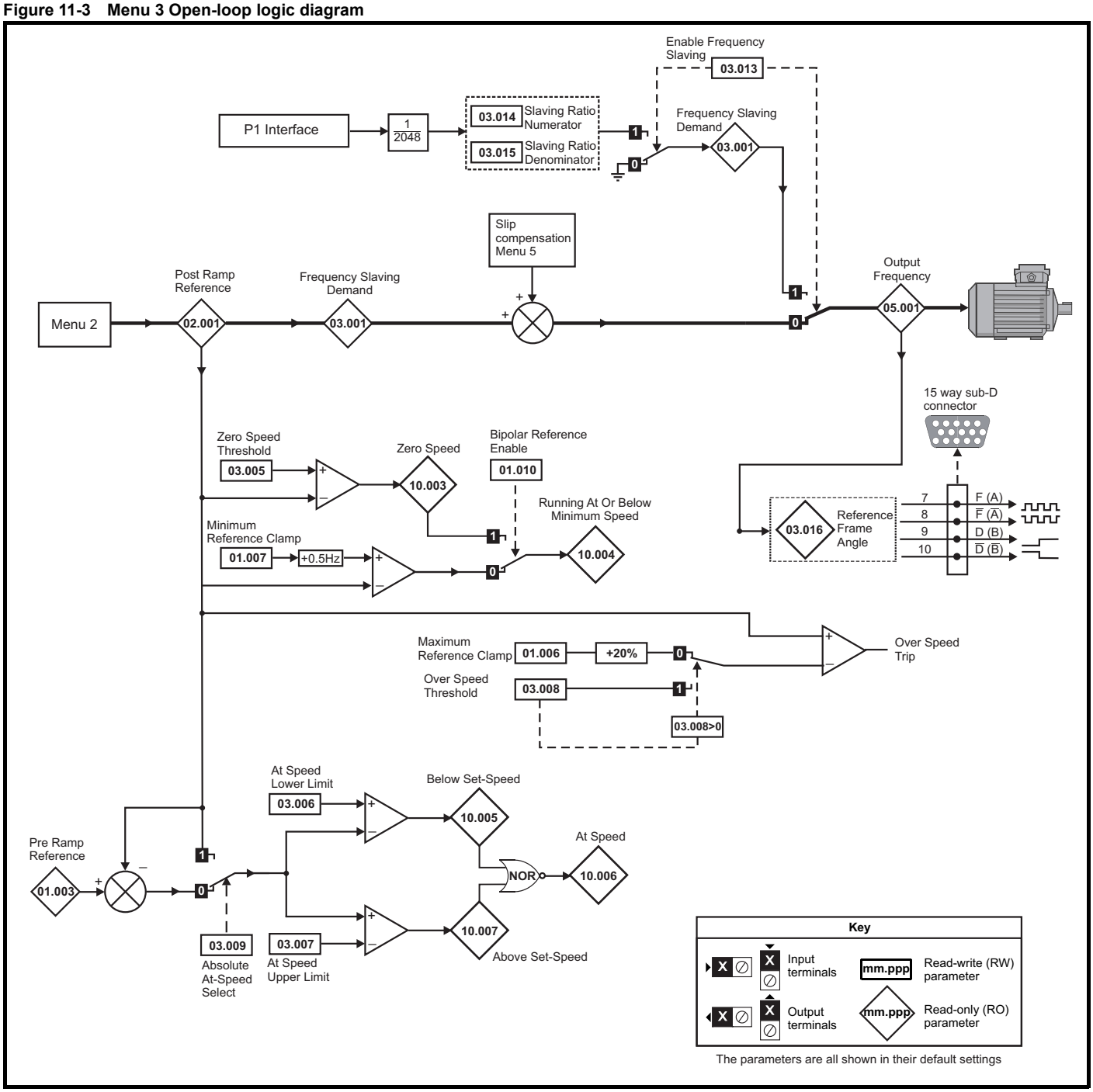
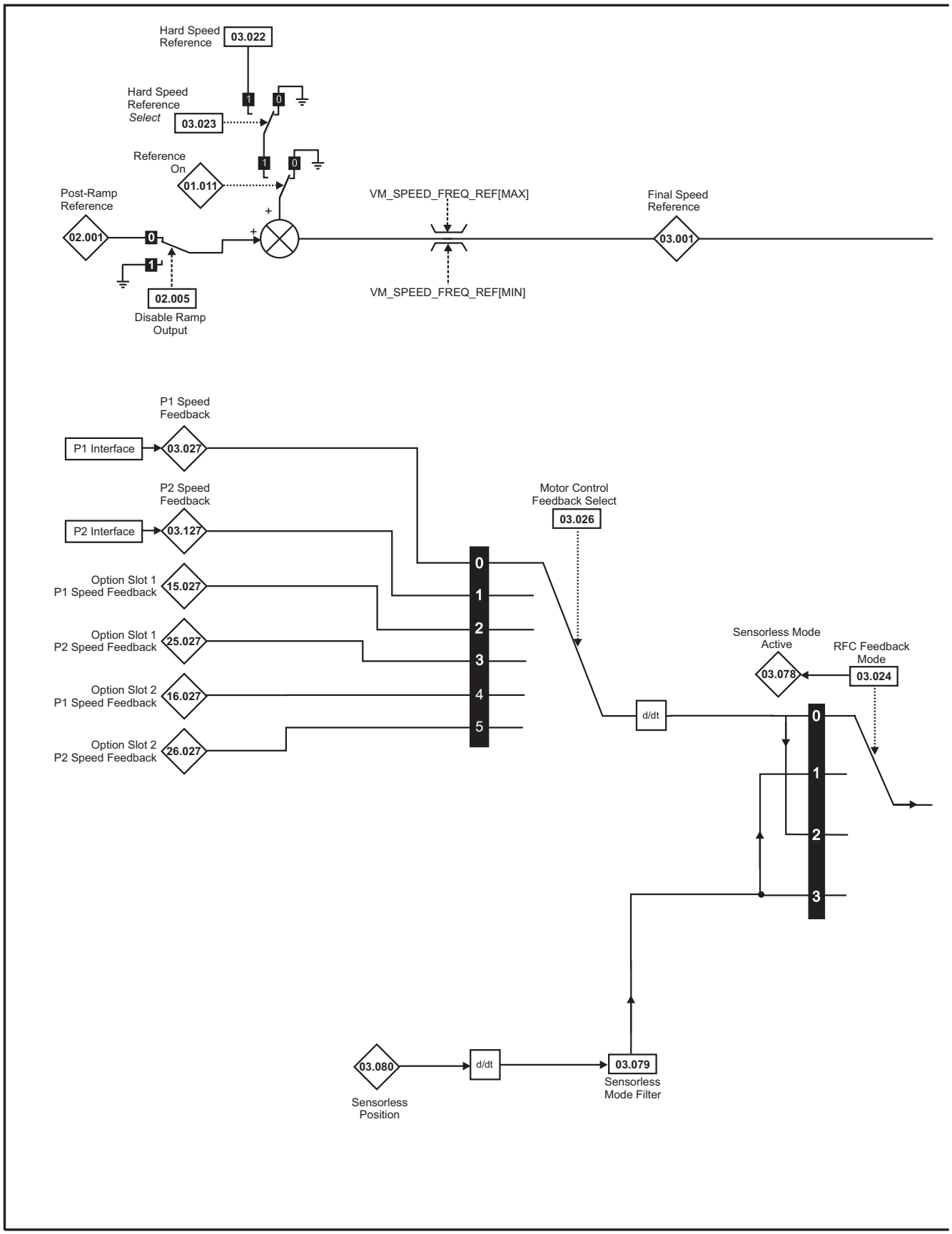


Figure 11-4 Menu 3 RFC-A, RFC-S logic diagram



NOTE

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

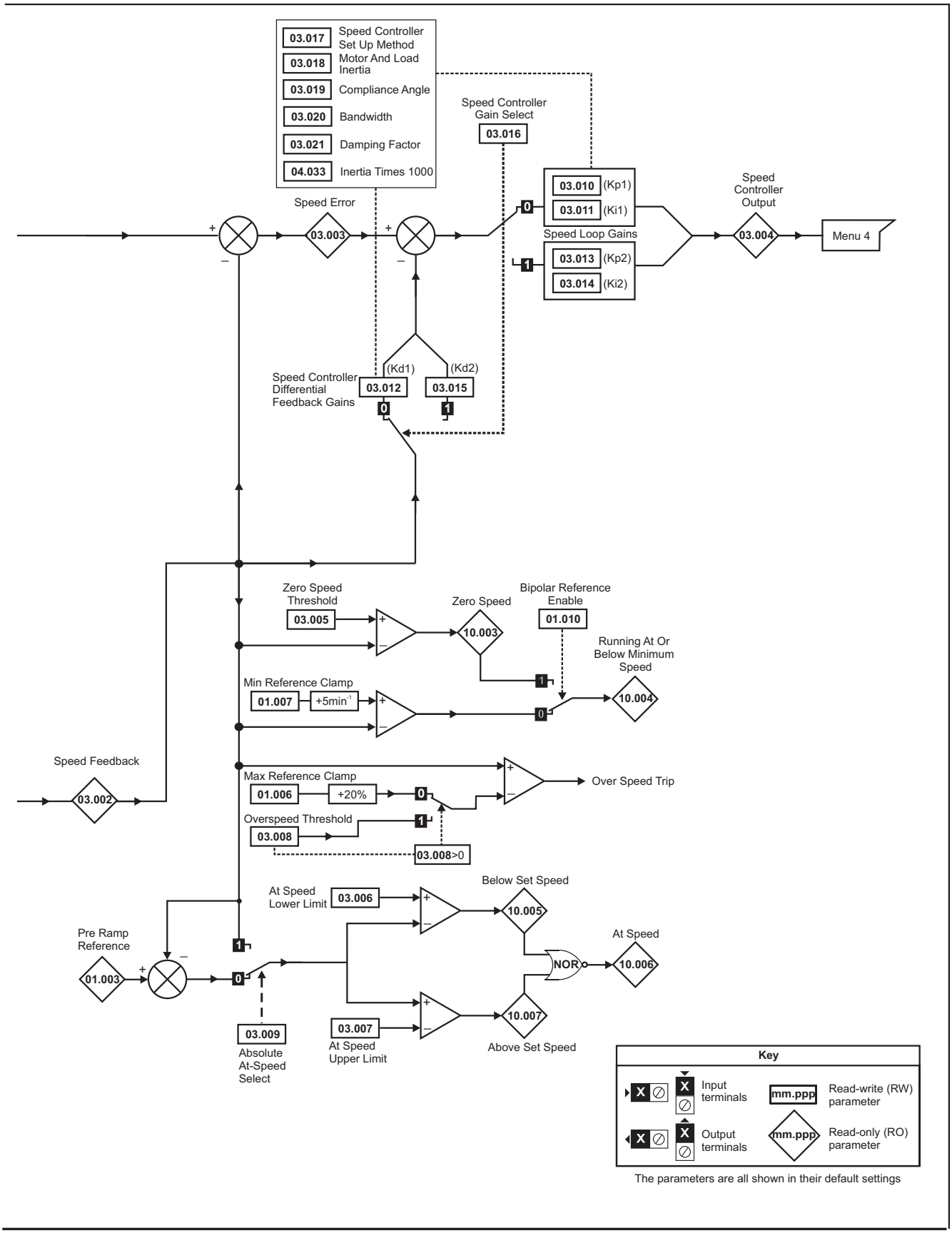

03.017 Speed Controller Set Up Method
03.018 Motor And Load Inertia
03.019 Compliance Angle
03.020 Bandwidth
03.021 Damping Factor
04.033 Inertia Times 1000
Speed Controller Gain Select
03.016
Speed Error
03.003
03.010 (Kp1)
03.011 (Ki1)
Speed Loop Gains
03.013 (Kp2)
03.014 (Ki2)
Speed Controller Output
03.004
Menu 4
Speed Controller Differential Feedback Gains
(Kd1)
(Kd2)
03.012
03.015
Zero Speed Threshold
03.005
Zero Speed
10.003
Bipolar Reference Enable
01.010
Running At Or Below Minimum Speed
10.004
Min Reference Clamp
01.007
+5min-1
Speed Feedback
03.002
Max Reference Clamp
01.006
+20%
Over Speed Trip
Overspeed Threshold
03.008
03.008>0
At Speed Lower Limit
03.006
Below Set Speed
10.005
Pre Ramp Reference
01.003
NOR
At Speed
10.006
03.009
Absolute At-Speed Select
03.007
At Speed Upper Limit
10.007
Above Set Speed
Key
Input terminals
Output terminals
mm.ppp
Read-write (RW) parameter
Read-only (RO) parameter
The parameters are all shown in their default settings

Figure 11-5 P1 Interface

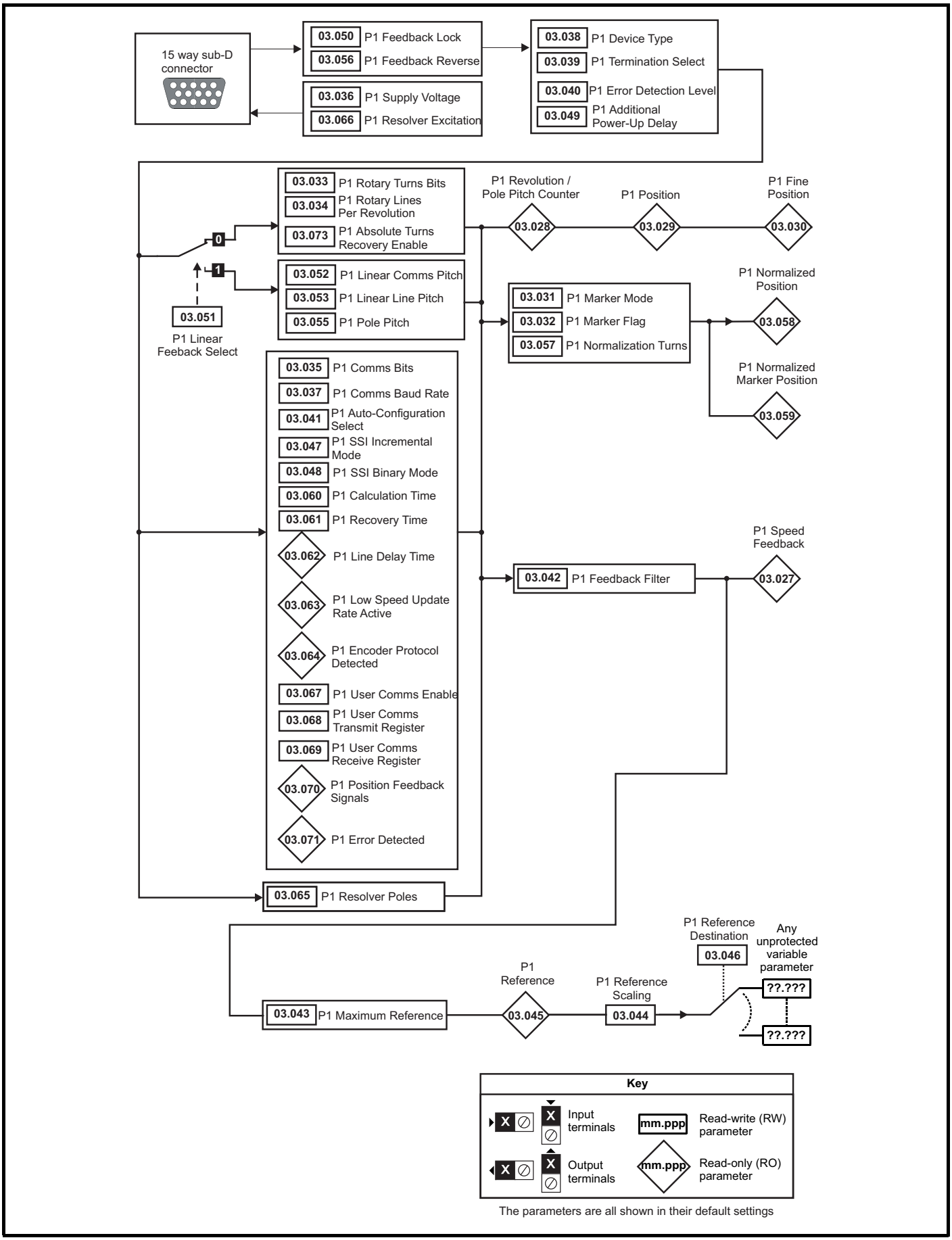


Figure 11-6 P2 Interface

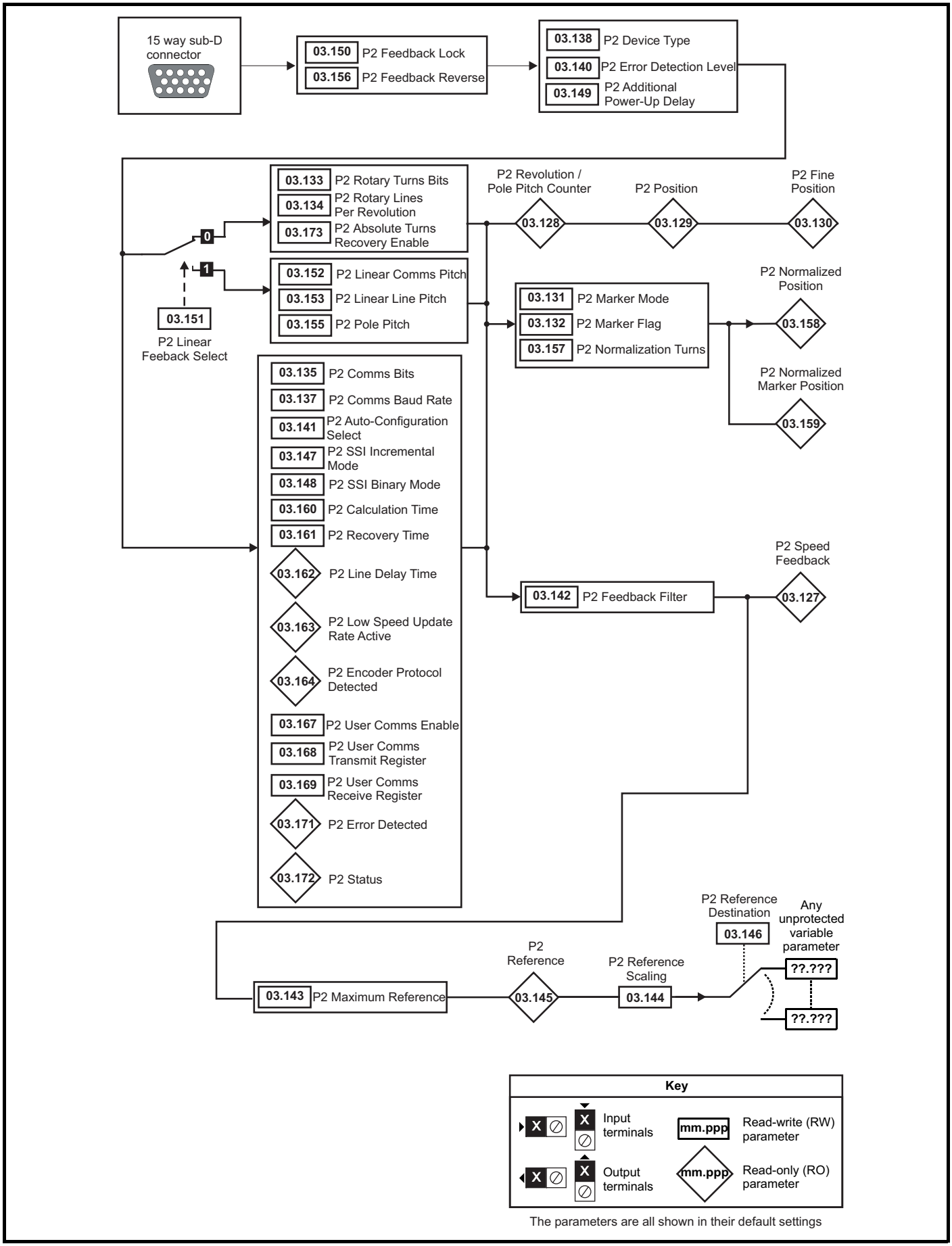


Figure 11-7 Freeze system logic

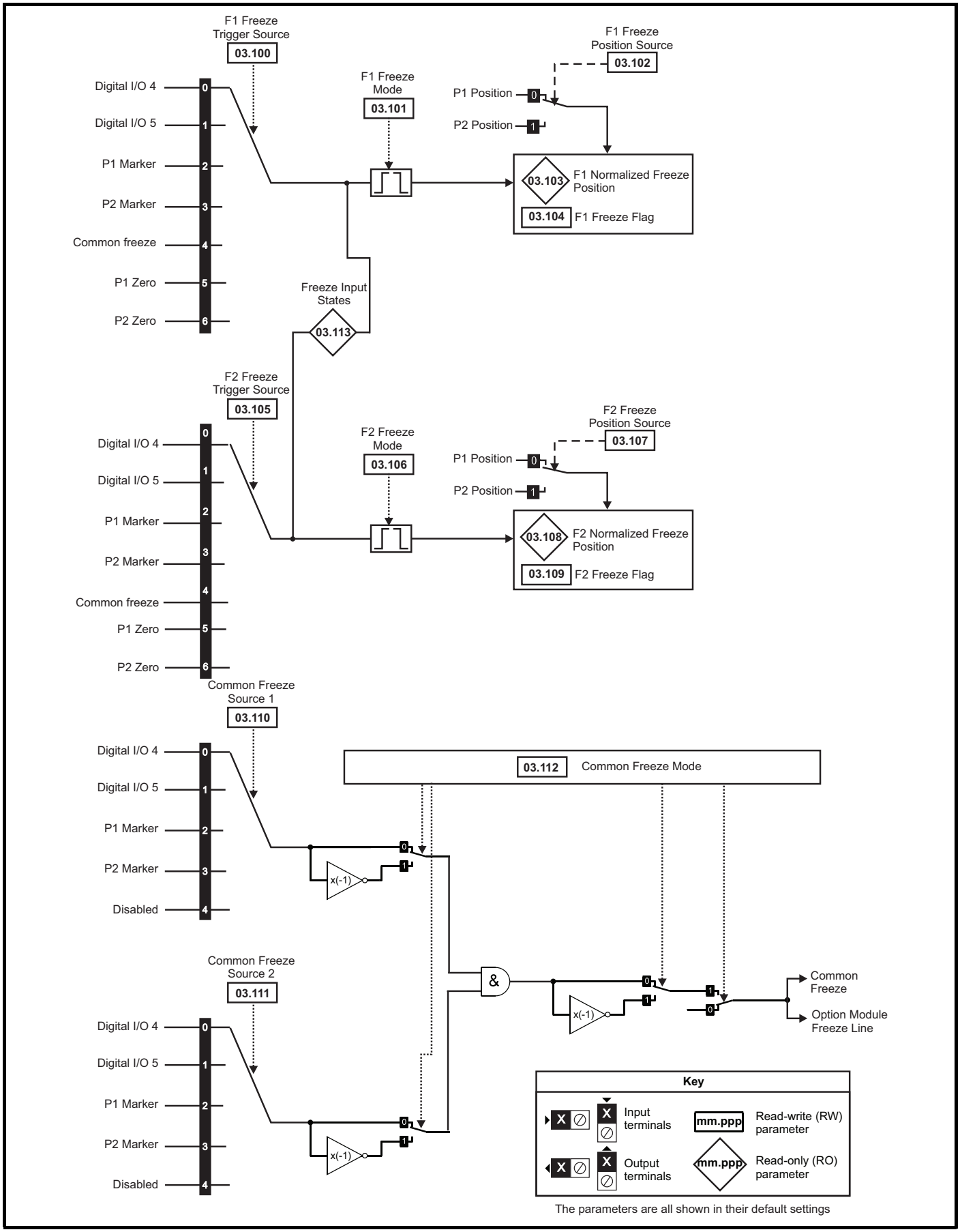


Figure 11-8 P1 Position feedback interface thermistor input

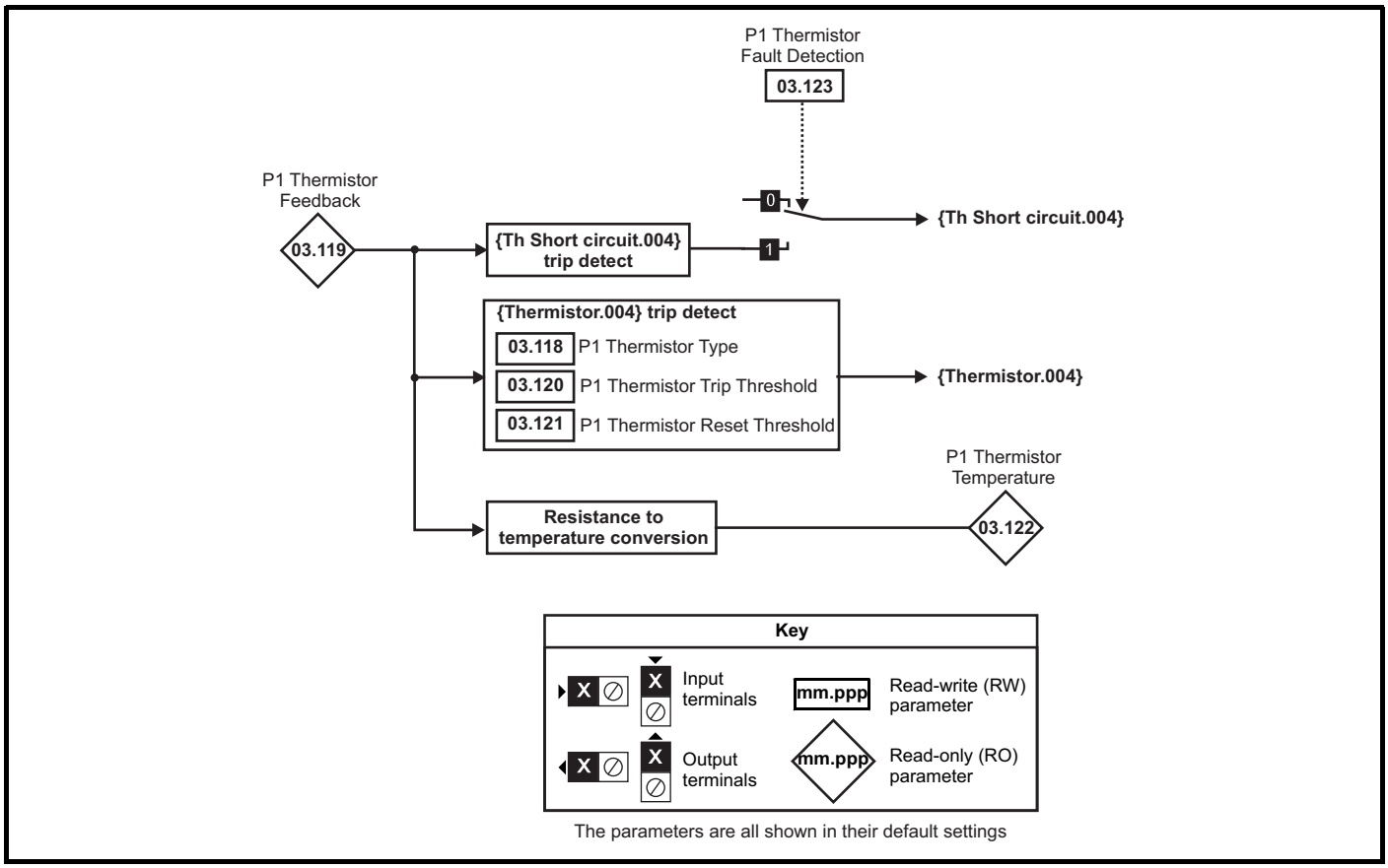
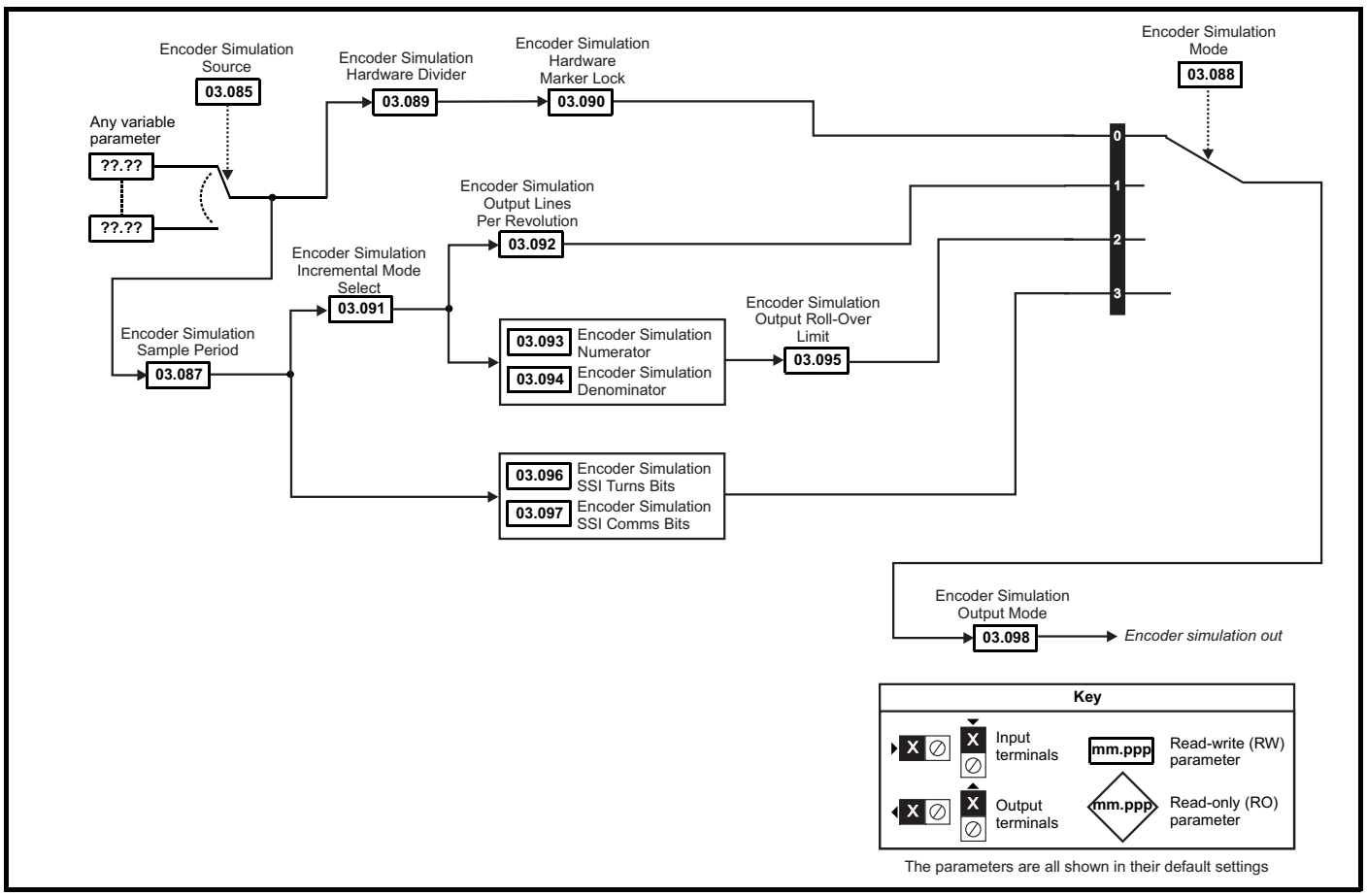


Figure 11-9 Encoder simulation



Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.001	Open-loop> Frequency Slaving Demand	±1000.0 Hz						RO	Num	ND	NC	PT	FI
	RFC> Final Speed Reference		VM_SPEED					RO	Num	ND	NC	PT	FI
03.002	Speed Feedback		VM_SPEED					RO	Num	ND	NC	PT	FI
03.003	Speed Error		VM_SPEED					RO	Num	ND	NC	PT	FI
03.004	Speed Controller Output		VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
03.005	Zero Speed Threshold	0.0 to 20.0 Hz	0 to 200 rpm		1.0 Hz	5 rpm		RW	Num				US
03.006	At Speed Lower Limit	0.0 to 550.0 Hz	0 to 33,000 rpm		1.0 Hz	5 rpm		RW	Num				US
03.007	At Speed Upper Limit	0.0 to 550.0 Hz	0 to 33,000 rpm		1.0 Hz	5 rpm		RW	Num				US
03.008	Over Speed Threshold	0.0 to 550.0 Hz	0 to 40,000 rpm		0.0 Hz	0 rpm		RW	Num				US
03.009	Absolute At Speed Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.010	Speed Controller Proportional Gain Kp1		0.0000 to 200.0000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
03.011	Speed Controller Integral Gain Ki1		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
03.012	Speed Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
03.013	Open-loop> Enable Frequency Slaving	Off (0) or On (1)			Off (0)			RW	Bit				US
	RFC> Speed Controller Proportional Gain Kp2		0.0000 to 200.0000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
03.014	Open-loop> Slaving Ratio Numerator	0.000 to 1.000			1.000			RW	Num				US
	RFC> Speed Controller Integral Gain Ki2		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
03.015	Open-loop> Slaving Ratio Denominator	0.001 to 1.000			1.000			RW	Num				US
	RFC> Speed Controller Differential Feedback Gain Kd2		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
03.016	Open-loop> Reference Frame Angle	0 to 65535						RO	Num	ND	NC	PT	
	RFC> Speed Controller Gain Select		Off (0) or On (1)			Off (0)		RW	Bit				US
03.017	Speed Controller Set-up Method		Disabled (0), Bandwidth (1), Comp Angle (2), Kp Gain Times 16 (3), Low Performance (4), Std Performance (5), High Performance (6), First Order (7)			Disabled (0)		RW	Txt				US
03.018	Motor And Load Inertia		0.00000 to 1000.00000 kgm^2			0.00000 kgm^2		RW	Num				US
03.019	Compliance Angle		0.0 to 360.0°			4.0°		RW	Num				US
03.020	Bandwidth		5 to 1000 Hz			10 Hz		RW	Num				US
03.021	Damping Factor		0.0 to 10.0			1.0		RW	Num				US
03.022	Hard Speed Reference		VM_SPEED_FREQ_REF			0.0		RW	Num				US
03.023	Hard Speed Reference Select		Off (0) or On (1)			Off (0)		RW	Bit				US
03.024	RFC Feedback Mode		Feedback (0), Sensorless (1), Feedback NoMax (2), Sensorless NoMax (3)			Feedback (0)		RW	Txt				US
03.025	Position Feedback Phase Angle			0.0 to 359.9°			0.0°	RW	Num	ND			US
03.026	Motor Control Feedback Select		P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5),			P1 Drive (0)		RW	Txt				US
03.027	P1 Speed Feedback	VM_SPEED						RO	Num	ND	NC	PT	FI
03.028	P1 Revolution/Pole Pitch Counter	0 to 65535						RO	Num	ND	NC	PT	PS
03.029	P1 Position	0 to 65535						RO	Num	ND	NC	PT	PS
03.030	P1 Fine Position	0 to 65535						RO	Num	ND	NC	PT	
03.031	P1 Marker Mode	0000 to 1111			0100			RW	Bin				US
03.032	P1 Marker Flag	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.033	P1 Rotary Turns Bits	0 to 16			16			RW	Num				US
03.034	P1 Rotary Lines Per Revolution	1 to 100000			1024		4096	RW	Num				US
03.035	P1 Comms Bits	0 to 48			0			RW	Num				US
03.036	P1 Supply Voltage	5V (0), 8V (1), 15V (2)			5V (0)			RW	Txt				US
03.037	P1 Comms Baud Rate	100k (0), 200k (1), 300k (2), 400k (3), 500k (4), 1M (5), 1.5M (6), 2M (7), 4M (8)			300k (2)			RW	Txt				US
03.038	P1 Device Type	AB (0), FD (1), FR (2), AB Servo (3), FD Servo (4), FR Servo (5), SC (6), SC Hiperface (7), EnDat (8), SC EnDat (9), SSI (10), SC SSI (11), SC Servo (12), BiSS (13), Resolver (14), SC SC (15), Commutation Only (16), SC BiSS (17)			AB (0)		AB Servo (3)	RW	Txt				US
03.039	P1 Termination Select	0 to 2			1			RW	Num				US
03.040	P1 Error Detection Level	0000 to 1111			0000	0001		RW	Bin				US
03.041	P1 Auto-configuration Select	Disabled (0) or Enabled (1)			Enabled (1)			RW	Txt				US
03.042	P1 Feedback Filter	Disabled (0), 1 (1), 2 (2), 4 (3), 8 (4), 16 (5) ms			Disabled (0)			RW	Txt				US
03.043	P1 Maximum Reference	0 to 33,000 rpm			1500 rpm		3000 rpm	RW	Num				US

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.044	P1 Reference Scaling	0.000 to 4.000			1.000			RW	Num				US
03.045	P1 Reference	±100.0 %						RO	Num	ND	NC	PT	FI
03.046	P1 Reference destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
03.047	P1 SSI Incremental Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.048	P1 SSI Binary Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.049	P1 Additional Power-up Delay	0.0 to 25.0 s			0.0 s			RW	Num				US
03.050	P1 Feedback Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.051	P1 Linear Feedback Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.052	P1 Linear Comms Pitch	0.001 to 100.000			0.001			RW	Num				US
03.053	P1 Linear Line Pitch	0.001 to 100.000			0.001			RW	Num				US
03.054	P1 Linear Comms And Line Pitch Units	millimetres (0) or micrometres (1)			millimetres (0)			RW	Txt				US
03.055	P1 Pole Pitch	0.01 to 1000.00 mm			10.00 mm			RW	Num				US
03.056	P1 Feedback Reverse	Off (0) or On (1)			Off (0)			RW	Bit				US
03.057	P1 Normalization Turns	0 to 16			16			RW	Num				US
03.058	P1 Normalized Position	-2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.059	P1 Normalized Marker Position	-2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.060	P1 Calculation Time	0 to 20 µs			5 µs			RW	Num				US
03.061	P1 Recovery Time	5 to 100 µs			30 µs			RW	Num				US
03.062	P1 Line Delay Time	0 to 5000 ns						RO	Num	ND	NC	PT	US
03.063	P1 Low Speed Update Rate Active	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.064	P1 Encoder Protocol Detected	None (0), Hiperface (1), EnDat 2.1 (2), EnDat 2.2 (3)						RO	Txt	ND	NC	PT	
03.065	P1 Resolver Poles	2 Poles (1) to 20 Poles (10)			2 Poles (1)			RW					US
03.066	P1 Resolver Excitation	6kHz 3V (0), 8kHz 3V (1), 6kHz 2V (2), 8kHz 2V (3), 6kHz Fast (4), 8kHz Fast (5), 6kHz 2V Fast (6), 8kHz 2V Fast (7)			6kHz 3V (0)		6kHz 3V Fast (4)	RW	Txt				US
03.067	P1 User Comms Enable	0 to 1			0			RW	Num		NC	PT	
03.068	P1 User Comms Transmit Register	0 to 65535			0			RW	Num		NC	PT	
03.069	P1 User Comms Receive Register	0 to 65535			0			RW	Num		NC	PT	
03.070	P1 Position Feedback Signals	000000 to 111111						RO	Bin	ND	NC	PT	
03.071	P1 Error Detected	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.073	P1 Absolute Turns Recovery Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
03.074	P1 Additional Configuration	0 to 511116116			0			RW	Bit				US
03.075	Initialise Position Feedback	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.076	Position Feedback Initialized	0000000000 to 1111111111			0000000000			RO	Bin		NC	PT	
03.078	Sensorless Mode Active		Off (0) or On (1)					RO	Bit	ND	NC	PT	
03.079	Sensorless Mode Filter		4 (0), 8 (1), 16 (2), 32 (3), 64 (4) ms			4 (0) ms	64 (4) ms	RW	Txt				US
03.080	Sensorless Position		-2147483648 to 2147483647					RO	Num	ND	NC	PT	
03.083	Full Motor Object Nameplate Transfer	Off (0) or On (1)			Off (0)			RW	Bit				US
03.085	Encoder Simulation Source	0.000 to 59.999			3.016	0.000		RW	Num			PT	US
03.086	Encoder Simulation Status	None (0), Full (1), No Marker Pulse (2)						RO	Txt	ND	NC	PT	
03.087	Encoder Simulation Sample Period	0.25 (0), 1 (1), 4, (2), 16 (3) ms			4 (2) ms	0.25 (0) ms		RW	Txt				US
03.088	Encoder Simulation Mode	Hardware (0), Lines Per Rev (1), Ratio (2), SSI (3)			Lines Per Rev (1)	Hardware (0)		RW	Txt				US
03.089	Encoder Simulation Hardware Divider	0 to 7			0			RW	Num				US
03.090	Encoder Simulation Hardware Marker Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.091	Encoder Simulation Incremental Mode Select	Off (0) or On (1)			On (1)	Off (0)		RW	Bit				US
03.092	Encoder Simulation Output Lines Per Revolution	1 to 16384			1024	4096		RW	Num				US
03.093	Encoder Simulation Numerator	1 to 65536			65536			RW	Num				US
03.094	Encoder Simulation Denominator	1 to 65536			65536			RW	Num				US
03.095	Encoder Simulation Output Roll-over Limit	1 to 65535			65535			RW	Num				US
03.096	Encoder Simulation SSI Turns Bits	0 to 16			16			RW	Num				US
03.097	Encoder Simulation SSI Comms Bits	2 to 48			33			RW	Num				US
03.098	Encoder Simulation Output Mode	AB/Gray (0), FD/Binary (1), FR/Binary (2)			AB/Gray (0)			RW	Txt				US
03.100	F1 Freeze Trigger Source	Digital Input 4 (0), Digital Input 5 (1), P1 Marker (2), P2 Marker (3), Common (4), P1 Zero (5), P2 Zero (6)			Digital Input 4 (0)			RW	Txt				US
03.101	F1 Freeze Mode	Rising 1st (0), Falling 1st (1), Rising all (2), Falling all (3)			Rising 1st (0)			RW	Txt				US
03.102	F1 Freeze Position Source	P1 (0), P2 (1), Time (2)			P1 (0)			RW	Txt				US
03.103	F1 Normalized Freeze Position	-2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.104	F1 Freeze Flag	Off (0) or On (1)			Off (0)			RW	Bit	ND	NC	PT	

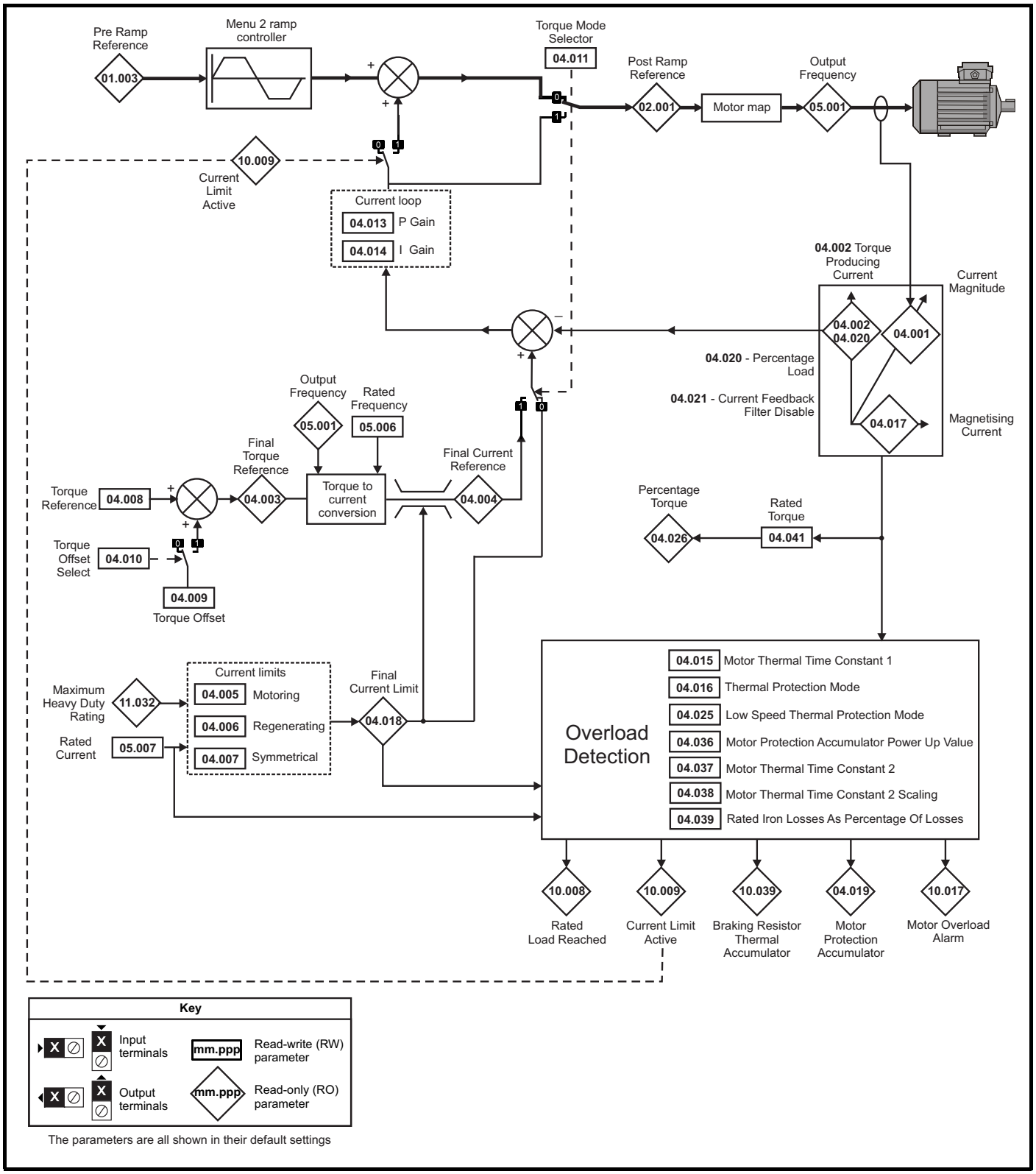
Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.105	F2 Freeze Trigger Source	Digital Input 4 (0), Digital Input 5 (1), P1 Marker (2), P2 Marker (3), Common (4), P1 Zero (5), P2 Zero (6)			Digital Input 4 (0)			RW	Txt				US
03.106	F2 Freeze Mode	Rising 1st (0), Falling 1st (1), Rising all (2), Falling all (3)			Rising 1st (0)			RW	Txt				US
03.107	F2 Freeze Position Source	P1 (0), P2 (1), Time (2)			P1 (0)			RW	Txt				US
03.108	F2 Normalized Freeze Position	-2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.109	F2 Freeze Flag	Off (0) or On (1)			Off (0)			RW	Bit	ND	NC	PT	
03.110	Common Freeze Source 1	Digital Input 4 (0), Digital Input 5 (1), P1 Marker (2), P2 Marker (3), Disabled (4)			Digital Input 4 (0)			RW	Txt				US
03.111	Common Freeze Source 2	Digital Input 4 (0), Digital Input 5 (1), P1 Marker (2), P2 Marker (3), Disabled (4)			Digital Input 4 (0)			RW	Txt				US
03.112	Common Freeze Mode	0000 to 1111			0000			RW	Bin				US
03.113	Freeze Input States	00 to 11						RO	Bin	ND	NC	PT	
03.118	P1 Thermistor Type	DIN44082 (0), KTY84 (1), 0.8mA (2)			DIN44082 (0)			RW	Txt				US
03.119	P1 Thermistor Feedback	0 to 5000 Ω						RO	Num	ND	NC	PT	
03.120	P1 Thermistor Trip Threshold	0 to 5000 Ω			3300 Ω			RW	Num				US
03.121	P1 Thermistor Reset Threshold	0 to 5000 Ω			1800 Ω			RW	Num				US
03.122	P1 Thermistor Temperature	-50 to 300 °C						RO	Num	ND	NC	PT	
03.123	P1 Thermistor Fault Detection	None (0), Temperature (1), Temp or Short (2)			None (0)		Temperature (1)	RW	Txt				US
03.127	P2 Speed Feedback	±VM_SPEED						RO	Num	ND	NC	PT	FI
03.128	P2 Revolution/Pole Pitch Counter	0 to 65535						RO	Num	ND	NC	PT	PS
03.129	P2 Position	0 to 65535						RO	Num	ND	NC	PT	PS
03.130	P2 Fine Position	0 to 65535						RO	Num	ND	NC	PT	
03.131	P2 Marker Mode	0000 to 1111			0100			RW	Bin				US
03.132	P2 Marker Flag	Off (0) or On (1)			Off (0)			RW	Bit		NC		
03.133	P2 Rotary Turns Bits	0 to 16			16			RW	Num				US
03.134	P2 Rotary Lines Per Revolution	0 to 100000			1024		4096	RW	Num				US
03.135	P2 Comms Bits	0 to 48			0			RW	Num				US
03.137	P2 Comms Baud Rate	100k (0), 200k (1), 300k (2), 400k (3), 500k (4), 1M (5), 1.5M (6), 2M (7), 4M (8) Baud			300k (2) Baud			RW	Txt				US
03.138	P2 Device type	None (0), AB (1), FD (2), FR (3), EnDat (4), SSI (5), BiSS (6)			None (0)			RW	Txt				US
03.140	P2 Error Detection Level	0000 to 1111			0001			RW	Bin				US
03.141	P2 Auto-configuration Select	Disabled (0), Enabled (1)			Enabled (1)			RW	Txt				US
03.142	P2 Feedback Filter	Disabled (0), 1 (1), 2 (2), 4 (3), 8 (4), 16 (5) ms			Disabled (0)			RW	Txt				US
03.143	P2 Maximum Reference	0 to 33,000 rpm			1500 rpm		3000 rpm	RW	Num				US
03.144	P2 Reference Scaling	0.000 to 4.000			1.000			RW	Num				US
03.145	P2 Reference	±100.0 %						RO	Num	ND	NC	PT	FI
03.146	P2 Reference Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
03.147	P2 SSI Incremental Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.148	P2 SSI Binary Mode	Off (0) or On (1)			Off (0)			RW	Bit				US
03.149	P2 Additional Power-up Delay	0.0 to 25.0 s			0.0 s			RW	Num				US
03.150	P2 Feedback Lock	Off (0) or On (1)			Off (0)			RW	Bit				US
03.151	P2 Linear Feedback Select	Off (0) or On (1)			Off (0)			RW	Bit				US
03.152	P2 Linear Comms Pitch	0.001 to 100.000			0.001			RW	Num				US
03.153	P2 Linear Line Pitch	0.001 to 100.000			0.001			RW	Num				US
03.154	P2 Linear Comms And Line Pitch Units	Millimetres (0) or Micrometres (1)			Millimetres (0)			RW	Txt				US
03.155	P2 Pole Pitch	0.01 to 1000.00 mm			10.00 mm			RW	Num				US
03.156	P2 Feedback Reverse	Off (0) or On (1)			Off (0)			RW	Bit				US
03.157	P2 Normalization Turns	0 to 16			16			RW	Num				US
03.158	P2 Normalized Position	-2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.159	P2 Normalized Marker Position	--2147483648 to 2147483647						RO	Num	ND	NC	PT	
03.160	P2 Calculation Time	0 to 20 µs			5 µs			RW	Num				US
03.161	P2 Recovery Time	5 to 100 µs			30 µs			RW	Num				US
03.162	P2 Line Delay Time	0 to 5000 ns						RO	Num	ND	NC	PT	US
03.163	P2 Low Speed Update Rate Active	Off (0) or On (1)						RO	Bit	ND	NC	PT	
03.164	P2 Encoder Protocol Detected	None (0), Hiperface (1), EnDat 2.1 (2), EnDat 2.2 (3)						RO	Txt	ND	NC	PT	
03.167	P2 User Comms Enable	0 to 1			0			RW	Num		NC	PT	
03.168	P2 User Comms Transmit Register	0 to 65535			0			RW	Num		NC	PT	
03.169	P2 User Comms Receive Register	0 to 65535			0			RW	Num		NC	PT	
03.171	P2 Error Detected	Off (0) or On (1)						RO	Bit	ND	NC	PT	

Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
03.172	P2 Status	None (0), AB (1), FD (2), FR (3), EnDat (4), SSI (5), EnDat Alt (7), SSI Alt (8)						RO	Txt	ND	NC	PT	
03.173	P2 Absolute Turns Recovery Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
03.174	P1 Additional Configuration	0 to 511116116			0			RW					

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 11-10 Menu 4 Open loop logic diagram



The parameters are all shown in their default settings

Figure 11-11 Menu 4 RFC-A logic diagram

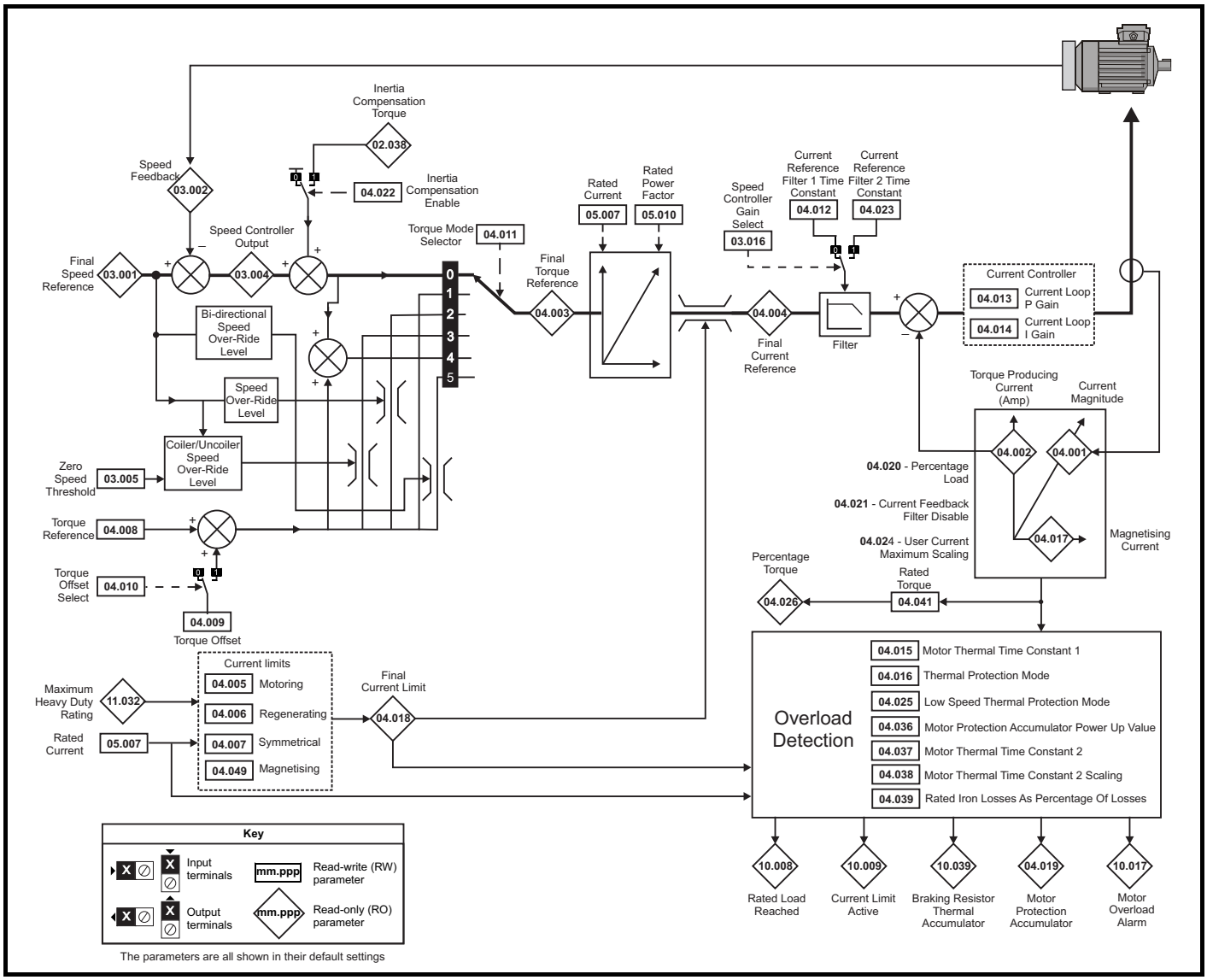
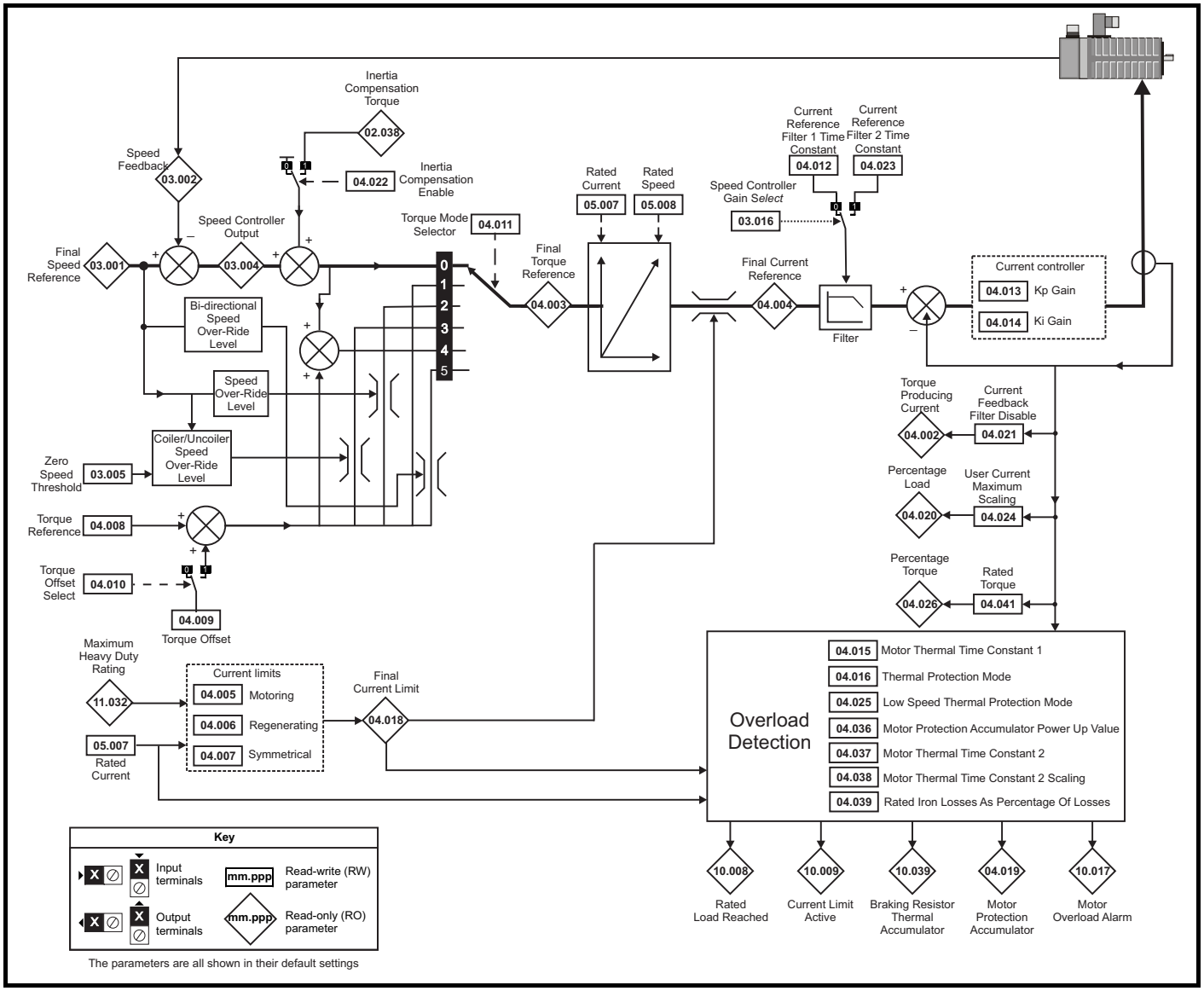


Figure 11-12 Menu 4 RFC-S logic diagram



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
04.001	Current Magnitude	0.000 to VM_DRIVE_CURRENT_UNIPOLAR A					RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current / Iq	VM_DRIVE_CURRENT A					RO	Num	ND	NC	PT	FI
04.003	Final Torque Reference	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
04.004	Final Current Reference	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	FI
04.005	Motoring Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165 %	250 %		RW	Num		RA		US
04.006	Regenerating Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165 %	250 %		RW	Num		RA		US
04.007	Symmetrical Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165 %	250 %		RW	Num		RA		US
04.008	Torque Reference	VM_USER_CURRENT_HIGH_RES %		0.00 %			RW	Num				US
04.009	Torque Offset	VM_USER_CURRENT %		0.0 %			RW	Num				US
04.010	Torque Offset Select	Off (0) or On (1)		Off (0)			RW	Bit				US
04.011	Torque Mode Selector	0 to 1	0 to 5	0			RW	Num				US
04.012	Current Reference Filter 1 Time Constant		0.0 to 25.0 ms		0.0 ms		RW	Num				US
04.013	Current Controller Kp Gain	0 to 30000		20	150		RW	Num				US
04.014	Current Controller Ki Gain	0 to 30000		40	2000		RW	Num				US
04.015	Motor Thermal Time Constant 1	1.0 to 3000.0 s		89.0 s			RW	Num				US
04.016	Thermal Protection Mode	Motor Trip (0), Motor Current Limit (1), Drive Current Limit (2), Motor and Drive Current Limit (3), Disabled (4)		Motor Trip (0)			RW	Bin				US
04.017	Magnetising Current / Id	VM_DRIVE_CURRENT A					RO	Num	ND	NC	PT	FI
04.018	Final Current Limit	VM_TORQUE_CURRENT %					RO	Num	ND	NC	PT	
04.019	Motor Protection Accumulator	0.0 to 100.0 %					RO	Num	ND	NC	PT	PS
04.020	Percentage Load	VM_USER_CURRENT %					RO	Num	ND	NC	PT	FI
04.021	Current Feedback Filter Disable	Off (0) or On (1)		Off (0)			RW	Bit				US
04.022	Inertia Compensation Enable		Off (0) or On (1)		Off (0)		RW	Bit				US
04.023	Current Reference Filter 2 Time Constant		0.0 to 25.0 ms		0.0 ms		RW	Num				US
04.024	User Current Maximum Scaling	0.0 to VM_TORQUE_CURRENT_UNIPOLAR %		165.0 %	300.0 %		RW	Num		RA		US
04.025	Low Speed Thermal Protection Mode	0 to 1		0			RW	Num				US
04.026	Percentage Torque	VM_USER_CURRENT %					RO	Num	ND	NC	PT	FI
04.030	Current Controller Mode		Off (0) or On (1)		Off (0)		RW	Bit				US
04.031	Notch Filter Centre Frequency		50 to 1000 Hz		100 Hz		RW	Num				US
04.032	Notch Filter Bandwidth		0 to 500 Hz		0 Hz		RW	Num				US
04.033	Inertia Times 1000		Off (0) or On (1)		Off (0)		RW	Bit				US
04.036	Motor Protection Accumulator Power-up Value	Power down (0), Zero (1), Real time (2)		Power down (0)			RW	Txt				US
04.037	Motor Thermal Time Constant 2	1.0 to 3000.0 s		89.0 s			RW	Num				US
04.038	Motor Thermal Time Constant 2 Scaling	0 to 100 %		0 %			RW	Num				US
04.039	Rated Iron Losses As Percentage Of Losses	0 to 100 %		0 %			RW	Num				US
04.041	Rated Torque	0.00 to 50000.00 N m		0.00 N m			RW	Num				US
04.042	Torque Estimation Minimum Frequency	0 to 100 %		5 %			RW	Num				US
04.043	Torque Correction Time Constant		0.00 to 10.00 s		0.00 s		RW	Num				US
04.044	Torque Correction Maximum		0 to 100 %		20 %		RW	Num				US
04.045	No-load Core Loss	0.000 to 99999.999 kW		0.000 kW			RW	Num				US
04.046	Rated Core Loss	0.000 to 99999.999 kW		0.000 kW			RW	Num				US
04.049	Magnetising Current Limit		0.0 to 100.0 %		100.0 %		RW	Num				US

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

11.6 Menu 5: Motor control

Figure 11-13 Menu 5 Open-loop logic diagram

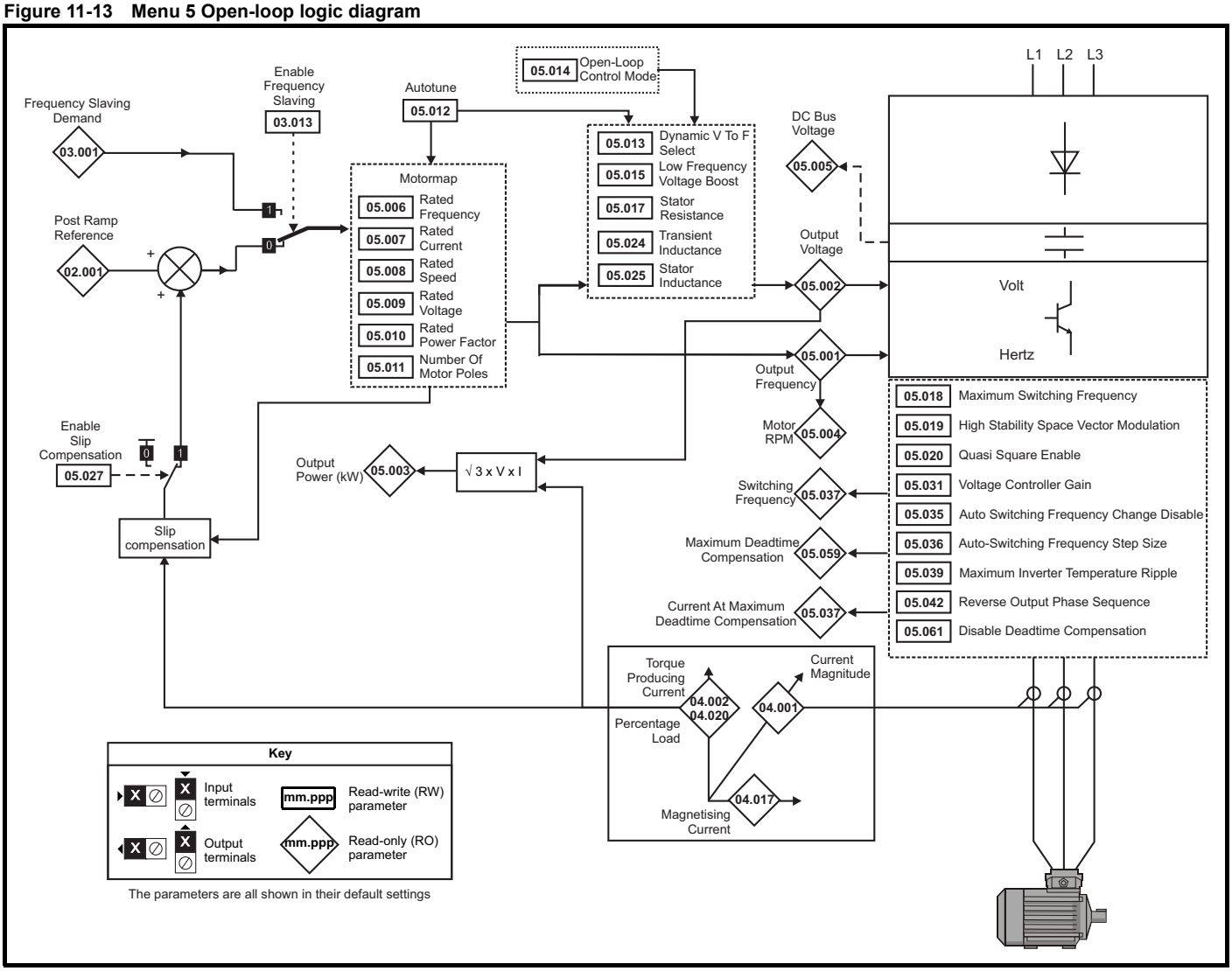
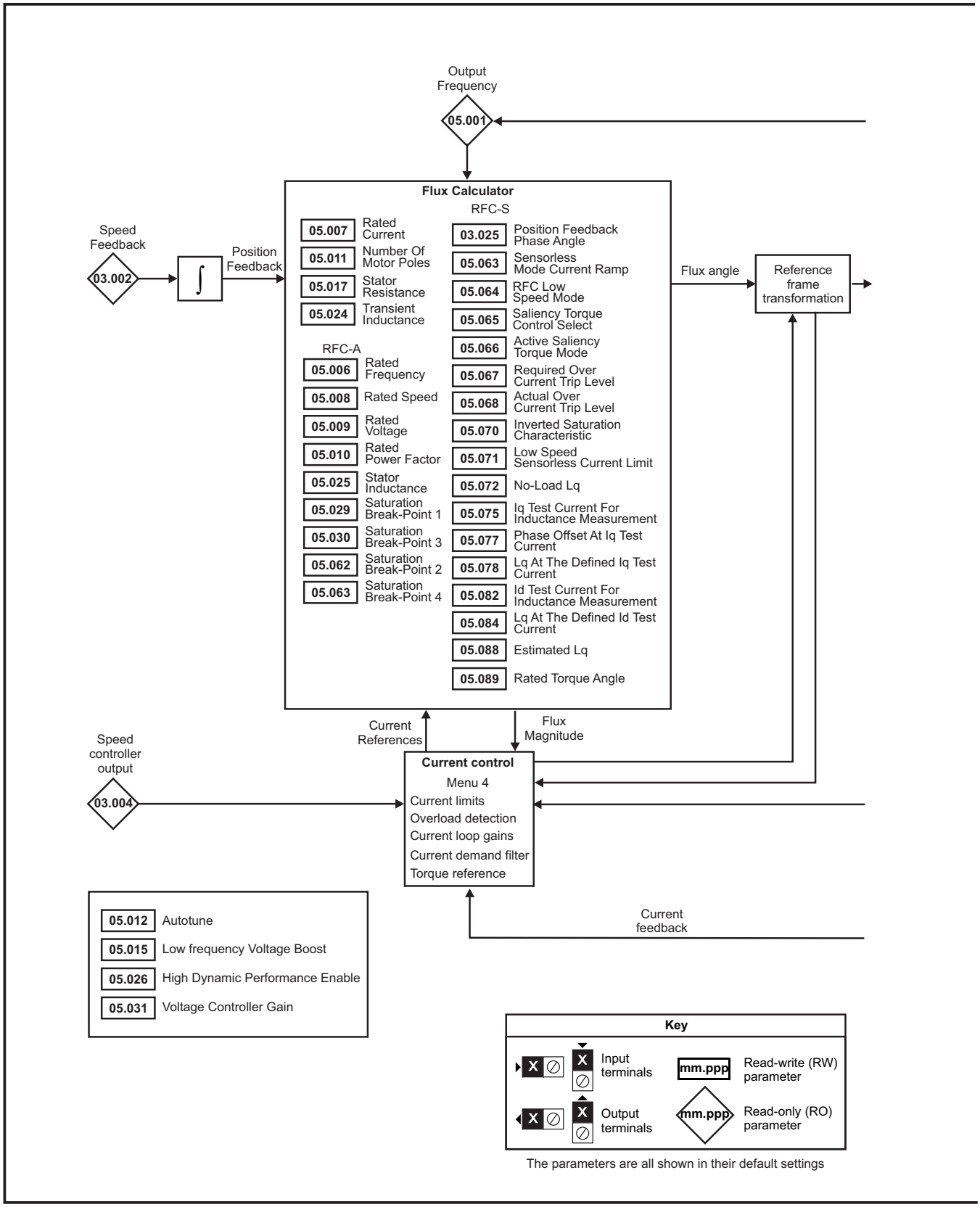
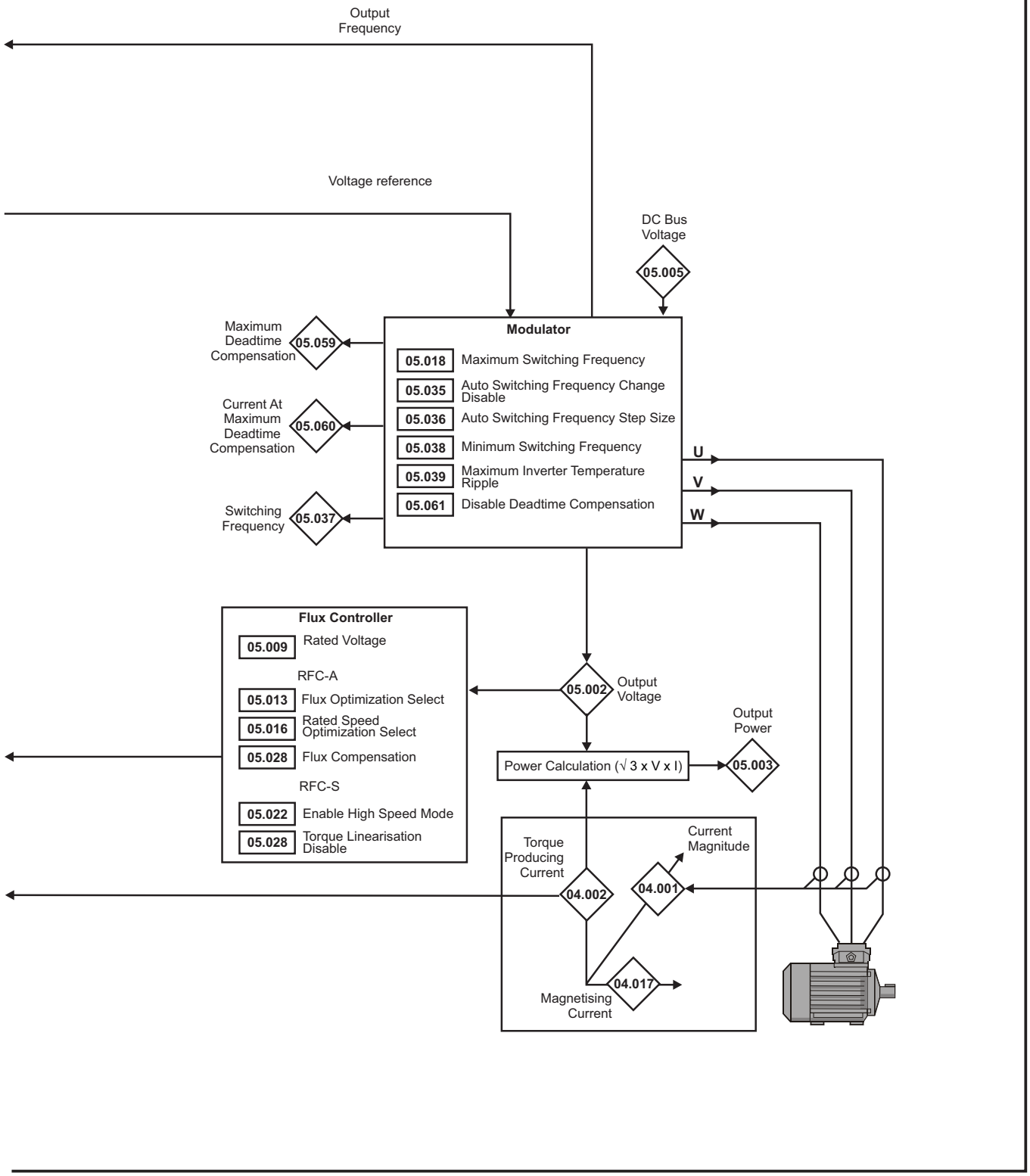


Figure 11-14 Menu 5 RFC-A, RFC-S logic diagram




Output Frequency
Voltage reference
DC Bus Voltage
05.005
Modulator
05.018 Maximum Switching Frequency
05.035 Auto Switching Frequency Change Disable
05.036 Auto Switching Frequency Step Size
05.038 Minimum Switching Frequency
05.039 Maximum Inverter Temperature Ripple
05.061 Disable Deadtime Compensation
Maximum Deadtime Compensation
05.059
Current At Maximum Deadtime Compensation
05.060
Switching Frequency
05.037
U
V
W
Flux Controller
05.009 Rated Voltage
RFC-A
05.013 Flux Optimization Select
05.016 Rated Speed Optimization Select
05.028 Flux Compensation
RFC-S
05.022 Enable High Speed Mode
05.028 Torque Linearisation 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

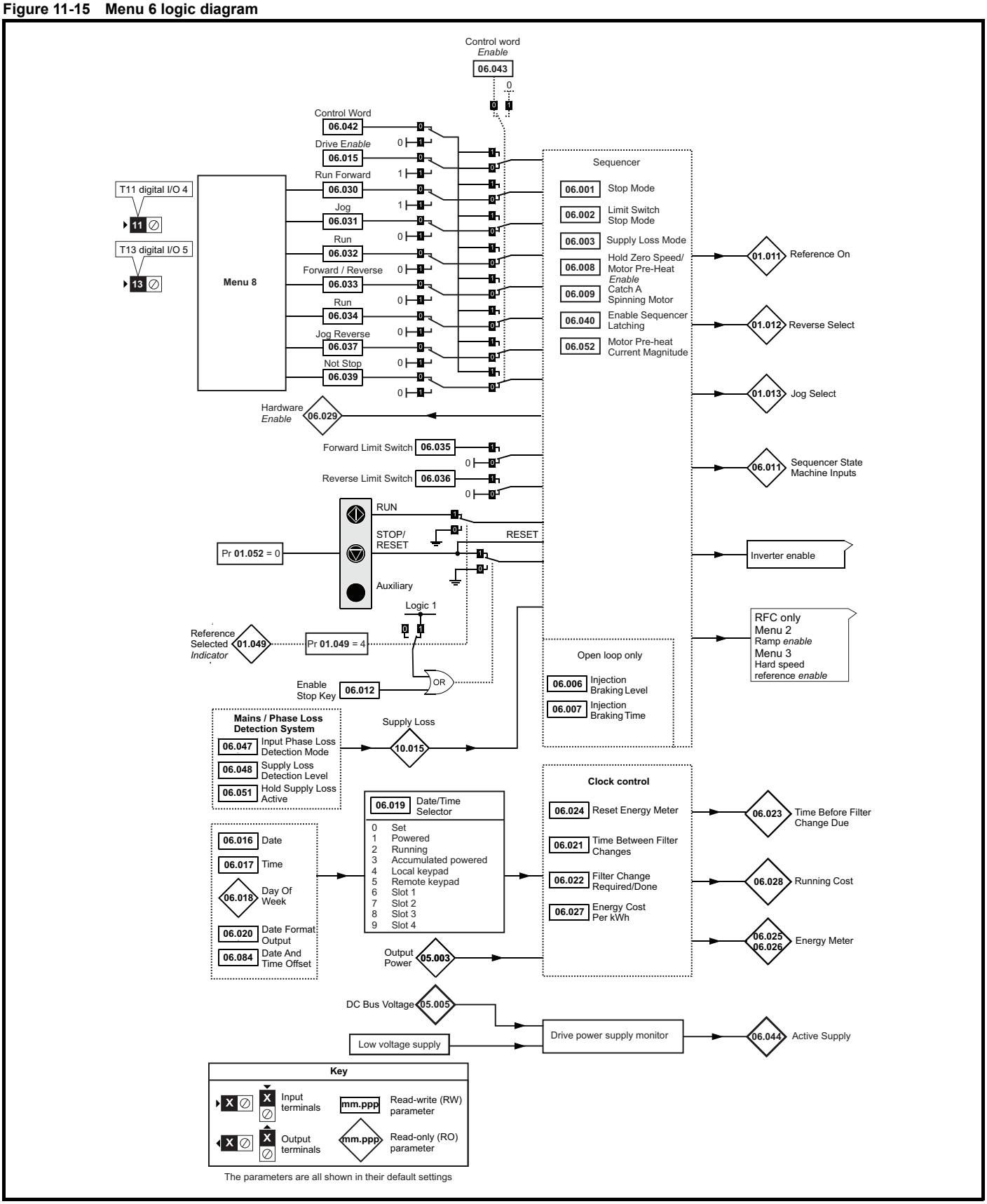
Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.001	Output Frequency	VM_SPEED_FREQ_REF	±2000.0 Hz					RO	Num	ND	NC	PT	FI
05.002	Output Voltage	0 to VM_AC_VOLTAGE V						RO	Num	ND	NC	PT	FI
05.003	Output Power	VM_POWER kW						RO	Num	ND	NC	PT	FI
05.004	Motor Rpm	±180000 rpm						RO	Num	ND	NC	PT	FI
05.005	D.c. Bus Voltage	0 to VM_DC_VOLTAGE V						RO	Num	ND	NC	PT	FI
05.006	Rated Frequency	0.0 to 550.0 Hz			50Hz: 50.0 60Hz: 60.0			RW	Num				US
05.007	Rated Current	0.000 to VM_RATED_CURRENT A			Maximum Heavy Duty Rating (11.032)			RW	Num		RA		US
05.008	Rated Speed	0 to 33000 rpm	0.00 to 33000.00 rpm		50Hz: 1500 rpm 60Hz: 1800 rpm	50Hz: 1450.00 rpm 60Hz: 1750.00 rpm	3000.00 rpm	RW	Num				US
05.009	Rated Voltage	0 to VM_AC_VOLTAGE_SET			200 V drive: 230 V 50 Hz - 400 V drive: 400 V 60 Hz - 400 V drive: 460 V 575 V drive: 575 V 690 V drive: 690 V			RW	Num		RA		US
05.010	Rated Power Factor	0.000 to 1.000			0.850			RW	Num		RA		US
05.011	Number Of Motor Poles	Automatic (0) to 480 Poles (240)			Automatic (0)		6 Poles (3)	RW	Num				US
05.012	Autotune	0 to 2	0 to 4	0 to 5	0			RW	Num		NC		US
05.013	Dynamic V To F Select	Off (0) or On (1)			Off (0)			RW	Bit				US
	Flux Optimization Select		Off (0) or On (1)			Off (0)		RW	Bit				US
05.014	Open-loop Control Mode	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5),			Ur I (4)			RW	Txt				US
	Phasing Test On Enable			Disabled (0), Short, (1), Short Once (2), Long (3), Long Once (4)			Disabled (0)	RW	Txt				US
05.015	Low Frequency Voltage Boost	0.0 to 25.0 %			1 %			RW	Num				US
	Minimal Movement Phasing Test Current			1 % (0), 2 % (1), 3 % (2), 6 % (3), 12 % (4), 25 % (5), 50 % (6), 100 % (7)			1 % (0)	RW	Txt				US
05.016	Rated Speed Optimization Select		Disabled (0), Classic Slow (1), Classic Fast (2), Combined (3), VARs Only (4), Voltage Only (5)			Disabled (0)		RW	Txt				US
	Minimal Movement Phasing Test Angle			0.00 to 25.00°			0.00°	RW	Num				US
05.017	Stator Resistance	0.000000 to 1000.000000 Ω			0.000000 Ω			RW	Num		RA		US
05.018	Maximum Switching Frequency	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)			8 kHz (4)			RW	Txt		RA		US
05.019	High Stability Space Vector Modulation	Off (0) or On (1)			Off (0)			RW	Bit				US
	Rated Speed Optimization Minimum Frequency		0 to 100 %			10 %		RW	Num				US
05.020	Quasi-square Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
	Rated Speed Optimization Minimum Load		0 to 100 %			50 %		RW	Num				US
05.021	Mechanical Load Test Level		0 to 100 %			0 %		RW	Num				US
05.022	Enable High Speed Mode			Limit (-1), Disable (0), Enable (1)			Disable (0)	RW	Txt				US
05.024	Transient Inductance	0.000 to 500.000 mH			0.000 mH			RW	Num		RA		US
	Ld			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.025	Stator Inductance	0.00 to 5000.00 mH			0.00 mH			RW	Num		RA		US
05.026	High Dynamic Performance Enable		Off (0) or On (1)			Off (0)		RW	Bit				US
05.027	Enable Slip Compensation	Off (0) or On (1)			On (1)			RW	Bit				US
	Flux Control Gain		0.1 to 10.0			1.0	1.0	RW	Num				US
05.028	Flux Compensation		0 to 2			0		RW	Num				US
	Torque Linearization Disable			Off (0) or On (1)			On (1)	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

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.032	Torque Per Amp		0.00 to 500.00 Nm/A					RO	Num	ND	NC	PT	
				0.00 to 500.00 Nm/A			1.60 Nm/A	RW	Num				US
05.033	Volts Per 1000 rpm			0 to 10,000 V			98	RW	Num				US
05.034	Percentage Flux		0.0 to 150.0 %					RO	Num	ND	NC	PT	FI
05.035	Auto-switching Frequency Change Disable	Enabled (0), Disabled (1), No Ripple Detect (2)			Enabled (0)			RW	Txt				US
05.036	Auto-switching Frequency Step Size	1 to 2			2			RW	Num				US
05.037	Switching Frequency	2 kHz (0), 3 kHz (1), 4 kHz (2), 6 kHz (3), 8 kHz (4), 12 kHz (5), 16 kHz (6)						RO	Txt	ND	NC	PT	
05.038	Minimum Switching Frequency	0 to VM_MIN_SWITCHING_FREQUENCY kHz			4 (2) kHz			RW	Txt				US
05.039	Maximum Inverter Temperature Ripple	20 to 60 °C			60 °C			RW	Num				US
05.040	Spin Start Boost	0.0 to 10.0			1.0			RW	Num				US
05.041	Voltage Headroom		0 to 20 %			0 %		RW	Num				US
05.042	Reverse Output Phase Sequence	Off (0) or On (1)			Off (0)			RW	Bit				US
05.044	Stator Temperature Source	User (0), P1 Drive (1), P1 Slot 1 (2), P1 Slot 2 (3), P1 Slot 3 (4), P1 Slot 4 (5)			User (0)			RW	Txt				US
05.045	User Stator Temperature	-50 to 300 °C			0 °C			RW	Num				
05.046	Stator Temperature	-50 to 300 °C						RO	Num	ND	NC	PT	
05.047	Stator Temperature Coefficient	0.00000 to 0.10000 $°C^{-1}$			0.00390 $°C^{-1}$			RW	Num				US
05.048	Stator Base Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.049	Enable Stator Compensation	Off (0) or On (1)			Off (0)			RW	Bit				US
05.050	Temperature Compensated Stator Resistance	0.000000 to 1000.000000 Ω						RO	Num	ND	NC	PT	
05.051	Rotor Temperature Source	User (0), P1 Drive (1), P1 Slot 1 (2), P1 Slot 2 (3), P1 Slot 3 (4), P1 Slot 4 (5)			User (0)			RW	Txt				US
05.052	User Rotor Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.053	Rotor Temperature	-50 to 300 °C						RO	Num	ND	NC	PT	
05.054	Rotor Temperature Coefficient	0.00000 to 0.10000 $°C^{-1}$			0.00390°C^{-1}		0.00100 $°C^{-1}$	RW	Num				US
05.055	Rotor Base Temperature	-50 to 300 °C			0 °C			RW	Num				US
05.056	Enable Rotor Compensation	Off (0) or On (1)			Off (0)			RW	Bit				US
05.057	Temperature compensated rated speed	0.00 to 18000.00 rpm	0.00 to 50000.00 rpm					RO	Num	ND	NC	PT	
	Rotor Temperature Compensation			0.000 to 2.000				RO	Num	ND	NC	PT	
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
	Sensorless Mode Current Ramp			0.00 to 1.00 s			0.20 s	RW	Num				US
05.064	RFC Low Speed Mode			Injection (0), Non-salient (1), Current (2), Current No Test (3)			Current (2)	RW	Txt				US
05.065	Saliency Torque Control Select			Disabled (0), Low (1), High (2), Auto (3)			Disabled (0)	RW	Txt				US
05.066	Active Saliency Torque Mode			Disabled (0), Low (1), High (2)				RO	Txt	ND	NC	PT	
05.067	Required Over-current Trip Level			0 to 100 %			0 %	RW	Num				US
05.068	Actual Over-current Trip Level			0 to 500 %				RO	Num	ND	NC	PT	
05.070	Inverted Saturation Characteristic			Off (0) or On (1)			Off (0)	RW	Bit				US
05.071	Low Speed Sensorless Mode Current Limit			0.0 to 1000.0 %			100.0 %	RW	Num		RA		US
05.072	No-load Lq			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.075	Iq Test Current For Inductance Measurement			0 to 200 %			100 %	RW	Num				US
05.077	Phase Offset At Iq Test Current			±90.0°			0.0°	RW	Num		RA		US
05.078	Lq At The Defined Iq Test Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.082	Id Test Current for Inductance Measurement			-100 to 0 %			-100 %	RW	Num				US
05.084	Lq At The Defined Id Test Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
05.085	Lq Incremental Inductance At Defined Id Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
05.087	User Defined Rated Torque Angle			0 to 90°			0°	RW	Num				US
05.088	Estimated Lq			0.000 to 500.000 mH				RO	Num	ND	NC	PT	FI
05.089	Rated Torque Angle			0 to 90°				RO	Num	ND	NC	PT	

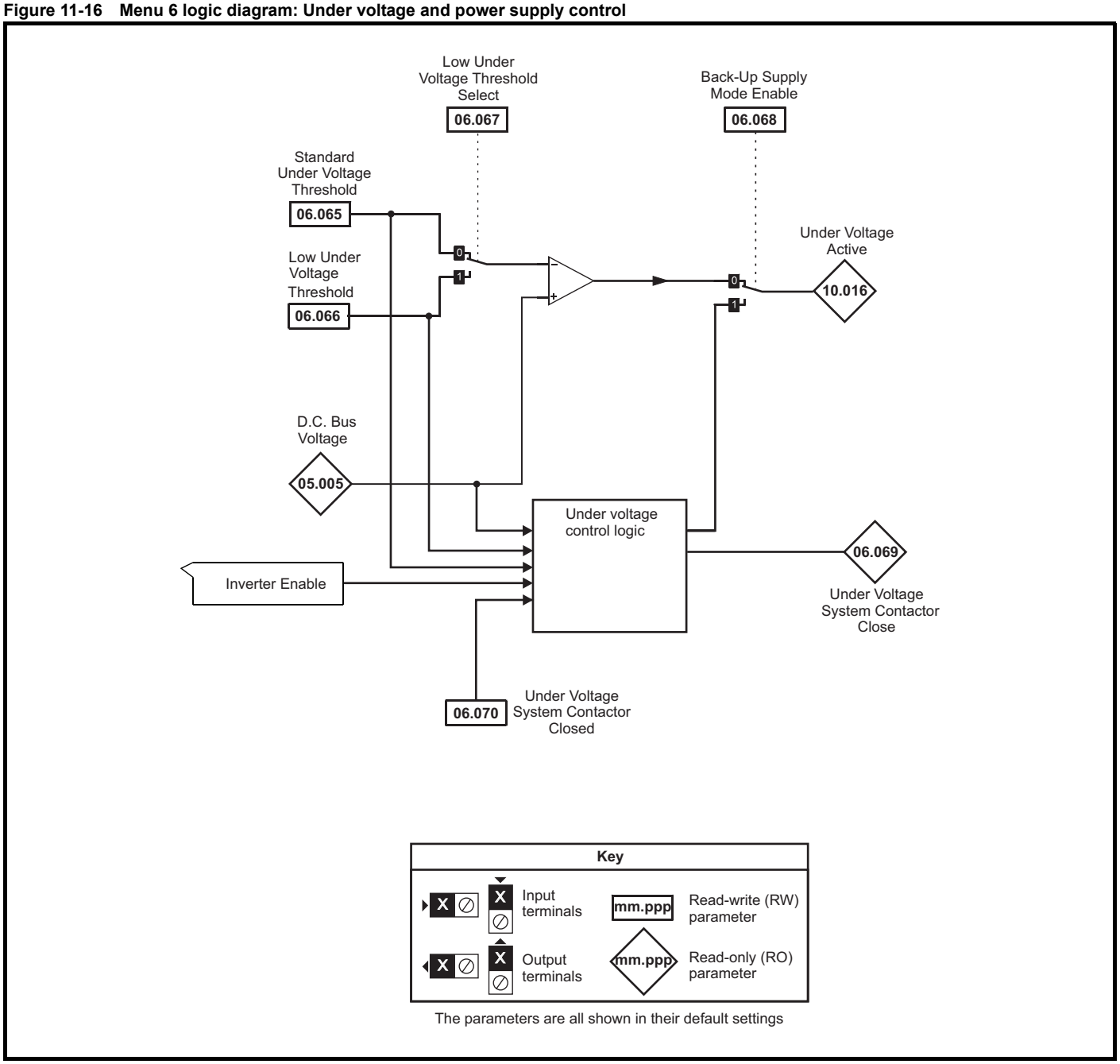
11.7 Menu 6: Sequencer and clock

Figure 11-15 Menu 6 logic diagram



The parameters are all shown in their default settings

Figure 11-16 Menu 6 logic diagram: Under voltage and power supply control



Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.001	Stop Mode	Coast (0), Ramp (1), Ramp d c l (2), dc l (3), Timed dc l (4), Disable (5)	Coast (0), Ramp (1), No Ramp (2)	Ramp (1)	Ramp (1)	No Ramp (2)	RW	Txt				US
06.002	Limit Switch Stop Mode		Stop (0) or Ramp (1)		Stop (0)		RW	Txt				US
06.003	Supply Loss Mode	Disable (0), Ramp Stop (1), Ride Thru (2)	Disable (0), Ramp Stop (1), Ride Thru (2), Limit Stop (3)	Disable (0)			RW	Txt				US
06.006	Injection Braking Level	0.0 to 150.0 %		100.0 %			RW	Num		RA		US
06.007	Injection Braking Time	0.0 to 100.0 s		1.0 s			RW	Num				US
06.008	Hold Zero Speed	Off (0) or On (1)		Off (0)		On (1)	RW	Bit				US
06.009	Catch A Spinning Motor	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)		Disable (0)	Enable (1)		RW	Txt				US
06.010	Enable Conditions	000000000000 to 111111111111					RO	Bin	ND	NC	PT	
06.011	Sequencer State Machine Inputs	000000 to 111111					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
06.015	Drive Enable	Off (0) or On (1)		On (1)			RW	Bit				US
06.016	Date	00-00-00 to 31-12-99		00-00-00			RW	Date	ND	NC	PT	
06.017	Time	00:00:00 to 23:59:59					RW	Time	ND	NC	PT	
06.018	Day Of Week	Sunday (0), Monday (1), Tuesday (2), Wednesday (3), Thursday (4), Friday (5), Saturday (6)					RO	Txt	ND	NC	PT	
06.019	Date/Time Selector	Set (0), Powered (1), Running (2), Acc Powered (3), Local Keypad (4), Remote Keypad (5), Slot 1 (6), Slot 2 (7), Slot 3 (8), Slot 4 (9)		Powered (1)			RW	Txt				US
06.020	Date Format	Std (0) or US (1)		Std (0)			RW	Txt				US
06.021	Time Between Filter Changes	0 to 30000 Hours		0 Hours			RW	Num				US
06.022	Filter Change Required / Change Done	Off (0) or On (1)		Off (0)			RW	Bit	ND	NC		
06.023	Time Before Filter Change Due	0 to 30000 Hours					RO	Num	ND	NC	PT	PS
06.024	Reset Energy Meter	Off (0) or On (1)		Off (0)			RW	Bit				
06.025	Energy Meter: MWh	-999.9 to 999.9 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	ND	NC	PT	
06.030	Run Forward	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.031	Jog	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		
06.039	Not Stop	Off (0) or On (1)		Off (0)			RW	Bit		NC		
06.040	Enable Sequencer Latching	Off (0) or On (1)		Off (0)			RW	Bit				US
06.041	Drive Event Flags	00 to 11		00			RW	Bin		NC		
06.042	Control Word	000000000000000 to 111111111111111		000000000000000			RW	Bin		NC		
06.043	Control Word Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.044	Active Supply	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.045	Cooling Fan control	0 to 11		10			RW	Num				US
06.047	Input Phase Loss Detection Mode	Full (0), Ripple Only (1), Disabled (2)		Full (0)			RW	Txt				US
06.048	Supply Loss Detection Level	0 to VM_SUPPLY_LOSS_LEVEL V		200 V drive: 205 V 400 V drive: 410 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 s (0), 1.0 s (1), 2.0 s (2), 4.0 s (3)		0.5 s (0)			RW	Txt				US
06.059	Output Phase Loss Detection Enable	Disabled (0) or Enabled (1)		Disabled (0)			RW	Txt				US
06.060	Standby Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.061	Standby Mode Mask	0000000 to 1111111		0000000			RW	Bin				US
06.065	Standard Under Voltage Threshold	0 to VM_STD_UNDER_VOLTS V		200 V drive: 230 V 400 V drive: 330 V			RW	Num		RA		US
06.066	Low Under Voltage Threshold	24 to VM_LOW_UNDER_VOLTS V		200 V drive: 175 V 400 V drive: 330 V			RW	Num		RA		US
06.067	Low Under Voltage Threshold Select	Off (0) or On (1)		Off (0)			RW	Bit				US

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
06.068	Back Up Supply Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
06.069	Under-Voltage System Contactor Close	Off (0) or On (1)					RO	Bit	ND	NC	PT	
06.070	Under-Voltage System Contactor Closed	Off (0) or On (1)		Off (0)			RW	Bit				
06.073	Braking IGBT Lower Threshold	0 to VM_DC_VOLTAGE_SET V		200 V drive: 390 V 400 V drive: 780 V			RW	Num		RA		US
06.074	Braking IGBT Upper Threshold	0 to VM_DC_VOLTAGE_SET V		200 V drive: 390 V 400 V drive: 780 V			RW	Num		RA		US
06.075	Low Voltage Braking IGBT Threshold	0 to VM_DC_VOLTAGE_SET V		0V			RW	Num		RA		US
06.076	Low Voltage Braking IGBT Threshold Select	Off (0) or On (1)		Off (0)			RW	Bit				
06.084	Date And Time Offset	±24.00 Hours		0.00 Hours			RW	Num				US

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

11.8 Menu 7: Analog I/O / Temperature Monitoring

Figure 11-17 Menu 7 logic diagram

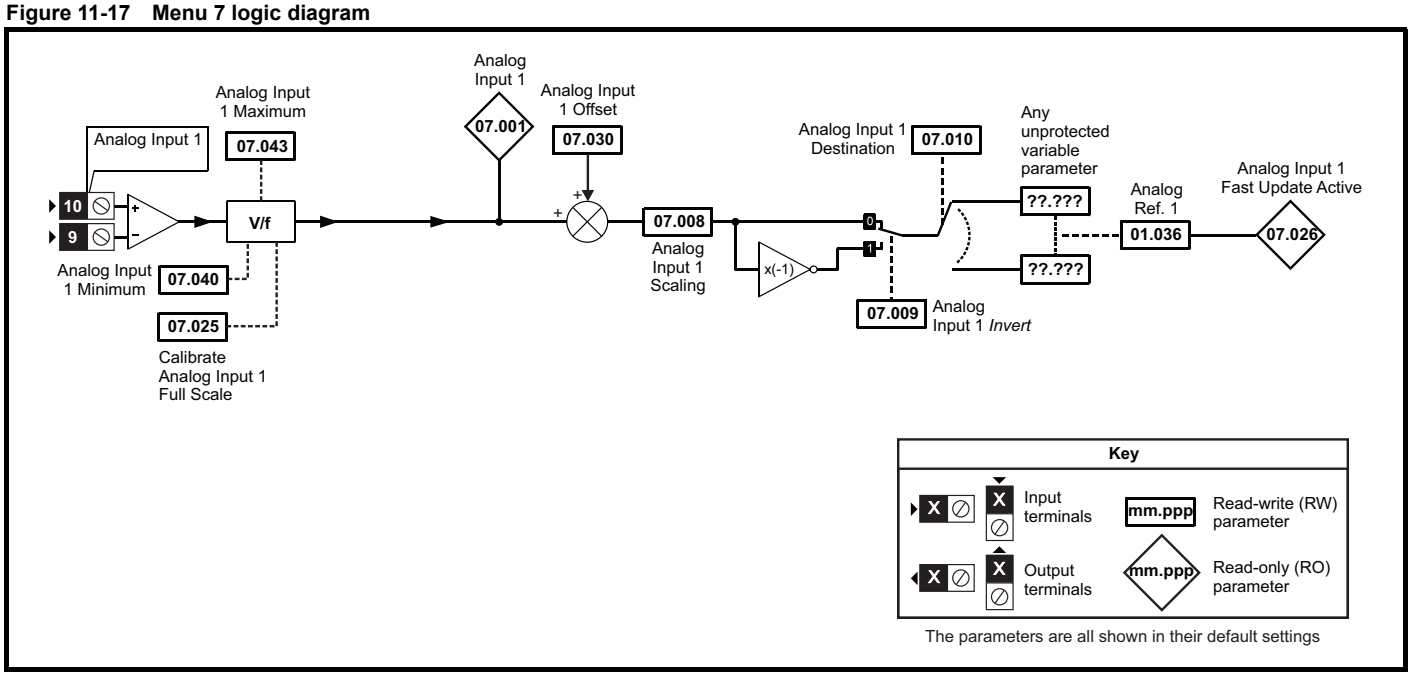
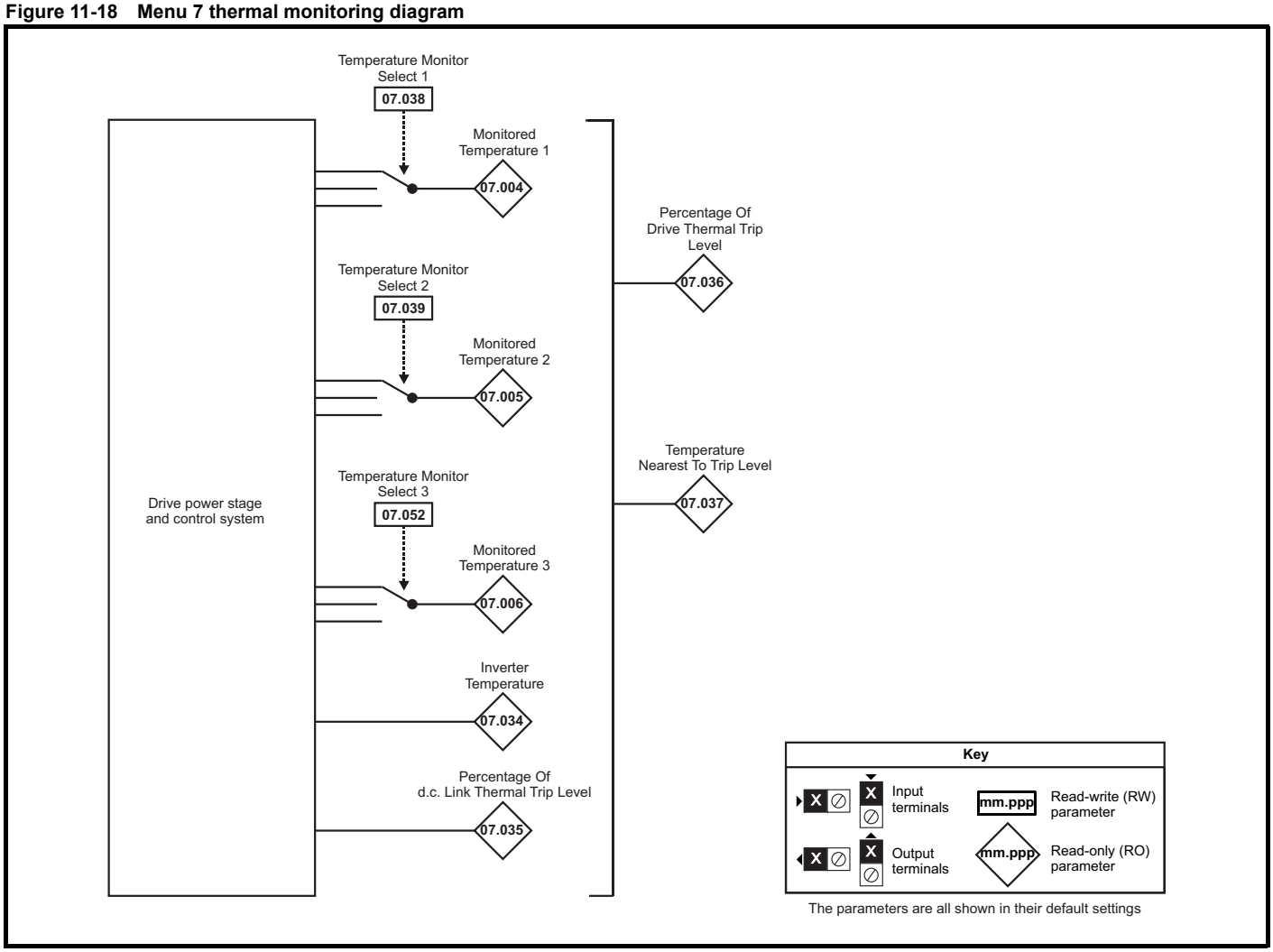


Figure 11-18 Menu 7 thermal monitoring diagram

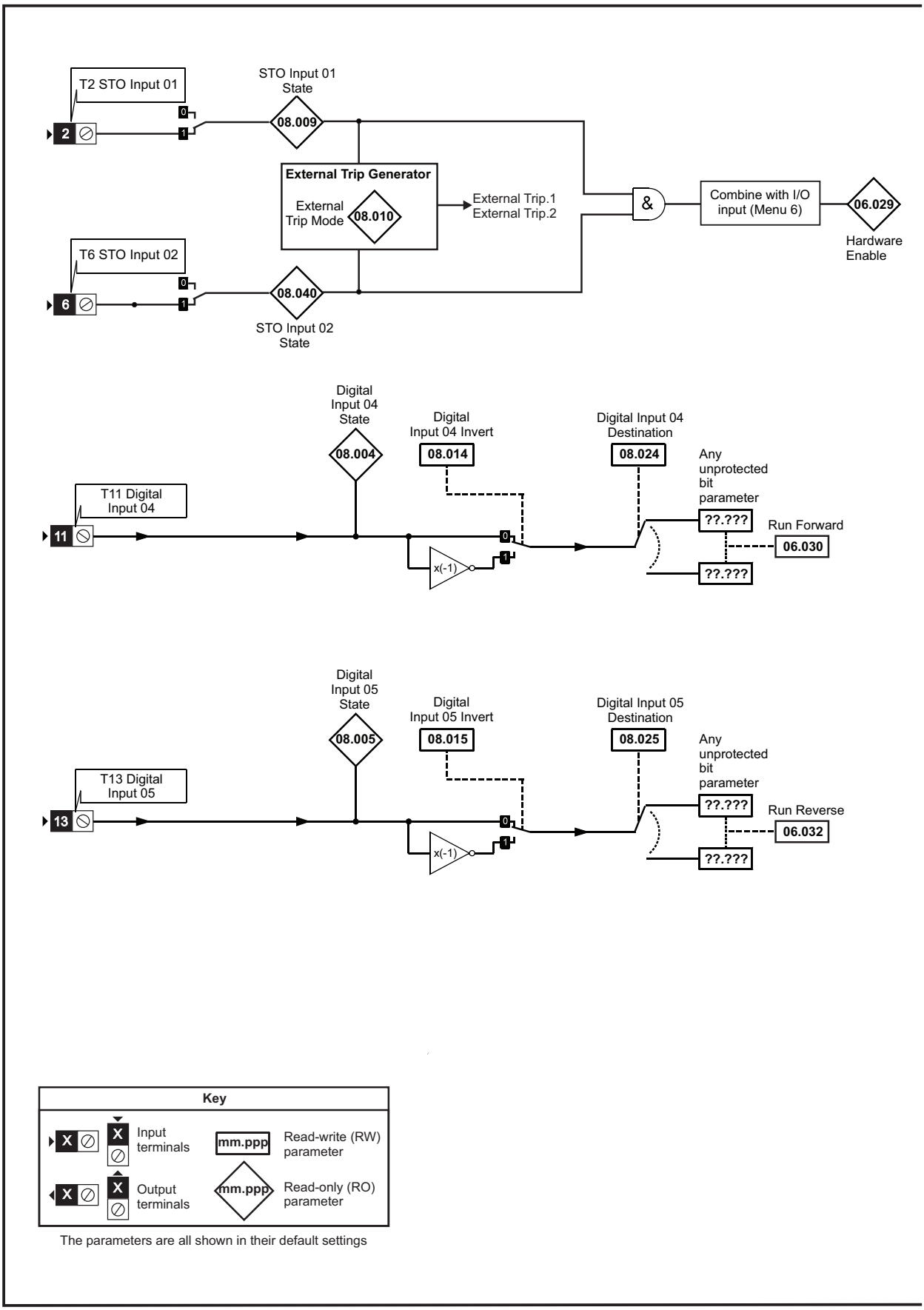


Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
07.001	Analog Input 1	±100.00 %					RO	Num	ND	NC	PT	FI
07.004	Monitored Temperature 1	±250 °C					RO	Num	ND	NC	PT	
07.005	Monitored Temperature 2	±250 °C					RO	Num	ND	NC	PT	
07.006	Monitored Temperature 3	±250 °C					RO	Num	ND	NC	PT	
07.008	Analog Input 1 Scaling	0.000 to 10.000		1.000			RW	Num				US
07.009	Analog Input 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
07.010	Analog Input 1 Destination	0.000 to 59.999		1.036			RW	Num	DE		PT	US
07.025	Calibrate Analog Input 1 Full Scale	Off (0) or On (1)		Off (0)			RW	Bit		NC		
07.026	Analog Input 1 Fast Update Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
07.030	Analog Input 1 Offset	±100.00 %		0.00 %			RW	Num				US
07.033	Power Output	±100.0 %					RO	Num	ND	NC	PT	
07.034	Inverter Temperature	±250 °C					RO	Num	ND	NC	PT	
07.035	Percentage Of d.c. Bus Thermal Trip Level	0 to 100 %					RO	Num	ND	NC	PT	
07.036	Percentage Of Drive Thermal Trip Level	0 to 100 %					RO	Num	ND	NC	PT	
07.037	Temperature Nearest To Trip Level	0 to 20999					RO	Num	ND	NC	PT	
07.038	Temperature Monitor Select 1	0 to 1999		1001			RW	Num				US
07.039	Temperature Monitor Select 2	0 to 1999		1002			RW	Num				US
07.040	Analog Input 1 Minimum	±100.00 %		-100.00 %			RW	Num				US
07.043	Analog Input 1 Maximum	±100.00 %		100.00 %			RW	Num				US
07.051	Analog Input 1 Full Scale	0 to 65535					RO	Num	ND	NC	PT	PS
07.052	Temperature Monitor Select 3	0 to 1999		1			RW	Num				US

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 11-19 Menu 8 Digital input and outputs logic diagram



The parameters are all shown in their default settings

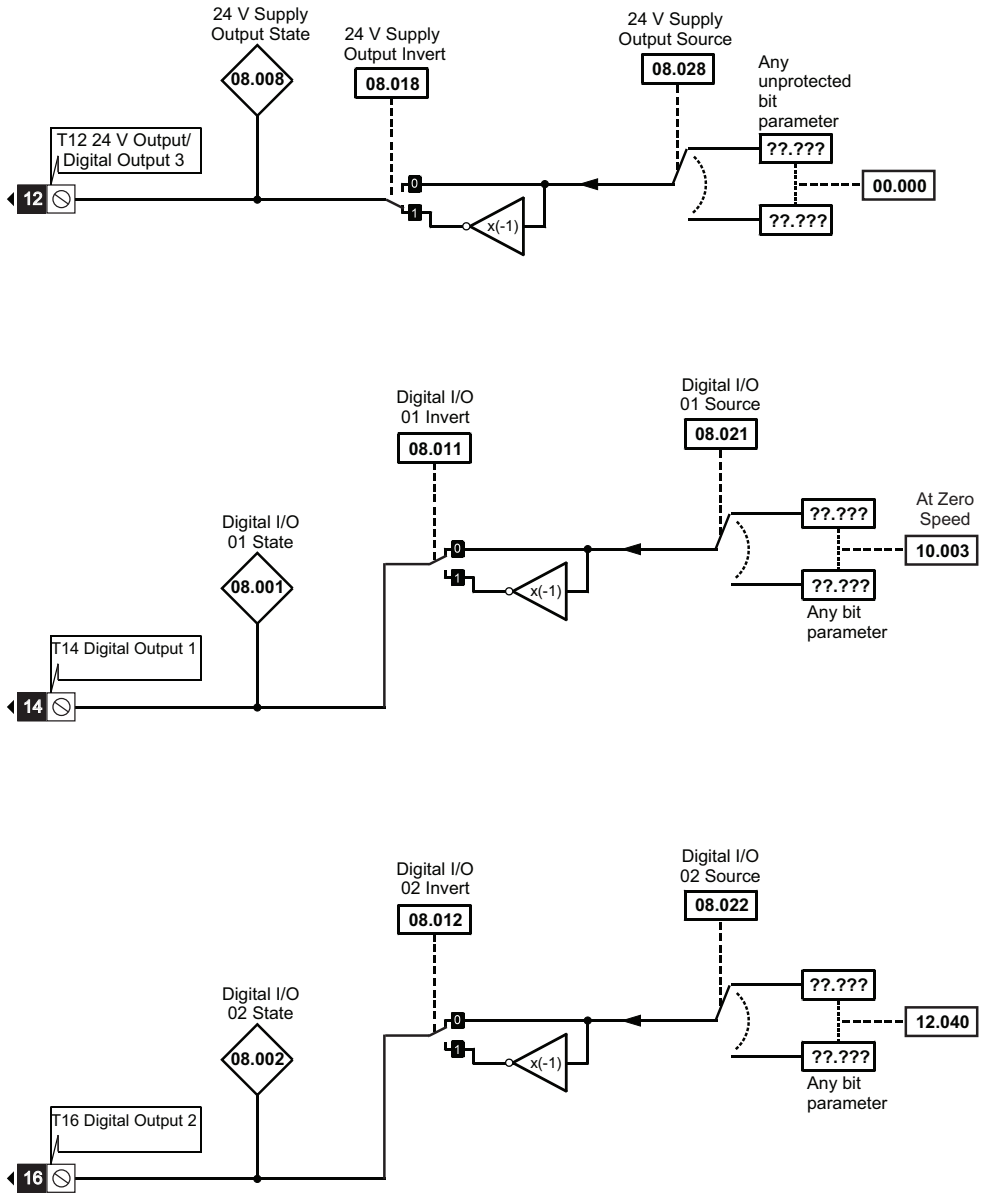
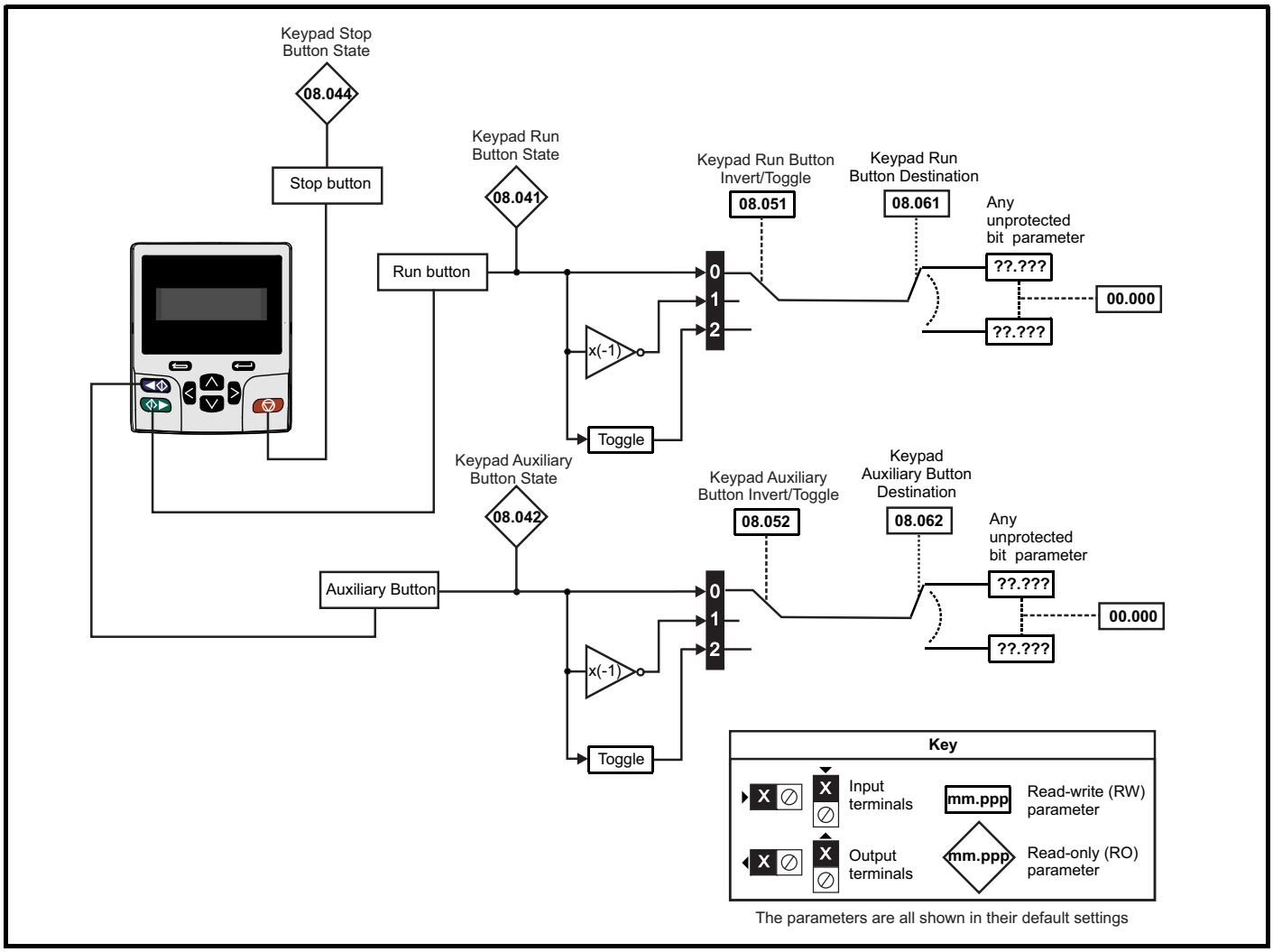

24 V Supply Output State
08.008
24 V Supply Output Invert
08.018
24 V Supply Output Source
08.028
Any unprotected bit parameter
??.???
??.???
00.000
T12 24 V Output/ Digital Output 3
12
0
1
x(-1)
Digital I/O 01 Invert
08.011
Digital I/O 01 Source
08.021
??.???
??.???
At Zero Speed
10.003
Any bit parameter
Digital I/O 01 State
08.001
T14 Digital Output 1
14
0
1
x(-1)
Digital I/O 02 Invert
08.012
Digital I/O 02 Source
08.022
??.???
??.???
12.040
Any bit parameter
Digital I/O 02 State
08.002
T16 Digital Output 2
16
0
1
x(-1)

Figure 11-20 Menu 8 Remote Keypad RTC buttons logic diagram



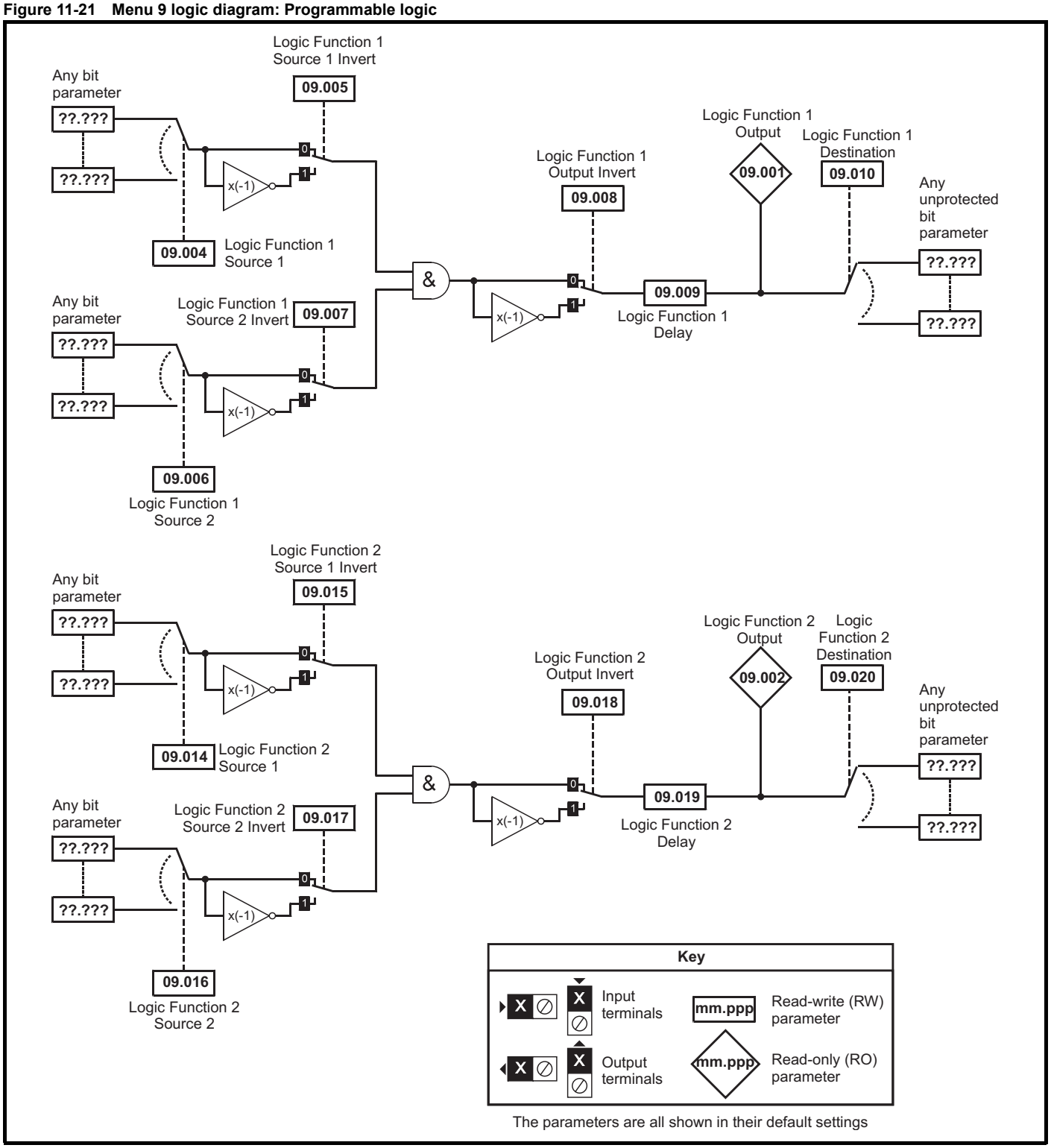
The parameters are all shown in their default settings

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
08.001	Digital I/O 01 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.002	Digital I/O 02 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.004	Digital Input 04 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.005	Digital Input 05 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.008	24V Supply Output State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.009	STO Input 01 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.010	External Trip Mode	Disable (0), STO 1 (1), STO 2 (2), STO 1 OR STO 2 (3)		Disable (0)			RW	Txt				US
08.011	Digital I/O 01 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.012	Digital I/O 02 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.014	Digital Input 04 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.015	Digital Input 05 Invert	Not Invert (0) or Invert (1)		Not Invert (0)			RW	Txt				US
08.018	24V Supply Output Invert	Not Invert (0) or Invert (1)		Invert (1)			RW	Txt				US
08.020	Digital I/O Read Word	0 to 511					RO	Num	ND	NC	PT	
08.021	Digital I/O 01 Source/Destination	0.000 to 59.999		10.003			RW	Num	DE		PT	US
08.022	Digital I/O 02 Source/Destination	0.000 to 59.999		12.040			RW	Num	DE		PT	US
08.024	Digital Input 04 Destination	0.000 to 59.999		6.030			RW	Num	DE		PT	US
08.025	Digital Input 05 Destination	0.000 to 59.999		6.032			RW	Num	DE		PT	US
08.028	24V Supply Output Source	0.000 to 59.999		0.000			RW	Num			PT	US
08.040	STO Input 02 State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.041	Keypad Run Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.042	Keypad Auxiliary Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.044	Keypad Stop Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.046	Drive Reset Button State	Off (0) or On (1)					RO	Bit	ND	NC	PT	
08.051	Keypad Run Button Invert/Toggle	Not Invert (0), Invert (1) or Toggle (2)		Not Invert (0)			RW	Txt				US
08.052	Keypad Auxiliary Button Invert/Toggle	Not Invert (0), Invert (1) or Toggle (2)		Not Invert (0)			RW	Txt				US
08.061	Keypad Run Button Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
08.062	Keypad Auxiliary Button Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
08.071	DI/O Output Enable Register 1	0000000000000000 to 1111111111111111		0000000000000000			RW	Bin			PT	US
08.072	DI/O Input Register 1	0000000000000000 to 1111111111111111					RO	Bin	ND	NC	PT	
08.073	DI/O Output Register 1	0000000000000000 to 1111111111111111		0000000000000000			RW	Bin			PT	

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

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

Figure 11-21 Menu 9 logic diagram: Programmable logic



The parameters are all shown in their default settings

Figure 11-22 Menu 9 logic diagram: Motorized pot and binary sum

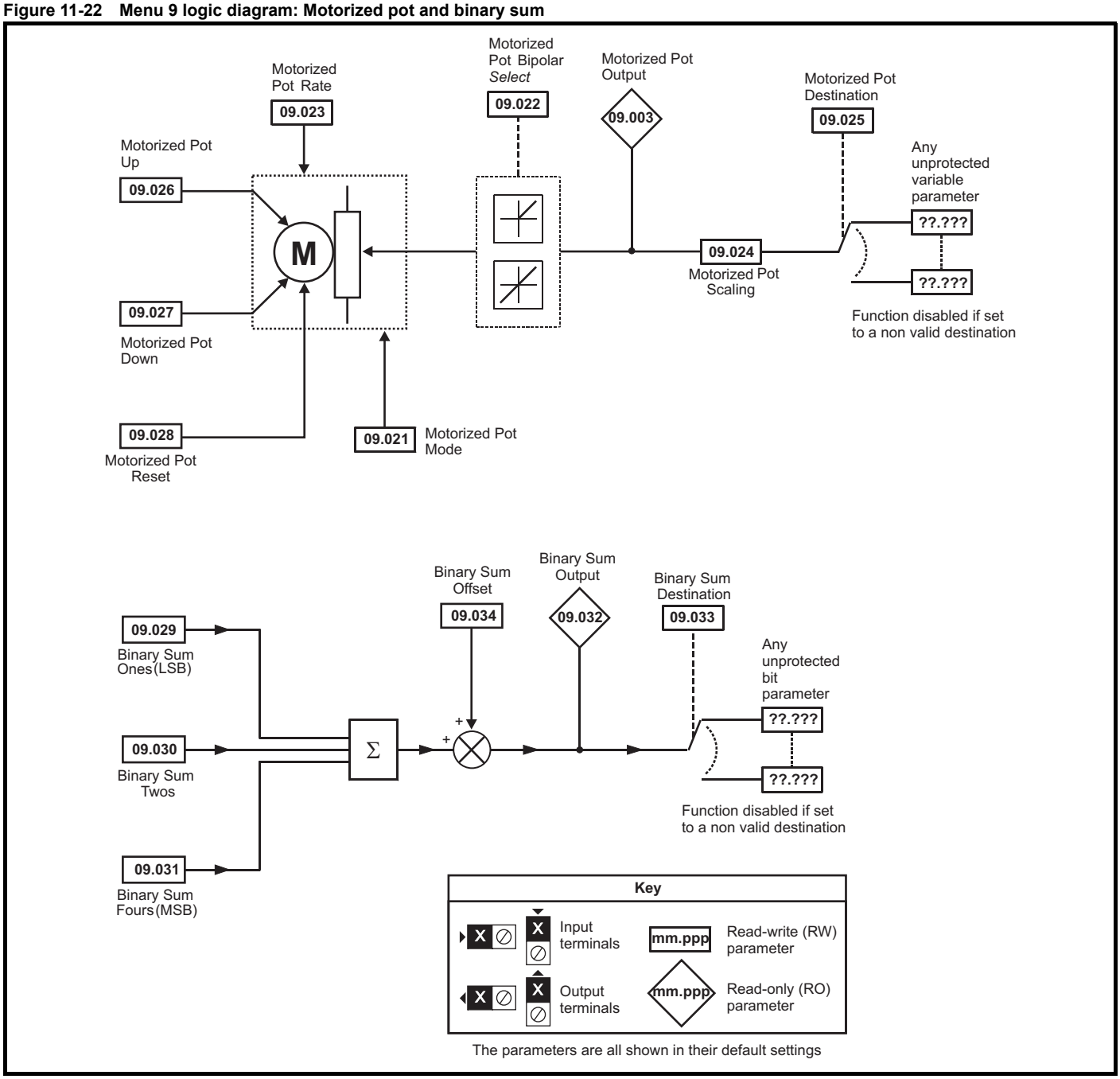
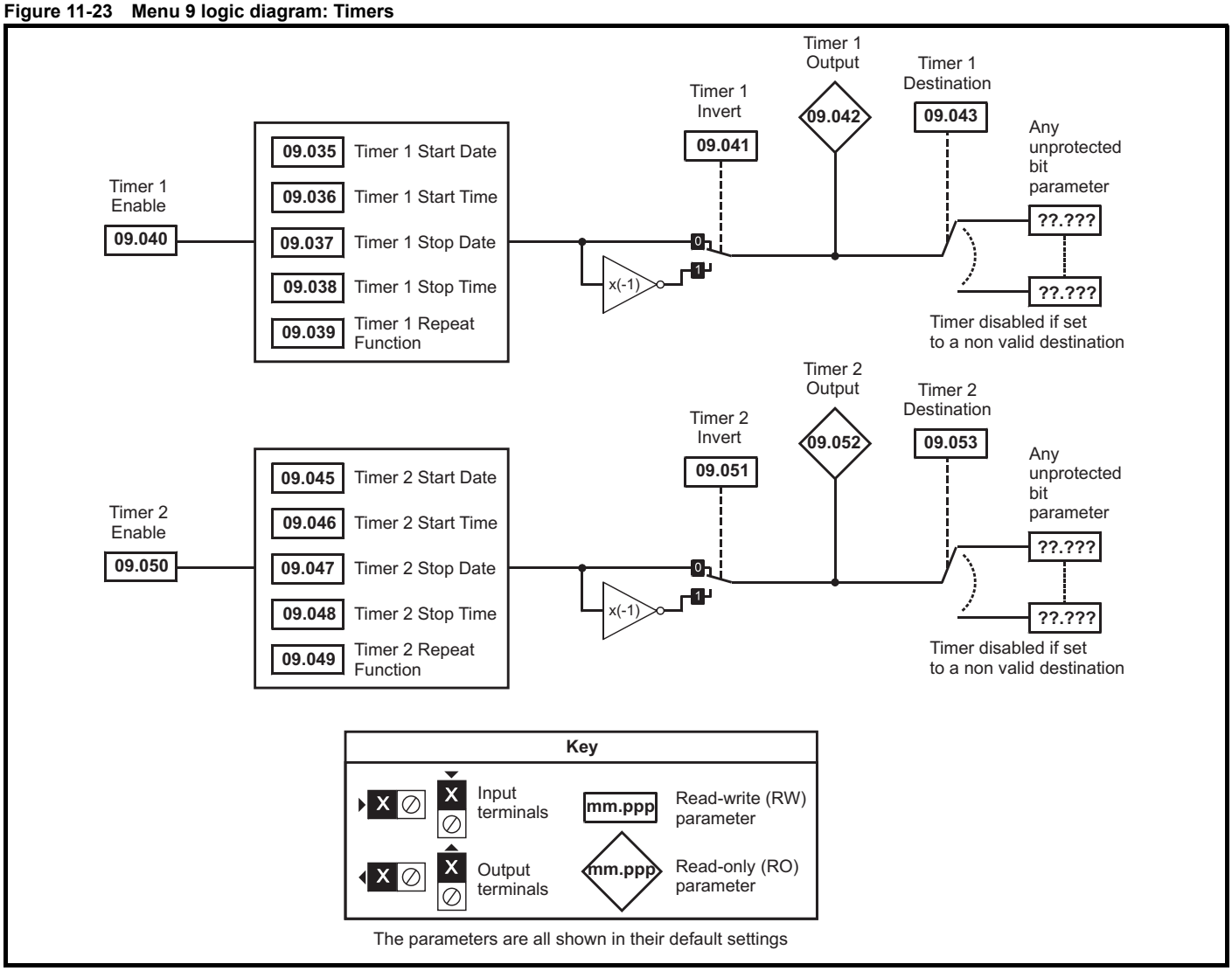
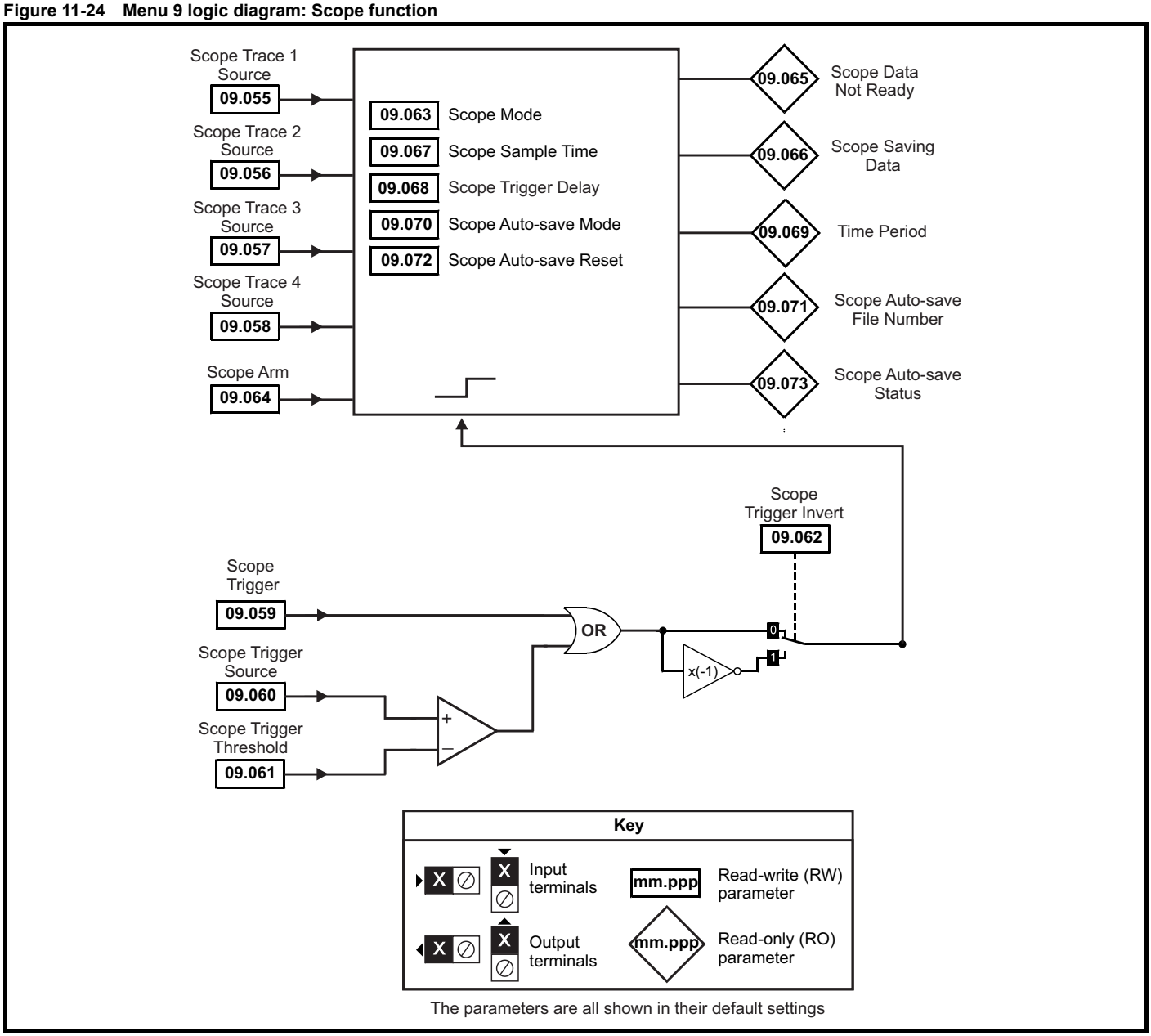


Figure 11-23 Menu 9 logic diagram: Timers



The parameters are all shown in their default settings

Figure 11-24 Menu 9 logic diagram: Scope function



The parameters are all shown in their default settings

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
09.001	Logic Function 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.002	Logic Function 2 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.003	Motorized Pot Output	±100.00 %					RO	Num	ND	NC	PT	PS
09.004	Logic Function 1 Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
09.005	Logic Function 1 Source 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.006	Logic Function 1 Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
09.007	Logic Function 1 Source 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.008	Logic Function 1 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.009	Logic Function 1 Delay	±25.0 s		0.0 s			RW	Num				US
09.010	Logic Function 1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.014	Logic Function 2 Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
09.015	Logic Function 2 Source 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.016	Logic Function 2 Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
09.017	Logic Function 2 Source 2 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.018	Logic Function 2 Output Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.019	Logic Function 2 Delay	±25.0 s		0.0 s			RW	Num				US
09.020	Logic Function 2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.021	Motorized Pot Mode	0 to 4		0			RW	Num				US
09.022	Motorized Pot Bipolar Select	Off (0) or On (1)		Off (0)			RW	Bit				US
09.023	Motorized Pot Rate	0 to 250 s		20 s			RW	Num				US
09.024	Motorized Pot Scaling	0.000 to 4.000		1.000			RW	Num				US
09.025	Motorized Pot Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.026	Motorized Pot Up	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.027	Motorized Pot Down	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.028	Motorized Pot Reset	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.029	Binary Sum Ones	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.030	Binary Sum Twos	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.031	Binary Sum Fours	Off (0) or On (1)		Off (0)			RW	Bit		NC		
09.032	Binary Sum Output	0 to 255					RO	Num	ND	NC	PT	
09.033	Binary Sum Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
09.034	Binary Sum Offset	0 to 248		0			RW	Num				US
09.035	Timer 1 Start Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.036	Timer 1 Start Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.037	Timer 1 Stop Date	00-00-00 to 31-12-99		00-00-00			RW	Date				US
09.038	Timer 1 Stop Time	00:00:00 to 23:59:59		00:00:00			RW	Time				US
09.039	Timer 1 Repeat Function	None (0), Hour (1), Day (2), Week (3), Month (4), Year (5), One off (6), Minute (7)		None (0)			RW	Txt				US
09.040	Timer 1 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
09.041	Timer 1 Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
09.042	Timer 1 Output	Off (0) or On (1)					RO	Bit	ND	NC	PT	
09.043	Timer 1 Destination	0.000 to 59.999		0.000			RW	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 59.999		0.000			RW	Num	DE		PT	US
09.055	Scope Trace 1 Source	0.000 to 59.999		5.001	3.002		RW	Num			PT	US
09.056	Scope Trace 2 Source	0.000 to 59.999		4.002			RW	Num			PT	US
09.057	Scope Trace 3 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.058	Scope Trace 4 Source	0.000 to 59.999		0.000			RW	Num			PT	US
09.059	Scope Trigger	Off (0) or On (1)		Off (0)			RW	Bit				
09.060	Scope Trigger Source	0.000 to 59.999		10.001			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)		Normal (1)			RW	Txt				US

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
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		4			RW	Num				US
09.068	Scope Trigger Delay	0 to 100 %		100 %			RW	Num				US
09.069	Scope Time Period	0.00 to 200000.00 ms					RO	Num	ND	NC	PT	
09.070	Scope Auto-save Mode	Disabled (0), Overwrite (1), Keep (2)		Disabled (0)			RW	Txt				US
09.071	Scope Auto-save File Number	0 to 99					RO	Num				PS
09.072	Scope Auto-save Reset	Off (0) or On (1)		Off (0)			RW	Bit				
09.073	Scope Auto-save Status	Disabled (0), Active (1), Stopped (2), Failed (3)					RO	Txt				PS

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

11.11 Menu 10: Status and trips

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
10.001	Drive OK	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.002	Drive Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.003	Zero Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.004	Running At Or Below Minimum Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.005	Below Set Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.006	At Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.007	Above Set Speed	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.008	Rated Load Reached	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.009	Current Limit Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.010	Regenerating	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.011	Braking IGBT Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.012	Braking Resistor Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.013	Reverse Direction Commanded	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.014	Reverse Direction Running	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.015	Supply Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.016	Under Voltage Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.017	Motor Overload Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.018	Drive Over-temperature Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.019	Drive Warning	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.020	Trip 0	0 to 255					RO	Txt	ND	NC	PT	PS
10.021	Trip 1	0 to 255					RO	Txt	ND	NC	PT	PS
10.022	Trip 2	0 to 255					RO	Txt	ND	NC	PT	PS
10.023	Trip 3	0 to 255					RO	Txt	ND	NC	PT	PS
10.024	Trip 4	0 to 255					RO	Txt	ND	NC	PT	PS
10.025	Trip 5	0 to 255					RO	Txt	ND	NC	PT	PS
10.026	Trip 6	0 to 255					RO	Txt	ND	NC	PT	PS
10.027	Trip 7	0 to 255					RO	Txt	ND	NC	PT	PS
10.028	Trip 8	0 to 255					RO	Txt	ND	NC	PT	PS
10.029	Trip 9	0 to 255					RO	Txt	ND	NC	PT	PS
10.030	Braking Resistor Rated Power	0.000 to 99999.999 kW		0.050 kW			RW	Num				US
10.031	Braking Resistor Thermal Time Constant	0.000 to 1500.000 s		2.000 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	1.0 to 600.0 s		1.0 s			RW	Num				US
10.036	Auto-reset Hold Drive ok	Off (0) or On (1)		Off (0)			RW	Bit				US
10.037	Action On Trip Detection	00000 to 11111		00000			RW	Bin				US
10.038	User Trip	0 to 255		0			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

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
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		70.00 Ω			RW	Num				US
10.062	Low Load Detected Alarm	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.063	Local Keypad Battery Low	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.064	Remote Keypad Battery Low	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.065	Auto-tune Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.066	Limit Switch Active	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.068	Hold Drive Healthy On Under Voltage	Off (0) or On (1)		Off (0)			RW	Bit				US
10.069	Additional Status Bits	0000000000 to 1111111111					RO	Bin	ND	NC	PT	
10.070	Trip 0 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.071	Trip 1 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.072	Trip 2 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.073	Trip 3 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.074	Trip 4 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.075	Trip 5 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.076	Trip 6 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.077	Trip 7 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.078	Trip 8 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.079	Trip 9 Sub-trip Number	0 to 65535					RO	Num	ND	NC	PT	PS
10.080	Stop Motor	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.081	Phase Loss	Off (0) or On (1)					RO	Bit	ND	NC	PT	
10.101	Drive Status	Inhibit (0), Ready (1), Stop (2), Scan (3), Run (4), Supply Loss (5), Deceleration (6), dc Injection (7), Position (8), Trip (9), Active (10), Off (11), Hand (12), Auto (13), Heat (14), Under Voltage (15), Phasing (16)					RO	Txt	ND	NC	PT	
10.102	Trip Reset Source	0 to 1023					RO	Num	ND	NC	PT	PS
10.103	Trip Time Identifier	-2147483648 to 2147483647 ms					RO	Num	ND	NC	PT	
10.104	Active Alarm	None (0), Brake Resistor (1), Motor Overload (2), Ind Overload (3), Drive Overload (4), Auto Tune (5), Limit Switch (6), Fire Mode (7), Low Load (8), Option Slot 1 (9), Option Slot 2 (10), Option Slot 3 (11), Option Slot 4 (12)					RO	Txt	ND	NC	PT	
10.105	Hand Off Auto State	Not Active (0), Off (1), Hand (2), Auto (3)					RO	Txt	ND	NC	PT	PS
10.106	Potential Drive Damage Conditions	0000 to 1111					RO	Bin	ND	NC	PT	PS
10.107	Auto-tune State	Not Active (0), Resistance (1), pLs (2), Ls (3), Flux (4), Flux Repeat (5), Ld Lq No-load (6), Lq (7), Ke (8), Inertia (9)					RO	Txt	ND	NC	PT	

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
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 / S	OL	RFC-A	RFC-S						
11.001	Option Synchronisation Select	Not Active (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4), Automatic (5)		Slot 3 (3)			RW	Txt				US
11.002	Option synchronisation Active	Not Active (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4)					RO	Txt	ND	NC	PT	
11.017	Keypad Defined Node Address	0.000 to 255					RO	Num				
11.018	Status Mode Parameter 1	0.000 to 59.999		0.000			RW	Num			PT	US
11.019	Status Mode Parameter 2	0.000 to 59.999		0.000			RW	Num			PT	US
11.020	Reset Serial Communications*	Off (0) or On (1)		Off (0)			RW	Bit	ND	NC		
11.021	Parameter 00.030 Scaling	0.000 to 10.000		1.000			RW	Num				US
11.022	Parameter Displayed At Power-up	0.000 to 0.080		0.010			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 2 NP (8), 7 1 NP (9), 7 1 EP (10), 7 1 OP (11), 7 2 NP M (12), 7 1 NP M (13), 7 1 EP M (14), 7 1 OP M (15)		8 2 NP (0)			RW	Txt				US
11.025	Serial Baud Rate*	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8), 76800 (9), 115200 (10)		19200 (6)			RW	Txt				US
11.026	Minimum Comms Transmit Delay*	0 to 250 ms		2 ms			RW	Num				US
11.027	Silent Period*	0 to 250 ms		0 ms			RW	Num				US
11.028	Drive Derivative	0 to 255					RO	Num	ND	NC	PT	
11.029	Software Version	00.00.00.00 to 99.99.99.99					RO	Num	ND	NC	PT	
11.030	User Security Code	0 to 2147483647		0			RW	Num	ND	NC	PT	US
11.031	User Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3)		Open-loop (1)	RFC-A (2)	RFC-S (3)	RW	Txt	ND	NC	PT	
11.032	Maximum Heavy Duty Rating	0.000 to 99999.999 A					RO	Num	ND	NC	PT	
11.033	Drive Rated Voltage	200 V (0), 400 V (1)					RO	Txt	ND	NC	PT	
11.034	Software Sub Version	0 to 99					RO	Num	ND	NC	PT	
11.036	NV Media Card File Previously Loaded	0 to 999					RO	Num		NC	PT	
11.037	NV Media Card File Number	0 to 999		0			RW	Num				
11.038	NV Media Card File Type	None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6)					RO	Txt	ND	NC	PT	
11.039	NV Media Card File Version	0 to 9999					RO	Num	ND	NC	PT	
11.040	NV Media Card File Checksum	--2147483648 to 2147483647					RO	Num	ND	NC	PT	
11.042	Parameter Cloning	None (0), Read (1), Program (2), Auto (3), Boot (4)		None (0)			RW	Txt		NC		US
11.043	Load Defaults	None (0), Standard (1), US (2)		None (0)			RW	Txt		NC		
11.044	User Security Status	Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)		Menu 0 (0)			RW	Txt	ND		PT	
11.045	Select Motor 2 Parameters	Motor 1 (0) or Motor 2 (1)		Motor 1 (0)			RW	Txt				US
11.046	Defaults Previously Loaded	0 to 2000					RO	Num	ND	NC	PT	US
11.047	Onboard User Program: Enable	Stop (0) or Run (1)		Run (1)			RW	Txt				US
11.048	Onboard User Program: Status	-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	000000000 to 999999999					RO	Num	ND	NC	PT	
11.053	Serial Number MS	0 to 999999999					RO	Num	ND	NC	PT	
11.054	Drive Date Code	0 to 65535					RO	Num	ND	NC	PT	
11.055	Onboard User Program: Clock Task Scheduled Interval	0 to 262140 ms					RO	Num	ND	NC	PT	
11.060	Maximum Rated Current	0.000 to 99999.999 A					RO	Num	ND	NC	PT	
11.061	Full Scale Current Kc	0.000 to 99999.999 A					RO	Num	ND	NC	PT	
11.062	Power Board Software Version Number	0.00 to 99.99					RO	Num	ND	NC	PT	
11.063	Product Type	0 to 255					RO	Num	ND	NC	PT	
11.064	Product Identifier Characters	M751					RO	Chr	ND	NC	PT	
11.065	Drive Rating And Configuration	00000000 to 99999999					RO	Num	ND	NC	PT	
11.066	Power Stage Identifier	0 to 255					RO	Num	ND	NC	PT	
11.067	Control Board Identifier	0.000 to 65.535					RO	Num	ND	NC	PT	
11.068	Internal I/O Identifier	0 to 255					RO	Num	ND	NC	PT	
11.069	Position Feedback Interface Identifier	0 to 255					RO	Num	ND	NC	PT	
11.070	Core Parameter Database Version	0.00 to 99.99					RO	Num	ND	NC	PT	
11.072	NV Media Card Create Special File	0 to 1		0			RW	Num		NC		
11.073	NV Media Card Type	None (0), SMART Card (1), SD Card (2)					RO	Txt	ND	NC	PT	

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
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		0			RW	Num	ND	NC	PT	
11.079	Drive Name Characters 1-4	---- (-2147483648) to --- (2147483647)		---- (0)			RW	Chr			PT	US
11.080	Drive Name Characters 5-8	---- (-2147483648) to --- (2147483647)		---- (0)			RW	Chr			PT	US
11.081	Drive Name Characters 9-12	---- (-2147483648) to --- (2147483647)		---- (0)			RW	Chr			PT	US
11.082	Drive Name Characters 13-16	---- (-2147483648) to --- (2147483647)		---- (0)			RW	Chr			PT	US
11.084	Drive Mode	Open-loop (1), RFC-A (2), RFC-S (3)					RO	Txt	ND	NC	PT	US
11.085	Security Status	None (0), Read-only (1), Status-only (2), No Access (3)					RO	Txt	ND	NC	PT	PS
11.086	Menu Access Status	Menu 0 (0) or All Menus (1)					RO	Txt	ND	NC	PT	PS
11.090	Keypad Port Serial Address	1 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)		0			RO	Txt	ND	NC	PT	

RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
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 11-25 Menu 12 logic diagram

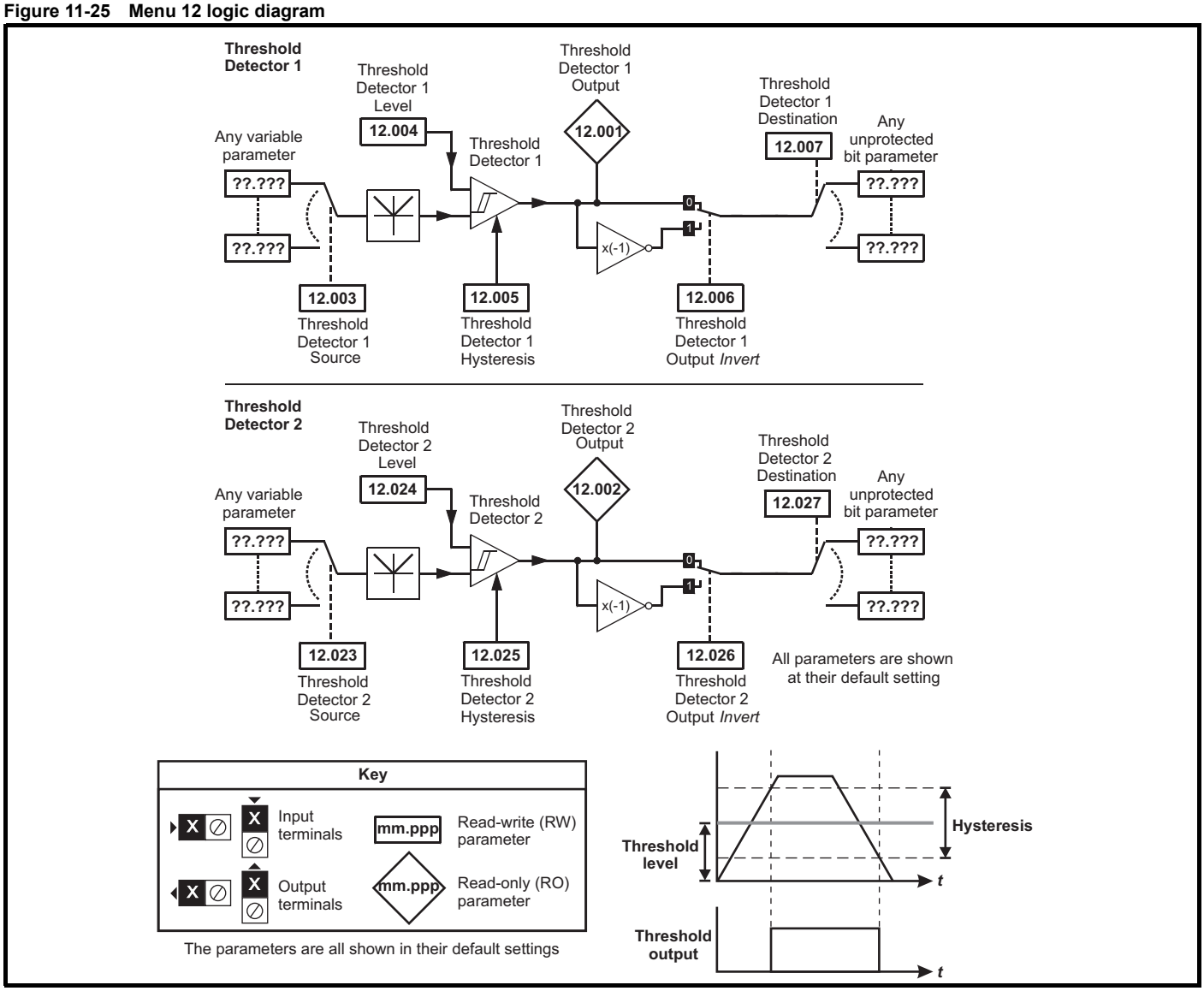
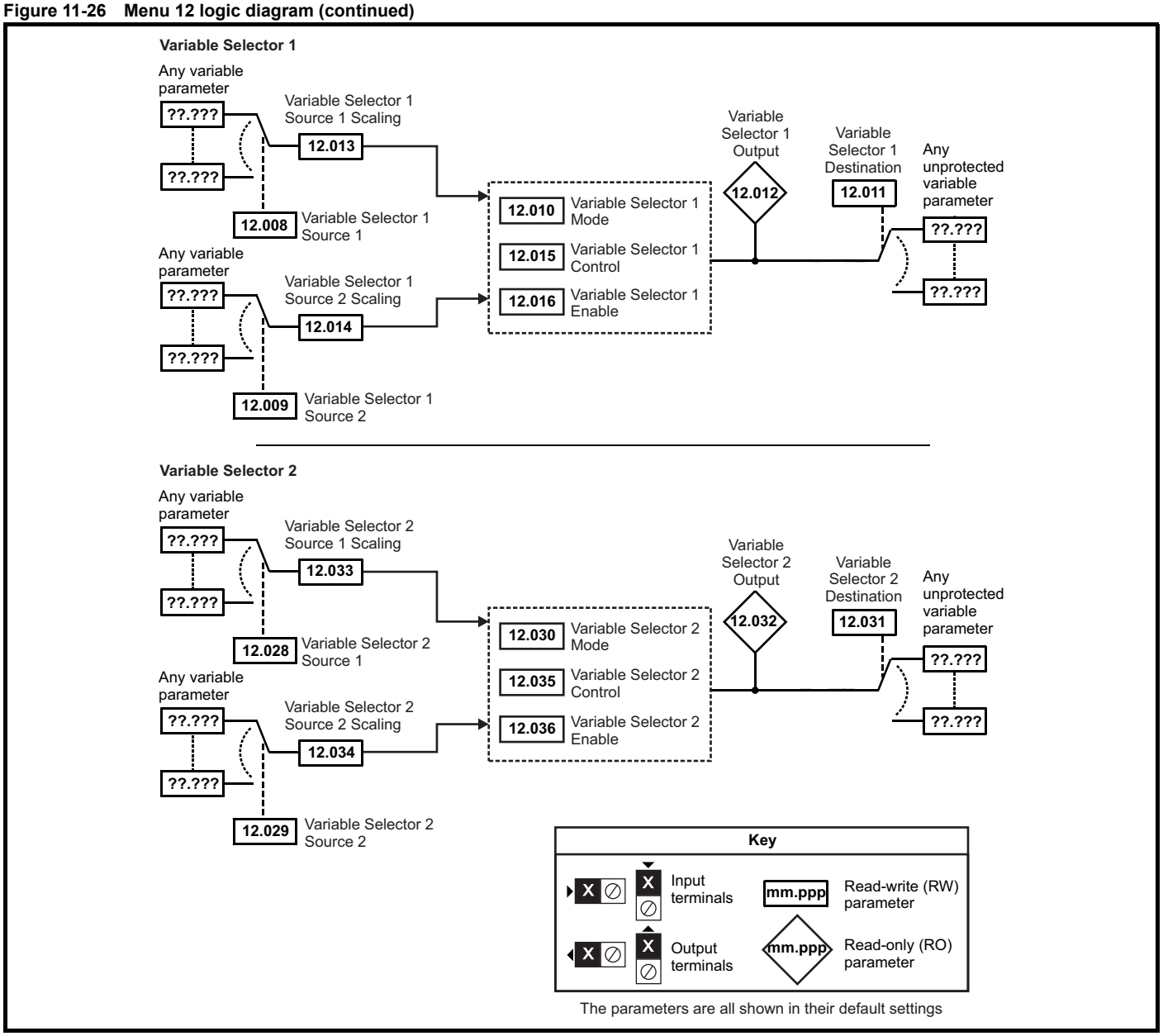


Figure 11-26 Menu 12 logic diagram (continued)



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

Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

Figure 11-27 Open-loop brake function

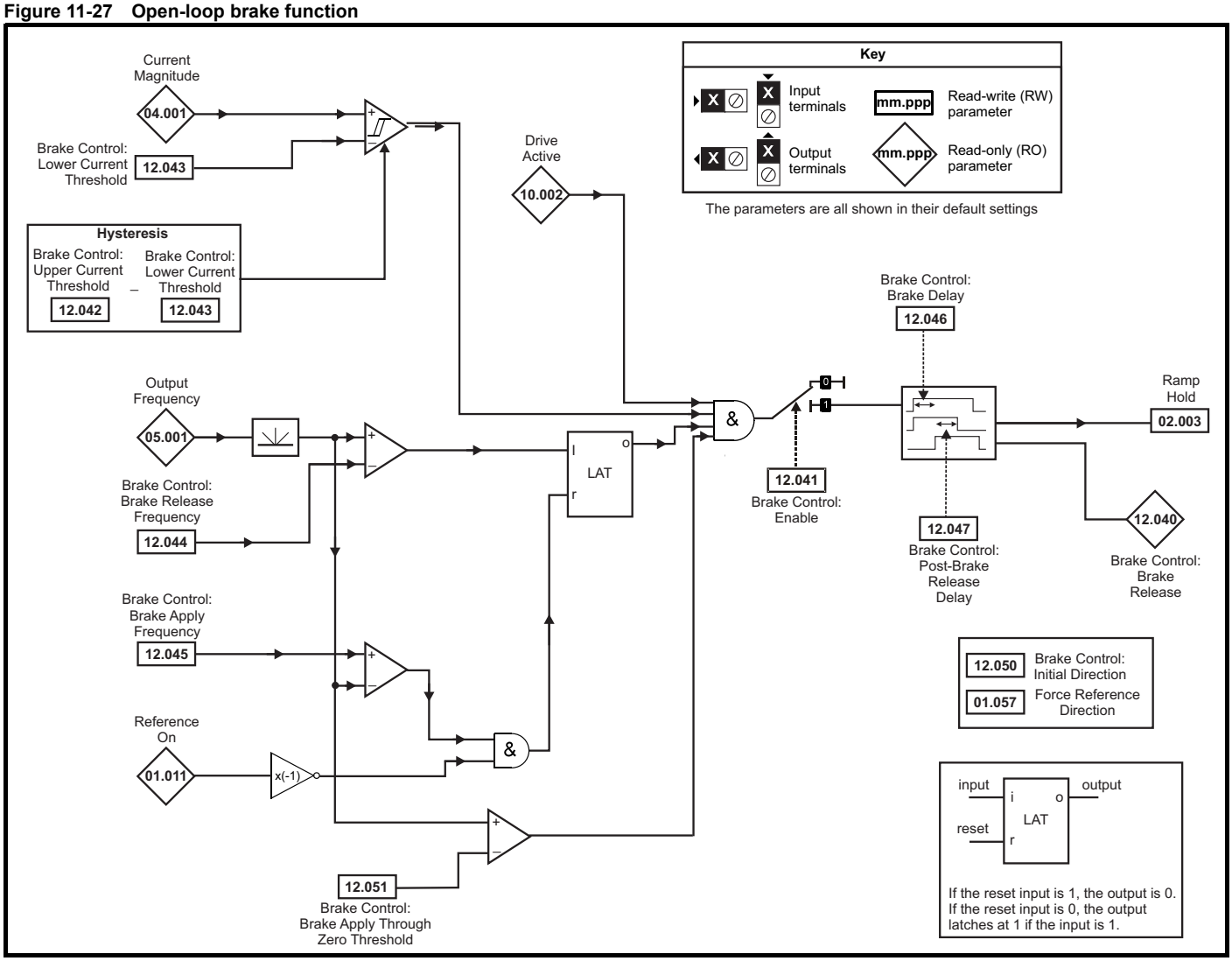
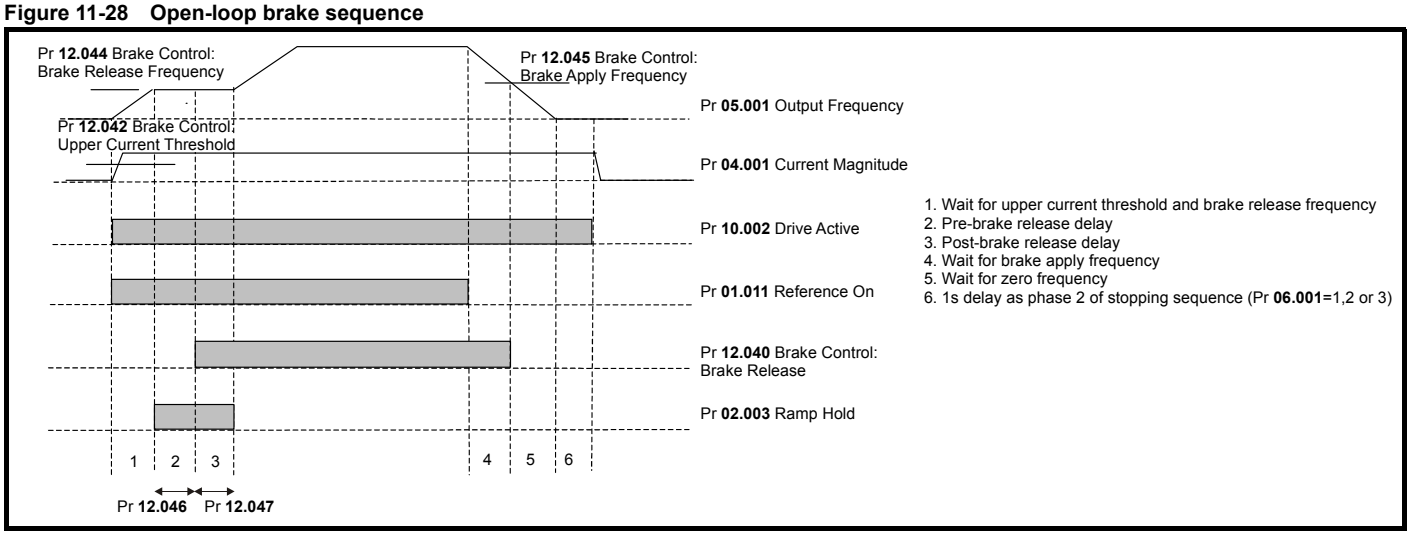


Figure 11-28 Open-loop brake sequence



WARNING

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

WARNING

Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

Figure 11-29 RFC-A mode with brake controller mode (12.052) =0 (RFC-A with position feedback mode)

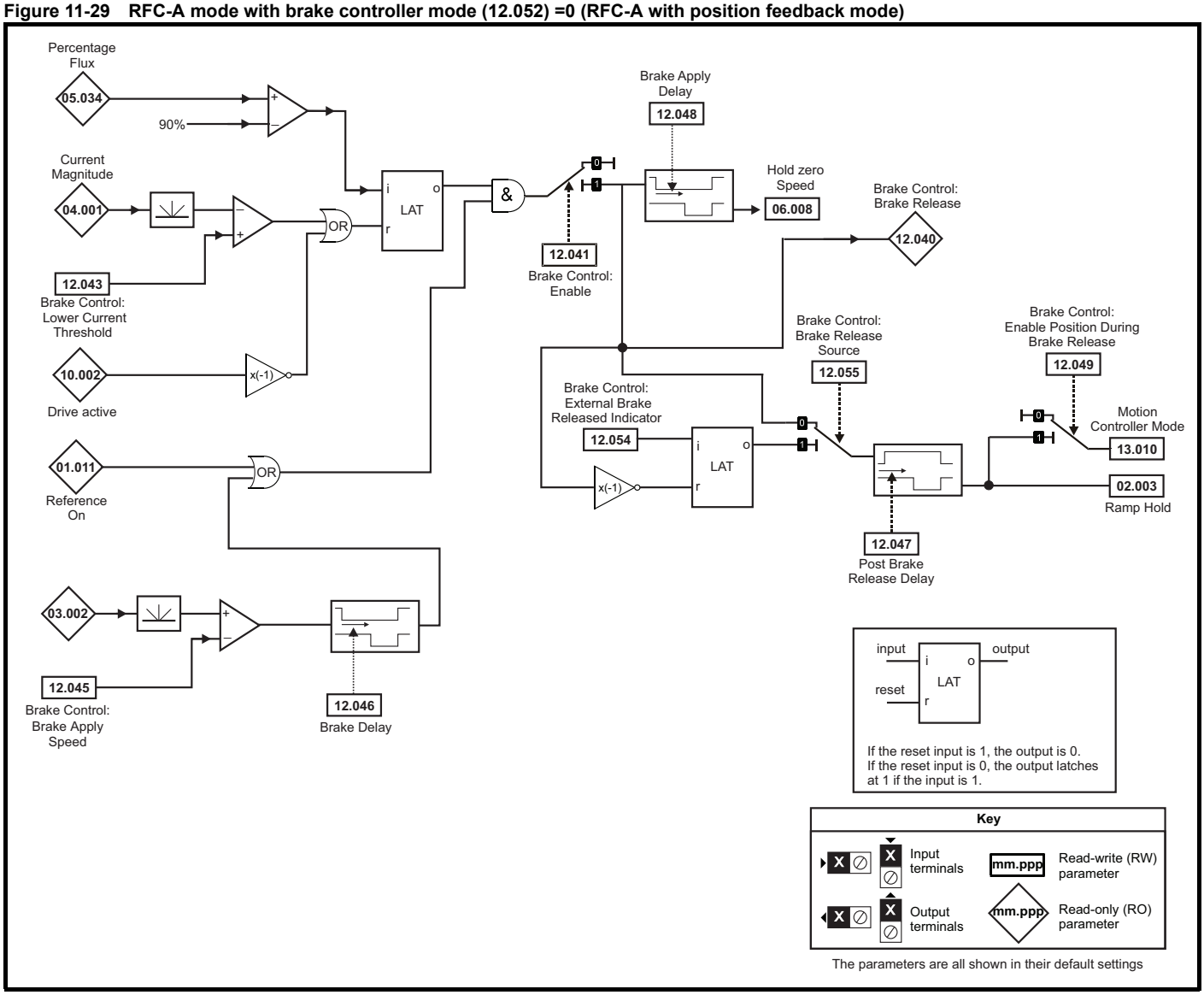
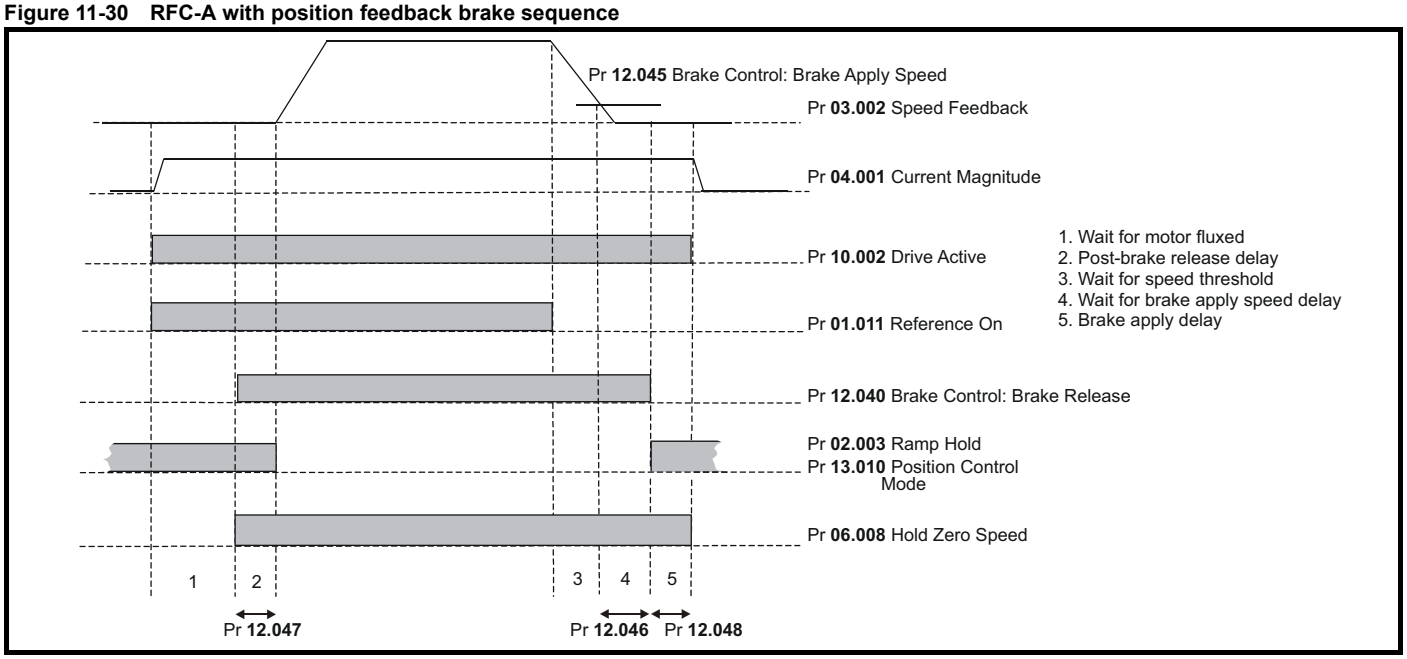


Figure 11-30 RFC-A with position feedback brake sequence



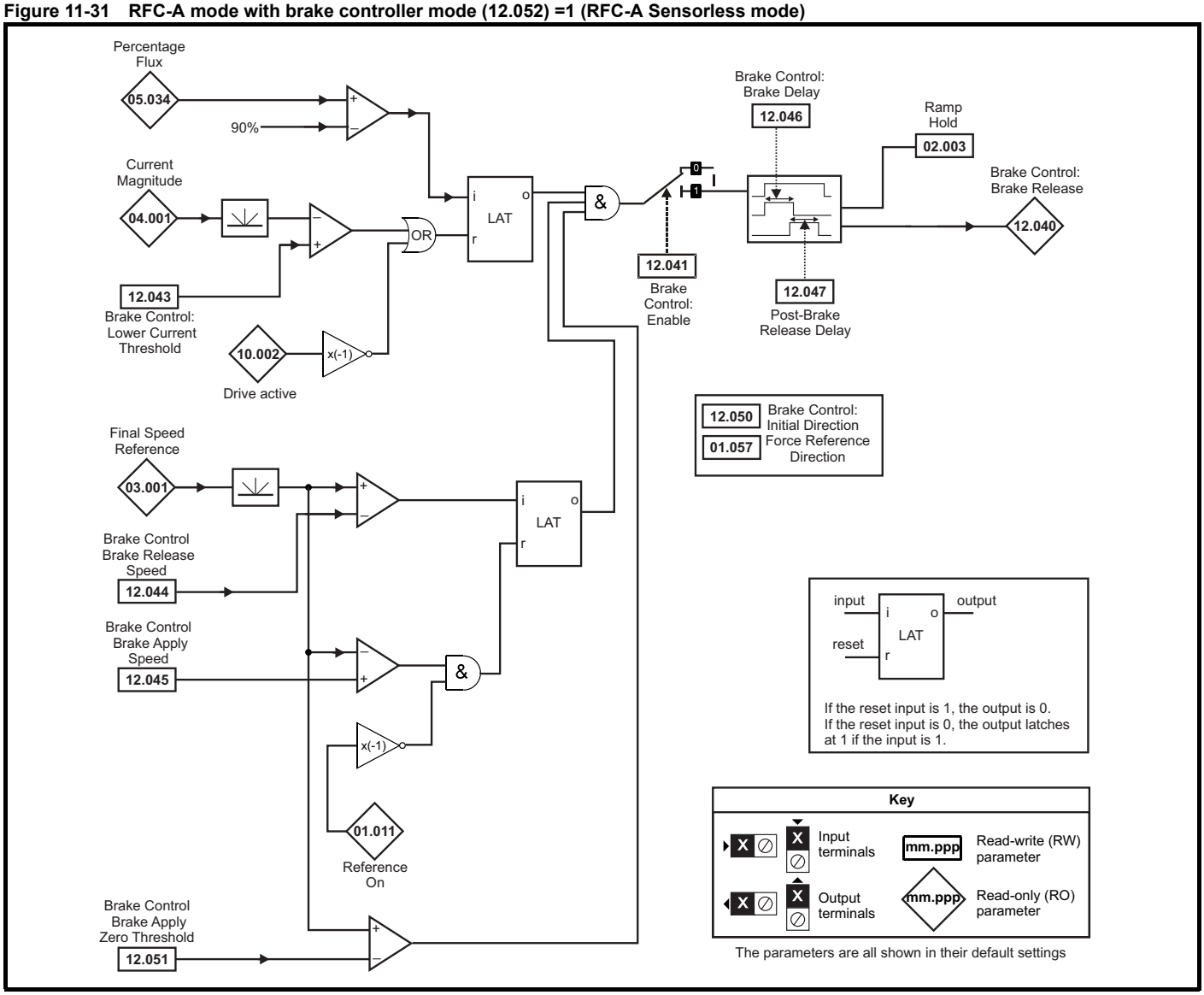
WARNING

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

WARNING

Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

Figure 11-31 RFC-A mode with brake controller mode (12.052) =1 (RFC-A Sensorless mode)



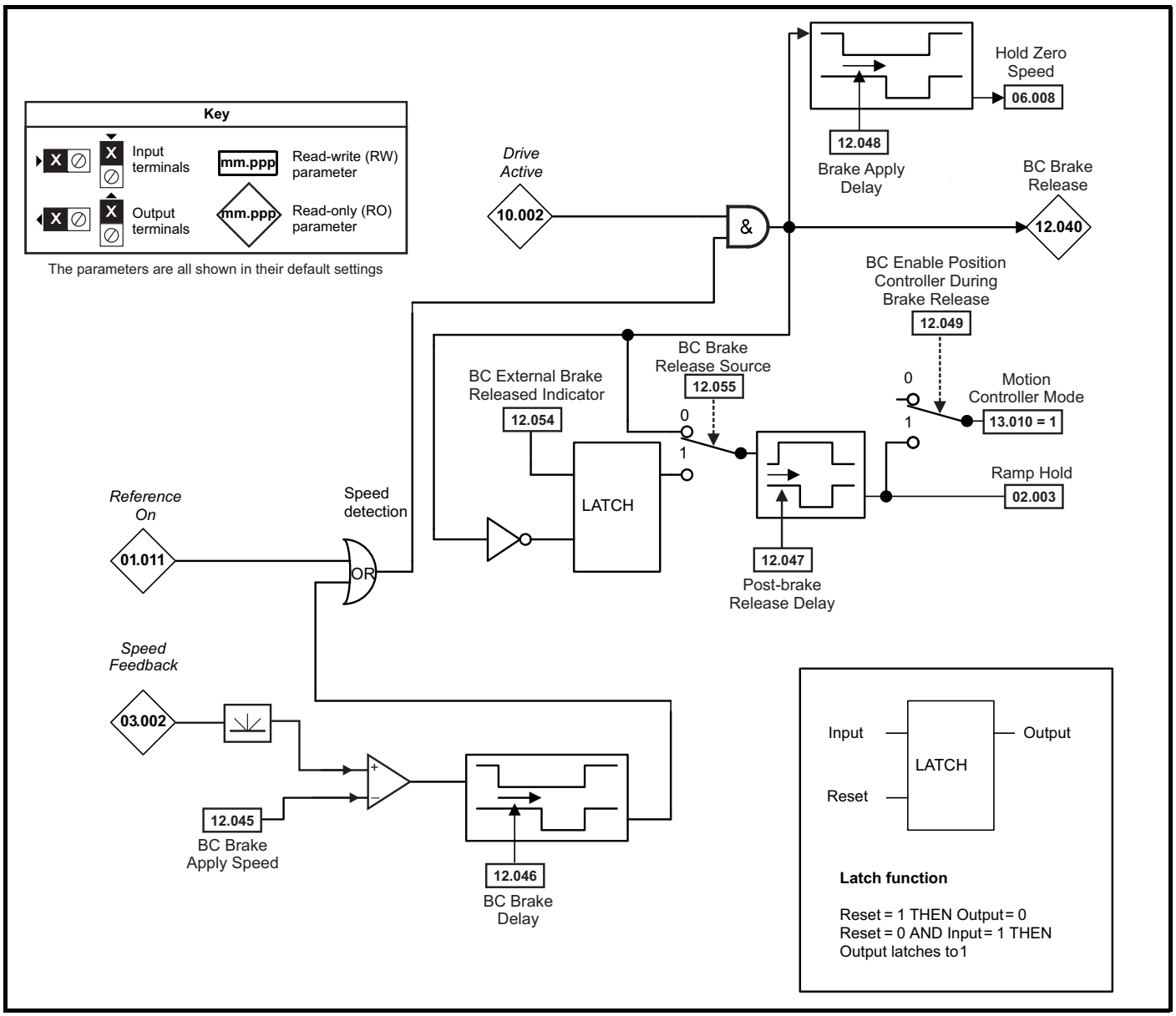
WARNING

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

Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

Figure 11-32 RFC-S brake function

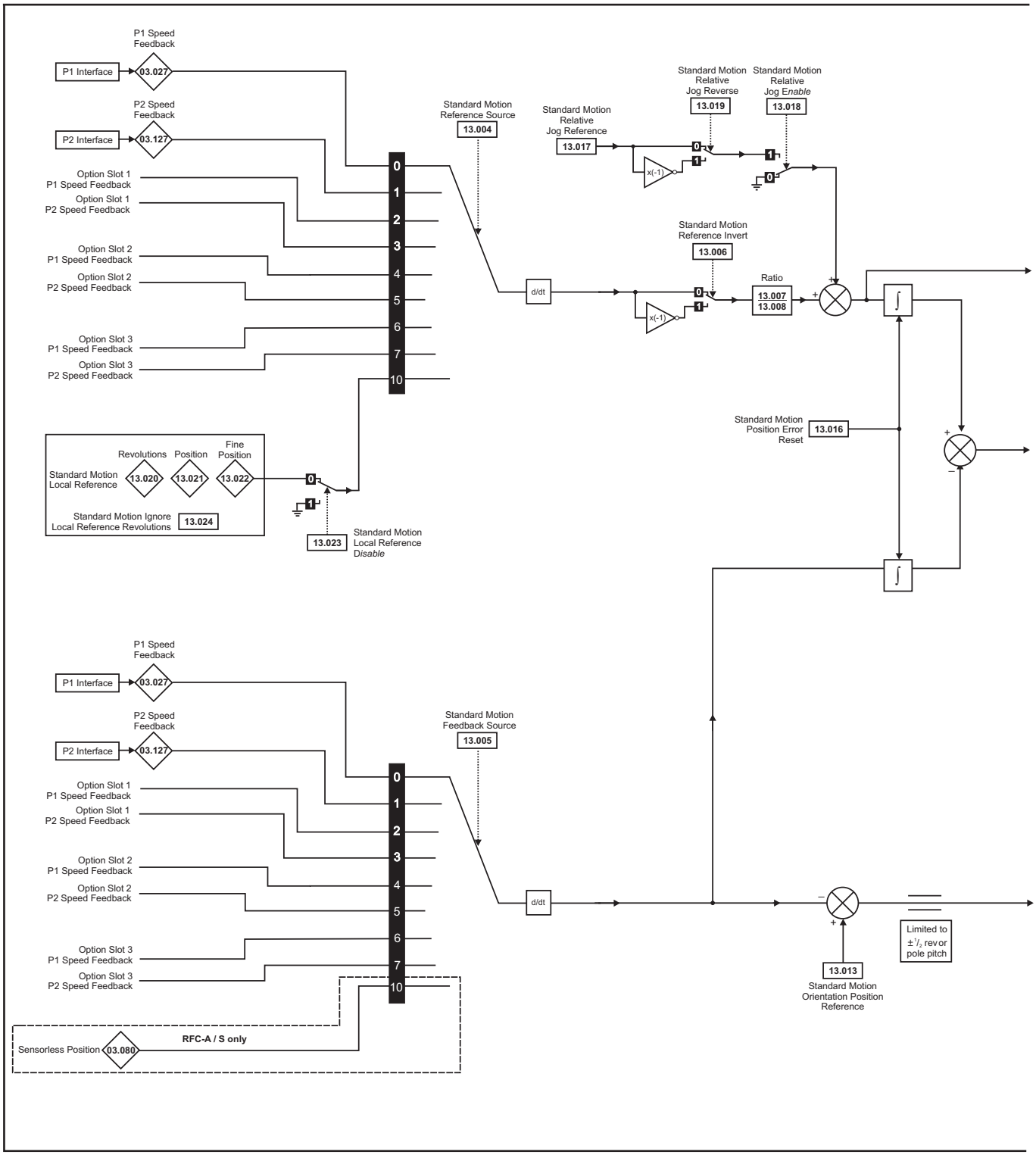


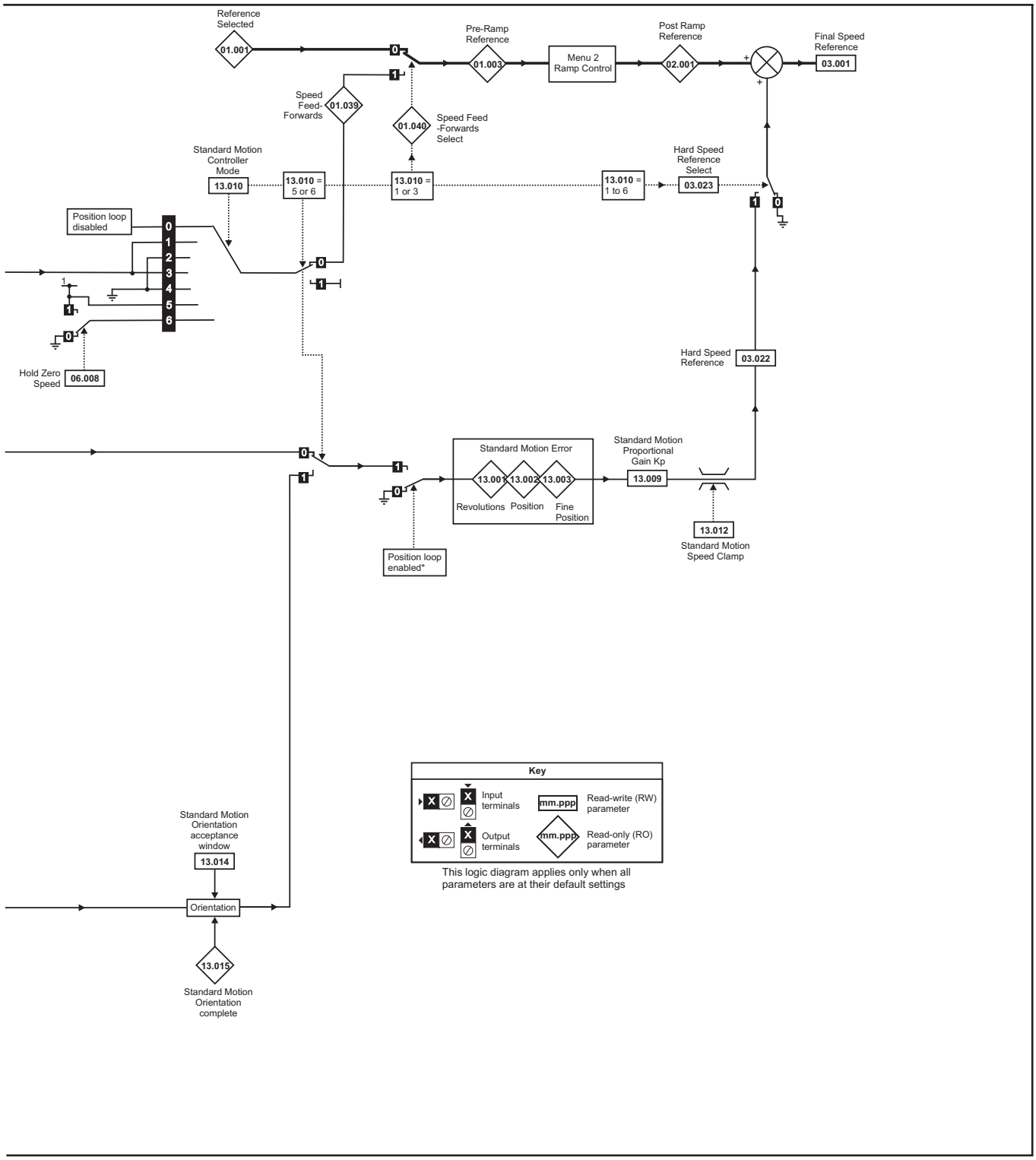
Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC- A	RFC- S	OL	RFC-A	RFC-S						
12.001	Threshold Detector 1 Output	Off (0) or On (1)						RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output	Off (0) or On (1)						RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source	0.000 to 59.999			0.000			RW	Num			PT	US
12.004	Threshold Detector 1 Level	0.00 to 100.00 %			0.00 %			RW	Num				US
12.005	Threshold Detector 1 Hysteresis	0.00 to 25.00 %			0.00 %			RW	Num				US
12.006	Threshold Detector 1 Output Invert	Off (0) or On (1)			Off (0)			RW	Bit				US
12.007	Threshold Detector 1 Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
12.008	Variable Selector 1 Source 1	0.000 to 59.999			0.000			RW	Num			PT	US
12.009	Variable Selector 1 Source 2	0.000 to 59.999			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), Sectional (10)			Input 1 (0)			RW	Txt				US
12.011	Variable Selector 1 Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
12.012	Variable Selector 1 Output	±100.00 %						RO	Num	ND	NC	PT	
12.013	Variable Selector 1 Source 1 Scaling	±4.000			1.000			RW	Num				US
12.014	Variable Selector 1 Source 2 Scaling	±4.000			1.000			RW	Num				US
12.015	Variable Selector 1 Control	0.00 to 100.00			0.00			RW	Num				US
12.016	Variable Selector 1 Enable	Off (0) or On (1)			On (1)			RW	Bit				US
12.023	Threshold Detector 2 Source	0.000 to 59.999			0.000			RW	Num			PT	US
12.024	Threshold Detector 2 Level	0.00 to 100.00 %			0.00 %			RW	Num				US
12.025	Threshold Detector 2 Hysteresis	0.00 to 25.00 %						RW	Num				US
12.026	Threshold Detector 2 Output Invert	Off (0) or On (1)			Off (0)			RW	Bit				US
12.027	Threshold Detector 2 Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
12.028	Variable Selector 2 Source 1	0.000 to 59.999			0.000			RW	Num			PT	US
12.029	Variable Selector 2 Source 2	0.000 to 59.999			0.000			RW	Num			PT	US
12.030	Variable Selector 2 Mode	Input 1 (0), Input 2 (1), Add (2), Subtract (3), Multiply (4), Divide (5), Time Const (6), Ramp (7), Modulus (8), Powers (9), Sectional (10)			Input 1 (0)			RW	Txt				US
12.031	Variable Selector 2 Destination	0.000 to 59.999			0.000			RW	Num	DE		PT	US
12.032	Variable Selector 2 Output	±100.00 %						RO	Num	ND	NC	PT	
12.033	Variable Selector 2 Source 1 Scaling	±4.000			1.000			RW	Num				US
12.034	Variable Selector 2 Source 2 Scaling	±4.000			1.000			RW	Num				US
12.035	Variable Selector 2 Control	0.00 to 100.00			0.00			RW	Num				US
12.036	Variable Selector 2 Enable	Off (0) or On (1)			On (1)			RW	Bit				US
12.040	Brake Control: Brake Release	Off (0) or On (1)						RO	Bit	ND	NC	PT	
12.041	Brake Control: Enable	Off (0) or On (1)			Off (0)			RW	Bit				US
12.042	Brake Control: Upper Current Threshold	0 to 200 %			50 %			RW	Num				US
12.043	Brake Control: Lower Current Threshold	0 to 200 %			10 %			RW	Num				US
12.044	Brake Control: Brake Release Frequency	0.0 to 20.0 Hz			1.0 Hz			RW	Num				US
	Brake Control: Brake Release Speed		0 to 200 rpm			10 rpm		RW	Num				US
12.045	Brake Control: Brake Apply Frequency	0.0 to 20.0 Hz			2.0 Hz			RW	Num				US
	Brake Control: Brake Apply Speed		0 to 200 rpm			5 rpm		RW	Num				US
12.046	Brake Control: Brake Delay	0.0 to 25.0 s			1.0 s			RW	Num				US
12.047	Brake Control: Post-brake Release Delay	0.0 to 25.0 s			1.0 s			RW	Num				US
12.048	Brake Control: Brake Apply Delay		0.0 to 25.0 s			1.0 s		RW	Num				US
12.049	Brake Control: Enable Position Control During Brake Release		Off (0) or On (1)			Off (0)		RW	Bit				US
12.050	Brake Control: Initial Direction	Ref (0), Forward (1), Reverse (2)			Ref (0)			RW	Txt				US
12.051	Brake Control: Brake Apply Through Zero Threshold	0.0 to 20.0 Hz	0 to 200 rpm		1.0 Hz	5 rpm		RW	Num				US
12.052	Brake Control: Mode		Off (0) or On (1)			Off (0)		RW	Bit				US
12.054	External Brake Released Indicator		Off (0) or On (1)			Off (0)		RW	Bit				
12.055	Brake Release Source		Off (0) or On (1)			Off (0)		RW	Bit				US

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

11.14 Menu 13: Standard motion controller

Figure 11-33 Menu 13 logic diagram





*The position controller is disabled and the error integrator is also reset under the following conditions:

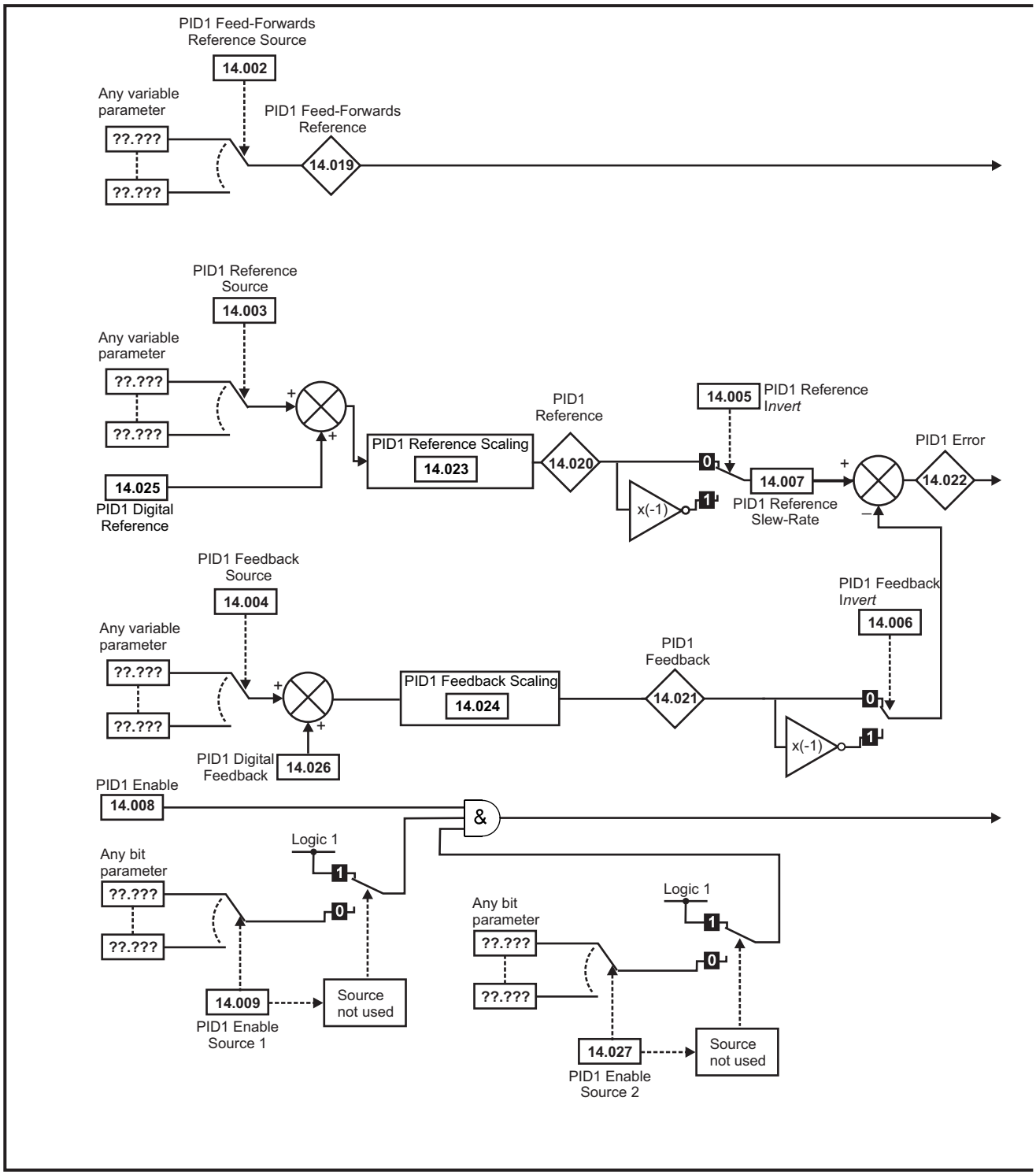
1. If the drive is disabled (i.e. inhibited, ready or tripped)
2. If the position controller mode (Pr **13.010**) is changed. The position controller is disabled transiently to reset the error integrator.
3. The absolute mode parameter (Pr **13.011**) is changed. The position controller is disabled transiently to reset the error integrator.
4. One of the position sources is invalid.
5. The position feedback initialized parameter (Pr **03.048**) is zero.

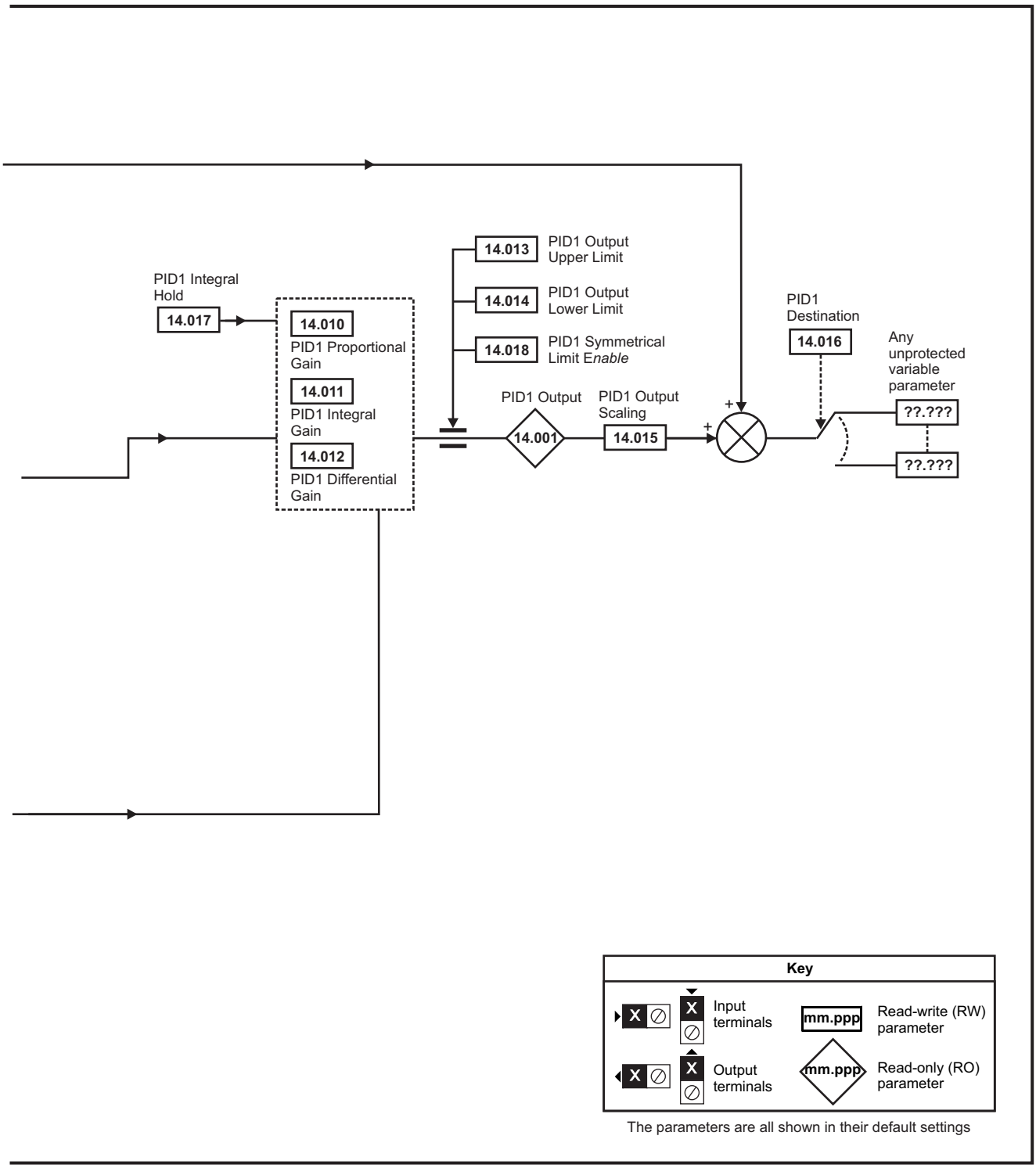
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
13.001	Standard Motion Revolutions Error	-32768 to 32767 revs					RO	Num	ND	NC	PT	
13.002	Standard Motion Position Error	-32768 to 32767					RO	Num	ND	NC	PT	
13.003	Standard Motion Fine Position Error	-32768 to 32767					RO	Num	ND	NC	PT	
13.004	Standard Motion Reference Source	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), Local (10)		P1 Drive (0)			RW	Txt				US
13.005	Standard Motion Feedback Source	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5)	P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5), Sensorless (10)	P1 Drive (0)			RW	Txt				US
13.006	Standard Motion Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
13.007	Standard Motion Ratio Numerator	0.000 to 10.000		1.000			RW	Num				US
13.008	Standard Motion Ratio Denominator	0.000 to 4.000		1.000			RW	Num				US
13.009	Standard Motion Proportional Gain Kp	0.00 to 100.00		25.00			RW	Num				US
13.010	Standard Motion Controller Mode	Disabled (0), Rigid Spd FF (1), Rigid (2), Non-rigid Spd FF(3), Non-Rigid (4)	Disabled (0), Rigid Spd FF (1), Rigid (2), Non-rigid Spd FF (3), Non-Rigid (4), Orientate Stop (5), Orientate (6)	Disabled (0)			RW	Txt				US
13.011	Standard Motion Absolute Mode Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
13.012	Standard Motion Speed Clamp	0 to 250 rpm		150 rpm			RW	Num				US
13.013	Standard Motion Orientation Position Reference	0 to 65535		0			RW	Num				US
13.014	Standard Motion Orientation Acceptance Window	0 to 4096		256			RW	Num				US
13.015	Standard Motion Orientation Complete	Off (0) or On (1)					RO	Bit	ND	NC	PT	
13.016	Standard Motion Position Error Reset	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.017	Standard Motion Relative Jog Reference	0.0 to 4000.0 rpm		0.0 rpm			RW	Num				US
13.018	Standard Motion Relative Jog Enable	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.019	Standard Motion Relative Jog Reverse	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.020	Standard Motion Local Reference Revolutions	0 to 65535 revs		0 revs			RW	Num		NC		
13.021	Standard Motion Local Reference Position	0 to 65535		0			RW	Num		NC		
13.022	Standard Motion Local Reference Fine Position	0 to 65535		0			RW	Num		NC		
13.023	Standard Motion Local Reference Disable	Off (0) or On (1)		Off (0)			RW	Bit		NC		
13.024	Standard Motion Ignore Local Reference Revolutions	Off (0) or On (1)		Off (0)			RW	Bit				US
13.026	Standard Motion Sample Rate	Not Active (0), 4ms (1)					RO	Txt				US

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

11.15 Menu 14: User PID controller

Figure 11-34 Menu 14 Logic diagram





The parameters are all shown in their default settings

NOTE

The same logic diagram above (Menu 14) can also be used for PID2 as they are the same.

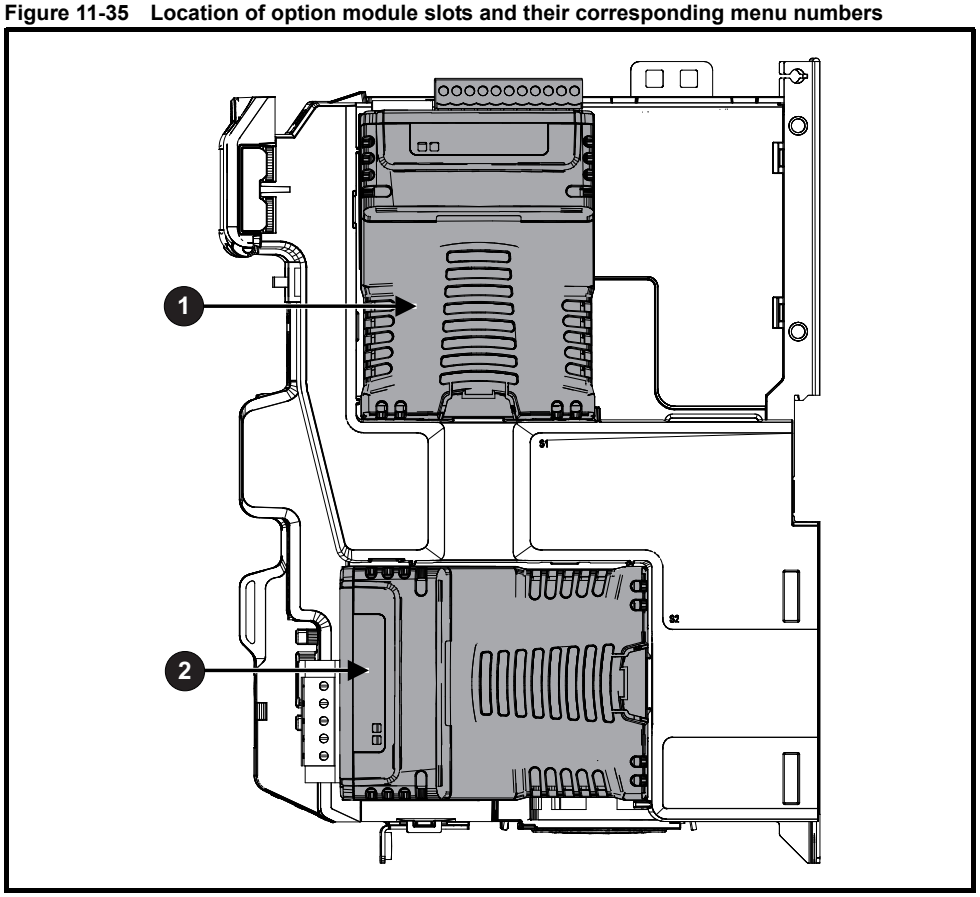
Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
14.001	PID1 Output	±100.00 %					RO	Num	ND	NC	PT	
14.002	PID1 Feed-forwards Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.003	PID1 Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.004	PID1 Feedback Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.005	PID1 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.006	PID1 Feedback Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.007	PID1 Reference Slew Rate	0.0 to 3200.0 s		0.0 s			RW	Num				US
14.008	PID1 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.009	PID1 Enable Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
14.010	PID1 Proportional Gain	0.000 to 4.000		1.000			RW	Num				US
14.011	PID1 Integral Gain	0.000 to 4.000		0.500			RW	Num				US
14.012	PID1 Differential Gain	0.000 to 4.000		0.000			RW	Num				US
14.013	PID1 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.014	PID1 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.015	PID1 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.016	PID1 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.017	PID1 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.018	PID1 Symmetrical Limit Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.019	PID1 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.020	PID1 Reference	±100.00 %					RO	Num	ND	NC	PT	
14.021	PID1 Feedback	±100.00 %					RO	Num	ND	NC	PT	
14.022	PID1 Error	±100.00 %					RO	Num	ND	NC	PT	
14.023	PID1 Reference Scaling	0.000 to 4.000		1.000			RW	Num				US
14.024	PID1 Feedback Scaling	0.000 to 4.000		1.000			RW	Num				US
14.025	PID1 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.026	PID1 Digital Feedback	±100.00 %		0.00 %			RW	Num				US
14.027	PID1 Enable Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
14.028	PID1 Pre-sleep Boost Level	0.00 to 100.00 %		0.00 %			RW	Num				US
14.029	PID1 Maximum Boost Time	0.0 to 250.0 s		0.0 s			RW	Num				US
14.030	PID1 Pre-sleep Boost Level Enable	Off (0) or On (1)					RO	Bit	ND	NC	PT	
14.031	PID2 Output	±100.00 %					RO	Num	ND	NC	PT	
14.032	PID2 Feed-forwards Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.033	PID2 Reference Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.034	PID2 Feedback Source	0.000 to 59.999		0.000			RW	Num			PT	US
14.035	PID2 Reference Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.036	PID2 Feedback Invert	Off (0) or On (1)		Off (0)			RW	Bit				US
14.037	PID2 Reference Slew Rate Limit	0.0 to 3200.0 s		0.0 s			RW	Num				US
14.038	PID2 Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.039	PID2 Enable Source 1	0.000 to 59.999		0.000			RW	Num			PT	US
14.040	PID2 Proportional Gain	0.000 to 4.000		1.000			RW	Num				US
14.041	PID2 Integral Gain	0.000 to 4.000		0.500			RW	Num				US
14.042	PID2 Differential Gain	0.000 to 4.000		0.000			RW	Num				US
14.043	PID2 Output Upper Limit	0.00 to 100.00 %		100.00 %			RW	Num				US
14.044	PID2 Output Lower Limit	±100.00 %		-100.00 %			RW	Num				US
14.045	PID2 Output Scaling	0.000 to 4.000		1.000			RW	Num				US
14.046	PID2 Destination	0.000 to 59.999		0.000			RW	Num	DE		PT	US
14.047	PID2 Integral Hold	Off (0) or On (1)		Off (0)			RW	Bit				
14.048	PID2 Symmetrical Limit Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.049	PID2 Feed-forwards Reference	±100.00 %					RO	Num	ND	NC	PT	
14.050	PID2 Reference	±100.00 %					RO	Num	ND	NC	PT	
14.051	PID2 Feedback	±100.00 %					RO	Num	ND	NC	PT	
14.052	PID2 Error	±100.00 %					RO	Num	ND	NC	PT	
14.053	PID2 Reference Scaling	0.000 to 4.000		1.000			RW	Num				US
14.054	PID2 Feedback Scaling	0.000 to 4.000		1.000			RW	Num				US
14.055	PID2 Digital Reference	±100.00 %		0.00 %			RW	Num				US
14.056	PID2 Digital Feedback	±100.00 %		0.00 %			RW	Num				US
14.057	PID2 Enable Source 2	0.000 to 59.999		0.000			RW	Num			PT	US
14.058	PID1 Feedback Output Scaling	0.000 to 4.000		1.000			RW	Num				US

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
14.059	PID1 Mode Selector	Fbk1 (0), Fbk2 (1), Fbk1 + Fbk2 (2), Min Fbk (3), Max Fbk (4), Av Fbk (5), Min Error (6), Max Error (7)		Fbk1 (0)			RW	Txt				US
14.060	PID1 Feedback Square Root Enable 1	Off (0) or On (1)		Off (0)			RW	Bit				US
14.061	PID2 Feedback Square Root Enable	Off (0) or On (1)		Off (0)			RW	Bit				US
14.062	PID1 Feedback Square Root Enable 2	Off (0) or On (1)		Off (0)			RW	Bit				US

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

11.16 Menus 15, 16 and 17: Option module set-up

Figure 11-35 Location of option module slots and their corresponding menu numbers



1. Solutions Module Slot 1 - Menu 15
2. Solutions Module Slot 2 - Menu 16

11.16.1 Parameters common to all categories

Parameter		Range(⇳)	Default(⇨)	Type					
mm.001	Module ID	0 to 65535		RO	Num	ND	NC	PT	
mm.002	Software Version	00.00.00.00 to 99.99.99.99		RO	Ver	ND	NC	PT	
mm.003	Hardware Version	0.00 to 99.99		RO	Num	ND	NC	PT	
mm.004	Serial Number LS	0 to 99999999		RO	Num	ND	NC	PT	
mm.005	Serial Number MS			RO	Num	ND	NC	PT	
mm.006	Module Status	Initialising (0) to Error (3)		RO	Txt	ND	NC	PT	
mm.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	
105	SI-Encoder	Feedback
106	SI-Universal Encoder	
209	SI-I/O	Automation (I/O Expansion)
310	MCi210	Automation (Applications)
311	MCi200	
431	SI-EtherCAT	Fieldbus
432	SI-PROFINET RT	
433	SI-Ethernet	
434	SI-PROFINET V2	
443	SI-PROFIBUS	
447	SI-DeviceNet	
448	SI-CANopen	

11.17 Menu 18: Application menu 1

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
18.001	Application Menu 1 Power-down Save Integer	-32768 to 32767		0			RW	Num				PS
18.002 to 18.010	Application Menu 1 Read-only Integer	-32768 to 32767					RO	Num	ND	NC		US
18.011 to 18.030	Application Menu 1 Read-write Integer	-32768 to 32767		0			RW	Num				US
18.031 to 18.050	Application Menu 1 Read-write bit	Off (0) or On (1)		Off (0)			RW	Bit				US
18.051 to 18.054	Application Menu 1 Power-down Save long Integer	-2147483648 to 2147483647		0			RW	Num				PS

11.18 Menu 19: Application menu 2

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
19.001	Application Menu 2 Power-down Save Integer	-32768 to 32767		0			RW	Num				PS
19.002 to 19.010	Application Menu 2 Read-only Integer	-32768 to 32767					RO	Num	ND	NC		US
19.011 to 19.030	Application Menu 2 Read-write Integer	-32768 to 32767		0			RW	Num				US
19.031 to 19.050	Application Menu 2 Read-write bit	Off (0) or On (1)		Off (0)			RW	Bit				US
19.051 to 19.054	Application Menu 2 Power-down Save long Integer	-2147483648 to 2147483647		0			RW	Num				PS

11.19 Menu 20: Application menu 3

Parameter		Range(⇳)		Default(⇨)			Type					
		OL	RFC-A / S	OL	RFC-A	RFC-S						
20.001 to 20.020	Application Menu 3 Read-write Integer	-32768 to 32767		0			RW	Num				
20.021 to 20.040	Application Menu 3 Read-write Long Integer	-2147483648 to 2147483647		0			RW	Num				

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

11.20 Menu 21: Second motor parameters

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
21.001	M2 Maximum Reference Clamp	VM_POSITIVE_REF_CLAMP2 Hz	VM_POSITIVE_REF_CLAMP2 rpm		50 Hz: 50.0 60 Hz: 60.0	50 Hz: 1500.0 60 Hz: 1800.0	3000.0	RW	Num				US
21.002	M2 Minimum Reference Clamp	VM_NEGATIVE_REF_CLAMP2 Hz	VM_NEGATIVE_REF_CLAMP2 rpm		0.0			RW	Num				US
21.003	M2 Reference Selector	A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Precision (5), Keypad Ref (6)			A1 Preset (1)			RW	Txt				US
21.004	M2 Acceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/100 rpm		5.0 s	2.000 s	0.200 s	RW	Num				US
21.005	M2 Deceleration Rate 1	0.0 to VM_ACCEL_RATE s/100 Hz	0.000 to VM_ACCEL_RATE s/100 rpm		10.0 s	2.000 s	0.200 s	RW	Num				US
21.006	M2 Rated Frequency	0.0 to 550.0 Hz			50 Hz: 50.0 60 Hz: 60.0			RW	Num				US
21.007	M2 Rated Current	0.000 to VM_RATED_CURRENT A			Maximum Heavy Duty Rating (11.032)			RW	Num		RA		US
21.008	M2 Rated Speed	0 to 33000 rpm	0.00 to 33000.00 rpm		50 Hz: 1500 rpm 60 Hz: 1800 rpm	50 Hz: 1450.00 rpm 60 Hz: 1750.00 rpm	3000.00 rpm	RW	Num				US
21.009	M2 Rated Voltage	0 to VM_AC_VOLTAGE_SET V			200V drive: 230 V 400V drive 50Hz: 400 V 400V drive 60Hz: 460 V			RW	Num		RA		US
21.010	M2 Rated Power Factor	0.000 to 1.000			0.850			RW	Num		RA		US
21.011	M2 Number Of Motor Poles	Automatic (0) to 480 Poles (240)			Automatic (0)		6 Poles (3)	RW	Txt				US
21.012	M2 Stator Resistance	0.000000 to 1000.000000 Ω			0.000000 Ω			RW	Num		RA		US
21.014	M2 Transient Inductance / Ld	0.000 to 500.000 mH			0.000 mH			RW	Num		RA		US
21.015	Motor 2 Active	Off (0) or On (1)						RO	Bit	ND	NC	PT	
21.016	M2 Motor Thermal Time Constant 1	1.0 to 3000.0 s			89.0 s			RW	Num				US
21.017	M2 Speed Controller Proportional Gain Kp1		0.0000 to 200.0000 s/rad			0.0300 s/rad	0.0100 s/rad	RW	Num				US
21.018	M2 Speed Controller Integral Gain Ki1		0.00 to 655.35 s^2/rad			0.10 s^2/rad	1.00 s^2/rad	RW	Num				US
21.019	M2 Speed Controller Differential Feedback Gain Kd1		0.00000 to 0.65535 1/rad			0.00000 1/rad		RW	Num				US
21.020	M2 Position Feedback Phase Angle			0.0 to 359.9 °			0.0 °	RW	Num	ND			US
21.021	M2 Motor Control Feedback Select		P1 Drive (0), P2 Drive (1), P1 Slot 1 (2), P2 Slot 1 (3), P1 Slot 2 (4), P2 Slot 2 (5)			P1 Drive (0)		RW	Txt				US
21.022	M2 Current Controller Kp Gain	0 to 30000			20	150		RW	Num				US
21.023	M2 Current Controller Ki Gain	0 to 30000			40	2000		RW	Num				US
21.024	M2 Stator Inductance	0.00 to 5000.00 mH			0.00 mH			RW	Num		RA		US
21.025	M2 Saturation Breakpoint 1		0.0 to 100.0 %			50.0 %		RW	Num				US
21.026	M2 Saturation Breakpoint 3		0.0 to 100.0 %			75.0 %		RW	Num				US
21.027	M2 Motoring Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %			165 %	250 %		RW	Num		RA		US
21.028	M2 Regenerating Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %			165 %	250 %		RW	Num		RA		US
21.029	M2 Symmetrical Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %			165 %	250 %		RW	Num		RA		US
21.030	M2 Volts Per 1000 rpm			0 to 10,000 V			98	RW	Num				US
21.032	M2 Current Reference Filter Time Constant 1		0.0 to 25.0 ms			0.0 ms		RW	Num				US
21.033	M2 Low Speed Thermal Protection Mode	0 to 1			0			RW	Num				US
21.034	M2 Current Controller Mode		Off (0) or On (1)			Off (0)		RW	Bit				US
21.035	M2 Notch Filter Centre Frequency		50 to 1000 Hz			100 Hz		RW	Num				US
21.036	M2 Notch Filter Bandwidth		0 to 500 Hz			0 Hz		RW	Num				US
21.039	M2 Motor Thermal Time Constant 2	1.0 to 3000.0 s			89.0 s			RW	Num				US
21.040	M2 Motor Thermal Time Constant 2 Scaling	0 to 100 %			0 %			RW	Num				US
21.041	M2 Saturation Breakpoint 2		0.0 to 100.0 %			0.0 %		RW	Num				US
21.042	M2 Saturation Breakpoint 4		0.0 to 100.0 %			0.0 %		RW	Num				US
21.043	M2 Torque Per Amp		0.00 to 500.00 Nm/A					RO	Num	ND	NC	PT	
	M2 Torque Per Amp			0.00 to 500.00 Nm/A			1.60 Nm/A	RW	Num				US
21.044	M2 No-load Core Loss	0.000 to 99999.999 kW			0.000 kW			RW	Num				US
21.045	M2 Rated Core Loss	0.000 to 99999.999 kW			0.000 kW			RW	Num				US
21.046	M2 Magnetising Current Limit		0.0 to 100.0 %			100.0 %		RW	Num				US
21.047	M2 Low Speed Sensorless Mode Current Limit			0.0 to 1000.0 %			20.0 %	RW	Num		RA		US
21.048	M2 No-load Lq			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
21.051	M2 Iq Test Current For Inductance Measurement			0 to 200 %			100 %	RW	Num				US
21.053	M2 Phase Offset At Iq Test Current			±90.0°			0.0°	RW	Num		RA		US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
21.054	M2 Lq At Defined Iq Test Current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US
21.058	M2 Id Test Current For Inductance Measurement			-100 to 0 %			-50 %	RW	Num				US
21.060	M2 Lq at the defined Id test current			0.000 to 500.000 mH			0.000 mH	RW	Num		RA		US

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

11.21 Menu 22: Additional Menu 0 set-up

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
22.001	Parameter 00.001 Set-up	0.000 to 59.999			1.007			RW	Num			PT	US
22.002	Parameter 00.002 Set-up	0.000 to 59.999			1.006			RW	Num			PT	US
22.003	Parameter 00.003 Set-up	0.000 to 59.999			2.011			RW	Num			PT	US
22.004	Parameter 00.004 Set-up	0.000 to 59.999			2.021			RW	Num			PT	US
22.005	Parameter 00.005 Set-up	0.000 to 59.999			1.014			RW	Num			PT	US
22.006	Parameter 00.006 Set-up	0.000 to 59.999			4.007			RW	Num			PT	US
22.007	Parameter 00.007 Set-up	0.000 to 59.999			5.014	3.010		RW	Num			PT	US
22.008	Parameter 00.008 Set-up	0.000 to 59.999			5.015	3.011		RW	Num			PT	US
22.009	Parameter 00.009 Set-up	0.000 to 59.999			5.013	3.012		RW	Num			PT	US
22.010	Parameter 00.010 Set-up	0.000 to 59.999			5.004	3.002		RW	Num			PT	US
22.011	Parameter 00.011 Set-up	0.000 to 59.999			5.001		3.029	RW	Num			PT	US
22.012	Parameter 00.012 Set-up	0.000 to 59.999			4.001			RW	Num			PT	US
22.013	Parameter 00.013 Set-up	0.000 to 59.999			4.002			RW	Num			PT	US
22.014	Parameter 00.014 Set-up	0.000 to 59.999			4.011			RW	Num			PT	US
22.015	Parameter 00.015 Set-up	0.000 to 59.999			2.004			RW	Num			PT	US
22.016	Parameter 00.016 Set-up	0.000 to 59.999			0.000	2.002		RW	Num			PT	US
22.017	Parameter 00.017 Set-up	0.000 to 59.999			8.026	4.012		RW	Num			PT	US
22.018	Parameter 00.018 Set-up	0.000 to 59.999			3.123			RW	Num			PT	US
22.019	Parameter 00.019 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.020	Parameter 00.020 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.021	Parameter 00.021 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.022	Parameter 00.022 Set-up	0.000 to 59.999			1.010			RW	Num			PT	US
22.023	Parameter 00.023 Set-up	0.000 to 59.999			1.005			RW	Num			PT	US
22.024	Parameter 00.024 Set-up	0.000 to 59.999			1.021			RW	Num			PT	US
22.025	Parameter 00.025 Set-up	0.000 to 59.999			1.022			RW	Num			PT	US
22.026	Parameter 00.026 Set-up	0.000 to 59.999			1.023	3.008		RW	Num			PT	US
22.027	Parameter 00.027 Set-up	0.000 to 59.999			1.024	3.034		RW	Num			PT	US
22.028	Parameter 00.028 Set-up	0.000 to 59.999			6.013			RW	Num			PT	US
22.029	Parameter 00.029 Set-up	0.000 to 59.999			11.036			RW	Num			PT	US
22.030	Parameter 00.030 Set-up	0.000 to 59.999			11.042			RW	Num			PT	US
22.031	Parameter 00.031 Set-up	0.000 to 59.999			11.033			RW	Num			PT	US
22.032	Parameter 00.032 Set-up	0.000 to 59.999			11.032			RW	Num			PT	US
22.033	Parameter 00.033 Set-up	0.000 to 59.999			6.009	5.016	0.000	RW	Num			PT	US
22.034	Parameter 00.034 Set-up	0.000 to 59.999			11.030			RW	Num			PT	US
22.035	Parameter 00.035 Set-up	0.000 to 59.999			11.024			RW	Num			PT	US
22.036	Parameter 00.036 Set-up	0.000 to 59.999			11.025			RW	Num			PT	US
22.037	Parameter 00.037 Set-up	0.000 to 59.999			11.023			RW	Num			PT	US
22.038	Parameter 00.038 Set-up	0.000 to 59.999			4.013			RW	Num			PT	US
22.039	Parameter 00.039 Set-up	0.000 to 59.999			4.014			RW	Num			PT	US
22.040	Parameter 00.040 Set-up	0.000 to 59.999			5.012			RW	Num			PT	US
22.041	Parameter 00.041 Set-up	0.000 to 59.999			5.018			RW	Num			PT	US
22.042	Parameter 00.042 Set-up	0.000 to 59.999			5.011			RW	Num			PT	US
22.043	Parameter 00.043 Set-up	0.000 to 59.999			5.010		3.025	RW	Num			PT	US
22.044	Parameter 00.044 Set-up	0.000 to 59.999			5.009			RW	Num			PT	US
22.045	Parameter 00.045 Set-up	0.000 to 59.999			5.008			RW	Num			PT	US
22.046	Parameter 00.046 Set-up	0.000 to 59.999			5.007			RW	Num			PT	US
22.047	Parameter 00.047 Set-up	0.000 to 59.999			5.006		5.033	RW	Num			PT	US
22.048	Parameter 00.048 Set-up	0.000 to 59.999			11.031			RW	Num			PT	US
22.049	Parameter 00.049 Set-up	0.000 to 59.999			11.044			RW	Num			PT	US
22.050	Parameter 00.050 Set-up	0.000 to 59.999			11.029			RW	Num			PT	US
22.051	Parameter 00.051 Set-up	0.000 to 59.999			10.037			RW	Num			PT	US
22.052	Parameter 00.052 Set-up	0.000 to 59.999			11.020			RW	Num			PT	US
22.053	Parameter 00.053 Set-up	0.000 to 59.999			4.015			RW	Num			PT	US
22.054	Parameter 00.054 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.055	Parameter 00.055 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.056	Parameter 00.056 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.057	Parameter 00.057 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US

Parameter		Range(⇳)			Default(⇨)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
22.058	Parameter 00.058 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.059	Parameter 00.059 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.060	Parameter 00.060 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.061	Parameter 00.061 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.062	Parameter 00.062 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.063	Parameter 00.063 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.064	Parameter 00.064 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.065	Parameter 00.065 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.066	Parameter 00.066 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.067	Parameter 00.067 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.068	Parameter 00.068 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.069	Parameter 00.069 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.070	Parameter 00.070 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.071	Parameter 00.071 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.072	Parameter 00.072 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.073	Parameter 00.073 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.074	Parameter 00.074 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.075	Parameter 00.075 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.076	Parameter 00.076 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.077	Parameter 00.077 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.078	Parameter 00.078 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.079	Parameter 00.079 Set-up	0.000 to 59.999			0.000			RW	Num			PT	US
22.080	Parameter 00.080 Set-up	0.000 to 59.999			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

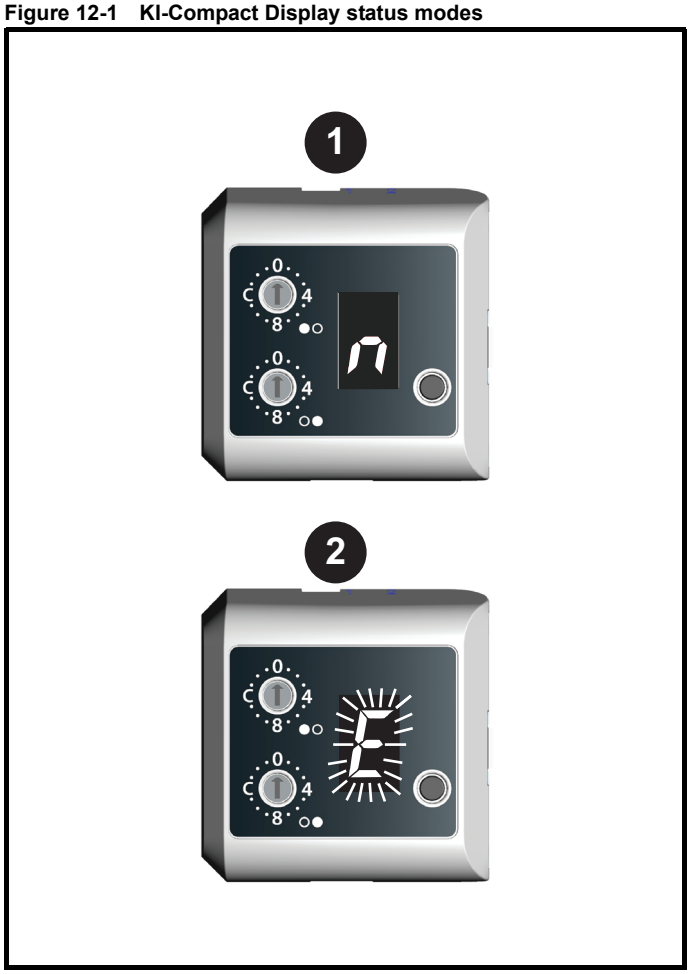
The KI-Compact Display and KI Remote Keypad RTC provide drive status information and drive trip indication for fault diagnosis.

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 distributor for repair.

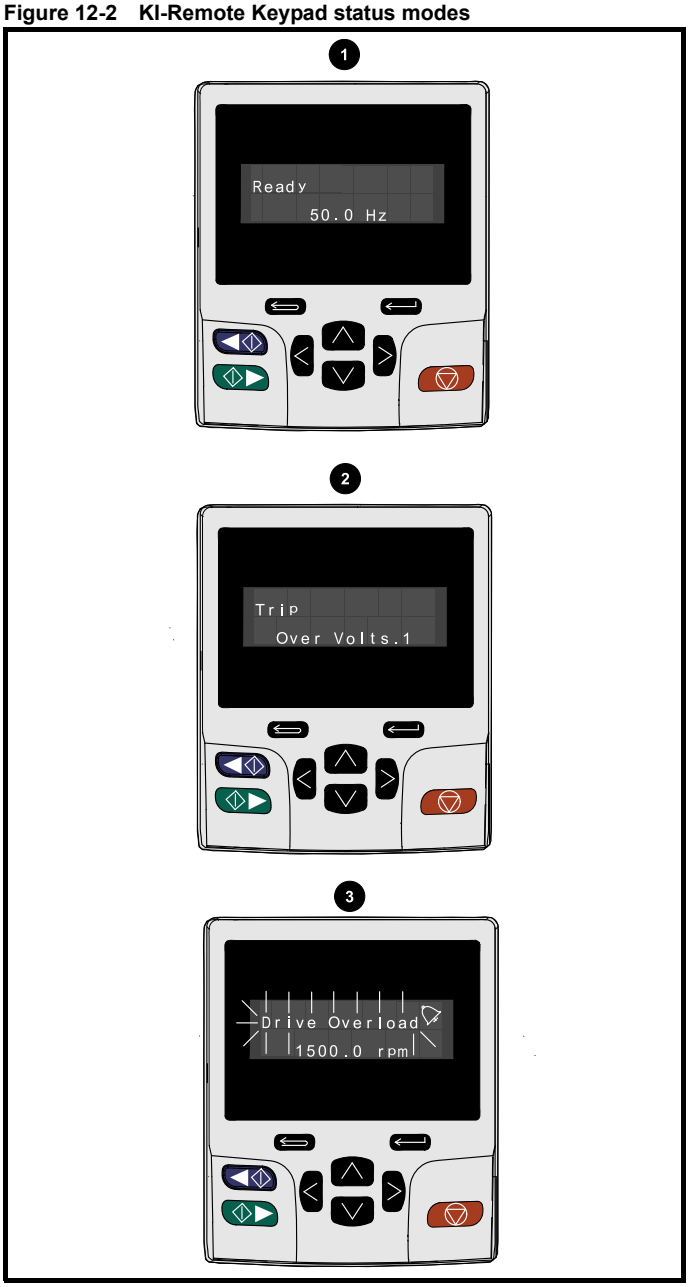
12.1 Status modes (KI-Compact Display, KI-Remote Keypad and drive LED status)

Figure 12-1 KI-Compact Display status modes



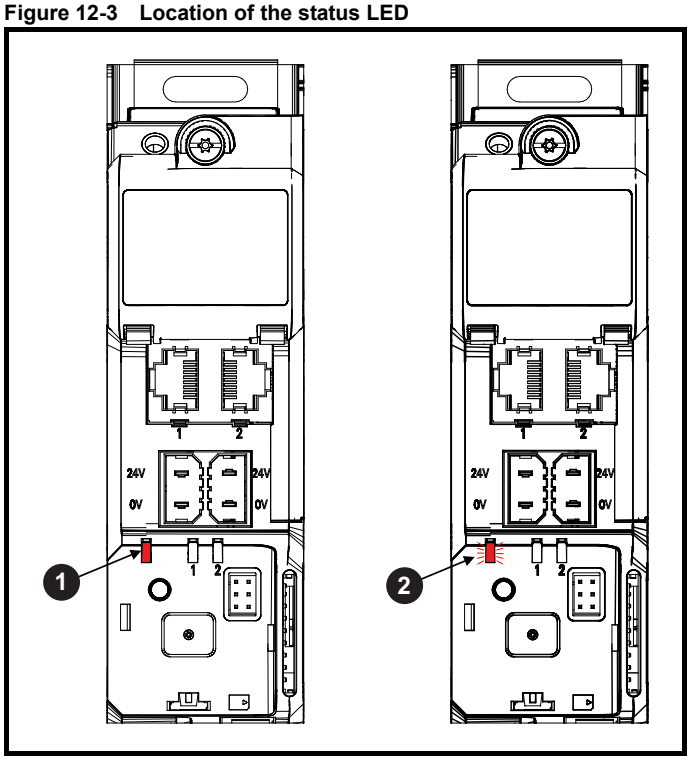
1. Drive OK status
2. Trip status (flashing)

Figure 12-2 KI-Remote Keypad status modes



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

Figure 12-3 Location of the status LED



1. Non flashing: Normal status
2. Flashing: Trip 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 KI-Compact Display is being used, a trip or HF (hardware fault) condition is indicated as a scrolling message, with an E prefix followed by a serial communications trip code and sub trip code where relevant. Refer to Table 12-1 for further information.

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

Display character	Trip code	Separator	Sub-trip code
E	Range 1 to 254	-	Range 1 to 65535
HF	Range 1 to 99		

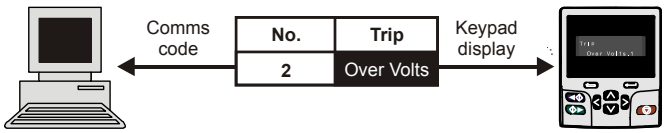
During a trip condition, where a KI-Remote Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip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

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 12-3.

Trips are listed alphabetically in Table 12-4 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr **10.001** 'Drive OK' using communication protocols. The most recent trip can be read in Pr **10.020** providing a trip number. It must be noted that the hardware trips (HF01 to HF20) do not have trip numbers. The trip number must be checked in Table 12-5 to identify the specific trip.

Example

1. Trip code 2 is read from Pr **10.020** via serial communications.
2. Checking Table 12-4 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 12-4.
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 12-2 is in the form xxyzz and used to identify the source of the trip.

Table 12-2 Trips associated with xxyzz sub-trip number

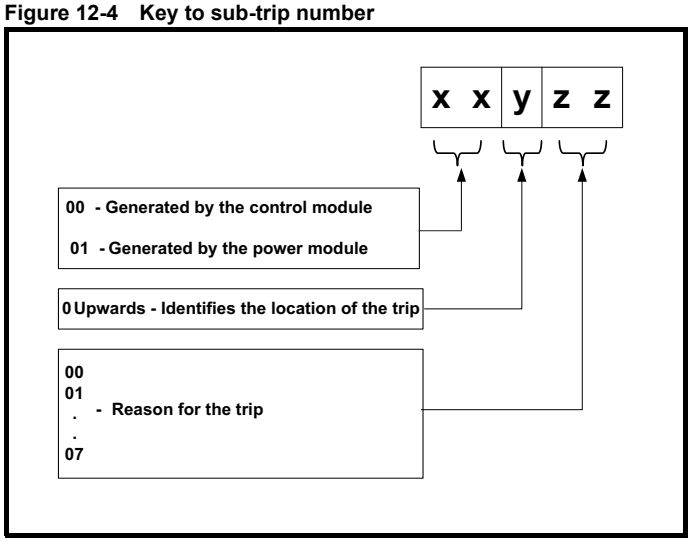
Over Volts	OHt dc bus
OI ac	Phase Loss
OI Brake	Power Comms
PSU	OI Snubber
OHt Inverter	Temp Feedback
OHt Power	Power Data
OHt Control	

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

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

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

Figure 12-4 Key to sub-trip number



For example, if the drive has tripped and the lower line of the display shows 'OHt Control.2', with the help of Table 12-3 below the trip can be interpreted as; an over temperature has been detected; the trip was generated by fault in the control module, the control board thermistor 2 over temperature. For further information on individual sub-trips, refer to the diagnosis column in Table 12-4.

Table 12-3 Sub-trip identification

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

12.4 Trips, Sub-trip numbers

Table 12-4 Trip indications

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>App Menu Changed</td><td>Customization table for an application module has changed</td></tr>
<tr><td>217</td><td>The App Menu Changed trip indicates that the customization table for an application menu has changed. The menu that has been changed can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Menu 18</td></tr>
<tr><td>2</td><td>Menu 19</td></tr>
<tr><td>3</td><td>Menu 20</td></tr>
</table>
If more than one menu has changed the lowest menu has priority. Drive user parameters must be saved to prevent this trip on the next power-up.
Recommended actions:
• Reset the trip and perform a parameter save to accept the new settings</td></tr>
<tr><td>Autotune 1</td><td>Position feedback did not change or required speed could not be reached</td></tr>
<tr><td>11</td><td>The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Recommended actions</th></tr>
<tr><td>1</td><td>The position feedback did not change when position feedback is being used during rotating auto-tune.</td><td>Ensure that the motor is free to turn (i.e. mechanical brake is released).
Check that the position feedback is selected correctly and operates correctly.</td></tr>
<tr><td>2</td><td>The motor did not reach the required speed during mechanical load measurement.</td><td>Ensure that the motor is free to turn and that the static load plus inertia is not too large for the drive to accelerate within the test time.</td></tr>
<tr><td>3</td><td>The required commutation signal edge could not be found during a rotating auto-tune with a Commutation Only position feedback device.</td><td>Check that the position feedback signals are connected correctly.</td></tr>
<tr><td>4</td><td>The required movement angle cannot be produced during a minimal movement test.</td><td>Reduce the angular movement required.</td></tr>
<tr><td>5</td><td>The second part of the minimal movement test during auto-tuning cannot locate the motor flux position accurately.</td><td>Reduce the angular movement required.</td></tr>
<tr><td>6</td><td>The phasing offset angle is measured twice during a stationary auto-tune and the results are not within 30^{o} of each other.</td><td>If a minimal movement test is being used and excessive motor movement is occurring during the test reduce the required angle movement. Otherwise try and increase the required angle movement.</td></tr>
<tr><td>7</td><td>The motor is moving when a phasing test on enable is selected and the drive is enabled, but the motor is still moving at a speed above the zero speed threshold.</td><td>Ensure that the motor is stationary before the drive is enabled.</td></tr>
<tr><td>8</td><td>An auto-tune has been attempted while the AMC is selected.</td><td>Set AMC Select (31.001) to zero to deselect the AMC.</td></tr>
</table>
Recommended actions:
• Ensure the motor is free to turn i.e. mechanical brake was released
• Ensure Pr 03.026 and Pr 03.038 are set correctly (or appropriate 2nd motor map parameters)
• Check feedback device wiring is correct
• Check encoder mechanical coupling to the motor</td></tr>
<tr><td>Autotune 2</td><td>Position feedback direction incorrect</td></tr>
<tr><td>12</td><td>The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The position feedback direction is incorrect when position feedback is being used during a rotating autotune</td></tr>
<tr><td>2</td><td>A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position..</td></tr>
</table>
Recommended actions:
• Check motor cable wiring is correct
• Check feedback device wiring is correct
• Swap any two motor phases</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Autotune 3</td><td>Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction</td></tr>
<tr><td>13</td><td>The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number.
<table><tr><th>Sub-trip</th><th>Reason</th></tr><tr><td>1</td><td>Measured inertia has exceeded the parameter range during a mechanical load measurement</td></tr><tr><td>2</td><td>The commutation signals changed in the wrong direction during a rotating autotune</td></tr><tr><td>3</td><td>The mechanical load test has been unable to identify the motor inertia.</td></tr></table>Recommended actions for sub-trip 2:
• Check motor cable wiring is correct
• Check feedback device U,V and W commutation signal wiring is correct
Recommended actions for sub-trip 3:
• Increase the test level
• If the test was carried out at standstill repeat the test with the motor rotating within the recommended speed range</td></tr>
<tr><td>Autotune 4</td><td>Drive encoder U commutation signal fail</td></tr>
<tr><td>14</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the U commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device U commutation signal wiring is correct (Encoder terminals 7 and 8)</td></tr>
<tr><td>Autotune 5</td><td>Drive encoder V commutation signal fail</td></tr>
<tr><td>15</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the V commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device V commutation signal wiring is correct (Encoder terminals 9 and 10)</td></tr>
<tr><td>Autotune 6</td><td>Drive encoder W commutation signal fail</td></tr>
<tr><td>16</td><td>A position feedback device with commutation signals is being used (i.e. AB Servo, FD Servo, FR Servo, SC Servo, or Commutations only encoder) and the W commutation signal did not change during a rotating autotune.
Recommended actions:
• Check feedback device W commutation signal wiring is correct (Encoder terminals 11 and 12)</td></tr>
<tr><td>Autotune 7</td><td>Motor number of poles / position feedback resolution set incorrectly</td></tr>
<tr><td>17</td><td>An Autotune 7 trip is initiated during a rotating autotune, if the motor poles or the position feedback resolution have been set up incorrectly where position feedback is being used.
Recommended actions:
• Check line per revolution for feedback device
• Check the number of poles in Pr 05.011</td></tr>
<tr><td>Autotune Stopped</td><td>Autotune test stopped before completion</td></tr>
<tr><td>18</td><td>The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed.
Recommended actions:
• Check the drive enable signal (terminals 2 & 6) were active during the autotune
• Check the run command was active in Pr 08.005 during autotune</td></tr>
<tr><td>Brake R Too Hot</td><td>Braking resistor overload timed out (I^2t)</td></tr>
<tr><td>19</td><td>The Brake R Too Hot indicates that braking resistor overload has timed out. The value in Braking Resistor Thermal Accumulator (10.039) is calculated using Braking Resistor Rated Power (10.030), Braking Resistor Thermal Time Constant (10.031) and Braking Resistor Resistance (10.061). The Brake R Too Hot trip is initiated when Braking Resistor Thermal Accumulator (10.039) reaches 100 %.
Recommended actions:
• Ensure the values entered in Pr 10.030, Pr 10.031 and Pr 10.061 are correct
• If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr 10.030, Pr 10.031 or Pr 10.061 to 0 to disable the trip.</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>CAM</td><td>Advanced motion controller CAM failure</td></tr>
<tr><td>99</td><td>The CAM trip indicates that the advanced motion controller CAM has detected a problem.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>AMC Cam Start Index (35.001) > AMC Cam Size (35.003) or AMC Cam Start Position In Segment (35.002) > Cam Table In for the start index</td></tr>
<tr><td>2</td><td>AMC CAM Index (35.007) has been made to change by more than 2 in one sample</td></tr>
<tr><td>3</td><td>The rate of change at a segment boundary has exceeded the maximum value</td></tr>
<tr><td>4</td><td>The sum of the AMC Cam Position In Segment (35.008) and the change of master position has exceeded the maximum value.</td></tr>
</table></td></tr>
<tr><td>Card Access</td><td>SD Card Write fail</td></tr>
<tr><td>185</td><td>The Card Access trip indicates that the drive was unable to access the SD 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 SD Card is installed / located correctly
• Replace the SD Card</td></tr>
<tr><td>Card Boot</td><td>The Menu 0 parameter modification cannot be saved to the SD Card</td></tr>
<tr><td>177</td><td>Menu 0 changes are automatically saved on exiting edit mode.
The Card Boot trip will occur if a write to a Menu 0 parameter has been initiated via the keypad by exiting edit mode and Pr 11.042 is set for auto or boot mode, but the necessary boot file has not been created on the SD Card to take the new parameter value. This occurs when Pr 11.042 is changed to Auto (3) or Boot (4) mode, but the drive is not subsequently reset. The action of resetting the trip will create the necessary file and prevent further trips.
Recommended actions:
• Ensure that Pr 11.042 is correctly set, and then reset the drive to create the necessary file on the SD Card
• Re-attempt the parameter write to the Menu 0 parameter</td></tr>
<tr><td>Card Busy</td><td>SD Card cannot be accessed as it is being accessed by an option module</td></tr>
<tr><td>178</td><td>The Card Busy trip indicates that an attempt has been made to access a file on SD Card, but the SD Card is already being accessed by an Option Module, such as one of the Applications modules. No data is transferred.
Recommended actions:
• Wait for the option module to finish accessing the SD Card and re-attempt the required function</td></tr>
<tr><td>Card Compare</td><td>SD Card file/data is different to the one in the drive</td></tr>
<tr><td>188</td><td>A compare has been carried out between a file on the SD Card and the drive. A Card Compare trip is initiated if the parameters on the SD 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 SD Card has been used for the compare.</td></tr>
<tr><td>Card Data Exists</td><td>SD Card data location already contains data</td></tr>
<tr><td>179</td><td>The Card Data Exists trip indicates that an attempt has been made to store data on an SD Card in a data block which already contains data. No data is transferred. The data should be erased from the card first to prevent this trip.
Recommended actions:
• Erase the data in data location
• Write data to an alternative data location</td></tr>
<tr><td>Card Drive Mode</td><td>SD Card parameter set not compatible with current drive mode</td></tr>
<tr><td>187</td><td>The Card Drive Mode trip is produced during a compare if the drive mode in the data block on the SD Card is different from the current drive mode. This trip is also produced if an attempt is made to transfer parameters from an SD Card to the drive if the operating mode in the data block is outside the allowed range of operating modes.
Recommended actions:
• Ensure the destination drive supports the drive operating mode in the parameter file.
• Clear the value in Pr mm.000 and reset the drive.
• Ensure destination drive operating mode is the same as the source parameter file.</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Card Error</td><td>SD Card data structure error</td></tr>
<tr><td>182</td><td>The Card Error trip indicates that an attempt has been made to access an SD Card but an error has been detected in the data structure on the card. Resetting the trip will cause the drive to erase and create the correct folder structure. The cause of the trip can be identified by the sub-trip.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>The required folder and file structure is not present</td></tr>
<tr><td>2</td><td>The <000> file is corrupted.</td></tr>
<tr><td>3</td><td>Two or more files in the <MCDF\> folder have the same file identification number.</td></tr>
</table>
Recommended actions:
• Erase all the data blocks and re-attempt the process
• Ensure the card is located correctly
• Replace the SD Card</td></tr>
<tr><td>Card Full</td><td>SD Card full</td></tr>
<tr><td>184</td><td>The Card Full trip indicates that an attempt has been made to create a data block on an SD Card, but there is not enough space left on the card.
Recommended actions:
• Delete a data block or the entire SD Card to create space
• Use a different SD Card</td></tr>
<tr><td>Card No Data</td><td>SD Card data not found</td></tr>
<tr><td>183</td><td>The Card No Data trip indicates that an attempt has been made to access non-existent file or block on an SD Card. No data is transferred.
Recommended actions:
• Ensure data block number is correct</td></tr>
<tr><td>Card Option</td><td>SD Card trip; option modules installed are different between source drive and destination drive</td></tr>
<tr><td>180</td><td>The Card Option trip indicates that parameter data or default difference data is being transferred from an SD Card to the drive, but the option module categories are different between source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the option modules that are different will be set to the default values and not the values from the card. This trip also applies if a compare is attempted between the data block and the drive.
Recommended actions:
• Ensure the correct option modules are installed.
• Ensure the option modules are in the same option module slot as the parameter set stored.
• Press the red reset button to acknowledge that the parameters for one or more of the option modules installed will be at their default values
• This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive.</td></tr>
<tr><td>Card Product</td><td>SD Card data blocks are not compatible with the drive derivative</td></tr>
<tr><td>175</td><td>If Drive Derivative (11.028) or Product Type (11.063) are different between the source and target drives then this trip is initiated either at power-up or when the card is accessed. It will have one of the following sub-trip numbers:
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>If Drive Derivative (11.028) is different between the source and target drives, this trip is initiated either at power-up or when the SD Card is accessed. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in parameter xx.000, and resetting the drive (this applies the warning suppression flag to the card).</td></tr>
<tr><td>2</td><td>If Product Type (11.063) is different between the source and target drives or if corruption is detected in the parameter file, this trip is initiated either at power-up or when the SD Card is accessed. This trip can be reset but no data are transferred in either direction between the drive and the card.</td></tr>
<tr><td>3</td><td>A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr xx.000, and resetting the drive (this applies the warning suppression flag to the card).</td></tr>
</table>
Recommended actions:
• Use a different SD Card
• This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive</td></tr>
</table>

Trip	Diagnosis
Card Rating	**SD 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 an SD Card to the drive, but the current and / or voltage ratings are different between source and destination drives. This trip also applies if a compare (using Pr **mm.000** set to 8yyy) is attempted between the data block on an SD 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	**SD Card has the Read Only bit set**
181	The *Card Read Only* trip indicates that an attempt has been made to modify a read-only SD Card or a read-only data block. An SD 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 SD Card
Card Slot	**SD Card Trip; Option module application program transfer has failed**
174	The *Card Slot* trip is initiated, if the transfer of an option module application program to or from an application module failed because the option module does not respond correctly. If this happens this trip is produced with the sub-trip indicating the option module slot number. **Recommended actions:** • Ensure the source / destination option module is installed on the correct slot
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 feedback offset is too large to be trimmed correctly. The sub-trip relates to the output phase for which the offset error has been detected. **Sub-trip** / **Phase**: 1 – U; 2 – V; 3 – W **Recommended actions:** • Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled • Hardware fault – Contact the supplier of the drive
Data Changing	**Drive parameters are being changed**
97	A user action or a file system write is active that is changing the drive parameters and the drive has been commanded to enable, i.e. *Drive Active* (10.002) = 1.The user actions that change drive parameters are loading defaults, changing drive mode, or transferring data from an NV memory card or a position feedback device to the drive. The file system actions that will cause this trip to be initiated if the drive is enabled during the transfer are writing a parameter or macro file to the drive, or transferring a derivative or user program to the drive. It should be noted that none of these actions can be started if the drive is active, and so the trip only occurs if the action is started and then the drive is enabled. **Recommended actions:** • Ensure the drive is not enabled when one of he following is being carried out Loading defaults Changing drive mode Transferring data from SD Card or position feedback device Transferring user programs

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Derivative ID</td><td>Derivative identification error</td></tr>
<tr><td>247</td><td>There is a problem with the identifier associated with derivative image which customizes the drive. The reason for the trip is given by the sub-trip as follows:
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>There should be a derivative image in the product but this has been erased.</td></tr>
<tr><td>2</td><td>The identifier is out of range.</td></tr>
<tr><td>3</td><td>The derivative image has been changed.</td></tr>
</table>
Recommended actions:
Contact the supplier of the drive</td></tr>
<tr><td>Derivative Image</td><td>Derivative Image error</td></tr>
<tr><td>248</td><td>The Derivative Image trip indicates that an error has been detected in the derivative image. The sub-trip number indicates the reason for the trip.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Comments</th></tr>
<tr><td>1 to 52</td><td>An error has been detected in the derivative image, contact the supplier of the drive.</td><td></td></tr>
<tr><td>61</td><td>The option module fitted in slot 1 is not allowed with the derivative image</td><td rowspan="4">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td></tr>
<tr><td>62</td><td>The option module fitted in slot 2 is not allowed with the derivative image</td></tr>
<tr><td>63</td><td>The option module fitted in slot 3 is not allowed with the derivative image</td></tr>
<tr><td>64</td><td>The option module fitted in slot 4 is not allowed with the derivative image</td></tr>
<tr><td>70</td><td>An option module that is required by the derivative image is not fitted in any slot</td><td rowspan="4">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td></tr>
<tr><td>71</td><td>An option module specifically required to be fitted in slot 1 not present</td></tr>
<tr><td>72</td><td>An option module specifically required to be fitted in slot 2 not present</td></tr>
<tr><td>73</td><td>An option module specifically required to be fitted in slot 3 not present</td></tr>
<tr><td>80 to 81</td><td>An error has been detected in the derivative image, contact the supplier of the drive.</td><td></td></tr>
</table>
Recommended action:
Contact the supplier of the drive</td></tr>
<tr><td>Destination</td><td>Two or more parameters are writing to the same destination parameter</td></tr>
<tr><td>199</td><td>The Destination trip indicates that destination parameters of two or more functions (Menus 3, 7, 8, 9, 12 or 14) within the drive are writing to the same parameter.
Recommended actions:
• Set Pr mm.000 to ‘Destinations’ or 12001 and check all visible parameters in all menus for parameter write conflicts</td></tr>
<tr><td>Drive Size</td><td>Power stage recognition: Unrecognized drive size</td></tr>
<tr><td>224</td><td>The Drive Size trip indicates that the control PCB has not recognized the drive size of the power circuit to which it is connected.
Recommended action:
• Ensure the drive is programmed to the latest firmware version
• Hardware fault - return drive to supplier</td></tr>
</table>

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

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

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

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

Recommended actions:

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

Encoder 1	**Drive position feedback interface power supply overload**
189	The *Encoder 1* trip indicates that the drive encoder power supply has been overloaded. Terminals 13 &14 of the 15 way D type connector can supply a maximum current of 200 mA @ 15 V or 300 mA @ 8 V and 5 V.

Recommended actions:

- Check encoder power supply wiring
- Disable the termination resistors (Pr **03.039** set to 0) to reduce current consumption
- For 5 V encoders with long cables, select 8 V (Pr **03.036**) and install a 5 V voltage regulator close to the encoder
- Check the encoder specification to confirm if it is compatible with the encoder port power supply current capability
- Replace the encoder
- Use an external power supply with higher current capability

Encoder 2	**Drive encoder (Feedback) wire break**
190	The *Encoder 2* trip indicates that the drive has detected a wire break on the 15 way D-type connector on the drive. The exact cause of the trip can be identified from the sub-trip number.

Sub-trip	Reason
1	Drive position feedback interface 1 on any input
2	Drive position feedback interface 2 on any input
11	Drive position feedback interface 1 on the A channel
12	Drive position feedback interface 1 on the B channel
13	Drive position feedback interface 1 on the Z channel

Recommended actions:

- Ensure that the position feedback device type selected in Pr **03.038** is correct for the position feedback device connected to the P1 interface on the drive.
- If wire break detection on the drive encoder input is not required, set Pr **03.040** = XXX0 to disable the Encoder 2 trip
- Check cable continuity
- Check wiring of feedback signals is correct
- Check encoder power supply is set correctly (Pr **03.036**)
- Replace encoder

Trip	Diagnosis
Encoder 3	**Phase offset incorrect while running**
191	The *Encoder 3* trip indicates that the drive has detected an incorrect UVW phase angle while running (RFC-S mode only) or SINCOS phase error. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Check encoder shield connections • Ensure the encoder cable is one uninterrupted cable • Check the encoder signal for noise with an oscilloscope • Check the integrity of the encoder mechanical mounting • For a UVW servo encoder, ensure that the phase rotation of the UVW commutation signals is the same as • the phase rotation of the motor • For a SINCOS encoder, ensure that motor and incremental SINCOS connections are correct and that for forward rotation of the motor, the encoder rotates clockwise (when looking at the shaft of the encoder) • Repeat the offset measurement test
Encoder 4	**Feedback device comms failure**
192	The Encoder 4 trip indicates that the encoder communications has timed out or the communications position message transfer time is too long. This trip can also be caused due to wire break in the communication channel between the drive and the encoder. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Ensure the encoder power supply setting (Pr **03.036**) is correct • Complete encoder auto-configuration (Pr **03.041**) • Check the encoder wiring • Replace the feedback device
Encoder 5	**Checksum or CRC error**
193	The *Encoder 5* trip indicates that there is a checksum or CRC error, or the SSI encoder is not ready. The Encoder 5 trip can also indicate a wire break to a communications based encoder. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Check the encoder cable shield connections • Ensure the cable is one uninterrupted cable - remove any connector blocks or if unavoidable minimise the length of any shield pigtails to the connector block • Check the encoder signal for noise with an oscilloscope • Check the comms resolution setting (Pr **03.035**) • If using a Hiperface, EnDat encoder carry out an encoder auto-configuration (Pr **03.041** = Enabled) • Replace the encoder
Encoder 6	**Encoder has indicated an error**
194	The *Encoder 6* trip indicates that the encoder has indicated an error or that the power supply has failed to an SSI encoder. The *Encoder 6* trip can also indicate a wire break to an SSI encoder. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • For SSI encoders, check the wiring and encoder power supply setting (Pr **03.036**) • Replace the encoder / contact the supplier of the encoder

Trip	Diagnosis
Encoder 7	**Set-up parameters for position feedback device have changed**
195	The *Encoder 7* trip indicates that the set-up parameters for position feedback device has changed. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Reset the trip and perform a save. • Ensure Pr **3.033** and Pr **03.035** are set correctly or carry out an encoder auto-configuration (Pr **03.041** = Enabled)
Encoder 8	**Position feedback interface has timed out**
196	The *Encoder 8* trip indicates that Position feedback interface communications time exceeds 250 µs. The feedback device which has caused the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Ensure the encoder is connected correctly • Ensure that the encoder is compatible • Increase baud rate
Encoder 9	**Position feedback is selected from a option module slot which does not have a feedback option module installed**
197	The *Encoder 9* trip indicates that position feedback source selected in Pr **03.026** (or Pr **21.021** for the second motor map) is not valid **Recommended actions:** • Check the setting of Pr **03.026** (or Pr **21.021** if the second motor parameters have been enabled) • Ensure that the option slot selected in Pr **03.026** has a feedback option module installed
Encoder 12	**Encoder could not be identified during auto-configuration**
162	The *Encoder 12* trip indicates that the drive is communicating with the encoder but the encoder type is not recognized. **Sub-trip** / **Reason** 1 – Drive position feedback interface 1 2 – Drive position feedback interface 2 **Recommended actions:** • Enter the encoder setup parameters manually • Check to see the encoder supports auto-configuration
Encoder 13	**Data read from the encoder is out of range during auto-configuration**
163	The *Encoder 13* trip indicates that the data read from the encoder was out of the range during auto-configuration. No parameters will be modified with the data read from the encoder as a result of auto configuration. The tens in the sub-trip number indicate the interface number (i.e. 1 for P1 interface and 2 for P2 interface). **Sub-trip** / **Reason** x1 – Rotary lines per revolution error x2 – Linear comms pitch error x3 – Linear line pitch error x4 – Rotary turns bits error x5 – Communications bits error x6 – Calculation time is too long x7 – Line delay measured is longer than 5 µs **Recommended actions:** • Enter the encoder setup parameters manually • Check to see the encoder supports auto-configuration

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>External Trip</td><td>An External trip is initiated</td></tr>
<tr><td>6</td><td>An External Trip has occurred. The cause of the trip can be identified from the sub trip number displayed after the trip string. See table below. An external trip can also be initiated by writing a value of 6 in Pr 10.038.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>External Trip Mode (08.010) = 1 or 3 and Safe Torque Off input 1 is low</td></tr>
<tr><td>2</td><td>External Trip Mode (08.010) = 2 or 3 and Safe Torque Off input 2 is low</td></tr>
<tr><td>3</td><td>External Trip (10.032) = 1</td></tr>
</table>
Recommended actions:
• Check the Safe Torque Off signal voltage (on terminals 2 & 6) equals to 24 V.
• Check the value of Pr 08.009 which indicates the digital state of terminals 2 & 6, equates to ‘on’.
• If external trip detection of the Safe Torque Off input is not required, set Pr 08.010 to OFF (0).
• Check the value of Pr 10.032.
• Select ‘Destinations’ (or enter 12001) in Pr mm.000 and check for a parameter controlling Pr 10.032.
• Ensure Pr 10.032 or Pr 10.038 (= 6) is not being controlled by serial comms</td></tr>
<tr><td>HF01</td><td>Data processing error: CPU address error</td></tr>
<tr><td></td><td>The HF01 trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF02</td><td>Data processing error: DMAC address error</td></tr>
<tr><td></td><td>The HF02 trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF03</td><td>Data processing error: Illegal instruction</td></tr>
<tr><td></td><td>The HF03 trip indicates that an illegal instruction has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF04</td><td>Data processing error: Illegal slot instruction</td></tr>
<tr><td></td><td>The HF04 trip indicates that an illegal slot instruction has occurred.This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF05</td><td>Data processing error: Undefined exception</td></tr>
<tr><td></td><td>The HF05 trip indicates that an undefined exception error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF06</td><td>Data processing error: Reserved exception</td></tr>
<tr><td></td><td>The HF06 trip indicates that a reserved exception error has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>HF07</td><td>Data processing error: Watchdog failure</td></tr>
<tr><td></td><td>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</td></tr>
<tr><td>HF08</td><td>Data processing error: CPU Interrupt crash</td></tr>
<tr><td></td><td>The HF08 trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
</table>

Trip	Diagnosis
HF09	**Data processing error: Free store overflow**
	The *HF09* trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF10	**Data processing error: Parameter routing system error**
	The *HF10* trip indicates that a Parameter routing system error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF11	**Data processing error: Access to EEPROM failed**
	The *HF11* trip indicates that access to the drive EEPROM has failed. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF12	**Data processing error: Main program stack overflow**
	The *HF12* trip indicates that the main program stack over flow has occurred. The stack can be identified by the sub-trip number. This trip indicates that the control PCB on the drive has failed. **Sub-trip** / **Stack** 1 – Background tasks 2 – Timed tasks 3 – Main system interrupts **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF13	**Data processing error: Firmware incompatible with hardware**
	The *HF13* trip indicates that the drive firmware is not compatible with the hardware. This trip indicates that the control PCB on the drive has failed. The sub-trip number gives the actual ID code of the control board hardware. **Recommended actions:** • Re-program the drive with the latest version of the drive firmware for *Digitax HD M751* • Hardware fault – Contact the supplier of the drive
HF14	**Data processing error: CPU register bank error**
	The *HF14* trip indicates that a CPU register bank error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF15	**Data processing error: CPU divide error**
	The *HF15* trip indicates that a CPU divide error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF16	**Data processing error: RTOS error**
	The *HF16* trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
HF17	**Data processing error: Clock supplied to the control board is out of specification**
	The *HF17* trip indicates that the clock supplied to the control board logic is out of specification. This trip indicates that the control PCB on the drive has failed. **Recommended actions:** • Hardware fault – Contact the supplier of the drive

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>HF18</td><td>Data processing error: Internal flash memory has failed</td></tr>
<tr><td></td><td>The HF18 trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Programming error while writing menu in flash</td></tr>
<tr><td>2</td><td>Erase flash block containing setup menus failed</td></tr>
<tr><td>3</td><td>Erase flash block containing application menus failed</td></tr>
</table>
Recommended actions:
• Hardware fault - Contact the supplier of the drive.</td></tr>
<tr><td>HF19</td><td>Data processing error: CRC check on the firmware has failed</td></tr>
<tr><td></td><td>The HF19 trip indicates that the CRC check on the drive firmware has failed.
Recommended actions:
• Re-program the drive
• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>HF20</td><td>Data processing error: ASIC is not compatible with the hardware</td></tr>
<tr><td></td><td>The HF20 trip indicates that the ASIC version is not compatible with the drive firmware. The ASIC version can be identified from the sub-trip number.
Recommended actions:
• Hardware fault - Contact the supplier of the drive</td></tr>
<tr><td>HF23 to HF25</td><td>Hardware fault</td></tr>
<tr><td></td><td>Recommended actions:
• If this trip occurs please consult the drive supplier.</td></tr>
</table>

Trip	Diagnosis
Inductance	**Inductance measurement out of range or motor saturation not detected**
8	This trip occurs in RFC-S mode when the drive has detected that the motor inductances are not suitable for the operation being attempted. The trip is either caused because the ratio or difference between Ld and Lq is too small or because the saturation characteristic of the motor cannot be measured. If the inductance ratio or difference is too small this is because one of the following conditions is true: (*No-load Lq* (05.072)- *Ld* (05.024)) / *Ld* (05.024) < 0.1 (*No-load Lq* (05.072) - *Ld* (05.024)) < (K / *Full Scale Current Kc* (11.061))H where: **_Drive Rated voltage_ (11.033)** / **K**: 200 V / 0.0073; 400 V / 0.0146; 575 V / 0.0174; 690 V / 0.0209 If the saturation characteristic of the motor cannot be measured this is because when the flux in the motor is changed the measured value of Ld does change sufficiently due to saturation to be measured. When half of *Rated Current* (05.007) is applied in the d axis of the motor in each direction the inductance must fall change at least (K / (2 x *Full Scale Current Kc* (11.061)). The specific reasons for each of the sub-trips are given in the table below: **Sub-trip** / **Reason**: 1 — The inductance ratio or difference is too small when the drive has been started in sensorless mode.; 2 — The saturation characteristic of the motor cannot be measured when the drive has been started in sensorless mode.; 3 — The inductance ratio or difference is too small when an attempt is made to determine the location of the motor flux during a stationary auto-tune in RFC-S mode. This trip is also produced when the inductance ratio or inductance difference is too small when carrying out a phasing test on starting in RFC-S mode. If position feedback is being used the measured value for *Position Feedback Phase Angle* (03.025) may not be reliable. Also the measured values of *Ld* (05.024) and *No-load Lq* (05.072) may not correspond to the d and q axis respectively.; 4 — The direction of the flux in the motor is detected by the change of inductance with different currents. This trip is initiated if the change cannot be detected when an attempt is made to perform a stationary auto-tune when position feedback is being used, or to perform a phasing test on starting in RFC-S mode. **Recommended actions for sub-trip 1:** • Ensure that *RFC Low Speed Mode* (05.064) is set to Non-salient (1), Current (2) or Current No test (3). **Recommended actions for sub-trip 2:** • Ensure that *RFC Low Speed Mode* (05.064) is set to Non-salient (1), Current (2) or Current No test (3). **Recommended actions for sub-trip 3:** • None. The trip acts as a warning. **Recommended actions for sub-trip 4:** • Stationary autotune is not possible. Perform a minimal movement or rotating autotune. • Phasing test on starting is not possible. Use a position feedback device with commutation signals or absolute position.
I/O Overload	**Digital output overload**
26	The *I/O Overload* trip indicates that the total current drawn from 24 V user supply or from the digital output has exceeded the limit. A trip is initiated if one or more of the following conditions: • Maximum output current from one digital output is 100 mA. • The combined maximum output current from outputs 1 and 2 is 100 mA • The combined maximum output current from output 3 and +24 V output is 100 mA **Recommended actions:** • Check total loads on digital outputs • Check control wiring is correct • Check output wiring is undamaged
Keypad Mode	**Keypad has been removed when the drive is receiving the speed reference from the keypad**
34	The *Keypad Mode* trip indicates that the drive is in keypad mode [*Reference Selector* (01.014) = 4 or 6 or M2 reference selector (21.003 = 4 or 6 if motor map 2 is selected] and the keypad has been removed or disconnected from the drive. **Recommended actions:** • Re-install keypad and reset • Change *Reference Selector* (01.014) to select the reference from another source

Trip	Diagnosis
Motor Too Hot	**Output current overload timed out (I^2t)**
20	The *Motor Too Hot* trip indicates a motor thermal overload based on the *Rated Current* (Pr **05.007**) and *Motor Thermal Time Constant* (Pr **04.015**). Pr **04.019** displays the motor temperature as a percentage of the maximum value. The drive will trip on *Motor Too Hot* when Pr **04.019** gets to 100 %. **Recommended actions:** • Ensure the load is not jammed / sticking • Check the load on the motor has not changed • If seen during an auto-tune test in RFC-S mode, ensure the motor *Rated Current* in Pr **05.007** is ≤ Heavy duty current rating of the drive • Tune the *Rated Speed* (Pr **05.008**) (RFC-A mode only) • Check feedback signal for noise • Ensure the motor rated current is not zero • This trip can be disabled and current limiting activated on the motor overload by setting thermal protection mode Pr **04.016** to 1.
Name Plate	**Electronic nameplate transfer has failed**
176	The *Name Plate* trip is initiated if an electronic name plate transfer between the drive and the motor has failed. The exact reason for the trip can be identified from the sub-trip number. **Sub-trip** / **Reason**: 1 – Not enough memory space to complete the transfer; 2 – Communication with encoder failed; 3 – The transfer has failed; 4 – The checksum of the stored object has failed **Recommended actions:** • Ensure that the device encoder memory has at least 128 bytes to store the nameplate data • When writing the motor object (Pr **mm.000** = 11000), ensure that the device encoder memory has at least 256 bytes to store all the nameplate data. • When transferring between option module and encoder, ensure that the option slot has a feedback option module installed. • Check if the encoder has been initialized in *Position Feedback Initialized* (03.076). • Verify the encoder wiring.
OHt Brake	**Braking IGBT over-temperature**
101	The *OHt Brake* over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model. **Recommended actions:** • Check braking resistor value is greater than or equal to the minimum resistance value
OHt Control	**Control stage over temperature**
23	This *OHt Control* trip indicates that a control stage over-temperature has been detected. From the sub-trip 'xxyzz', the Thermistor location is identified by 'zz'. **Source** / **xx** / **y** / **zz** / **Description**: Control system / 00 / 0 / 01 / Control board thermistor 1 over temperature; Control system / 00 / 0 / 02 / Control board thermistor 2 over temperature; Control system / 00 / 0 / 03 / I/O board thermistor over temperature **Recommended actions:** • Check enclosure / drive fans are still functioning correctly • Check enclosure ventilation paths • Check enclosure door filters • Increase ventilation • Reduce the drive switching frequency • Check ambient temperature

Trip	Diagnosis
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 with sub-trip 200 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 It is also possible in a multi-power module system for DC bus over-temperature to be detected from within the power stage. From this source the estimated temperature as a percentage of trip is not available and the trip is indicated as follows: **Source** | **xx** | **y** | **zz** | **Description** Control system | 01 | 0 | 00 | Power stage gives trip with sub-trip 0 **Recommended actions:** • Check the AC supply voltage balance and levels • Check DC bus ripple level • Reduce duty cycle • Reduce motor load • Check the output current stability. If unstable; Check the motor map settings with motor nameplate (Pr **05.006**, Pr **05.007**, Pr **05.008**, Pr **05.009**, Pr **05.010**, Pr **05.011**) – (All Modes) Disable slip compensation (Pr **05.027** = 0) – (Open loop) Disable dynamic V to F operation (Pr **05.013** = 0) - (Open loop) Select fixed boost (Pr **05.014** = Fixed) – (Open loop) Select high stability space vector modulation (Pr **05.020** = 1) – (Open loop) Disconnect the load and complete a rotating auto-tune (Pr **05.012**) – (RFC-A, RFC-S) Auto-tune the rated speed value (Pr **05.016** = 1) – (RFC-A, RFC-S) Reduce speed loop gains (Pr **03.010**, Pr **03.011**, Pr **03.012**) – (RFC-A, RFC-S) Add a speed feedback filter value (Pr **03.042)** – (RFC-A, RFC-S) Add a current demand filter (Pr **04.012**) – (RFC-A, RFC-S) Check encoder signals for noise with an oscilloscope (RFC-A, RFC-S) Check encoder mechanical coupling - (RFC-A, RFC-S)
OHt Inverter	**Inverter over temperature based on thermal model**
21	This trip indicates that an IGBT junction over-temperature has been detected based on a software thermal model. The sub-trip indicates which model has initiated the trip in the form xxyzz as given below: **Source** | **xx** | **y** | **zz** | **Description** Control system | 00 | 1 | 00 | Inverter thermal model Control system | 00 | 3 | 00 | Braking IGBT thermal model **Recommended actions with sub-trip 100:** • Reduce the selected drive switching frequency • Ensure *Auto-switching Frequency Change Disable* (05.035) is set to Off • Reduce duty cycle • Increase acceleration / deceleration rates • Reduce motor load • Check DC bus ripple • Ensure all three input phases are present and balanced **Recommended actions with sub-trip 300:** • Reduce the braking load

Trip	Diagnosis
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 which is indicating the over-temperature is identified by 'zz'.The thermistor numbering is different for a single module type drive (i.e. no parallel board fitted) and a multi-module type drive (i.e. parallel board fitted with one or more power modules) as shown below: **Single module type drive:** **Source** | **xx** | **y** | **zz** | **Description** Power system | 01 | 0 | zz | Thermistor location defined by zz in the power board Power system | 01 | Rectifier number | zz | Thermistor location defined by zz in the rectifier **Multi-module type system:** **Source** | **xx** | **y** | **zz** | **Description** Power system | power module number | 0 | 01 | U phase power device Power system | power module number | 0 | 02 | V phase power device Power system | power module number | 0 | 03 | W phase power device Power system | power module number | 0 | 04 | Rectifier Power system | power module number | 0 | 05 | General power system Power system | power module number | 0 | 00 | Braking IGBT Note that the power module that has caused the trip cannot be identified except for the braking IGBT temperature measurement **Recommended actions:** • Check enclosure / drive fans are still functioning correctly • Force the heatsink fans to run at maximum speed • Check enclosure ventilation paths • Check enclosure door filters • Increase ventilation • Reduce the drive switching frequency • Reduce duty cycle • Increase acceleration / deceleration rates • Use S ramp (Pr **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 VM_DRIVE_CURRENT[MAX]. This trip cannot be reset until 10 s after the trip was initiated. **Source** | **xx** | **y** | **zz** | **Description** Control system | 00 | 0 | 00 | Instantaneous over-current trip when the measured AC current exceeds VM_DRIVE_CURRENT[MAX]. Power system | Power module number | 0 **Recommended actions:** • Acceleration/deceleration rate is too short • If seen during auto-tune reduce the voltage boost • Check for short circuit on the output cabling • Check integrity of the motor insulation using an insulation tester • Check feedback device wiring • Check feedback device mechanical coupling • Check feedback signals are free from noise • Is motor cable length within limits for the frame size • Reduce the values in the speed loop gain parameters - (Pr **03.010**, **03.011**, **03.012**) or (Pr **03.013**, **03.014**, **03.015**) • Has the phase angle autotune been completed? (RFC-S mode only) • Reduce the values in current loop gain parameters (RFC-A, RFC-S modes only)

Trip	Diagnosis
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. **Source** / **xx** / **y** / **zz** / **Description**: Power system / Power module number / 0 / 00 / Braking IGBT instantaneous over-current 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
OI dc	**Power module over current detected from IGBT on state voltage monitoring**
109	The *OI dc* trip indicates that the short circuit protection for the drive output stage has been activated. The table below shows where the trip has been detected. This trip cannot be reset until 10 s after the trip was initiated. **Source** / **xx** / **y** / **zz**: Control system / 00 / 0 / 00; Power system / Power module number / 0 / 00 **Recommended actions:** • Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester • Replace the drive
OI Snubber	**Snubber over-current detected**
92	The *OI Snubber* trip indicates that an over-current condition has been detected in the rectifier snubber circuit. The reason for the trip can be identified by the sub-trip number. **Source** / **xx** / **y** / **zz** / **Description**: Power system / 01 / Rectifier number* / 00 / Rectifier snubber over-current trip detected. * For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault. **Recommended actions:** • Ensure the internal EMC Filter is installed • Ensure the motor cable length does not exceed the maximum for selected switching frequency • Check for supply voltage imbalance • Check for supply disturbance such as notching from a DC drive • Check the motor and motor cable insulation with an insulation tester • Install an output line reactor or sinusoidal filter
Option Disable	**Option module does not acknowledge during drive mode changeover**
215	The *Option Disable* trip indicates that the option module did not acknowledge to the drive that communications with the drive has been stopped during the drive mode changeover with in the allocated time. **Recommended trip:** • Reset the trip • If the trip persists, replace the option module
Out Phase Loss	**Output phase loss detected**
98	The *Out Phase Loss* trip indicates that phase loss has been detected at the drive output. **Sub-trip** / **Reason**: 1 / U phase detected as disconnected when drive enabled to run.; 2 / V phase detected as disconnected when drive enabled to run.; 3 / W phase detected as disconnected when drive enabled to run.; 4 / Output phase loss detected when the drive is running. **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

Trip	Diagnosis
Over Speed	**Motor speed has exceeded the over speed threshold**
7	In open loop mode, if the *Output Frequency* (05.001) exceeds the threshold set in *Over Speed Threshold* (03.008) in either direction an *Over Speed* trip is produced. In RFC-A and RFC-S mode, if the Speed Feedback (03.002) exceeds the *Over Speed Threshold* in Pr **03.008** in either direction an *Over Speed* trip is produced. If Pr **03.008** is set to 0.0 the threshold is then equal to 1.2 x the value set in Pr **01.006**. In RFC-A and RFC-S mode, if an SSI encoder is being used and Pr **03.047** is set to 0 an *Over Speed* trip will be produced when the encoder passes through the boundary between its maximum position and zero. **Recommended actions:** • Check the motor is not being driven by another part of the system • Reduce the *Speed Controller Proportional Gain* (03.010) to reduce the speed overshoot (RFC-A, RFC-S modes only) • If an SSI encoder is being used set Pr **03.047** to 1 The above description relates to a standard Over Speed trip, however in RFC-S mode it is possible to produce an *Over Speed.1* trip. This is caused if the speed is allowed to exceed the safe level in RFC-S mode with flux weakening when *Enable High Speed Mode* (05.022) is set to -1.
Over Volts	**DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds**
2	The *Over Volts* trip indicates that the DC bus voltage has exceeded the VM_DC_VOLTAGE[MAX] or VM_DC_VOLTAGE_SET[MAX] for 15 s. The trip threshold varies depending on voltage rating of the drive as shown below. **Voltage rating** / **VM_DC_VOLTAGE[MAX]** / **VM_DC_VOLTAGE_SET[MAX]** 200 / 415 / 410 400 / 830 / 815 575 / 990 / 970 690 / 1190 / 1175 **Sub-trip Identification** **Source** / **xx** / **y** / **zz** Control system / 00 / 0 / 01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX]. Control system / 00 / 0 / 02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX]. **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	**Supply phase loss**
32	The Phase Loss trip indicates that the drive has detected an input phase loss or large supply imbalance. Phase loss can be detected directly from the supply where the drive has a thyristor base charge system (Frame size 8 and above). If phase loss is detected using this method the drive trips immediately and the xx part of the sub-trip is set to 01. In all sizes of drive phase loss is also detected by monitoring the ripple in the DC bus voltage in which case the drive attempts to stop the drive before tripping unless bit 2 of *Action On Trip Detection* (10.037) is set to one. When phase loss is detected by monitoring the ripple in the DC bus voltage the xx part of the sub-trip is zero. **Source** / **xx** / **y** / **zz** Control system / 00 / 0 / 00: Phase loss detected from DC bus ripple Power system (1) / Power module number / Rectifier number (2) / 00: Phase loss detected directly from the supply (1) Input phase loss detection can be disabled when the drive required to operate from the DC supply or from a single phase supply in *Input Phase Loss Detection Mode* (06.047). (2) For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault. This trip does not occur in regen mode. **Recommended actions:** • Check the AC supply voltage balance and level at full load • Check the DC bus ripple level with an isolated oscilloscope • Check the output current stability • 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.

Trip	Diagnosis
Phasing Error	**RFC-S mode phasing failure due to incorrect phase angle**
198	The *Phasing Error* trip indicates that the phase offset angle in Pr **03.025** (or Pr **21.020** if the second motor map is being used) is incorrect if position feedback is being used and the drive is unable to control the motor correctly. **Recommended actions:** • Check the encoder wiring • Check the encoder signals for noise with an oscilloscope • Check the encoder mechanical coupling • Perform an auto-tune to measure the encoder phase angle or manually enter the correct phase angle into Pr **03.025** • Spurious *Phasing Error* trips can sometimes be seen in very dynamic applications. This trip can be disabled by setting the over-speed threshold in Pr **03.008** to a value greater than zero. If sensorless control is being used this indicates that significant instability has occurred and the motor has accelerated without control. **Recommended actions:** • Ensure that the motor parameters are set-up correctly. • Reduce the speed controller gains.
Power Comms	**Communication has been lost / errors detected between power, control and rectifier modules**
90	A *Power Comms* trip indicates a communications problem within the power system of the drive. The reason for the trip can be identified by the sub-trip number. **Type of drive** / **xx** / **y** / **zz** Single power module system / 01 / Rectifier number* / 00: Excessive communications errors detected by the rectifier module. * For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault. **Recommended actions:** • Hardware fault – Contact the supplier of the drive
Power Data	**Power system configuration data error**
220	The *Power Data* trip indicates that there is an error in the configuration data stored in the power system. **Source** / **xx** / **y** / **zz** / **Description** Control system / 00 / 0 / 02 / There is no data table to be uploaded to the control board Control system / 00 / 0 / 03 / The power system data table is bigger than the space available in the control pod to store it. Control system / 00 / 0 / 04 / The size of the table given in the table is incorrect. Control system / 00 / 0 / 05 / Table CRC error. Control system / 00 / 0 / 06 / The version number of the generator software that produced the table is too low. i.e. a table from a newer generator is required that includes features that have been added to the table that may not be present. Control system / 00 / 0 / 07 / The power board data table does not match the power board hardware identifier. Power system / 01 / 0 / 00 / The power data table used internally by the power module has an error. (For a multi-power module drive this indicates any error with the code tables in the power system). Power system / 01 / 0 / 01 / The power data table that should be 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.

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>PSU</td><td>Internal power supply fault</td></tr>
<tr><td>5</td><td>The PSU trip indicates that one or more internal power supply rails are outside limits or overloaded.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th><th>Description</th></tr>
<tr><td>Control system</td><td>00</td><td>0</td><td rowspan="2">00</td><td>Internal power supply overload</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>Rectifier number*</td><td>Rectifier internal power supply overload</td></tr>
</table>
* For a parallel power-module system the rectifier number will be zero as it is not possible to determine which rectifier has detected the fault.
Recommended actions:
• Remove any option modules and perform a reset
• Remove encoder connection and perform a reset
• Hardware fault within the drive – return the drive to the supplier</td></tr>
<tr><td>PSU 24V</td><td>24V internal power supply overload</td></tr>
<tr><td>9</td><td>The total user load of the drive and option modules has exceeded the internal 24 V power supply limit. The user load consists of the drive digital outputs and main encoder supply.
Recommended actions:
• Reduce the load and reset
• Provide an external 24 V power supply on control terminal 2
• Remove all option modules</td></tr>
<tr><td>Reserved</td><td>Reserved trips</td></tr>
<tr><td>01
95
104 – 108
170 – 173
228 - 246</td><td>These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.
<table>
<tr><th>Trip Number</th><th>Description</th></tr>
<tr><td>01</td><td>Reserved resettable trip</td></tr>
<tr><td>95</td><td>Reserved resettable trip</td></tr>
<tr><td>104 - 108</td><td>Reserved resettable trip</td></tr>
<tr><td>170 - 173</td><td>Reserved resettable trip</td></tr>
<tr><td>228 - 246</td><td>Reserved non-resettable trip</td></tr>
</table></td></tr>
<tr><td>Resistance</td><td>Measured resistance has exceeded the parameter range</td></tr>
<tr><td>33</td><td>This trip indicates that either the value being used for motor stator resistance is too high or that an attempt to do a test involving measuring motor stator resistance has failed. The maximum for the stator resistance parameters is generally higher than the maximum value that can be used in the control algorithms. If the value exceeds (V_{FS} / v2) / Full Scale Current Kc (11.061), where V_{FS} is the full scale DC bus voltage then this trip is initiated. If the value is the result of a measurement made by the drive then sub-trip 1 is applied, or if it is because the parameter has been changed by the user then sub-trip 3 is applied. During the stator resistance section of auto-tuning an additional test is performed to measured the drive inverter characteristics to provide the compensation necessary for dead-times. If the inverter characteristic measurement fails then sub-trip 2 is applied.
<table>
<tr><th>Sub-trip</th><th>Reason</th></tr>
<tr><td>1</td><td>Measured stator resistance exceeded the allowed range</td></tr>
<tr><td>2</td><td>It was not possible to measure the inverter characteristic</td></tr>
<tr><td>3</td><td>The stator resistance associated with the presently selected motor map exceeds the allowed range</td></tr>
</table>
Recommended actions:
• Check that the value that has been entered in the stator resistance does not exceed the allowed range (for the presently selected motor map)
• Check the motor cable / connections
• Check the integrity of the motor stator winding using a insulation tester
• Check the motor phase to phase resistance at the drive terminals
• Check the motor phase to phase resistance at the motor terminals
• Ensure the stator resistance of the motor falls within the range of the drive model
• Select fixed boost mode (Pr 05.014 = Fixed) and verify the output current waveforms with an oscilloscope
• Replace the motor</td></tr>
</table>

Trip	Diagnosis
Slot App Menu	**Application menu Customization conflict error**
216	The Slot App Menu trip indicates that more than one option slot has requested to customize the application menus 18, 19 and 20. The sub-trip number indicates which option slot has been allowed to customize the menus. **Recommended actions:** • Ensure that only one of the Application modules is configured to customize the application menus 18, 19 and 20
SlotX Different	**Option module in option slot X has changed**
204 **209** **214**	The *SlotX Different* trip indicates that the option module in option slot X on the drive is a different type to that installed when parameters were last saved on the drive. The sub-trip number gives the identification code of the module that was originally fitted.The reason for the trip can be identified by the sub-trip number. **Sub-trip** / **Reason** 1 – No module was installed previously 2 – A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu. 3 – A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu. 4 – A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus. >99 – Shows the identifier of the module previously installed. **Recommended actions:** • Turn off the power, ensure the correct option modules are installed in the correct option slots and re-apply the power. • Confirm that the currently installed option module is correct, ensure option module parameters are set correctly and perform a user save in Pr **mm.000.**
SlotX Error	**Option module in option slot X has detected a fault**
202 **207** **212**	The *SlotX Error* trip indicates that the option module in option slot X on the drive has detected an error. The reason for the error can be identified by the sub-trip number. **Recommended actions:** • See the relevant *Option Module User Guide* for details of the trip
SlotX HF	**Option module X hardware fault**
200 **205** **210**	The *SlotX HF* trip indicates that the option module in option slot X cannot operate. 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 corrupt 3 – There is insufficient memory available to allocate the comms buffers for this module 4 – The module has not indicated that it is running correctly during drive power-up 5 – Module has been removed after power-up or it has stopped working 6 – The module has not indicated that it has stopped accessing drive parameters during a drive mode change 7 – The module has failed to acknowledge that a request has been made to reset the drive processor 8 – The drive failed to correctly read the menu table from the module during drive power up 9 – The drive failed to upload menu tables from the module and timed out (5 s) 10 – Menu table CRC invalid **Recommended actions:** • Ensure the option module is installed correctly • Replace the option module • Replace the drive
SlotX Not Fitted	**Option module in option slot X has been removed**
203 **208** **213**	The *SlotX Not Fitted* trip indicates that the option module in option slot X on the drive has been removed since the last power up. **Recommended actions:** • Ensure the option module is installed correctly. • Re-install the option module. • To confirm that the removed option module is no longer required perform a save function in Pr **mm.000**.

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>SlotX Watchdog</td><td>Option module watchdog function service error</td></tr>
<tr><td>201
206
211</td><td>The SlotX Watchdog trip indicates that the option module installed in Slot X has started the option watchdog function and then failed to service the watchdog correctly.
Recommended actions:
• Replace the option module</td></tr>
<tr><td>Soft Start</td><td>Soft start relay failed to close, soft start monitor failed</td></tr>
<tr><td>226</td><td>The Soft Start trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Stored HF</td><td>Hardware trip has occurred during last power down</td></tr>
<tr><td>221</td><td>The Stored HF trip indicates that a hardware trip (HF01 –HF20) has occurred and the drive has been power cycled. The sub-trip number identifies the HF trip i.e. stored HF.17.
Recommended actions:
• Enter 1299 in Pr mm.000 and press reset to clear the trip</td></tr>
<tr><td>Sub-array RAM</td><td>RAM allocation error</td></tr>
<tr><td>227</td><td>The Sub-array RAM indicates that an option module, derivative image or user program image has requested more parameter RAM than is allowed. The RAM allocation is checked in order of resulting sub-trip numbers, and so the failure with the highest sub-trip number is given. The sub-trip is calculated as (parameter size) + (parameter type) + sub-array number.
<table>
<tr><th>Parameter size</th><th>Value</th></tr>
<tr><td>1 bit</td><td>1000</td></tr>
<tr><td>8 bit</td><td>2000</td></tr>
<tr><td>16 bit</td><td>3000</td></tr>
<tr><td>32 bit</td><td>4000</td></tr>
<tr><td>64 bit</td><td>5000</td></tr>
</table>
<table>
<tr><th>Parameter type</th><th>Value</th></tr>
<tr><td>Volatile</td><td>0</td></tr>
<tr><td>User save</td><td>100</td></tr>
<tr><td>Power-down save</td><td>200</td></tr>
</table>
<table>
<tr><th>Sub-array</th><th>Menus</th><th>Value</th></tr>
<tr><td>Applications menus</td><td>18-20</td><td>1</td></tr>
<tr><td>Derivative image</td><td>29</td><td>2</td></tr>
<tr><td>User program image</td><td>30</td><td>3</td></tr>
<tr><td>Option slot 1 set-up</td><td>15</td><td>4</td></tr>
<tr><td>Option slot 1 applications</td><td>25</td><td>5</td></tr>
<tr><td>Option slot 2 set-up</td><td>16</td><td>6</td></tr>
<tr><td>Option slot 2 applications</td><td>26</td><td>7</td></tr>
<tr><td>Option slot 3 set-up</td><td>17</td><td>8</td></tr>
<tr><td>Option slot 3 applications</td><td>27</td><td>9</td></tr>
<tr><td>Option slot 4 set-up</td><td>24</td><td>10</td></tr>
<tr><td>Option slot 4 applications</td><td>28</td><td>11</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>Temp Feedback</td><td>Internal thermistor has failed</td></tr>
<tr><td>218</td><td>The Temp Feedback trip indicates that an internal thermistor has failed. The thermistor location can be identified by the sub-trip number.
<table>
<tr><th>Source</th><th>xx</th><th>y</th><th>zz</th></tr>
<tr><td>Control PCB</td><td>00</td><td>0</td><td>01: Control PCB thermistor 1
02: Control PCB thermistor 2
03: I/O PCB thermistor</td></tr>
<tr><td>Power system</td><td>Power module number</td><td>0</td><td>00: Temperature feedback provided via power system comms.
<table>
<tr><th></th><th>Frame 7</th><th>Frame 8</th><th>Frame 9 & 10</th></tr>
<tr><td>21:</td><td>Rectifier thermistor</td><td>Power PCB thermistor 1</td><td>SMPS thermistor</td></tr>
<tr><td>22:</td><td>Power PCB thermistor</td><td>Power PCB thermistor 2</td><td>Heat Sink Fan SMPS thermistor</td></tr>
<tr><td>23:</td><td>Power PCB thermistor</td><td>Rectifier thermistor</td><td>Power PCB thermistor</td></tr>
</table></td></tr>
<tr><td>Power system</td><td>01</td><td>Rectifier number*</td><td>Always zero</td></tr>
</table>
* For a parallel power-module system the rectifier number will be zero as it is not possible to determine which rectifier has detected the fault.
Recommended actions:
• Hardware fault – Contact the supplier of the drive</td></tr>
<tr><td>Th Brake Res</td><td>Brake resistor over temperature</td></tr>
<tr><td>10</td><td>The Th Brake Res is initiated, If hardware based braking resistor thermal monitoring is connected and the resistor overheats. If the braking resistor is not used then this trip must be disabled with bit 3 of Action On Trip Detection (10.037) to prevent this trip.
Recommended actions:
• Check brake resistor wiring
• Check braking resistor value is greater than or equal to the minimum resistance value
• Check braking resistor insulation</td></tr>
<tr><td>Th Short Circuit</td><td>Motor thermistor short circuit</td></tr>
<tr><td>25</td><td>The Th Short Circuit trip indicates that the motor thermistor connected to the drive is short circuit or low impedance i.e. < 50 Ω. The location of the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Source</th></tr>
<tr><td>4</td><td>Position feedback interface</td></tr>
</table>
Recommended actions:
• Check thermistor continuity
• Replace motor / motor thermistor</td></tr>
<tr><td>Thermistor</td><td>Motor thermistor over-temperature</td></tr>
<tr><td>24</td><td>The Thermistor trip indicates that the motor thermistor connected to the drive has indicated a motor over temperature. The location of the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Source</th></tr>
<tr><td>4</td><td>Position feedback interface</td></tr>
</table>
Recommended actions:
• Check motor temperature
• Check Threshold Level (07.048)
• Check thermistor continuity</td></tr>
<tr><td>Undefined</td><td>Drive has tripped and the cause of the trip is Undefined</td></tr>
<tr><td>110</td><td>The Undefined trip indicates that the power system has generated but did not identify the trip from the power system. The cause of the trip is unknown.
Recommended actions:
• Hardware fault – return the drive to the supplier</td></tr>
</table>

<table>
<tr><th>Trip</th><th>Diagnosis</th></tr>
<tr><td>User Program

249</td><td>On board user program error
The User Program trip indicates that an error has been detected in the onboard user program image. The reason for the trip can be identified by the sub-trip number.
<table>
<tr><th>Sub-trip</th><th>Reason</th><th>Comments</th></tr>
<tr><td>1</td><td>Divide by zero</td><td></td></tr>
<tr><td>2</td><td>Undefined trip</td><td></td></tr>
<tr><td>3</td><td>Attempted fast parameter access set-up with non-existent parameter</td><td></td></tr>
<tr><td>4</td><td>Attempted access to non-existent parameter</td><td></td></tr>
<tr><td>5</td><td>Attempted write to read-only parameter</td><td></td></tr>
<tr><td>6</td><td>Attempted an over-range write</td><td></td></tr>
<tr><td>7</td><td>Attempted read from write-only parameter</td><td></td></tr>
<tr><td>30</td><td>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.</td><td>Occurs when the drive powers-up or the image is programmed. The image tasks will not run</td></tr>
<tr><td>31</td><td>The image requires more RAM for heap and stack than can be provided by the drive.</td><td>As 30</td></tr>
<tr><td>32</td><td>The image requires an OS function call that is higher than the maximum allowed</td><td>As 30</td></tr>
<tr><td>33</td><td>The ID code within the image is not valid</td><td>As 30</td></tr>
<tr><td>40</td><td>The timed task has not completed in time and has been suspended</td><td>Onboard User Program: Enable (11.047) is reset to zero when the trip is initiated</td></tr>
<tr><td>41</td><td>Undefined function called, i.e. a function in the host system vector table that has not been assigned.</td><td>As 40</td></tr>
<tr><td>52</td><td>Customized menu table CRC check failed</td><td>As 30</td></tr>
<tr><td>53</td><td>Customized menu table changed</td><td>Occurs when the drive powers-up or the image is programmed and the table has changed. Defaults are loaded for the user program menu and the trip will keep occurring until drive parameters are saved.</td></tr>
<tr><td>80</td><td>Image is not compatible with the control board</td><td>Initiated from within the image code</td></tr>
<tr><td>81</td><td>Image is not compatible with the control board serial number</td><td>As 80</td></tr>
<tr><td>100</td><td>Image has detected and prevented attempted pointer access outside of the IEC task's heap area.</td><td></td></tr>
<tr><td>101</td><td>Image has detected and prevented misaligned pointer usage.</td><td></td></tr>
<tr><td>102</td><td>Image has detected an array bounds violation and prevented its access.</td><td></td></tr>
<tr><td>103</td><td>Image has attempted to convert a data type to or from an unknown data type, has failed and has shut itself down.</td><td></td></tr>
<tr><td>104</td><td>Image has attempted to use an unknown user service function.</td><td></td></tr>
<tr><td>200</td><td>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.)</td><td></td></tr>
<tr><td>201</td><td>Parameter access is not supported. An attempt to read database other than the host drive.</td><td></td></tr>
<tr><td>202</td><td>Parameter does not exist. Database was host drive but the specified parameter does not exist.</td><td></td></tr>
<tr><td>203</td><td>Parameter is read-only.</td><td></td></tr>
<tr><td>204</td><td>Parameter is write-only.</td><td></td></tr>
<tr><td>205</td><td>Unknown parameter error.</td><td></td></tr>
<tr><td>206</td><td>Invalid bit present in parameter. The parameter does not contain the specified bit.</td><td></td></tr>
<tr><td>207</td><td>Parameter format lookup failed. Failed to get parameter information data.</td><td></td></tr>
<tr><td>208</td><td>An over-range write has been attempted.</td><td></td></tr>
</table></td></tr>
<tr><td>User Prog Trip

96</td><td>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</td></tr>
</table>

Trip	Diagnosis
User Save	**User Save error / not completed**
36	The *User Save* trip indicates that an error has been detected in the user save parameters saved in non-volatile memory. For example, following a user save command, If the power to the drive was removed when the user parameters were being saved. **Recommended actions:** • Perform a user save in Pr **mm.000** to ensure that the trip doesn't occur the next time the drive is powered up. • Ensure that the drive has enough time to complete the save before removing the power to the drive.
User Trip	**User generated trip**
40 -89 **112 -159**	These trips are not generated by the drive and are to be used by the user to trip the drive through an application program. **Recommended actions:** • Check the user program
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 1 s 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 12-5 Serial communications look up table

No	Trip	No	Trip	No	Trip
1	**Reserved 001**	95	**Reserved 95**	195	**Encoder 7**
2	**Over Volts**	96	**User Prog Trip**	196	**Encoder 8**
3	**OI ac**	97	**Data Changing**	198	**Phasing Error**
4	**OI Brake**	98	**Out Phase Loss**	199	**Destination**
5	**PSU**	99	**CAM**	200	**Slot1 HF**
6	**External Trip**	100	**Reset**	201	**Slot1 Watchdog**
7	**Over Speed**	101	**OHt Brake**	202	**Slot1 Error**
8	**Inductance**	102	**Reserved 102**	203	**Slot1 Not Fitted**
9	**PSU 24V**	104 - 108	**Reserved 104 - 108**	204	**Slot1 Different**
10	**Th Brake Res**	109	**OI dc**	205	**Slot2 HF**
11	**Autotune 1**	110	**Undefined**	206	**Slot2 Watchdog**
12	**Autotune 2**	111	**Configuration**	207	**Slot2 Error**
13	**Autotune 3**	112 - 159	**User Trip 112 - 159**	208	**Slot2 Not Fitted**
14	**Autotune 4**	161	**User Trip 161**	209	**Slot2 Different**
15	**Autotune 5**	162	**Encoder 12**	210	**Slot3 HF**
16	**Autotune 6**	163	**Encoder 13**	211	**Slot3 Watchdog**
17	**Autotune 7**	164 - 168	**Reserved 164 - 168**	212	**Slot3 Error**
18	**Autotune Stopped**	170 - 173	**Reserved 170 - 173**	213	**Slot3 Not Fitted**
19	**Brake R Too Hot**	174	**Card Slot**	214	**Slot3 Different**
20	**Motor Too Hot**	175	**Card Product**	215	**Option Disable**
21	**OHt Inverter**	176	**Name Plate**	216	**Slot App Menu**
22	**OHt Power**	177	**Card Boot**	217	**App Menu Changed**
23	**OHt Control**	178	**Card Busy**	218	**Temp Feedback**
24	**Thermistor**	179	**Card Data Exists**	220	**Power Data**
25	**Th Short Circuit**	180	**Card Option**	221	**Stored HF**
26	**I/O Overload**	181	**Card Read Only**	222	**Reserved 222**
27	**OHt dc bus**	182	**Card Error**	224	**Drive Size**
28	**An Input Loss 1**	183	**Card No Data**	225	**Current Offset**
30	**Watchdog**	184	**Card Full**	226	**Soft Start**
31	**EEPROM Fail**	185	**Card Access**	227	**Sub-array RAM**
32	**Phase Loss**	186	**Card Rating**	228 - 246	**Reserved 228 - 246**
33	**Resistance**	187	**Card Drive Mode**	247	**Derivative ID**
34	**Keypad Mode**	188	**Card Compare**	248	**Derivative Image**
35	**Control Word**	189	**Encoder 1**	249	**User Program**
36	**User Save**	190	**Encoder 2**	255	**Reset Logs**
37	**Power Down Save**	191	**Encoder 3**		
40 -89	**User Trip 40 - 89**	192	**Encoder 4**		
90	**Power Comms**	193	**Encoder 5**		
92	**OI Snubber**	194	**Encoder 6**		

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 12-6 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. If an KI-Keypad is installed it will show the trip, but the keypad will not function.
1	Stored HF trip	{Stored HF}	This trip cannot be cleared unless 1299 is entered into *Parameter* (**mm.000**) and a reset is initiated.
2	Non-resettable trips	Trip numbers 218 to 247, {Slot1 HF}, {Slot2 HF}, {Slot3 HF} or {Slot4 HF}	These trips cannot be reset.
3	Volatile memory failure	{EEPROM Fail}	This can only be reset if Parameter **mm.000** is set to 1233 or 1244, or if *Load Defaults* (11.043) is set to a non-zero value.
4	SD Card trips	Trip numbers 174, 175 and 177 to 188	These trips are priority 5 during power-up.
4	Internal 24V and position feedback interface power supply	{PSU 24V} and {Encoder 1}	These trips can override {Encoder 2} to {Encoder 6} trips.
5	Trips with extended reset times	{OI ac}, {OI Brake}, and OI dc}	These trips cannot be reset until 10 s after the trip was initiated.
5	Phase loss and d.c. link power circuit protection	{Phase Loss} and {Oht dc bus}	The drive will attempt to stop the motor before tripping if a {Phase Loss}. 000 trip occurs unless this feature has been disabled (see *Action On Trip Detection* (10.037). The drive will always attempt to stop the motor before tripping if an {Oht dc bus} occurs.
5	Standard trips	All other trips	

12.5 Internal / Hardware trips

Trips {HF01} to {HF25} are internal faults that do not have trip numbers. If one of these trips occurs, the main drive processor has detected an irrecoverable error. All drive functions are stopped and the trip message will be displayed on the drive keypad. If a non permanent trip occurs this may be reset by power cycling the drive. On power up after it has been power cycled the drive will trip on Stored HF. The sub-trip code is the number of the original HF trip. 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 KI-Remote Keypad display by alternating the alarm string with the drive status string on the first row and showing the alarm symbol in the last character in the first row. If an action is not taken to eliminate any alarm except "Auto Tune and Limit Switch" the drive may eventually trip. Alarms are not displayed when a parameter is being edited, but the user will still see the alarm character on the upper row.

Table 12-7 Alarm indications

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

12.7 Status indications

Table 12-8 Status indications

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

Table 12-9 Option module and SD Card and other status indications at power-up

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

12.8 Programming error indications

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

Table 12-10 Programming error indications

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

12.9 Displaying the trip history

The drive retains a log of the last ten trips that have occurred. *Trip 0* (10.020) to *Trip 9* (10.029) store the most recent 10 trips that have occurred where *Trip 0* (10.020) is the most recent and *Trip 9* (10.029) is the oldest. When a new trip occurs it is written to *Trip 0* (10.020) and all the other trips move down the log, with oldest being lost. The date and time when each trip occurs are also stored in the date and time log, i.e. *Trip 0 Date* (10.041) to *Trip 9 Time* (10.060). The date and time are taken from *Date* (06.016) and *Time* (06.017). 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 12-5 is the value transmitted.

NOTE

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

12.10 Behaviour of the drive when tripped

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

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

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

13 UL listing information

This section is intended to be used in conjunction with the Digitax HD M75X Series Installation and Technical Guide.

13.1 Scope

All models are cUL Listed to Canadian and US requirements.

The UL file reference is: NMMS / 7. E171230.

13.2 Applicant and Listee

Nidec Control Techniques Ltd

The Gro

Pool Road

Newtown

Powys

SY16 3BE

UK.

13.3 Manufacturer

Products are manufactured at several sites worldwide.

Primary manufacturing site:

Nidec Industrial Automation UK Ltd

Unit 79

Mochdre Industrial Estate

Newtown

Powys

SY16 4LE

UK.

The Manufacturing Location Code is: 8D14

13.4 Model numbers

Model numbers are listed within the 'Ratings' section (Chapter 2 - Product Information) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.5 Safety information

Appropriate installation warnings, cautions and notes are located in the Chapter 1 *Safety information* on page 8.

13.6 Adjustments

The *Digitax HD M75X Series Installation and Technical Guide* gives details of all safety-relevant adjustments intended for the user. The identification or function of each control or indicating device and fuse is clearly marked in the diagrams in the *Digitax HD M75X Series Installation and Technical Guide*.

Maintenance adjustments are also described in the *Digitax HD M75X Series Installation and Technical Guide*. They should only be made by qualified personnel. Clear warnings are provided where excessive adjustment could lead to a hazardous state of the Power Drive System (PDS), Complete Drive Module (CDM) or Basic Drive Module (BDM). Any special equipment necessary for making adjustments is specified and described in the 'Mechanical Installation' (Chapter 3) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.7 Ratings

The electrical ratings are listed within the 'Ratings' section (Chapter 2 - Product Information) of the *Digitax HD* M75X Series Installation and Technical Guide.

13.8 Short circuit current rating

All drives:

5 kA when protected by Listed fuses as specified in the *Digitax HD M75X Series Installation and Technical Guide*.

100 kA when protected by recognized supplemental fuses as specified in the *Digitax HD M75X Series Installation and Technical Guide*.

13.9 Overvoltage category

The Over Voltage Category is OVC III.

OVC III applies to equipment permanently connected in fixed installations (Downstream of and including the main distribution board).

13.10 Input current, fuse ratings and cable sizes

Electrical installation shall be in accordance with the US National Electrical Code, the Canadian Electrical Code and any additional local codes, as required.

The ground (earth) connections and the DC power connections must use UL Listed ring terminals sized according to the field wiring. Only one cable is permitted to be connected to each field wiring terminal.

The recommended cable sizes and fuse ratings are shown in the 'Technical Data' (Chapter 6) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.11 Motor cable size and maximum length

The recommended motor cable sizes and maximum length are shown in the 'Technical Data' (Chapter 6) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.12 Multiple wiring arrangements

The drives are able to operate from either a single phase or a three-phase AC supply.

Additionally, the drives are able to operate from a DC supply with a range from 24 Vdc up to the maximum rated DC supply voltage.

It is possible for the drive to go from operating on a normal line power supply voltage to operating on a much lower supply voltage without interruption. The wiring arrangements are shown in the 'Electrical installation' (Chapter 4) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.13 External 24 V supply

An external 24 Vdc supply is required to power the low voltage circuits within the drive. The low voltage circuits are isolated from the live circuits.

The 24 V supply must be protected by a supplemental fuse.

Refer to the 'Electrical installation' (Chapter 4) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.14 Common DC bus systems

Multiple drives can be connected together via a common DC bus. For further details, refer to 'Multi axis system design' (Chapter 5) of the *Digitax HD M75X Series Installation and Technical Guide.*

13.15 Solid state short circuit protection

Integral solid state short circuit protection is provided. However, this does not provide branch circuit protection.

In the event of a ground (earth) fault within the drive, the input protective devices (fuses or circuit breaker) provide overcurrent protection in the usual way.

All AC drives incorporate solid state short circuit protection. If a ground (earth) fault occurs in the motor circuit, the solid-state protection

operates, the inverter trips and all power switches (IGBTs) are switched off within a very short time, typically less than 10 µs. The total trip time is unlikely to exceed 100 µs.

In the event of failure of the solid state short circuit protection, one or more of the inverter power devices then fails either open or short circuit. If the failure mode is open-circuit, the fault is interrupted. If the failure mode is short-circuit, the input protection devices (fuses or circuit breaker) clear the fault and open the circuit.

13.16 Motor overload protection

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

13.17 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 described in Chapter 8 *Optimization* on page 77.

The duration of the overload is dependent on motor thermal time constant. The maximum programmable time constant depends on the drive model. The method of adjustment of the overload protection is provided.

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.

13.18 Enclosure rating

All drives are Open Type.

13.19 Mounting

Drives may be mounted

- Singly
- Side by side
- Stacked one above another when fitted with a rear vent kit

The drives are equipped with a rear vent that allows heated air to be exhausted from the rear of the drive rather than the through the top. This mounting arrangement provides the following benefits:

- Reduction in enclosure size.
- Allow vertical stacking of drives.
- Reduce the need for a secondary enclosure fan.

Refer to the ‘Mechanical Installation’ (Chapter 3) of the *Digitax HD M75X Series Installation and Technical Guide*.

For compact multi axis installations, the rear venting kit allows drives to be vertically mounted one above the other, where this is the case, a minimum clearance of 100 mm (3.94 in) should be maintained between drives.

A current derating must be applied to the drive if the rear vent kit is installed. Derating information is provided in the ‘Technical Data’ (Chapter 6) of the *Digitax HD M75X Series Installation and Technical Guide*. Failure to do so may result in nuisance tripping.

13.20 Operating temperature

The drives are suitable for use up to 40 °C (104 °F) surrounding air temperature. Operation up to 55 °C (131 °F) is permitted with de-rated output. Refer to the ‘Technical Data’ (Chapter 6) of the *Digitax HD M75X Series Installation and Technical Guide*.

13.21 Pollution degree

Drives are designed for operation in a pollution degree 2 environment or better (dry, non-conductive pollution only).

13.22 Plenum rating

The drives are not suitable for installation in a compartment (duct) handing conditioned air.

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