



**Nidec**  
All for dreams

*Control User Guide*

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***Digitax HD M753***

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Variable Speed AC drive for  
Servo and Induction motors

Part Number: 0478-0461-03  
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>

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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
dddd	Current rating	Example 01000 = 100 A
e	Drive format	A = 6P Rectifier + Inverter (internal choke), D = Inverter, E = 6P Rectifier + Inverter (external choke), T = 12P Rectifier + Inverter (external choke)

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

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)

**Nidec Control Techniques Ltd, The Gro, Newtown, Powys. UK. 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
dddd	Current rating	Example 01000 = 100 A
e	Drive format	A = 6P Rectifier + Inverter (internal choke), D = Inverter, E = 6P Rectifier + Inverter (external choke), T = 12P Rectifier + Inverter (external choke)

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

**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

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Conformity Engineer  
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**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.



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

### NOTE

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

## 1.2 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

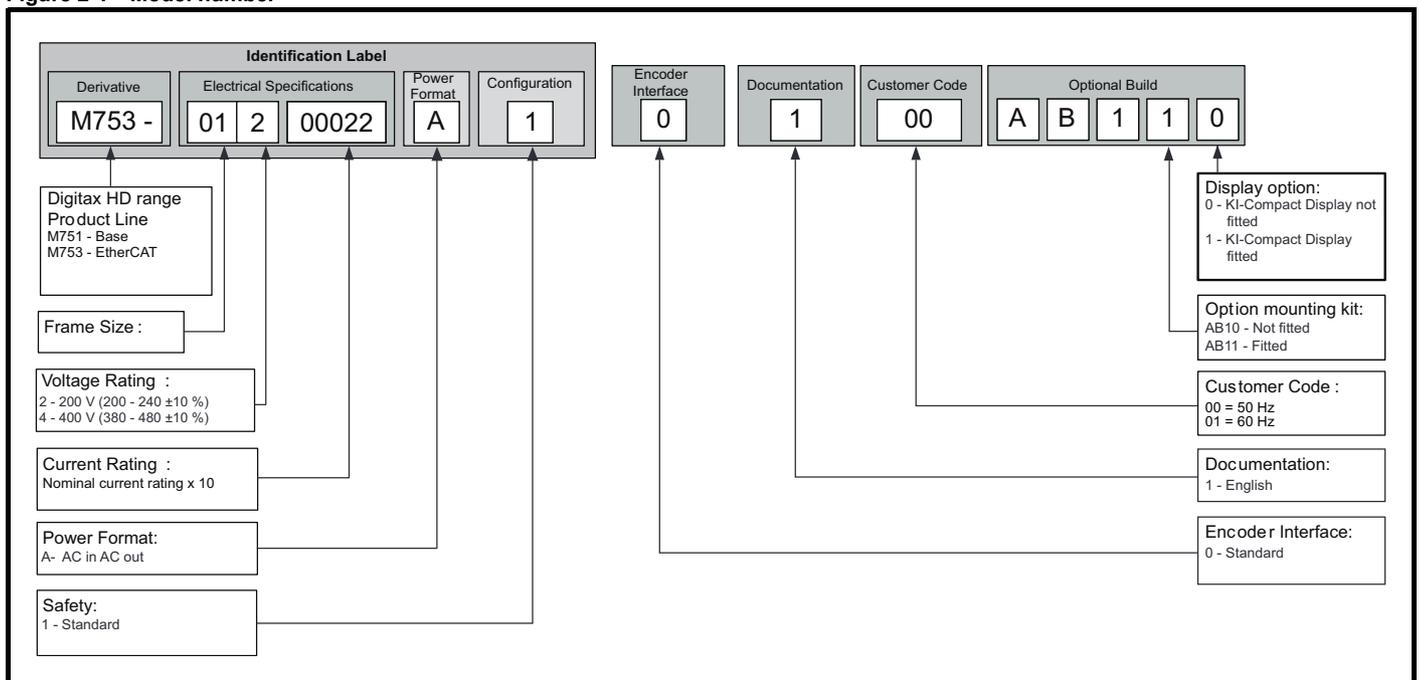
##### Digitax HD M753 EtherCAT

- 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 Flux Control 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 Flux Control 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

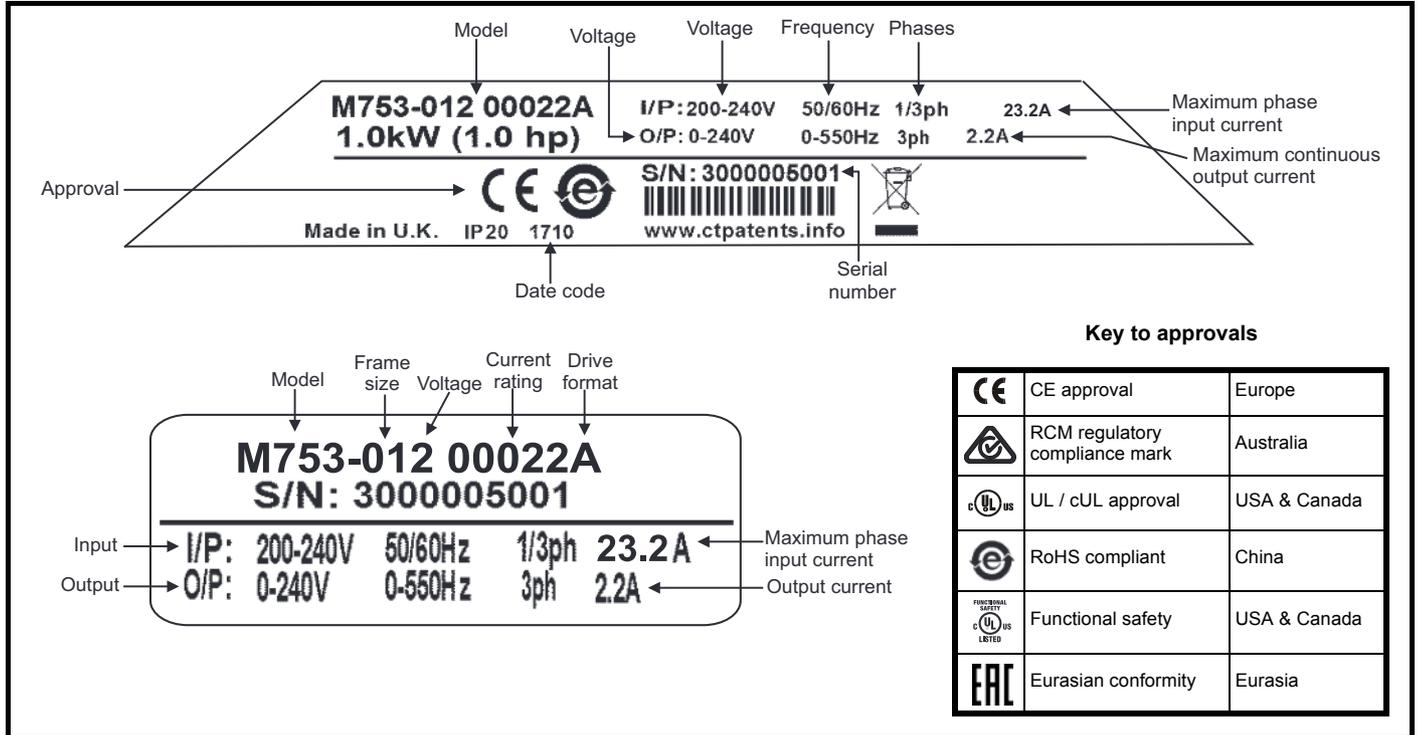
Encoder type	Pr 3.038 setting
Quadrature incremental encoders with or without marker pulse	AB (0)
Quadrature incremental encoders with UVW commutation signals for absolute position for permanent magnet motors with or without marker pulse	AB Servo (3)
Forward / reverse incremental encoders with or without 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)
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.

## 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**

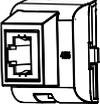
Type	Option module*	Color	Name	Further Details
Fieldbus		Purple	SI-PROFIBUS	<b>PROFIBUS option</b> PROFIBUS adapter for communications with the drive
		Medium Grey	SI-DeviceNet	<b>DeviceNet option</b> DeviceNet adapter for communications with the drive
		Light Grey	SI-CANopen	<b>CANopen option</b> CANopen 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	<b>PROFINET V2 option</b> PROFINET V2 adapter for communications with the drive Note: PROFINET V2 replaces PROFINET RT.
		Brown Red	SI-EtherCAT	<b>EtherCAT option</b> EtherCAT adapter for communications with the drive
Automation (I/O expansion)		Orange	SI-I/O	<b>Extended I/O</b> Increases the I/O capability by adding the following combinations: <ul style="list-style-type: none"> <li>• Digital I/O</li> <li>• Digital Inputs</li> <li>• Analog Inputs (differential or single ended)</li> <li>• Analog Output</li> <li>• Relays</li> </ul>
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	<b>Machine Control Studio Compatible Applications Processor</b> 2nd processor for running pre-defined and/or customer created application software.
		Moss Green	MCi210	<b>Machine Control Studio Compatible Applications Processor (with Ethernet communications)</b> 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	<b>Single segment display option</b> Compact display with single character code drive status representation, node address setting and a push button reset
Keypad		Remote-Keypad RTC	<b>Remote LCD keypad option</b> 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)	<b>Drive encoder breakout kit</b> Provides screw terminal interface for encoder wiring.
Accessory		KI-Compact 485 adaptor (82700000020300)	<b>KI-Compact 485 adaptor</b> 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)	<b>SI-Option Mounting kit</b> 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



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



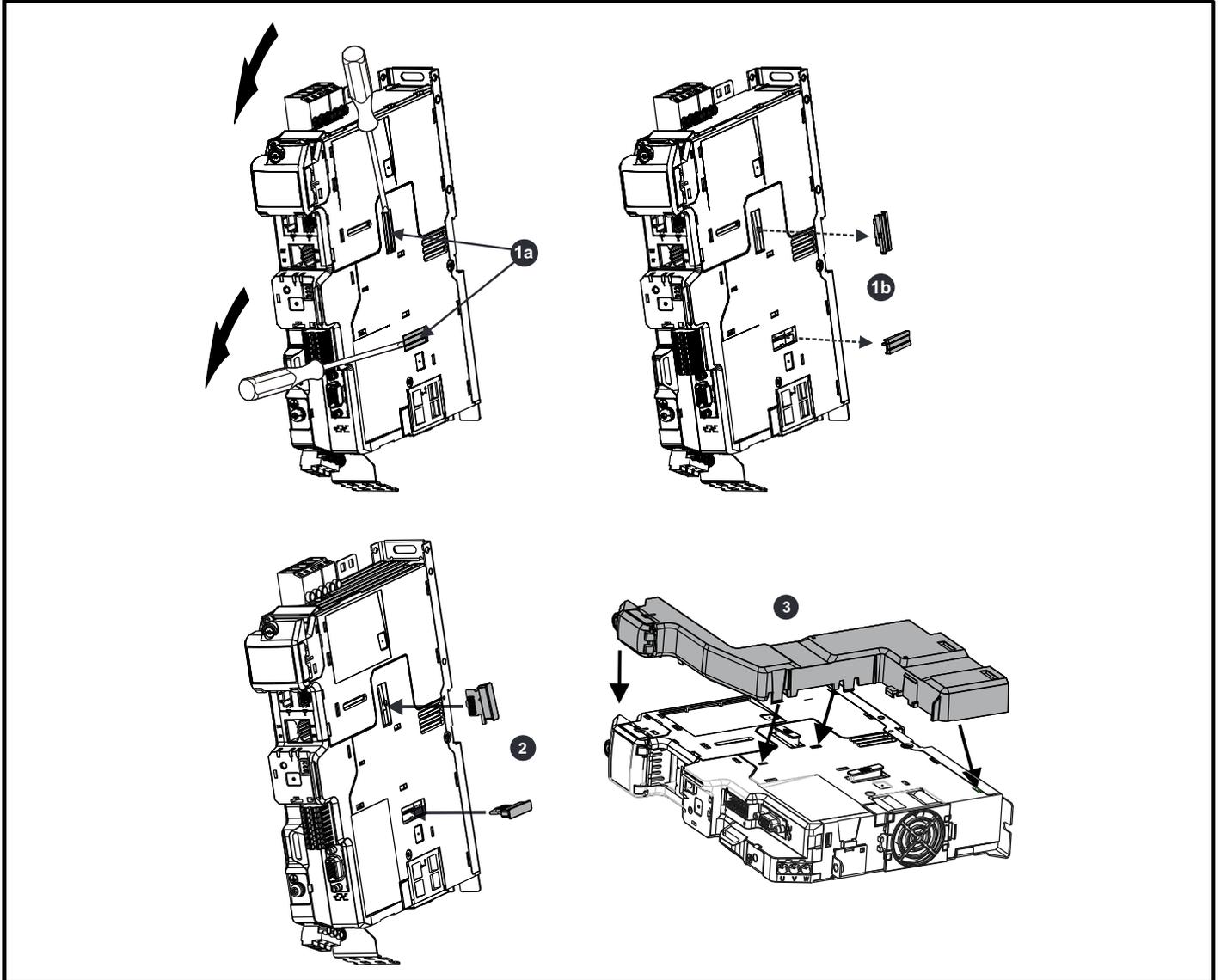
Care must be taken when handling the option module interface card to avoid contaminating the gold contacts. Gold contacts must not be touched directly, handle the interface card using the protective cover provided in the mounting kit.

CAUTION

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 15.

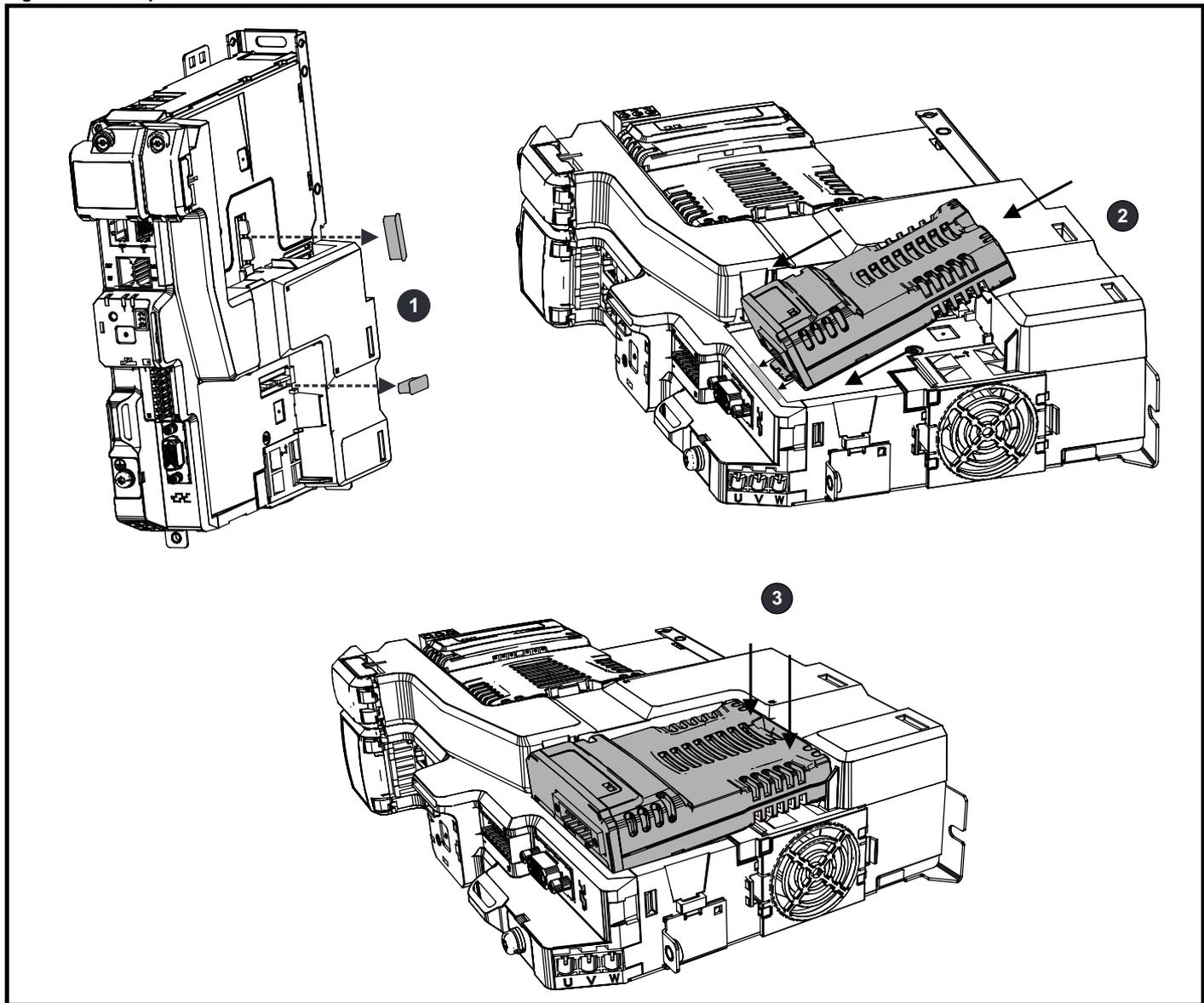
For fitting instructions, refer to Figure 3-1.

**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



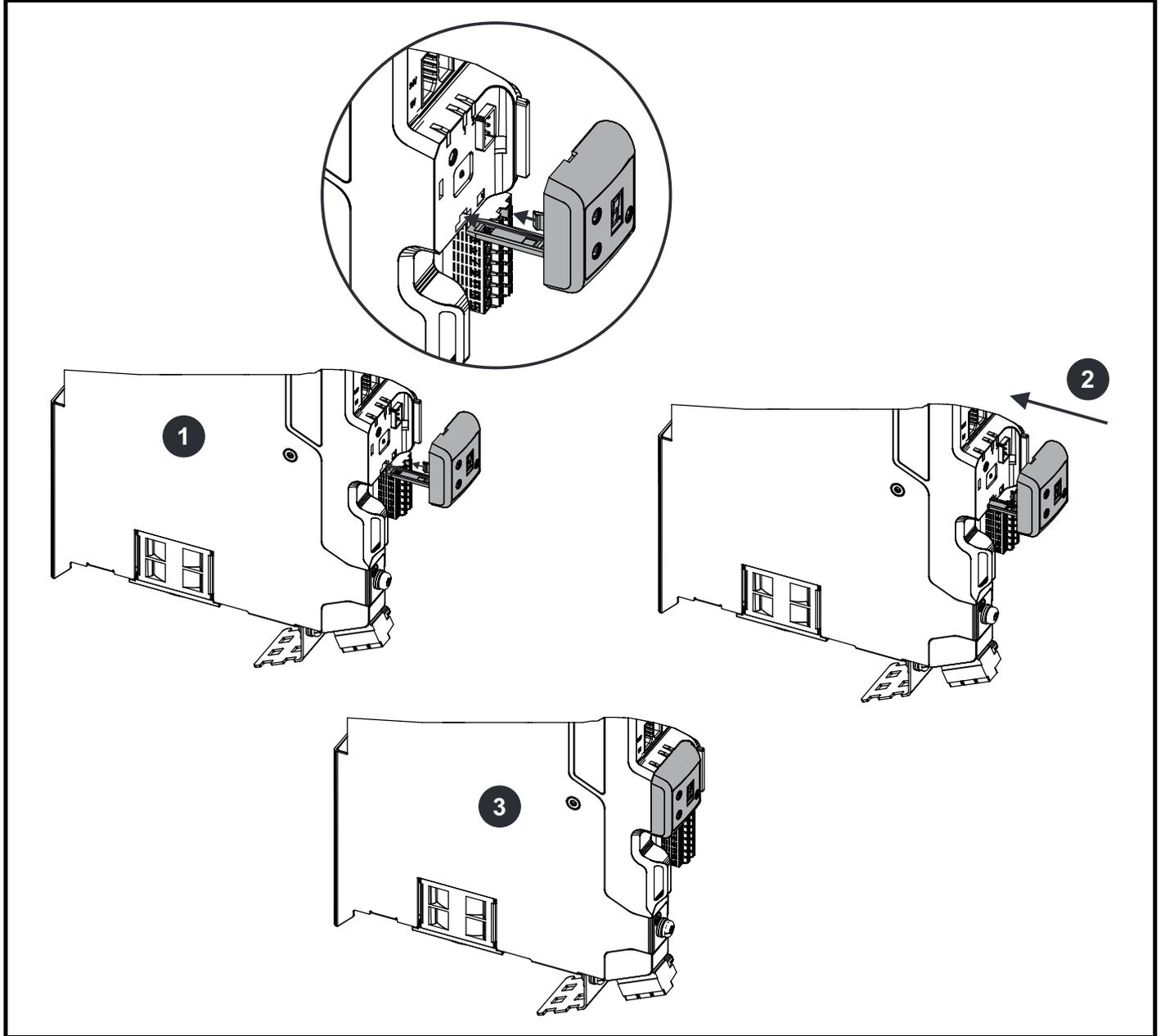
1. Remove the protective interface card cover.
2. Align and insert the option module tab into the slot on the drive plastic.
3. Once the option module tab is located into the slot on the drive, push down at the rear of the option module until it clicks into place.

**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

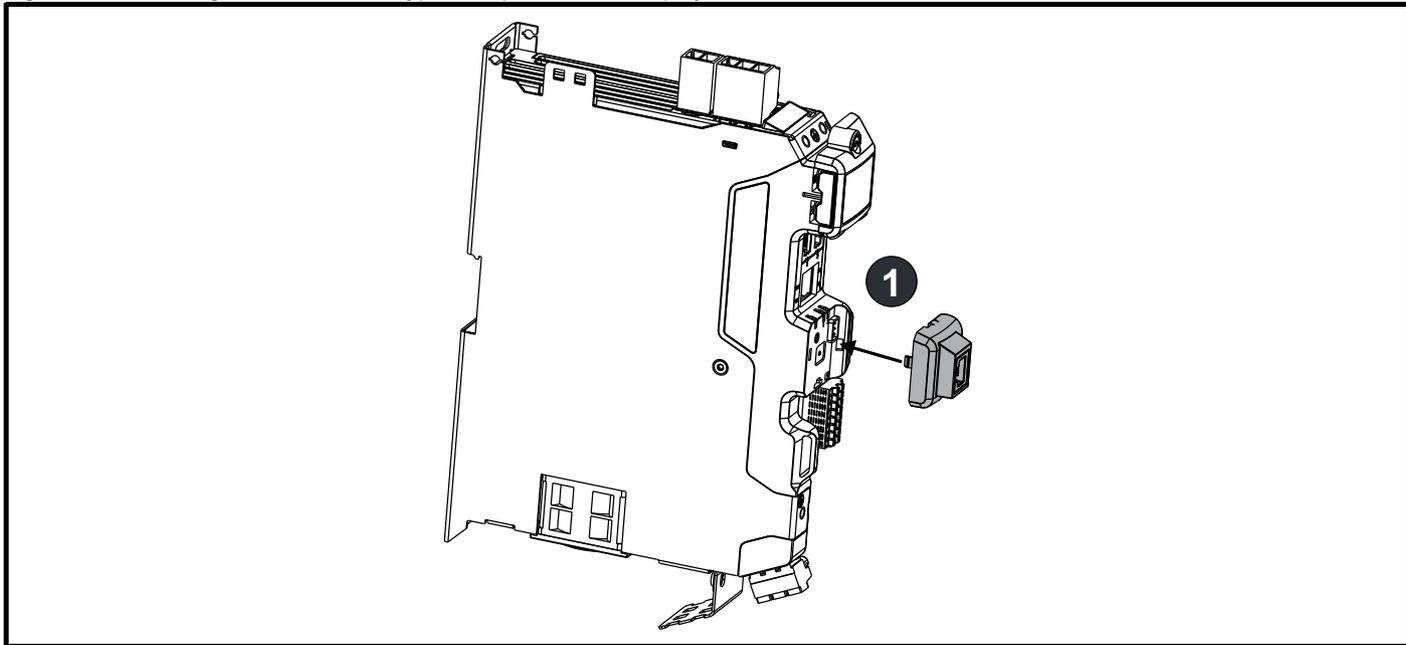


1. Align display tether with slot.
2. Slide the display and tether in the direction shown.
3. Push display until it clicks into position.

### 3.3 KI-Remote Keypad Adaptor installation

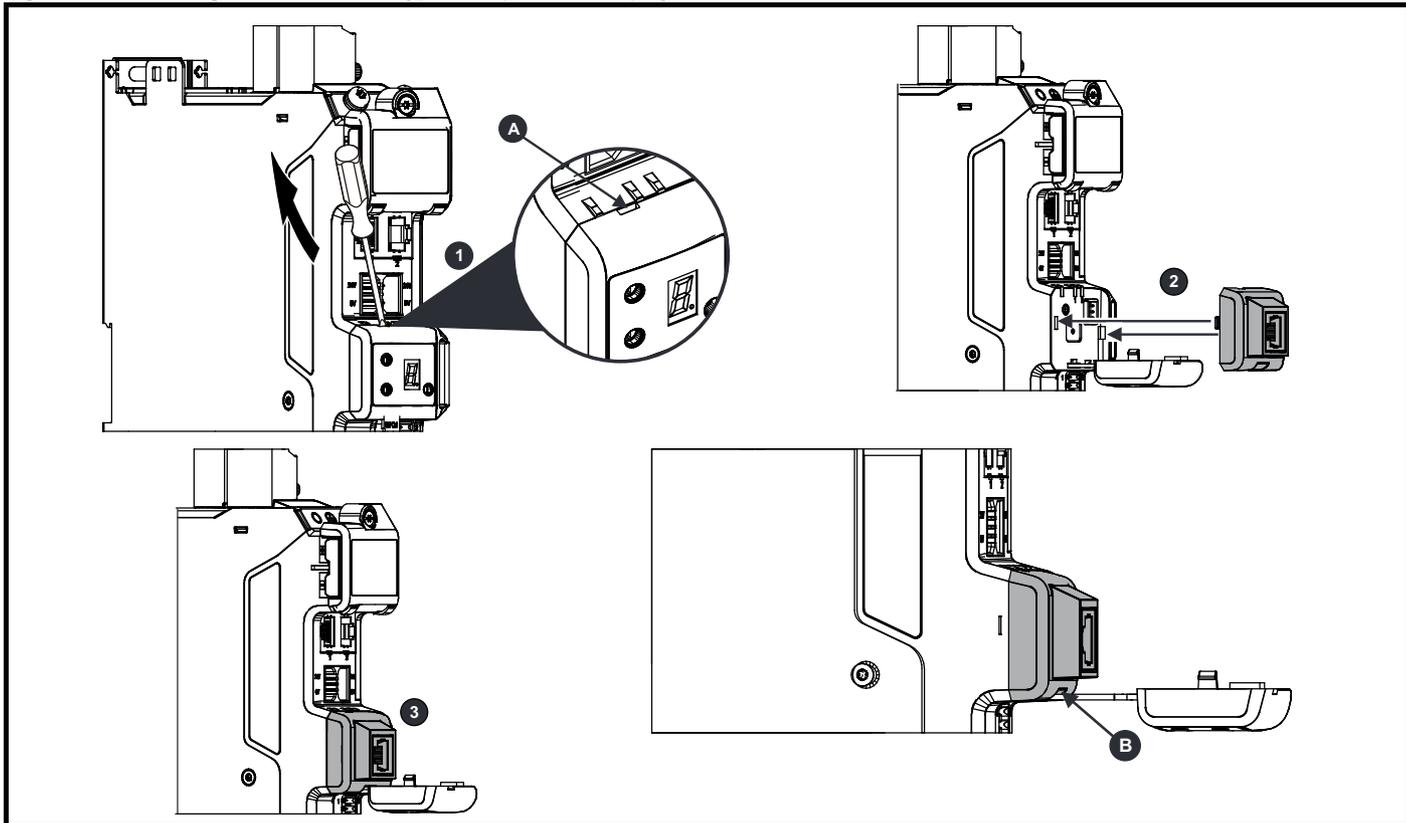
The M75X Remote Keypad Adaptor provides an EIA-485 port for permanent connection to a KI-Remote Keypad or the temporary attachment for PC tool connection. The KI-Remote Keypad Adaptor is available from the supplier of the drive. Refer to Table 2-4 *Additional options* on page 15.

**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**

<b>1</b>	<b>0V common</b>
<b>2</b>	<b>+24 Vdc</b>
<b>All frame sizes</b>	
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

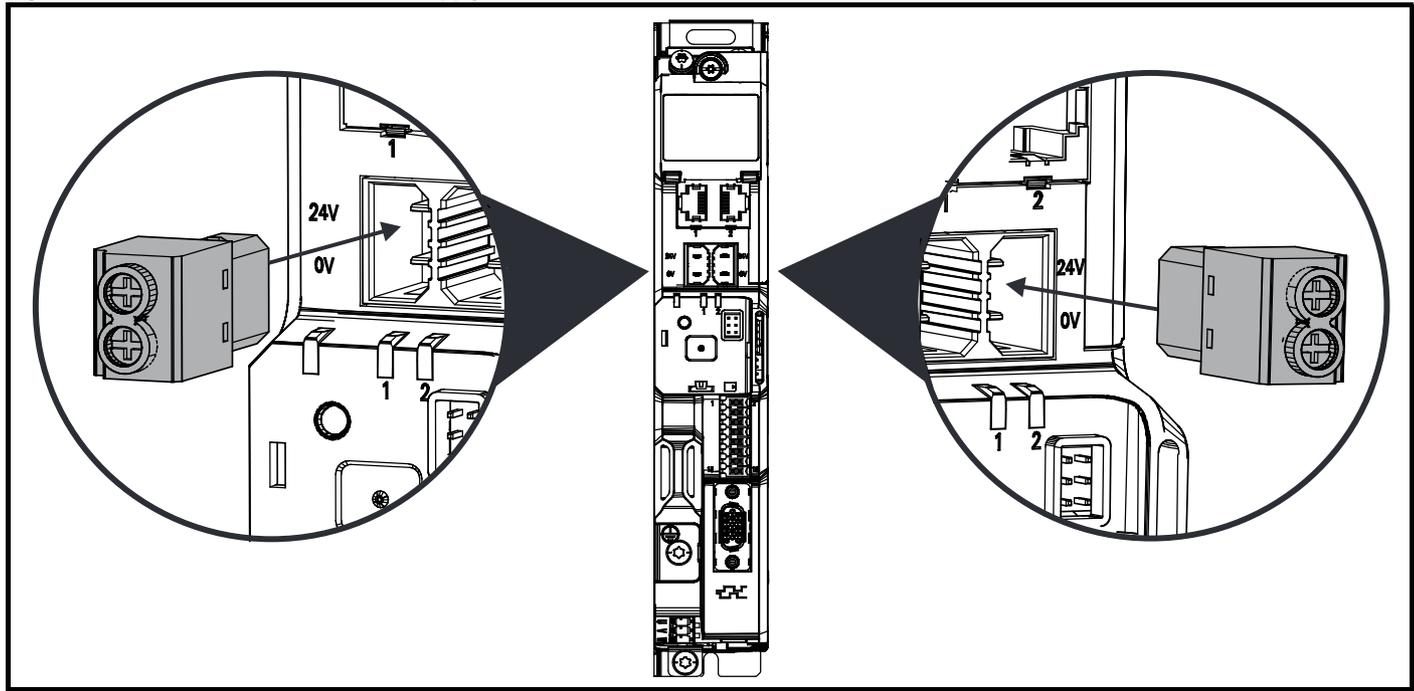
**Table 4-2 24 Vdc typical input current and power requirements**

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 Control connections

### 4.3.1 Digitax HD M75X control connections

Table 4-3 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.



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.



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).

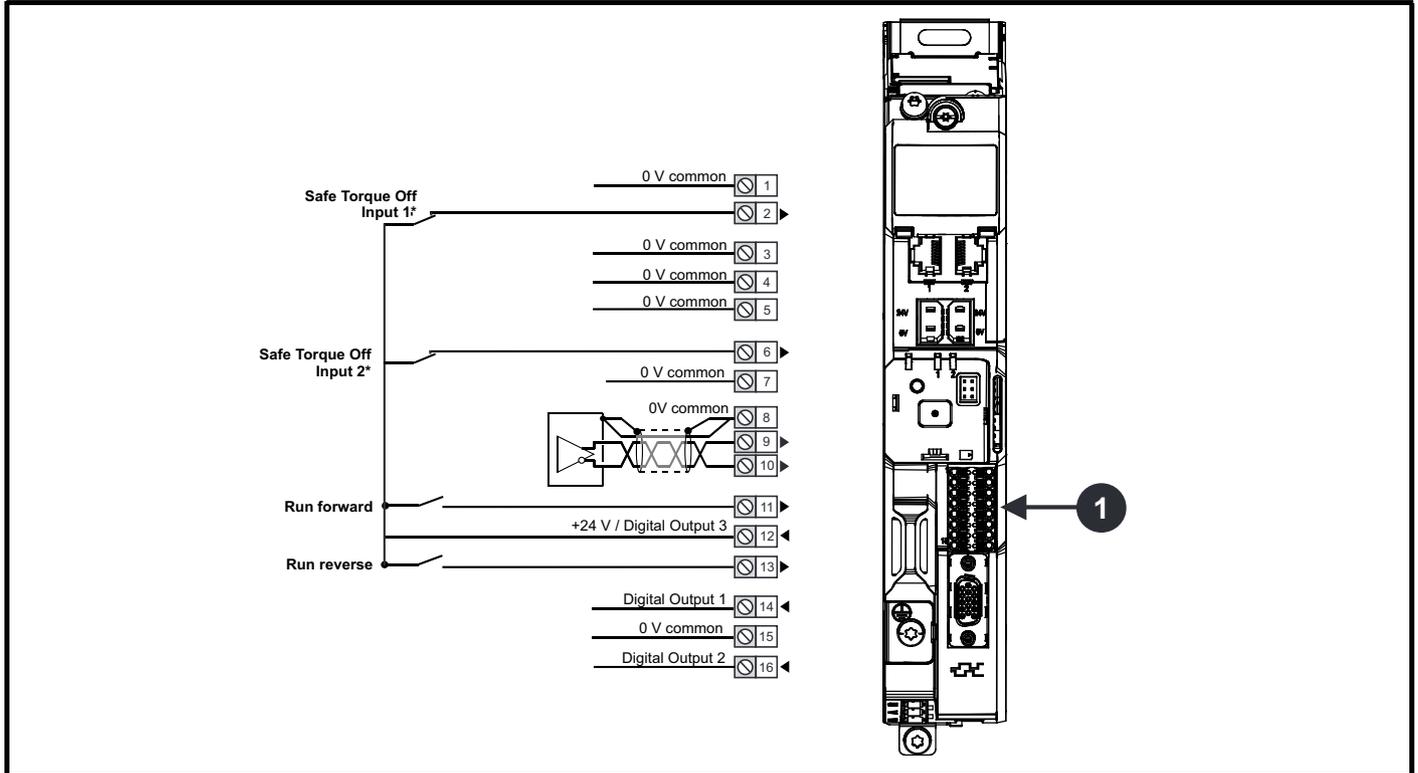
#### NOTE

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



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.

Figure 4-2 Default control terminal functions



1. Polarized signal connections.

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

### 4.3.2 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
<b>Function</b>	
<b>Common connection for all external devices. Internally connected to ground.</b>	

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

Refer to section 4.5 *Safe Torque Off (STO)* on page 30 for further information.

<b>Analog input</b>	
9	<b>Inverting input</b>
10	<b>Non-inverting input</b>
<b>Default function</b>	<b>Frequency/speed reference</b>
Type of input	Bipolar differential analog voltage
Mode controlled by:	Pr <b>07.007</b>
<b>Operating in Voltage mode</b>	
Full scale voltage range	$\pm$ 10 V $\pm$ 2 %
Maximum offset	$\pm$ 10 mV
Absolute maximum voltage range	$\pm$ 36 V relative to 0V
Absolute maximum differential input voltage	$\pm$ 36 V
Working common mode voltage range	$\pm$ 13 V relative to 0V
Input resistance	$\geq$ 100 k $\Omega$
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	$\sim$ 3 kHz
Resolution	12 bits (11 bits plus sign)
Sample / update period	250 $\mu$ s with destinations Pr <b>01.036</b> , Pr <b>01.037</b> , Pr <b>03.022</b> or Pr <b>04.008</b> 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	<b>Digital Input 4</b>
13	<b>Digital Input 5</b>
<b>Terminal 11 default function</b>	<b>RUN FORWARD input</b>
<b>Terminal 13 default function</b>	<b>RUN REVERSE input</b>
Type	Negative or positive logic digital inputs
Logic mode controlled by...	Pr <b>08.029</b>
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 $\pm$ 0.8 V (IEC 61131-2, type 1)
Sample / Update period	250 $\mu$ s when configured as an input with destinations Pr <b>06.035</b> or Pr <b>06.036</b> . 600 $\mu$ s when configured as an input with destination Pr <b>06.029</b> . 2 ms in all other cases.

12	<b>+24 V user output / Digital Output 3 (selectable)</b>
<b>Terminal 12 default function</b>	<b>+24 V user output</b>
Programmability	Can be switched on or off to act as a third digital output (positive logic only) by setting the source Pr <b>08.028</b> and source invert Pr <b>08.018</b>
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).

<b>14</b>	<b>Digital Output 1</b>
<b>Terminal 14 default function</b>	<b>AT ZERO SPEED output</b>
Type	Positive logic voltage source outputs
<b>Operating as an output</b>	
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)

<b>16</b>	<b>Digital Output 2</b>
<b>Terminal 16 default function</b>	<b>High current motor brake output</b>
Type	Positive logic voltage source outputs
<b>Operating as an output</b>	
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)

## 4.4 Position feedback connections

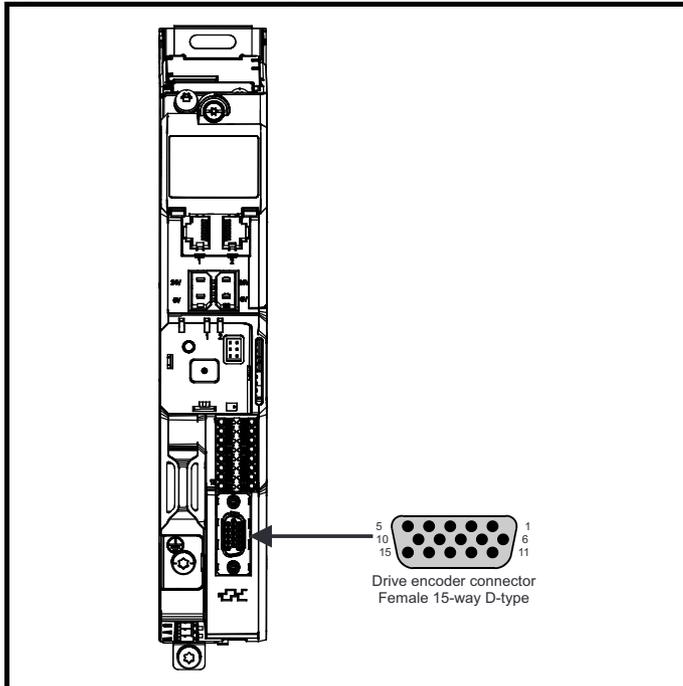
The following functions are provided via the 15-way high density D-type connector on the drive:

- 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 4-6.

### 4.4.1 Location of position feedback connector

Figure 4-3 Location of the position feedback



## 4.4.2 Compatible position feedback devices

Table 4-4 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 4-5 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 4-6 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 4-6 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.

### 4.4.3 Position feedback connection details

Table 4-7 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 4-8 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* <sup>1</sup>			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* <sup>1</sup>			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* <sup>1</sup>			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\	

\*<sup>1</sup> 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.

#### 4.4.4 Position feedback terminal specifications

<b>1</b>	<b>A,F, Cosref, Data, Cos H</b>
<b>2</b>	<b>A\,F\ Cosref\, Data\, Cos L</b>
<b>AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5)</b>	
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
<b>SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15), SC BiSS (17)</b>	
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 4-9.
Maximum applied differential voltage and common mode voltage range	±4 V
<b>Resolution:</b> The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-9 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port.	
<b>EnDat (8), SSI (10), BiSS (13)</b>	
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
<b>Resolver (14)</b>	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 - 8 kHz
Input voltage	0.6 Vrms
Minimum impedance	85 Ω
<b>Common to All</b>	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

<b>3</b>	<b>B, D, R Sinref, Clock, Sin H</b>
<b>4</b>	<b>B\, D\, R\, Sinref\, Clock\, Sin L</b>
<b>AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5)</b>	
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
<b>SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC SC (15), SC BiSS (17)</b>	
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 4-9.
Maximum applied differential voltage and common mode voltage range	±4 V
<b>Resolution:</b> The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-9 shows the number of bits of interpolated information at different frequencies and with different voltage levels at the drive encoder port.	
<b>EnDat (8), SSI (10), BiSS (13)</b>	
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
<b>Resolver (14)</b>	
Type	2 Vrms sinusoidal signal
Operating Frequency	6 - 8 kHz
Input voltage	0.6 Vrms
Minimum impedance	85 Ω
<b>Common to All</b>	
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.

<b>5</b>	<b>Z, Data, Freeze, Ref H</b>
<b>6</b>	<b>ZI, DataI, FreezeI, Ref L</b>
<b>AB (0), FD (1), FR (2), AB Servo (3), FD Servo(4), FR Servo (5), SC SC (15)</b>	
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
<b>SC Hiperface (7), SC EnDat (9), SC SSI (11), SC Servo (12), SC BiSS (17)</b>	
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
<b>EnDat (8), SSI (10)</b>	
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
<b>Resolver (14)</b>	
Type	Differential voltage
Nominal voltage	0 – 2 Vrms depending on turns ratio
Operating frequency	6 - 8 KHz
Minimum impedance	85 Ω
<b>Common to All</b>	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

<b>7</b>	<b>U, C, Not used, Not used</b>
<b>8</b>	<b>UI, CI, Not used, Not used</b>
<b>AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)</b>	
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
<b>SC SC (15)</b>	
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 4-9.
Maximum applied differential voltage and common mode voltage range	±4 V
<b>EnDat (8), SSI (10), BiSS (13)</b>	
Not used	
<b>Resolver (14)</b>	
Not used	
<b>Common to All</b>	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

<b>9</b>	<b>V, D, Not used, Not used</b>
<b>10</b>	<b>VI, DI, Not used, Not used</b>
<b>AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)</b>	
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
<b>SC SC (15)</b>	
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 4-9.
Maximum applied differential voltage and common mode voltage range	±4 V
<b>EnDat (8), SSI (10), BiSS (13)</b>	
Not used	
<b>Resolver (14)</b>	
Not used	
<b>Common to All</b>	
Absolute maximum applied voltage relative to 0V	-9 V to 14 V
Maximum differential voltage between terminals (with termination resistors enabled)	±6 V

<b>11</b>	<b>W, Clock, Not used, Not used</b>
<b>12</b>	<b>W, Clock, Not used, Not used</b>
<b>AB Servo (3), FD Servo(4), FR Servo (5), SC Servo (12)</b>	
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
<b>SC EnDat (9), SC SSI (11)</b>	
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 4-9.
Maximum applied differential voltage and common mode voltage range	±4 V
<b>EnDat (8), SSI (10), BiSS (13)</b>	
Not used	
<b>Resolver (14)</b>	
Not used	
<b>Common to All</b>	
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

<b>13</b>	<b>Feedback device supply</b>
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 <b>03.036</b> . 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.	

<b>14</b>	<b>0V Common</b>
-----------	------------------

<b>15</b>	<b>Motor thermistor input</b>
Thermistor type is selected in <i>P1 Thermistor Type</i> ( <b>03.118</b> ).	

#### Sincos encoder resolution

The sine wave frequency can be up to 500 kHz but the resolution is reduced at high frequency. Table 4-9 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 4-9 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

## 4.5 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)	$4.21 \times 10^{-11}$ 1/h	<1 %
Low demand mode of operation (not EN 61800-5-2)		
PFDavg	$3.68 \times 10^{-6}$	< 1 %

According to EN ISO 13849-1

Type	Value	Classification
Category	4	
Performance Level (PL)	e	
MTTF <sub>D</sub> (STO1)	>2500 years	High
MTTF <sub>D</sub> (STO2)	>2500 years	High
MTTFD (Single channel STO)	>2500 years	High
DC <sub>avg</sub>	≥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.



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



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



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



It is essential to observe the maximum permitted voltage of 5 V for a safe low (disabled) state of Safe Torque Off. The connections to the drive must be arranged so that voltage drops in the 0 V wiring cannot exceed this value under any loading condition. It is strongly recommended that the Safe Torque Off 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 via a KI-Remote keypad adaptor.

#### 5.1.1 KI-Compact Display

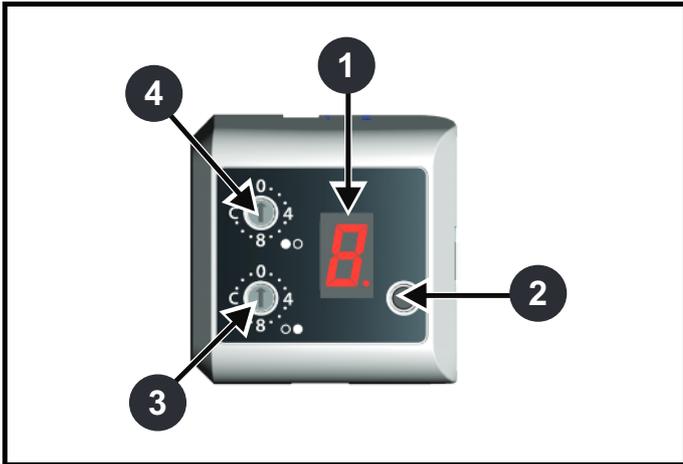
The M75X display provides the following features:

- Displays drive status information.
- Allows the drive to be identified with a unique EtherCAT station alias configured 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 14.

#### 5.1.2 Drive state representation

Figure 5-1 KI-Compact Display



1. Single Character display.
2. Reset switch.
3. Rotary dial for station alias setting (least significant).
4. Rotary dial for station alias 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 to either of two 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 Station alias configuration

A station alias can be used to uniquely identify a particular slave on the EtherCAT network, however it is unnecessary for a user to set a station alias in order to initiate EtherCAT communications.

When a Digitax HD M753 is fitted with a KI-Compact Display the rotary dials on the display allow for an EtherCAT station alias to be configured when set to a non zero value. The station alias feature will also need to be configured in the EtherCAT master.

The station alias setting configured using the KI-Compact Display is an 8 bit value (decimal 1 to 255). The most significant nibble is set by adjusting the top dial and the 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 Table 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 configured station alias 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 station alias setting in decimal, dial settings and station alias setting are separated with a hyphen (-).

Once the desired dial configurations have been set, the KI-Compact Display will transfer the value to Pr **11.017 Keypad defined node address** and if the value is not zero it will be updated as the station alias in the EtherCAT background. In this case Pr **17.035 Configured station alias** is ignored.

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 station alias 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**

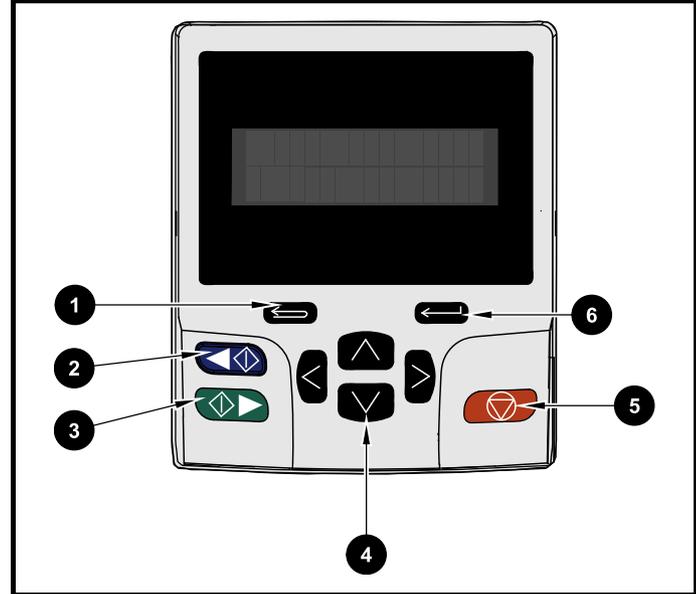
The KI-Compact Display can be installed/removed while the drive is powered. A delay of 10 seconds should be maintained following power up or following a node address dial adjustment before the KI-Compact Display can be removed from the drive, to ensure correct transfer of station alias configuration 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 5-3.

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:

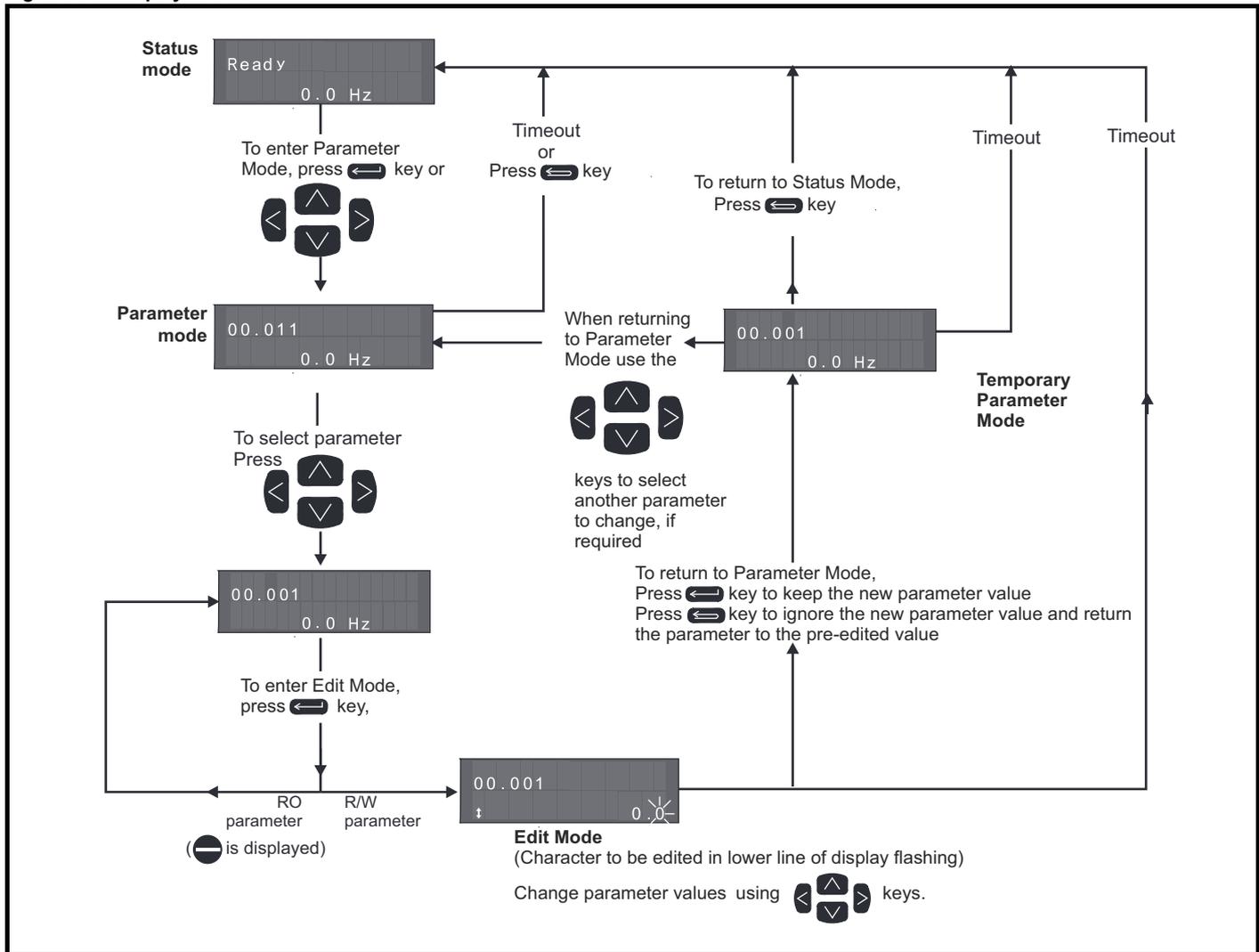
- Navigation Keys - Used to navigate the parameter structure and change parameter values.
- Enter / Mode button - Used to toggle between parameter edit and view mode.
- Escape / Exit button - Used to exit from parameter edit or view mode. In parameter edit mode, if parameter values are edited and the 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**

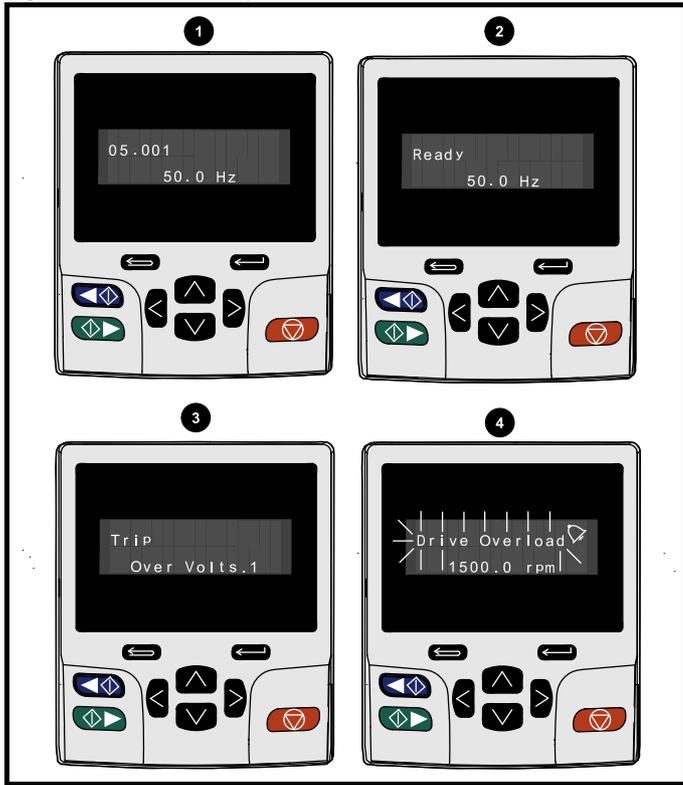
In 'parameter mode':

- 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 13-4 *Trip indications* on page 225.

**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**

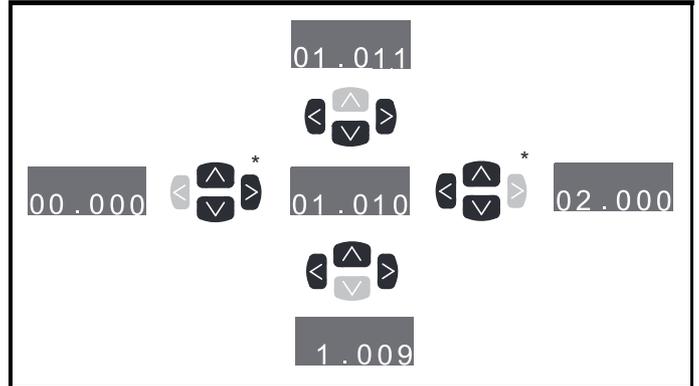
For new parameter-values to apply after the line power supply to the drive is interrupted, new values must be saved. Refer to section 5.7 *KL-Remote Keypad saving parameters* on page 39.

## 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**



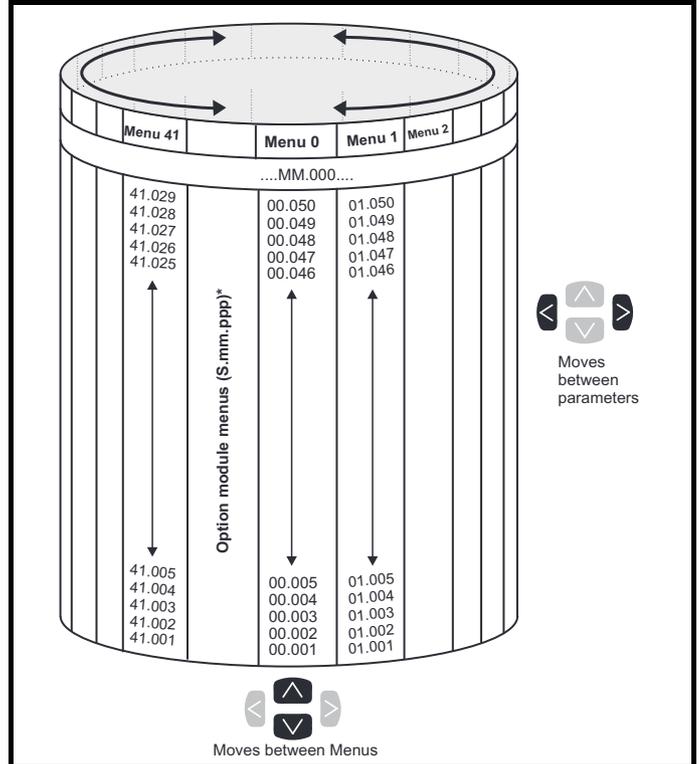
\* Can only be used to move between menus if all menus have been enabled (Pr **00.049**). Refer to section 5.9 *Parameter access level and security* on page 39.

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.

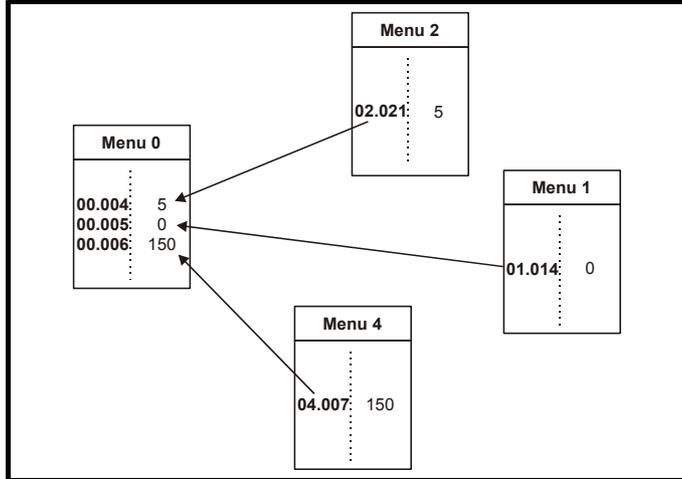
## 5.4 Menu 0

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 41.

**Figure 5-8 Menu 0 copying**



## 5.5 Advanced menus

The advanced menu 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**
Slot 3	Slot 3 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
<b>Brake Resistor</b>	Brake resistor overload. <i>Braking Resistor Thermal Accumulator</i> (10.039) in the drive has reached 75.0 % of the value at which the drive will trip.
<b>Motor Overload</b>	<i>Motor Protection Accumulator</i> (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is > 100 %.
<b>Ind Overload</b>	Regen inductor overload. <i>Inductor Protection Accumulator</i> (04.019) in the drive has reached 75.0 % of the value at which the drive will trip and the load on the drive is > 100 %.
<b>Drive Overload</b>	Drive over temperature. <i>Percentage Of Drive Thermal Trip Level</i> (07.036) in the drive is greater than 90 %.
<b>Auto Tune</b>	The autotune procedure has been initialized and an autotune in progress.
<b>Limit Switch</b>	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
<b>Inhibit</b>	The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr <b>06.015</b> is set to 0. The other conditions that can prevent the drive from enabling are shown as bits in <i>Enable Conditions</i> (06.010).	Disabled
<b>Ready</b>	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
<b>Stop</b>	The drive is stopped / holding zero speed.	Enabled
<b>Run</b>	The drive is active and running.	Enabled
<b>Scan</b>	The drive is enabled in Regen mode and is trying to synchronize to the supply.	Enabled
<b>Supply Loss</b>	Supply loss condition has been detected.	Enabled
<b>Deceleration</b>	The motor is being decelerated to zero speed / frequency because the final drive run has been deactivated.	Enabled
<b>dc injection</b>	The drive is applying dc injection braking.	Enabled
<b>Position</b>	Positioning / position control is active during an orientation stop.	Enabled
<b>Trip</b>	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
<b>Active</b>	The Regen unit is enabled and synchronized to the supply.	Enabled
<b>Under Voltage</b>	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled
<b>Heat</b>	The motor pre-heat function is active.	Enabled
<b>Phasing</b>	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
<b>Booting</b>	<b>Parameters</b>	Parameters are being loaded
Drive parameters are being loaded from an SD Card.		
<b>Booting</b>	<b>User Program</b>	User program being loaded
User program is being loaded from an SD Card to the drive.		
<b>Booting</b>	<b>Option Program</b>	User program being loaded
User program is being loaded from an SD Card to the option module in slot X.		
<b>Writing To</b>	<b>NV Card</b>	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.		
<b>Waiting For</b>	<b>Power System</b>	Waiting for power stage
The drive is waiting for the processor in the power stage to respond after power-up.		
<b>Waiting For</b>	<b>Options</b>	Waiting for an option module
The drive is waiting for the options modules to respond after power-up.		
<b>Uploading From</b>	<b>Options</b>	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 & 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 (11.044)	Access level	User security	Menu 0 status	Advanced menu status
0	Menu 0	Open	RW	Not visible
		Closed	RO	Not visible
1	All Menus	Open	RW	RW
		Closed	RO	RO
2	Read-only Menu 0	Open	RO	Not visible
		Closed	RO	Not visible
3	Read-only	Open	RO	RO
		Closed	RO	RO
4	Status only	Open	Not visible	Not visible
		Closed	Not visible	Not visible
5	No access	Open	RW	Not visible
		Closed	Not visible	Not visible

The default settings of the drive are Parameter Access Level Menu 0 and user Security Open i.e. read / write access to Menu 0 with the advanced menus not visible.

### 5.9.1 User Security Level / Access Level

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

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

### 5.9.2 Changing the User Security Level /Access Level

The security level is determined by the setting of Pr **00.049** or Pr **11.044**. The Security Level can be changed through the 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.

## 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 12.1 *Parameter ranges and Variable minimum/maximums* on page 139.

### 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 %			165.0 %	250 %		RW	Num		RA		US
00.007 Open-loop Control Mode {05.014}	Ur S (0), Ur I (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 <sup>2</sup> /rad				0.10 s <sup>2</sup> /rad	1.00 s <sup>2</sup> /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	

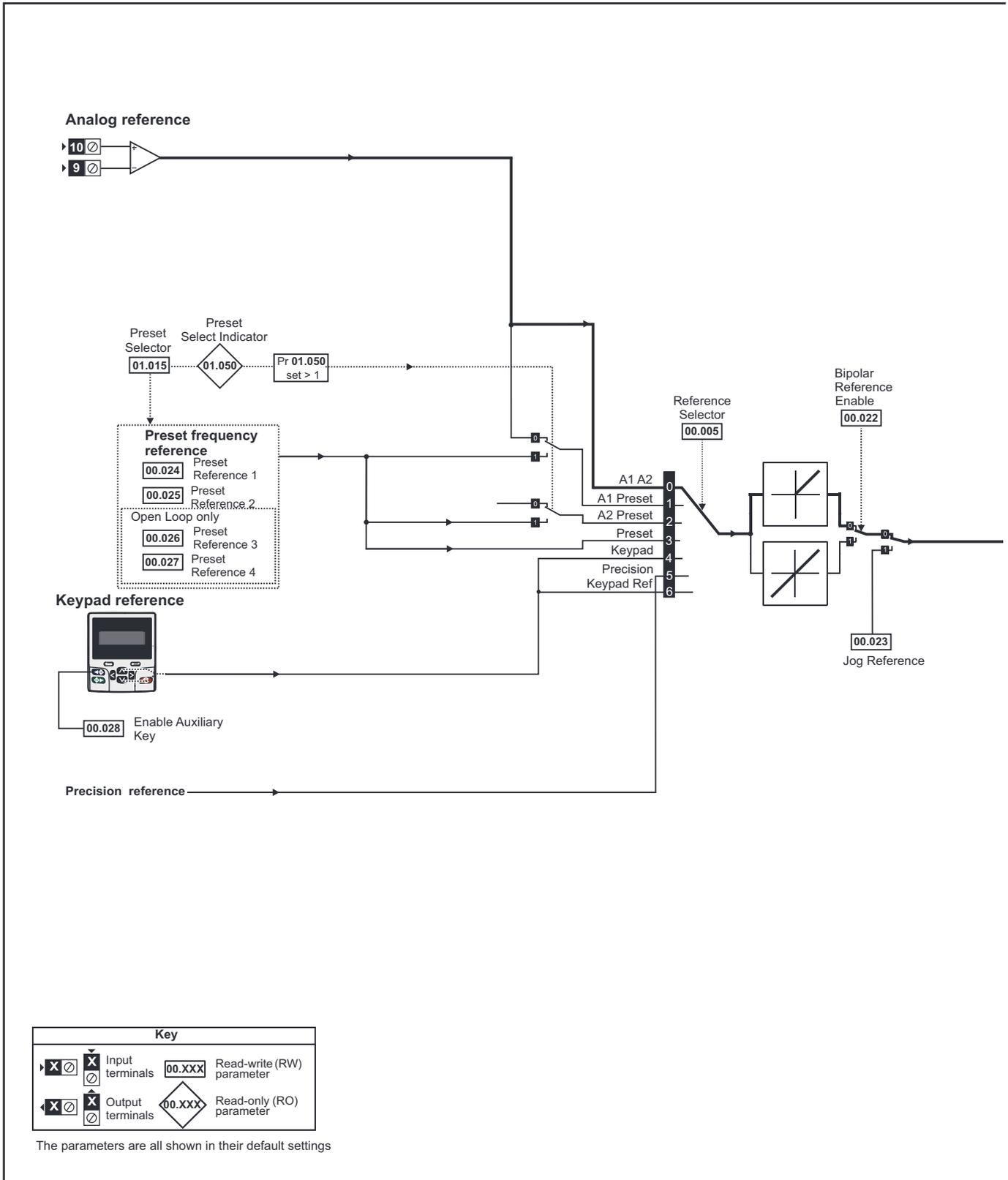
Parameter	Range			Default			Type						
	OL	RFC-A	RFC-S	OL	RFC-A	RFC-S							
00.030	Parameter Cloning	{11.042}	None (0), Read (1), Program (2), Auto (3), Boot (4)			None (0)			RW	Txt		NC	US
00.031	Drive Rated Voltage	{11.033}	200 V (0), 400 V (1)						RO	Txt	ND	NC	PT
00.032	Maximum Heavy Duty Rating	{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 <sup>31</sup> -1			0			RW	Num	ND	NC	PT
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), Regen (4)			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 999999999						RO	Num	ND	NC	PT
00.051	Action On Trip Detection	{10.037}	0 to 31			0			RW	Bin			US
00.053	Motor Thermal Time Constant 1	{04.015}	1.0 to 3000.0 s			89.0 s			RW	Num			US

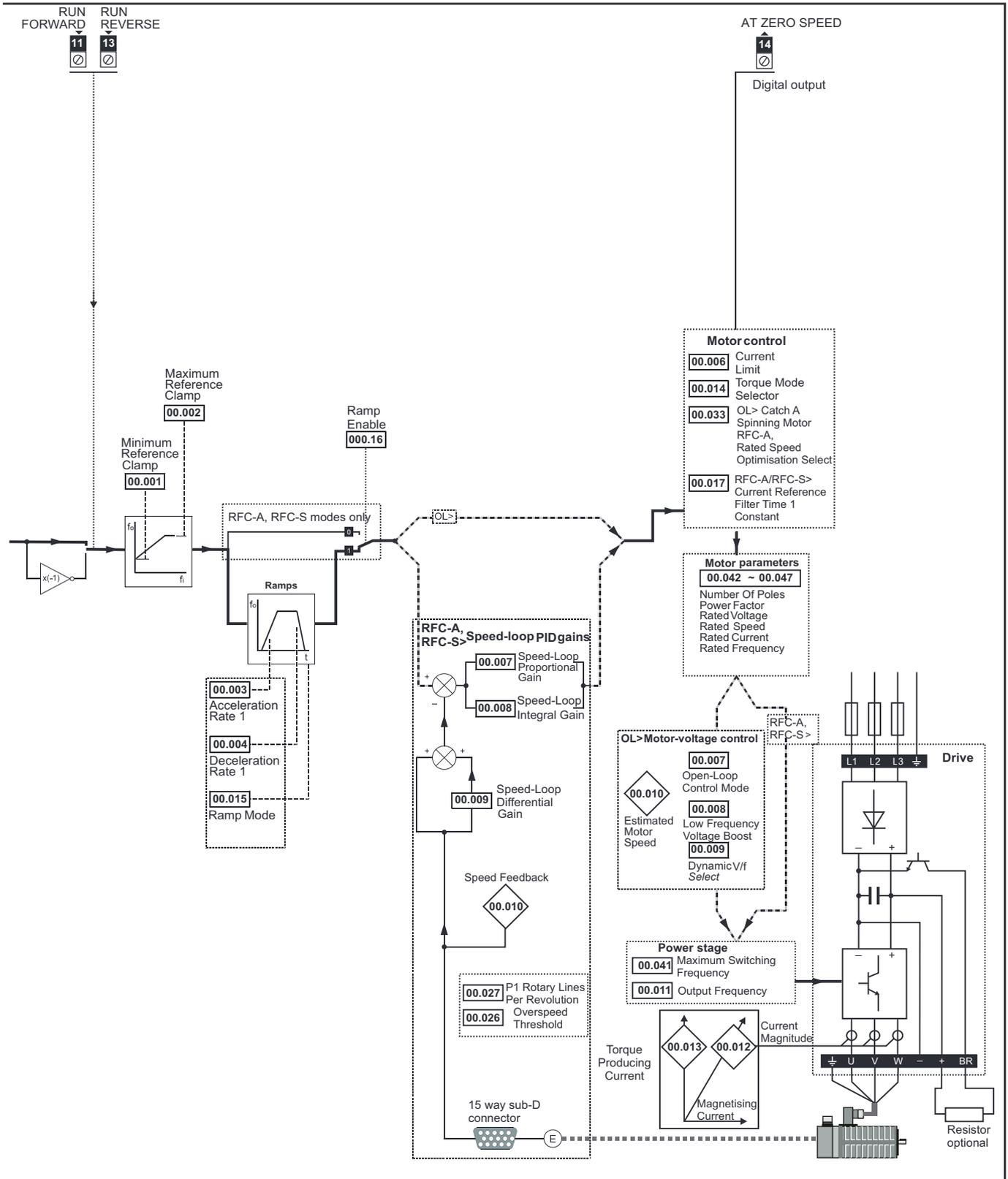
\* Following a rotating autotune Pr 00.043 {05.010} is continuously written by the drive, calculated from the value of Stator Inductance (Pr 05.025). To manually enter a value into Pr 00.043 {05.010}, Pr 05.025 will need to be set to 0. Please refer to the description of Pr 05.010 in the *Parameter Reference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

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	<b>Basic parameters</b>	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	Advanced parameters	Diagnostics	UL listing information
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Figure 6-1 Menu 0 logic diagram





## 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 <i>Under Voltage Active</i> (Pr <b>10.016</b> ) is not active and <i>Low Under Voltage Threshold Select</i> mode (Pr <b>06.067</b> = 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 10 *SD Card Operation* on page 130 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
<b>RW</b>	Read/Write: can be written by the user
<b>RO</b>	Read only: can only be read by the user
<b>Bit</b>	1 bit parameter. 'On' or 'Off' on the display
<b>Num</b>	Number: can be uni-polar or bi-polar
<b>Txt</b>	Text: the parameter uses text strings instead of numbers.
<b>Bin</b>	Binary parameter
<b>IP</b>	IP Address parameter
<b>Mac</b>	Mac Address parameter
<b>Date</b>	Date parameter
<b>Time</b>	Time parameter
<b>Chr</b>	Character parameter
<b>FI</b>	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
<b>DE</b>	Destination: This parameter selects the destination of an input or logic function.
<b>RA</b>	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.
<b>ND</b>	No default: The parameter is not modified when defaults are loaded
<b>NC</b>	Not copied: not transferred to or from non-volatile media during copying.
<b>PT</b>	Protected: cannot be used as a destination.
<b>US</b>	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
<b>PS</b>	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	
<b>OL</b>	↕ VM_NEGATIVE_REF_CLAMP1 Hz / rpm						0.0 Hz	
<b>RFC-A</b>							0.0 rpm	
<b>RFC-S</b>								

(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	
<b>OL</b>	↕ VM_POSITIVE_REF_CLAMP1 Hz / rpm						50Hz default: 50.0 Hz 60Hz default: 60.0 Hz	
<b>RFC-A</b>							50Hz default:1500.0 rpm 60Hz default:1800.0 rpm	
<b>RFC-S</b>							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	
<b>OL</b>	↕ 0.0 to VM_ACCEL_RATE s/100 Hz						5.0 s/100 Hz	
<b>RFC-A</b>							2.000 s/1000 rpm	
<b>RFC-S</b>							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	
<b>OL</b>	↕ 0.0 to VM_ACCEL_RATE s/100 Hz						10.0 s/100 Hz	
<b>RFC-A</b>							2.000 s/1000 rpm	
<b>RFC-S</b>							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	
<b>OL</b>	↕ A1 A2 (0), A1 Preset (1), A2 Preset (2), Preset (3), Keypad (4), Precision (5), Keypad Ref (6)						A1 Preset (1)	
<b>RFC-A</b>								
<b>RFC-S</b>								

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
OL	165 %
RFC-A	0.0 to VM_MOTOR1_CURRENT_LIMIT %
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:

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

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:

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

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
OL	Ur S (0), Ur (1), Fixed (2), Ur Auto (3), Ur I (4), Square (5)
RFC-A	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 12-4 on page 156 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
OL	0.0 to 25.0 %
RFC-A	0.10 s <sup>2</sup> /rad
RFC-S	1.00 s <sup>2</sup> /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 12-4 on page 156 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
OL	Off (0) or On (1)
RFC-A	0.00000 to 0.65535 1/rad
RFC-S	0.00000 1/rad

#### Open-loop

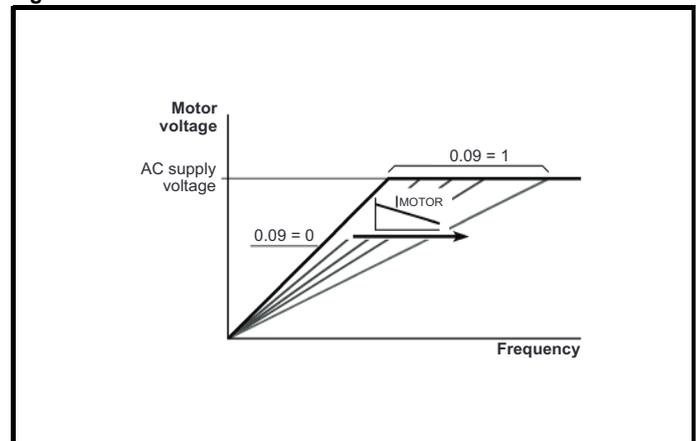
Set Pr **00.009 (05.013)** at 0 when the V/f characteristic applied to the motor is to be fixed. It is then based on the rated voltage and frequency of the motor.

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 12-4 *Menu 3 RFC-A, RFC-S logic diagram* on page 156 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	↕	VM_SPEED rpm		⇒					
RFC-S									

### 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	↕	VM_SPEED_FREQ_REF Hz		⇒					
RFC-A									
RFC-S	↕	0 to 65535		⇒					

### Open-loop and RFC-A

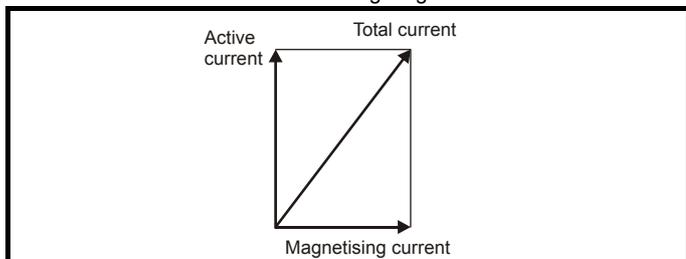
Pr **00.011** displays the frequency at the drive output.

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

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	↕	VM_DRIVE_CURRENT A		⇒					
RFC-S									

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	↕	0 to 5		⇒	0				
RFC-S									

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	↕	Fast (0), Standard (1)		⇒	Fast (0)				
RFC-S									

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

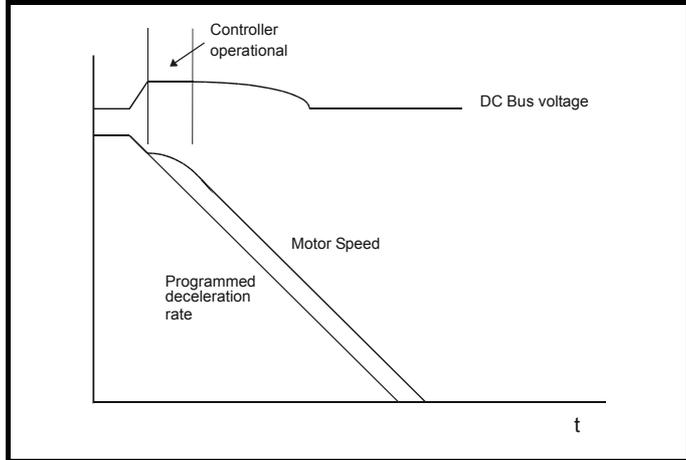
### 0: Fast ramp

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
OL	↕
RFC-A	↕
RFC-S	↕
	Off (0) or On (1)
	⇒
	On (1)

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
RFC-A	↕
RFC-S	↕
	0.0 to 25.0 ms
	⇒
	0.0 ms

### 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	
RFC-A	↕
RFC-S	↕
	None (0), Temperature (1), Temp and short (2)
	⇒
	None (0)
	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
OL	
RFC-A	↕
RFC-S	↕
	OFF (0) or On (1)
	⇒
	OFF (0)

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
OL	↕
RFC-A	↕
RFC-S	↕
	0.0 to 400.0 Hz
	⇒
	0.0
	0.0 to 4000.0 rpm
	⇒
	0.0

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 <b>00.001</b> Minimum reference clamp	No
Pr <b>00.002</b> Maximum reference clamp	Yes

00.024 {01.021} Preset Reference 1	
RW	Num
OL	
RFC-A	↕
RFC-S	↕
	VM_SPEED_FREQ_REF
	⇒
	0.0

00.025 {01.022} Preset Reference 2	
RW	Num
OL	
RFC-A	↕
RFC-S	↕
	VM_SPEED_FREQ_REF
	⇒
	0.0

<b>00.026 {01.023}</b>	<b>Preset Reference 3 (OL)</b>												
<b>00.026 {03.008}</b>	<b>Overspeed Threshold (RFC)</b>												
RW	Num											US	
<b>OL</b>	↕	VM_SPEED_FREQ_REF Hz											
<b>RFC-A</b>	↕	0 to 40000 rpm											0.0
<b>RFC-S</b>													

**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.

<b>00.027 {01.024}</b>	<b>Preset Reference 4 (OL)</b>												
<b>00.027 {03.034}</b>	<b>P1 Rotary Lines Per Revolution (RFC)</b>												
RW	Num											US	
<b>OL</b>	↕	VM_SPEED_FREQ_REF Hz											0.0
<b>RFC-A</b>	↕	1 to 100000											1024
<b>RFC-S</b>													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.

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

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

<b>00.029 {11.036}</b>	<b>NV Media Card File Previously Loaded</b>												
RO	Num						NC	PT					
<b>OL</b>	↕	0 to 999											
<b>RFC-A</b>													
<b>RFC-S</b>													

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

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

\* 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 10 *SD Card Operation* on page 130.

<b>00.031 {11.033}</b>	<b>Drive Rated Voltage</b>												
RO	Txt							ND	NC	PT			
<b>OL</b>	↕	200 V (0), 400 V (1)											
<b>RFC-A</b>													
<b>RFC-S</b>													

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

<b>00.032 {11.032}</b>	<b>Maximum Heavy Duty Rating</b>												
RO	Num							ND	NC	PT			
<b>OL</b>	↕	0.000 to 99999.999 A											
<b>RFC-A</b>													
<b>RFC-S</b>													

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

<b>00.033 {06.009}</b>	<b>Catch A Spinning Motor (OL)</b>												
<b>00.033 {05.016}</b>	<b>Rated Speed Optimisation Select (RFC-A)</b>												
RW	Txt												US
<b>OL</b>	↕	Disable (0), Enable (1), Fwd Only (2), Rev Only (3)											Disable (0)
<b>RFC-A</b>	↕	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 <sup>31</sup> -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.

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

00.039 {04.014}		Current Controller Ki Gain											
RW	Num												US
OL	↕												40
RFC-A	↕	0 to 30000										⇒	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										⇒	
RFC-A	↕	0 to 4										⇒	0
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 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 92, 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								

### 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	↕ VM_AC_VOLTAGE_SET	↔	0 to	↔	200 V drive: 230 V 50Hz default 400 V drive: 400 V 60Hz default 400 V drive: 460 V
RFC-A					
RFC-S					

Enter the value from the rating plate of the motor.

00.045 {05.008} Rated Speed		RW	Num	US
OL	↕ 0.00 to 33000.00 rpm	↔	0 to 33000 rpm	↔ 50 Hz default: 1500 rpm 60 Hz default: 1800 rpm
RFC-A				
RFC-S				

#### 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	↕ 0.000 to VM_RATED_CURRENT	↔		↔	Maximum Heavy Duty Rating (00.032)
RFC-A					
RFC-S					

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

00.047 {05.006} Rated Frequency (OL, RFC-A)		RW	Num	US
OL	↕ 0.0 to 550.0 Hz	↔	0.0 to 550.0 Hz	↔ 50 Hz default: 50.0 Hz 60 Hz default: 60.0 Hz
RFC-A				
RFC-S				

#### 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		Menu 0 (0), All Menus (1), Read-only Menu 0 (2), Read-only (3), Status Only (4), No Access (5)				⇒	Menu 0 (0)			
RFC-A	⇕									
RFC-S										

This parameter controls access via the drive keypad as follows:

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

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

00.050 {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<sub>binary</sub>) Th Brake Res trip is disabled

Pr 00.051 = 12 (1100<sub>binary</sub>) 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										

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	<b>Basic parameters</b>	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	Advanced parameters	Diagnostics	UL listing information
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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.



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

**WARNING**



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.

**CAUTION**



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

**WARNING**

## 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.

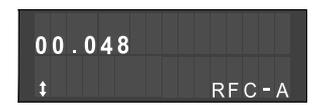
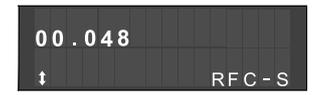
## 7.2 Changing the operating mode

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:

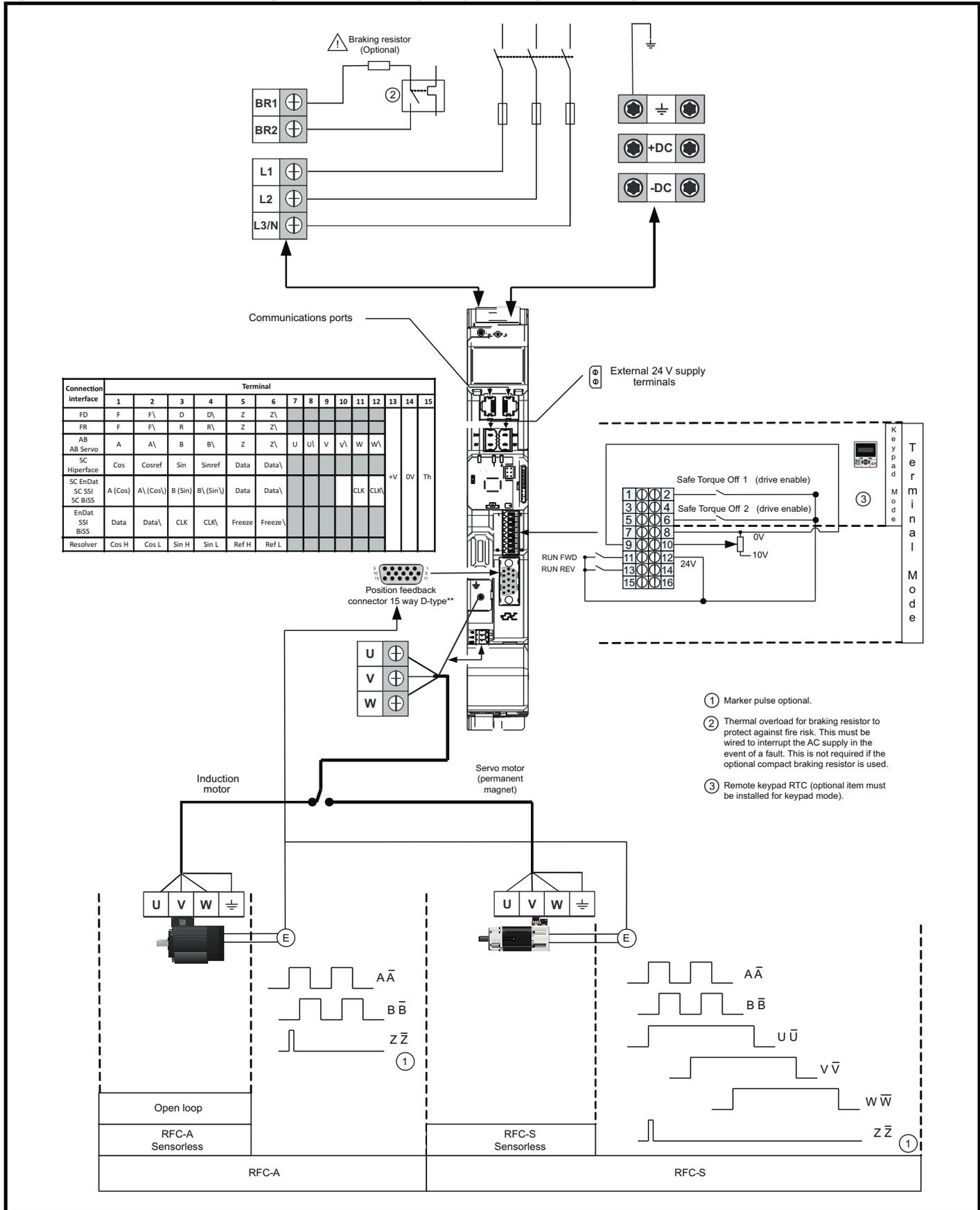
Pr 00.048 setting		Operating mode
	1	Open-loop
	2	RFC-A
	3	RFC-S

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)**

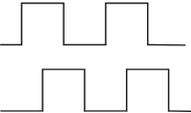
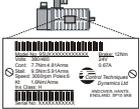
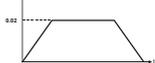
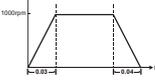


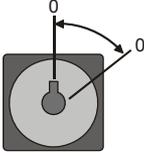
## 7.3 Quick start commissioning / start-up

### 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 on page 67.

Action	Detail	
Before power-up	Ensure: <ul style="list-style-type: none"> <li>The drive enable signal is not given (terminal 2 &amp; 6).</li> <li>Run signal is not given.</li> <li>Motor and feedback device are connected.</li> </ul>	
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 <i>KI-Remote Keypad changing the operating mode</i> on page 39. Ensure: <ul style="list-style-type: none"> <li>Drive displays 'inhibit'</li> </ul> If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.	
Set motor feedback parameters	<b>Incremental encoder basic set-up</b> Enter: <ul style="list-style-type: none"> <li>Drive encoder type in Pr <b>03.038</b> = AB Servo (3): Quadrature encoder with commutation outputs.</li> <li>Encoder power supply in Pr <b>03.036</b> = 5 V (0), 8 V (1) or 15 V (2).</li> </ul> <p><b>NOTE</b></p> <p>If output voltage from the encoder is &gt;5 V, then the termination resistors must be disabled Pr <b>03.039</b> to 0.</p> <div style="border: 1px solid black; padding: 5px;">  Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. <p><b>CAUTION</b></p> </div> <ul style="list-style-type: none"> <li>Drive encoder Pulses Per Revolution in Pr <b>03.034</b> (set according to encoder)</li> <li>Drive encoder termination resistor setting in Pr <b>03.039</b>: <ul style="list-style-type: none"> <li><b>0</b> = A-A\, B-B\, Z-Z\ termination resistors disabled</li> <li><b>1</b> = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled</li> <li><b>2</b> = A-A\, B-B\, Z-Z\ termination resistors enabled</li> </ul> </li> </ul>	
Enter motor nameplate details	Enter: <ul style="list-style-type: none"> <li>Motor rated current in Pr <b>00.046</b> (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.</li> <li>Number of poles in Pr <b>00.042</b></li> <li>Motor rated voltage in Pr <b>00.044</b> (V)</li> </ul>	
Set maximum speed	Enter: <ul style="list-style-type: none"> <li>Maximum speed in Pr <b>00.002</b> (rpm)</li> </ul>	
Set acceleration / deceleration rates	Enter: <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>00.003</b> (s/1000 rpm)</li> <li>Deceleration rate in Pr <b>00.004</b> (s/1000 rpm) (If braking resistor installed, set Pr <b>00.015</b> = Fast. Also ensure Pr <b>10.030</b>, Pr <b>10.031</b> and Pr <b>10.061</b> are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).</li> </ul>	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in <i>P1 Thermistor Type</i> (03.118). Motor thermistor fault detection is enabled as default, it can be deselected in Pr <b>03.123</b> . Refer to Pr <b>03.123</b> for further information.	

Action	Detail	
Autotune	<p>The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive. 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.</p> <ul style="list-style-type: none"> <li>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 <b>00.038</b> and Pr <b>00.039</b> are updated. If Sensorless mode is not selected then <i>Position Feedback Phase Angle</i> (00.043) is set-up for the selected position feedback.</li> <li>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 <b>00.038</b> and Pr <b>00.039</b> are updated.</li> </ul> <div style="border: 1px solid black; padding: 5px;">  <p>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.</p> </div> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr <b>00.040</b> = 1 for a stationary autotune, Pr <b>00.040</b> = 2 for a rotating autotune.</li> <li>Close the run signal (terminal 11 or 13).</li> <li>Close the drive enable signal (terminal 2 &amp; 6).</li> </ul> <p>The upper row of the display will flash 'Auto Tune' while the drive is performing the test.</p> <ul style="list-style-type: none"> <li>Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill.</li> </ul> <p>If the drive trips it cannot be reset until the drive enable signal (terminal 2 &amp; 6) has been removed. See section 13 <i>Diagnostics</i> on page 222.</p> <ul style="list-style-type: none"> <li>Remove the drive enabled and run signal from the drive.</li> </ul>	
Save parameters	<p>Select 'Save Parameters' in Pr <b>MM.000</b> (alternatively enter a value of 1001 in Pr <b>MM.000</b>) and press red </p>	
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	<p>Ensure:</p> <ul style="list-style-type: none"> <li>The drive enable signal is not given (terminal 2 &amp; 6).</li> <li>Run signal is not given</li> <li>Motor is connected</li> </ul>	
Power-up the drive	<p>Verify that RFC-S mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 <i>KI-Remote Keypad changing the operating mode</i> on page 39, otherwise restore parameter defaults (see section 5.8 <i>Restoring parameter defaults</i> on page 39).</p> <p>Ensure:</p> <ul style="list-style-type: none"> <li>Drive displays 'inhibit'</li> </ul> <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.</p>	
Select RFC-S (Sensorless control) mode and disable encoder wirebreak trip	<ul style="list-style-type: none"> <li>Set Pr <b>03.024</b> = 1 or 3 to select RFC-S Sensorless mode.</li> <li>Set Pr <b>03.040</b> = 0000 to disable the wire break.</li> </ul>	
Enter motor nameplate details	<p>Enter:</p> <ul style="list-style-type: none"> <li>Motor rated current in Pr <b>00.046</b> (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.</li> <li>Number of poles in Pr <b>00.042</b></li> <li>Motor rated voltage in Pr <b>00.044</b> (V)</li> </ul>	
Set maximum speed	<p>Enter:</p> <ul style="list-style-type: none"> <li>Maximum speed in Pr <b>00.002</b> (rpm)</li> </ul>	
Set acceleration / deceleration rates	<p>Enter:</p> <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>00.003</b> (s/1000 rpm). It is recommended that the ramp rates are increased from the default value of 0.200 s/1000 rpm.</li> <li>Deceleration rate in Pr <b>00.004</b> (s/1000 rpm) (If braking resistor installed, set Pr <b>00.015</b> = Fast. Also ensure Pr <b>10.030</b>, Pr <b>10.031</b> and Pr <b>10.061</b> are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).</li> </ul>	
Set stop mode	<p>Enter:</p> <ul style="list-style-type: none"> <li>Set Stop Mode to Ramp in Pr <b>06.001</b></li> </ul>	
Set hold zero speed	<p>Enter:</p> <ul style="list-style-type: none"> <li>Set Hold Zero Speed to Off (0) in Pr <b>06.008</b>.</li> </ul>	
Autotune	<p>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.</p> <ul style="list-style-type: none"> <li>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 <b>00.038</b> and Pr <b>00.039</b> are updated.</li> </ul> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr <b>00.040</b> = 1 or 2 for a stationary autotune. (Both perform the same tests).</li> <li>Close the run signal (terminal 11 or 13).</li> <li>Close the drive enable signal (terminal 2 &amp; 6).</li> <li>The upper row of the display will flash 'Auto Tune' while the drive is performing the test.</li> <li>Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill.</li> </ul> <p>If the drive trips it cannot be reset until the drive enable signal (terminal 2 &amp; 6) has been removed. See Chapter 13 <i>Diagnostics</i> on page 222.</p> <ul style="list-style-type: none"> <li>Remove the drive enabled and run signal from the drive.</li> </ul>	
Check Saliency	<p>In sensorless mode, when the motor speed is below Pr <b>00.045</b> / 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.</p> <p>The ratio No-load Lq (Pr <b>00.056</b>) / Ld (Pr <b>05.024</b>) provides a measure of the saliency. If this value is &gt; 1.1, then Injection (0) mode may be used. Current (2) mode may be used (but with limitations). If this value is &lt; 1.1, then Current (2) mode must be used (this is the default of Pr <b>05.064</b>).</p>	
Save parameters	<p>Select 'Save Parameters' in Pr <b>mm.000</b> (alternatively enter a value of 1001 in Pr <b>mm.000</b>) and press red </p>	
Run	<p>Drive is now ready to run</p>	

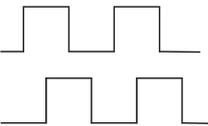
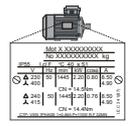
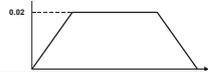
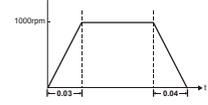
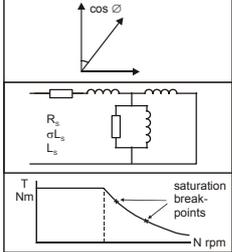
### 7.3.3 Open loop

Action	Detail																																									
Before power-up	Ensure: <ul style="list-style-type: none"> <li>The drive enable signal is not given (terminal 2 &amp; 6).</li> <li>Run signal is not given</li> <li>Motor is connected</li> </ul>																																									
Power-up the drive	Verify that Open Loop mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 <i>KI-Remote Keypad changing the operating mode</i> on page 39. Ensure: <ul style="list-style-type: none"> <li>Drive displays 'Inhibit'</li> </ul> If the drive trips, see section 13 <i>Diagnostics</i> on page 222.																																									
Enter motor nameplate details	Enter: <ul style="list-style-type: none"> <li>Motor rated frequency in Pr <b>00.047</b> (Hz)</li> <li>Motor rated current in Pr <b>00.046</b> (A)</li> <li>Motor rated speed in Pr <b>00.045</b> (rpm)</li> <li>Motor rated voltage in Pr <b>00.044</b> (V) - check if <math>\Delta</math> or <math>\Delta</math> connection</li> </ul>	 <table border="1"> <tr> <td colspan="2">Mot X XXXXXXXXXX</td> <td colspan="2">No XXXXXXXXXXXX kg</td> </tr> <tr> <td>IP55</td> <td>1.0 F</td> <td>°C 40</td> <td>s S1</td> </tr> <tr> <td>V</td> <td>Hz</td> <td>min</td> <td>kW</td> </tr> <tr> <td>Δ 230</td> <td>50</td> <td>1445</td> <td>2.20</td> </tr> <tr> <td>Δ 400</td> <td>50</td> <td>1445</td> <td>2.20</td> </tr> <tr> <td>Δ 240</td> <td>50</td> <td>1445</td> <td>2.20</td> </tr> <tr> <td>Δ 415</td> <td>50</td> <td>1445</td> <td>2.20</td> </tr> <tr> <td colspan="2">CN = 14.5Nm</td> <td colspan="2">CN = 14.4Nm</td> </tr> <tr> <td colspan="2">CN = 14.4Nm</td> <td colspan="2">CN = 14.4Nm</td> </tr> <tr> <td colspan="4">CTP- VEN 1PHASE I=0.46A P=110W R.F. 32MIN</td> </tr> </table>	Mot X XXXXXXXXXX		No XXXXXXXXXXXX kg		IP55	1.0 F	°C 40	s S1	V	Hz	min	kW	Δ 230	50	1445	2.20	Δ 400	50	1445	2.20	Δ 240	50	1445	2.20	Δ 415	50	1445	2.20	CN = 14.5Nm		CN = 14.4Nm		CN = 14.4Nm		CN = 14.4Nm		CTP- VEN 1PHASE I=0.46A P=110W R.F. 32MIN			
Mot X XXXXXXXXXX		No XXXXXXXXXXXX kg																																								
IP55	1.0 F	°C 40	s S1																																							
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Δ 400	50	1445	2.20																																							
Δ 240	50	1445	2.20																																							
Δ 415	50	1445	2.20																																							
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CN = 14.4Nm		CN = 14.4Nm																																								
CTP- VEN 1PHASE I=0.46A P=110W R.F. 32MIN																																										
Set maximum frequency	Enter: <ul style="list-style-type: none"> <li>Maximum frequency in Pr <b>00.002</b> (Hz)</li> </ul>																																									
Set acceleration / deceleration rates	Enter: <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>00.003</b> (s/100 Hz)</li> <li>Deceleration rate in Pr <b>00.004</b> (s/100 Hz) (If braking resistor installed, set Pr <b>00.015</b> = Fast. Also ensure Pr <b>10.030</b> and Pr <b>10.031</b> and Pr <b>10.061</b> are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).</li> </ul>																																									
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in <i>P1 Thermistor Type</i> (03.118). The motor thermistor can be selected in Pr <b>03.123</b> . Refer to Pr <b>03.123</b> for further information.																																									
Autotune	<p>The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A rotating autotune should be used whenever possible so the measured value of power factor of the motor is used by the drive.</p> <div style="border: 1px solid black; padding: 5px;"> <p><b>WARNING</b> A rotating autotune will cause the motor to accelerate up to <math>2/3</math> base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable.</p> </div> <ul style="list-style-type: none"> <li>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 <b>00.043</b>.</li> <li>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 <math>2/3</math> base speed in the direction selected. The rotating autotune measures the power factor of the motor.</li> </ul> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr <b>00.040</b> = 1 for a stationary autotune or set Pr <b>00.040</b> = 2 for a rotating autotune</li> <li>Close the Drive Enable signal (terminal 2 &amp; 6). The drive will display 'Ready'.</li> <li>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.</li> <li>Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill.</li> </ul> <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.</p> <ul style="list-style-type: none"> <li>Remove the drive enable and run signal from the drive.</li> </ul>	 <p>The diagram shows a vector diagram with <math>\cos \phi</math> on the vertical axis and a horizontal axis. Below it is a circuit diagram with a resistor <math>R_s</math> and an inductor <math>\sigma L_s</math> in series, connected to a voltage source.</p>																																								
Save parameters	Select 'Save Parameters' in Pr <b>mm.000</b> (alternatively enter a value of 1001 in Pr <b>mm.000</b> ) 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

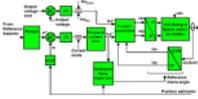
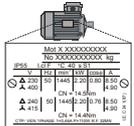
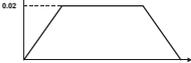
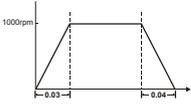
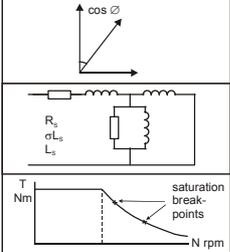
For simplicity only an incremental quadrature encoder will be considered here. For information on setting up one of the other supported speed feedback devices, refer to section on page 67.

Action	Detail	
Before power-up	Ensure: <ul style="list-style-type: none"> <li>The drive enable signal is not given (terminal 2 &amp; 6).</li> <li>Run signal is not given</li> <li>Motor and feedback device are connected</li> </ul>	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 <i>KL-Remote Keypad changing the operating mode</i> on page 39. Ensure: <ul style="list-style-type: none"> <li>Drive displays 'Inhibit'</li> </ul> If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.	
Set motor feedback parameters	<b>Incremental encoder basic set-up</b> Enter: <ul style="list-style-type: none"> <li>Drive encoder type in Pr <b>03.038</b> = AB (0): Quadrature encoder</li> <li>Encoder power supply in Pr. <b>03.036</b> = 5 V (0), 8 V (1) or 15 V (2).</li> </ul> <b>NOTE</b> If output voltage from the encoder is >5 V, then the termination resistors must be disabled Pr <b>03.039</b> to 0.   Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device. <b>CAUTION</b> <ul style="list-style-type: none"> <li>Drive encoder Lines Per Revolution (LPR) in Pr <b>03.034</b> (set according to encoder)</li> <li>Drive encoder termination resistor setting in Pr <b>03.039</b>:  <b>0</b> = A-A\, B-B\, Z-Z\ termination resistors disabled  <b>1</b> = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled  <b>2</b> = A-A\, B-B\, Z-Z\ termination resistors enabled</li> </ul>	
Enter motor nameplate details	<ul style="list-style-type: none"> <li>Motor rated frequency in Pr <b>00.047</b> (Hz)</li> <li>Motor rated current in Pr <b>00.046</b> (A)</li> <li>Motor rated speed in Pr <b>00.045</b> (rpm)</li> <li>Motor rated voltage in Pr <b>00.044</b> (V) - check if <math>\Delta</math> or <math>\Lambda</math> connection</li> </ul>	
Set maximum speed	Enter: Maximum speed in Pr <b>00.002</b> (rpm)	
Set acceleration / deceleration rates	Enter: <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>00.003</b> (s/1000 rpm)</li> <li>Deceleration rate in Pr <b>00.004</b> (s/1000 rpm) (If braking resistor installed, set Pr <b>00.015</b> = Fast. Also ensure Pr <b>10.030</b>, Pr <b>10.031</b> and Pr <b>10.061</b> are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).</li> </ul>	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in <i>P1 Thermistor Type</i> (03.118). The motor thermistor can be selected in Pr <b>03.123</b> . Refer to Pr <b>03.123</b> 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.   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. <b>WARNING</b> The drive can be stopped at any time by removing the run signal or removing the drive enable. <ul style="list-style-type: none"> <li>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 <b>00.038</b> and Pr <b>00.039</b> 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 <b>00.043</b>.</li> <li>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 <math>2/3</math> base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor.</li> </ul> To perform an autotune: <ul style="list-style-type: none"> <li>Set Pr <b>00.040</b> = 1 for a stationary autotune or set Pr <b>00.040</b> = 2 for a rotating autotune</li> <li>Close the drive enable signal (terminal 2 &amp; 6). The drive will display 'Ready'.</li> <li>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.</li> <li>Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill</li> </ul> If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222. <ul style="list-style-type: none"> <li>Remove the drive enable and run signal from the drive.</li> </ul>	

Action	Detail	
Save parameters	Select 'Save Parameters' in Pr <b>mm.000</b> (alternatively enter a value of 1001 in Pr <b>mm.000</b> ) 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: <ul style="list-style-type: none"> <li>The drive enable signal is not given (terminal 2 &amp; 6).</li> <li>Run signal is not given</li> <li>Motor is connected</li> </ul>	
Power-up the drive	Verify that RFC-A mode is displayed as the drive powers up. If the mode is incorrect see section 5.6 <i>KI-Remote Keypad changing the operating mode</i> on page 39. Ensure: <ul style="list-style-type: none"> <li>Drive displays 'Inhibit'</li> </ul> If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.	
Select RFC-A (Sensorless control) mode and disable encoder wire-break trip	<ul style="list-style-type: none"> <li>Set Pr <b>03.024</b> = 1 or 3 to select RFC-A Sensorless mode</li> <li>Set Pr <b>03.040</b> = 0000 to disable the wire break</li> </ul>	
Enter motor nameplate details	Enter: <ul style="list-style-type: none"> <li>Motor rated frequency in Pr <b>00.047</b> (Hz)</li> <li>Motor rated current in Pr <b>00.046</b> (A)</li> <li>Motor rated speed in Pr <b>00.045</b> (rpm)</li> <li>Motor rated voltage in Pr <b>00.044</b> (V) - check if <math>\Delta</math> or <math>\text{Y}</math> connection</li> </ul>	
Set maximum speed	Enter: <ul style="list-style-type: none"> <li>Maximum speed in Pr <b>00.002</b> (rpm)</li> </ul>	
Set acceleration / deceleration rates	Enter: <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>00.003</b> (s/1000rpm)</li> <li>Deceleration rate in Pr <b>00.004</b> (s/1000rpm) (If braking resistor installed, set Pr <b>00.015</b> = Fast. Also ensure Pr <b>10.030</b>, Pr <b>10.031</b> and Pr <b>10.061</b> are set correctly, otherwise premature 'Brake R Too Hot' trips may be seen).</li> </ul>	
Motor thermistor set-up	The motor thermistor connection is made through the drive encoder port (terminal 15). The thermistor type is selected in <i>P1 Thermistor Type</i> (03.118). The motor thermistor can be selected in Pr <b>03.123</b> . Refer to Pr <b>03.123</b> for further information.	
Select or deselect catch a spinning motor mode	If catch a spinning motor mode is not required then set Pr <b>06.009</b> to 0. If catch a spinning motor mode is required then leave Pr <b>06.009</b> at the default of 1, but depending on the size of the motor the value in Pr <b>05.040</b> may need to be adjusted. Pr <b>05.040</b> defines a scaling function used by the algorithm that detects the speed of the motor. The default value of Pr <b>05.040</b> is 1 which is suitable for small motors (< 4 kW). For larger motors the value in Pr <b>05.040</b> will need to be increased. Approximate values of Pr <b>05.040</b> 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 <b>05.040</b> 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	<p>The drive is able to perform either a stationary or a rotating autotune. The motor must be at a standstill before an autotune is enabled. A stationary autotune will give moderate performance whereas a rotating autotune will give improved performance as it measures the actual values of the motor parameters required by the drive.</p> <p><b>NOTE</b> It is highly recommended that a rotating autotune is performed (Pr <b>00.040</b> set to 2).</p> <p><b>WARNING</b> A rotating autotune will cause the motor to accelerate up to <math>\frac{2}{3}</math> base speed in the direction selected regardless of the reference provided. Once complete the motor will coast to a stop. The enable signal must be removed before the drive can be made to run at the required reference. The drive can be stopped at any time by removing the run signal or removing the drive enable.</p> <ul style="list-style-type: none"> <li>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 <b>00.038</b> and Pr <b>00.039</b> 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 <b>00.043</b>.</li> <li>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 <math>\frac{2}{3}</math> base speed in the direction selected. The rotating autotune measures the stator inductance of the motor and calculates the power factor.</li> </ul> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr <b>00.040</b> = 1 for a stationary autotune or set Pr <b>00.040</b> = 2 for a rotating autotune</li> <li>Close the drive enable signal (terminal 2 &amp; 6). The drive will display 'Ready' or 'Inhibit'.</li> <li>Close the run signal (terminal 11or13). The upper row of the display will flash 'Auto Tune' while the drive is performing the autotune.</li> <li>Wait for the drive to display 'Ready' or 'Inhibit' and for the motor to come to a standstill.</li> </ul> <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 222.</p> <ul style="list-style-type: none"> <li>Remove the drive enable and run signal from the drive.</li> </ul>	

Action	Detail	
Save parameters	Select 'Save Parameters' in Pr <b>MM.000</b> (alternatively enter a value of 1001 in Pr <b>MM.000</b> ) 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>

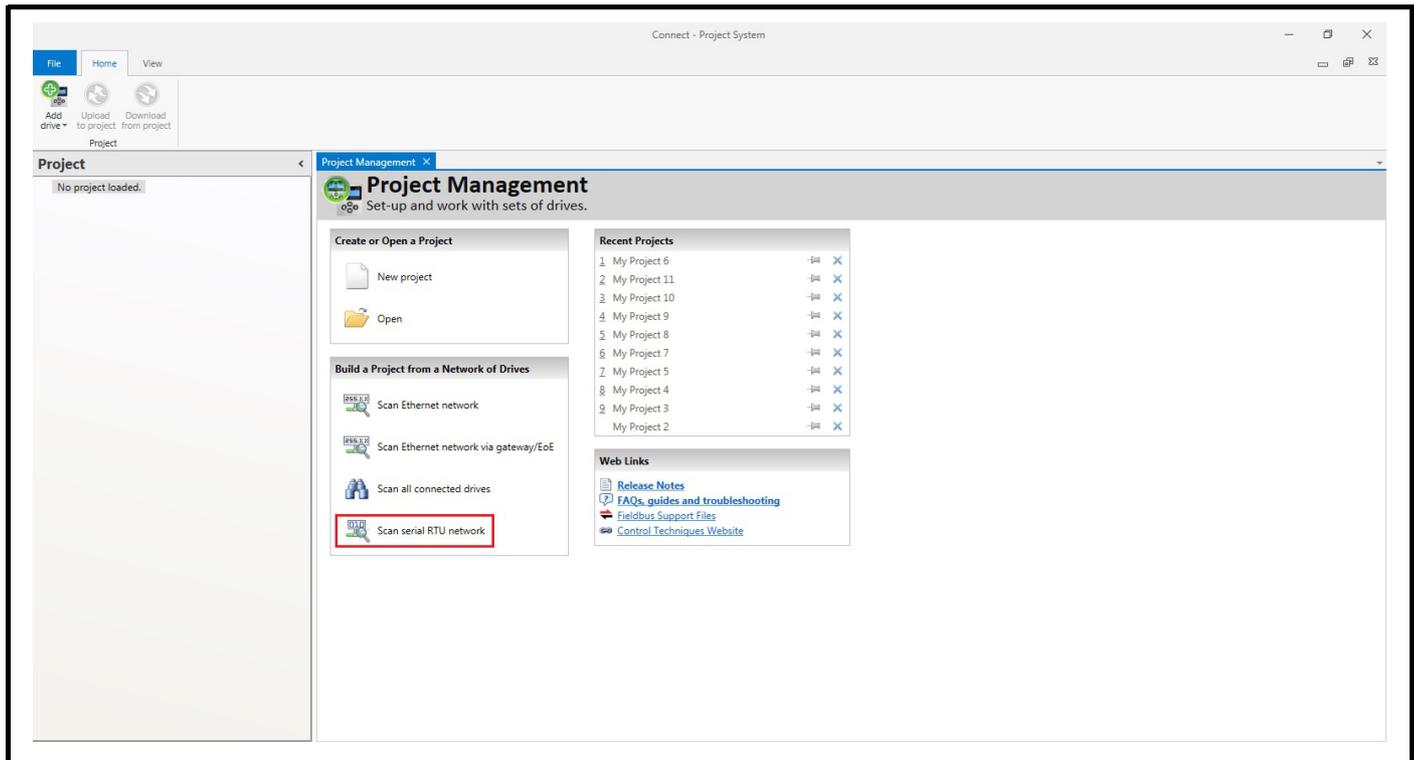
### Connect system requirements

- 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

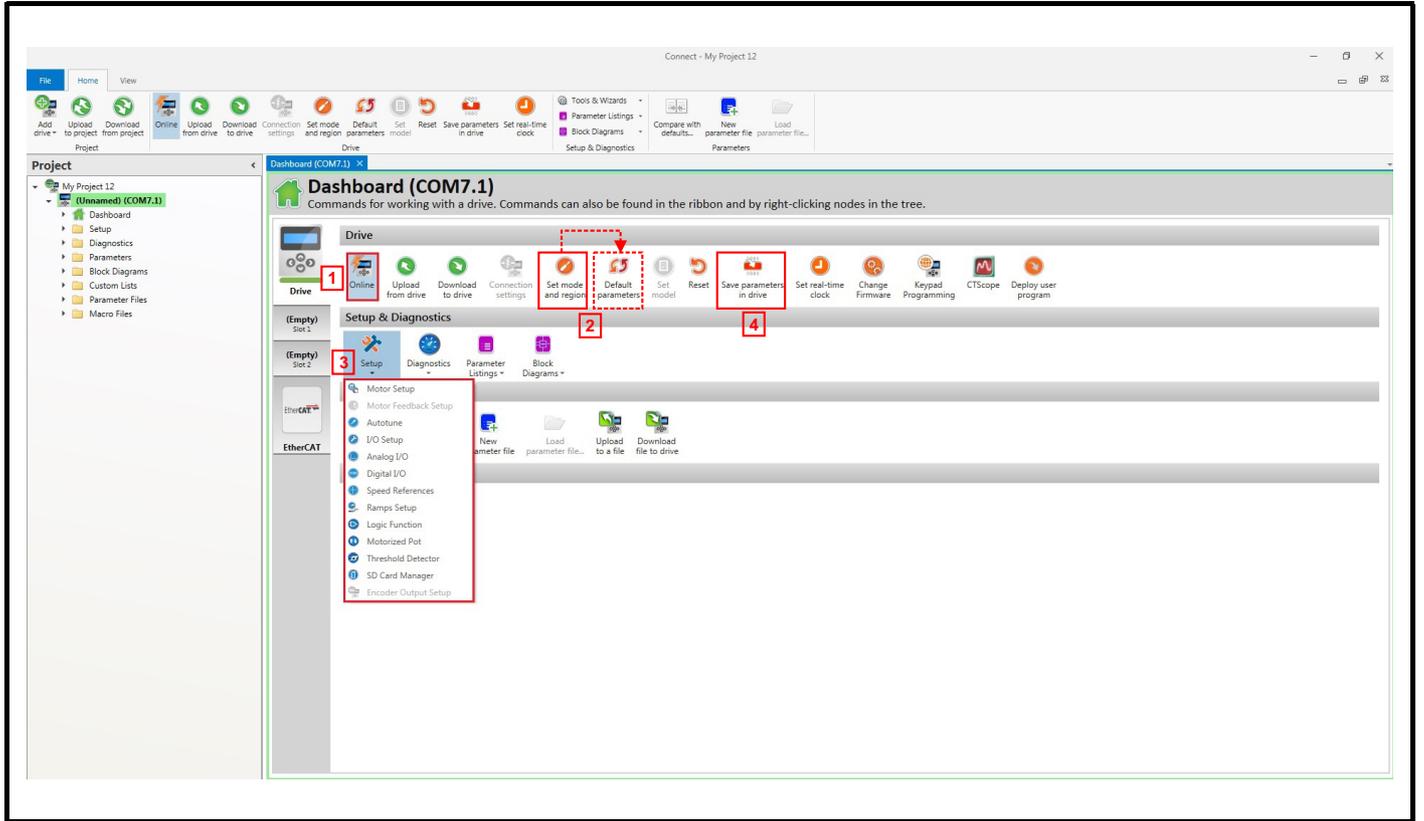
1. Start Connect, and on the 'Project Management' screen select 'Scan serial RTU network' (M751 only when connected to the drive communication port or all variants when connecting via the KI-Compact 485 adaptor), 'Scan Ethernet network' (M750 only or M753 when using Ethernet over EtherCAT protocol) or '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	<p>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.</p> <p><b>NOTE</b></p> <p>If output voltage from the encoder is &gt; 5 V, then the termination resistors must be disabled Pr <b>03.039</b> to 0.</p> <div style="border: 1px solid black; padding: 5px;"> <p> <b>CAUTION</b> Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.</p> </div>
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 <b>10.030</b> and Pr <b>10.031</b> and Pr <b>10.061</b> 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. <b>NOTE</b> 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

<i>Device Type</i> (03.038)	<b>AB</b> (0) for a quadrature encoder without commutation signals * <b>AB Servo</b> (3) for a quadrature encoder with commutation signals <b>SC</b> (6) for a Sincos encoder without commutation signals * <b>SC Servo</b> (12) for a Sincos encoder with commutation signals <b>SC SC</b> (15) for a Sincos encoder with absolute position from single sin and cosine signals																													
<i>Supply Voltage</i> (03.036)	<b>5 V</b> (0), <b>8 V</b> (1) or <b>15 V</b> (2) <b>NOTE</b> If output voltage from the encoder is >5 V, then the termination resistors must be disabled. Set Pr <b>03.039</b> to 0																													
<i>Rotary Line Per Revolution</i> (03.034)	Set to the number of lines or sine waves per revolution of the encoder.																													
<i>Termination Select</i> (03.039) (AB or AB Servo only)	<b>0</b> = A, B, Z termination resistors disabled <b>1</b> = A, B termination resistors enabled and Z termination resistors disabled <b>2</b> = A, B, Z termination resistors enabled																													
<i>Marker Mode</i> (03.031)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>No action is taken unless marker flag is zero before marker event occurs</td> </tr> <tr> <td>x</td> <td>x</td> <td>1</td> <td>x</td> <td>Pr <b>03.028</b> and Pr <b>03.058</b> are set to zero</td> </tr> <tr> <td>x</td> <td>1</td> <td>x</td> <td>x</td> <td>Pr <b>03.028</b>, Pr <b>03.029</b>, Pr <b>03.030</b> and the related part of Pr <b>03.058</b> are not reset. Pr <b>03.058</b> is transferred to Pr <b>03.059</b> and Pr <b>03.032</b> is set to 1.</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>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.</td> </tr> </tbody> </table>	Bit				Description	3	2	1	0	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs	x	x	1	x	Pr <b>03.028</b> and Pr <b>03.058</b> are set to zero	x	1	x	x	Pr <b>03.028</b> , Pr <b>03.029</b> , Pr <b>03.030</b> and the related part of Pr <b>03.058</b> are not reset. Pr <b>03.058</b> is transferred to Pr <b>03.059</b> and Pr <b>03.032</b> 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.
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<i>Error Detection Level</i> (03.040)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>Enable wire break detection</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>Disable trips <i>Encoder 1 to Encoder 6</i></td> </tr> </tbody> </table>	Bit				Description	3	2	1	0	x	x	x	1	Enable wire break detection	1	x	x	x	Disable trips <i>Encoder 1 to Encoder 6</i>										
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1	x	x	x	Disable trips <i>Encoder 1 to Encoder 6</i>																										

\* 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.**

<i>Device Type</i> (03.038)	<b>FD</b> (1) for frequency and direction signals without commutation signals* <b>FR</b> (3) for forward and reverse signals without commutation signals* <b>FD Servo</b> (4) for frequency and direction signals with commutation signals <b>FR Servo</b> (5) for forward and reverse signals with commutation signals																													
<i>Supply Voltage</i> (03.036)	<b>5 V</b> (0), <b>8 V</b> (1) or <b>15 V</b> (2) <b>NOTE</b> If output voltage from the encoder is > 5 V, then the termination resistors must be disabled. Set Pr <b>03.039</b> to 0																													
<i>Rotary Line Per Revolution</i> (03.034)	Set to the number of pulses per revolution of the encoder divided by 2.																													
<i>Termination Select</i> (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																													
<i>Marker Mode</i> (03.031)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>No action is taken unless marker flag is zero before marker event occurs</td> </tr> <tr> <td>x</td> <td>x</td> <td>1</td> <td>x</td> <td>Pr <b>03.028</b> and Pr <b>03.058</b> are set to zero</td> </tr> <tr> <td>x</td> <td>1</td> <td>x</td> <td>x</td> <td>Pr <b>03.028</b>, Pr <b>03.029</b>, Pr <b>03.030</b> and the related part of Pr <b>03.058</b> are not reset. Pr <b>03.058</b> is transferred to Pr <b>03.059</b> and Pr <b>03.032</b> is set to 1.</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>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.</td> </tr> </tbody> </table>	Bit				Description	3	2	1	0	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs	x	x	1	x	Pr <b>03.028</b> and Pr <b>03.058</b> are set to zero	x	1	x	x	Pr <b>03.028</b> , Pr <b>03.029</b> , Pr <b>03.030</b> and the related part of Pr <b>03.058</b> are not reset. Pr <b>03.058</b> is transferred to Pr <b>03.059</b> and Pr <b>03.032</b> 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.
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\* 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**

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

### Absolute SSI communications only encoder, or Absolute Sincos encoder with SSI communications

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

### UVW commutation signal only encoders\*

<i>Device Type</i> (03.038)	Commutation Only (16) for a quadrature encoder with commutation signals*
<i>Supply Voltage</i> (03.036)	<b>5 V</b> (0), <b>8 V</b> (1) or <b>15 V</b> (2)
<i>Error Detection Level</i> (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

<i>Device Type</i> (03.038)	Resolver (14)																			
<i>Resolver Poles</i> (03.065)	Set number of Resolver poles 2 poles (1) to 20 poles (10)																			
<i>Resolver Excitation</i> (03.066)	Set Resolver excitation voltage and frequency 6 kHz 3V (0), 8 kHz 3V (1), 6 kHz 2V (2), 8 kHz 2V (3)																			
<i>Error Detection Level</i> (03.040)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>Enable wire break detection</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>Disable trips <i>Encoder 1 to Encoder 6</i></td> </tr> </tbody> </table> <p>So for example, to enable the wire break error detection, set Pr <b>03.040</b> to 0001.</p>	Bit				Description	3	2	1	0	x	x	x	1	Enable wire break detection	1	x	x	x	Disable trips <i>Encoder 1 to Encoder 6</i>
Bit				Description																
3	2	1	0																	
x	x	x	1	Enable wire break detection																
1	x	x	x	Disable trips <i>Encoder 1 to Encoder 6</i>																

### 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)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>No action is taken unless marker flag is zero before marker event occurs</td> </tr> <tr> <td>x</td> <td>x</td> <td>1</td> <td>x</td> <td>Pr <b>03.128</b> and Pr <b>03.158</b> are set to zero</td> </tr> <tr> <td>x</td> <td>1</td> <td>x</td> <td>x</td> <td>Pr <b>03.128</b>, Pr <b>03.129</b>, Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> is set to 1.</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>This Bit in has no effect.</td> </tr> </tbody> </table>	Bit				Description	3	2	1	0	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs	x	x	1	x	Pr <b>03.128</b> and Pr <b>03.158</b> are set to zero	x	1	x	x	Pr <b>03.128</b> , Pr <b>03.129</b> , Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> is set to 1.	1	x	x	x	This Bit in has no effect.
	Bit				Description																									
	3	2	1	0																										
	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs																									
	x	x	1	x	Pr <b>03.128</b> and Pr <b>03.158</b> are set to zero																									
x	1	x	x	Pr <b>03.128</b> , Pr <b>03.129</b> , Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> 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)	<table border="1"> <thead> <tr> <th colspan="4">Bit</th> <th rowspan="2">Description</th> </tr> <tr> <th>3</th> <th>2</th> <th>1</th> <th>0</th> </tr> </thead> <tbody> <tr> <td>x</td> <td>x</td> <td>x</td> <td>1</td> <td>No action is taken unless marker flag is zero before marker event occurs</td> </tr> <tr> <td>x</td> <td>x</td> <td>1</td> <td>x</td> <td>Pr <b>03.128</b> and Pr <b>03.158</b> are set to zero</td> </tr> <tr> <td>x</td> <td>1</td> <td>x</td> <td>x</td> <td>Pr <b>03.128</b>, Pr <b>03.129</b>, Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> is set to 1.</td> </tr> <tr> <td>1</td> <td>x</td> <td>x</td> <td>x</td> <td>This Bit in has no effect.</td> </tr> </tbody> </table>	Bit				Description	3	2	1	0	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs	x	x	1	x	Pr <b>03.128</b> and Pr <b>03.158</b> are set to zero	x	1	x	x	Pr <b>03.128</b> , Pr <b>03.129</b> , Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> is set to 1.	1	x	x	x	This Bit in has no effect.
	Bit				Description																									
	3	2	1	0																										
	x	x	x	1	No action is taken unless marker flag is zero before marker event occurs																									
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x	1	x	x	Pr <b>03.128</b> , Pr <b>03.129</b> , Pr <b>03.130</b> and the related part of Pr <b>03.158</b> are not reset. Pr <b>03.158</b> is transferred to Pr <b>03.159</b> and Pr <b>03.132</b> is set to 1.																										
1	x	x	x	This Bit in has no effect.																										

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

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

## 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 4-6 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	
<i>Encoder Simulation Source</i> (03.085)	This parameter must be set to <b>03.029</b> to select the P1 position interface as the source.
<i>Encoder Simulation Mode</i> (03.088)	Set to a value of <b>Hardware (0)</b>
<i>Encoder Simulation Hardware Divider</i> (03.089)	This parameter defines the divider ratio between the device connected to the P1 position feedback interface and the output. <b>0</b> = 1/1 <b>1</b> = 1/2 <b>2</b> = 1/4 <b>3</b> = 1/8 <b>4</b> = 1/16 <b>5</b> = 1/32 <b>6</b> = 1/64 <b>7</b> = 1/128
<i>Encoder Simulation Hardware Marker Lock</i> (03.090)	<b>0</b> = The marker output is derived directly from the marker input <b>1</b> = 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
<i>Encoder Simulation Output Mode</i> (03.098)	<b>AB/Gray (0)</b> for a AB quadrature output signals <b>FD/Binary (1)</b> for Frequency and Direction output signals <b>FR/Binary (2)</b> 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	
<i>Encoder Simulation Source</i> (03.085)	Set to the parameter number of the position source Pr <b>03.029</b> to use the P1 position interface on the drive as the source. Pr <b>03.129</b> 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.
<i>Encoder Simulation Mode</i> (03.088)	Set to a value of <b>Lines Per Rev (1)</b>
<i>Encoder Simulation Output Lines Per Revolution</i> (03.092)	Set to the required output lines per revolution. The maximum output lines per revolution are 16384.
<i>Encoder Simulation Output Mode</i> (03.098)	<b>AB/Gray (0)</b> for a AB quadrature output signals

Frequency and Direction or Forward and Reverse output signals, software mode setup – Lines per revolution	
<i>Encoder Simulation Source</i> (03.085)	Set to the parameter number of the position source Pr <b>03.029</b> to use the P1 position interface on the drive as the source. Pr <b>03.129</b> 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.
<i>Encoder Simulation Mode</i> (03.088)	Set to a value of <b>Lines Per Rev (1)</b>
<i>Encoder Simulation Output Lines Per Revolution</i> (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.
<i>Encoder Simulation Output Mode</i> (03.098)	<b>FD/Binary (1)</b> for Frequency and Direction output signals <b>FR/Binary (2)</b> 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).

<b>AB quadrature output signals, software mode setup – Ratio</b>	
<b>Frequency and Direction or Forward and Reverse output signals, software mode setup</b>	
<i>Encoder Simulation Source</i> (03.085)	Set to the parameter number of the position source Pr <b>03.029</b> to use the P1 position interface on the drive as the source. Pr <b>03.129</b> 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.
<i>Encoder Simulation Mode</i> (03.088)	Set to a value of <b>Ratio (2)</b>
<i>Encoder Simulation Numerator</i> (03.093) and <i>Encoder Simulation Denominator</i> (03.094)	Set these two parameters to give the required output ratio.
<i>Encoder Simulation Output Mode</i> (03.098)	<b>AB/Gray (0)</b> for a AB quadrature output signals <b>FD/Binary (1)</b> for Frequency and Direction output signals <b>FR/Binary (2)</b> 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.

<b>Absolute SSI data, software mode setup</b>	
<i>Encoder Simulation Source</i> (03.085)	Set to the parameter number of the position source Pr <b>03.029</b> to use the P1 position interface on the drive as the source. Pr <b>03.129</b> 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.
<i>Encoder Simulation Mode</i> (03.088)	Set to a value of <b>SSI (3)</b>
<i>Encoder Simulation SSI Turns Bits</i> (03.096)	Set to the number of bits representing the number of turns in the position message.
<i>Encoder Simulation SSI Comms Bits</i> (03.097)	Set to the number bits in the whole position message.
<i>Encoder Simulation Output Mode</i> (03.098)	<b>AB/Gray (0)</b> for position data in Gray code format <b>FD/Binary (1)</b> or <b>FR/Binary (2)</b> for position data in binary format

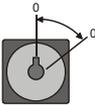
# 8 Optimization

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

<b>Pr 00.046 {05.007} Rated Current</b>	<b>Defines the maximum motor continuous current</b>
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: <ul style="list-style-type: none"> <li>Current limits (see section 8.2 <i>Current limits</i> on page 92, for more information)</li> <li>Motor thermal overload protection (see section 8.3 <i>Motor thermal protection</i> on page 92, for more information)</li> </ul>	
<b>Pr 00.042 {05.011} Number Of Motor Poles</b>	<b>Defines the number of motor poles</b>
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 <b>00.042</b> is set to "Automatic" the number of poles is 6.	
<b>Pr 00.040 {05.012} Autotune</b>	
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. <ul style="list-style-type: none"> <li><b>Stationary Autotune</b> 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 <i>Position Feedback Phase Angle</i> (00.043) as compared to rotating autotune. A stationary test is performed to measure <i>Stator Resistance</i> (05.017), <i>Ld</i> (05.024), <i>Maximum Deadtime Compensation</i> (05.059), <i>Current At Maximum Deadtime Compensation</i> (05.060), <i>No Load Lq</i> (05.072). If <i>Enable Stator Compensation</i> (05.049) = 1 then <i>Stator Base Temperature</i> (05.048) is made equal to <i>Stator Temperature</i> (05.046). The <i>Stator Resistance</i> (05.017) and the <i>Ld</i> (05.024) are then used to set up <i>Current controller Kp Gain</i> (00.038) and <i>Current Controller Ki Gain</i> (00.039). If sensorless mode is not selected then <i>Position Feedback Phase Angle</i> (00.043) is set up for the position from the position feedback interface selected with <i>Motor Control Feedback Select</i> (03.026). To perform a Stationary autotune, set Pr <b>00.040</b> to 1, and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).</li> <li><b>Rotating Autotune</b> The rotating autotune must be performed on unloaded motor. This testing 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, <i>Rated Current</i> (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 <i>Position Feedback Phase Angle</i> (00.043) is set-up for the position from the position feedback interface selected with <i>Motor Control Feedback Select</i> (03.026). A stationary test is then performed to measure <i>Stator Resistance</i> (05.017), <i>Ld</i> (05.024), <i>Maximum Deadtime Compensation</i> (05.059), <i>Current At Maximum Deadtime Compensation</i> (05.060) and <i>No Load Lq</i> (05.072). <i>Stator Resistance</i> (05.017) and <i>Ld</i> (05.024) are used to set up <i>Current Controller Kp Gain</i> (00.038) and <i>Current Controller Ki Gain</i> (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 <b>00.040</b> to 2, and provide the drive with both an enable signal (terminal 2 &amp; 6) and a run signal (terminal 11 or 13).</li> </ul>	
	
<ul style="list-style-type: none"> <li><b>Mechanical load measurement test using signal injection</b> 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 <i>Torque Per Amp</i> (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 <i>Mechanical Load Test Level</i> (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 <i>Mechanical Load Test Level</i> (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 (<i>Autotune</i> (00.040) = 4) where a series of torque levels are applied to accelerate and decelerate the motor to measure the inertia. <ol style="list-style-type: none"> <li>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. <i>Motor And Load Inertia</i> (03.018) and <i>Inertia Times 1000</i> (04.033) are set up. To perform this autotune test, set Pr <b>00.040</b> to 3 and provide the drive with both an enable signal (terminal 2 and 6) and a run signal (terminal 11 or 13).</li> </ol> </li> <li><b>Mechanical load measurement using applied torque</b> 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 <i>Rated Speed</i> (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 <i>Mechanical Load Test Level</i> (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. <ol style="list-style-type: none"> <li>The motor is accelerated in the required direction up to 3/4 of the maximum speed reference and then decelerated to zero speed.</li> <li>The test is repeated with progressively higher torques until the required speed is reached.</li> <li><i>Motor And Load Inertia</i> (03.018) and <i>Inertia Times 1000</i> (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).</li> </ol> </li> </ul>	

### 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

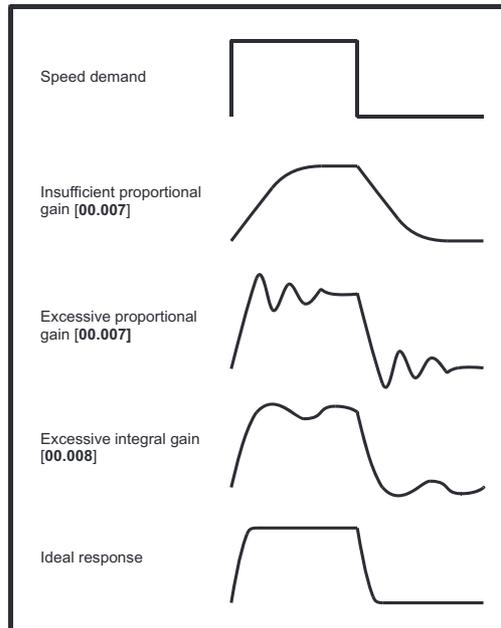
If compliance angle based set-up is required, the drive can calculate Kp and Ki if the following parameters are set up correctly:

- 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  $\omega_{bw} = 2\pi \times \text{Bandwidth}$  (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

<b>Pr 00.046 {05.007} Rated Current</b>	<b>Defines the maximum motor continuous current</b>
<p>The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:</p> <ul style="list-style-type: none"> <li>Current limits (see section 8.2 <i>Current limits</i> on page 92, for more information)</li> <li>Motor thermal overload protection (see section 8.3 <i>Motor thermal protection</i> on page 92, for more information)</li> </ul>	
<b>Pr 00.042 {05.011} Number Of Motor Poles</b>	<b>Defines the number of motor poles</b>
<p>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 <b>00.042</b> is set to "Automatic" the number of poles is 6.</p>	
<b>Pr 00.040 {05.012} Autotune</b>	
<p>There are three autotune tests available in RFC-S sensorless mode, a stationary autotune and an inertia measurement test.</p> <ul style="list-style-type: none"> <li>Stationary Autotune (Pr <b>00.040 {05.012}</b> = 1)</li> </ul> <p>The stationary autotune can be used to measure all the necessary parameters for basic control. The tests measures <i>Stator Resistance</i> (05.017), <i>Ld</i> (05.024), <i>No Load Lq</i> Pr <b>00.056 {05.072}</b>, <i>Maximum Deadtime Compensation</i> (05.059) and <i>Current At Maximum Deadtime Compensation</i> (05.060). If <i>Enable Stator Compensation</i> (05.049) = 1 then <i>Stator Base Temperature</i> (05.048) is made equal to <i>Stator Temperature</i> (05.046). The <i>Stator Resistance</i> (05.017) and <i>Ld</i> (05.024) are then used to set up <i>Current controller Kp Gain</i> Pr <b>00.038 {04.013}</b> and <i>Current Controller Ki Gain</i> Pr <b>00.039 {04.014}</b>. To perform a Stationary autotune, set Pr <b>00.040</b> to 1, and provide the drive with both an enable signal (terminal 2 &amp; 6) and a run signal (terminal 11 or 13).</p> <ul style="list-style-type: none"> <li>Rotating Autotune (Pr <b>00.040 {05.012}</b> = 2)</li> </ul> <p>In sensorless mode, if Rotating autotune is selected (Pr <b>00.040</b> = 2), then a stationary autotune is performed.</p> <ul style="list-style-type: none"> <li>Inertia measurement test (Pr <b>00.040 {05.012}</b> = 4)</li> </ul> <p><b>NOTE:</b> It is not possible to perform this test if, after autotune, the ratio <i>No load Lq</i> Pr <b>00.056 {05.072}</b> / <i>Ld</i> (05.024) &lt; 1.1 and Pr <b>00.054 {05.064}</b> has been set to Non-salient.</p> <p>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 <i>Speed loop gains</i>) 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 <i>Rated Speed</i> Pr <b>00.045 {05.008}</b> 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 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 <i>Mechanical Load Test Level</i> (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 <b>00.040</b> to 4, and provide the drive with both an enable signal (on terminal 2 &amp; 6) and a run signal (on terminal 11 or 13).</p> <p>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 &amp; 6, setting the drive Enable Parameter (<b>06.015</b>) to Off (0) or disabling the drive via the control word (Pr <b>06.042</b> &amp; Pr <b>06.043</b>).</p>	
<b>Pr 00.038 {04.013} / Pr 00.039 {04.014} Current Loop Gains</b>	
<p>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 <b>00.038 {04.013}</b> 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 <i>Autotune</i> Pr <b>00.040</b>, earlier in this table) the drive measures the <i>Stator Resistance</i> (05.017) and <i>Transient Inductance</i> (05.024) of the motor and calculates the current loop gains.</p> <p>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.</p>	

### 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 {03.012} and Pr 03.015

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

There are 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:

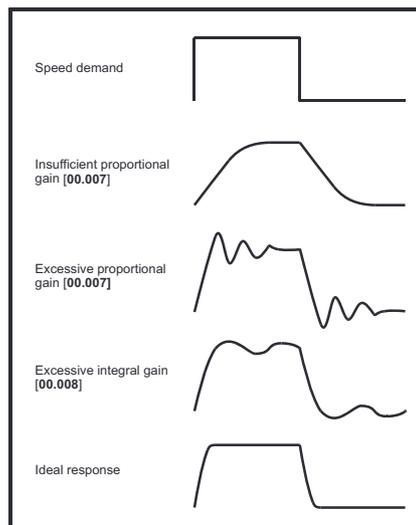
Pr 03.019 - Required compliance angle,

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  $wbw = 2\pi \times \text{Bandwidth}$  (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

<b>Pr 00.046 {05.007} Rated Current</b>	<b>Defines the maximum continuous motor current</b>
<p>The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:</p> <ul style="list-style-type: none"> <li>• Current limits (see section 8.2 <i>Current limits</i> on page 92, for more information)</li> <li>• Motor thermal overload protection (see section 8.3 <i>Motor thermal protection</i> on page 92, for more information)</li> <li>• Vector mode voltage control (see <i>Open Loop Control Mode</i> (00.007), later in this table)</li> <li>• Slip compensation (see <i>Enable Slip Compensation</i> (05.027), later in this table)</li> <li>• Dynamic V/F control</li> </ul>	
<b>Pr 00.044 {05.009} Rated Voltage</b>	<b>Defines the voltage applied to the motor at rated frequency</b>
<b>Pr 00.047 {05.006} Rated Frequency</b>	<b>Defines the frequency at which rated voltage is applied</b>
<p>The <i>Rated Voltage</i> (00.044) and the <i>Rated Frequency</i> (00.047) are used to define the voltage to frequency characteristic applied to the motor (see <i>Open Loop Control Mode</i> (00.007), later in this table). The <i>Rated Frequency</i> (00.047) is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see <i>Rated Speed</i> (00.045), later in this table).</p>	
	<p>The graph shows 'Output voltage' on the y-axis and 'Output frequency' on the x-axis. A line starts at the origin and rises linearly to a point where the frequency is Pr 00.047 and the voltage is Pr 00.044. From this point, the voltage remains constant at Pr 00.044 for higher frequencies. A dashed line from the point (Pr 00.047 / 2, Pr 00.044 / 2) shows the linear portion of the characteristic.</p>
<b>Pr 00.045 {05.008} Rated Speed</b>	<b>Defines the full load rated speed of the motor</b>
<b>Pr 00.042 {05.011} Number Of Motor Poles</b>	<b>Defines the number of motor poles</b>
<p>The motor rated speed and the number of poles are used with the motor rated frequency to calculate the rated slip of induction machines in Hz.</p> $\text{Rated slip (Hz)} = \text{Motor rated frequency} - (\text{Number of pole pairs} \times [\text{Motor rated speed} / 60]) = \mathbf{00.047} = \left( \frac{\mathbf{00.042}}{2} \times \frac{\mathbf{00.045}}{60} \right)$ <p>If <b>Pr 00.045</b> is set to 0 or to synchronous speed, slip compensation is disabled. If slip compensation is required this parameter should be set to the nameplate value, which should give the correct rpm for a hot machine. Sometimes it will be necessary to adjust this when the drive is commissioned because the nameplate value may be inaccurate. Slip compensation will operate correctly both below base speed and within the field-weakening region. Slip compensation is normally used to correct for the motor speed to prevent speed variation with load. The rated load rpm can be set higher than synchronous speed to deliberately introduce speed droop. This can be useful to aid load sharing with mechanically coupled motors.</p> <p><b>Pr 00.042</b> is also used in the calculation of the motor speed display by the drive for a given output frequency. When <b>Pr 00.042</b> is set to 'Automatic', the number of motor poles is automatically calculated from the rated frequency <b>Pr 00.047</b>, and the motor rated speed <b>Pr 00.045</b>.</p> $\text{Number of poles} = 120 \times (\text{Rated Frequency} (00.047) / \text{Rated Speed} (00.045)) \text{ rounded to the nearest even number.}$	
<b>Pr 00.043 {05.010} Rated Power Factor</b>	<b>Defines the angle between the motor voltage and current</b>
<p>The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. The power factor is used in conjunction with the <i>Rated Current</i> (00.046), 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).</p>	
<b>Pr 00.040 {05.012} Autotune</b>	
<p>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.</p> <ul style="list-style-type: none"> <li>• 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 <i>Stator Resistance</i> (05.017), <i>Transient Inductance</i> (05.024), <i>Maximum Deadtime Compensation</i> (05.059) and <i>Current At Maximum Deadtime Compensation</i> (05.060) which are required for good performance in vector control modes (see <i>Open Loop Control Mode</i> (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 <b>Pr 00.043</b>. To perform a Stationary autotune, set <b>Pr 00.040</b> to 1, and provide the drive with both an enable signal (terminal 2 &amp; 6) and a run signal (terminal 11 or 13).</li> <li>• 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 <i>Rated Frequency</i> (05.006) x 2/3, and the frequency is maintained at that level for 4 seconds. <i>Stator Inductance</i> (05.025) is measured and this value is used in conjunction with other motor parameters to calculate <i>Rated Power Factor</i> (05.010). To perform a Rotating autotune, set <b>Pr 00.040</b> to 2, and provide the drive with both an enable signal (terminal 2 &amp; 6) and a run signal (terminal 11 or 13).</li> </ul> <p>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 &amp; 6, setting the <i>Drive Enable</i> (06.015) to OFF (0) or disabling the drive via the <i>Control Word</i> (06.042) and <i>Control Word Enable</i> (06.043).</p>	

### 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)

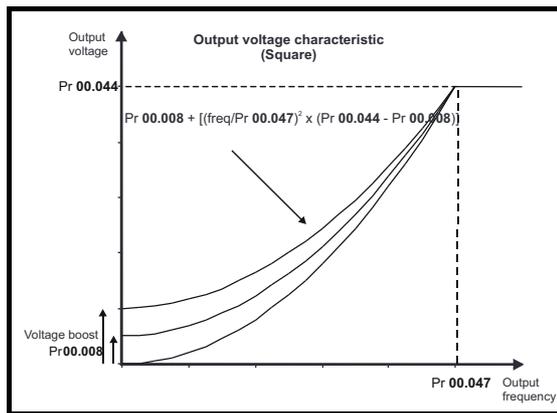
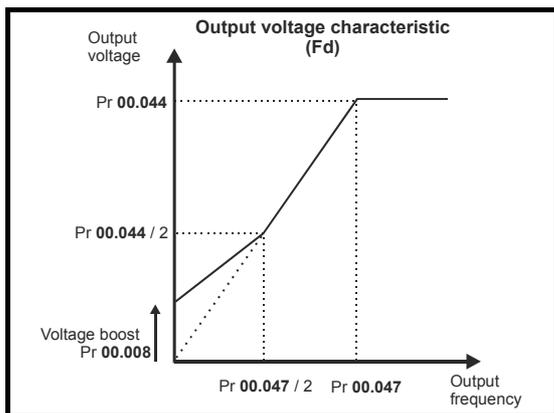
#### Fixed boost

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.

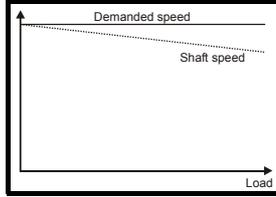
(5) **Square** = This mode provides the motor with a square law voltage characteristic from 0 Hz to *Rated Frequency* (00.047), and then a constant voltage above rated frequency. This mode is suitable for variable torque applications like fans and pumps where the load is proportional to the square of 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  $\frac{1}{2} \times$  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

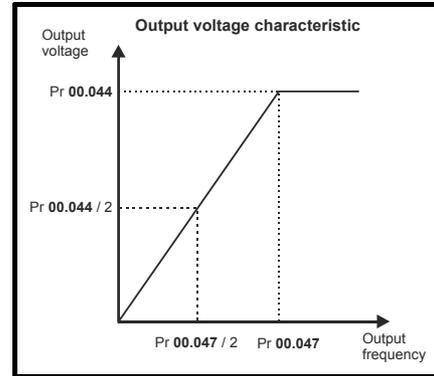
#### Pr 00.044 {05.009} Rated Voltage

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 =  $120 \times (\text{Motor Rated Frequency (00.047)} / \text{Motor Rated Speed (00.045)})$  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.
  - 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.

- The motor is accelerated in the required direction up to 3/4 of the maximum speed reference and then decelerated to zero speed.
- The test is repeated with progressively higher torques until the required speed is reached.
- 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

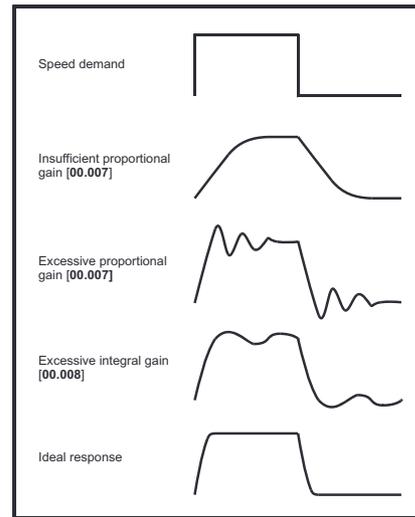
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of 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  $\omega_{bw} = 2\pi \times \text{Bandwidth}$  (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

<b>Pr 00.046 {05.007} Motor Rated Current</b>	<b>Defines the maximum motor continuous current</b>
<p>The motor rated current parameter must be set to the maximum continuous current of the motor. The motor rated current is used in the following:</p> <ul style="list-style-type: none"> <li>• Current limits (see section 8.2 <i>Current limits</i> on page 92, for more information).</li> <li>• Motor thermal overload protection (see section 8.3 <i>Motor thermal protection</i> on page 92, for more information)</li> <li>• Vector control algorithm</li> </ul>	
<b>Pr 00.044 {05.009} Rated Voltage</b>	<b>Defines the voltage applied to the motor at rated frequency</b>
<b>Pr 00.047 {05.006} Rated Frequency</b>	<b>Defines the frequency at which rated voltage is applied</b>
<p>The <i>Rated Voltage</i> (00.044) and the <i>Rated Frequency</i> (00.047) are used to define the voltage to frequency characteristic applied to the motor (see <i>Open Loop Control Mode</i> (00.007), later in this table). The motor rated frequency is also used in conjunction with the motor rated speed to calculate the rated slip for slip compensation (see motor <i>Rated Speed</i> (00.045), later in this table).</p>	
<p>The graph, titled 'Output voltage characteristic', plots Output voltage on the vertical axis against Output frequency on the horizontal axis. A solid line starts at the origin and rises linearly to a point where the frequency is Pr 00.047 and the voltage is Pr 00.044. From this point, the line becomes horizontal, indicating constant voltage. A dashed line from the point (Pr 00.044 / 2, Pr 00.047 / 2) on the linear portion meets the axes at Pr 00.044 / 2 on the y-axis and Pr 00.047 / 2 on the x-axis.</p>	
<b>Pr 00.045 {05.008} Rated Speed</b>	<b>Defines the full load rated speed of the motor</b>
<b>Pr 00.042 {05.011} Number Of Motor Poles</b>	<b>Defines the number of motor poles</b>
<p>The motor rated speed and motor rated frequency are used to determine the full load slip of the motor which is used by the vector control algorithm. Incorrect setting of this parameter has the following effects:</p> <ul style="list-style-type: none"> <li>• Reduced efficiency of motor operation</li> <li>• Reduction of maximum torque available from the motor</li> <li>• Reduced transient performance</li> <li>• Inaccurate control of absolute torque in torque control modes</li> </ul> <p>The nameplate value is normally the value for a hot motor; however, some adjustment may be required when the drive is commissioned if the nameplate value is inaccurate. Either a fixed value can be entered in this parameter or an optimization system may be used to automatically adjust this parameter (see <i>Rated Speed Optimization Select</i> (05.016), later in this table).</p> <p>When Pr 00.042 is set to 'Automatic', the number of motor poles is automatically calculated from the motor <i>Rated Frequency</i> (00.047), and the motor <i>Rated Speed</i> (00.045).</p> <p>Number of poles = <math>120 \times (\text{Motor Rated Frequency (00.047)} / \text{Motor Rated Speed (00.045)}) / \text{Motor}</math> rounded to the nearest even number.</p>	
<b>Pr 00.043 {5.010} Rated Power Factor</b>	<b>Defines the angle between the motor voltage and current</b>
<p>The power factor is the true power factor of the motor, i.e. the angle between the motor voltage and current. If the <i>Stator Inductance</i> (05.025) is set to zero then the power factor is used in conjunction with the motor <i>Rated Current</i> (00.046) 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 <i>Autotune</i> (Pr 00.040), later in this table).</p>	

### 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  $\frac{3}{4} \times \text{Rated Speed}$  (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 {03.012} and Pr 03.015

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

There are 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).

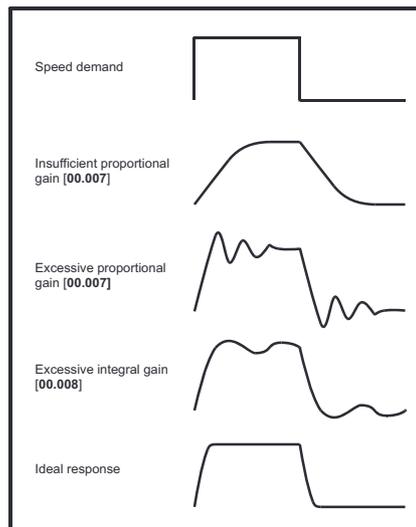
3. Pr 03.017 = 2, Compliance angle set-up

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  $\omega_{bw} = 2\pi \times \text{Bandwidth}$  (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:

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

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

Where:

$I$  = Current Magnitude (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:

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

Where:

$T$  = *Motor Protection Accumulator* (04.019)

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

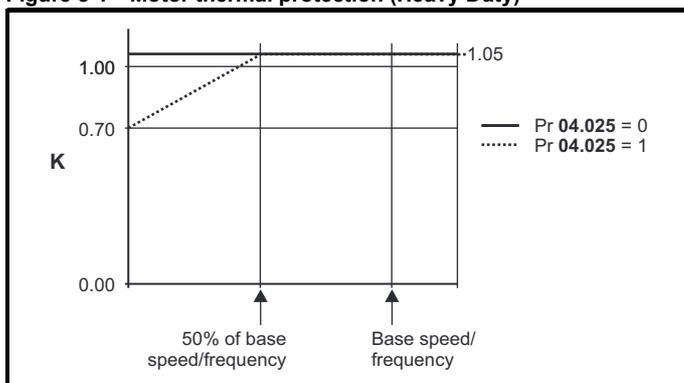
$\tau_1$  = *Motor Thermal Time Constant 1* (00.053)

$\tau_2$  = *Motor Thermal Time Constant 2* (04.037)

$K_1$  = Varies, see below

If *Rated Current* (00.046)  $\leq$  *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  $K_1$  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  $(K - 0.05) \times 100$  % 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 - 167 $\mu$ s 6 kHz - 83 $\mu$ s 12 kHz - 83 $\mu$ s	2 kHz - 250 $\mu$ s 4 kHz - 125 $\mu$ s 8 kHz - 62.5 $\mu$ s 16 kHz - 62.5 $\mu$ s	Peak limit	Current controllers
Level 2	250 $\mu$ s	2 kHz - 500 $\mu$ s 4 kHz - 250 $\mu$ s 8 kHz - 250 $\mu$ s 16 kHz - 250 $\mu$ s	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):

$$\begin{aligned} \text{Maximum speed limit (rpm)} &= \frac{500 \text{ kHz} \times 60}{\text{ELPR}} \\ &= \frac{3.0 \times 10^7}{\text{ELPR}} \end{aligned}$$

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

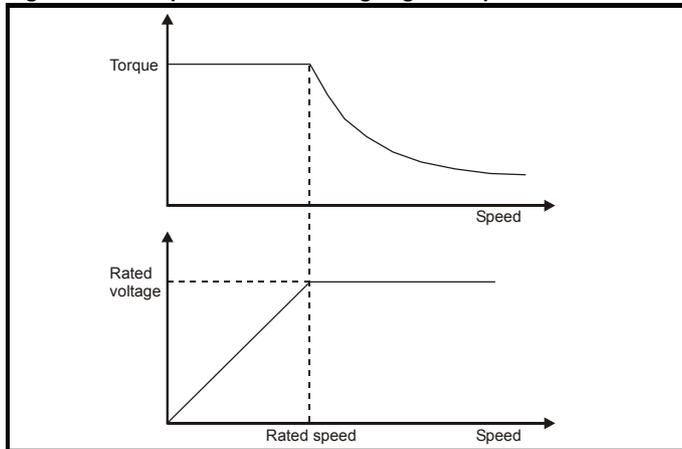
This maximum speed limit is defined by the device selected with the speed feedback selector (Pr **03.026**), and the ELPR set for the position feedback device. In RFC-A mode it is possible to disable this limit via Pr **03.024**, so that the drive can be switched between operation with and without feedback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

# 9 EtherCAT interface

## 9.1 Features

- Standard RJ45 with support for shielded twisted pair, half-duplex / full-duplex and 10 Mbs /100 Mbs connectivity
- Dual 100 Mbps EtherCAT interfaces for use in line topologies i.e. daisy chaining
- Control loop synchronization
- Control cycle times down to 250 μs
- Configured Station Alias
- CANopen over EtherCAT (CoE) which includes:
  - Support of CANopen CiA402
- Cyclic sync position mode
- Interpolated position mode
- Velocity mode
- Homing mode
- One transmit and one receive PDOs via cyclic synchronous communication
- Additional one transmit and one receive PDOs via non-synchronised cyclic communication
- SDO access to all profile objects and drive parameters
- Cyclic sync velocity mode
- Cyclic sync torque mode

## 9.2 What is EtherCAT?

EtherCAT is an open high performance Ethernet-based fieldbus system that overcomes the system limitations of other Ethernet solutions. The Ethernet packet is no longer received, then interpreted and copied as process data at every connection; instead the Ethernet frame is processed on the fly.

The development goal of EtherCAT was to apply Ethernet to automation applications that require short data update times (also called cycle times) with low communication jitter (for synchronization purposes) and low hardware costs. Typical application fields for EtherCAT are machine controls (e.g. semiconductor tools, metal forming, packaging, injection moulding, assembly systems, printing machines, robotics and many others).

## 9.3 EtherCAT interface information

### 9.3.1 Bus media

The EtherCAT interface incorporates two 100 BASE-TX RJ45 ports.

### 9.3.2 Cabling considerations

To ensure long-term reliability it is recommended that any cables used to connect a system together be tested using a suitable Ethernet cable tester, this is of particular importance when cables are constructed on site.

### 9.3.3 Cable

Cables should be shielded and as a minimum, meet TIA Cat 5e requirements.

#### NOTE

Cabling issues are the single biggest cause of network downtime. Ensure cabling is correctly routed, wiring is correct, connectors are correctly installed and any switches or routers used are rated for industrial use. Office grade Ethernet equipment does not generally offer the same degree of noise immunity as equipment intended for industrial use.

### 9.3.4 Maximum network length

The main restriction imposed on Ethernet cabling is the length of a single segment of cable.

The EtherCAT interface has two 100BASE-TX Ethernet ports, which support segment lengths of up to 100 m. This means that the maximum cable length which can be used between one EtherCAT port and another 100BASE-TX port is 100 m however it is not recommended that the full 100 m cable length is used. The total network length is not restricted by

the Ethernet standard but depends on the number of devices on the network and the transmission media (copper, fiber optic, etc.).

#### NOTE

The EtherCAT system designer must consider the impact that the selected network structure will have on performance.

## 9.4 EtherCAT interface terminal descriptions

The EtherCAT interface has two RJ45 Ethernet ports for the EtherCAT network.

The *Digitax HD M753* has two RJ45 Ethernet ports for the EtherCAT network, refer to Figure 9-1 Location of the communication connectors.

A: EtherCAT port 1.

B: EtherCAT port 2.

The shell of the RJ45 connector is capacitively coupled to ground.

Figure 9-1 Location of the communication connectors

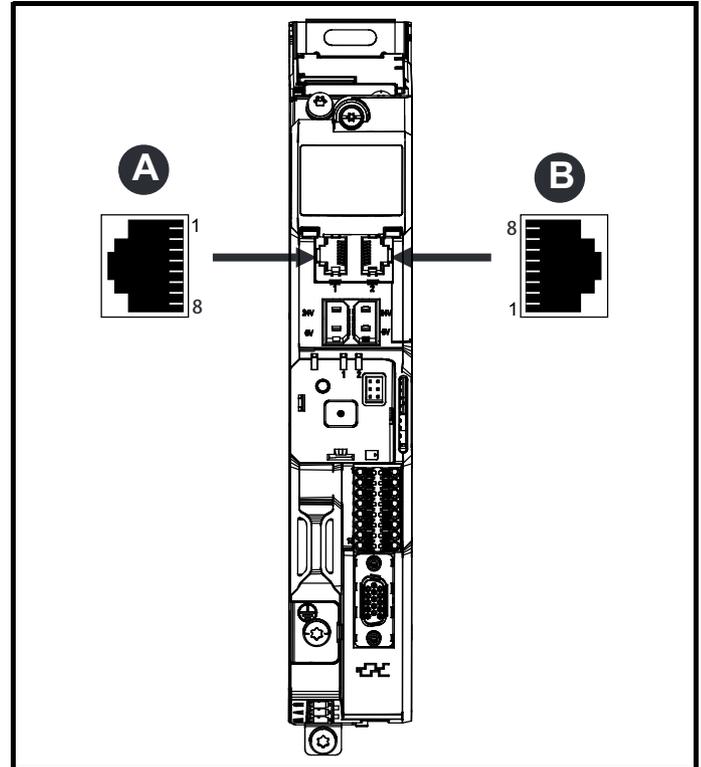


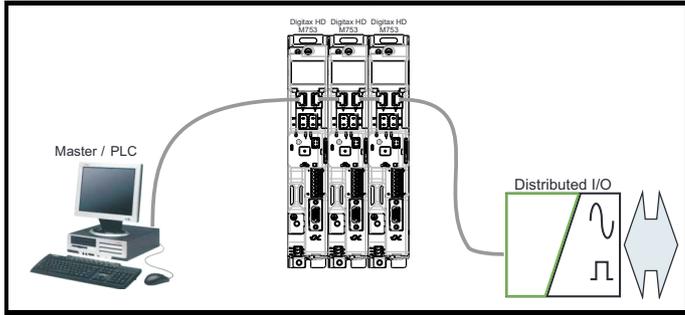
Table 9-1 EtherCAT terminal descriptions

Pin	EtherCAT port 1 - IN	Pin	EtherCAT port 2 - OUT
1	Transmit +	1	Transmit +
2	Transmit -	2	Transmit -
3	Receive +	3	Receive +
4	Not used	4	Not used
5	Not used	5	Not used
6	Receive -	6	Receive -
7	Not used	7	Not used
8	Not used	8	Not used

## 9.5 Network topology

Daisy chain implementation is recommended on EtherCAT networks (see Figure 9-2). Other Ethernet network topologies can be used but care must be taken to ensure that the system still operates within the constraints specified by the designer.

**Figure 9-2 EtherCAT interface daisy chain network topology**



## 9.6 Minimum node-to-node cable length

There is no minimum length of cable recommended in the Ethernet standards. To avoid possible problems it is recommended that you allow sufficient cable length to ensure good bend radii on cables and avoid unnecessary strain on connectors.

## 9.7 Quick start guide

This section is intended to provide a generic guide for setting up EtherCAT interface with a master/controller PLC. It will cover the basic steps required to get cyclic data communicating using the CANopen over EtherCAT (CoE) protocol on the EtherCAT interface.

**Table 9-2 PDO test mappings**

	RxPDO1	TxPDO1
Mapping 1	0x6040 ( <i>controlword</i> ) (16-bits)	0x6041 ( <i>statusword</i> ) (16-bits)
Mapping 2	0x6042 ( <i>vl_target_velocity</i> ) (16-bits)	0x6064 ( <i>position_actual_value</i> ) (32-bits)
Mapping 3	Pr 20.021 (32-bits)	N/A

**NOTE**

It is strongly recommended that the latest firmware be used where possible to ensure that all features are supported.

Due to the large number of different masters that support CoE, details cannot be provided for a specific master. Generic support is available through the supplier of the drive. Before contacting your supplier or local Drive Centre for support please ensure you have referred to section 13 *Diagnostics* on page 222 and have checked that the SDO/PDO configurations are correct.

### 9.7.1 EtherCAT XML file

EtherCAT device description files are provided (in the form of .xml files). These files provide the master with information about the EtherCAT interface and drive configuration to aid with its configuration. These files are available from your local Drive Centre or supplier. They should be placed in the directory specified by the master e.g. when using TwinCAT this could be C:\TwinCAT\3.1\Config\lo\EtherCAT.

**NOTE**

The master may have to be re-started for the file to be loaded.

### 9.7.2 Configuring the EtherCAT interface for cyclic communications

Unlike other fieldbus communication protocols, CoE does not require that any module parameters be changed in order to achieve communications. The baud rate of the network is fixed and the module is automatically allocated an address.

To check that the ethernet cable connected to the EtherCAT interface on the drive is connected correctly, look at the LED on the front of the

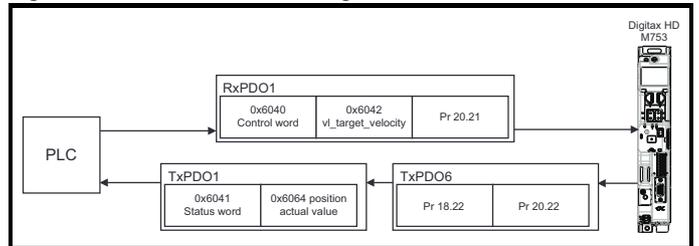
EtherCAT interface relating to the connector being used, if this light is a solid green color then a link is established with the master, if this light is off then check the cabling and also check that the master has started communications.

In the master, scan the network ensuring that the EtherCAT interface is connected correctly to the master. If the network is configured correctly the EtherCAT node(s) should be visible in the PLC master.

Decide on the input / output data you wish to send cyclically (objects and/or parameters). Cyclic data is implemented on CoE networks by using "Process Data Objects" or PDOs. Separate data objects are used for receiving (TxPDOs - from the slave to the master) and transmitting (RxPDOs - from the master to the slave) data.

These PDOs contain the cyclic data (objects and/or parameters), the RxPDOs available are 1, 2, 3, 5 and 6, the TxPDOs available are 1, 2, 3, 5 and 6 (for more information on these PDOs including default mappings please see section 9.13.2 *RxPDO mappings* on page 100 and section 9.13.3 *TxPDO mappings* on page 101).

**Figure 9-3 EtherCAT PDO configuration**



RxPDO1 and TxPDO1 will need to be enabled in the master. Once enabled you will need to add mappings to the PDOs.

The format used when mapping objects to PDOs is as follows:

- Index: Object index number (0x0000)
- Sub-index: Object sub-index number (0x00)
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

The format used when mapping drive parameters to PDOs is as follows:

- Index: 0x2000 + (0x100 x S) + menu number
- Sub-index: 0x00 + parameter number
- Size: Dependant on the size (in bytes) of the object to be mapped (range: 1-4)

For example Pr 20.021 would be index 0x2014, sub-index 0x15 and the size would be 4 (the parameter is a 32-bit signed value).

**NOTE**

The values are normally expressed in hexadecimal, so care must be taken to enter the correct parameter number.

For this example the following objects will need to be set in order to achieve the mappings of the parameters/objects in the PDOs.

**Table 9-3 Cyclic data mapping configuration**

RxPDO1:		TxPDO1:	
Object:	0x1600	Object:	0x1A00
Sub-index:	0x00	Sub-index:	0x00
Size:	1	Size:	1
Value:	3	Value:	2
Sub-index:	0x01	Sub-index:	0x01
Size:	4	Size:	4
Value:	0x60400010	Value:	0x60410010
Sub-index:	0x02	Sub-index:	0x02
Size:	4	Size:	4
Value:	0x60420010	Value:	0x60640020
Sub-index:	0x03	Not Used	
Size:	4		
Value:	0x20141520		

**NOTE**

The format used to define the value of a mapped object is as follows:  
 Bit 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap).  
 Bit 8 to 15: Sub-index of the mapped object (if a gap, zero).  
 Bit 16 to 31: Index of the mapped object (if a gap, zero).

### 9.7.3 Configuring the sync managers

The sync manager is used to control the transmission of CANopen PDOs over the EtherCAT network.

The EtherCAT interface supports two pair of sync managers. In addition to sync manager 2 and sync manager 3 which are used for synchronized cyclic communication, EtherCAT interface also supports sync manager 4 and sync manager 5 which are non-synchronous and can be used for non-synchronized cyclic communication.

The two pair of sync managers can work at the same time in parallel, and each sync manager can be assigned with one PDO (RxPDO or TxPDO).

#### NOTE

The maximum number of mappings in one PDO is twelve. There are no restrictions on the data length of these parameters (i.e. It is possible to map twelve 32-bit parameters in one PDO).

Special for sync manager 4 and sync manager 5, the number of mappings can be up to thirty two, when PDO 6 (RxPDO 6 or TxPDO 6) is used. These extra number of mappings are helpful to applications which require a large number of non-synchronous low priority data exchange.

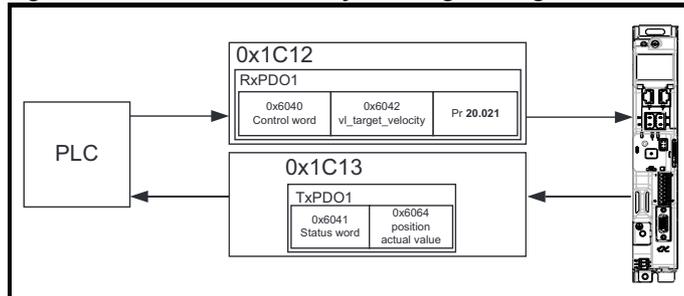
#### NOTE

The master (PC/PLC) may not support sync manager 4 and sync manager 5, please refer to the master controller documentation for the details on the support for sync manager 4 and sync manager 5.

The following objects 0x1C12 - sync manager 2 PDO assignment (RxPDO) and 0x1C13 – sync manager 3 PDO assignment (TxPDO) are required to assign PDOs to the synchronization task.

For the purpose of the example assign one RxPDO to sync manager 2 and one TxPDOs to sync manager 3.

**Figure 9-4 EtherCAT interface sync manager configuration**



#### Assigning RxPDO to the sync manager

To assign RxPDO1 to sync manager 2 PDO assignment set the values below to the following objects:

- Index: 0x1C12
- Sub index: 0x00
- Size: 1
- Value: 1

Setting object 0x1C12, sub-index 0 to a value of 1 (as above) indicates that one RxPDO will be assigned to the sync manager 2 assignment.

- Index: 0x1C12
- Sub index: 0x01
- Size: 2
- Value: 0x1600

Setting object 0x1C12, sub-index 1 to a value of 0x1600 (as above) maps RxPDO1 to the process data output sync.

#### Assigning TxPDO to the sync manager

To assign TxPDO1 to sync manager 3 PDO assignment set the values below to the following objects:

- Index: 0x1C13
- Sub index: 0x00
- Size: 1
- Value: 1

Setting object 0x1C13, sub-index 0 to a value of 1 (as above) indicates that one TxPDOs will be assigned to the sync manager 3 assignment.

- Index: 0x1C13
- Sub index: 0x01
- Size: 2
- Value: 0x1A00

Setting object 0x1C13, sub-index 1 to a value of 0x1A00 (as above) maps TxPDO1 to the process data input sync.

#### Configuring sync manager 4 and sync manager 5

Similar to the configuration of sync manager 2 and sync manager 3 described above, objects 0x1C14-sync manager 4 PDO assignment (RxPDO) and 0x1C15-sync manager 5 PDO assignment (TxPDO) are used to assign PDOs to non-synchronized task.

Sync manager 4 and sync manager 5 require support from master (PC/PLC) side. Depending on the master, the PDOs assigned to the sync managers may require to be configured to a different sync unit manually, please refer to the master controller documentation for full details about configuration at master side.

#### Download the configuration to the master.

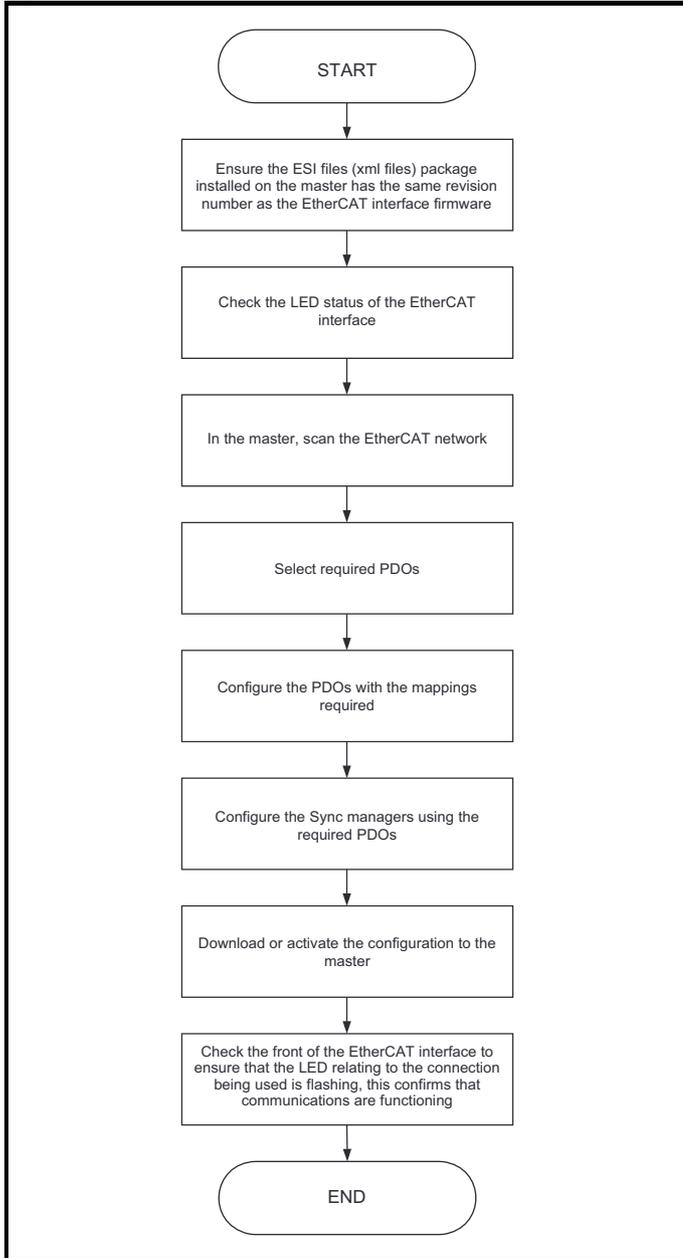
After downloading the configuration to the master the LED(s) on the front of the EtherCAT interface should flash, depending on the port(s) connected.

Values written to parameters over RxPDOs should now be viewable using the drive's keypad so long as the master has put the slave into the operational state; also, parameter values changed using the drive keypad will be updated on the master.

## 9.8 Quick start flowchart

Figure 9-5 details the steps required to achieve cyclic communications on the EtherCAT network. This flowchart should be used as the starting point for all configurations.

Figure 9-5 Quick start flowchart



## 9.9 Saving parameters to the drive

To avoid loss of the configured settings when the drive is powered down a save function must be carried out.

To store drive parameters:

Using a KI-Remote Keypad

- Select 'save parameters in PR mm.000 (alternatively enter a value of 1000 in PR mm.000).
- Press the red  reset button.

Using Connect

- Select the save parameters in drive function



## 9.10 Station alias configuration

A station alias can be used to uniquely identify a particular slave on the EtherCAT network, however it is unnecessary for a user to set a station alias in order to initiate EtherCAT communications.

When a Digitax HD M753 is fitted with a KI-Compact Display the rotary dials on the display allow for an EtherCAT station alias to be configured when set to a non zero value. The station alias feature will also need to be configured in the EtherCAT master.

The station alias setting configured using the KI-Compact Display is an 8 bit value (decimal 1 to 255). The most significant nibble is set by adjusting the top dial and the 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 Table 9-4.

Table 9-4 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 station alias 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 station alias setting in decimal, dial settings and station alias setting are separated with a hyphen (-).

Once the desired dial configurations have been set, the KI-Compact Display will transfer the value to Pr **11.017 Keypad defined node address** and if the value is not zero it will be updated as the station alias in the EtherCAT background. In this case Pr **17.035 Configured station alias** is ignored.

Example:

To set a node address of 55 via the display, with reference to Table 9-4, set the most significant dial to 3 (decimal 48) and the least significant dial to 7 (decimal 7).

### NOTE

The station alias 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 station alias configuration data.

## 9.11 Process Data Objects (PDOs)

Cyclic data is implemented on EtherCAT networks by using "Process Data Objects" or PDOs. Separate data objects are used for transmitting (TxPDOs) and receiving (RxPDOs) data. PDO configuration objects are usually pre-configured in the EtherCAT master controller and downloaded to the EtherCAT interface at network Initialization using SDOs.

## 9.12 Service Data Object (SDO) parameter access

The service data object (SDO) provides access to all objects in the EtherCAT object dictionary and the drive parameters are mapped into the object dictionary as 0x2XXX objects in the following way:

Index:  $0x2000 + (0x100 \times S) + \text{menu number}$

Sub-index:  $0x00 + \text{parameter number}$

For example Pr **20.021** would be index 0x2014 and the sub-index would be 0x15. The values are usually expressed in base 16 (hexadecimal), so care must be taken to enter the correct parameter number.

All other supported entries in the EtherCAT interface object dictionary can also be accessed using SDOs. Refer to the master controller documentation for full details about implementing SDO transfers within the particular master controller.

### Bit parameter mapping

When mapping to drive bit parameters, the parameter is stored in the drive as an 8-bit value, therefore for correct operation, the data type SINT (short integer) should be used for mapping to these parameters.

The following table shows the drive bit parameter value for a given value in the EtherCAT master.

EtherCAT Value		Parameter Value
Decimal	Hex (0x)	
-128 to 0	80 to 00	0 (Off)
1 to 127	01 to 7F	1 (On)

#### NOTE

This is contrary to other option modules where any value other than zero will result in the parameter being set to a 1 (On).

#### NOTE

Sub-index 0 for any menu will return the highest sub-index available for the object (i.e. the highest parameter number).

#### NOTE

The following SDO services are supported:

- Initiate SDO Download (Write)
- Initiate SDO Upload (Read)
- Abort SDO Transfer (Error)

## 9.13 CANopen over EtherCAT (CoE)

The CoE protocol over EtherCAT uses a modified form of the CANopen object dictionary. This is specified in Table 9-5 *CoE object dictionary*.

**Table 9-5 CoE object dictionary**

Index	Object dictionary area
0x0000 to 0x0FFF	Data type area
0x1000 to 0x1FFF	CoE communication area
0x2000 to 0x5FFF	Manufacturer specific area
0x6000 to 0x9FFF	Profile area
0xA000 to 0xFFFF	Reserved area

The object description format describes object related information such as size, range and descriptions and is detailed in Table 9-6 *Object description format*.

**Table 9-6 Object description format**

<index>	<object name>		
Sub-index 0			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			

For entries having sub-indices

**Table 9-7 Object description format with sub-indices**

<index>	<object name>		
Sub-index 0			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			
Sub-index 1			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			
Sub-index ...			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			
Sub-index n-1			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			
Sub-index n			
Access: <access>	Range: <range>	Size: <size>	Unit: <unit>
Default: <default>	Type: <type>		
Description: <description>			

Definitions:

- <index>: A signed 16-bit number. This is the index of the object dictionary entry specified in four hexadecimal characters.
- <access>: A value describing how the object may be accessed (RW = read/write, RO = read-only and WO = write-only).
- <size>: The size of the object/sub-index in bytes.
- <unit>: The physical unit (e.g. ms, counts per second etc.).
- <type>: Data type:-

Data type	Size (bytes)	Range	Description
USINT	1	0 to 255	Unsigned short integer
SINT	1	-128 to 127	Signed short integer
UINT	2	0 to 65535	Unsigned integer
INT	2	-32768 to 32767	Signed integer
UDINT	4	0 to $2^{32}$	Unsigned double integer
DINT	4	$-2^{31}$ to $2^{31}-1$	Signed double integer

### 9.13.1 CoE communication area

The first set of objects specify general communication settings.

**Table 9-8 Device type object**

0x1000		Device type	
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	Dependent on drive type / mode (see description).		Type: UDINT
Description:			
The primary CoE functional profile is CiA402, so the value of this object is defined as follows:			
Bits 0 to 15 (Device Profile Number): 402			
Bit 16 (Frequency Converter): x			
Bit 17 (Servo Drive): y			
Bit 18 (Stepper Motor): 0			
Bit 24 (DC Drive - Manufacturer specific): 0			
Bits 25-31 (Manufacturer specific): 0			
This value will be dependent on the drive operating mode and / or type. In open-loop and RFC-A, bit 16 will be set, while bit 17 will be clear. In RFC-S mode, bit 17 will be set, while bit 16 will be clear.			

**Table 9-9 Identity object**

0x1018		Identity object	
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default:	4		Type: USINT
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x000000F9 (249)		Type: UDINT
Description: This contains the EtherCAT Technology Group vendor ID for Control Techniques (0x000000F9).			
Sub-index 2			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0x01mmvvt		Type: UDINT
Description:			
Product code.			
This contains the drive product code.			
Byte0 (tt): Drive type (2 = M753)			
Byte1 (vv): Drive variant/derivative (derived from Pr 11.028)			
Byte2 (mm): Drive mode (derived from Pr 11.084)			
Byte3 (gg): Drive generation (0 = Unidrive SP; 1 = Unidrive M)			
Sub-index 3			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	Derived from Pr S.00.002		Type: UDINT
Description: Module firmware version in the format <i>major.minor.version.build</i>			
Sub-index 4			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default:	0		Type: UDINT
Description: A value of zero will be returned rather than the module serial number			

### 9.13.2 RxPDO mappings

Objects with indices from 0x1600 to 0x17FF specify receive PDO mappings. The mappings from CiA402 are included as standard (the PDO mappings will have the following default values).

**Table 9-10 RxPDO mappings**

PDO No.	Mapped object indices	Mapped default object names
1	0x6040	controlword
2	0x6040 0x6060	controlword modes_of_operation
3	0x6040 0x607A	controlword target_position
5	0x6040 0x6071	controlword target_torque
6	0x6040 0x6042	controlword vl_target_velocity
8	0x2006:2A	drive controlword

The RxPDO mapping objects are defined in the following tables.

Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file (specified as "CF" in the following descriptions).

**NOTE**

Depending on the drive type and operation mode, not all the RxPDO mappings are defined in the XML configuration file.

**Table 9-11 RxPDO mapping 1**

0x1600		Receive PDO mapping 1	
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default:	1		Type: USINT
Description: The number of mapped objects in the PDO			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the CiA402 control word (0x6040)		Type: UDINT
Description:			
A mapping to an object with the following format:			
Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.			
Bits 8 to 15: Sub-index of the mapped object.			
Bits 16 to 31: Index of the mapped object.			

**Table 9-12 RxPDO mapping 2**

0x1601		Receive PDO mapping 2	
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default:	2		Type: USINT
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60400010 - the CiA402 control word (0x6040)		Type: UDINT
Description:			
A mapping to an object with the following format:			
Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.			
Bits 8 to 15: Sub-index of the mapped object.			
Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFF	Size: 4 bytes	Unit: N/A
Default:	0x60600008 - the CiA402 modes of operation object (0x6060)		Type: UDINT
Description:			
A mapping to an object with the following format:			
Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20.			
Bits 8 to 15: Sub-index of the mapped object.			
Bits 16 to 31: Index of the mapped object.			

**Table 9-13 RxPDO mapping 3**

<b>0x1602 Receive PDO mapping 3</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x607A0020 - the CiA402 target position (0x607A).	Type: UDINT		
Description: A mapping to an object with the following format:  A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

**Table 9-14 RxPDO mapping 5**

<b>0x1604 Receive PDO mapping 5</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60710010 - the CiA402 target torque (0x6071).	Type: UDINT		
Description: A mapping to an object with the following format:  A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

**Table 9-15 RxPDO mapping 6**

<b>0x1605 Receive PDO mapping 6</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 32	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60400010 - the CiA402 control word (0x6040)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60420010 - the CiA402 vI target velocity (0x6042)	Type: UDINT		
Description: A mapping to an object with the following format:  A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

**Table 9-16 RxPDO mapping 8**

<b>0x1607 Receive PDO mapping 8</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x20062A10 - Drive control word (Pr 06.042)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap is required, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

**9.13.3 TxPDO mappings**

Objects with the indices from 0x1A00 to 0x1BFF specify transmit PDO mappings. The following mappings from CiA402 are included as standard.

**Table 9-17 TxPDO mappings**

PDO number	Mapping object index	Mapping object name
1	0x6041	<i>statusword</i>
2	0x6041 0x6061	<i>statusword</i> <i>modes_of_operation_display</i>
3	0x6041 0x6064	<i>statusword</i> <i>position_actual_value</i>
5	0x6041 0x6077	<i>statusword</i> <i>torque_actual_value</i>
6	0x6041 0x6044	<i>statusword</i> <i>vI_velocity_actual_value</i>
8	0x200A:28	<i>drive statusword</i>

The PDO mapping objects are defined below. Each mapping object has the maximum number of sub-indices (each representing an object mapped to a PDO) defined in the XML configuration file.

**NOTE**

Depending on the drive type and operation mode, not all the TxPDO mappings are defined in the XML configuration file.

**Table 9-18 TxPDO mapping 1**

<b>0x1A00 Transmit PDO mapping 1</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of mapped objects in the PDO			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041)	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

**Table 9-19 TxPDO mapping 2**

<b>0x1A01 Transmit PDO mapping 2</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041)	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60610008 - the CiA402 modes of operation display object (0x6061)	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

**Table 9-20 Tx PDO mapping 3**

<b>0x1A02 Transmit PDO mapping 3</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041)	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60640020 - the CiA402 actual position (0x6064)	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

**Table 9-21 TxPDO mapping 5**

<b>0x1A04 Transmit PDO mapping 5</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041).	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60770010 - the CiA402 actual torque (0x6077)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

**Table 9-22 TxPDO mapping 6**

<b>0x1A05 Transmit PDO mapping 6</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 32	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of mapped objects in this PDO.			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60410010 - the CiA402 status word (0x6041).	Type: UDINT		
Default: 0x60410010 - the CiA402 status word (0x6041)			
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			
Sub-index 2: 2nd mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x60440010 - the CiA402 actual motor speed (0x6044).	Type: UDINT		
Description: A mapping to an object with the following format: Bits 0 to 7: Length of the mapped object in bits, e.g. a 32-bit parameter would have a length of 32 or 0x20. Bits 8 to 15: Sub-index of the mapped object. Bits 16 to 31: Index of the mapped object.			

**Table 9-23 TxPDO mapping 8**

<b>0x1A07 Transmit PDO mapping 8</b>			
Sub-index 0: Number of mapped objects			
Access: RW	Range: 0 to 12	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of mapped objects in this PDO.			
Sub-index 1: 1st mapped object			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x200A2810 - Drive status word (Pr 10.040)	Type: UDINT		
Description: A mapping to an object. This will have the following format: Bits 0 to 7: Length of the mapped object in bits (if a gap is required, bit length of the gap). Bits 8 to 15: Sub-index of the mapped object (if a gap, zero). Bits 16 to 31: Index of the mapped object (if a gap, zero).			

### 9.13.4 Sync manager configuration

The sync managers are the EtherCAT means for setting access attributes for different areas of memory and triggering or notifying the application when the memory is accessed. The following objects specify how the sync managers (and thus corresponding memory areas) are utilized by the CoE protocol.

**Table 9-24 Sync manager communication type object**

<b>0x1C00 Sync manager communication type</b>			
Sub-index 0 - number of sync manager channels used			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 6	Type: USINT		
Description: The number of sync manager protocols used by the CoE protocol.			
Sub-index 1 - Usage of sync manager 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: Sync manager 0 is used by CoE as the mailbox receive channel (master to slave).			
Sub-index 2 - Usage of sync manager 1			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: Sync manager 1 is used by CoE as the mailbox send channel (slave to master).			
Sub-index 3 - Usage of sync manager 2			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 3	Type: USINT		
Description: Sync manager 2 is used by CoE as the process data output (RxPDOx - master to slave).			
Sub-index 4 - Usage of sync manager 3			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 4	Type: USINT		
Description: Sync manager 3 is used by CoE as the process data input (TxPDOs - slave to master).			
Sub-index 5 - Usage of sync manager 4			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 3	Type: USINT		
Description: Sync manager 4 is used by CoE as the process data output (RxPDOx - master to slave).			
Sub-index 6 - Usage of sync manager 5			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 4	Type: USINT		
Description: Sync manager 5 is used by CoE as the process data input (TxPDOs - slave to master).			

**Table 9-25 Sync manager 0 PDO assignment object**

<b>0x1C10 Sync manager 0 PDO assignment</b>			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description: Number of assigned PDOs. The mailbox received sync manager can never have PDOs assigned to it.			

**Table 9-26 Sync manager 1 PDO assignment object**

<b>0x1C11 Sync manager 1 PDO assignment</b>			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description: Number of assigned PDOs. The mailbox send sync manager can never have PDOs assigned to it.			

**Table 9-27 Sync manager 2 PDO assignment object**

0x1C12 Sync manager 2 PDO assignment			
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of RxPDOs assigned to this sync manager (used for process data output).			
Sub-indices 1 to (sub-index 0)			
Access: RW	Range: 0x1600 to 0x17FF	Size: 2 bytes	Unit: N/A
Default: One of the defined RxPDO mappings	Type: UINT		
Description: The object index of an RxPDO to assign to this sync manager. The default RxPDO assigned to the object is depending on the drive type and operation mode. For example, with M753 in open loop mode, by default this is assigned to RxPDO mapping 6 ( <i>v<sub>L</sub>_target_velocity and controlword</i> ), which is 0x1605 in hexadecimal.			

**Table 9-28 Sync manager 3 PDO assignment object**

0x1C13 Sync manager 3 PDO assignment			
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of TxPDOs assigned to this sync manager (used for process data input).			
Sub-indices 1 to (sub-index 0)			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default: One of the defined TxPDO mappings	Type: UINT		
Description: The object index of a TxPDO to assign to this sync manager. The default TxPDO assigned to the object is depending on the drive type and operation mode. For example, with M753 in open loop mode, by default this is assigned to TxPDO mapping 6 ( <i>v<sub>L</sub>_velocity_actual_value and statusword</i> ), which is 0x1A05 in hexadecimal.			

**Table 9-29 Sync manager 4 PDO assignment object**

0x1C14 Sync manager 4 PDO assignment			
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of RxPDOs assigned to this sync manager (used for low priority process cyclic data).			
Sub-index 1 to (sub-index 0)			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description: The object index of a RxPDO to assign to this sync manager.			

**Table 9-30 Sync manager 5 PDO assignment object**

0x1C15 Sync manager 5 PDO assignment			
Sub-index 0			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of TxPDOs assigned to this sync manager (used for low priority process cyclic data).			
Sub-index 1 to (sub-index 0)			
Access: RW	Range: 0x1A00 to 0x1BFF	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description: The object index of a TxPDO to assign to this sync manager.			

Sync managers 2 and 3 are used for high-priority deterministic process cyclic data.

Sync managers 4 and 5 are used for low-priority non-deterministic process cyclic data, they support:

- A maximum of 32 x 32-bit parameters allowed in each PDO when PDO6 is used (maximum of 12 x 32-bit parameters only in other PDOs).
- Slot parameter mapping (e.g. SI-Applications Plus menu 7x parameters)
- Note: when using slot parameter mapping, the data size must be 4 bytes (32 bits)
- Minimum cycle time of 2 ms.

### 9.13.5 Feedback encoder source

**Table 9-31 Feedback encoder source**

0x3000 Position Feedback Encoder Configuration			
Sub-index 0			
Access: RW	Range: 0 to 11	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description: This specifies the source for position controller feedback, and the source for CiA402 position feedback objects, even when position control is not being performed. This will have a value as follows:  0 - The feedback source for the position controller will match the drive motor control feedback source (as specified in menu 3). 1 - Drive feedback source, P1 interface. 2 - Drive feedback source, P2 interface. 3 - Slot 1 position feedback module, P1 interface. 4 - Slot 1 position feedback module, P2 interface. 5 - Slot 2 position feedback module, P1 interface. 6 - Slot 2 position feedback module, P2 interface. 11 - Sensorless (the sensorless algorithm estimates position feedback). This value will be ignored on drives where no encoder input is present. This object will be read upon a transition from the EtherCAT Pre-operational state to the Safe-operational state.			

**NOTE**

If the position feedback encoder configuration is changed then the change will only be made active upon a module reset or changing the mode of operation (0x6060), however, if the module is reset to activate the change then a "Sync Task Orun" trip may be seen.

**NOTE**

The value of objects 0x3000 will be ignored on drives which do not support position feedback.

## 9.14 Ethernet over EtherCAT(EoE)

This protocol allows standard Ethernet messages and protocols to be tunnelled through the EtherCAT network; it is an EtherCAT mailbox protocol which provides a means to fragment Ethernet frames and pass the fragments within EtherCAT datagrams.

It is possible to upgrade the Digitax HD M753 host drive firmware via EoE and the EtherCAT master using the change firmware function in Connect.

Updating the EtherCAT interface firmware via the EtherCAT master is not possible. To update the EtherCAT interface firmware it is necessary to connect to the drive via the KI-Compact 485 Adaptor and a USB to EIA-485 or EIA-232 to EIA485 isolated converter. A suitable USB to EIA-485 converter is available from the supplier of the drive (Part number 4500-0096). The EtherCAT interface firmware can then be upgraded using the change firmware function in Connect.

**NOTE**

When a drive firmware update or a file download via EoE is performed, EtherCAT interface may report a "Drive Sync Loss" warning and send an 'SafeOp' state.

Some configuration of the PLC is required to establish the EoE tunnel which involves allocation of IP addresses to the EtherCAT modules and to allow forwarding of packets. This is documented with the PLC documentation.

Some additional configuration of the routing tables within the PC is also required to allow the PC operating system to know to route the packets via the PLC. This is standard network routing configuration required whenever there is a gateway or router between it and the destination network.

## 9.15 Additional position loop scaling

For the cases where different feedback devices with different resolutions are required for the drive velocity loop and the position loop, scaling of the position loop output will be provided.

When the value of these objects are configured to non-default values, they will be applied to the AMC scaling ratio. It will be simplified and multiplied to the AMC output user unit's ratio.

In order to prevent the overflow risk of AMC scaling parameters, before the new AMC output user unit's ratio taking action, it will be checked to make sure the numerator and the denominator of the multiplied result are within 1 to  $2^{31}-1$  range. If outside the range, the AMC scaling ratios will stay at the previous values and the module will trip with 'APLS Failure'.

### NOTE

This calculation occurs only during certain state transitions.

**Table 9-32 Additional position loop scaling**

0x3004 Additional position loop scaling			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: USINT	
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 1 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 1		Type: UDINT	
Description: The additional position loop output scaling numerator			
Sub-index 2			
Access: RW	Range: 1 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 1		Type: UDINT	
Description: The additional position loop output scaling denominator			

## 9.16 Cyclic data loss behaviour

If the timeout period in sub-index 1 is set to 0 then no PDO loss actions will occur. If sub-index 1 is set to a non-zero value and no mapped synchronous PDOs have been accessed for longer than a specified timeout period according to Sub-index 1, the cyclic data loss behaviour will occur.

The drive will first be stopped using the Fault reaction option code object; while this is occurring, the PDO Loss alarm will be set. The cyclic data loss trip will occur according to the setting in Subindex 2. A setting will also be provided to allow a cyclic data loss trip to be forced instantly, if required, regardless of the Fault reaction option code. The number of missed cyclic data objects will be counted and stored in Sub-index 3.

Cyclic data loss detection is only provided for default data task configuration (0x3006, 0x3007).

**Table 9-33 Cyclic data loss behaviour**

0x3005 Cyclic data loss behaviour			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2		Type: USINT	
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 65535	Size: 2 byte	Unit: ms
Default: 0		Type: UINT	
Description: The maximum time, in ms, allowed between accesses to synchronous PDOs (read or writes). If no PDO access occurs for this period, the option will start cyclic data loss handling. If a value of zero is set, no cyclic data loss handling will occur. When used in modes that provide interpolation, thus having a mode-specific cycle time, the loss must be for the duration of (maximum time) cycle. The maximum time will be aligned to the start of a cycle. So for a position cycle time of 4 ms and a maximum time configuration of 6 ms, this would result in a loss detection of 2 cycles or 8 ms of PDO's. The time will always be rounded up to the next cycle. If the maximum time is configured to less than the cycle time then this will be rounded up to the cycle time. For a time of 0 ms the cyclic data loss detection will not trigger for any loss.			
Sub-index 2			
Access: RW	Range: 0 to 3	Size: 1 byte	Unit: N/A
Default: 0		Type: USINT	
Description: Cyclic Data Loss Action; the value will select an action as follows: 0: a trip will never occur; however, a cyclic data loss will still be handled by initiating a motor stop according to the Fault reaction option code and indicating an alarm as previously described. 1: the cyclic data loss trip will occur only after the motor has been stopped according to the Fault reaction option code; in so far as the motor stop can actually be detected, depending on the feedback actually in use, if any. 2: a trip will occur immediately on cyclic data loss (this implies that the motor will coast; no other motor stop will be initiated). 3: no trip and no motor stop.			
Sub-index 3			
Access: RO	Range: 0 to 32767	Size: 2 byte	Unit: N/A
Default: 0		Type: INT	
Description: Cyclic loss counter Provides an indication of the number of PDO's lost. The counter is limited so when it reaches 32767 it stops counting. The counter is reset when the EtherCAT profile mode is changed.			

### NOTE

There are two mechanisms monitoring the cyclic data communication, they are cyclic data loss and PDO loss. Cyclic data loss means the complete cyclic link connection has been lost, for example, unplugging the EtherCAT cable. PDO loss means one or more PDO data packets have been lost within one sync cycle, while the cyclic link connection is still running.

Object 0x3005 configures the behaviour on a cyclic data loss, which allows the user to define the time period of losing cyclic data to be treated as cyclic data loss and what action should the drive take in the event of it.

In the event of the PDO data not being detected within the synchronisation cycle the drive will indicate a 'PDOs Lost' alarm.

## 9.17 Drive profile (CiA402) support

The EtherCAT interface supports the following modes of the CiA402 profile:

- Homing Mode
- Cyclic Synchronous Position Mode
- Interpolated Position Mode
- vl velocity mode
- Cyclic Synchronous Velocity Mode
- Cyclic Synchronous Torque Mode

### 9.17.1 0x6040 Controlword

This provides the primary method of controlling the behavior of the drive e.g. enabling, disabling, resetting, etc. Table 9-34 describes the format of the control word. The individual bits are used in combinations (see Table 9-35) to sequence the drive through the state machine described in Figure 9-6.

**Table 9-34 Controlword**

0x6040		Controlword													
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: N/A												
Default: N/A	Type: UINT														
Description:	Provides the primary method of controlling the behavior of the drive.														
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Reserved		ila	r	oms	h	fr	oms	hos	eo	qs	ev	so			

LEGEND: ms = manufacturer-specific; r = reserved; oms = operation mode specific; h = halt; fr = fault reset; hos = homing operation start; eo = enable operation; qs = quick stop; ev = enable voltage; so = switch on

**Table 9-35 Command coding**

Command	Bits of the controlword				
	Bit 7	Bit 3	Bit 2	Bit 1	Bit 0
Shutdown	0	X	1	1	0
Switch on	0	0	1	1	1
Switch on + enable operation	0	1	1	1	1
Disable voltage	0	X	X	0	X
Quick stop	0	X	0	1	X
Disable operation	0	0	1	1	1
Enable operation	0	1	1	1	1
Fault reset		X	X	X	X

NOTE: Automatic transition to Enable operation state after executing SWITCHED ON state functionality.

### 9.17.2 0x6041 Statusword

This provides feedback about the current operating state of the drive. Table 9-36 describes the format of the status word and illustrates how the individual statusword bits are combined to represent the current state of the drive.

**Table 9-36 Statusword bit functions**

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
ms		ha	ila	tr	rm	ms	w	sod	qs	ve	f	oe	so	rts0	

LEGEND: ms = manufacturer-specific; ha = homing attained; oms = operation mode specific; ila = internal limit active; tr = target reached; rm = remote; w = warning; sod = switch on disabled; qs = quick stop; ve = voltage enabled; f = fault; oe = operation enabled; so = switched on; rts0 = ready to switch on

**Table 9-37 State coding**

Statusword	State
xxxx xxxx x0xx 0000b	Not ready to switch on
xxxx xxxx x1xx 0000b	Switch on disabled
xxxx xxxx x01x 0001b	Ready to switch on
xxxx xxxx x01x 0011b	Switched on
xxxx xxxx x01x 0111b	Operation enabled
xxxx xxxx x00x 0111b	Quick stop active
xxxx xxxx x0xx 1111b	Fault reaction active
xxxx xxxx x0xx 1000b	Fault

When using CoE to control the motor position, if the status word indicates a fault due to a drive trip, then to clear the fault, the fault reset command should be executed; if the drive is reset by the keypad then the status word will not be reset and will still indicate a fault condition.

## 9.18 Common profile features

### 9.18.1 Sequencing control

These are the supported objects used to control the drive:

**Table 9-38 Sequencing control supported objects**

Index	Name
6040	Controlword
6041	Statusword
605B	shutdown_option_code
605C	disable_operation_option_code
605A	quick_stop_option_code
605D	halt_option_code
605E	fault_reaction_option_code
6060	modes_of_operation
6061	modes_of_operation_display
6080	max_motor_speed
6084	profile_deceleration
6085	quick_stop_deceleration
6502	supported_drive_modes

The behaviour of the sequencing control is shown in Figure 9-6 on page 107. This state machine indicates how the drive will be controlled. Status word is abbreviated to "SW" in the diagram.

The initial state of the CiA402 state machine is "NOT READY TO SWITCH ON". The module must be in the EtherCAT operational state before any further state transitions can happen. If the module goes back to pre-operational state when the CiA402 state machine is in the "SWITCH ON DISABLED", "READY TO SWITCH ON", "SWITCHED ON", "OPERATION ENABLE" or "QUICK STOP ACTIVE" states, the option will transition to the "NOT READY TO SWITCH ON" state. This implies that the drive will stop according to the configured stopping method and the drive will be inhibited after the motor has stopped.

In the state "QUICK STOP ACTIVE", the currently selected mode of operation indicates how a quick stop should be handled. When the drive is stopped (using the ramp defined in 0x605A Quick\_Stop\_Option\_Code object), and the Quick stop option code doesn't indicate that the state should remain at "QUICK STOP ACTIVE", the state will move to "SWITCH ON DISABLED".

If one of the drive limit switches becomes active, the drive will be slowed down with the ramp specified by the quick stop option code.

The "internal limit active" bit (11) of the status word will be updated in states "OPERATION ENABLED" and "QUICK STOP ACTIVE". It will be set as soon as the hardware/software limit becomes active, and it will be cleared as soon as the limit becomes inactive. This bit is supported in cyclic sync position mode, cyclic sync velocity mode, interpolation position mode and homing mode.

The default value in mode\_of\_operation will be 2 (i.e. velocity mode) on an Open loop drive or mode, and it will be 8 (Cyclic Sync Position mode) with RFC-A or RFC-S (and on any drive and mode combination that can support position control). It can be changed at any time as long as the motor is at zero speed. If the mode of operation is correct and any associated data is correct, the change will occur and the new operation mode will be reflected in the mode\_of\_operation\_display object. If the mode is invalid, or data is incorrect, the mode of operation will not be changed.

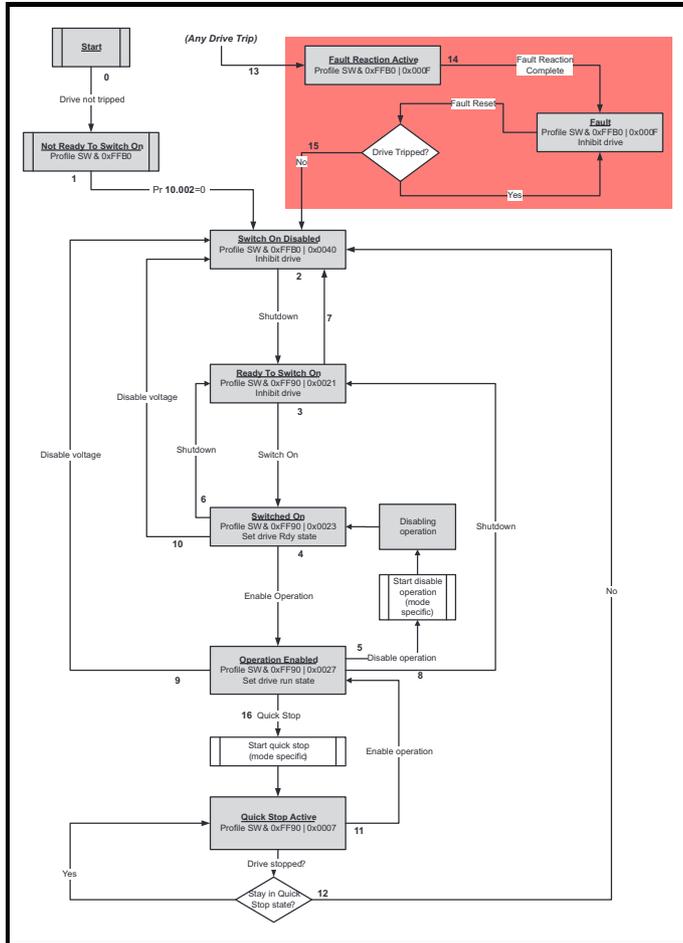
The mode\_of\_operation object is read in all CiA402 states so that the operating mode can be changed at any time, which is necessary for homing: some axes (e.g. vertical axes) have to be homed and start ordinary positioning operation without the need to remove power from the motor, which, on a vertical axis, might allow a tool, to fall and be damaged or cause damage. However, the state machine will not perform a mode change until the motor is at zero speed, as far as can be determined.

The max\_motor\_speed object specifies a maximum speed in RPM; it will have a default value matching the drive parameter Pr 01.006 ("Maximum reference clamp", the object value will be set to the value of Pr 01.006 at power up, or if Pr 01.006 is explicitly changed), and it will be used to set this parameter. It will also be scaled and used to set the position controller output speed clamp (Pr 39.011). It will be applied in all of the CiA402 operating modes. For example, if the max\_motor\_speed object is set to 6000, the position controller output speed clamp will be set to a value to give a limit of 6000 rpm.

The initial value of gear\_ratio, feed\_constant and additional\_position\_loop\_scaling objects (e.g. user configuration in start-up list) will be checked during the EtherCAT operational state transition 'READY TO SWITCH ON' to 'SWITCHED ON'. During earlier CiA402 state machine transitions, the value of these objects can be changed at any time. However the change won't take effect until a CiA402 state transition from 'READY TO SWITCH ON' to 'SWITCHED ON' happens.

If any ratio fails to be applied, the EtherCAT module will not apply new values to the AMC.

**Figure 9-6 CoE state machine diagram**



**Table 9-39 CoE state machine transition and events**

Transition	Event(s)	Action(s)
0	Automatic transition after power-on or reset application	Drive device self-test and/or self Initialization shall be performed
1	Automatic transition	Communication shall be activated
2	Shutdown command from control device or local signal	None
3	Switch on command received from control device or local signal	Power section shall be switched on if not already switched on
4	Enable operation command received from control device or local signal	Drive function shall be enabled and clear all internal set-points
5	Disable operation command received from control device or local signal	Drive function shall be disabled
6	Shutdown command received from control device or local signal	The high-power shall be switched off immediately, and the motor shall be free to rotate if not braked; additional action depends on the shutdown option code
7	Quick stop or disable voltage command from control device or local signal	None
8	Shutdown command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
9	Disable voltage command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
10	Disable voltage or quick stop command from control device or local signal	The high-power shall be switched off immediately if possible, and the motor shall be free to rotate if not braked
11	Quick stop command from control device or local signal	The quick stop function shall be started
12	Automatic transition when the quick stop function is completed and quick stop option code 1, 2, 3 or 4 disable voltage command received from control device (dependant on the quick stop option code)	The power section shall be switched off
13	Fault signal	The configure fault reaction function shall be executed
14	Automatic transition	The drive function shall be disabled; the high-power may be switched off
15	Fault reset command from control device or local signal	A reset of the fault condition is carried out, if no fault exists currently on the drive device; after leaving the Fault state, the Fault reset bit in the controlword shall be cleared by the control device
16	Enable operation command from control device, if the quick stop option code is 5, 6, 7 or 8	The drive function shall be enabled

### 9.18.2 0x605A Quick stop option code

This object indicates what action is performed when the quick stop function is executed. The slow down ramp is the deceleration value of the used mode of operations.

**Table 9-40 Quick\_stop\_option\_code**

<b>0x605A</b>	<b>Quick_stop_option_code</b>		
Sub-index 0			
Access: RW	Range: 0 to 6	Size: 2 bytes	Unit: N/A
Default: 2	Type: INT		
Description:	Specifies what action is performed in the event of a quick stop function. See Table 9-39 <i>CoE state machine transition and events</i> on page 107 for more information.		

**Table 9-41 Quick stop value definitions**

Value	Definition
0	Disable drive function
1	Slow down on slow down ramp and transit into Switch on disabled
2	Slow down on quick stop ramp and transit into Switch on disabled
5	Slow down on slow down ramp and stay in Quick stop active
6	Slow down on quick stop ramp and stay in Quick stop active

### 9.18.3 0x605B Shutdown\_option\_code

This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.

**Table 9-42 Shutdown\_option\_code**

<b>0x605B</b>	<b>Shutdown_option_code</b>		
Sub-index 0			
Access: RW	Range: -1 to 1	Size: 2 bytes	Unit: N/A
Default: N/A	Type: INT		
Description:	Used to control what action is performed if there is a transition from the Operation Enabled state to the Ready To Switch On state.		

**Table 9-43 Shutdown\_option\_code values**

Value	Definition
0	Disable drive function (switch off the drive power stage)
1	Slow down with slow down ramp; disable the drive function
-1	Slow down with slow down ramp, wait for brake to be fully applied (by waiting for Zero Hold (Pr 6.008) to clear); then disable the drive

### 9.18.4 0x605C Disable\_operation\_option\_code

Disable drive function (switch off the drive power stage).

This object is used to control what action is performed if there is a transition from the 'Operation Enabled' state to the 'Switched On' state.

**Table 9-44 Disabled\_operation\_option\_code**

<b>0x605C</b>	<b>Disable_operation_option_code</b>		
Sub-index 0			
Access: RW	Range: 0 to 1	Size: 2 bytes	Unit: N/A
Default: N/A	Type: INT		
Description:	This object is used to control what action is performed if there is a transition from the Operation Enabled state to the Switched On state.		

**Table 9-45 Disable\_operation\_option\_code values**

Value	Definition
0	Disable drive function (switch off the drive power stage)
1	Slow down with slow down ramp; disable the drive function

### 9.18.5 0x605D Halt\_option\_code

This object shall indicate what action is performed when the halt function is executed.

#### Fault\_reaction\_option\_code

<b>0x605D</b>	<b>Halt_option_code</b>		
Sub-index 0			
Access: RW	Range: 0 to 2	Size: Signed 16	Unit: N/A
Default: 0	Type: INT		
Description:	This object is used to control what action is performed if a Halt is called.		

#### Fault\_reaction\_option\_code values

Value	Definition
0	Reserved (no action)
1	Slow down with slow down ramp; stay in Operation enabled
2	Slow down with quick stop ramp; stay in Operation enabled

### 9.18.6 0x605E Fault\_reaction\_option\_code

This object is used to control what action is performed when a fault is detected (PDO loss).

This object is ignored if the drive is tripped.

**Table 9-46 Fault\_reaction\_option\_code**

<b>0x605E</b>	<b>Fault_reaction_option_code</b>		
Sub-index 0			
Access: RW	Range: 0 to 2	Size: 2 bytes	Unit: N/A
Default: N/A	Type: INT		
Description:	This object is used to control what action is performed when a fault is detected.		

**Table 9-47 Fault\_reaction\_option\_code values**

Value	Definition
0	Disable drive function, motor is free to rotate
1	Slow down on slow down ramp
2	Slow down on quick stop ramp

### 9.18.7 0x6060 Modes\_of\_operation

This object is used to request a change in the mode of operation.

**Table 9-48 Modes\_of\_operation**

<b>0x6060</b>	<b>Modes_of_operation</b>		
Sub-index 0			
Access: RW	Range: 0 to 10	Size: 1 byte	Unit: N/A
Default: 2	Type: SINT		
Description:	This object is used to request a change in the mode of operation.		

#### NOTE

The default for this object is dependent on the drive operating mode. In Open-loop the default is 2. In RFC-S the default is 8.

**Table 9-49 Modes\_of\_operation values**

Value	Definition
0	No mode change
2	vI velocity mode
6	Homing mode
7	Interpolated Position mode
8	Cyclic Sync Position mode
9	Cyclic Sync Velocity mode
10	Cyclic Sync Torque mode

### 9.18.8 0x6061 Modes\_of\_operation\_display

This read only object indicates the active mode of operation.

**Table 9-50 Modes\_of\_operation\_display**

<b>0x6061</b>	<b>Modes_of_operation_display</b>		
Sub-index 0			
Access: RO	Range: 0 to 10	Size: 1 byte	Unit: N/A
Default: N/A	Type: SINT		
Description: Used to provide the active mode of operation.			

**Table 9-51 Modes\_of\_operation\_display values**

Value	Definition
0	No mode change
2	vl velocity mode
6	Homing mode
7	Interpolated Position mode
8	Cyclic Sync Position mode
9	Cyclic Sync Velocity mode
10	Cyclic Sync Torque mode

### 9.18.9 0x6084 Profile deceleration

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object (0x605A) is set to 1 or 5. This object is also used for shutdown when shutdown option code (0x605B) is set to 1, and for disable operation when disable operation option code (0x605C) is set to 1. It is also used if the fault reaction code object (0x605E) is 1. The value is given in user defined acceleration units. This object will not be used for vl velocity mode. This object will not be used for vl velocity mode.

**Table 9-52 Profile deceleration**

<b>0x6084</b>	<b>Profile deceleration</b>		
Access: RW	Range:0 to 65536	Size: 4 bytes	Unit: N/A
Default: 65536	Type: UDINT		
Description: Provides the deceleration ramp for the positioning modes			

### 9.18.10 0x6085 Quick\_stop\_deceleration

This object is used to configure the deceleration rate used to stop the motor when the quick stop function is activated and the quick stop code object (0x605A) is set to 2 or 6. The quick stop deceleration is also used if the fault reaction code object (0x605E) is 2. The value is given in user-defined acceleration units. This object will not be used for vl velocity mode.

**Table 9-53 Quick\_stop\_deceleration**

<b>0x6085</b>	<b>Quick_stop_deceleration</b>		
Sub-index 0			
Access: RW	Range:Range:0 to 65536	Size: 4 bytes	Unit: N/A
Default: 65536	Type: UDINT		
Description: Quick stop function for the positioning related modes.			

### 9.18.11 Profile units

The EtherCAT interface implementation provides a means to convert profile units into position controller and drive units. All scaling values are standard profile objects. The following objects are supported:

**Table 9-54 Supported profile units**

Index	Name
0x608F	<i>position_encoder_resolution</i>
0x6091	<i>gear_ratio</i>
0x6092	<i>feed_constant</i>

The initial value of the feed constant object (0x6092) shall be calculated from the normalization turns parameter of the associated encoder channel if the default values have not been modified.

If either value is non default the values will be taken as is.

For positions, the scaling control will include a feed constant, a gear ratio and an encoder resolution. These values will be combined together to scale the drive position (i.e. encoder increments) to position in user-defined unit by the following formula.

$$\text{user defined unit position} = \frac{\text{drive position} \cdot \text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ratio}}$$

It will be possible to change these values non-cyclically (i.e. using SDOs), it will not, however, be possible to change these values cyclically (i.e. by mapping PDOs to them).

The position encoder resolution object 0x608F will be read-only and its value will be derived from drive parameter values. The numerator of 0x608F will be derived from the normalization turns parameter of the associated encoder channel. The denominator of 608F will be always 1.

The user-defined position and velocity values will be handled in signed 32-bit values. The scaled position will rollover the boundary if it is too large.

When the gear ratio or the feed constant is applied, the combination of  $\frac{\text{feed constant}}{\text{position encoder resolution} \cdot \text{gear ratio}}$  will be calculated and simplified.

The result will be applied to the AMC slave user unit's ratio and its inverse value will be put in the AMC output user unit's ratio. To prevent the overflow risk of AMC ratio parameters, before being applied, the size will be checked to make sure the numerator and the denominator of the combined results are within 1 to  $2^{31}-1$  range. If not, the module will trip 'Scaling failure' and the AMC scaling ratios will stay previous value.

#### NOTE

The Gear ratio object will not be used for Homing mode.

### 9.18.12 0x608F Position\_encoder\_resolution

This read only object indicates the configured encoder increments per number of motor revolutions.

The information is read from the drive's encoder configuration.

**Table 9-55 Position\_encoder\_resolution**

<b>0x608F</b>	<b>Position_encoder_resolution</b>		
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description:			
Sub-index 1			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 65536	Type: UDINT		
Description: Encoder increments, derived from the normalization turns of the associate encoder channel			
Sub-index 2			
Access: RO	Range: N/A	Size: 4 bytes	Unit: N/A
Default: 1	Type: UDINT		
Description: Motor revolutions, always 1			

### 9.18.13 0x6091 Gear\_ratio

This object is used to apply scaling. When configured, appropriate user units can be used to control the position of the shaft beyond a gearbox. The gear ratio is calculated using the following formula:

$$\text{gear ratio} = \text{motor shaft revolutions} / \text{driving shaft revolutions}$$

**Table 9-56 Gear\_ratio**

0x6091 Gear_ratio			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description:			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 1	Type: UDINT		
Description: Motor revolutions			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 1	Type: UDINT		
Description: Shaft revolutions			

### 9.18.14 0x6092 Feed\_constant

This is used to configure a feed constant. This is the measurement distance per one revolution of the output shaft of the gearbox. The feed constant is calculated using the following formula:

$$\text{feed constant} = \text{feed} / \text{driving shaft revolutions}$$

**Table 9-57 Feed\_constant**

0x6092 Feed_constant			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description:			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 65536	Type: UDINT		
Description: Feed			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 1	Type: UDINT		
Description: Shaft revolutions			

### 9.18.15 Touch Probe Functionality

#### 9.18.15.1 General touch probe definition

Touch probe function is supported in RFC-S mode and RFC-A mode. It is not available in open-loop mode.

Touch probe 1 only is supported, which allows a positive and/or a negative edge to be registered and distinguished between; both of the two drive freeze sources will be utilised in order to achieve this function (F1 will be used to detect positive edges and F2 will be used to detect negative edges).

The position capture source of the touch probe 1 will follow the object 0x3000 Position Feedback Encoder Configuration. Currently touch probe function only supports the drive P1 or P2 interface as the position capture source.

The trigger source of the touch probe 1 can be configured to use either: drive digital inputs (currently only digital input 4 and digital input 5 are supported) or, the position encoder zero impulse signal through object 0x60B8 and 0x60D0. When the hardware zero impulse signal is used as the trigger source, the position capture source interface marker input will be used to trigger the freeze system. When the software zero impulse signal is used, the freeze system will be trigger when the normalized

position value of the position capture source interface passes through zero in either direction.

The following objects are supported:

Index	Name
60B8	Touch probe function
60B9	Touch probe status
60BA	Touch probe 1 positive edge
60BB	Touch probe 1 negative edge
60D0	Touch probe source

**Table 9-58 Touch probe function**

0x60B8 Touche probe function			
Access: RW	Range: N/A	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description:			
This will specify the touch probe functionality; the following bits are supported:			
	<b>Bit</b>	<b>Value</b>	<b>Definition</b>
	0	0	Switch off touch probe 1
		1	Enable touch probe 1
	1	0	Trigger first event
		1	Continuous trigger
	3, 2	00 <sub>b</sub>	Trigger with touch probe 1 input (drive digital input 4)
		01 <sub>b</sub>	Trigger with hardware zero impulse signal of position encoder
		10 <sub>b</sub>	Touch probe source as defined in object 0x60D0,sub-index 0x01
	4	11 <sub>b</sub>	Reserved
		0	Switch off sampling at positive edge of touch probe 1
	5	1	Enable sampling at positive edge of touch probe 1
		0	Switch off sampling at negative edge of touch probe 1
	6-15	1	Enable sampling at negative edge of touch probe 1
		-	<Unused; Have no effect>

**Table 9-59 Touch probe status**

0x60B9 Touch probe status			
Access: RO	Range: N/A	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description:			
This indicates the status of the touch probe functionality; the bits, when set, will have the following meanings:			
	<b>Bit</b>	<b>Value</b>	<b>Definition</b>
	0	0	Touch probe 1 is switched off
		1	Touch probe 1 is enabled
	1	0	Touch probe 1 no positive edge value stored
		1	Touch probe 1 positive edge position stored
	2	0	Touch probe 1 no negative edge value stored
		1	Touch probe 1 negative edge position stored
	3-15	-	<Unused; Always 0>

**Table 9-60 Touch probe source**

0x60D0 Touch probe source			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 1	Type: USINT		
Description: The number of the highest sub-index of this object			
Sub-index 1			
Access: RW	1 to 5	Size: 2 bytes	Unit: N/A
Default: 1	Type: INT		
Description: Touch probe 1 source			

The touch probe source can be defined with the following values:

Value	Definition
1	Drive digital input 4
2	Drive digital input 5
3	Not supported
4	Not supported
5	Hardware zero impulse signal of position encoder
6	Software zero impulse signal of position encoder
-1	P1 marker
-2	P2 marker

**Table 9-61 Touch probe 1 positive edge**

0x60BA Touch probe 1 positive edge			
Access: RO	Range: N/A	Size: 4 bytes	Unit: User-defined position units
Default: 0	Type: DINT		
Description: This will contain a position value frozen when a positive edge occurred on the touch probe 1 input. The value will only be valid when the positive position stored bit is set.			

**Table 9-62 Touch probe 1 negative edge**

0x60BB Touch probe 1 negative edge			
Access: RO	Range: N/A	Size: 4 bytes	Unit: User-defined position units
Default: 0	Type: DINT		
Description: This will contain a position value frozen when a negative edge occurred on the touch probe 1 input. The value will only be valid when the negative position stored bit is set.			

The Touch Probe Status (0x60B9), Touch probe 1 positive edge (0x60BA) and Touch probe 1 negative (0x60BB) objects will be updated every 250  $\mu$ s, and it will be possible to include them in TxPDOs.

The enable touch probe 1 (bit 0), enable positive edge sampling (bit 4) and enable negative edge sampling (bit 5) of the Touch probe function (0x60B8) objects will be read and acted upon every 250  $\mu$ s.

The other bits of the touch probe function object and the touch probe source object 0x60D0 which are used for touch probe configuration (i.e. trigger source, trigger mode) will be acted up on in the background. However the touch probe configuration will not manipulate the drive freeze system until first time enabled, this is to make sure customer configuration for the drive freeze system will not be changed if they are not using touch probe. After drive system first been configured, the new touch probe configuration will take effect when the CANopen state machine leaves operating states (i.e. operation-enabled and quick-stop-active).

It will be possible to include touch probe function object 0x60B8 in the RxPDOs. The touch probe source (0x60D0) object can only be accessed by SDO.

### 9.18.15.2 Trigger mode of touch probe

There are two trigger modes that can be configured via trigger mode (bit 1) of the touch probe function object (0x60B8):

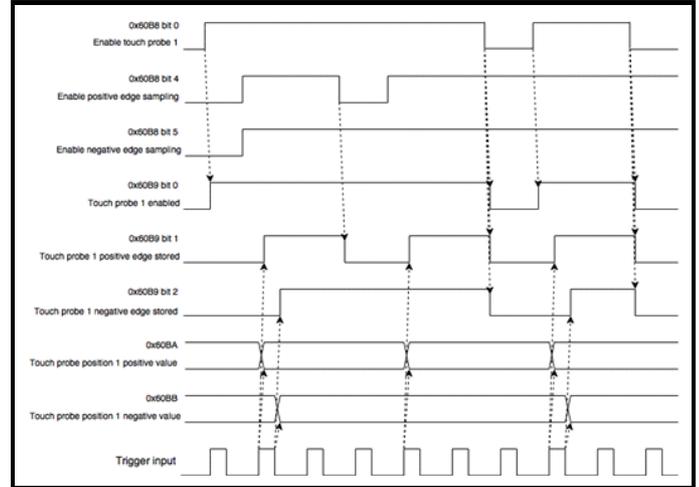
- **Trigger first event:** this mode captures the position and set the position stored bit when the first event of the trigger source occurs. The further events won't be captured until the enable bit(s) is cleared and reset.

- **Continuous:** this mode captures the position each time an event occurs from the trigger source.

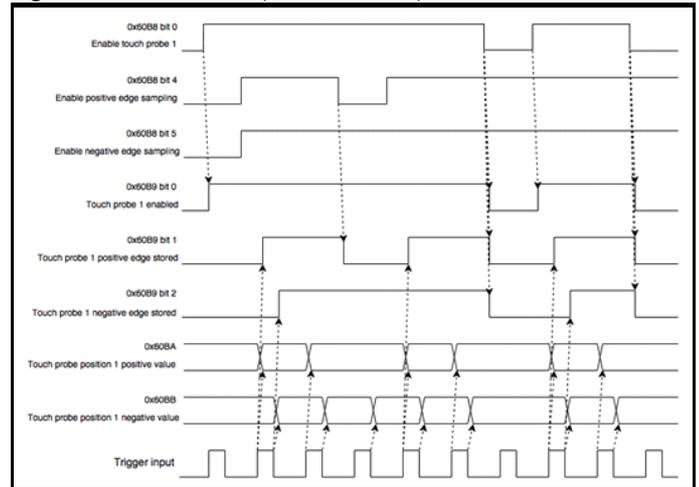
The position stored bit will only set for the first trigger, no further indication when additional events occur. The value in the stored position object(s) will reflect the most recent record. The position stored bit will be cleared once the associate enable bit is cleared, however the stored position will retain.

Here are two example timing diagrams, to explain the operation sequence of the touch probe function:

**Figure 9-7 Trigger first event (0x60B8 bit1 = 0)**



**Figure 9-8 Continuous (0x60B8 bit1 = 1)**



### 9.18.16 Basic position control

Basic position control is supported in RFC-A and RFC-S modes.

The position control described here is used under the interpolated position mode of operation. Table 9-63 lists the objects that are supported:

**Table 9-63 Basic position control supported objects**

Index	Name
0x6062	<i>position_demand_value</i>
0x6065	<i>following_error_window</i>
0x6067	<i>position_window</i>
0x60F4	<i>following_error_actual_value</i>
0x60FB	<i>position_control_parameter_set</i>

### 9.18.17 0x6062 Position\_demand\_value

This read only object is used to provide the currently demanded position value. The value is given in user defined position units.

**Table 9-64 Position\_demand\_value**

<b>0x6062 Position_demand_value</b>			
Sub-index 0			
Access: RO	Range: 0x80000000 to 0x7FFFFFFF	Size: 4 bytes	Unit: N/A
Default: N/A	Type: DINT		
Description: Used to provide the currently demanded position value.			

### 9.18.18 0x6064 Position\_actual\_value

This read only object provides the actual value of the position feedback device. The value is given in internal units.

**Table 9-65 Position\_actual\_value**

<b>0x6064 Position_actual_value</b>			
Sub-index 0			
Access: RO	Range: 0x80000000 to 0x7FFFFFFF	Size: 4 bytes	Unit: N/A
Default: N/A	Type: DINT		
Description: This read only object provides the actual value of the position feedback device. The value is given in internal units.			

### 9.18.19 Following error window

This object can be used to indicate and configure the range of position values, symmetrical to the position demand value, outside of which a following error occurs. The value is given in user-defined position units.

**Table 9-66 Following error window**

<b>0x6065 Following error window</b>			
Sub-index 0			
Access: RW	Range: Range: 0 to 0x7FFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x7FFFFFFF	Type: UDINT		
Description: Permitted range of position values before a following error occurs.			

### 9.18.20 Position window

This object can be used to indicate and configure the symmetrical range of acceptable position values relative to the target position, within which the target position will be regarded as having been reached. The value is given in user-defined position units.

**Table 9-67 Position window**

<b>0x6067 Position window</b>			
Sub-index 0			
Access: RW	Range: 0 to 0x7FFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0x7FFFFFFF	Type: UDINT		
Description: Permitted range of position values for target position to be regarded as reached.			

### 9.18.21 Motor rated current

This object indicates the configured motor rated current. The value is given in mA.

**Table 9-68 Motor rated current**

<b>0x6075 Motor rated current</b>			
Sub-index 0			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: mA
Default: 0xFFFFFFFF	Type: UDINT		
Description: Motor rated current value derived from Pr 05.007.			

### 9.18.22 0x6080 Max motor speed

**Table 9-69 Max motor speed**

<b>0x6080 Max motor speed</b>			
Sub-index 0			
Access: RW	Range: 0 to 40000	4 bytes	Unit: rpm
Default: N/A	Type: UDINT		
Description: This object indicates the configured maximum allowed speed for the motor in either direction. It is used to protect the motor and changing the value of this object will also change Pr 1.006. The value is given in rotations per minute (rpm). Changing Pr 1.006 will also automatically update the value in the objects.			

### 9.18.23 0x60F4 Following\_error\_actual\_value

This read only object provides the actual value of the following error. The value is given in userdefined position units.

**Table 9-70 Following\_error actual\_value**

<b>0x60F4 Following_error actual_value</b>			
Sub-index 0			
Access: RO	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: N/A	Type: DINT		
Description: This read only object provides the actual value of the following error.			

### 9.18.24 0x60FB Position\_control\_parameter\_set object

**Table 9-71 Position\_control\_parameter\_set object**

<b>0x60FB Position_control_parameter_set</b>			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of control loop parameters.			
Sub-index 1			
Access: RW	Range: 0 to 500000	Size: 4 bytes	Unit: Depends on Pr 39.007
Default: 2500	Type: DINT		
Description: The position controller proportional gain.			
Sub-index 2			
Access: RW	Range: 0 to 2000	Size: 2 bytes	Unit: Depends on Pr 39.010
Default: 1000 (i.e. a gain of 1)	Type: INT		
Description: The position controller speed feed forward gain.			

The AMC position controller (Advanced Motion Controller) kernel is used by the basic internal position control, this object is only available when the AMC is enabled.

The *position\_demand\_value* object contains the value supplied by either the interpolated position mode or the profile position mode (in user units). It is updated every control loop cycle. The values in the *position\_control\_parameter\_set* will be read in the background, so they cannot be mapped cyclically (i.e. including them in PDOs is not allowed).

## 9.18.25 Supported drive modes

This object provides information on the supported drive modes.

**Table 9-72 Supported drive modes**

0x6502 Supported drive modes																															
Sub-index 0																															
Access: RO	Range: 0 to 0xFFFFFFFF																														
Default: N/A	Type: UDINT																														
Provides information on the supported drive modes as shown below.																															
<table border="1"> <tr> <td>31</td><td>16</td><td>15</td><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td> </tr> <tr> <td>ms</td><td>r</td><td>cstca</td><td>cst</td><td>csv</td><td>csp</td><td>ip</td><td>hm</td><td>r</td><td>tq</td><td>pv</td><td>vl</td><td>pp</td><td></td><td></td> </tr> </table>		31	16	15	11	10	9	8	7	6	5	4	3	2	1	0	ms	r	cstca	cst	csv	csp	ip	hm	r	tq	pv	vl	pp		
31	16	15	11	10	9	8	7	6	5	4	3	2	1	0																	
ms	r	cstca	cst	csv	csp	ip	hm	r	tq	pv	vl	pp																			
<table border="1"> <thead> <tr> <th>Mnemonic</th> <th>Description</th> <th>Value</th> </tr> </thead> <tbody> <tr> <td>r</td> <td>Reserved</td> <td>0</td> </tr> <tr> <td>ms</td> <td>Manufacturer specific bits</td> <td>0 = Function is not supported 1 = Function is supported</td> </tr> <tr> <td>cstca</td> <td>Cyclic sync torque mode with communication angle</td> <td rowspan="8">0 = Mode is not supported 1 = Mode is supported</td> </tr> <tr> <td>cst</td> <td>Cyclic sync torque mode</td> </tr> <tr> <td>csv</td> <td>Cyclic sync velocity mode</td> </tr> <tr> <td>csp</td> <td>Cyclic sync position mode</td> </tr> <tr> <td>ip</td> <td>Interpolated position mode</td> </tr> <tr> <td>hm</td> <td>Homing mode</td> </tr> <tr> <td>tq</td> <td>Torque profile mode</td> </tr> <tr> <td>pv</td> <td>Profile velocity</td> </tr> <tr> <td>vl</td> <td>Velocity mode</td> </tr> <tr> <td>pp</td> <td>Profile position mode</td> </tr> </tbody> </table>		Mnemonic	Description	Value	r	Reserved	0	ms	Manufacturer specific bits	0 = Function is not supported 1 = Function is supported	cstca	Cyclic sync torque mode with communication angle	0 = Mode is not supported 1 = Mode is supported	cst	Cyclic sync torque mode	csv	Cyclic sync velocity mode	csp	Cyclic sync position mode	ip	Interpolated position mode	hm	Homing mode	tq	Torque profile mode	pv	Profile velocity	vl	Velocity mode	pp	Profile position mode
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pv	Profile velocity																														
vl	Velocity mode																														
pp	Profile position mode																														

## 9.19 Interpolated position mode

Interpolated position mode operates in RFC-A and RFC-S modes.

Table 9-73 lists the objects that are supported:

**Table 9-73 Supported Interpolated position mode objects**

Index	Name
0x60C0	<i>interpolation_submode_select</i>
0x60C1	<i>interpolation_data_record</i>
0x60C2	<i>interpolation_time_period</i>

### NOTE

When using one of the CiA402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the EtherCAT interface going into the SAFEOPERATIONAL state.

### 9.19.1 0x60C0 Interpolation\_sub-mode\_select

**Table 9-74 0x60C0 Interpolation\_sub-mode\_select**

0x60C0 Interpolation_sub-mode_select	
Sub-index 0	
Access: RW	Range: 0
Default: 0 (Linear interpolation)	Type: INT
Description: Specifies the interpolation type. At present the only supported Interpolation Sub-Mode is 'Linear Interpolation'.	

### 9.19.2 0x60C1 Interpolation\_data\_record

This object is used to specify the target position. Linear interpolation is used to generate position demand values every 250 μs. The position is specified in user-defined position units. The value is written into sub-index 1.

**Table 9-75 0x60C1 Interpolation\_data\_record**

0x60C1 Interpolation_data_record	
Sub-index 0	
Access: RO	Range: N/A
Default: 1	Type: USINT
Description: This object is used to specify the target position.	
Sub-index 1	
Access: RW	Range: 0x80000000 to 0x7FFFFFFF
Default: N/A	Type: DINT
Description: The set-point.	

## 9.19.3 0x60C2 Interpolation\_time\_period

**Table 9-76 Interpolation\_time\_period**

0x60C2 Interpolation_time_period	
Sub-index 0	
Access: RO	Range: N/A
Default: 2	Type: USINT
Description: The number of the last sub-index in this object.	
Sub-index 1	
Access: RW	Range: 0 to 255
Default: 250 (units are dependent on the value in sub-index 2)	Type: USINT
Description: The number of time units between interpolator re-starts. A time unit is defined by sub-index 2. The interpolator time period value is checked to ensure that it is valid. Valid values are 250 μs, 500 μs or any multiple of 1 ms. An attempt to write other values results in an SDO Abort code.	
Sub-index 2	
Access: RW	Range: -6 to 0
Default: -6 (a time unit of 1 μs)	Type: SINT
Description: This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10 <sup>(sub-index 2)</sup> . The range of values allows for the shortest time unit to be 1 μs, and the longest to be 1 s.	

The implementation of interpolated position mode allows synchronous operation only, where a fixed, common interpolation interval is defined. The time specified must always be an integer multiple of the control loop cycle time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds), see Table 9-77 for more information.

**Table 9-77 Interpolation time period units**

Value in 0x60C2, sub-index 2	Description
0	1 second
-1	0.1 of a second
-2	0.01 of a second
-3	0.001 of a second
-4	0.0001 of a second
-5	0.00001 of a second
-6	0.000001 of a second

The time period is checked to ensure that it is an integer multiple of the control loop cycle time. Only linear interpolation is currently supported, this loop inserts a delay of one interpolation time period.

The input buffer has a maximum size of 1 data record, and a data record contains one position in profile-defined units. The buffer is a FIFO buffer. On each interpolator time period, a value is read from this buffer. The correct number of data points for a specific interpolation mode are stored internally. When a new position command is loaded in, the oldest position command in the data set is discarded.

## 9.20 vl velocity mode

When the drive is in either of the RFC-A or RFC-S operating modes the scaled velocity is written to the drive internal speed shortcut. When the drive is in an open-loop operating mode the scaled velocity is written to the user preset reference parameter (Pr 01.021). Table 9-78 lists the objects that are supported:

**Table 9-78 vl velocity mode supported objects**

Index	Name
0x3008	Active velocity mode redirection
0x6042	vl_target_velocity
0x6043	vl_velocity_demand
0x6044	vl_velocity_actual_value
0x6046	vl_velocity_min_max_amount
0x6048	vl_velocity_acceleration
0x6049	vl_velocity_deceleration
0x604A	vl_velocity_quick_stop
0x604B	vl_setpoint_factor
0x604C	vl_dimension_factor

### 9.20.1 Activate velocity mode redirection

This object provides the facility to redirect the velocity mode reference from the normal velocity mode object (0x6042) to the cyclic sync velocity mode object (0x60FF).

**Table 9-79 Activate velocity mode redirection**

0x3008	Activate velocity mode redirection
Sub-index 0	
Access: RW	Range: 0 to 1   Size: 1 byte   Unit: N/A
Default: 0	Type: USINT
Description:	Redirects the velocity mode reference from object 0x6042 to object 0x60FF. Normally object 0x60FF is the reference for csv mode and object 0x6042 is the reference for velocity mode. Activating this object means that object 0x60FF will be used as the reference for velocity mode. Units are RPM in the range -32768 to 32767.  This object value change will take effect on a CiA402 transition from "Ready to switch on" to "Switched on".

### 9.20.2 0x6042 vl\_target\_velocity

This object is used to set the required velocity of the system. It is multiplied by the *vl\_dimension\_factor* and the *vl\_setpoint\_factor*. The value is given in rpm, If the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 9-80 vl\_target\_velocity**

0x6042	vl_target_velocity
Sub-index 0	
Access: RW	Range: -32768 to +32767   Size: 2 bytes   Unit: rpm
Default: 0	Type: INT
Description:	Used to set the required velocity of the system.

### 9.20.3 0x6043 vl\_velocity\_demand

This read only object provides the instantaneous velocity demand generated by the drive ramp function. The value is given in rpm if the *vl\_dimension\_factor* and the *vl\_setpoint\_factor* have the value 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 9-81 vl\_velocity\_demand**

0x6043	vl_velocity_demand
Sub-index 0	
Access: RO	Range: -32768 to +32767   Size: 2 bytes   Unit: rpm
Default: 0	Type: INT
Description:	Provides the instantaneous velocity demand generated by the drive ramp function.

### 9.20.4 0x6044 vl\_velocity\_actual\_value

This read only object provides the velocity at the motor spindle or load. In a closed loop system this is determined from the motor feedback device and in an open loop system it is derived from the drive's estimated velocity.

The value is given in rpm if the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units. Positive values indicate forward direction and negative values indicate reverse direction.

**Table 9-82 velocity\_actual\_value**

0x6044	vl_velocity_actual_value
Sub-index 0	
Access: RO	Range: -32768 to +32767   Size: 2 bytes   Unit: N/A
Default: 0	Type: INT
Description:	Provides the velocity at the motor spindle or load.

### 9.20.5 0x6046 vl\_velocity\_min\_max\_amount

This object is used to configure the minimum and maximum velocity.

The value is given in rpm if the *vl\_dimension\_factor* has the value of 1, otherwise the value is in user units.

**Table 9-83 vl\_velocity\_min\_max\_amount**

0x6046	vl_velocity_min_max_amount
Sub-index 0	
Access: RO	Range: N/A   Size: 1 byte   Unit: N/A
Default: 2	Type: USINT
Description:	The number of sub-indices in this object.
Sub-index 1	
Access: RW	Range: 0 to 40000   Size: 4 bytes   Unit: rpm
Default: 0	Type: UDINT
Description:	Used to configure the minimum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite <i>vl_velocity_min</i> positive and <i>vl_velocity_min</i> negative.
Sub-index 2	
Access: RW	Range: 0 to 40000   Size: 4 bytes   Unit: rpm
Default: 40000	Type: UDINT
Description:	Used to configure the maximum velocity (both in the forward and reverse direction) that the system can operate at. Writing to this sub index will overwrite <i>vl_velocity_max</i> positive and <i>vl_velocity_max</i> negative.

### 9.20.6 0x6048 vl\_velocity\_acceleration

This object is used to configure the delta speed and delta time of the slope of the acceleration ramp.

Example: To ramp to 1000 rpm in 5 s, possible values for delta speed and delta time are 10000 and 50 respectively.

$$vl\_velocity\_acceleration = \text{delta speed} / \text{delta time}$$

**Table 9-84 0x6048 vl\_velocity\_acceleration**

0x6048 vl_velocity_acceleration			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: rpm
Default: 1000	Type: UDINT		
Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: s
Default: 2	Type: UINT		
Description: The value of delta time is given in seconds.			

### 9.20.7 0x6049 vl\_velocity\_deceleration

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp.

Example: To decelerate by 800 rpm in 10 s, possible values for delta speed and delta time are 8000 and 100 respectively.

$$vl\_velocity\_deceleration = \text{delta speed} / \text{delta time}$$

**Table 9-85 0x6049 vl\_velocity\_deceleration**

0x6049 vl_velocity_deceleration			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: rpm
Default: 1000	Type: UDINT		
Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: s
Default: 2	Type: UINT		
Description: The value of delta time is given in seconds.			

### 9.20.8 0x604A vl\_velocity\_quick\_stop

This object is used to configure the delta speed and delta time of the slope of the deceleration ramp for quick stop.

Example: To decelerate by 800 rpm in 10 s, possible values for delta speed and delta time are 8000 and 100 respectively.

$$vl\_velocity\_deceleration = \text{delta speed} / \text{delta time}$$

**Table 9-86 0x604A vl\_velocity\_quick\_stop**

0x604A vl_velocity_quick_stop			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: rpm
Default: 1000	Type: UDINT		
Description: The value of delta speed is given in rpm if the <i>vl_dimension_factor</i> and the <i>vl_setpoint_factor</i> have the value 1, otherwise the value is in user units.			
Sub-index 2			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: s
Default: 2	Type: UINT		
Description: The value of delta time is given in seconds.			

### 9.20.9 0x604B vl\_setpoint\_factor

This object is used to configure the numerator and denominator of the *vl\_setpoint\_factor*. The *vl\_setpoint\_factor* modifies the resolution or directing range of the specified setpoint. It does not influence the velocity limit function and the ramp function. A value of 0 must not be used.

**Table 9-87 0x604B vl\_setpoint\_factor**

0x604B vl_setpoint_factor			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: -32768 to +32767	Size: 2 bytes	Unit: N/A
Default: 1	Type: INT		
Description: <i>vl_setpoint_factor</i> numerator (a value of 0 is not valid).			
Sub-index 2			
Access: RW	Range: -32768 to +32767	Size: 2 bytes	Unit: N/A
Default: 1	Type: INT		
Description: <i>vl_setpoint_factor</i> denominator (a value of 0 is not valid).			

### 9.20.10 0x604C vl\_dimension\_factor

This object is used to configure the numerator and denominator of the *vl\_dimension\_factor*. The *vl\_dimension\_factor* is used to scale the user units so that they can be used in a way that relates to the specific application.

#### Calculating the vl\_dimension\_factor:

Every user-specific velocity consists of a specific unit referred to as a specific unit of time (e.g. 1/s, bottles/min, m/s,...). The purpose of the *vl\_dimension\_factor* is to convert this specific unit to the revolutions/minute unit. A value of 0 must not be used.

$$\text{Velocity [user-defined unit]} / \text{Dimension factor [rpm/user-defined unit]} = \text{Velocity [rpm]}$$

**Table 9-88 0x604C vl\_dimension\_factor**

0x604C vl_dimension_factor			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of sub-indices in this object.			
Sub-index 1			
Access: RW	Range: -32768 to +32767	Size: 2 bytes	Unit: N/A
Default: 1	Type: INT		
Description: vl_dimension_factor numerator (a value of 0 is not valid).			
Sub-index 2			
Access: RW	Range: -32768 to +32767	Size: 2 bytes	Unit: N/A
Default: 1	Type: INT		
Description: vl_dimension_factor denominator (a value of 0 is not valid).			

The *vl\_target\_velocity* object is re-read every new profile cycle. It is scaled to appropriate units using the *vl\_dimension\_factor* and *vl\_setpoint\_factor* objects and then written to the drive preset reference 1 parameter (Pr 01.021).

The object *vl\_velocity\_min\_max* is handled every profile cycle. The *vl\_target\_velocity* is limited according to the values set in the object *vl\_velocity\_min\_max*, which is read every profile cycle. The object *vl\_velocity\_min\_max\_amount* is mapped to *vl\_velocity\_min\_max*.

The value of the *vl\_velocity\_demand* object is calculated in the background. The option reads the value of parameter Pr 02.001 (post ramp reference), scaled from RPM to user units using *vl\_dimension\_factor* and *vl\_setpoint\_factor*, and writes the value to the *vl\_velocity\_demand* object.

On a closed-loop drive, the speed feedback is calculated internally every profile cycle, scaled to the same units as *vl\_target\_velocity* and written to the *vl\_velocity\_actual\_value* object. On an openloop drive, the estimated motor speed is read from Pr 05.004 (motor RPM) in the background, scaled to the units of *vl\_target\_velocity* and written to the *vl\_velocity\_actual\_value* object.

The *vl\_velocity\_acceleration* and *vl\_velocity\_deceleration* objects are handled in the background. They are read, scaled to drive acceleration units (depending on the drive operating mode), and written to the drive acceleration rate and deceleration rate presets. In addition, if the drive acceleration rate preset is changed, the *vl\_velocity\_acceleration* object is updated, and if the drive deceleration rate preset is changed (Pr 02.021), the *vl\_velocity\_deceleration* object is updated.

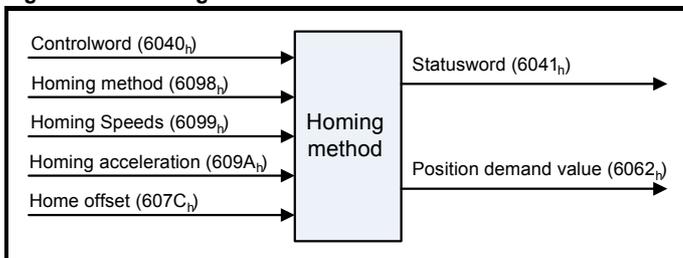
## 9.21 Homing mode

This section describes the method by which a drive seeks the home position (also called, the datum, reference point or zero point).

Figure 9-9 shows the defined input objects as well as the output objects. The user may specify the speeds, acceleration and the method of homing. There is a further object named home offset, which allows the user to displace zero in the user's coordinate system from the home position.

There is no output data except for those bits in the statusword, which return the status or result of the homing process and the demand to the position control loops.

**Figure 9-9 Homing mode function**



By choosing a homing method the following behavior is determined: The homing signal (home switch), the direction of actuation and where appropriate the position of the index pulse.

An encircled number in Figure 9-10 to Figure 9-15 indicates the code for selection of this homing position. The direction of movement is also indicated.

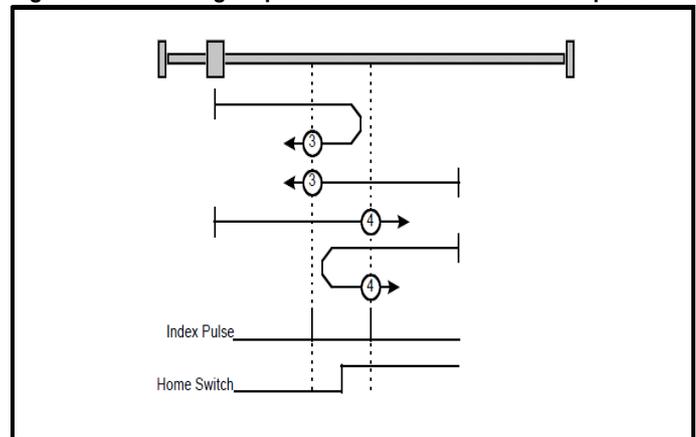
There are two sources of homing signal available: These are the home switch and the index pulse from an encoder.

### 9.21.1 General homing definitions

**Method 3 and 4: Homing on positive home switch and index pulse**  
Using these methods as shown in Figure 9-10 *Homing on positive home switch and index pulse* on page 116, the initial direction of movement shall be dependent on the state of the home switch.

The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

**Figure 9-10 Homing on positive home switch and index pulse**

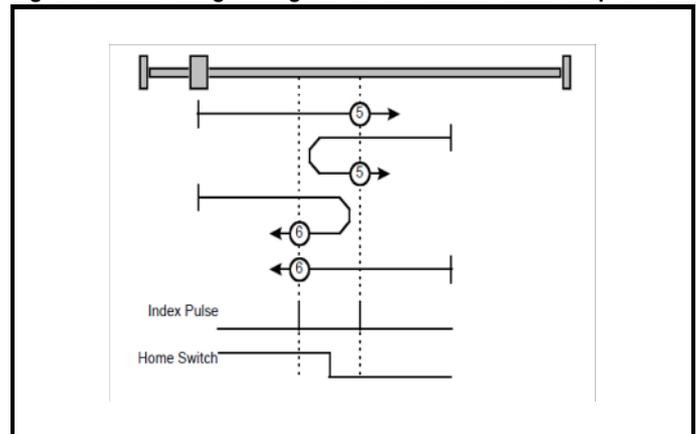


### Method 5 and 6: Homing on negative home switch and index pulse

Using these methods as shown in Figure 9-11 *Homing on negative home switch and index pulse* on page 116, the initial direction of movement shall be dependent on the state of the home switch.

The home position shall be at the index pulse either to the left or the right of the point where the home switch changes state. If the initial position is sited so that the direction of movement shall reverse during homing, the point at which the reversal takes place is anywhere after a change of state of the home switch.

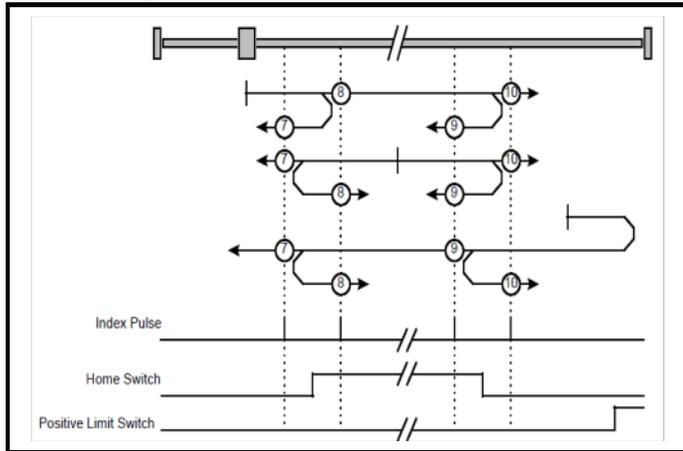
**Figure 9-11 Homing on negative home switch and index pulse**



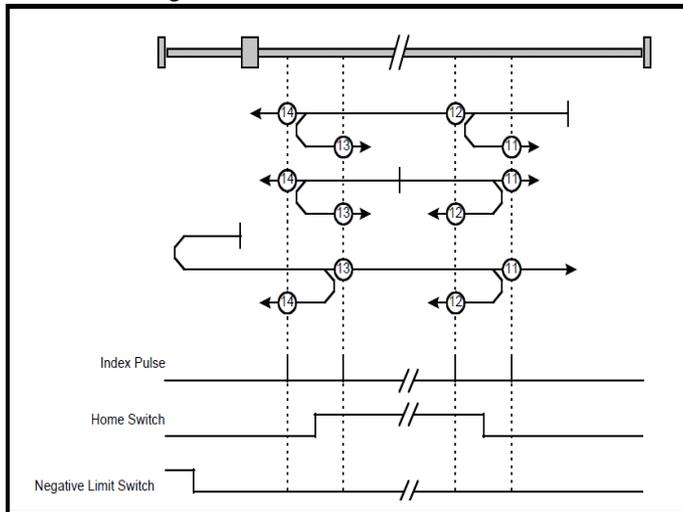
### Method 7 to 14: Homing on home switch and index pulse

These methods use a home switch, which is active over only a portion of the travel; in effect the switch has a 'momentary' action as the axis's position sweeps past the switch. Using the methods 7 to 10, the initial direction of movement shall be to the right, and using methods 11 to 14 the initial direction of movement shall be to the left except if the home switch is active at the start of the motion. In this case the initial direction of motion shall be dependent on the edge being sought. The home position shall be at the index pulse on either side of the rising or falling edges of the home switch, as shown in Figure 9-12 *Homing on home switch and index pulse - positive initial motion* on page 117 and Figure 9-13 *Homing on home switch and index pulse - negative initial motion* on page 117. If the initial direction of movement leads away from the home switch, the drive shall reverse on encountering the relevant limit switch.

**Figure 9-12 Homing on home switch and index pulse - positive initial motion**



**Figure 9-13 Homing on home switch and index pulse - negative initial motion**



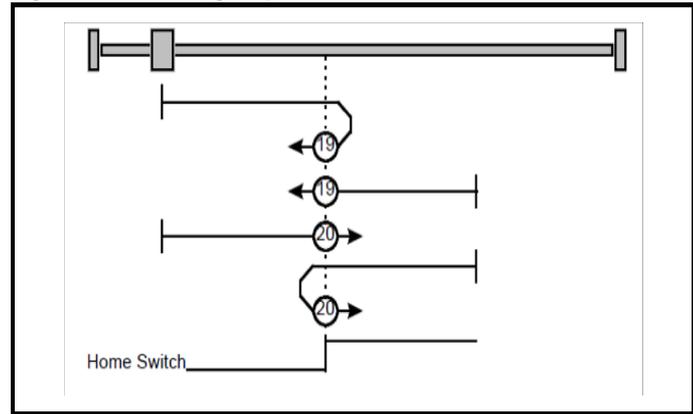
### Method 15 and 16: Reserved

These methods are reserved.

### Method 17 to 30: Homing without index pulse

These methods are similar to methods 3 to 14 except that the home position is not dependent on the index pulse but only dependent on the relevant home transitions. For example methods 19 and 20 are similar to methods 3 and 4 as shown in Figure 9-14 *Homing on positive home switch* on page 117.

**Figure 9-14 Homing on positive home switch**



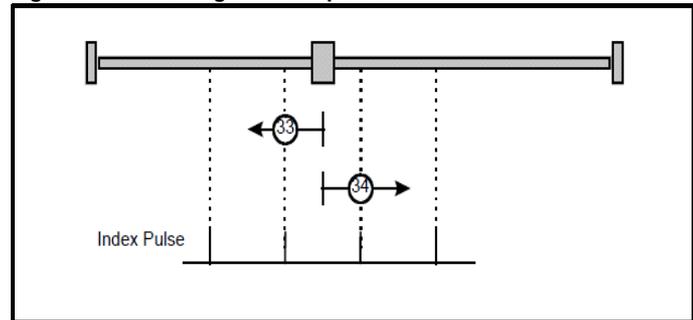
### Method 31 and 32: Reserved

These methods are reserved.

### Method 33 and 34: Homing on index pulse

Using these methods, the direction of homing is negative or positive respectively. The home position shall be at the index pulse found in the selected direction as shown in Figure 9-15 *Homing on index pulse* on page 117.

**Figure 9-15 Homing on index pulse**



### Method 35: Homing on the current position

In this method, the current position shall be taken to be the home position. This method does not require the drive device to be in operational enabled state.

### Use of controlword and statusword

The homing mode uses some bits of the controlword and the statusword for mode-specific purposes. Table 9-89 *Definition of bits 4 and 8 of the controlword* on page 117 defines the values for bits 4 and 8 of the controlword.

**Table 9-89 Definition of bits 4 and 8 of the controlword**

Bit	Value	Definition
4	0	Do not start homing procedure.
	1	Start or continue homing procedure.
8	0	Enable bit 4.
	1	Stop Axis according to the configured Slow down or Quick stop ramp

**Table 9-90 Definition of bits 10 and 12 of the statusword**

Bit 12	Bit 10	Definition
0	0	Homing procedure is in progress.
0	1	Homing procedure is interrupted or not started.
1	0	Homing is attained, but target is not reached.
1	1	Homing procedure was completed successfully.
0	0	Homing error occurred, velocity is not 0.
0	1	Homing error occurred, velocity is 0.
1	X	Reserved.

## 9.21.2 Homing mode object definitions

### 0x3003 Homing source

This object indicates the configured source of the homing switch used during the homing procedure. Table 9-91 *Homing source* on page 118 specifies the object description.

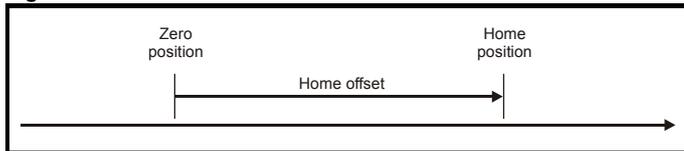
**Table 9-91 Homing source**

0x3003 Homing source object			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 1 to 6	Size: 1 byte	Unit: N/A
Default: 5	Type: USINT		
Description: The source of homing switch. This will specify the number of a drive digital input/output; the selected DIO also needs to be configured as an input. This value will be read when CiA402 homing operation mode is selected.			
Sub-index 2			
Access: RW	Range: 0 to 1	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description: Freeze or marker source for homing; this value will be read when CiA402 homing operation mode is selected. This will have a value as follows: 0 - Use the marker of the feedback source selected for position feedback (see object 0x3000) 1 - Use the F1 freeze of the selected feedback source (drive or numbered option module). 2 - Use the F2 freeze of the selected feedback source (drive or numbered option module).			

### 0x607C Home offset

This object indicates the configured difference between the zero position for the application and the machine home position (found during homing). During homing the machine home position is found and once the homing is completed, the zero position is offset from the home position by adding the home offset to the home position. All subsequent absolute moves shall be taken relative to this new zero position. This is illustrated in Figure 9-16 *Home offset definition* on page 118. The value of this object shall be given in user-defined position units. Negative values indicate the opposite direction.

**Figure 9-16 Home offset definition**



**Table 9-92 Home offset**

0x607C Home offset			
Sub-index 0			
Access: RW	Range: 0x80000000 to 0x7FFFFFFF	Size: 4 bytes	Unit: User-defined position units
Default: 0	Type: DINT		
Description: Homing offset value.			

### 0x6098 Homing method

This object indicates the configured homing method that shall be used. Table 9-93 *Homing method* on page 118 specifies the object description, and Table 9-94 *Homing method values* on page 118 specifies the value ranges for this object.

**Table 9-93 Homing method**

0x6098 Homing method			
Sub-index 0			
Access: RW	Range: 0 - 37	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description: The homing method that shall be used.			

**Table 9-94 Homing method values**

Value	Definition
0	No homing method assigned
3	Method 3 shall be used
to	
34	Method 34 shall be used
35	Method 35 shall be used

### 0x6099 Homing speeds

This object indicates the configured speeds used during the homing procedure. The values shall be given in user-defined velocity units. Table 9-95 *Homing speeds* on page 118 specifies the object description.

**Table 9-95 Homing speeds**

0x6099 Homing speeds			
Sub-index 0			
Access: RO	Range: 2	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0	Type: UDINT		
Description: Speed during search for a switch.			
Sub-index 2			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: N/A
Default: 0	Type: UDINT		
Description: Speed during search for a zero.			

### 0x609A Homing acceleration

This object indicates the configured acceleration and deceleration to be used during the homing operation. The value shall be given in user-defined acceleration units. Table 9-96 *Homing acceleration* on page 118 specifies the object description.

**Table 9-96 Homing acceleration**

0x609A Homing acceleration			
Sub-index 0			
Access: RW	Range: 0 to 0xFFFFFFFF	Size: 4 bytes	Unit: User-defined acceleration units
Default: 65536	Type: UDINT		
Description: Indicates the configured acceleration and deceleration to be used during homing operation.			

## 9.22 Cyclic sync position mode

Cyclic sync position mode is supported in RFC-A and RFC-S modes. It is not supported in open-loop.

**Table 9-97 Cyclic sync position mode**

Index	Name
0x607A	target_position
0x60C0	interpolation sub-mode select
0x60C2	interpolation_time_period

### NOTE

When using one of the CiA402 positioning modes, Distributed Clocks must be enabled. Failure to do so may result in the EtherCAT interface going into the SAFEOPERATIONAL state.

Cyclic sync position mode provides linear interpolation which will always insert a delay of one position command. The time specified must always be an integer multiple of the control loop cycle

time. The time period index has a minimum value of -6 (i.e. the smallest time unit will be microseconds). The time period is checked to ensure that it an integer multiple of the control loop cycle time.

A velocity feed forward will be calculated for the position controller. On each interpolator time period, a value is read from the target\_position object. The correct number of data points for linear interpolation is stored internally. When a new target position is loaded in, the oldest position command in the data set will be discarded.

### 9.22.1 0x607A Target\_position

This object indicates the commanded position that the drive should move to in cyclic sync position mode using the current settings of motion control parameters such as velocity, acceleration, deceleration, motion profile type etc. The value of this object is given in user-defined position units.

**Table 9-98 Target position**

0x607A Target position			
Sub-index 0			
Access: RW	Range: 0x8000000 to 0x7FFFFFFF	Size: 4 bytes	Unit: User-defined position units
Default: N/A	Type: DINT		
Description: Indicates the command positions that the drive should move to in cyclic sync position mode.			

**Table 9-99 Interpolation sub-mode select**

0x60C0 Interpolation sub-mode select			
Sub-index 0			
Access: RW	Range: 0 to 0	Size: 2 bytes	Unit: N/A
Default: 0 (Linear Interpolation)	Type: INT		
Description: This will specify the interpolation type. The values have the following meanings: 0 = Linear Interpolation.			

**Table 9-100 Interpolation time period**

0x60C2 Interpolation time period			
Sub-index 0			
Access: RO	Range: N/A	Size: 1 byte	Unit: N/A
Default: 2	Type: USINT		
Description: The number of the last sub-index in this object.			
Sub-index 1			
Access: RW	Range: 0 to 255	Size: 1 byte	Unit: (sub-index 2)
Default: 250	Type: USINT		
Description: The number of time units between interpolator restarts. A time unit is defined by sub-index 2. The interpolator time period value will be checked to ensure that it is valid. Valid values are 250 μs, 500 μs or any multiple of 1 ms. Selecting other values will result in an error indication.			
Sub-index 2			
Access: RW	Range: -6 to 0	Size: 1 byte	Unit: N/A
Default: -6 (a time unit of 1 μs)	Type: SINT		
Description: This specifies the time unit for the interpolation time period. Sub-index 2 specifies the unit exponent. The time unit, therefore, is 10 <sup>(sub-index 2)</sup> . The range of values allows for the shortest time unit to be 1 μs, and the longest to be 1s.			

## 9.23 Cyclic Synchronous Velocity Mode

Cyclic Synchronous Velocity mode is supported in RFC-A and RFC-S operating modes.

This profile will operate on the control loop cycle time, using the drive's AMC speed reference (which is read by the drive every 250 μs, and the AMC will be configured to run in velocity mode).

The following objects are supported:

Index	Name
606C	Velocity actual value
60B1	Velocity Offset
60C2	interpolation_time_period
60FF	target_velocity

The target\_velocity object will be re-read every new profile cycle (as specified by the interpolation\_time\_period. This velocity demand will be scaled appropriately and written to the drive; interpolation will be used to generate additional intermediate values if the interpolation\_time\_period is greater than the interval at which the drive will read the hard speed reference parameter.

### 9.23.1 Velocity actual value

This object provides the facility to read the actual velocity feedback value.

**Table 9-101 Velocity actual value**

0x606C Velocity actual value			
Sub-index 0			
Access: RO	Range: -2 <sup>31</sup> to +2 <sup>31</sup> -1	Size: 4 bytes	Unit: N/A
Default: 0	Type: DINT		
Description: Indicates the actual velocity feedback value. Value is given in user-defined velocity unit.			

### 9.23.2 Target velocity

This object is used to specify the target velocity value. The value is given in user-defined units.

**Table 9-102 Target velocity**

0x60FF Target velocity			
Sub-index 0			
Access: RW	Range: -2 <sup>31</sup> to +2 <sup>31</sup> -1	Size: 4 bytes	Unit: N/A
Default: 0	Type: DINT		
Description: Specifies the target velocity value in user-defined velocity units.			

### 9.23.3 Velocity offset

This object is used to specify the velocity offset value. The value is given in user-defined units.

**Table 9-103 Velocity offset**

0x60B1 Velocity offset			
Sub-index 0			
Access: RW	Range: -2 <sup>31</sup> to +2 <sup>31</sup> -1	Size: 4 bytes	Unit: N/A
Default: 0	Type: DINT		
Description: Specifies the velocity offset value in user-defined velocity units. The target velocity value is added to the velocity offset value to give the final velocity reference value.			

## 9.24 Cyclic Synchronous Torque Mode

*Cyclic Synchronous Torque Mode* will operate on the control loop cycle time, using the drive's torque reference (which is read by the drive every 250 µs).

The following objects will be supported:

Index	Name
6071	target_torque
6073	max_current
6075	motorRatedCurrent
6077	torqueActualValue
6078	Current actual value
60B2	Torque Offset
60C2	Interpolation_time_period

The target\_torque object will be re-read every new control loop cycle; this torque value will be limited by the max\_current object (which is read in the background). This torque demand will be scaled appropriately and written to the drive *Torque Reference* (Pr **04.008**); interpolation will be used to generate additional intermediate values if the interpolation\_time\_period is greater than the interval at which the drive will read the torque reference parameter. The drive *Motor Rated Current* (Pr **05.007** or the second motor map equivalent) will be read in the background and written to the object motorRatedCurrent, which will be read-only.

### 9.24.1 Target torque

This object is used to specify the target torque value. The value is given in user-defined units.

**Table 9-104 Target torque**

0x6071 Target torque			
Sub-index 0			
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0	Type: INT		
Description:	Specifies the target torque value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.00 % in Pr <b>04.008</b> ).		

### 9.24.2 Maximum current

This object is used to specify the maximum current value. The value is given in user-defined units.

**Table 9-105 Maximum current**

0x6073 Maximum current			
Sub-index 0			
Access: RW	Range: 0 to 65535	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description:	Specifies the maximum current value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.007</b> ). This value is also changed when Pr <b>04.007</b> is written to.		

### 9.24.3 Torque actual value

This object provides the actual instantaneous torque value. The value is given in user-defined units.

**Table 9-106 Torque actual value**

0x6077 Torque actual value			
Sub-index 0			
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0	Type: INT		
Description:	Indicates the actual instantaneous torque value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.003</b> ). For open-loop mode, this value is taken from Pr <b>04.026</b> , for closed-loop mode this value is taken from Pr <b>04.003</b> .		

### 9.24.4 Current actual value

This object provides the actual instantaneous current value. The value is given in user-defined units.

**Table 9-107 Current actual value**

0x6078 Current actual value			
Sub-index 0			
Access: RO	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0	Type: INT		
Description:	Indicates the actual instantaneous current value. Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 % in Pr <b>04.004</b> ).		

### 9.24.5 Torque offset

This object is used to specify the torque offset value. The value is given in user-defined units.

**Table 9-108 Torque offset**

0x60B2 Torque offset			
Sub-index 0			
Access: RW	Range: -32768 to 32767	Size: 2 bytes	Unit: N/A
Default: 0	Type: INT		
Description:	Indicates the required torque value as a percentage of rated motor torque, Value is in 0.1 % units. (e.g. A value of 1000 equates to 100.0 %). The value is written to Pr <b>04.008</b> . The maximum and minimum is defined by parameter Pr <b>4.024</b> (which itself is limited by drive size and other parameters). It is therefore for this reason that range for 0x60B2 is set as the maximum range for a signed integer.		

## 9.25 Error Handling

The following objects will be provided to indicate an error condition:

Index	Name
1001	error_register
603F	error_code

**Table 9-109 Error register**

0x1001 Error register			
Sub-index 0			
Access: RO	Range: 0 to 255	Size: 1 byte	Unit: N/A
Default: 0	Type: USINT		
Description:	A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits will be supported: 0: Generic error 1: Current 2: Voltage 3: Temperature When an error is indicated in this object, the particular error code will be contained in object 0x603F (Error code).		

**Table 9-110 Error code**

0x603F Error code			
Sub-index 0			
Access: RO	Range: 0x0 to 0xFFFF	Size: 2 bytes	Unit: N/A
Default: 0	Type: UINT		
Description:	A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in the Error code table below.		

**Table 9-111 Error code definitions**

Error code	Meaning	Corresponding drive trip code (if available)
0x0000	Error reset / No error	0 – None
0xFF01	Generic error	(Any trip code not elsewhere in table)
0x2300	Current, device output side	3 – OI ac
0x3130	Phase failure	32 – Phase Loss 98 - Out Phase Loss
0x2230	Short circuit/ground leakage (device internal)	5 – PSU 9 – PSU 24V 92 - Snubber OI
0x3210	DC link over-voltage	2 – Over Volts
0x3230	Load error	38 - Low Load
0x4310	Excess temperature drive	21 – OHT Inverter 22 – OHT Power 23 – OHT Control 27 – OHT dc bus 101 - OHT Brake
0x5112	"Supply low voltage" and "U2 = supply +24 V"	91 - User 24V
0x5200	Control device hardware	200 - Slot 1 Hardware Fault 203 - Slot 1 Not Fitted 204 - Slot 1 Different 205 - Slot 2 Hardware Fault 208 - Slot 2 Not Fitted 209 - Slot 2 Different 210 - Slot 3 Hardware Fault 213 - Slot 3 Not Fitted 214 - Slot 3 Different 250 - Slot 4 Hardware Fault 253 - Slot 4 Not Fitted 254 - Slot 4 Different 221 - Stored HF
0x5400	Power section	111 - Config P 220 - Power Data 223 - Rating Mismatch
0x5510	RAM	227 - Sub Array RAM Allocation
0x5530	Data storage (Non-volatile data memory)	31 – EEPROM Fail 36 – User Save 37 – Power Down Save
0x5430	Input stages	94 - Rectifier set up
0x5440	Contacts	226 - Soft Start
0x6010	Software reset (watchdog)	30 – Watchdog
0x6320	Parameter Error	199 - Destination 216 - Slot App Menu Crash 217 - App menu changed
0x7112	Brake chopper (over current brake chopper)	4 – OI Brake 19 – Brake R Too Hot
0x7113	Protective circuit break chopper	10 - Th Brake Res
0x7120	Motor	11 - Autotune 1 12 - Autotune 2 13 - Autotune 3 20 - Motor Too Hot
0x7122	Motor error or commutation malfunction	14 – Autotune 4 15 – Autotune 5 16 – Autotune 6 24 - Thermistor 25 - Th Short Circuit 33 - Resistance
0x7300	Sensor	17 - Autotune 7 162 to 163 – Encoder 12 to Encoder 13 176 – Name Plate 189 to 198 – Encoder 1 to Encoder 10 218 - Temp Feedback
0x7310	Speed	7 - Over speed

Error code	Meaning	Corresponding drive trip code (if available)
0x7500	Communication	90 - Power Comms 103 - Interconnect
0x7600	Data storage (external)	174 - Card Slot 175 – Card Product 177 – Card Boot 178 – Card Busy 179 – Card Data Exists 180 – Card Option 181 – Card Read Only 182 – Card Error 183 – Card No Data 184 – Card Full 185 – Card Access 186 – Card Rating 187 – Card Drive Mode 188 – Card Compare

## 9.26 Advanced features

### 9.26.1 Distributed clocks

The EtherCAT interface supports Distributed clocks. This is the scheme used by EtherCAT to accurately time synchronize slave devices. Position, speed and current control loops can all be synchronized.

The EtherCAT Distributed Clocks facility can be used to provide a time synchronization signal so the drive speed and current tasks are synchronized to the network. The position controller, and appropriate motion features will also be synchronized to the drive speed task.

#### NOTE

In CoE interpolated position mode the position command provided by the master every interpolation cycle time is used to generate a position command for the drive every 250  $\mu$ s.

### 9.26.2 Time synchronization support

The EtherCAT distributed clocks facility can be used to provide a time synchronisation signal so that the drive tasks (including the motion, speed and current tasks) are synchronised to the network. The option synchronous task will also be synchronized to the drive OPT\_SYNC signal.

If possible, the Ethernet interface will provide a synchronization signal suitable for the longest interval drive cyclic task (this will also, of course, synchronize the higher rate tasks, if they are phase locked to the lowest rate task).

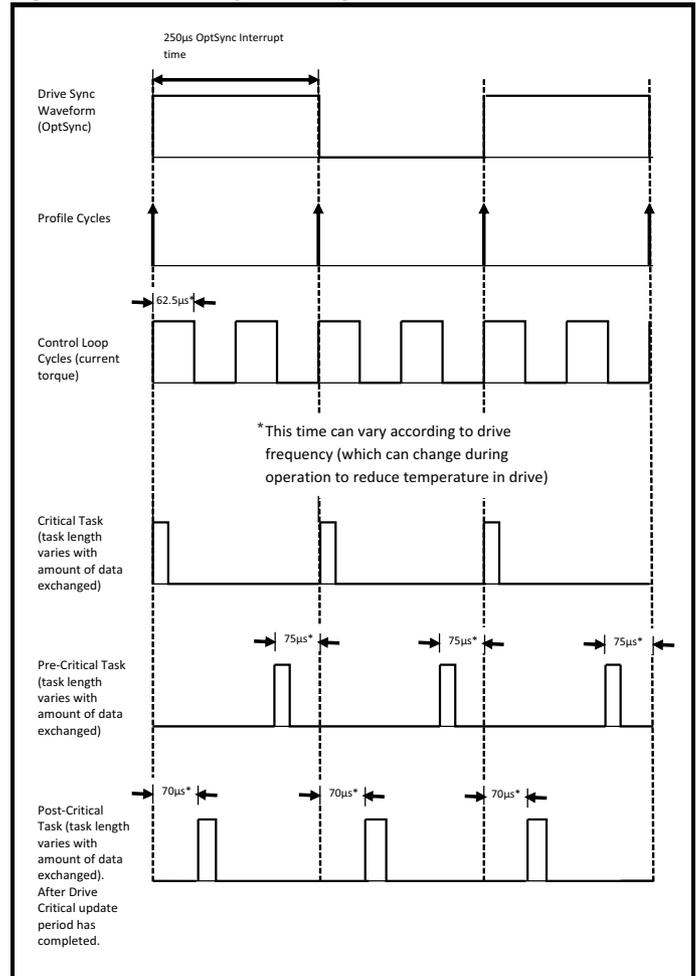
The drive motion and speed loops are executed every 250  $\mu$ s, which coincides with OPT\_SYNC edges. This will be referred to as the control loop cycle. Synchronization must be enabled if the Cyclic Sync or Interpolated Position modes are used; an error will be indicated if this is not the case. These modes have an operating mode cycle time of the interpolation cycle time; other modes will have an operating mode cycle time matching the synchronous task (250  $\mu$ s).

Any operating mode cycle will be restarted every operating mode cycle time, in phase with the synchronisation events; if synchronization is enabled, the operating mode will not start execution until the first synchronization event occurs. If synchronization is lost, an error will be indicated, and the standard EtherCAT action for this event will occur.

Command and feedback values which are handled cyclically will be read at defined times in the cycle. Command values handled/used every cycle (operating mode or control loop) will be cached from the object dictionary in the task immediately before the drive critical update period. Any feedback values read during a cycle will be scaled as appropriate in that cycle, cached, and then written to the object dictionary in the task occurring immediately after the drive critical update period. Feedback values that change internally between control loop cycles (but whose objects are only updated every profile cycle) will be read from the last control loop cycle in the operating mode cycle. PDO data will be copied to and from the object dictionary (from and to the sync manager memory areas) in the drive critical update period at the beginning of every operating mode cycle.

PDO data mapped to drive parameters (but not parameters accessed using Inter-Option Communications, or eCMP), will be written to those parameters in the critical update period at the beginning of every control loop cycle. This behaviour can be modified by the advanced cyclic data configuration objects.

Figure 9-17 Profile Cycle Timing



## 9.27 EtherCAT protocol support

The following are supported:

- Four Sync Managers. Two are used for the Mailbox Protocol (non-cyclic data) and two are used for process data (cyclic data)
- Distributed Clocks
- CANopen over EtherCAT (CoE)

## 9.28 Advanced Cyclic Data Task Configuration

This configuration will allow the timing behaviour of the cyclic data handling to be modified; specifically, it will allow the tasks in which cyclic data is handled to be changed. The default configuration will be specified to reduce delays as much as possible, in case it is necessary to close control loops over the network.

**Table 9-112 Out cyclic data configuration**

0x3006		Out cyclic data configuration					
Sub-index 0							
Access:	RO	Range:	N/A	Size:	1 byte	Unit:	N/A
Default:	2	Type:	USINT				
Description:	The number of the last sub-index in this object.						
Sub-index 1							
Access:	RW	Range:	0 to 2	Size:	1 byte	Unit:	ms
Default:	0	Type:	USINT				
Description:	<p>High priority cyclic data task; selects the task in which high priority out (master to slave) cyclic data is copied from the intermediate buffer to the mapped objects, parameters, etc.</p> <p>0 - Pre-Drive Critical update period. The default; this is the task that, on Digitax HD, starts execution 75 µs before the drive critical update period.</p> <p>1 - Drive Critical update period. Occurs for the first 70 µs following an edge of the OPT_SYNC signal.</p> <p>2 - Post-Drive Critical update period. The task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.</p> <p>3 - Sync Manager task. This is the AL event task which occurs upon a sync manager access.</p>						
Sub-index 2							
Access:	RW	Range:	0 to 2	Size:	1 byte	Unit:	N/A
Default:	3	Type:	USINT				
Description:	Reserved						

**Table 9-113 In cyclic data configuration**

0x3007		In cyclic data configuration					
Sub-index 0							
Access:	RO	Range:	N/A	Size:	1 byte	Unit:	N/A
Default:	2	Type:	USINT				
Description:	The number of the last sub-index in this object.						
Sub-index 1							
Access:	RW	Range:	0 to 2	Size:	1 byte	Unit:	ms
Default:	2	Type:	USINT				
Description:	<p>High priority cyclic data task; selects the task in which high priority in (slave to master) cyclic data is copied to the intermediate buffer from the mapped objects, parameters, etc.</p> <p>0 - Pre-Drive Critical update period. The default; this is the task that, on M600 and above, starts execution 75 µs before the drive critical update period. This time may need to be modified after measuring actual task periods (hopefully it will be possible to start at a time closer to the critical update period).</p> <p>1 - Drive Critical update period. Occurs during the first 70 µs following an edge of the OPT_SYNC signal.</p> <p>2 - Post Drive Critical update period. The task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.</p> <p>3 - Sync Manager task. The AL event task which occurs upon a sync manager access.</p>						
Sub-index 2							
Access:	RW	Range:	0 to 2	Size:	1 byte	Unit:	N/A
Default:	2	Type:	USINT				
Description:	<p>Intermediate buffer copy task. Selects the task in which the high priority in (slave to master) cyclic data is copied from the intermediate buffer into the sync manager space.</p> <p>0 - Pre Drive Critical update period. The task that, on M600 and above, starts execution 75 µs before the drive critical update period. This time may need to be modified after measuring actual task periods (hopefully it will be possible to start at a time closer to the critical update period).</p> <p>1 - Drive Critical update period. Occurs during the first 70 µs following an edge of the OPT_SYNC signal.</p> <p>2 - Post Drive Critical update period. The default; it is the task that occurs immediately after the critical update period, up until the Pre Drive Critical Update Period.</p> <p>3 - Sync Manager task. The AL event task which occurs upon a sync manager access.</p>						

## 9.29 Supported objects

Table 9-114 lists the objects currently supported by the EtherCAT interface.

**Table 9-114 EtherCAT Interface Object Dictionary**

Object Ref. (0x)	Description	Data Type		Access	Profile					
		Sub-index	Type		Velocity	Interpolated	Homing	Cyclic Sync	Cyclic Sync	Cyclic Sync
1000	Device type	0	UDINT	RO	Y	Y	Y	Y	Y	Y
1001	Error register	0	USINT	RO	Y	Y	Y	Y	Y	Y
1018	Identity object (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Identity object (Vendor ID)	1	UDINT	RO	Y	Y	Y	Y	Y	Y
	Identity object (Product Code)	2	UDINT	RO	Y	Y	Y	Y	Y	Y
	Identity object (Software Version)	3	UDINT	RO	Y	Y	Y	Y	Y	Y
	(Reserved)	4	UDINT	RO	Y	Y	Y	Y	Y	Y
1600	Receive PDO mapping 1 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 1 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1601	Receive PDO mapping 2 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 2 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1602	Receive PDO mapping 3 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 3 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1604	Receive PDO mapping 5 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 5 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1605	Receive PDO mapping 6 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 6 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1607	Receive PDO mapping 8 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Receive PDO mapping 8 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1A00	Transmit PDO mapping 1 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 1 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1A01	Transmit PDO mapping 2 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 2 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1A02	Transmit PDO mapping 3 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 3 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1A04	Transmit PDO mapping 5 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 5 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1A05	Transmit PDO mapping 6 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 6 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile					
		Sub-index	Type		Velocity	Interpolated	Homing	Cyclic Sync	Cyclic Sync	Cyclic Sync
1A07	Transmit PDO mapping 8 (Number of objects)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	Transmit PDO mapping 8 (Mapped object 1 to si0)	1 to si0	UDINT	RW	Y	Y	Y	Y	Y	Y
1C00	Sync manager communication type (Number of SM protocols)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM0 Usage)	1	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM1 Usage)	2	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM2 Usage)	3	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM3 Usage)	4	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM4 Usage)	5	USINT	RO	Y	Y	Y	Y	Y	Y
	Sync manager communication type (SM5 Usage)	6	USINT	RO	Y	Y	Y	Y	Y	Y
1C10	SM0 PDO assignment (Number of PDOs)	0	USINT	RO	Y	Y	Y	Y	Y	Y
1C11	SM1 PDO assignment (Number of PDOs)	0	USINT	RO	Y	Y	Y	Y	Y	Y
1C12	SM2 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	SM2 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y
1C13	SM3 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	SM3 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y
1C14	SM4 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	SM4 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y
1C15	SM5 PDO assignment (Number of PDOs)	0	USINT	RW	Y	Y	Y	Y	Y	Y
	SM5 PDO assignment (Assigned PDO index)	1	UINT	RW	Y	Y	Y	Y	Y	Y
2smm	Drive parameter access (s = slot 0x0 to 0xF, mm=menu 0x00 to 0xFF)	pp (pp=par 0x00 to 0xFF)	[var]	RW	Y	Y	Y	Y	Y	Y
3000	Position feedback encoder configuration	0	USINT	RW	Y	Y	Y	Y	Y	Y
3003	Homing source (Number of last sub-index)	0	USINT	RO	N	N	Y	N	N	N
	Homing source (Homing switch source)	1	USINT	RW	N	N	Y	N	N	N
	Homing source (Freeze/marker source)	2	USINT	RW	N	N	Y	N	N	N
3004	Additional position loop scaling (Number of last sub-index)	0	USINT	RO	N	Y	Y	Y	Y	Y
	Additional position loop scaling (Numerator)	1	DINT	RW	N	Y	Y	Y	Y	Y
	Additional position loop scaling (Denominator)	2	DINT	RW	N	Y	Y	Y	Y	Y

Object Ref. (0x)	Description	Data Type		Access	Profile					
		Sub-index	Type		Velocity	Interpolated	Homing	Cyclic Sync	Cyclic Sync	Cyclic Sync
3005	Cyclic data loss behaviour (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Cyclic data loss behaviour (Timeout (ms))	1	UINT	RW	Y	Y	Y	Y	Y	Y
	Cyclic data loss behaviour (Timeout (ms))	1	UINT	RW	Y	Y	Y	Y	Y	Y
	Cyclic Loss counter	3	INT	RO	Y	Y	Y	Y	Y	Y
3006	Out cyclic data configuration (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Out cyclic data configuration (Copy to drive task)	1	USINT	RW	Y	Y	Y	Y	Y	Y
	Out cyclic data configuration (Copy from master task)	2	USINT	RW	Y	Y	Y	Y	Y	Y
3007	In cyclic data configuration (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	In cyclic data configuration (Copy from drive task)	1	USINT	RW	Y	Y	Y	Y	Y	Y
	In cyclic data configuration (Copy to master task)	2	USINT	RW	Y	Y	Y	Y	Y	Y
3008	Activate velocity mode redirection	0	USINT	RW	Y	N	N	Y	N	N
603F	Error code	0	UINT	RO	Y	Y	Y	Y	Y	Y
6040	Control word	0	UINT	WO	Y	Y	Y	Y	Y	Y
6041	Status word	0	UINT	RO	Y	Y	Y	Y	Y	Y
6042	vl_target_velocity	0	INT	RW	Y	N	N	N	N	N
6043	vl_velocity_demand	0	INT	RO	Y	N	N	N	N	N
6044	vl_velocity_actual_value	0	INT	RO	Y	N	N	N	N	N
6046	vl_velocity_min_max_amount (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_velocity_min_max_amount (Minimum velocity (rpm))	1	UDINT	RW	Y	N	N	N	N	N
	vl_velocity_min_max_amount (Maximum velocity (rpm))	2	UDINT	RW	Y	N	N	N	N	N
6048	vl_velocity_acceleration (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_velocity_acceleration (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N
	vl_velocity_acceleration (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N
6049	vl_velocity_deceleration (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_velocity_deceleration (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N
	vl_velocity_deceleration (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N
604A	vl_velocity_quick_stop (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_velocity_quick_stop (Delta speed value (rpm))	1	UDINT	RW	Y	N	N	N	N	N
	vl_velocity_quick_stop (Delta time value (s))	2	UINT	RW	Y	N	N	N	N	N
604B	vl_setpoint_factor (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_setpoint_factor (Numerator)	1	INT	RW	Y	N	N	N	N	N
	vl_setpoint_factor (Denominator)	2	INT	RW	Y	N	N	N	N	N

Object Ref. (0x)	Description	Data Type		Access	Profile					
		Sub-index	Type		Velocity	Interpolated	Homing	Cyclic Sync	Cyclic Sync	Cyclic Sync
604C	vl_dimension_factor (Number of last sub-index)	0	USINT	RO	Y	N	N	N	N	N
	vl_dimension_factor (Numerator)	1	INT	RW	Y	N	N	N	N	N
	vl_dimension_factor (Denominator)	2	INT	RW	Y	N	N	N	N	N
605A	Quick stop option code	0	UINT	RW	Y	Y	Y	Y	Y	Y
605B	Shutdown option code	0	UINT	RW	Y	Y	Y	Y	Y	Y
605C	Disable operation option code	0	UINT	RW	Y	Y	Y	Y	Y	Y
605D	Halt option code	0	INT	RW	Y	Y	Y	Y	Y	Y
605E	Fault reaction option code	0	UINT	RW	Y	Y	Y	Y	Y	Y
6060	Modes of operation	0	USINT	RW	Y	Y	Y	Y	Y	Y
6061	Modes of operation display	0	USINT	RO	Y	Y	Y	Y	Y	Y
6062	Position demand value	0	DINT	RO	Y	Y	Y	Y	Y	Y
6064	Position actual value	0	DINT	RO	Y	Y	Y	Y	Y	Y
6065	Following error window	0	UDINT	RW	N	Y	N	N	N	Y
6067	Position window	0	UDINT	RW	N	Y	N	N	N	Y
606C	Velocity actual value	0	DINT	RO	Y	Y	Y	Y	Y	Y
6071	Target torque	0	INT	RW	N	N	N	N	Y	N
6073	Max current	0	UINT	RW	Y	Y	Y	Y	Y	Y
6075	Motor rated current	0	UDINT	RO	Y	Y	Y	Y	Y	Y
6077	Torque actual value	0	INT	RO	Y	Y	Y	Y	Y	Y
6078	Current actual value	0	INT	RO	Y	Y	Y	Y	Y	Y
607A	Target position	0	DINT	RW	N	N	N	N	N	Y
607C	Home offset	0	DINT	RW	N	N	Y	N	N	N
6080	Max motor speed	0	UDINT	RW	Y	Y	Y	Y	Y	Y
6084	Profile deceleration	0	UDINT	RW	N	Y	Y	Y	Y	Y
6085	Quick stop deceleration	0	UDINT	RW	N	Y	Y	Y	Y	Y
608F	Position encoder resolution (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Position encoder resolution (Encoder increments)	1	UDINT	RO	Y	Y	Y	Y	Y	Y
	Position encoder resolution (Motor revolutions)	2	UDINT	RO	Y	Y	Y	Y	Y	Y
6091	Gear ratio (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Gear ratio (Motor revolutions)	1	UDINT	RW	Y	Y	Y	Y	Y	Y
	Gear ratio (Shaft revolutions)	2	UDINT	RW	Y	Y	Y	Y	Y	Y
6092	Feed constant (Number of last sub-index)	0	USINT	RO	Y	Y	Y	Y	Y	Y
	Feed constant (Feed value)	1	UDINT	RW	Y	Y	Y	Y	Y	Y
	Feed constant (Shaft revolutions)	2	UDINT	RW	Y	Y	Y	Y	Y	Y
6098	Homing method	0	USINT	RW	N	N	Y	N	N	N
6099	Homing speeds (Number of last sub-index)	0	USINT	RO	N	N	Y	N	N	N
	Homing speeds (Speed during switch search)	1	UDINT	RW	N	N	Y	N	N	N
	Homing speeds (Speed during zero point search)	2	UDINT	RW	N	N	Y	N	N	N
609A	Homing acceleration	0	UDINT	RW	N	N	Y	N	N	N
60B1	Velocity offset	0	DINT	RW	N	N	N	Y	N	N

Object Ref. (0x)	Description	Data Type		Access	Profile						
		Sub-index	Type		Velocity	Interpolated	Homing	Cyclic Sync	Cyclic Sync	Cyclic Sync	
60B2	Torque offset	0	INT	RW	N	N	N	Y	Y	Y	
60C0	Interpolation sub-mode select	0	INT	RW	N	Y	N	Y	Y	Y	
60C1	Interpolation data record (Number of last sub-index)	0	USINT	RO	N	Y	N	N	N	N	
	Interpolation data record (Target position)	1	UDINT	RW	N	Y	N	N	N	N	
60C2	Interpolation time period (Number of last sub-index)	0	USINT	RO	N	Y	N	Y	Y	Y	
	Interpolation time period (Number of time periods)	1	USINT	RW	N	Y	N	Y	Y	Y	
	Interpolation time period (Time period exponent)	2	SINT	RW	N	Y	N	Y	Y	Y	
60F4	Following error actual value	0	DINT	RO	N	Y	N	N	N	Y	
60FB	Position control parameter set (Number of last sub-index)	0	USINT	RO	N	Y	N	Y	Y	Y	
	Position control parameter set (Proportional gain)	1	DINT	RO	N	Y	N	Y	Y	Y	
	Position control parameter set (Speed feed forward gain)	2	DINT	RO	N	Y	N	Y	Y	Y	
60FF	Target velocity	0	DINT	RW	N	N	N	Y	N	N	
6502	Supported drive modes	0	UDINT	RO	Y	Y	Y	Y	Y	Y	

### 9.30 EtherCAT Interface - Setup

Parameter		Range(⌘)		Default(⇔)			Type						
		OL	RFC-A / S	OL	RFC-A	RFC-S							
3.00.001	Module ID	0 to 65535					RO	Num	ND	NC	PT		
3.00.002	Software Version	0 to 99999999					RO	Num	ND	NC	PT		
3.00.003	Hardware version	0.00 to 655.35					RO	Num	ND	NC	PT		
3.00.004	Serial Number LS	00000000 to 99999999					RO	Num	ND	NC	PT		
3.00.005	Serial Number MS	0 to 99999999					RO	Num	ND	NC	PT		
3.00.006	Status	Bootldr - Update (-2), Bootldr - Idle (-1), Initialising (0), OK (1), Config (2), Error (3)					RO	Txt	ND	NC	PT		
3.00.007	Reset	Off (0) or On (1)				Off (0)	RW	Bit		NC			
3.00.008	Default	Off (0) or On (1)				Off (0)	RW	Bit		NC			
3.00.031	Slot indicator	1 to 8					RO	Num	ND	NC	PT		
3.00.032	Slot menu number	0 to 255					RO	Num	ND	NC	PT		
3.00.033	Disable drive control	Off (0) or On (1)				Off (0)	RW	Bit					US
3.00.034	Allow EEPROM Upgrade	Off (0) or On (1)				Off (0)	RW	Bit					
3.00.035	Configured station alias	0 to 65535				0	RW	Num		NC	PT	US	
3.00.036	Consistency trigger for synchronous outputs	Off (0) or On (1)				Off (0)	RW	Bit					US
3.00.037	Consistency trigger parameter for synchronous outputs	0 to 999999				0	RW	Num	DE				US
3.00.038	Consistency trigger for synchronous inputs	Off (0) or On (1)				Off (0)	RW	Bit					US
3.00.039	Consistency trigger parameter for synchronous inputs	0 to 999999				0	RW	Num	DE				US
3.00.040	Consistency trigger for non-synchronous outputs	Off (0) or On (1)				Off (0)	RO	Bit					US
3.00.041	Consistency trigger parameter for non-synchronous outputs	0 to 999999				0	RO	Num	DE				US
3.00.042	Consistency trigger for non-synchronous inputs	Off (0) or On (1)				Off (0)	RW	Bit					US
3.00.043	Consistency trigger parameter for non-synchronous inputs	0 to 999999				0	RW	Num	DE				US
3.00.045	Homing Position Save	Off (0) or On (1)				Off (0)	RO	Bit			PT	US	
3.00.046	Homing Position Parameter	51 to 54				51	RW	Num			PT	US	

### 9.31 EtherCAT Interface - Status and Configuration

Parameter		Range(⌘)		Default(⇔)			Type						
		OL	RFC-A / S	OL	RFC-A	RFC-S							
3.01.001	EtherCAT run indicator	Unknown State (0), Init (1), PreOp (2), Unknown State (3), SafeOp (4), Unknown State (5), SafeOp to Op (6), Unknown State (7), Op (8)					RO	Txt	ND	NC	PT		
3.01.002	PDO Accesses per second	0 to 65535					RO	Num	ND	NC	PT		
3.01.004	Mapped parameter xx.000	0 to 65535					RW	Num	ND	NC	PT		

### 9.32 EtherCAT Interface – EoE Status

Parameter		Range(⌘)		Default(⇔)			Type						
		OL	RFC-A / S	OL	RFC-A	RFC-S							
3.02.003	EoE Status	Initialising (0), Link Down (1), Not Applicable (2), Not Applicable (3), Ready (4), Active (5), Active With Errs (6)					RO	Txt	ND	NC	PT		
3.02.004	EoE Network Message Count	0.0 to 6553.5 Messages/s					RO	Num	ND	NC	PT		
3.02.006	EoE IP Address	0.0.0.0 to 255.255.255.255					RO	IP	ND	NC	PT		
3.02.007	EoE Subnet Mask	0.0.0.0 to 255.255.255.255					RO	IP	ND	NC	PT		
3.02.008	EoE Default Gateway	0.0.0.0 to 255.255.255.255					RO	IP	ND	NC	PT		
3.02.011	EoE Virtual MAC Address	00:00:00:00:00:00 to FF:FF:FF:FF:FF:FF					RO	Mac	ND	NC	PT		

### 9.33 EtherCAT Interface – Resources

Parameter		Range(⌘)		Default(⇔)			Type						
		OL	RFC-A / S	OL	RFC-A	RFC-S							
3.09.010	PreCritical Task % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.011	Critical Task % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.012	PostCritical Task % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.020	PreCritical Worst Task % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.021	Critical Task Worst % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.022	PostCritical Task Worst % Free	0 to 100 %					RO	Num	ND	NC	PT		
3.09.023	OutDataPositionPercent	0 to 100 %					RO	Num	ND	NC	PT		
3.09.030	PCB Temperature	-128 to 127 °C					RO	Num	ND	NC			

# 10 SD Card Operation

## 10.1 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.

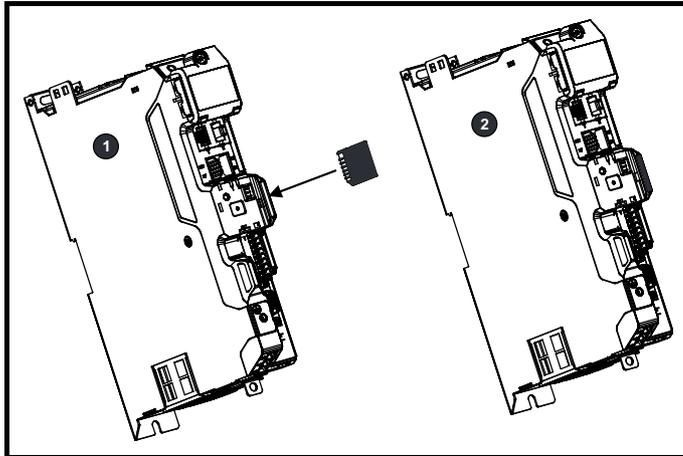
Ensure the SD Card is inserted with the contacts facing the left-hand side of the drive.

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 10-1 Installation of the SD Card



1. Installing the SD Card
2. SD Card installed

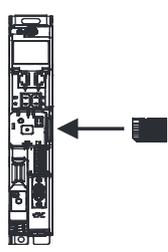
## 10.2 SD Card support

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**

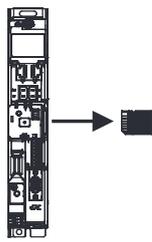
If the read only flag is set then only codes 6yyy or 9777 are effective.

Figure 10-2 Basic SD Card operation



Drive reads all parameters from the SD Card

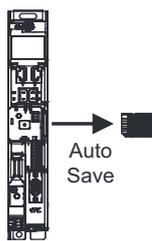
**Pr 00.030 = Read +** 



Programs all drive parameters to the SD Card

**NOTE**  
Overwrites any data already in data block 1

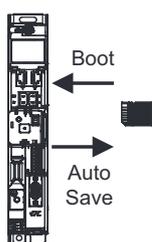
**Pr 00.030 = Program +** 



Auto Save

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

**Pr 00.030 = Auto +** 



Boot

Auto Save

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

**Pr 00.030 = Boot +** 

The whole card may be protected from writing or erasing by setting the read-only flag as detailed section 10.3.9 9888 / 9777 - *Setting and clearing the SD Card read only flag* on page 132.

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.

## 10.3 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 10-1.

**Table 10-1 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 <b>mm.000</b> ( <b>mm.000</b> ) 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.

### 10.3.1 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).

### 10.3.2 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.

### 10.3.3 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.

**10.3.4 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.

**10.3.5 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.

**10.3.6 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.

**10.3.7 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.

**10.3.8 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

**10.3.9 9888 / 9777 - Setting and clearing the SD Card read only flag**

The SD 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

**10.4 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.

**10.5 NV Media / SD Card parameters**

**Table 10-2 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
Fl	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	⇕	None (0), Open-loop (1), RFC-A (2), RFC-S (3), Regen (4), User Prog (5), Option App (6)	⇒				
RFC-S							

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

Pr <b>11.038</b>	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

<b>11.039</b>		<b>NV Media Card File Version</b>		
RO	Num	ND	NC	PT
OL				
RFC-A	⇕	0 to 9999	⇒	
RFC-S				

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

<b>11.040</b>		<b>NV Media Card File Checksum</b>		
RO	Num	ND	NC	PT
OL				
RFC-A	⇕	-2147483648 to 2147483647	⇒	
RFC-S				

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

<b>11.042 {00.030}</b>		<b>Parameter Cloning</b>	
RW	Txt	NC	US*
OL			
RFC-A	⇕	None (0), Read (1), Program (2), Auto (3), Boot (4)	None (0)
RFC-S			

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

**NOTE**

If Pr **11.042** is equal to 1 or 2, this value is not transferred to the drive or saved to the EEPROM. If Pr **11.042** is set to 3 or 4 the value is saved to the EEPROM

None (0) = Inactive

Read (1) = Read parameter set from the SD Card

Program (2) = Program a parameter set to the SD Card

Auto (3) = Auto save

Boot (4) = Boot mode

<b>11.072</b>		<b>NV Media Card Create Special File</b>	
RW	Num	NC	
OL			
RFC-A	⇕	0 to 1	0
RFC-S			

If *NV Media Card Create Special File* (11.072) = 1 when a parameter file is transferred to an 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.

<b>11.073</b>		<b>NV Media Card Type</b>		
RO	Txt	ND	NC	PT
OL				
RFC-A	⇕	None (0), SD Card (1)	⇒	
RFC-S				

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.

<b>11.075</b>		<b>NV Media Card Read-only Flag</b>		
RO	Bit	ND	NC	PT
OL				
RFC-A	⇕	Off (0) or On (1)	⇒	
RFC-S				

*NV Media Card Read-only Flag* (11.075) shows the state of the read-only flag for the currently installed card.

<b>11.076</b>		<b>NV Media Card Warning Suppression Flag</b>		
RO	Bit	ND	NC	PT
OL				
RFC-A	⇕	Off (0) or On (1)	⇒	
RFC-S				

*NV Media Card Warning Suppression Flag* (11.076) shows the state of the warning flag for the currently installed card.

<b>11.077</b>		<b>NV Media Card File Required Version</b>		
RW	Num	ND	NC	PT
OL				
RFC-A	⇕	0 to 9999	⇒	
RFC-S				

The value of *NV Media Card File Required Version* (11.077) is used as the version number for a file when it is created on an SD Card. *NV Media Card File Required Version* (11.077) is reset to 0 when the file is created or the transfer fails.

## 10.6 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 13 *Diagnostics* on page 222 for more information on SD Card trips.

# 11 Onboard PLC

## 11.1 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](http://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.

## 11.2 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.

## 11.3 Features

The Digitax HD M Onboard PLC user program has the following features:

### 11.3.1 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.

### 11.3.2 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.

### 11.3.3 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.

### 11.3.4 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.

## 11.4 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.

## 11.5 Onboard PLC trips

If the drive detects an error in the user program it will initiate a User Program trip. The sub-trip number for the User Program trip details the reason for the error. See Chapter 13 *Diagnostics* on page 222 for more information on the User Program trip.

## 12 Advanced parameters

This is a quick reference to all parameters in the drive showing units, ranges limits etc, with block diagrams to illustrate their function. Full descriptions of the parameters can be found in the *Parameter Reference Guide*.



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

**Table 12-1 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 12-2 Key to parameter table coding**

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

**Table 12-3 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											

## 12.1 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.

<b>VM_AC_VOLTAGE</b>		Range applied to parameters showing AC voltage
<b>Units</b>	V	
<b>Range of [MIN]</b>	0	
<b>Range of [MAX]</b>	0 to 930	
<b>Definition</b>	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 12-4. VM_AC_VOLTAGE[MIN] = 0	

<b>VM_AC_VOLTAGE_SET</b>		Range applied to the AC voltage set-up parameters
<b>Units</b>	V	
<b>Range of [MIN]</b>	0	
<b>Range of [MAX]</b>	0 to 690	
<b>Definition</b>	VM_AC_VOLTAGE[MAX] is drive voltage rating dependent. See Table 12-4. VM_AC_VOLTAGE[MIN] = 0	

<b>VM_ACCEL_RATE</b>		Maximum applied to the ramp rate parameters
<b>Units</b>	s / 100 Hz, s / 1000 rpm, s / 1000 mm/s	
<b>Range of [MIN]</b>	Open-loop: 0.0 RFC-A, RFC-S: 0.000	
<b>Range of [MAX]</b>	Open-loop: 0.0 to 3200.0 RFC-A, RFC-S: 0.000 to 3200.000	
<b>Definition</b>	Open-loop mode If <i>Ramp Rate Units</i> (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.0 If <i>Ramp Rate Units</i> (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.0 x Pr <b>01.006</b> / 100.0  VM_ACCEL_RATE[MIN] = 0.0  RFC-A, RFC-S modes If <i>Ramp Rate Units</i> (02.039) = 0: VM_ACCEL_RATE[MAX] = 3200.000 If <i>Ramp Rate Units</i> (02.039) = 1: VM_ACCEL_RATE[MAX] = 3200.000 x Pr <b>01.006</b> / 1000.0  VM_ACCEL_RATE[MIN] = 0.000  If the second motor map is selected (Pr <b>11.045</b> = 1) Pr <b>21.001</b> is used instead of Pr <b>01.006</b> .	

<b>VM_AMC_JERK_UNIPOLAR</b>		Range applied to the parameters showing the AMC jerk
<b>Units</b>	User units / ms / ms / ms	
<b>Range of [MIN]</b>	0	
<b>Range of [MAX]</b>	107374.1823	
<b>Definition</b>	VM_AMC_JERK_UNIPOLAR[MAX] = 107374.1823 / AMC Auto Resolution Scaling (31.016)  VM_AMC_JERK_UNIPOLAR[MIN] = 0	

<b>VM_AMC_POSITION</b>		Range applied to the parameters showing the AMC position	
<b>Unit</b>	User units		
<b>Range of [MIN]</b>	-2147483648		
<b>Range of [MAX]</b>	2147483647		
<b>Definition</b>	VM_AMC_POSITION is modified by <i>AMC Auto Resolution Scaling</i> (31.016) and <i>AMC Roll Over Limit</i> (31.010). See the table below.		
	<b>AMC Roll Over Limit (31.010)</b>	<b>= 0</b>	<b>&gt; 0</b>
	VM_AMC_POSITION[MAX]	2147483647 / <i>AMC Auto Resolution Scaling</i> (31.016)	<i>AMC Roll Over Limit</i> (31.010) - 1
	VM_AMC_POSITION[MIN]	-2147483648 / <i>AMC Auto Resolution Scaling</i> (31.016)	0

<b>VM_AMC_POSITION_CAM</b>		Range applied to the parameters showing the AMC cam position	
<b>Unit</b>	User units		
<b>Range of [MIN]</b>	-1073741824		
<b>Range of [MAX]</b>	1073741823		
<b>Definition</b>	VM_AMC_POSITION_CAM is modified by <i>AMC Auto Resolution Scaling</i> (31.016) and <i>AMC Roll Over Limit</i> (31.010). See the table below.		
	<b>AMC Roll Over Limit (31.010)</b>	<b>= 0</b>	<b>&gt; 0</b>
	VM_AMC_POSITION_CAM[MAX]	1073741823 / <i>AMC Auto Resolution Scaling</i> (31.016)	<i>AMC Roll Over Limit</i> (31.010) - 1
	VM_AMC_POSITION_CAM[MIN]	-1073741824 / <i>AMC Auto Resolution Scaling</i> (31.016)	- <i>AMC Roll Over Limit</i> (31.010) + 1

<b>VM_AMC_POSITION_CAM_UNIPOLAR</b>		Unipolar version of VM_AMC_POSITION_CAM	
<b>Unit</b>	User units		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	1073741823		
<b>Definition</b>	VM_AMC_POSITION_CAM_UNIPOLAR is modified by <i>AMC Auto Resolution Scaling</i> (31.016) and <i>AMC Roll Over Limit</i> (31.010). See the table below. .		
	<b>AMC Roll Over Limit (31.010)</b>	<b>= 0</b>	<b>&gt; 0</b>
	VM_AMC_POSITION_CAM_UNIPOLAR[MAX]	1073741823 / <i>AMC Auto Resolution Scaling</i> (31.016)	<i>AMC Roll Over Limit</i> (31.010) - 1
	VM_AMC_POSITION_CAM_UNIPOLAR[MIN]	0	0

<b>VM_AMC_POSITION_REF</b>		Range applied to the AMC position reference		
<b>Unit</b>	User units			
<b>Range of [MIN]</b>	-2147483648			
<b>Range of [MAX]</b>	2147483647			
<b>Definition</b>	VM_AMC_POSITION_REF is modified by <i>AMC Auto Resolution Scaling</i> (31.016), <i>AMC Roll Over Limit</i> (31.010) and <i>AMC Rotary Mode</i> (34.005). See the table below.			
	<b>AMC Roll Over Limit (31.010)</b>	<b>= 0</b>	<b>&gt; 0</b>	
	<b>AMC Rotary Mode (34.005)</b>	<b>Not active</b>	<b>&lt; 4</b>	<b>= 4</b>
	VM_AMC_POSITION_REF[MAX]	2147483647 / <i>AMC Auto Resolution Scaling</i> (31.016)	<i>AMC Roll Over Limit</i> (31.010) - 1	1073741823 / <i>AMC Auto Resolution Scaling</i> (31.016)
	VM_AMC_POSITION_REF[MIN]	-2147483648 / <i>AMC Auto Resolution Scaling</i> (31.016)	0	-1073741824 / <i>AMC Auto Resolution Scaling</i> (31.016)

<b>VM_AMC_POSITION_UNIPOLAR</b>		Unipolar version of VM_AMC_POSITION	
<b>Unit</b>	User units		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	2147483647		
<b>Definition</b>	VM_AMC_POSITION_UNIPOLAR is modified by <i>AMC Auto Resolution Scaling</i> (31.016) and <i>AMC Roll Over Limit</i> (31.010). See the table below.		
	<b>AMC Roll Over Limit (31.010)</b>	<b>= 0</b>	<b>&gt; 0</b>
	VM_AMC_POSITION_UNIPOLAR[MAX]	2147483647 / <i>AMC Auto Resolution Scaling</i> (31.016)	<i>AMC Roll Over Limit</i> (31.010) - 1
	VM_AMC_POSITION_UNIPOLAR[MIN]	0	0

<b>VM_AMC_RATE</b>		Range applied to the parameters showing the AMC acceleration	
<b>Unit</b>	User units / ms / ms		
<b>Range of [MIN]</b>	1073742.824		
<b>Range of [MAX]</b>	1073741.823		
<b>Definition</b>	VM_AMC_RATE_UNIPOLAR[MAX] = 1073741.823 / <i>AMC Auto Resolution Scaling</i> (31.016)		
	VM_AMC_RATE_UNIPOLAR[MIN] = 1073741.824 / <i>AMC Auto Resolution Scaling</i> (31.016)		

<b>VM_AMC_RATE_UNIPOLAR</b>		Unipolar version of VM_AMC_RATE	
<b>Unit</b>	User units / ms / ms		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	1073741.823		
<b>Definition</b>	VM_AMC_RATE_UNIPOLAR[MAX] = 1073741.823 / <i>AMC Auto Resolution Scaling</i> (31.016)		
	VM_AMC_RATE_UNIPOLAR[MIN] = 0		

<b>VM_AMC_ROLLOVER</b>		Maximum applied to the AMC Rollover parameter	
<b>Unit</b>	User units / ms / ms		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	1073741823		
<b>Definition</b>	VM_AMC_ROLLOVER[MAX] = 1073741823 / <i>AMC Auto Resolution Scaling</i> (31.016)		
	VM_AMC_ROLLOVER[MIN] = 0		

<b>VM_AMC_SPEED</b>		Range applied to the parameters showing the AMC speed	
<b>Unit</b>	User units / ms / ms		
<b>Range of [MIN]</b>	-21474836.48		
<b>Range of [MAX]</b>	21474836.47		
<b>Definition</b>	VM_AMC_SPEED[MAX] = 21474836.47 / <i>AMC Auto Resolution Scaling</i> (31.016)		
	VM_AMC_SPEED[MIN] = -21474836.48 / <i>AMC Auto Resolution Scaling</i> (31.016)		

<b>VM_AMC_SPEED_UNIPOLAR</b>		Unipolar version of VM_AMC_SPEED	
<b>Unit</b>	User units / ms		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	21474836.47		
<b>Definition</b>	VM_SPEED_UNIPOLAR[MAX] = 21474836.47 / <i>AMC Auto Resolution Scaling</i> (31.016)		
	VM_SPEED_UNIPOLAR[MIN] = 0		

<b>VM_DC_VOLTAGE</b>		Range applied to parameters showing DC voltage	
<b>Units</b>	V		
<b>Range of [MIN]</b>	0		
<b>Range of [MAX]</b>	0 to 1190		
<b>Definition</b>	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 12-4.		
	VM_DC_VOLTAGE[MIN] = 0		

<b>VM_DC_VOLTAGE_SET</b>		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 12-4. VM_DC_VOLTAGE_SET[MIN] = 0	

<b>VM_DRIVE_CURRENT</b>		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 <i>Full Scale Current Kc</i> (11.061). VM_DRIVE_CURRENT[MIN] = - VM_DRIVE_CURRENT[MAX]	

<b>VM_DRIVE_CURRENT_UNIPOLAR</b>		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	

<b>VM_HIGH_DC_VOLTAGE</b>		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 12-4. VM_HIGH_DC_VOLTAGE[MIN] = 0	

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

<b>VM_MIN_SWITCHING_FREQUENCY</b>		Range applied to the minimum switching frequency parameter
Units	User units	
Range of [MIN]	0	
Range of [MAX]	0 to 6	
Definition	VM_MIN_SWITCHING_FREQUENCY[MAX] = <i>Maximum Switching Frequency</i> (05.018) VM_MIN_SWITCHING_FREQUENCY[MIN] = 0 for motor control modes, or 1 for Regen mode (subject to the maximum)	

VM_MOTOR1_CURRENT_LIMIT VM_MOTOR2_CURRENT_LIMIT		Range applied to current limit parameters
<b>Units</b>	%	
<b>Range of [MIN]</b>	0.0	
<b>Range of [MAX]</b>	0.0 to 1000.0	
<b>Definition</b>	VM_MOTOR1_CURRENT_LIMIT[MIN] = 0.0	
	<b>Open-loop</b> VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{Tlimit} / I_{Trated}) \times 100 \%$ Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ $I_{Mrated} = Pr \ 05.007 \sin \phi$ $I_{Trated} = Pr \ 05.007 \times \cos \phi$ $\cos \phi = Pr \ 05.010$ $I_{MaxRef}$ is 0.7 x Pr 11.061 when the motor rated current set in Pr 05.007 is less than or equal to Pr 11.032 (i.e. Heavy duty).	
	<b>RFC-A</b> VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{Tlimit} / I_{Trated}) \times 100 \%$ Where: $I_{Tlimit} = I_{MaxRef} \times \cos(\sin^{-1}(I_{Mrated} / I_{MaxRef}))$ $I_{Mrated} = Pr \ 05.007 \times \sin \phi_1$ $I_{Trated} = Pr \ 05.007 \times \cos \phi_1$ $\phi_1 = \cos^{-1}(Pr \ 05.010) + \phi_2$ . $\phi_1$ is calculated during an autotune. See the variable minimum / maximum calculations in the <i>Parameter Reference Guide</i> for more information regarding $\phi_2$ . $I_{MaxRef}$ 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).	
	<b>RFC-S and Regen</b> VM_MOTOR1_CURRENT_LIMIT[MAX] = $(I_{MaxRef} / Pr \ 05.007) \times 100 \%$ Where: $I_{MaxRef}$ is 0.9 x Pr 11.061 when the motor rated current set in Pr 05.007 is 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																		
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s																			
<b>Range of [MIN]</b>	Open-loop: -550.0 to 0.0 RFC-A, RFC-S: -50000.0 to 0.0																			
<b>Range of [MAX]</b>	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0																			
<b>Definition</b>	<table border="1"> <thead> <tr> <th>Negative Reference Clamp Enable (01.008)</th> <th>Bipolar Reference Enable (01.010)</th> <th>VM_NEGATIVE_REF_CLAMP1[MIN]</th> <th>VM_NEGATIVE_REF_CLAMP1[MAX]</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0.0</td> <td>Pr 01.006</td> </tr> <tr> <td>0</td> <td>1</td> <td>0.0</td> <td>0.0</td> </tr> <tr> <td>1</td> <td>X</td> <td>-VM_POSITIVE_REF_CLAMP1[MAX]</td> <td>0.0</td> </tr> </tbody> </table>				Negative Reference Clamp Enable (01.008)	Bipolar Reference Enable (01.010)	VM_NEGATIVE_REF_CLAMP1[MIN]	VM_NEGATIVE_REF_CLAMP1[MAX]	0	0	0.0	Pr 01.006	0	1	0.0	0.0	1	X	-VM_POSITIVE_REF_CLAMP1[MAX]	0.0
	Negative Reference Clamp Enable (01.008)	Bipolar Reference Enable (01.010)	VM_NEGATIVE_REF_CLAMP1[MIN]	VM_NEGATIVE_REF_CLAMP1[MAX]																
	0	0	0.0	Pr 01.006																
	0	1	0.0	0.0																
1	X	-VM_POSITIVE_REF_CLAMP1[MAX]	0.0																	
VM_NEGATIVE_REF_CLAMP2 is defined in the same way except that Pr 21.001 is used instead of Pr 01.006.																				

<b>VM_POSITIVE_REF_CLAMP1</b> <b>VM_POSITIVE_REF_CLAMP2</b>		Limits applied to the positive frequency or speed reference clamp												
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s													
<b>Range of [MIN]</b>	Open-loop: 0.0 RFC-A, RFC-S: 0.0													
<b>Range of [MAX]</b>	Open-loop: 550.0 RFC-A, RFC-S: 0.0 to 50000.0													
<b>Definition</b>	<p>VM_POSITIVE_REF_CLAMP1[MAX] defines the range of the positive reference clamp, <i>Maximum Reference Clamp</i> (01.006), which in turn limit the references. In RFC-A and RFC-S modes a limit is applied so that the position feedback does not exceed the speed where the drive can no longer interpret the feedback signal correctly as given in the table below. The limit is based on the position feedback device selected with <i>Motor Control Feedback Select</i> (03.026). It is possible to disable this limit if the <i>RFC Feedback Mode</i> (03.024) <math>\geq 1</math> (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.</p> <table border="1"> <thead> <tr> <th>Feedback device</th> <th>VM_POSITIVE_REF_CLAMP1[MAX]</th> </tr> </thead> <tbody> <tr> <td>AB, AB Servo</td> <td>(500 kHz x 60 / rotary lines per revolution) rpm (500 kHz x linear line pitch in mm) mm/s</td> </tr> <tr> <td>FD, FR, FD Servo, FR Servo</td> <td>(500 kHz x 60 / rotary lines per revolution)/2 rpm (500 kHz x linear line pitch in mm)/2 mm/s</td> </tr> <tr> <td>SC, SC Hiper, SC EnDat, SC SSI, SC Servo</td> <td>(500 kHz x 60 / sine waves per revolution) rpm (500 kHz x linear line pitch in mm) mm/s</td> </tr> <tr> <td>Resolver</td> <td>(250 Hz x 60) rpm (250 Hz x pole pitch in mm) mm/s</td> </tr> <tr> <td>Any other device</td> <td>50000.0 rpm or mm/s</td> </tr> </tbody> </table> <p>In open-loop mode VM_POSITIVE_REF_CLAMP1[MAX] is fixed at 550.0 Hz            In RFC mode a limit is applied to the speed reference of 550 x 60 / Motor pole pairs. Therefore, with a 4 pole motor the limit for VM_POSITIVE_REF_CLAMP1[MAX] will be 16,500 rpm.            VM_POSITIVE_REF_CLAMP1[MIN] = 0.0            VM_POSITIVE_REF_CLAMP2 is defined in the same way as VM_POSITIVE_REF_CLAMP1 except            VM_POSITIVE_REF_CLAMP2[MAX] defines the range of the positive reference clamp, <i>M2 Maximum Reference Clamp</i> (21.001), which in turn limits the references.</p>		Feedback device	VM_POSITIVE_REF_CLAMP1[MAX]	AB, AB Servo	(500 kHz x 60 / rotary lines per revolution) rpm (500 kHz 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
	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												

<b>VM_POWER</b>		Range applied to parameters that either set or display power
<b>Units</b>	kW	
<b>Range of [MIN]</b>	-99999.999 to 0.000	
<b>Range of [MAX]</b>	0.000 to 99999.999	
<b>Definition</b>	<p>VM_POWER[MAX] is rating dependent and is chosen to allow for the maximum power that can be output by the drive with maximum a.c. output voltage, at maximum controlled current and unity power factor.</p> $VM\_POWER[MAX] = \sqrt{3} \times VM\_AC\_VOLTAGE[MAX] \times VM\_DRIVE\_CURRENT[MAX] / 1000$ $VM\_POWER[MIN] = -VM\_POWER[MAX]$	

<b>VM_RATED_CURRENT</b>		Range applied to rated current parameters
<b>Units</b>	A	
<b>Range of [MIN]</b>	0.000	
<b>Range of [MAX]</b>	0.000 to 99999.999	
<b>Definition</b>	<p>VM_RATED_CURRENT [MAX] = <i>Maximum Rated Current</i> (11.060) and is dependent on the drive rating. This is the Heavy Duty rating of the drive.</p> $VM\_RATED\_CURRENT [MIN] = 0.000$	

<b>VM_REGEN_REACTIVE</b>		Range applied to the reactive current reference in Regen mode
<b>Units</b>	%	
<b>Range of [MIN]</b>	-1000.0 to 0.0	
<b>Range of [MAX]</b>	0.0 to 1000.0	
<b>Definition</b>	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]	

<b>VM_SPEED</b>		Range applied to parameters showing speed
<b>Units</b>	Open-loop, RFC-A, RFC-S: rpm or mm/s	
<b>Range of [MIN]</b>	Open-loop, RFC-A, RFC-S: -50000.0 to 0.0	
<b>Range of [MAX]</b>	Open-loop, RFC-A, RFC-S: 0.0 to 50000.0	
<b>Definition</b>	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]	

<b>VM_SPEED_FREQ_KEYPAD_REF</b>		Range applied to the keypad reference		
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s			
<b>Range of [MIN]</b>	Open-loop: -550.0 to 550.0 RFC-A, RFC-S: -50000.0 to 50000.0			
<b>Range of [MAX]</b>	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0			
<b>Definition</b>	This variable maximum is applied to <i>Keypad Control Mode Reference</i> (01.017). The maximum applied to these parameters is the same as other frequency reference parameters. VM_SPEED_FREQ_USER_REFS [MAX] = VM_SPEED_FREQ_REF[MAX] However the minimum is dependent on <i>Negative Reference Clamp Enable</i> (01.008) and <i>Bipolar Reference Enable</i> (01.010).			
	<b>Negative Reference Clamp Enable (01.008)</b>	<b>Bipolar Reference Enable (01.010)</b>	<b>VM_SPEED_FREQ_USER_REFS[MIN]</b>	
	0	0	If <i>Select Motor 2 Parameters</i> (11.045) = 0 <i>Minimum Reference Clamp</i> (01.007), otherwise <i>M2 Minimum Reference Clamp</i> (21.002)	
	0	1	-VM_SPEED_FREQ_REF[MAX]	
	1	0	0.0	
	1	1	-VM_SPEED_FREQ_REF[MAX]	

<b>VM_SPEED_FREQ_REF</b>		Range applied to the frequency or speed reference parameters
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s	
<b>Range of [MIN]</b>	Open-loop: -550.0 to 0.0 RFC-A, RFC-S: -50000.0 to 0.0	
<b>Range of [MAX]</b>	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0	
<b>Definition</b>	If Pr <b>01.008</b> = 0: VM_SPEED_FREQ_REF[MAX] = Pr <b>01.006</b> If Pr <b>01.008</b> = 1: VM_SPEED_FREQ_REF[MAX] = Pr <b>01.006</b> or  Pr <b>01.007</b> ], whichever is larger. If the second motor map is selected (Pr <b>11.045</b> = 1) Pr <b>21.001</b> is used instead of Pr <b>01.006</b> and Pr <b>21.002</b> instead of Pr <b>01.007</b> .  VM_SPEED_FREQ_REF[MIN] = -VM_SPEED_FREQ_REF[MAX].	

<b>VM_SPEED_FREQ_REF_UNIPOLAR</b>		Unipolar version of VM_SPEED_FREQ_REF
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s	
<b>Range of [MIN]</b>	Open-loop: 0.0 RFC-A, RFC-S: 0.0	
<b>Range of [MAX]</b>	Open-loop: 0.0 to 550.0 RFC-A, RFC-S: 0.0 to 50000.0	
<b>Definition</b>	VM_SPEED_FREQ_REF_UNIPOLAR[MAX] = VM_SPEED_FREQ_REF[MAX] VM_SPEED_FREQ_REF_UNIPOLAR[MIN] = 0.0	

<b>VM_SPEED_FREQ_USER_REFS</b>		Range applied to Analog reference parameters
<b>Units</b>	Open-loop: Hz RFC-A, RFC-S: rpm or mm/s	
<b>Range of [MIN]</b>	Open-loop: -550.00 to 550.00 RFC-A, RFC-S: -50000.0 to 50000.0	
<b>Range of [MAX]</b>	Open-loop: 0.00 to 550.00 RFC-A, RFC-S: 0.0 to 50000.0	
<b>Definition</b>	VM_SPEED_FREQ_USER_REFS= VM_SPEED_FREQ_REF[MAX]	
	<i>Negative Reference Clamp Enable (01.008)</i>	<i>Bipolar Reference Enable (01.010)</i>
	0	0
	0	1
	1	0
		<b>VM_SPEED_FREQ_USER_REFS [MIN]</b>
		Pr <b>01.007</b>
		-VM_SPEED_FREQ_REF[MAX]
		0.0
		-VM_SPEED_FREQ_REF[MAX]
If the second motor map is selected (Pr <b>11.045</b> = 1) Pr <b>21.002</b> is used instead of Pr <b>01.007</b> .		

<b>VM_STD_UNDER_VOLTS</b>		Range applied to the standard under-voltage threshold
<b>Units</b>	V	
<b>Range of [MIN]</b>	0 to 1150	
<b>Range of [MAX]</b>	0 to 1150	
<b>Definition</b>	VM_STD_UNDER_VOLTS[MAX] = VM_DC_VOLTAGE_SET / 1.1 VM_STD_UNDER_VOLTS[MIN] is voltage rating dependent. See Table 12-4	

<b>VM_SUPPLY_LOSS_LEVEL</b>		Range applied to the supply loss threshold
<b>Units</b>	V	
<b>Range of [MIN]</b>	0 to 1150	
<b>Range of [MAX]</b>	0 to 1150	
<b>Definition</b>	VM_SUPPLY_LOSS_LEVEL[MAX] = VM_DC_VOLTAGE_SET[MAX] VM_SUPPLY_LOSS_LEVEL[MIN] is drive voltage rating dependent. See Table 12-4	

<b>VM_SWITCHING_FREQUENCY</b>		Range applied to the maximum switching frequency parameters
<b>Units</b>	User units	
<b>Range of [MIN]</b>	0	
<b>Range of [MAX]</b>	0 to 6	
<b>Definition</b>	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)	

<b>VM_TORQUE_CURRENT</b>		Range applied to torque and torque producing current parameters (where this is used in Regen mode it refers to the active current)
<b>Units</b>	%	
<b>Range of [MIN]</b>	-1000.0 to 0.0	
<b>Range of [MAX]</b>	0.0 to 1000.0	
<b>Definition</b>	<i>Select Motor 2 Parameters (11.045)</i>	
	0	<b>VM_TORQUE_CURRENT [MAX]</b> VM_MOTOR1_CURRENT_LIMIT[MAX]
	1	VM_MOTOR2_CURRENT_LIMIT[MAX]
	VM_TORQUE_CURRENT[MIN] = -VM_TORQUE_CURRENT[MAX]	

<b>VM_TORQUE_CURRENT_UNIPOLAR</b>		Unipolar version of VM_TORQUE_CURRENT
<b>Units</b>	%	
<b>Range of [MIN]</b>	0.0	
<b>Range of [MAX]</b>	0.0 to 1000.0	
<b>Definition</b>	VM_TORQUE_CURRENT_UNIPOLAR[MAX] = VM_TORQUE_CURRENT[MAX] VM_TORQUE_CURRENT_UNIPOLAR[MIN] = 0.0	

<b>VM_USER_CURRENT</b>		Range applied to torque reference and percentage load parameters with one decimal place
<b>Units</b>	%	
<b>Range of [MIN]</b>	-1000.0 to 0.0	
<b>Range of [MAX]</b>	0.0 to 1000.0	
<b>Definition</b>	<p>VM_USER_CURRENT[MAX] = <i>User Current Maximum Scaling</i> (04.024)</p> <p>VM_USER_CURRENT[MIN] = -VM_USER_CURRENT[MAX]</p> <p><i>User Current Maximum Scaling</i> (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to <i>Percentage Load</i> (04.020), <i>Torque Reference</i> (04.008) and <i>Torque Offset</i> (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user.</p> <p>The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.</p>	

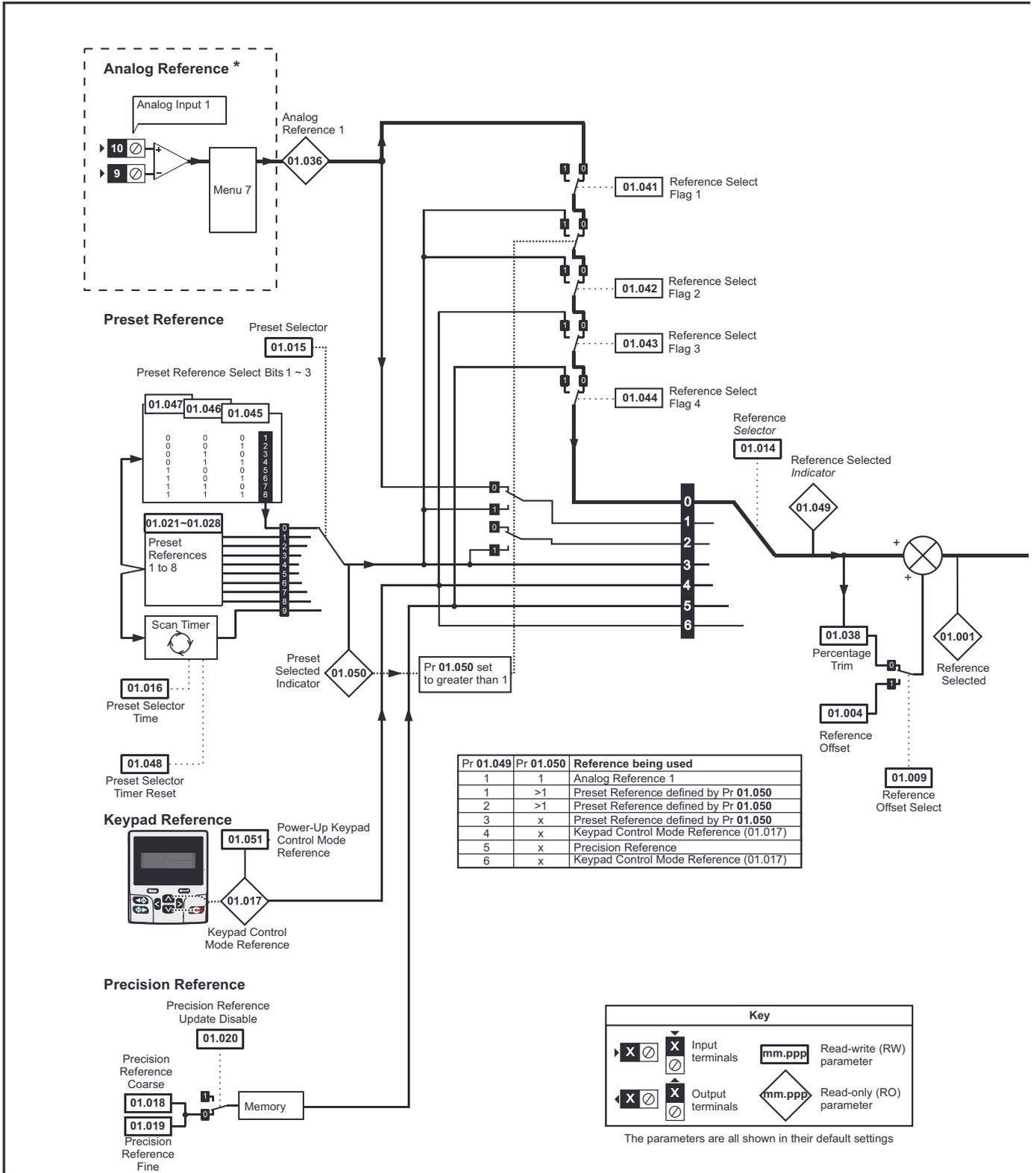
<b>VM_USER_CURRENT_HIGH_RES</b>		Range applied to torque reference and percentage load parameters with two decimal places
<b>Units</b>	%	
<b>Range of [MIN]</b>	-1000.00 to 0.00	
<b>Range of [MAX]</b>	0.00 to 1000.00	
<b>Definition</b>	<p>VM_USER_CURRENT_HIGH_RES[MAX] = <i>User Current Maximum Scaling</i> (04.024) with an additional decimal place</p> <p>VM_USER_CURRENT_HIGH_RES[MIN] = -VM_USER_CURRENT_HIGH_RES[MAX]</p> <p><i>User Current Maximum Scaling</i> (04.024) defines the variable maximum/minimums VM_USER_CURRENT and VM_USER_CURRENT_HIGH_RES which are applied to <i>Percentage Load</i> (04.020), <i>Torque Reference</i> (04.008) and <i>Torque Offset</i> (04.009). This is useful when routing these parameters to an analog output as it allows the full scale output value to be defined by the user.</p> <p>The maximum value (VM_TORQUE_CURRENT_UNIPOLAR [MAX]) varies between drive sizes with default parameters loaded. For some drive sizes the default value may be reduced below the value given by the parameter range limiting.</p>	

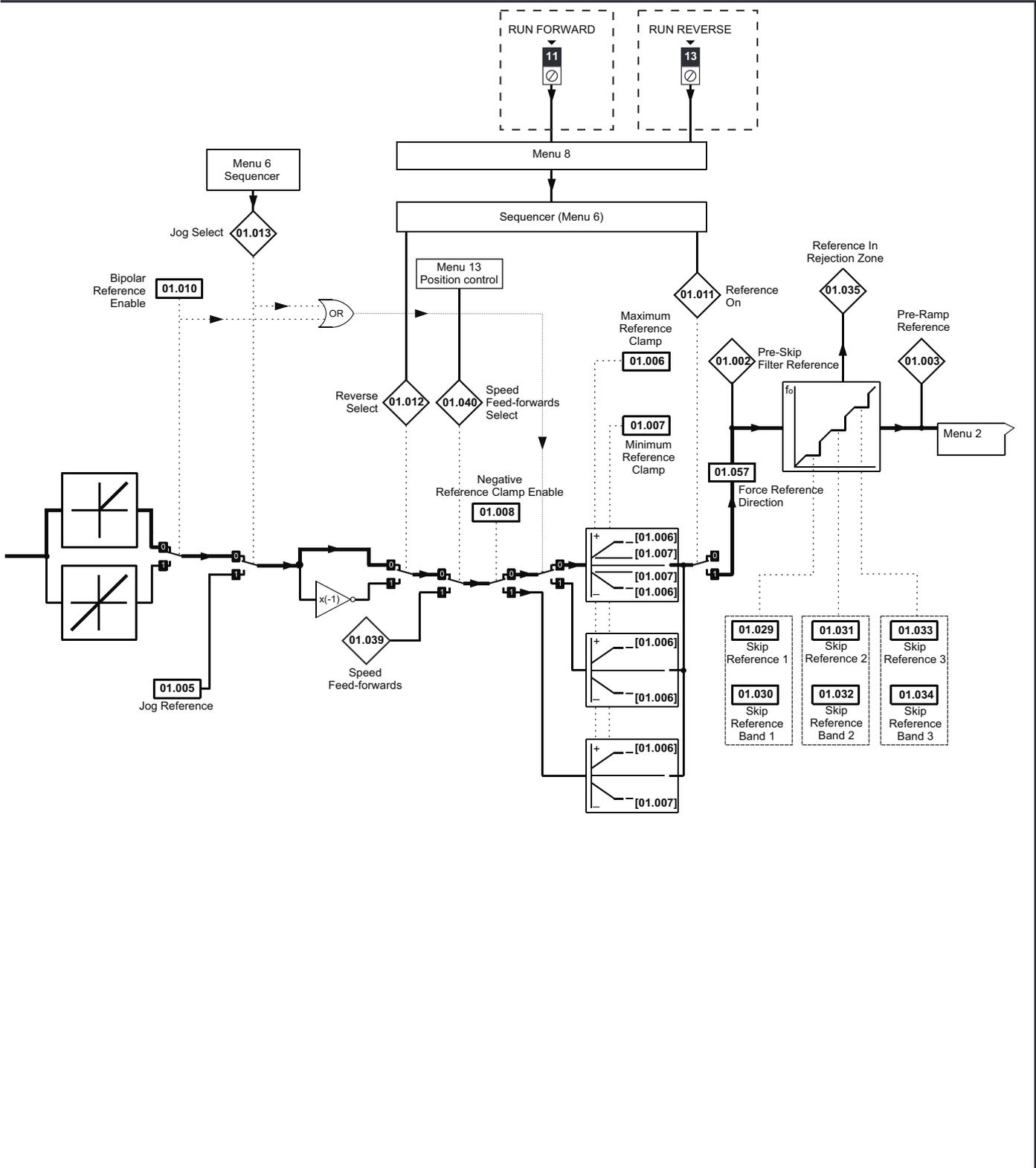
Table 12-4 Voltage ratings dependant values

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

## 12.2 Menu 1: Frequency / speed reference

Figure 12-1 Menu 1 logic diagram





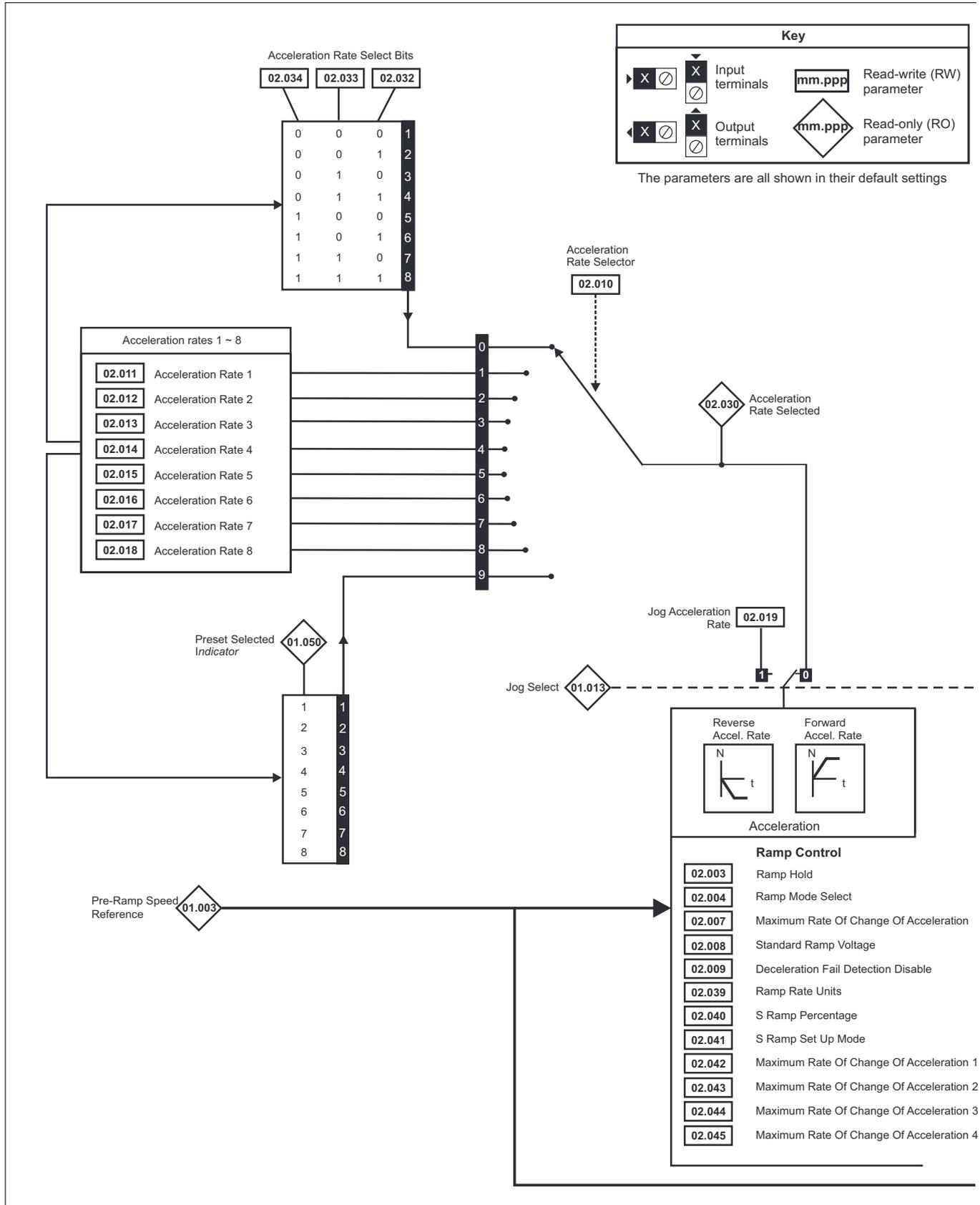
Parameter	Range(φ)		Default(⇒)			Type										
	OL	RFC-A / S	OL	RFC-A	RFC-S											
01.001	Reference Selected	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm								RO	Num	ND	NC	PT	
01.002	Pre-Skip Filter Reference	VM_SPEED_FREQ_REF Hz	VM_SPEED_FREQ_REF rpm								RO	Num	ND	NC	PT	
01.003	Pre-Ramp Reference	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_	VM_SPEED_FREQ_USER_	0.0							RO	Num		NC		
01.037	Analog Reference 2	REFS Hz	REFS rpm	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				

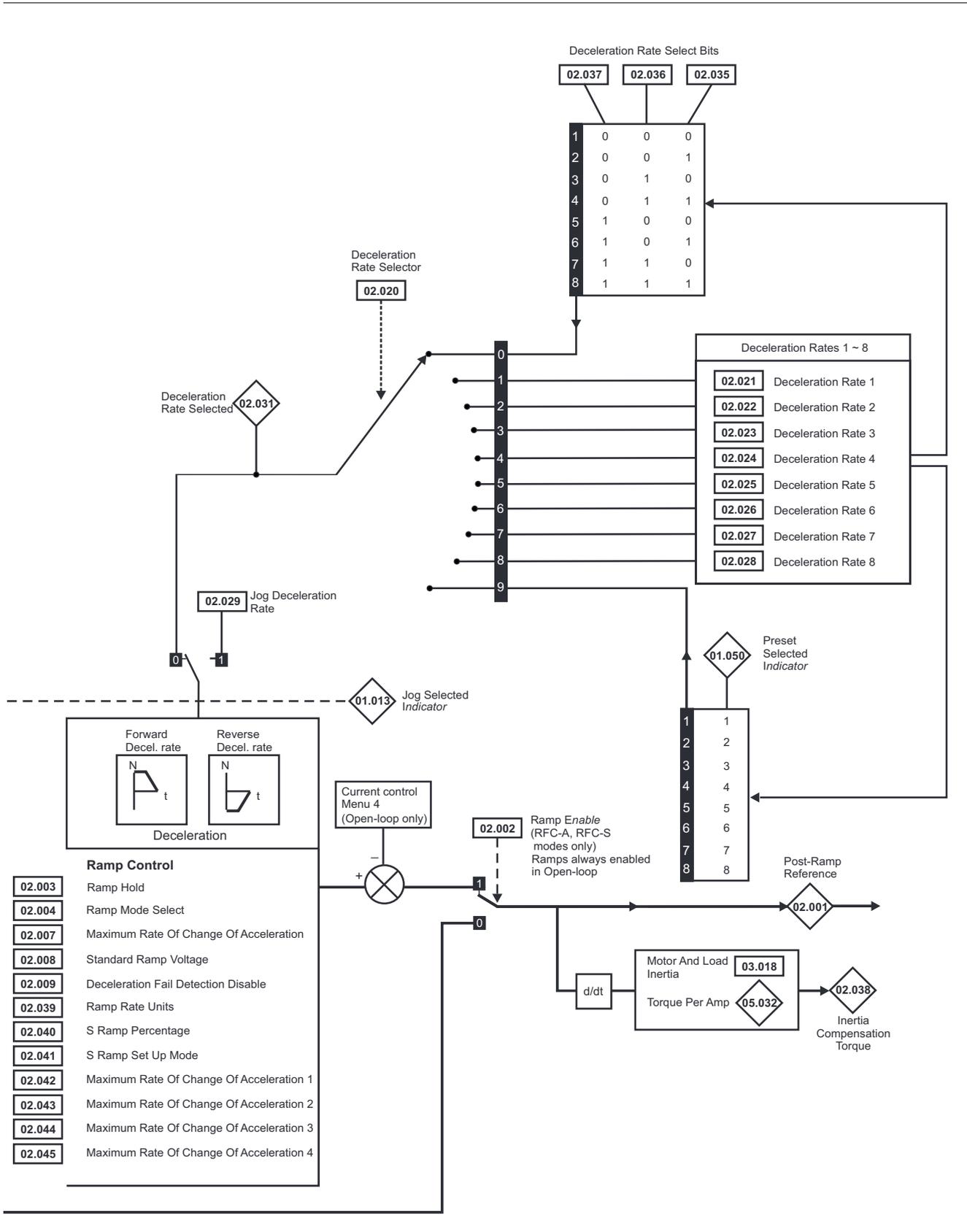
RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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## 12.3 Menu 2: Ramps

Figure 12-2 Menu 2 logic diagram





Parameter		Range(↕)		Default(⇨)			Type						
		OL	RFC-A / S	OL	RFC-A	RFC-S	RO	Num	ND	NC	PT		
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 <sup>2</sup> /100 Hz	0.000 to 100.000 s <sup>2</sup> /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

## 12.4 Menu 3: Frequency slaving, speed feedback and speed control

Figure 12-3 Menu 3 Open-loop logic diagram

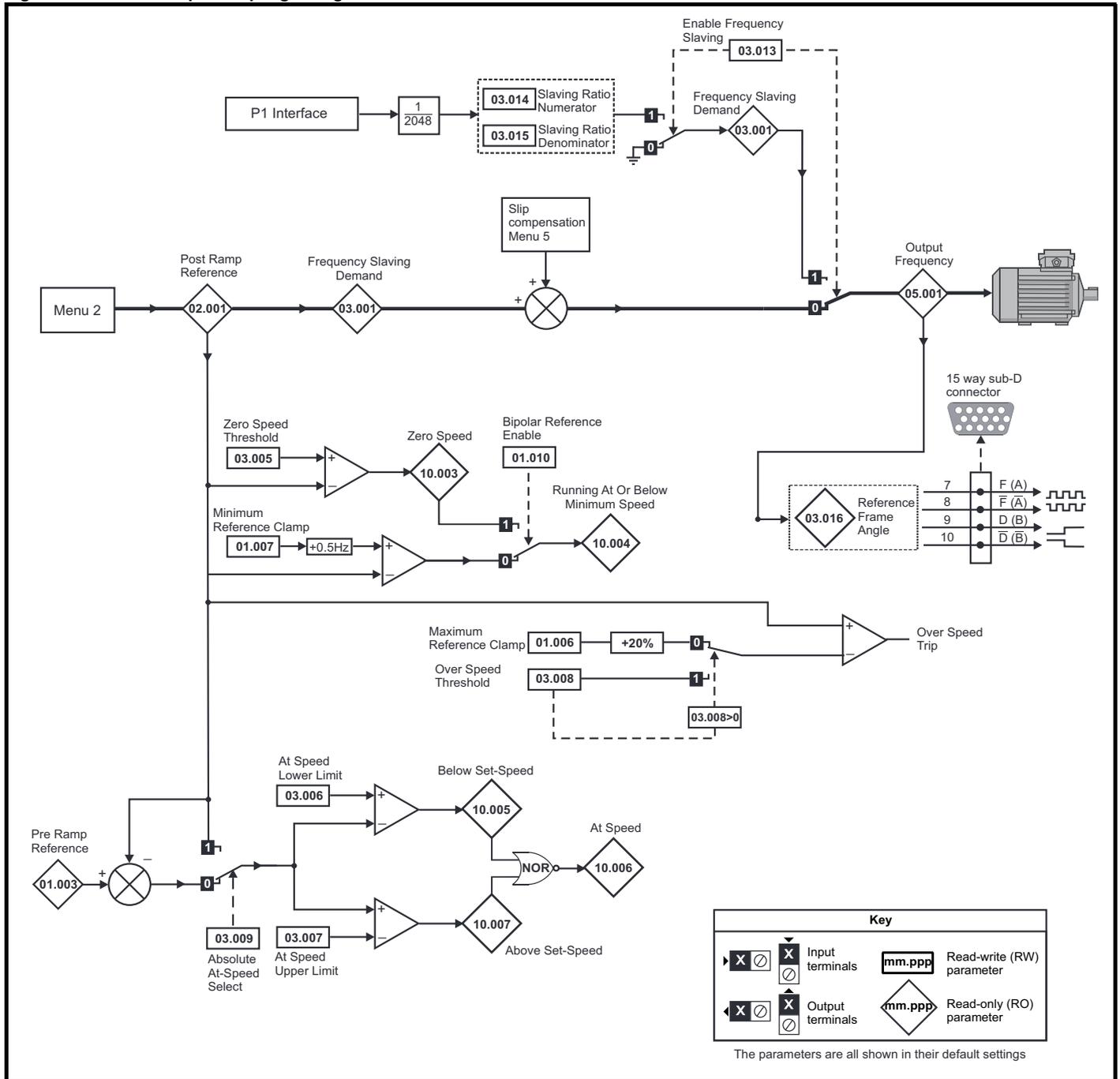
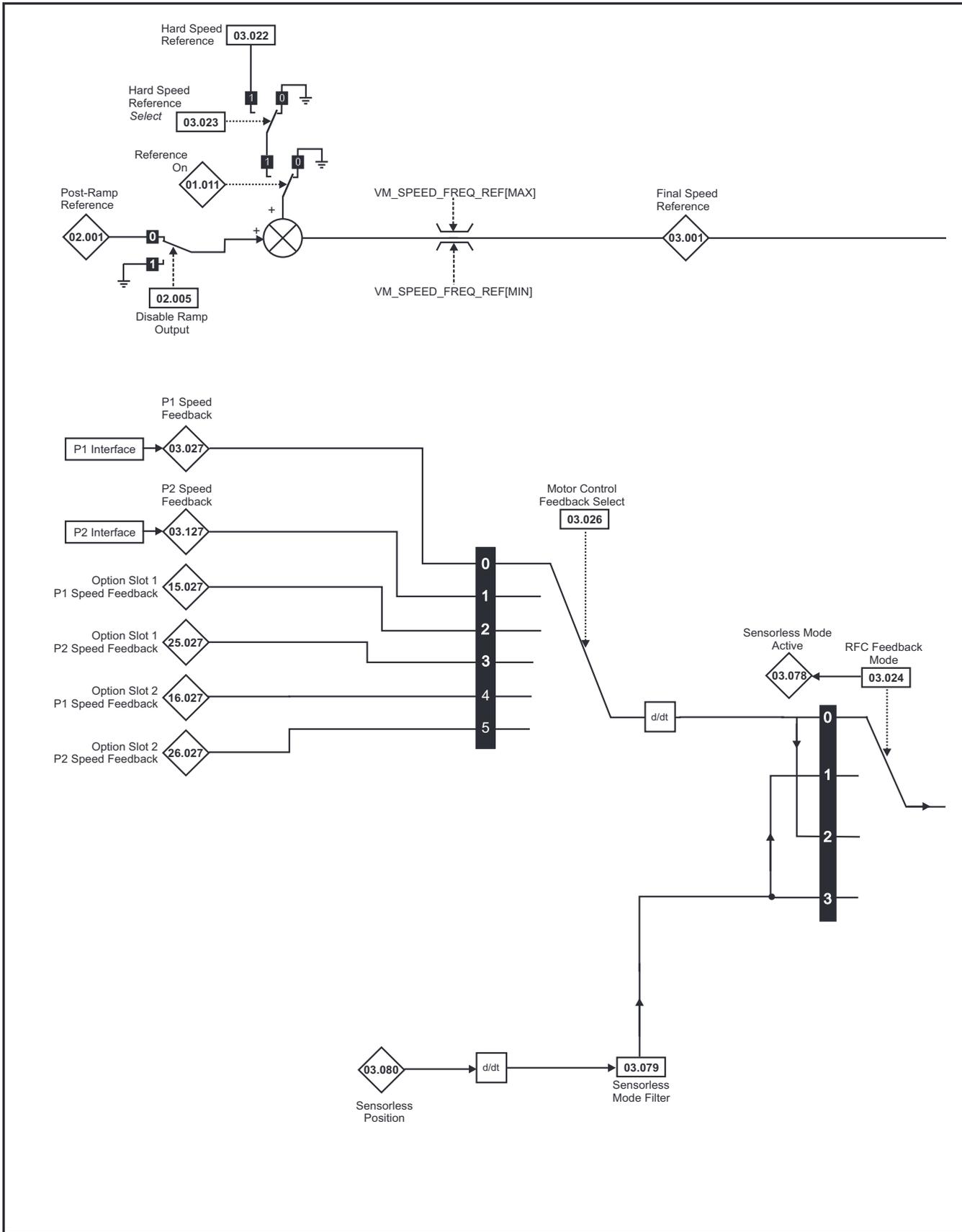
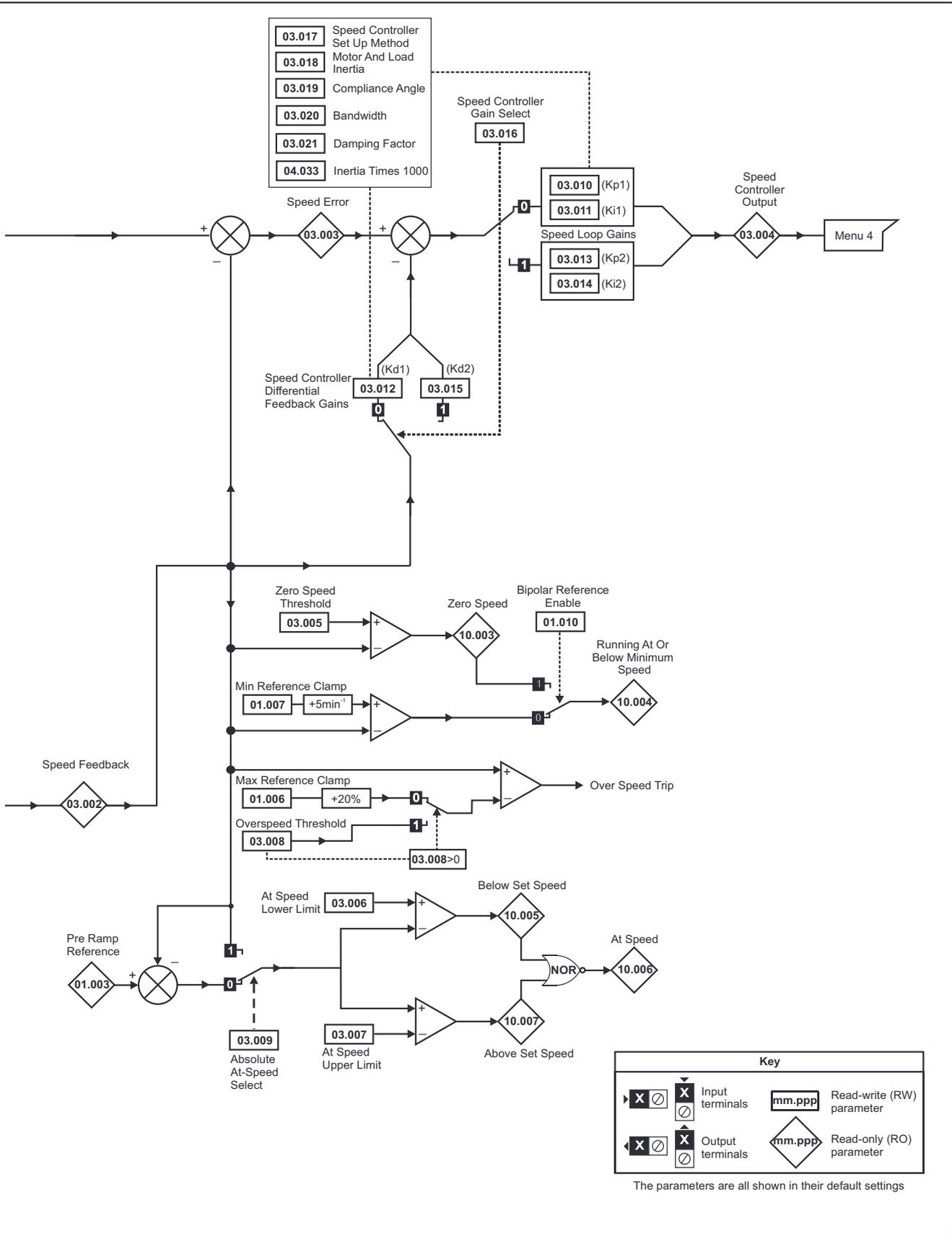


Figure 12-4 Menu 3 RFC-A, RFC-S logic diagram

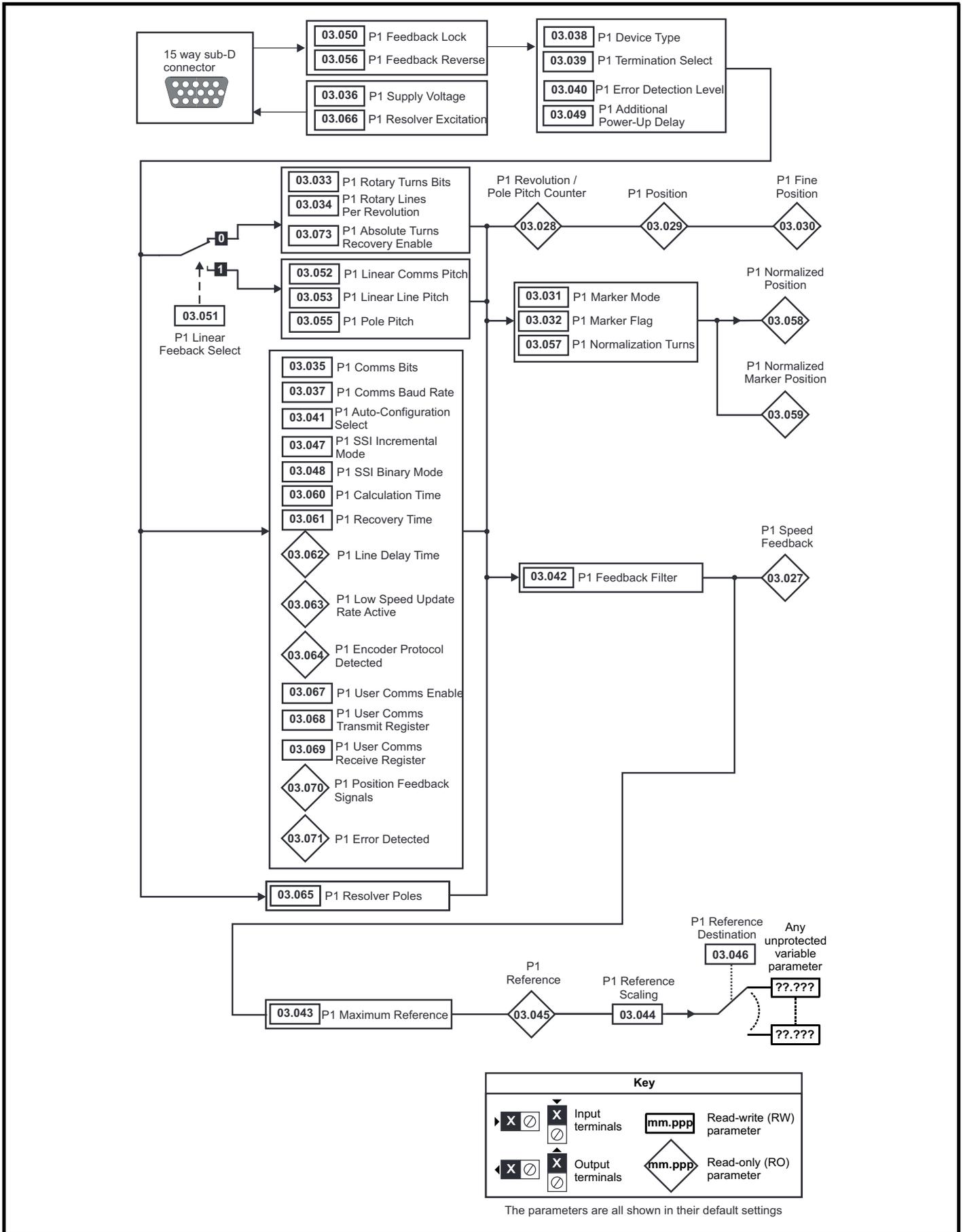


**NOTE**

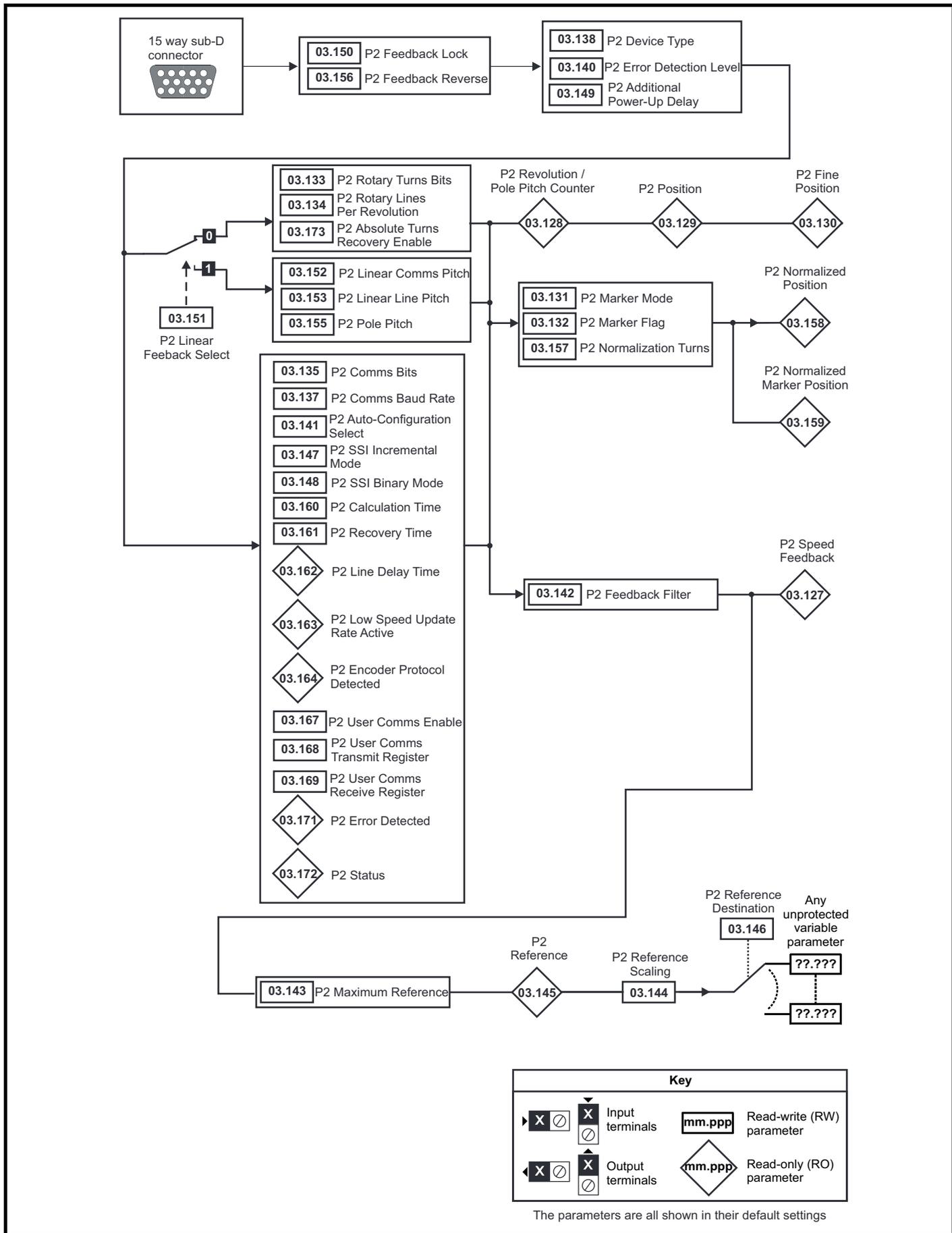
\* Automatic change over if the relevant 'bit' of *Position Feedback Initialized* (03.076) is 0.



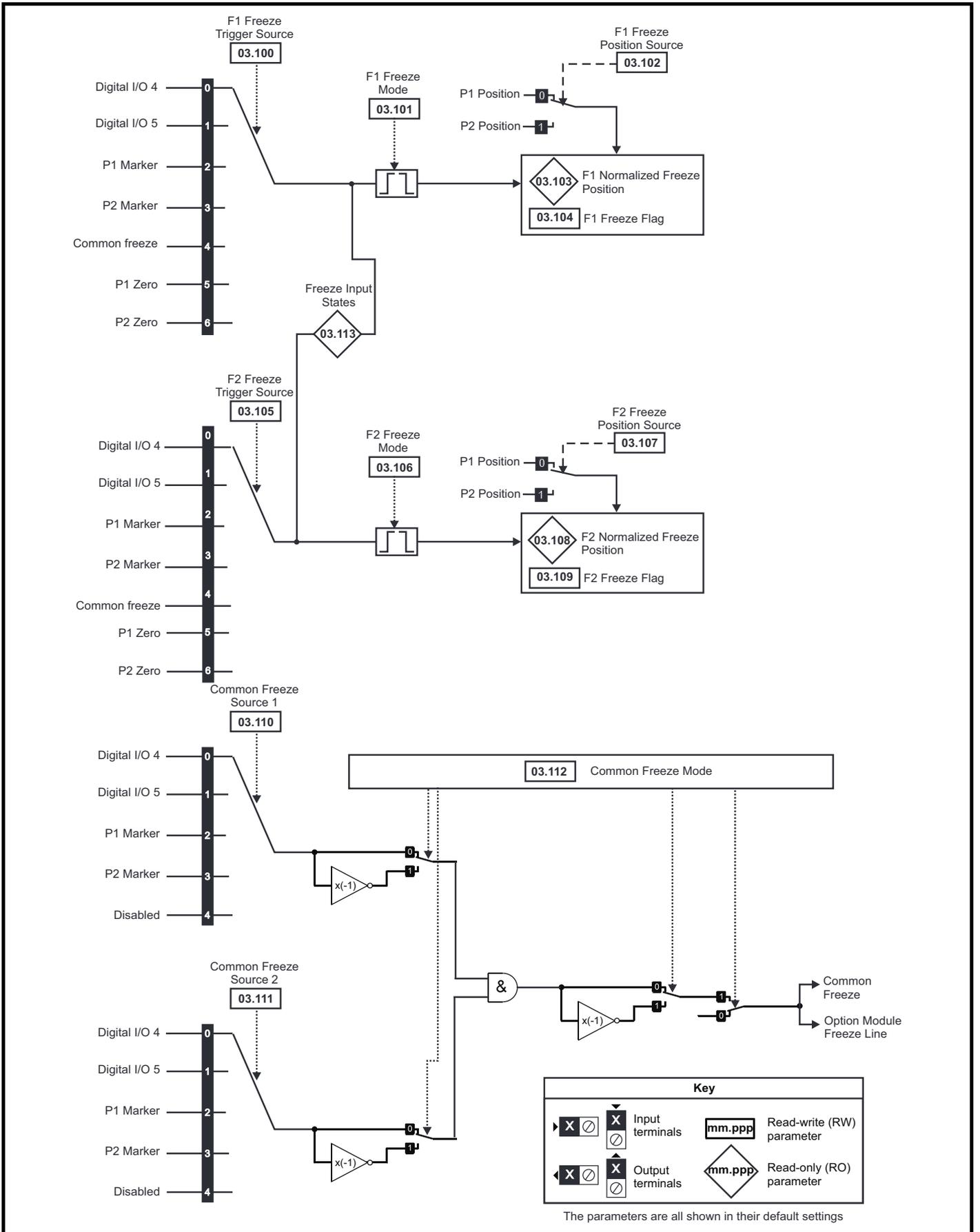
**Figure 12-5 P1 Interface**



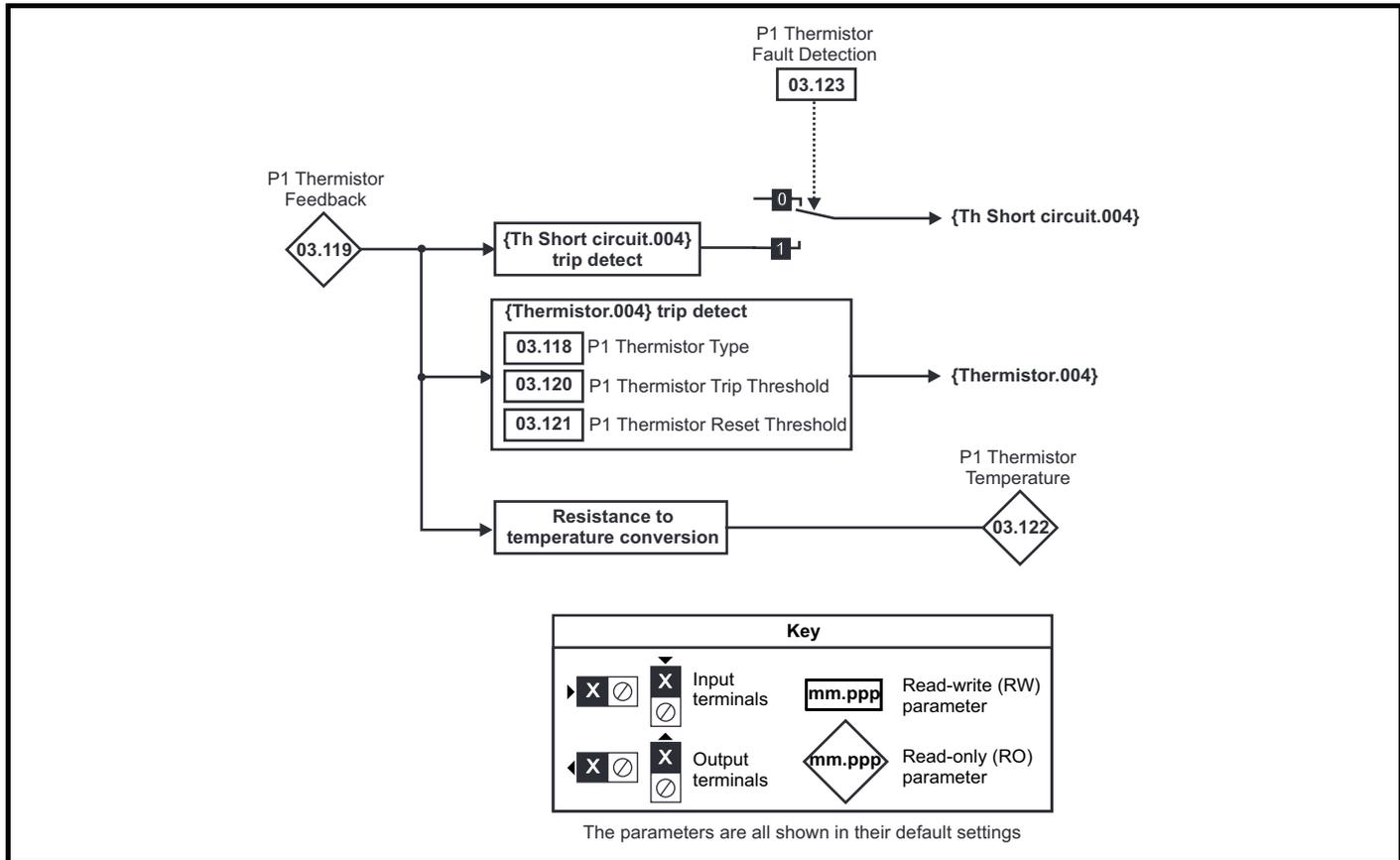
**Figure 12-6 P2 Interface**



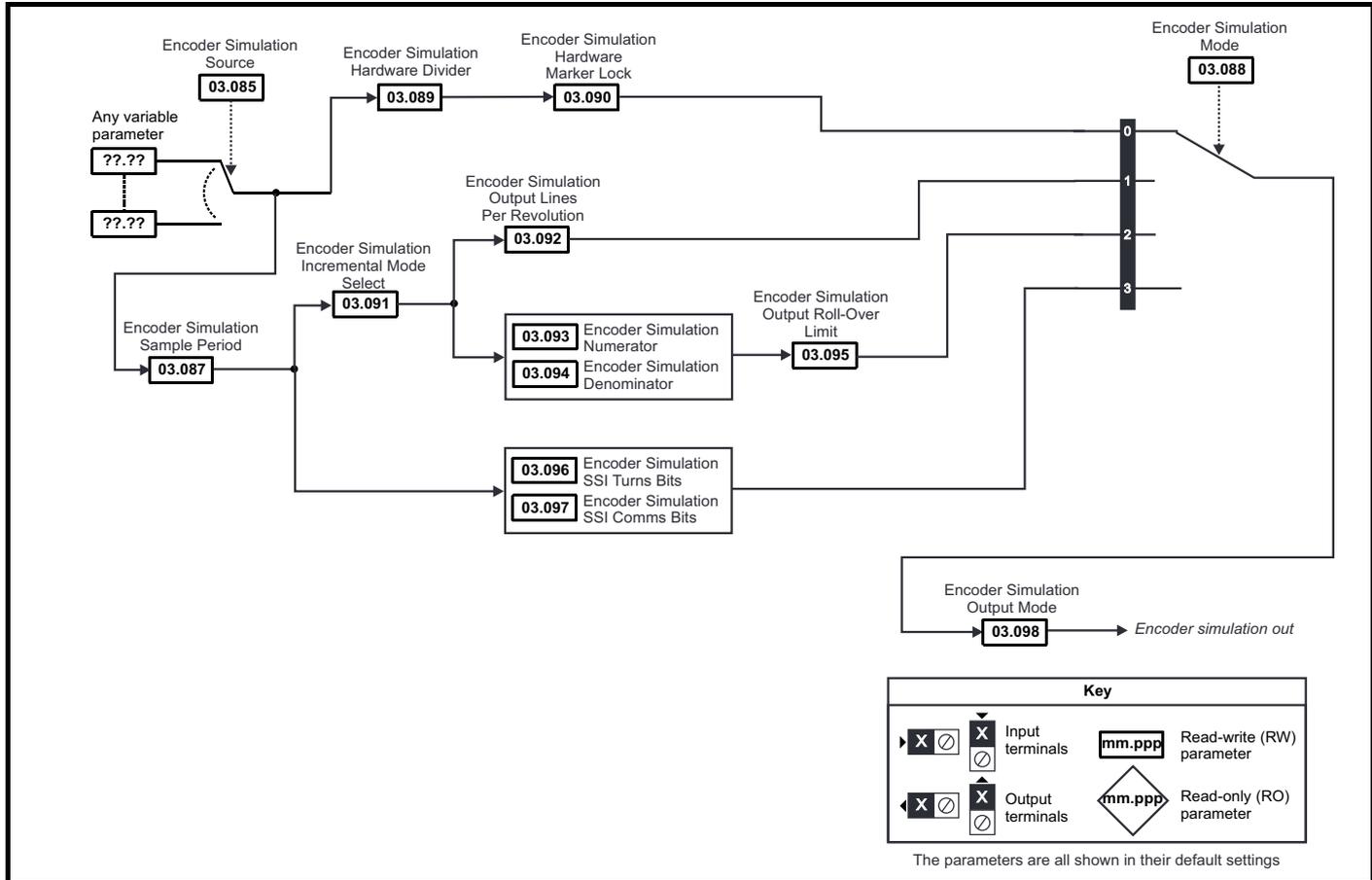
**Figure 12-7 Freeze system logic**



**Figure 12-8 P1 Position feedback interface thermistor input**



**Figure 12-9 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 <sup>2</sup> /rad			0.10 s <sup>2</sup> /rad	1.00 s <sup>2</sup> /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 <sup>2</sup> /rad			0.10 s <sup>2</sup> /rad	1.00 s <sup>2</sup> /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 <sup>2</sup>			0.00000 kgm <sup>2</sup>		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					
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)			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	

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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Parameter		Range			Default			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S	RO	Txt	ND	NC	PT	US
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

## 12.5 Menu 4: Torque and current control

Figure 12-10 Menu 4 Open loop logic diagram

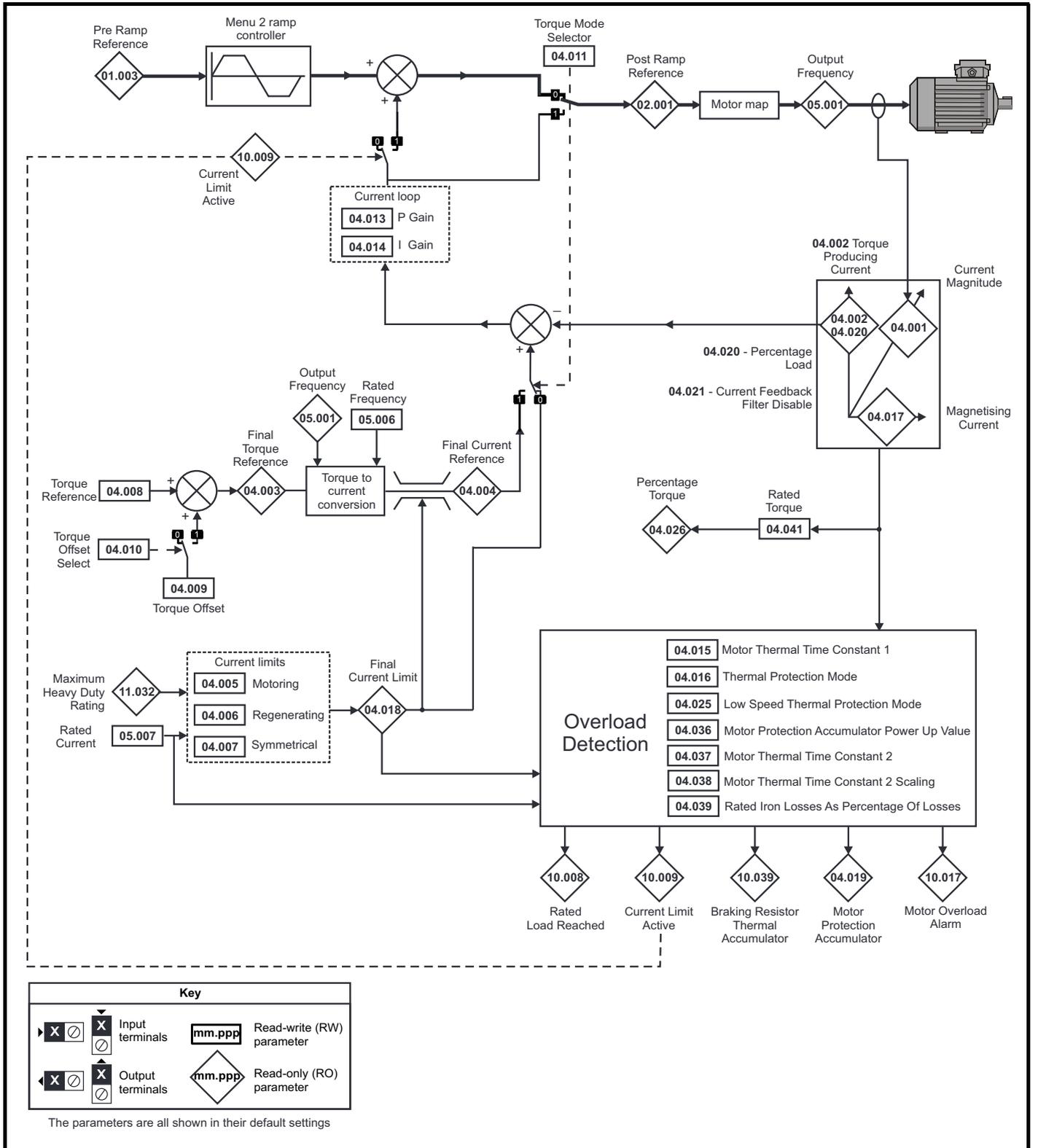


Figure 12-11 Menu 4 RFC-A logic diagram

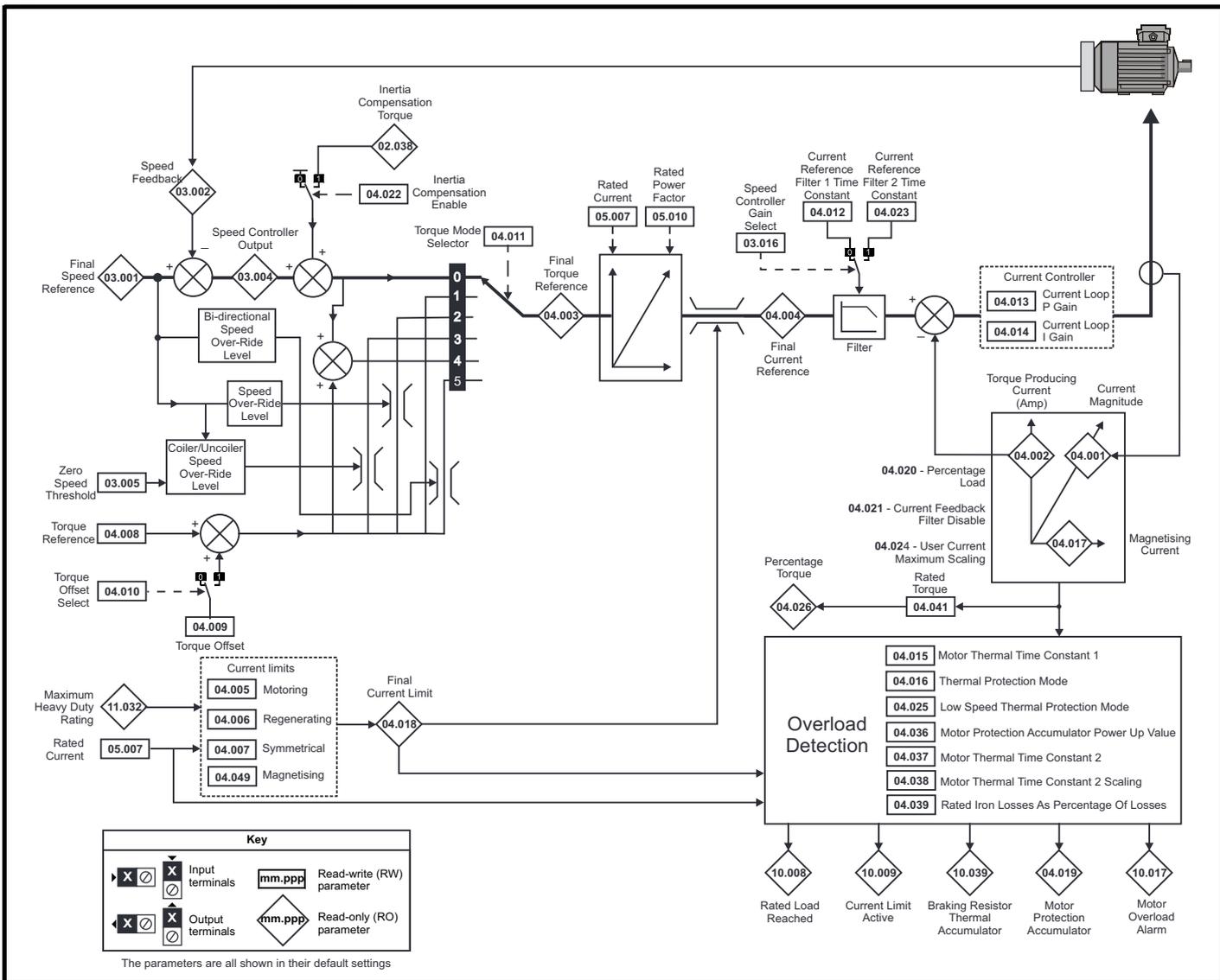
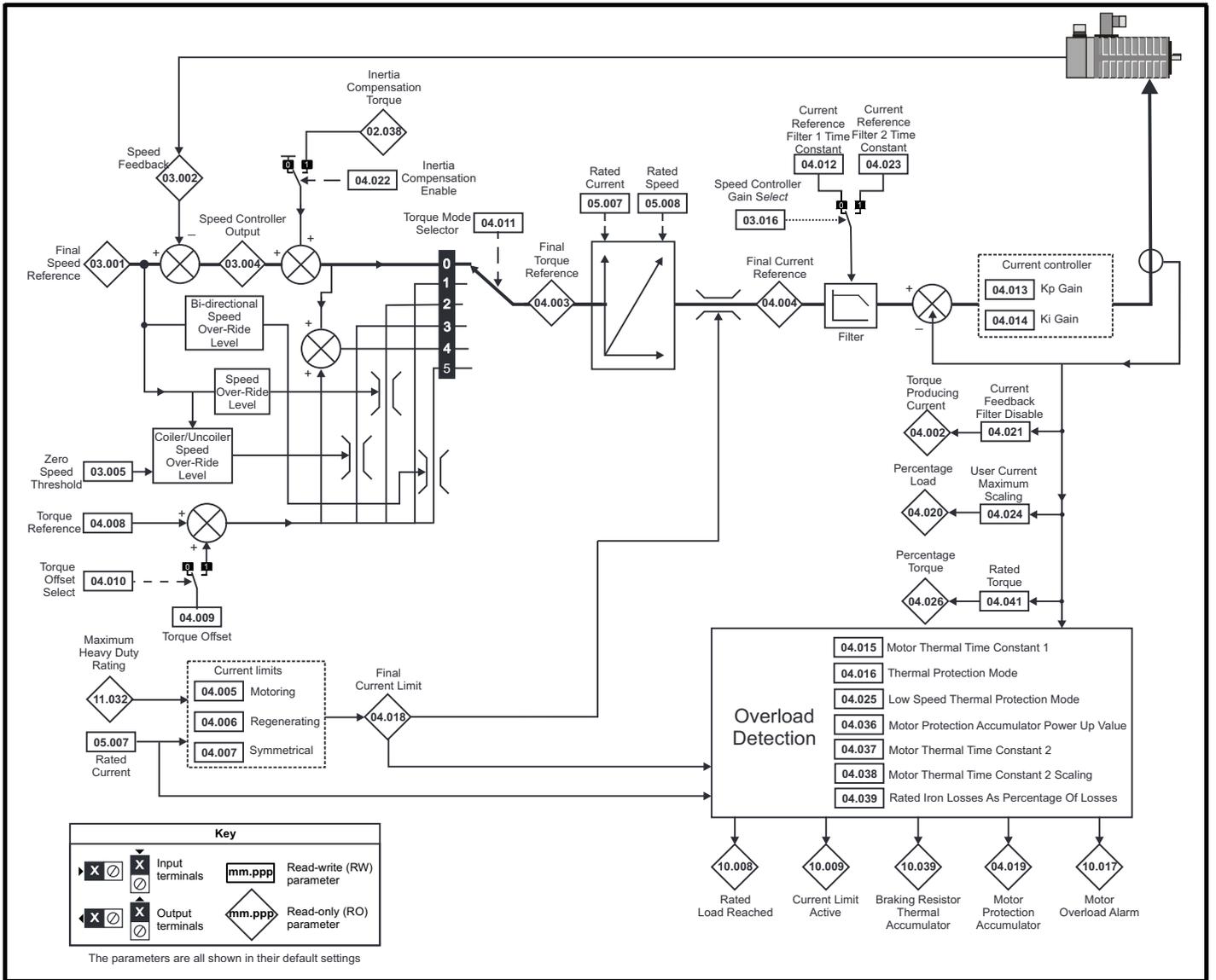


Figure 12-12 Menu 4 RFC-S logic diagram

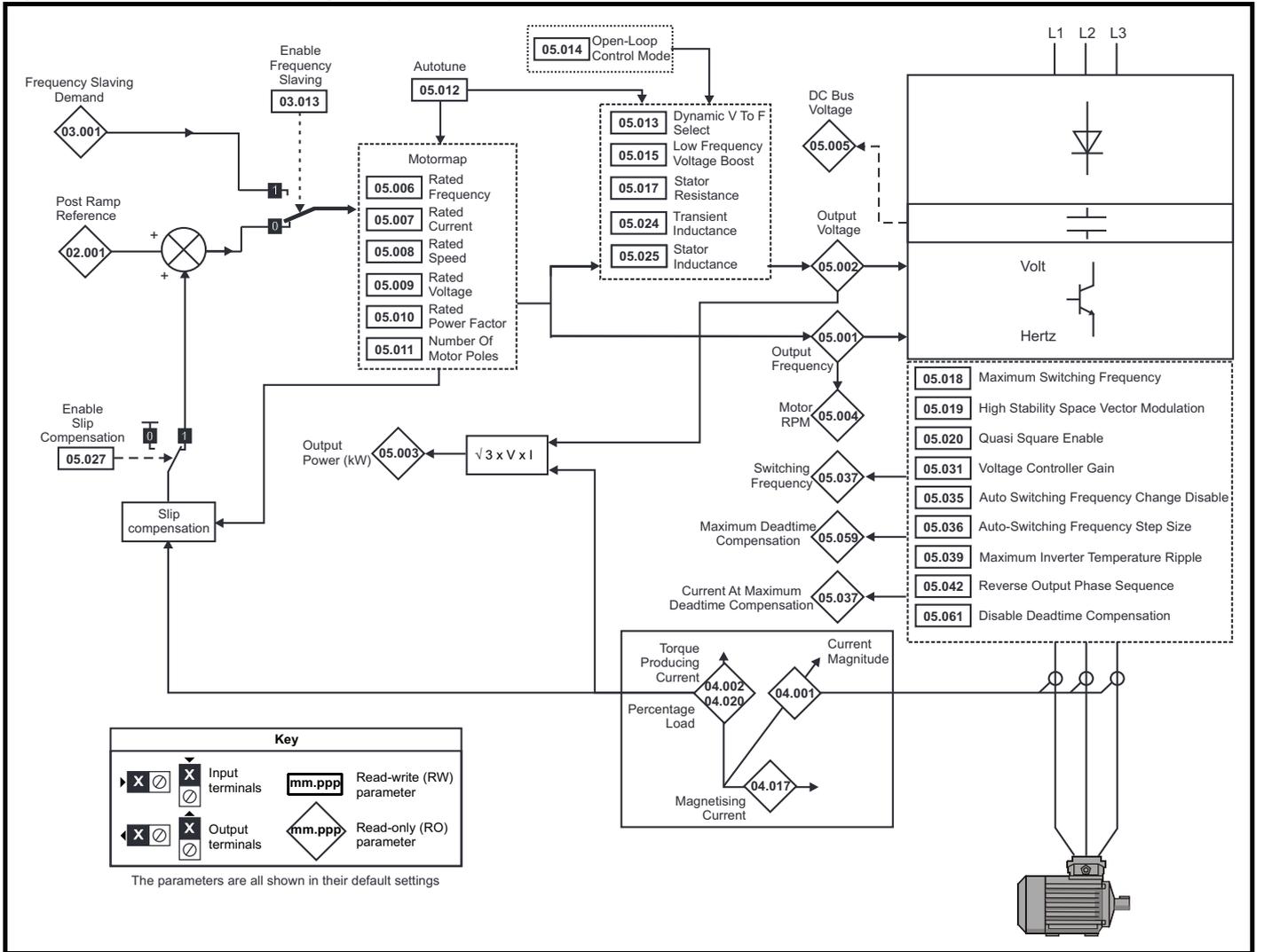


Parameter	Range(⇅)		Default(⇄)			Type					
	OL	RFC-A / S	OL	RFC-A	RFC-S	RO	Num	ND	NC	PT	FI
04.001	Current Magnitude	0.000 to VM_DRIVE_CURRENT_UNIPOLAR A				RO	Num	ND	NC	PT	FI
04.002	Torque Producing Current / Iq	VM_DRIVE_CURRENT A				RO	Num	ND	NC	PT	FI
04.003	Final Torque Reference	VM_TORQUE_CURRENT %				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 %		165.0 %	250.0 %	RW	Num		RA		US
04.006	Regenerating Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165.0 %	250.0 %	RW	Num		RA		US
04.007	Symmetrical Current Limit	0.0 to VM_MOTOR1_CURRENT_LIMIT %		165.0 %	250.0 %	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

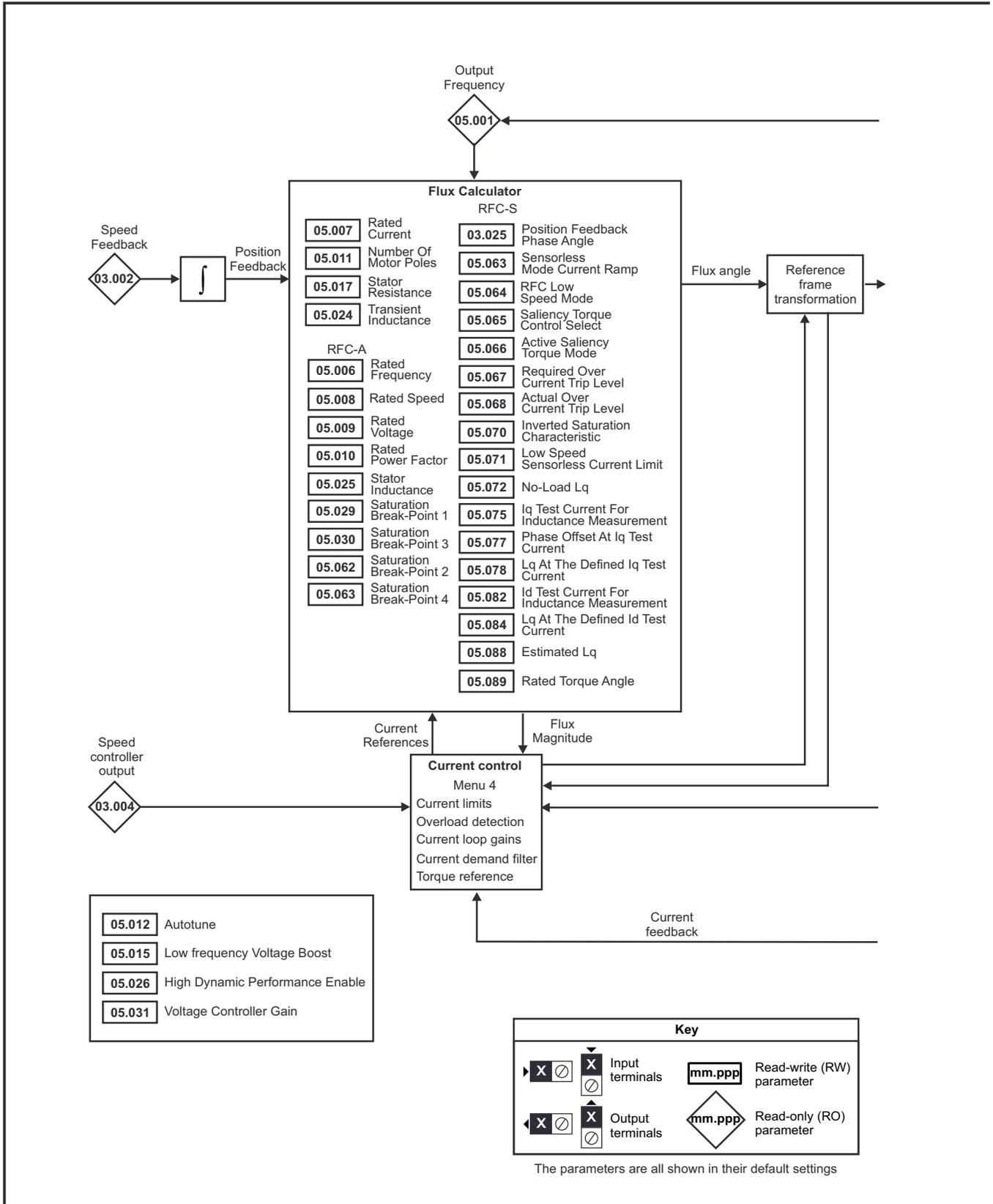
## 12.6 Menu 5: Motor control

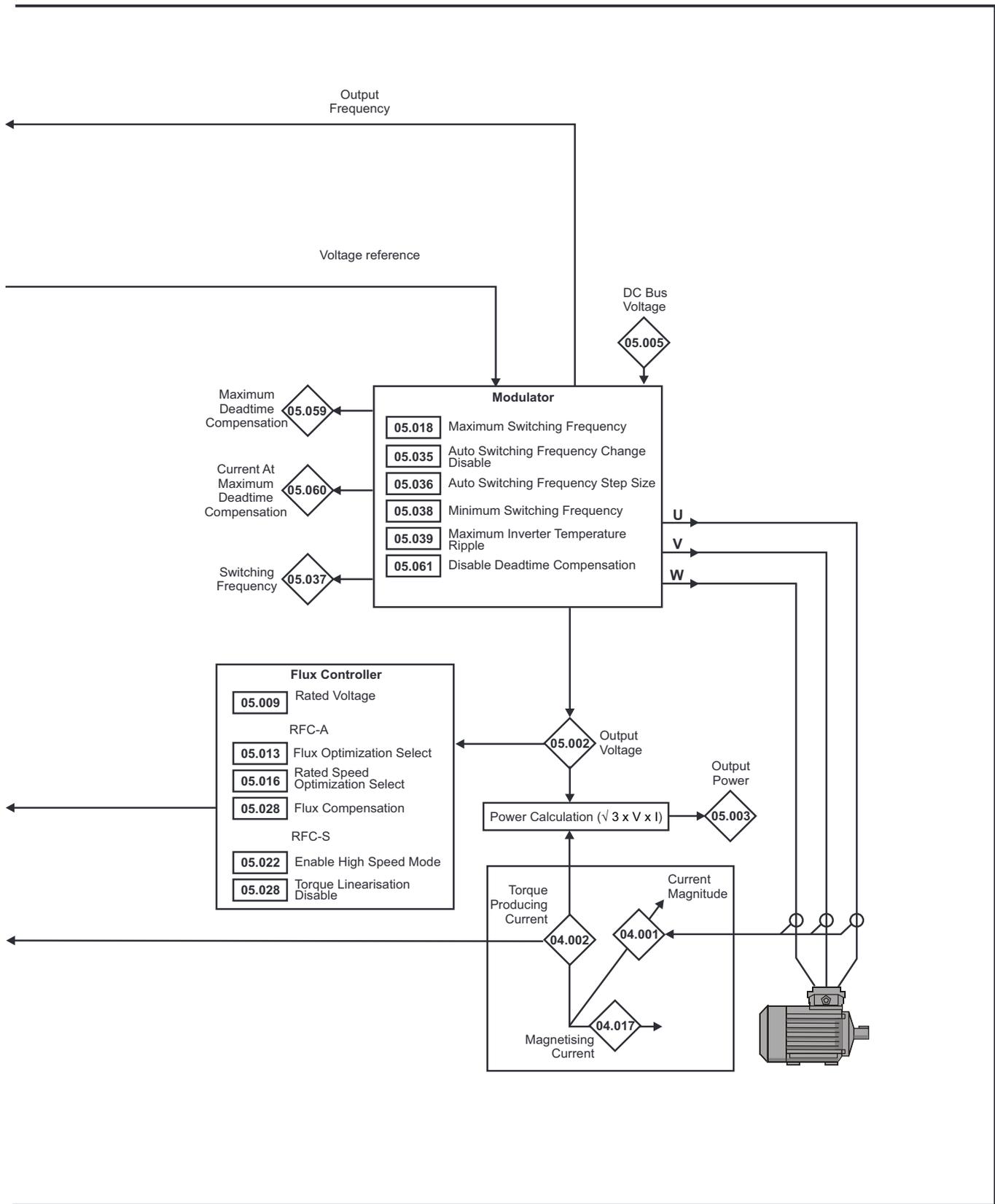
Figure 12-13 Menu 5 Open-loop logic diagram



Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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Figure 12-14 Menu 5 RFC-A, RFC-S logic diagram





Parameter	Range(⇄)			Default(⇄)			Type						
	OL	RFC-A	RFC-S	OL	RFC-A	RFC-S	RO	Num	ND	NC	PT	FI	
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
	Low Frequency Voltage Boost	0.0 to 25.0 %				1 %		RW	Num				US
05.015	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				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 <sup>-1</sup>			0.00390 °C <sup>-1</sup>			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 <sup>-1</sup>			0.00390 °C <sup>-1</sup>	0.00100 °C <sup>-1</sup>		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	
			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
05.063 Sensorless Mode Current Ramp			0.00 to 1.00 s			0.20 s	RW	Num				US
05.064 RFC Low Speed Mode			Injection (0), Non-salient (1), Current (2), Current No Test (3)			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

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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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	

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

## 12.7 Menu 6: Sequencer and clock

Figure 12-15 Menu 6 logic diagram

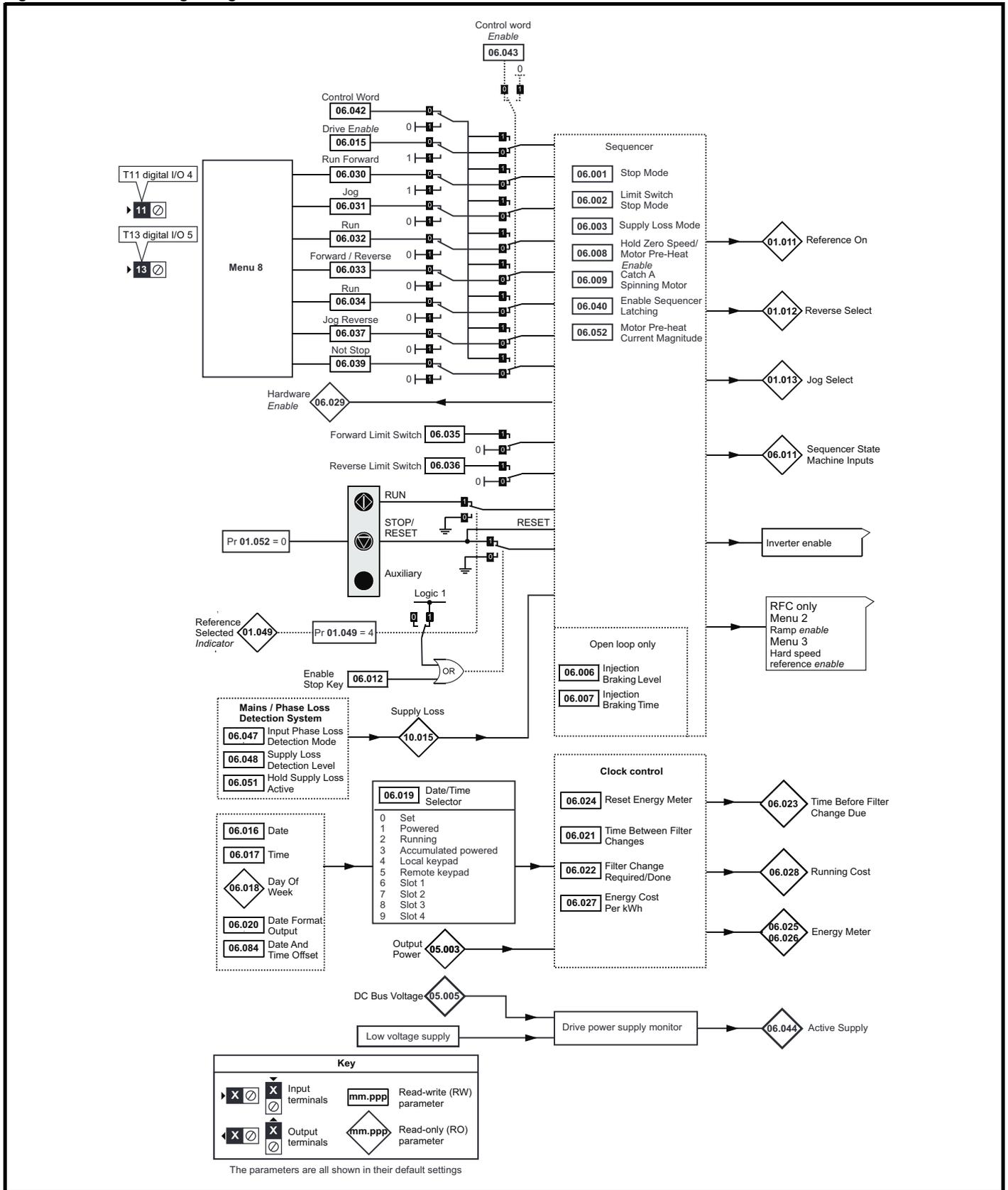
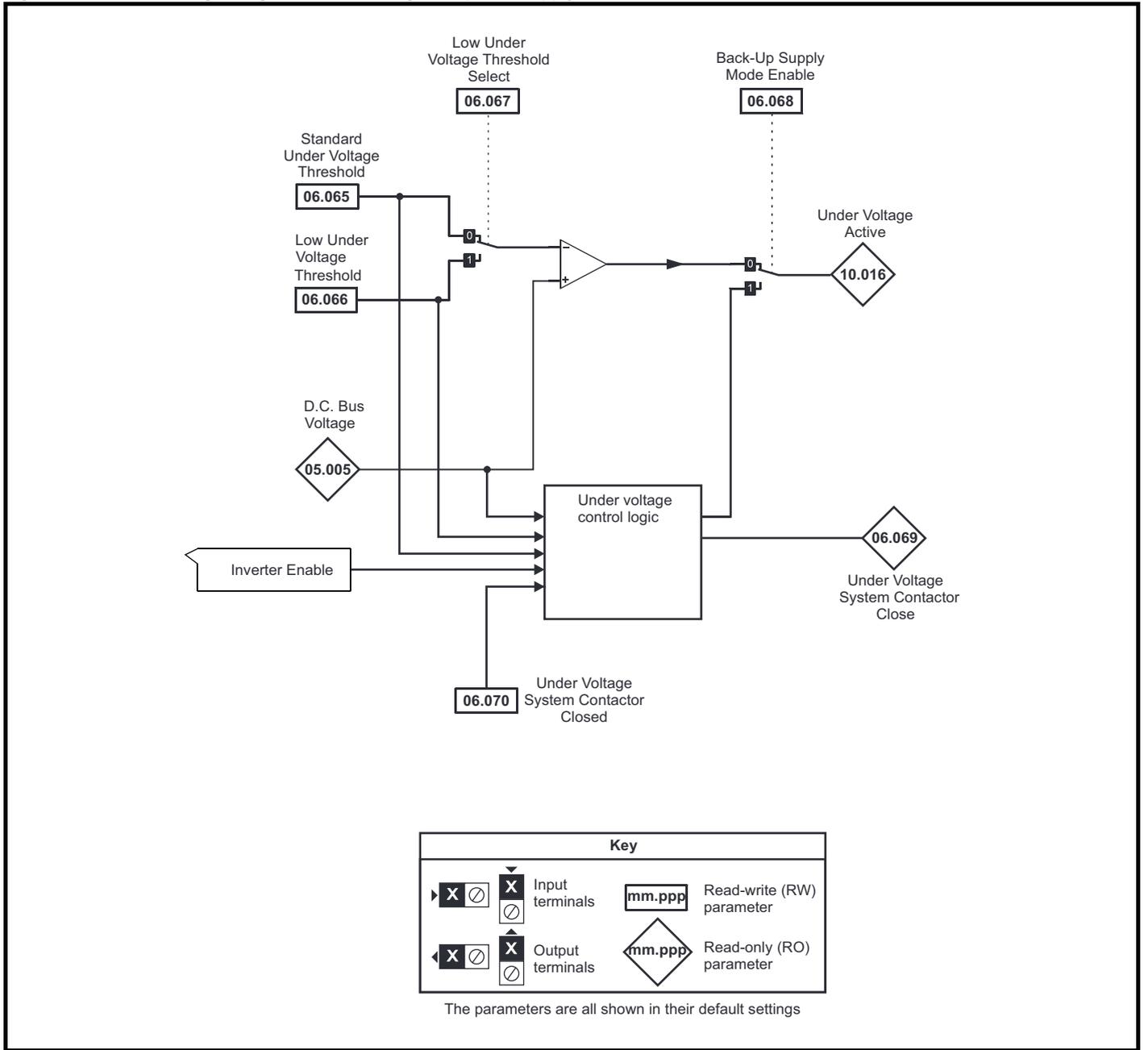


Figure 12-16 Menu 6 logic diagram: Under voltage and power supply control



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	00000000000000 to 1111111111111111		00000000000000			RW	Bin		NC			
06.043	Control Word Enable	Off (0) or On (1)		Off (0)			RW	Bit					US
06.044	Active Supply	Off (0) or On (1)					RO	Bit	ND	NC	PT		
06.045	Cooling Fan control	0 to 11		10			RW	Num					US
06.047	Input Phase Loss Detection Mode	Full (0), Ripple Only (1), Disabled (2)		Full (0)			RW	Txt					US
06.048	Supply Loss Detection Level	0 to VM_SUPPLY_LOSS_LEVEL 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

## 12.8 Menu 7: Analog I/O / Temperature Monitoring

Figure 12-17 Menu 7 logic diagram

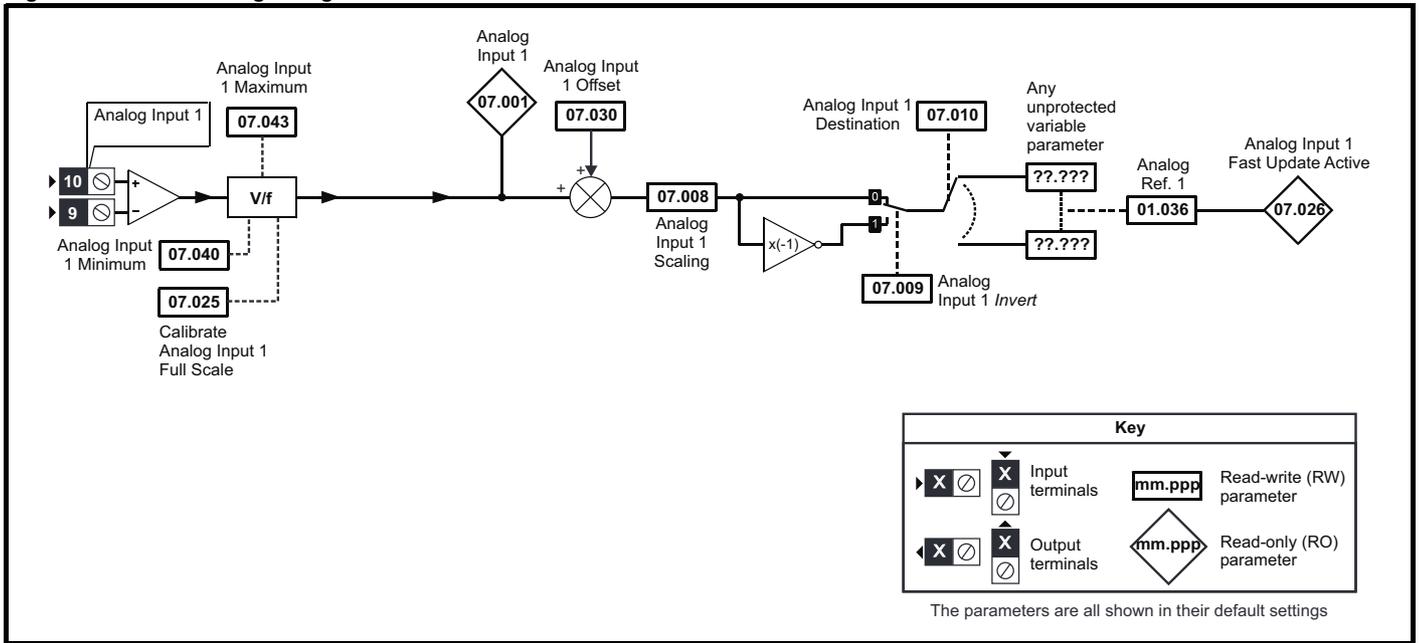
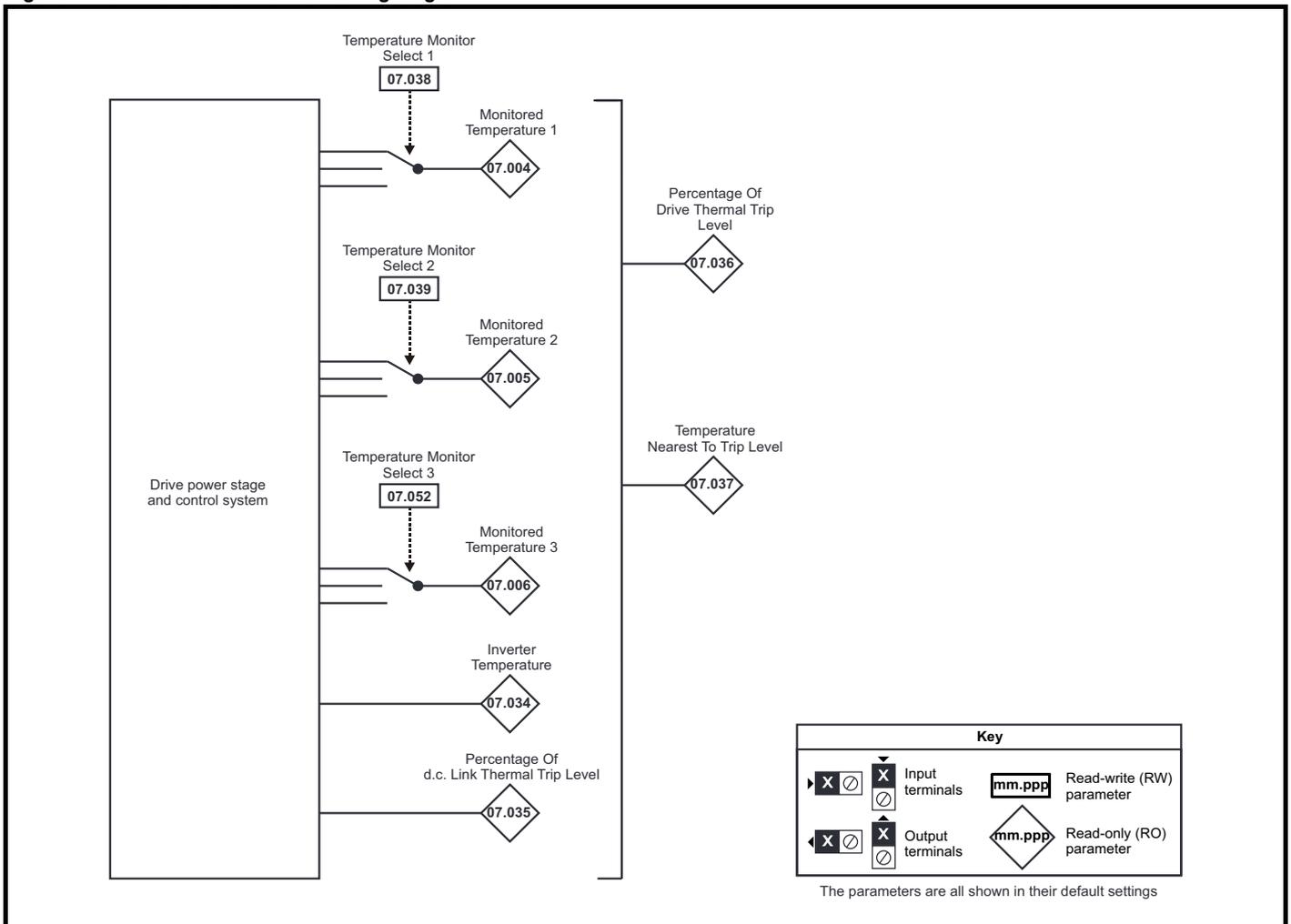


Figure 12-18 Menu 7 thermal monitoring diagram



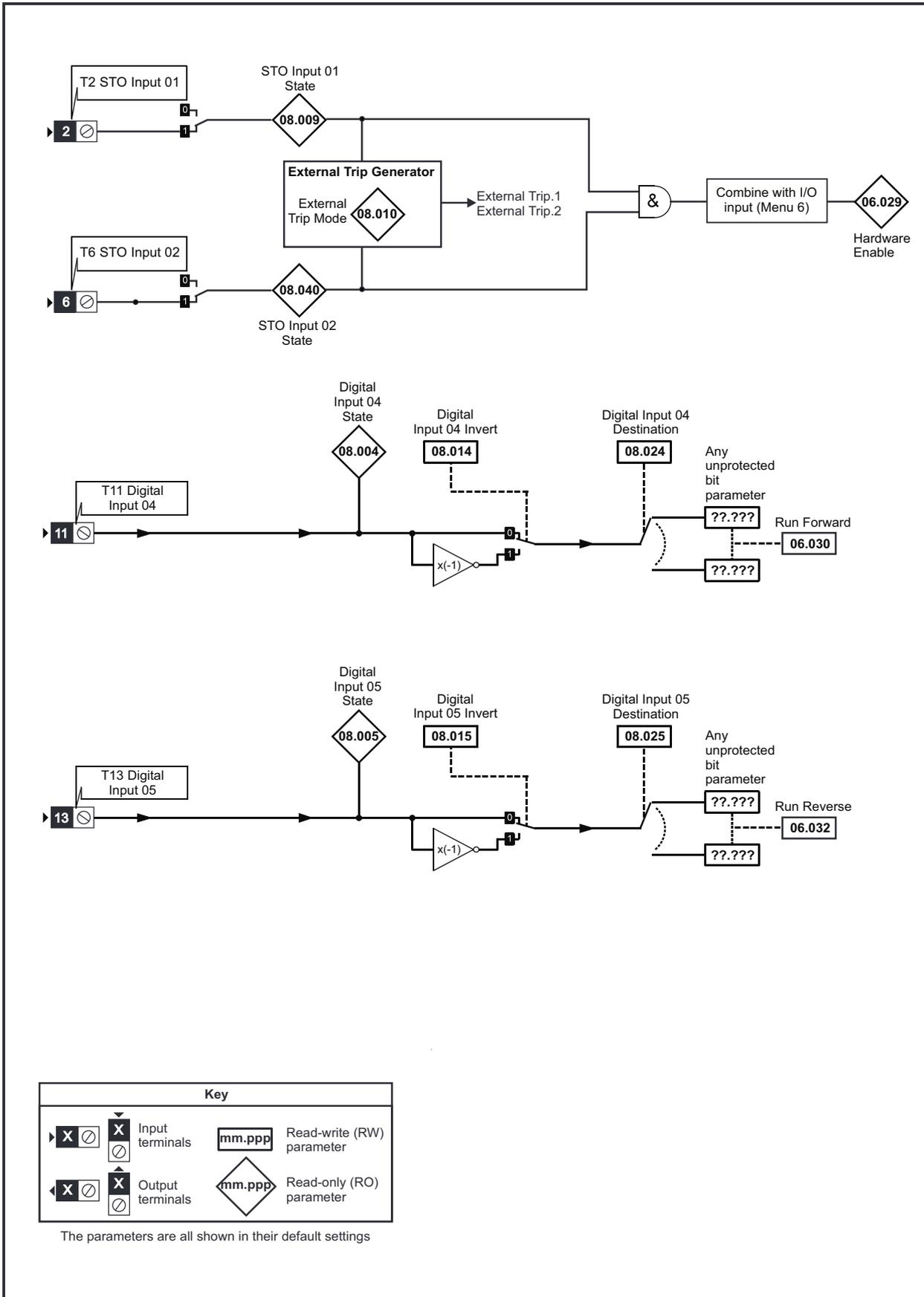
Parameter	Range(φ)		Default(⇔)			Type					
	OL	RFC-A / S	OL	RFC-A	RFC-S						
07.001	Analog Input 1	±100.00 %				RO	Num	ND	NC	PT	FI
07.004	Monitored Temperature 1	±250 °C				RO	Num	ND	NC	PT	
07.005	Monitored Temperature 2	±250 °C				RO	Num	ND	NC	PT	
07.006	Monitored Temperature 3	±250 °C				RO	Num	ND	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

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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## 12.9 Menu 8: Digital I/O

Figure 12-19 Menu 8 Digital input and outputs logic diagram



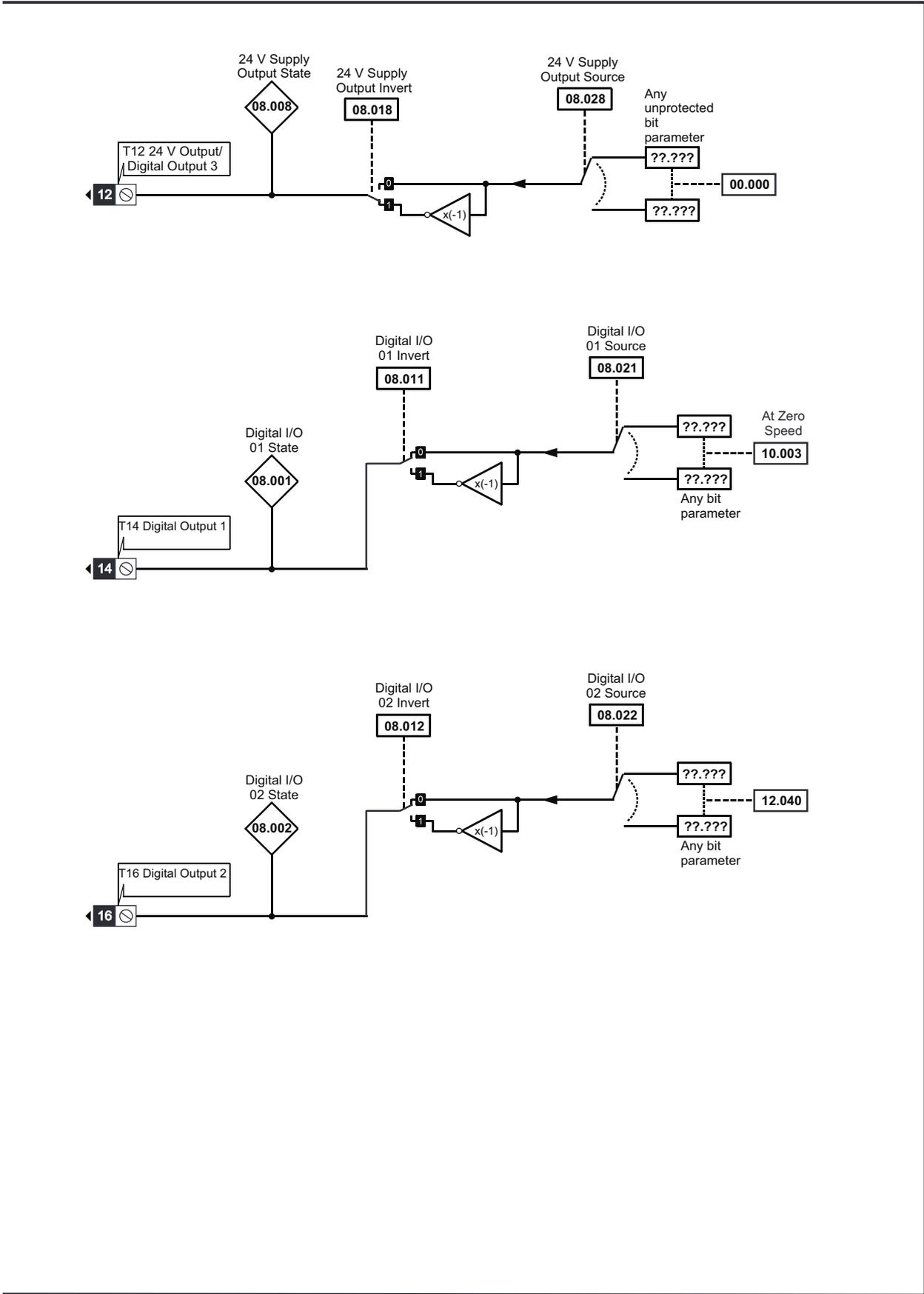
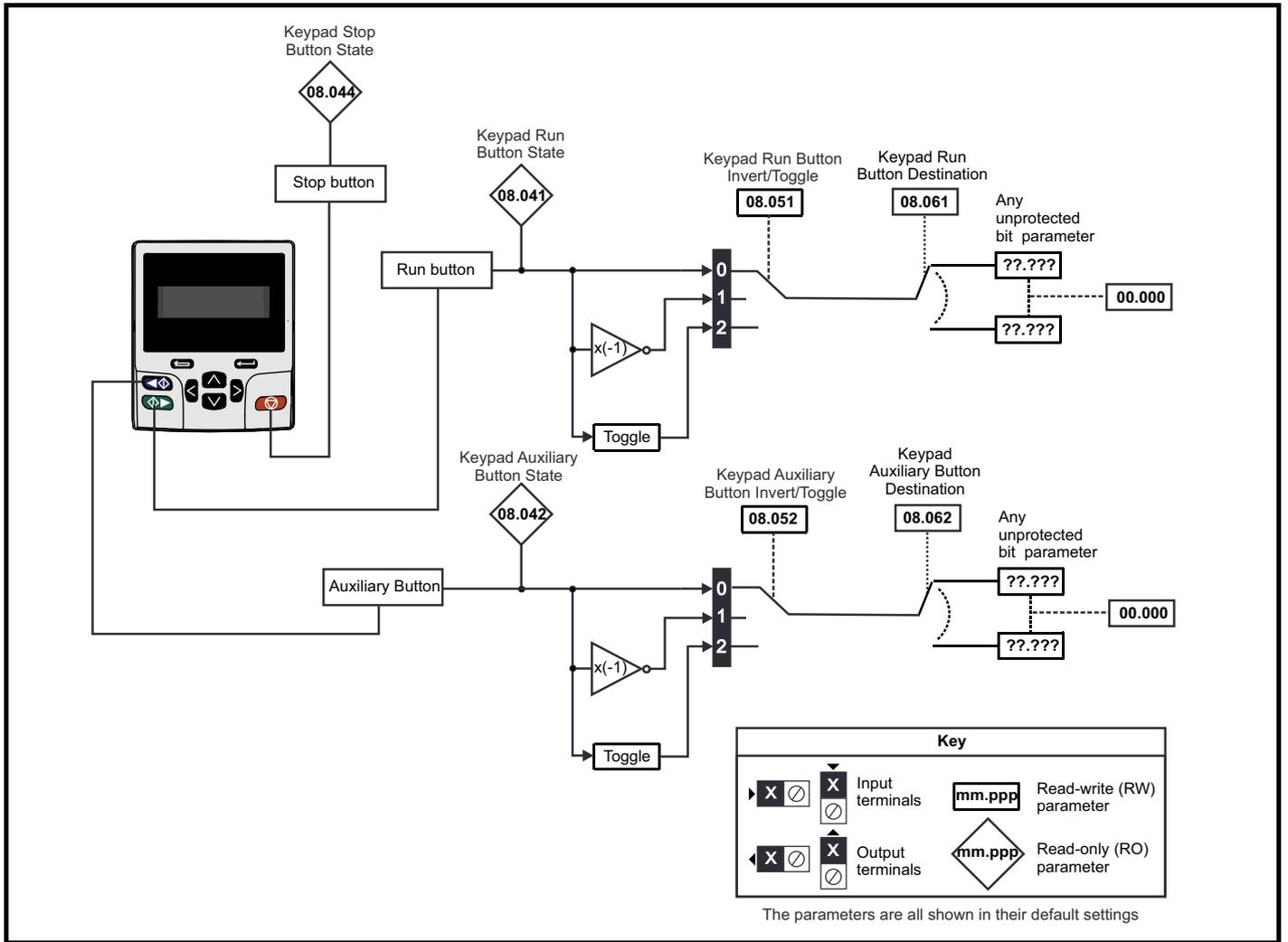


Figure 12-20 Menu 8 Remote Keypad RTC buttons logic diagram

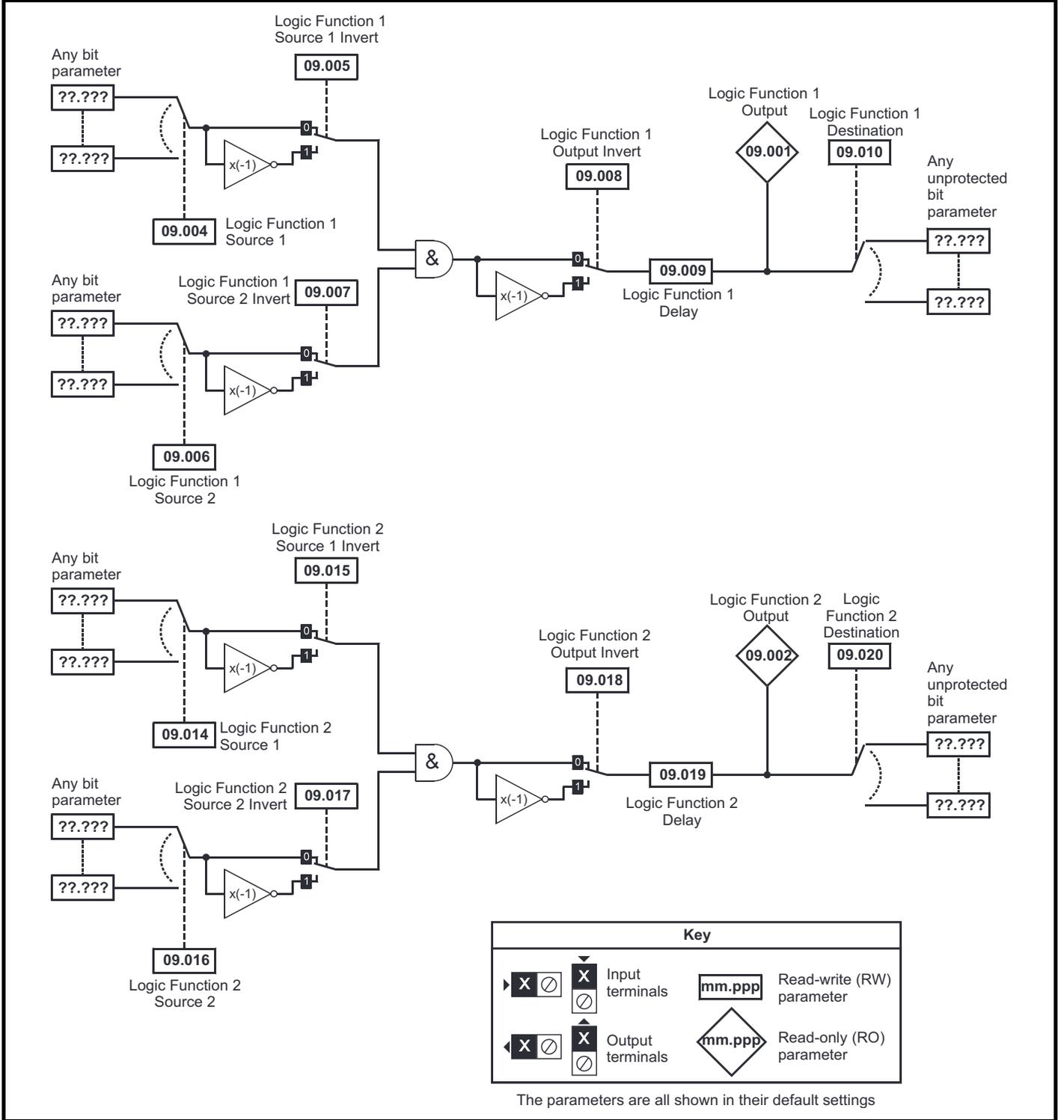


Parameter	Range(⌀)		Default(⇄)			Type					
	OL	RFC-A / S	OL	RFC-A	RFC-S	RO	Bit	ND	NC	PT	US
08.001	Digital I/O 01 State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.002	Digital I/O 02 State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.004	Digital Input 04 State	Off (0) or On (1)				RO	Bit	ND	NC	PT	
08.005	Digital 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

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

Figure 12-21 Menu 9 logic diagram: Programmable logic



**Figure 12-22 Menu 9 logic diagram: Motorized pot and binary sum**

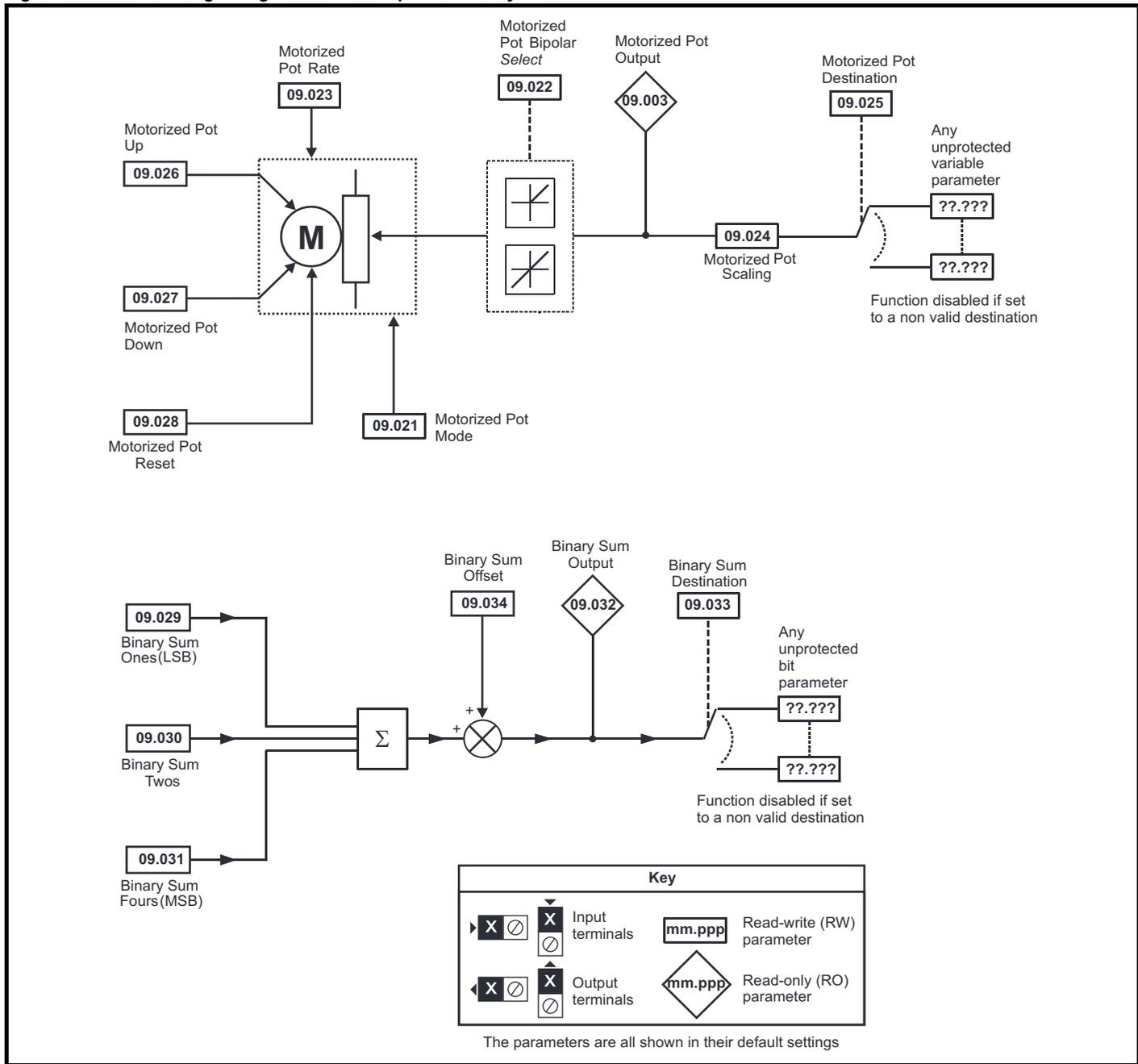
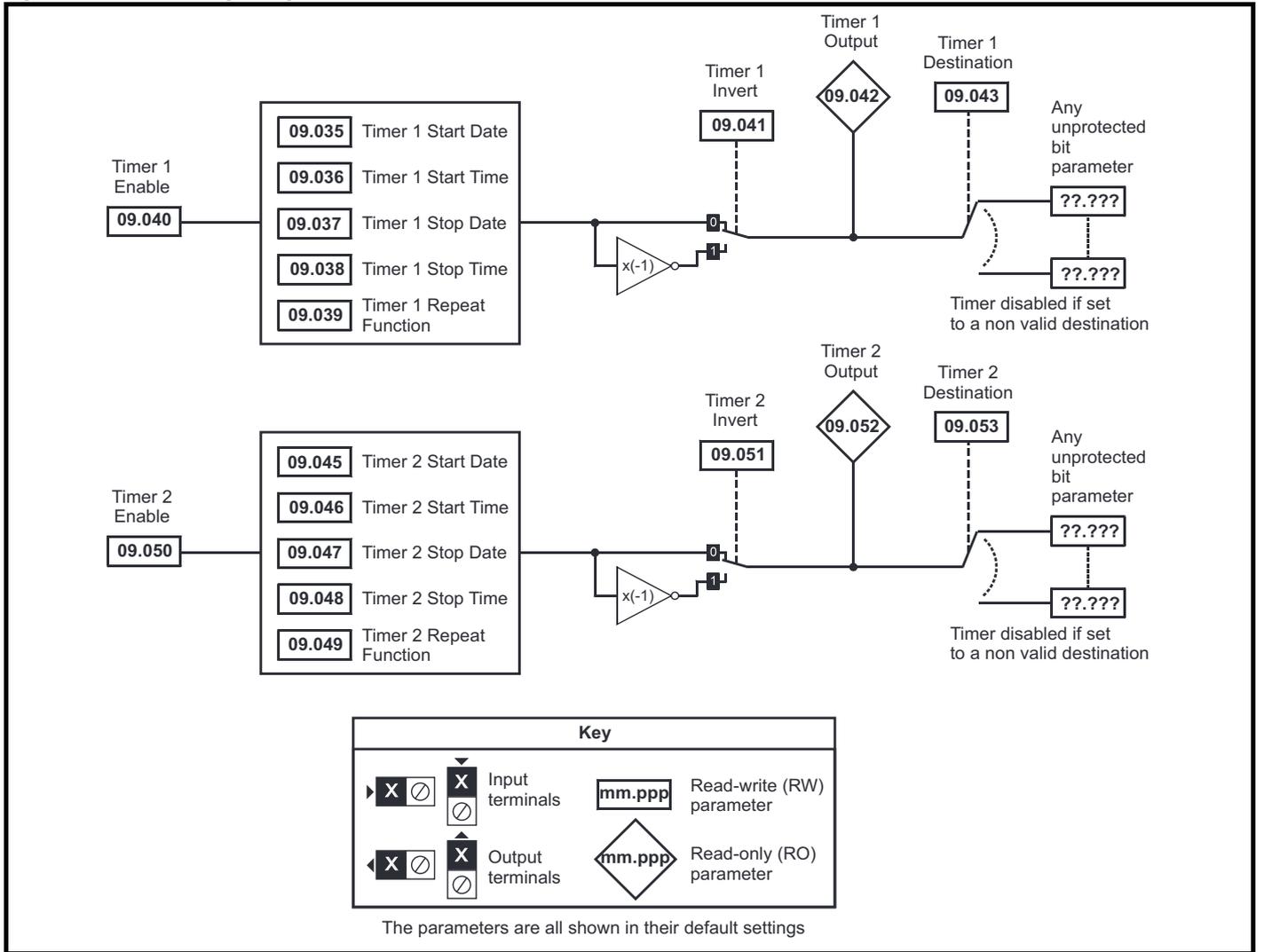
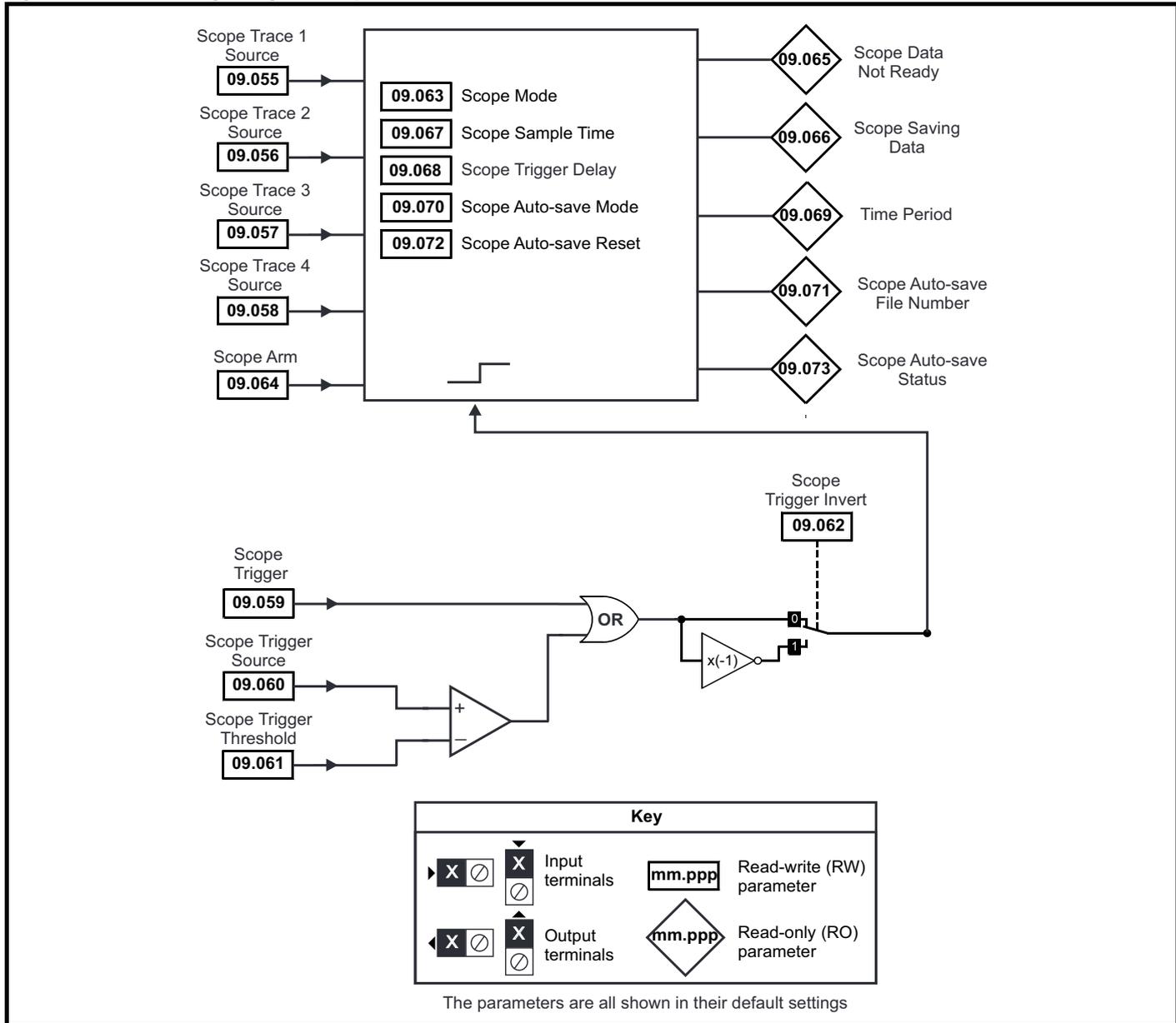


Figure 12-23 Menu 9 logic diagram: Timers



**Figure 12-24 Menu 9 logic diagram: Scope function**



Parameter	Range(φ)		Default(⇒)			Type					
	OL	RFC-A / S	OL	RFC-A	RFC-S	RO	Bit	ND	NC	PT	
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

## 12.11 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	00000000000000 to 11111111111111				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

## 12.12 Menu 11: General drive set-up

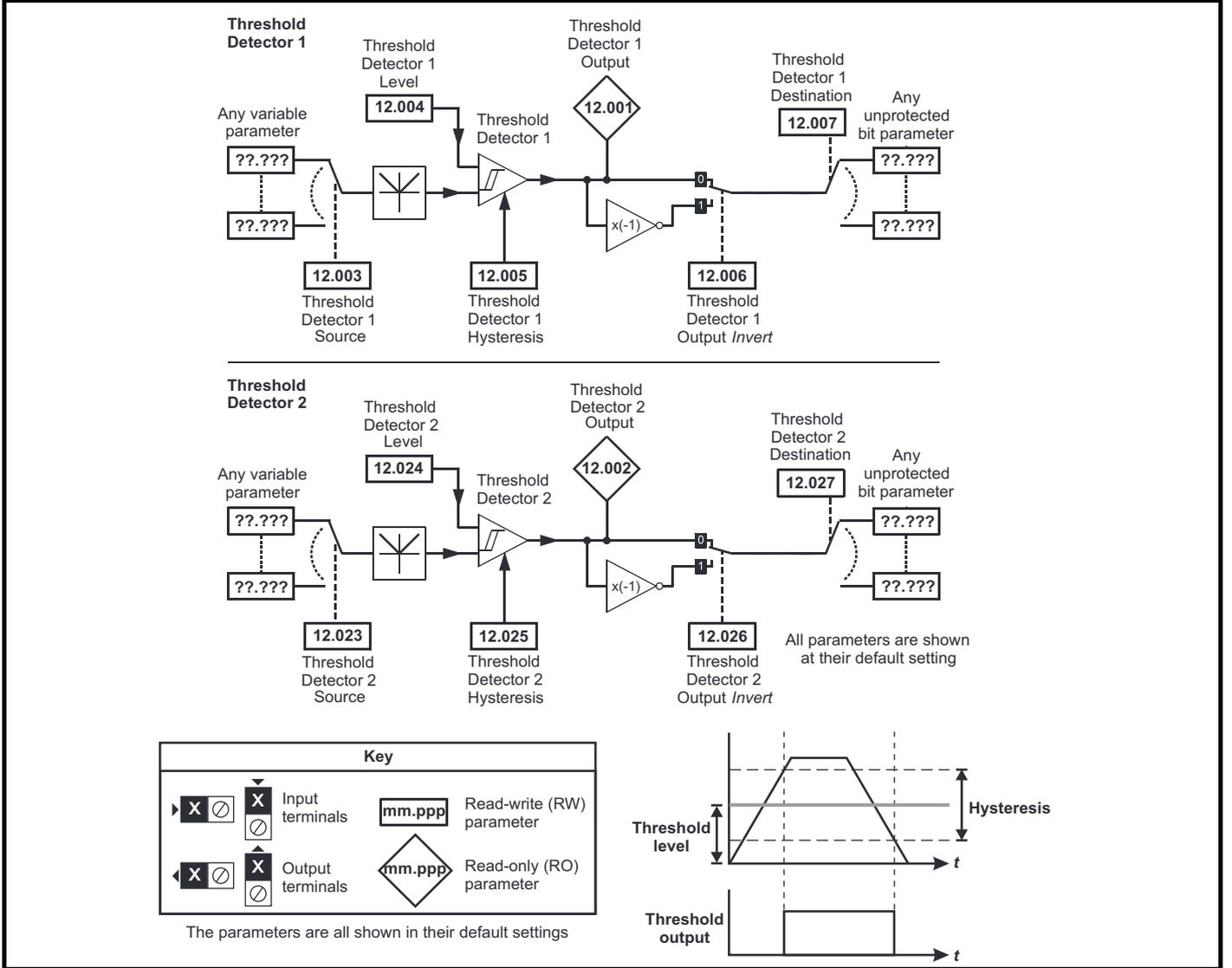
Parameter	Range(⌘)		Default(⇨)			Type						
	OL	RFC-A / S	OL	RFC-A	RFC-S							
11.001	Option Synchronisation Select	Not Active (0), Slot 1 (1), Slot 2 (2), Slot 3 (3), Slot 4 (4), Automatic (5)	Slot 3 (3)			RW	Txt					US
11.002	Option synchronisation Active	Not Active (0), Slot 1 (1), Slot 2 (2), Slot 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
11.021	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
11.028	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	M753				RO	Chr	ND	NC	PT		
11.065	Drive Rating And Configuration	00000000 to 999999999				RO	Num	ND	NC	PT		
11.066	Power Stage Identifier	0 to 255				RO	Num	ND	NC	PT		
11.067	Control Board Identifier	0.000 to 65.535				RO	Num	ND	NC	PT		
11.068	Internal I/O Identifier	0 to 255				RO	Num	ND	NC	PT		
11.069	Position Feedback Interface Identifier	0 to 255				RO	Num	ND	NC	PT		
11.070	Core Parameter Database Version	0.00 to 99.99				RO	Num	ND	NC	PT		
11.072	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		
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		

Parameter	Range(⇅)		Default(⇒)			Type								
	OL	RFC-A / S	OL	RFC-A	RFC-S									
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	

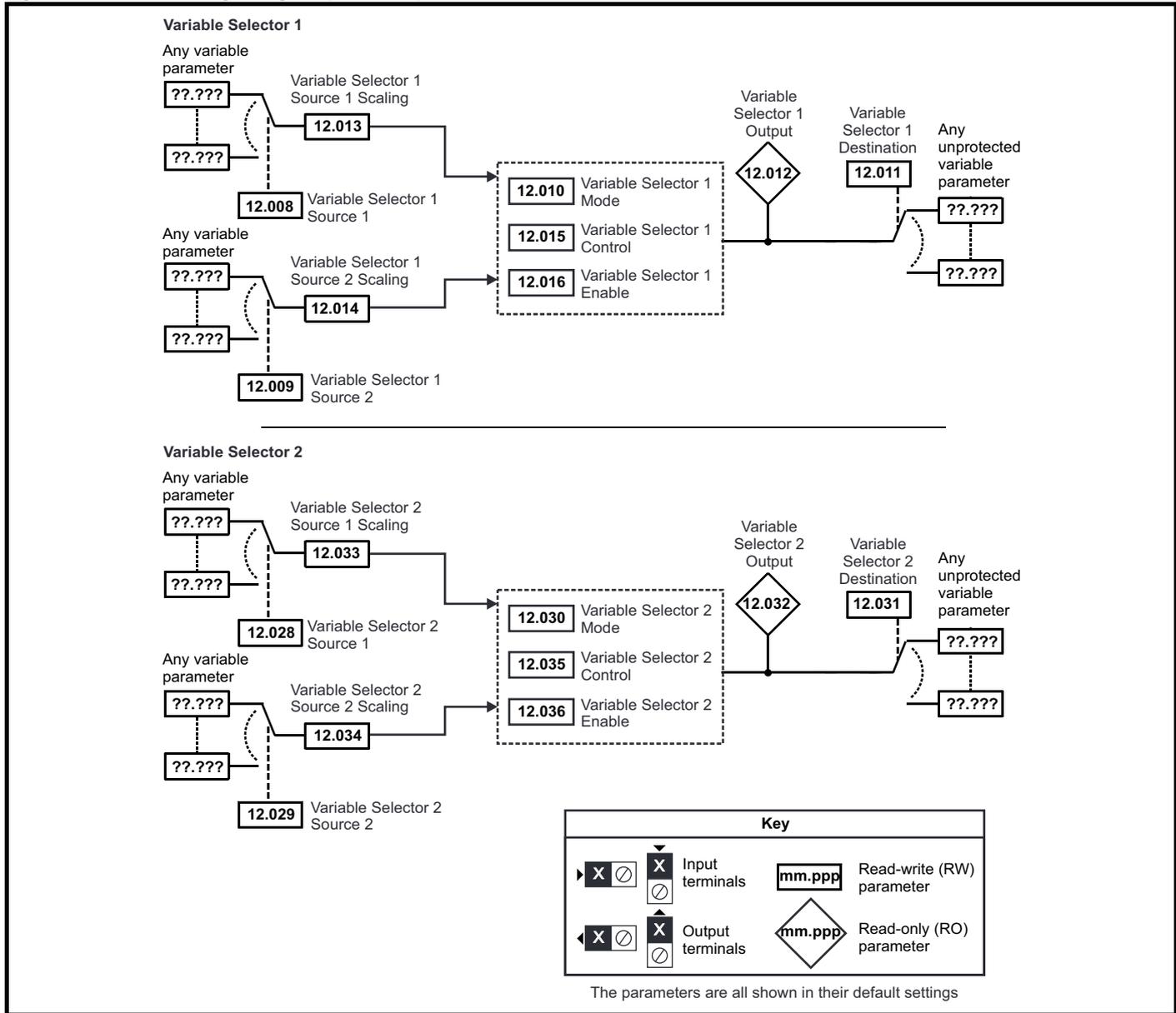
RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination
IP	IP address	Mac	Mac address	Date	Date parameter	Time	Time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

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

Figure 12-25 Menu 12 logic diagram



**Figure 12-26 Menu 12 logic diagram (continued)**



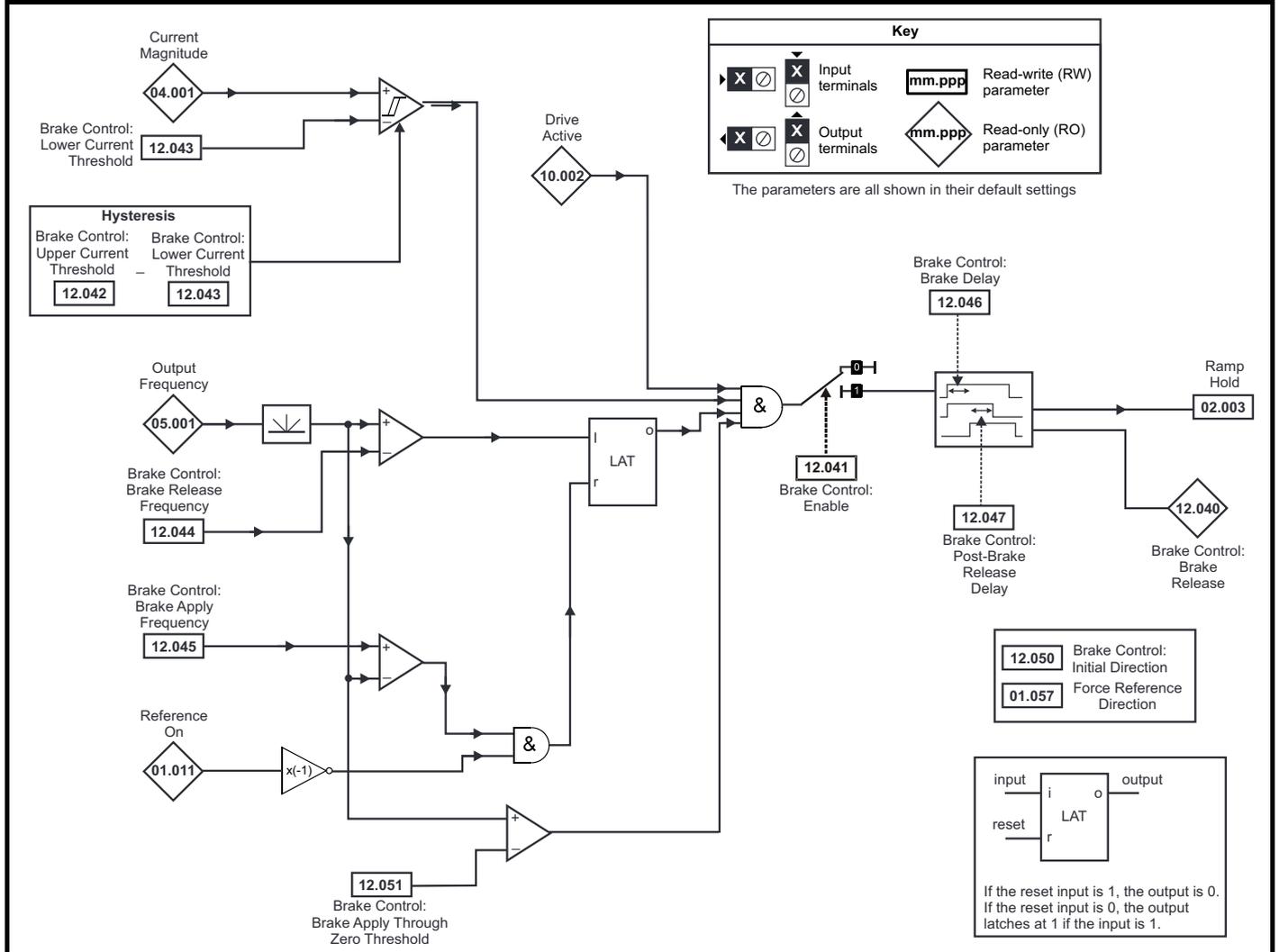


The brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in 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.

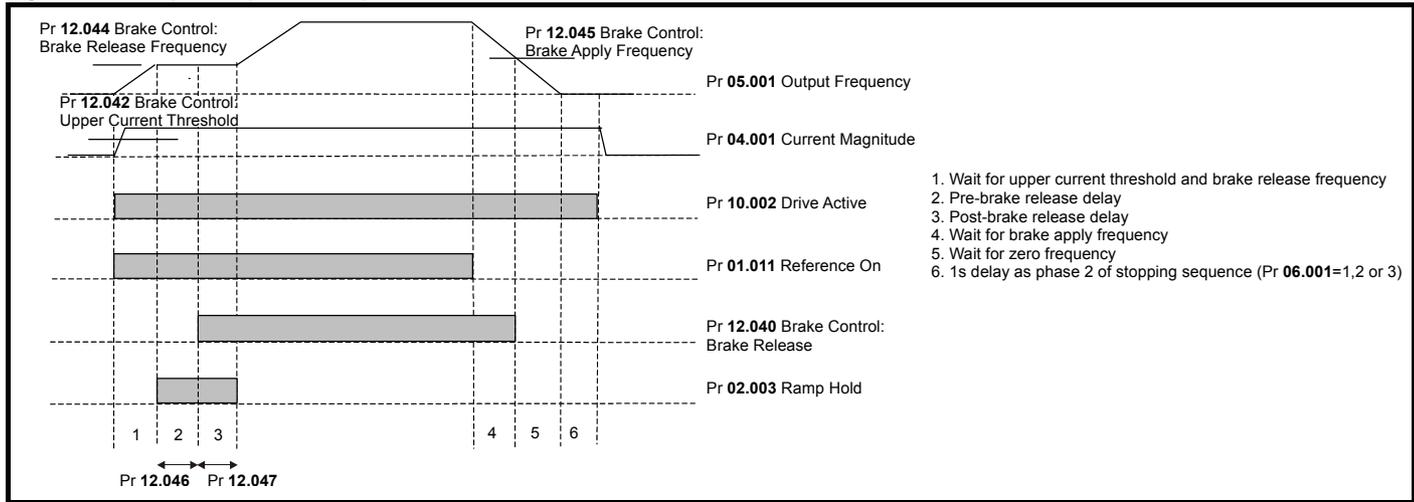


Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

**Figure 12-27 Open-loop brake function**



**Figure 12-28 Open-loop brake sequence**



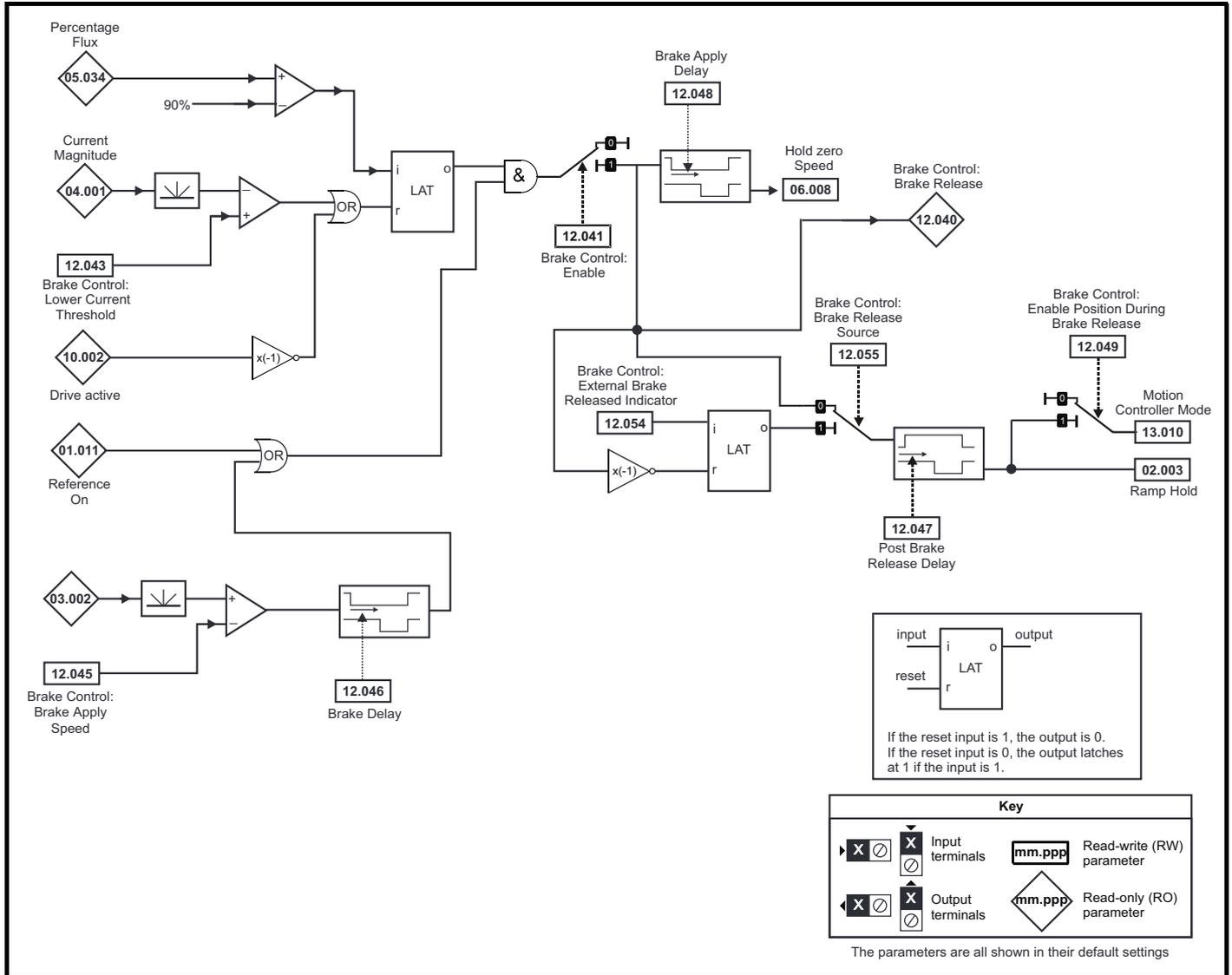


The brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in 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.

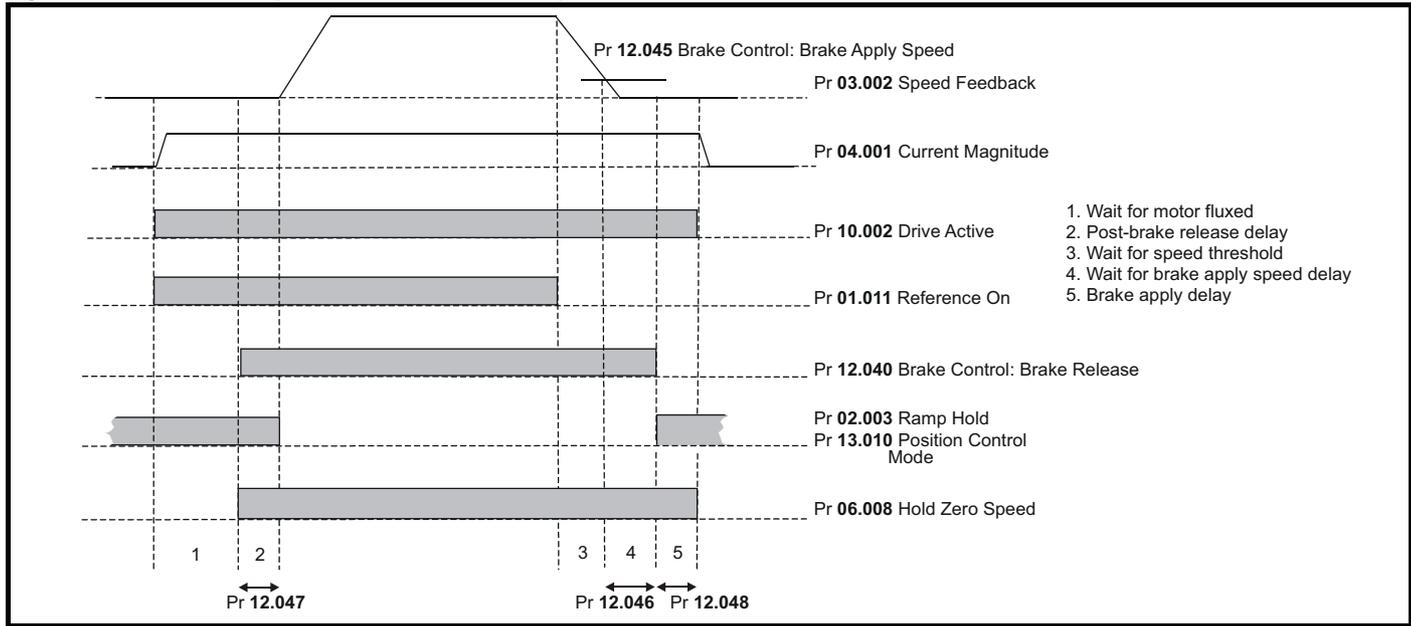


Digital Output 2 in default configuration is selected as an output to release a brake. When drive terminals are programmed to non default settings the result of incorrect or delayed programming must be considered as this may result in the brake being released inadvertently.

**Figure 12-29 RFC-A mode with brake controller mode (12.052) =0 (RFC-A with position feedback mode)**



**Figure 12-30 RFC-A with position feedback brake sequence**



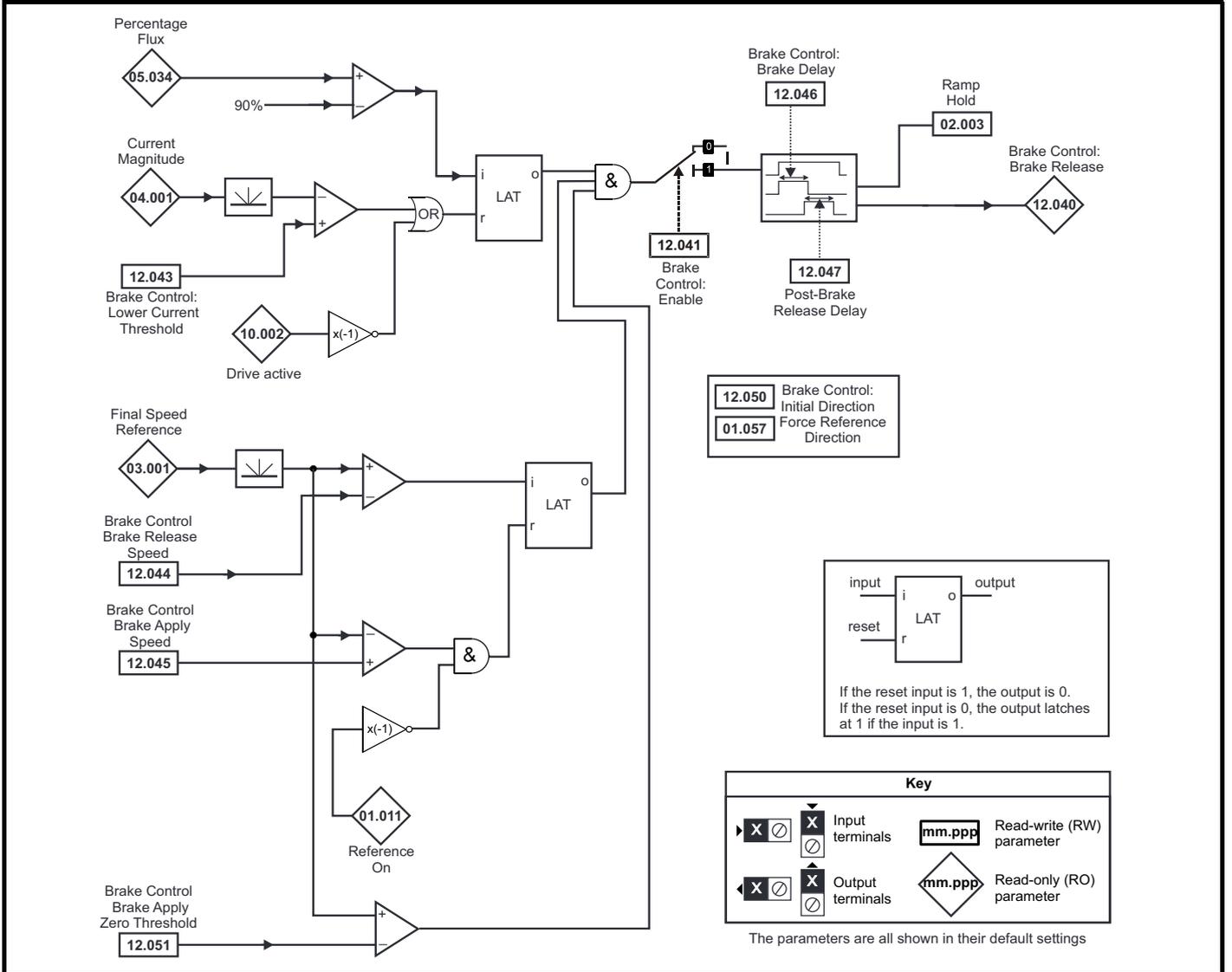


The brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in 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.



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 12-31 RFC-A mode with brake controller mode (12.052) =1 (RFC-A Sensorless mode)**



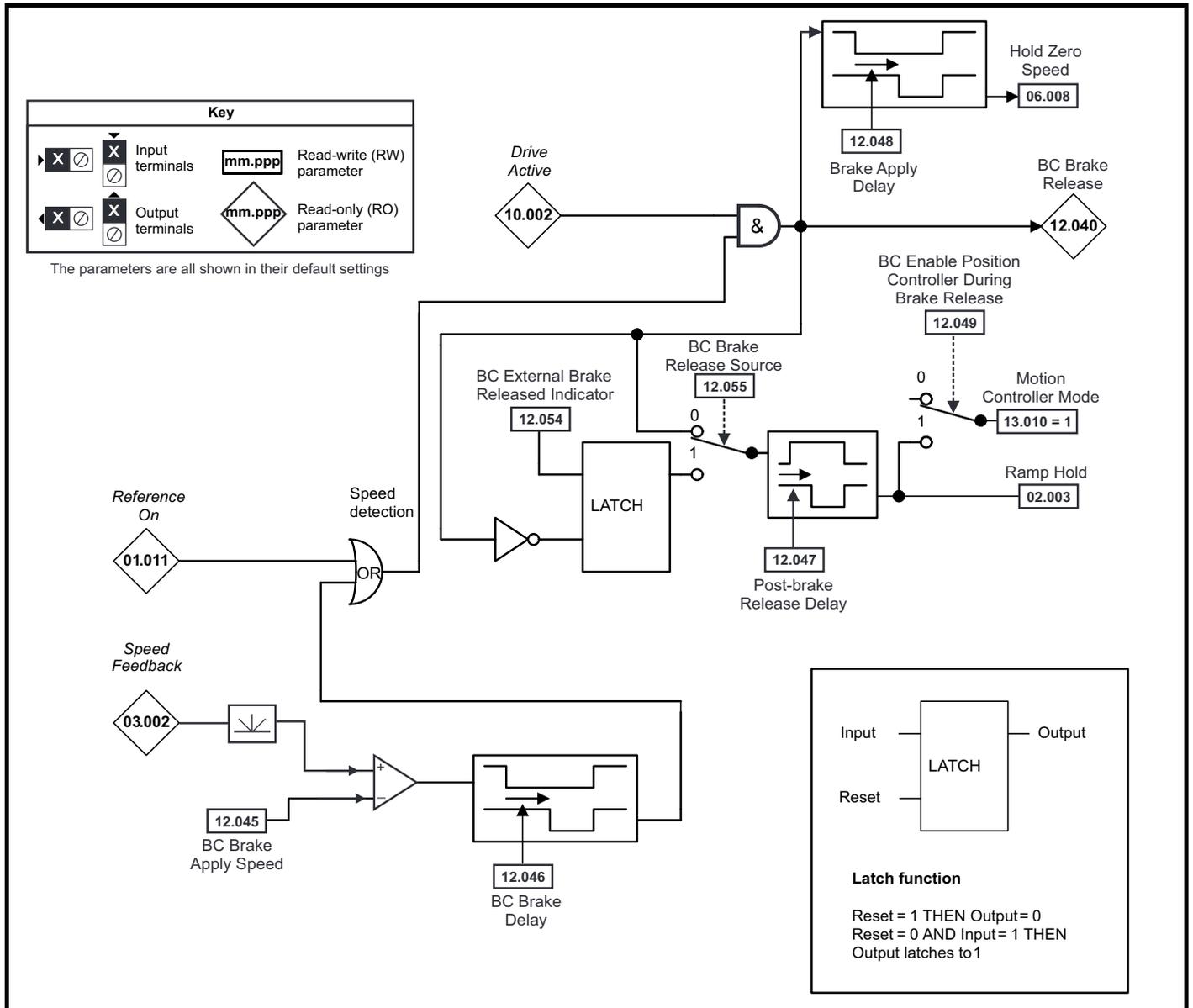


The brake control functions are provided to allow well co-ordinated operation of an external brake with the drive. While both hardware and software are designed to high standards of quality and robustness, they are not intended for use as safety functions, i.e. where a fault or failure would result in 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.



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 12-32 RFC-S brake function**



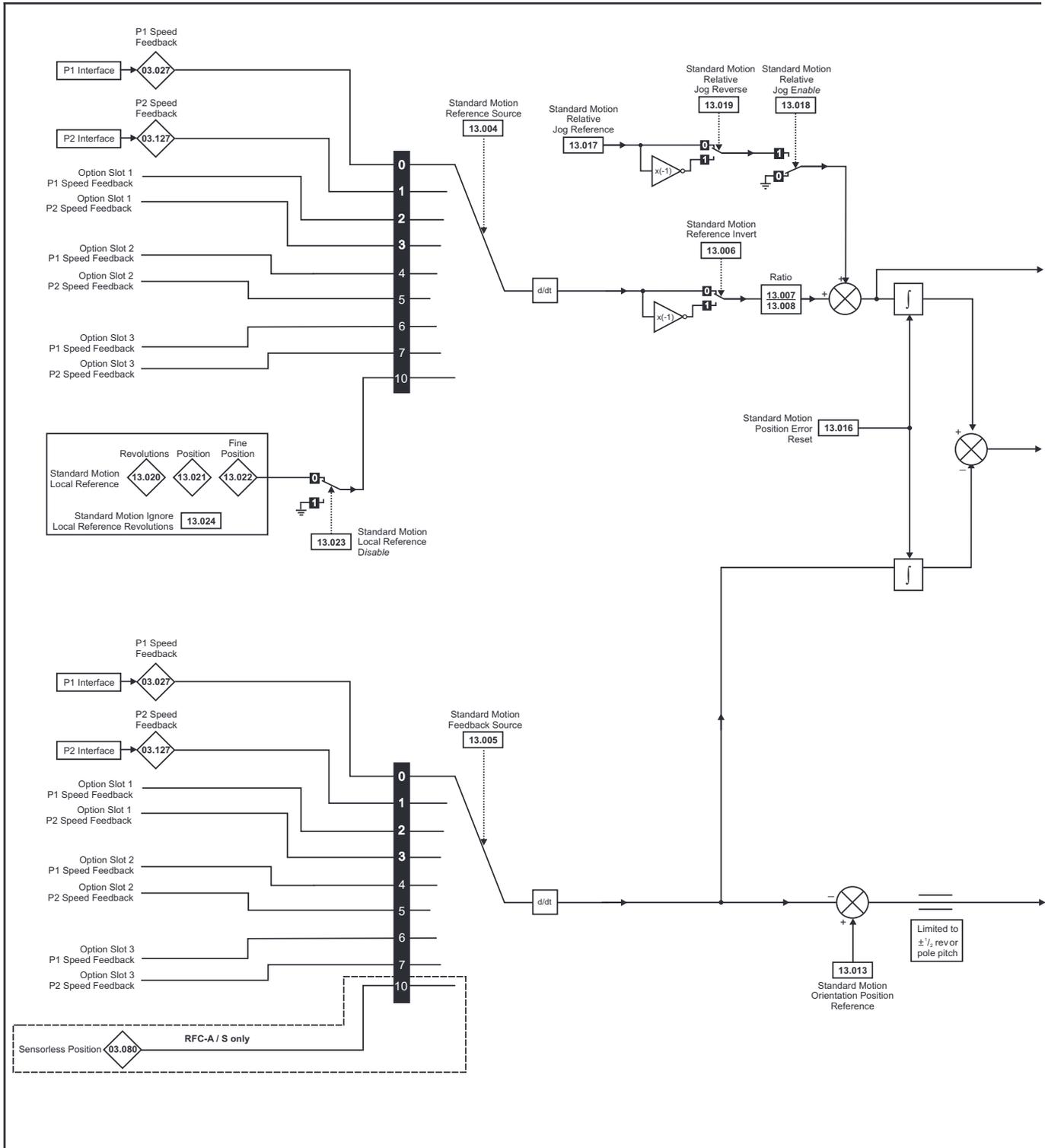
Parameter	Range(⇅)			Default(⇄)			Type					
	OL	RFC- A	RFC- S	OL	RFC-A	RFC-S	RO	Bit	ND	NC	PT	US
12.001	Threshold Detector 1 Output			Off (0) or On (1)			RO	Bit	ND	NC	PT	
12.002	Threshold Detector 2 Output			Off (0) or On (1)			RO	Bit	ND	NC	PT	
12.003	Threshold Detector 1 Source			0.000 to 59.999				Num			PT	US
12.004	Threshold Detector 1 Level			0.00 to 100.00 %				Num				US
12.005	Threshold Detector 1 Hysteresis			0.00 to 25.00 %				Num				US
12.006	Threshold Detector 1 Output Invert			Off (0) or On (1)				Bit				US
12.007	Threshold Detector 1 Destination			0.000 to 59.999				Num	DE		PT	US
12.008	Variable Selector 1 Source 1			0.000 to 59.999				Num			PT	US
12.009	Variable Selector 1 Source 2			0.000 to 59.999				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)				Txt				US
12.011	Variable Selector 1 Destination			0.000 to 59.999				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				Num				US
12.014	Variable Selector 1 Source 2 Scaling			±4.000				Num				US
12.015	Variable Selector 1 Control			0.00 to 100.00				Num				US
12.016	Variable Selector 1 Enable			Off (0) or On (1)				Bit				US
12.023	Threshold Detector 2 Source			0.000 to 59.999				Num			PT	US
12.024	Threshold Detector 2 Level			0.00 to 100.00 %				Num				US
12.025	Threshold Detector 2 Hysteresis			0.00 to 25.00 %				Num				US
12.026	Threshold Detector 2 Output Invert			Off (0) or On (1)				Bit				US
12.027	Threshold Detector 2 Destination			0.000 to 59.999				Num	DE		PT	US
12.028	Variable Selector 2 Source 1			0.000 to 59.999				Num			PT	US
12.029	Variable Selector 2 Source 2			0.000 to 59.999				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)				Txt				US
12.031	Variable Selector 2 Destination			0.000 to 59.999				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				Num				US
12.034	Variable Selector 2 Source 2 Scaling			±4.000				Num				US
12.035	Variable Selector 2 Control			0.00 to 100.00				Num				US
12.036	Variable Selector 2 Enable			Off (0) or On (1)				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)				Bit				US
12.042	Brake Control: Upper Current Threshold			0 to 200 %			50 %		Num			US
12.043	Brake Control: Lower Current Threshold			0 to 200 %				Num				US
12.044	Brake Control: Brake Release Frequency			0.0 to 20.0 Hz			1.0 Hz		Num			US
	Brake Control: Brake Release Speed			0 to 200 rpm			10 rpm		Num			US
12.045	Brake Control: Brake Apply Frequency			0.0 to 20.0 Hz			2.0 Hz		Num			US
	Brake Control: Brake Apply Speed			0 to 200 rpm				5 rpm		Num		US
12.046	Brake Control: Brake Delay			0.0 to 25.0 s				1.0 s		Num		US
12.047	Brake Control: Post-brake Release Delay			0.0 to 25.0 s				1.0 s		Num		US
12.048	Brake Control: Brake Apply Delay			0.0 to 25.0 s				1.0 s		Num		US
12.049	Brake Control: Enable Position Control During Brake Release			Off (0) or On (1)				Bit				US
12.050	Brake Control: Initial Direction			Ref (0), Forward (1), Reverse (2)				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		Num		US
12.052	Brake Control: Mode			Off (0) or On (1)				Bit				US
12.054	External Brake Released Indicator			Off (0) or On (1)				Bit				US
12.055	Brake Release Source			Off (0) or On (1)				Bit				US

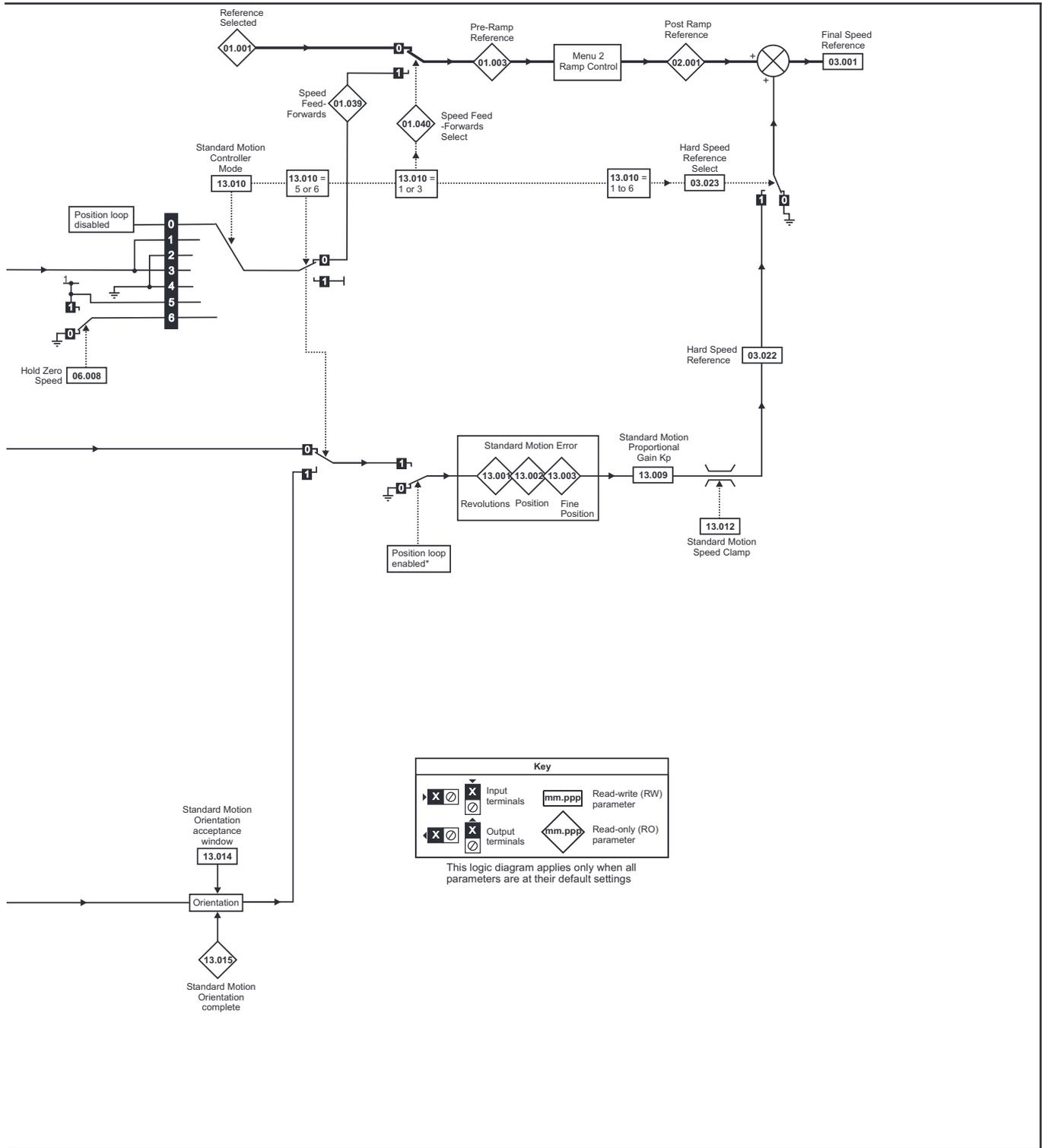
RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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## 12.14 Menu 13: Standard motion controller

Figure 12-33 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.

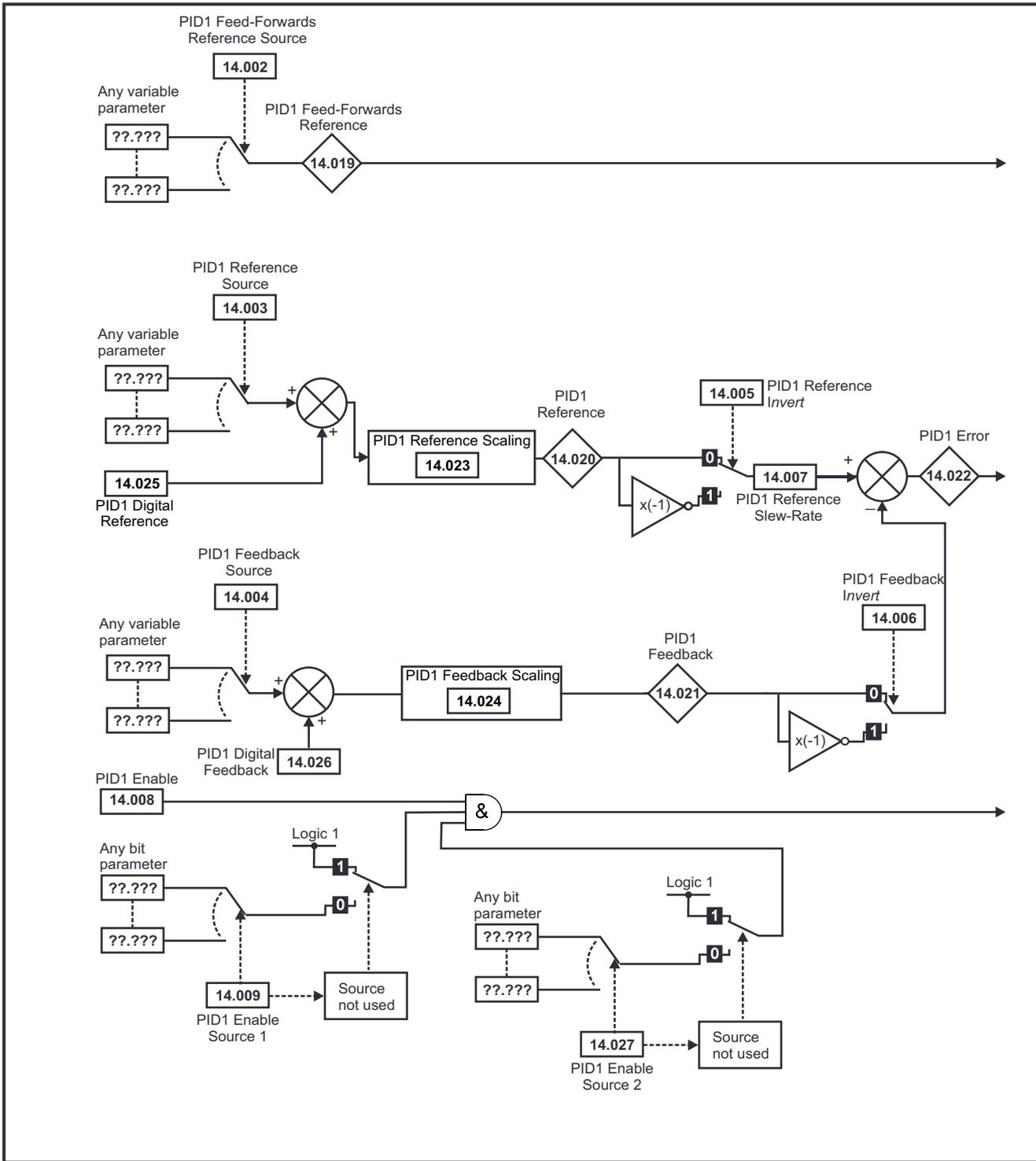
Parameter	Range(⌘)		Default(⇄)			Type						
	OL	RFC-A / S	OL	RFC-A	RFC-S							
13.001	Standard Motion Revolutions Error	-32768 to 32767 revs				RO	Num	ND	NC	PT		
13.002	Standard Motion Position Error	-32768 to 32767				RO	Num	ND	NC	PT		
13.003	Standard Motion Fine Position Error	-32768 to 32767				RO	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

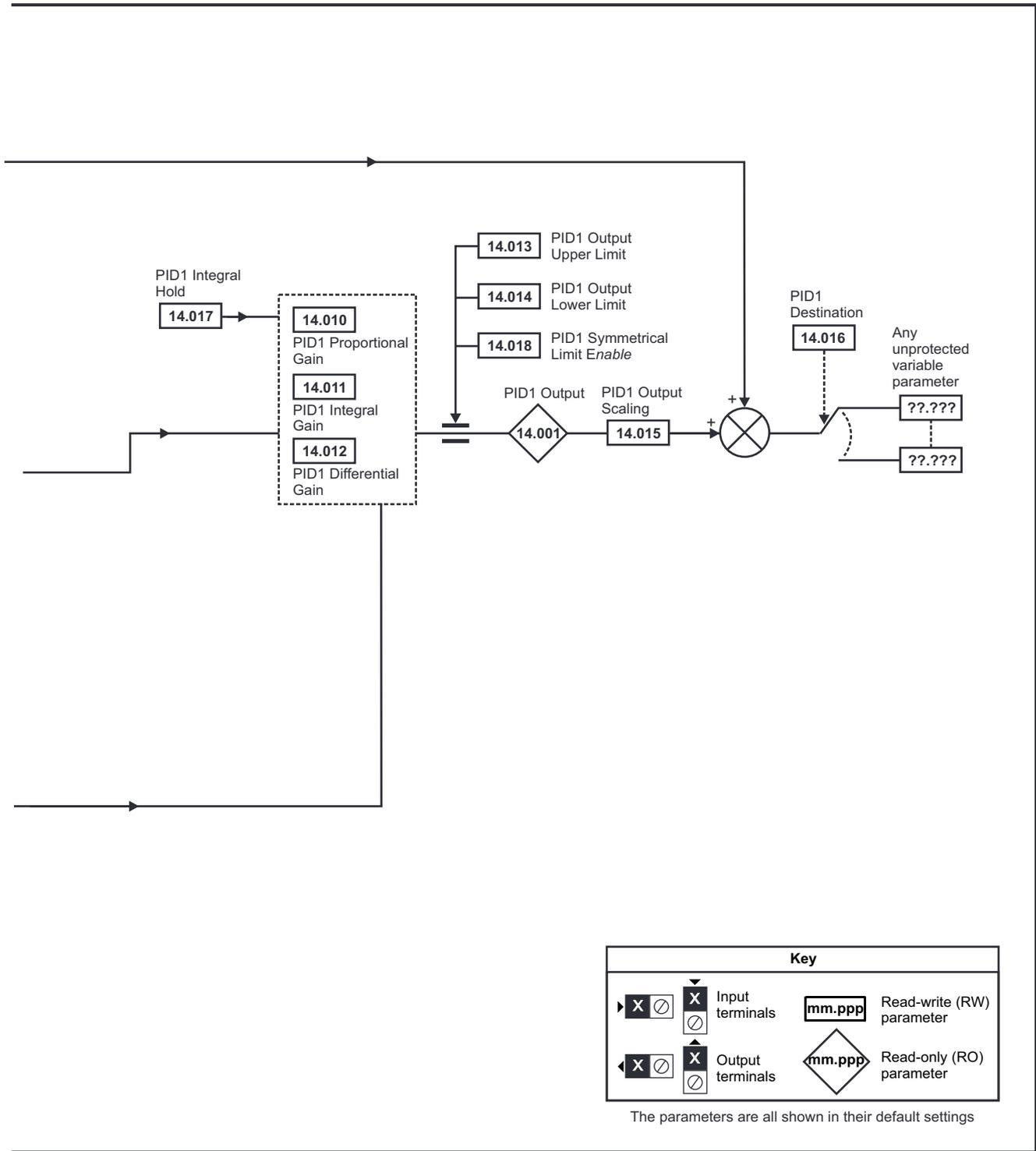
RW	Read / Write	RO	Read only	Num	Number parameter	Bit	Bit parameter	Txt	Text string	Bin	Binary parameter	FI	Filtered
ND	No default value	NC	Not copied	PT	Protected parameter	RA	Rating dependent	US	User save	PS	Power-down save	DE	Destination

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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## 12.15 Menu 14: User PID controller

Figure 12-34 Menu 14 Logic diagram





**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

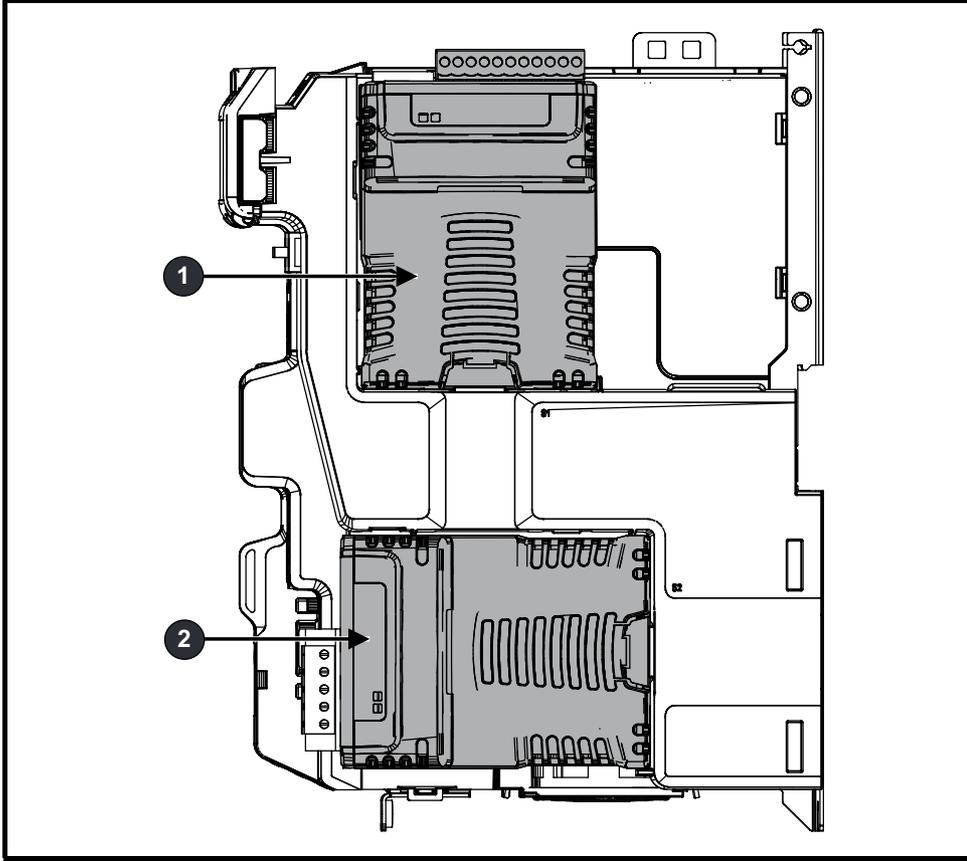
Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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Parameter		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

## 12.16 Menus 15, 16 and 17: Option module set-up

Figure 12-35 Location of option module slots and their corresponding menu numbers



1. Solutions Module Slot 1 - Menu 15
2. Solutions Module Slot 2 - Menu 16

### 12.16.1 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	

## 12.17 Menus 17: EtherCAT Interface - Setup

Parameter	Range(⌘)		Default(⇔)			Type							
	OL	RFC-A / S	OL	RFC-A	RFC-S								
17.001	Module ID	0 to 65535				RO	Num	ND	NC	PT			
17.002	Software Version	0 to 99999999				RO	Num	ND	NC	PT			
17.003	Hardware version	0.00 to 655.35				RO	Num	ND	NC	PT			
17.004	Serial Number LS	00000000 to 99999999				RO	Num	ND	NC	PT			
17.005	Serial Number MS	0 to 99999999				RO	Num	ND	NC	PT			
17.006	Status	Bootldr - Update (-2), Bootldr - Idle (-1), Initialising (0), OK (1), Config (2), Error (3)				RO	Txt	ND	NC	PT			
17.007	Reset	Off (0) or On (1)			Off (0)	RW	Bit		NC				
17.008	Default	Off (0) or On (1)			Off (0)	RW	Bit		NC				
17.031	Slot indicator	1 to 8				RO	Num	ND	NC	PT			
17.032	Slot menu number	0 to 255				RO	Num	ND	NC	PT			
17.033	Disable drive control	Off (0) or On (1)			Off (0)	RW	Bit						US
17.034	Allow EEPROM Upgrade	Off (0) or On (1)			Off (0)	RW	Bit						
17.035	Configured station alias	0 to 65535			0	RW	Num		NC	PT	US		
17.036	Consistency trigger for synchronous outputs	Off (0) or On (1)			Off (0)	RW	Bit						US
17.037	Consistency trigger parameter for synchronous outputs	0 to 999999			0	RW	Num	DE					US
17.038	Consistency trigger for synchronous inputs	Off (0) or On (1)			Off (0)	RW	Bit						US
17.039	Consistency trigger parameter for synchronous inputs	0 to 999999			0	RW	Num	DE					US
17.040	Consistency trigger for non-synchronous outputs	Off (0) or On (1)			Off (0)	RO	Bit						US
17.041	Consistency trigger parameter for non-synchronous outputs	0 to 999999			0	RO	Num	DE					US
17.042	Consistency trigger for non-synchronous inputs	Off (0) or On (1)			Off (0)	RW	Bit						US
17.043	Consistency trigger parameter for non-synchronous inputs	0 to 999999			0	RW	Num	DE					US
17.045	Homing Position Save	Off (0) or On (1)			Off (0)	RO	Bit				PT		US
17.046	Homing Position Parameter	51 to 54			51	RW	Num				PT		US

## 12.18 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

## 12.19 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

## 12.20 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

## 12.21 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 <sup>2</sup> /rad		0.10 s <sup>2</sup> /rad		1.00 s <sup>2</sup> /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 %		165.0 %		250.0 %	RW	Num		RA		US
21.028	M2 Regenerating Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %		165.0 %		250.0 %	RW	Num		RA		US
21.029	M2 Symmetrical Current Limit	0.0 to VM_MOTOR2_CURRENT_LIMIT %		165.0 %		250.0 %	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

Safety information	Product information	Mechanical installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	EtherCAT interface	SD Card Operation	Onboard PLC	<b>Advanced parameters</b>	Diagnostics	UL listing information
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Parameter		Range(⇅)			Default(⇔)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S						
21.053	M2 Phase Offset At Iq Test Current			± 90.0 °			0.0 °	RW	Num		RA		US
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

## 12.22 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	Parameter	Range(⇅)			Default(⇒)			Type					
		OL	RFC-A	RFC-S	OL	RFC-A	RFC-S	RW	Num			PT	US
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

# 13 Diagnostics

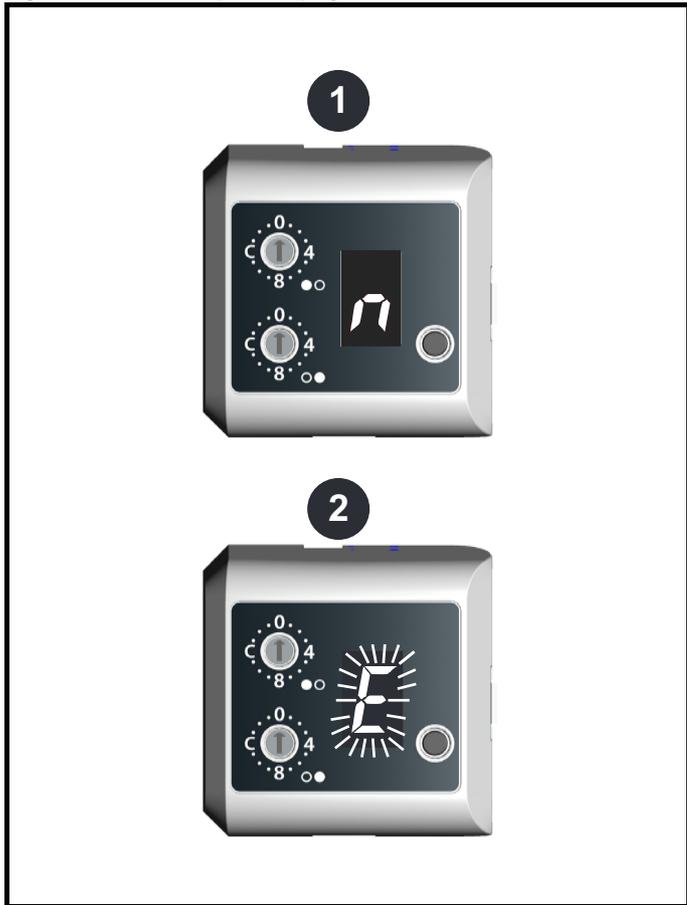
The KI-Compact Display and KI Remote Keypad RTC provide drive status information and drive trip indication for fault diagnosis.



**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.

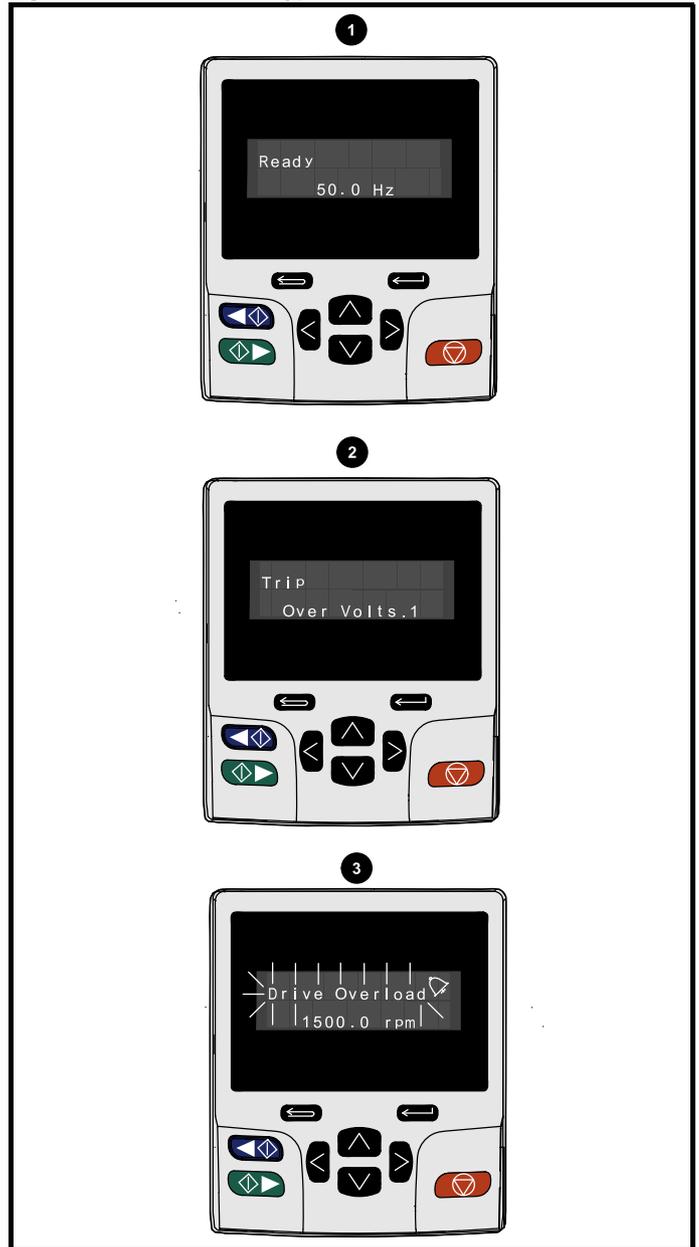
## 13.1 Status modes (KI-Compact Display, KI-Remote Keypad and drive LED status)

Figure 13-1 KI-Compact Display status modes



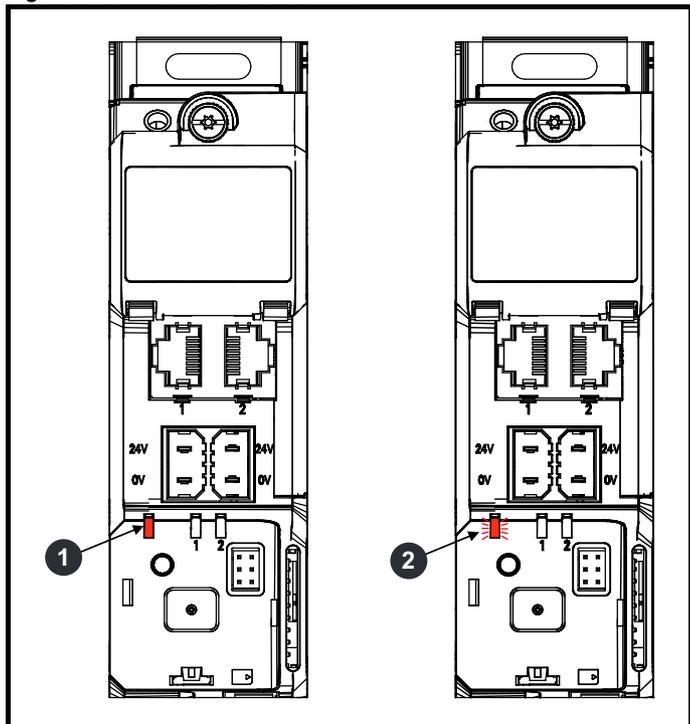
1. Drive OK status
2. Trip status (flashing)

Figure 13-2 KI-Remote Keypad status modes



1. Drive OK status
2. Trip status
3. Alarm status

**Figure 13-3 Location of the status LED**



1. Non flashing: Normal status
2. Flashing: Trip status

## 13.2 Trip indications

The output of the drive is disabled under any trip condition so that the drive stops controlling the motor. If the motor is running when the trip occurs it will coast to a stop.

During a trip condition, where a KI-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 13-1 for further information.

**Table 13-1 Trips associated with xxyzz sub-trip number**

Display character	Trip code	Separator	Sub-trip code
	Range 1 to 254		Range 1 to 65535
	Range 1 to 99		

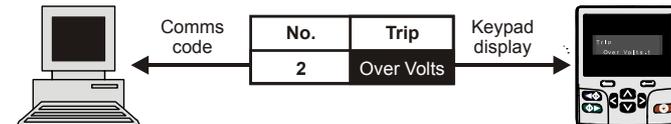
During a trip condition, where a KI-Remote Keypad is being used, the upper row of the display indicates that a trip has occurred and the lower row of the keypad display will display the trip string. Some trips have a sub-trip number to provide additional information about the trip. If a trip has a sub-trip 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 13-3.

Trips are listed alphabetically in Table 13-4 based on the trip indication shown on the drive display. Alternatively, the drive status can be read in Pr 10.001 'Drive OK' using communication protocols. The most recent trip can be read in Pr 10.020 providing a trip number. It must be noted that the hardware trips (HF01 to HF20) do not have trip numbers. The trip number must be checked in Table 13-5 to identify the specific trip.

### Example

1. Trip code 2 is read from Pr 10.020 via serial communications.
2. Checking Table 13-4 shows Trip 2 is an Over Volts trip.



3. Look up Over Volts in Table 13-4.
4. Perform checks detailed under *Diagnosis*.

## 13.3 Identifying a trip / trip source

Some trips only contain a trip string whereas some other trips have a trip string along with a sub-trip number which provides the user with additional information about the trip.

A trip can be generated from a control system or from a power system. The sub-trip number associated with the trips listed in Table 13-2 is in the form xxyzz and used to identify the source of the trip.

**Table 13-2 Trips associated with xxyzz sub-trip number**

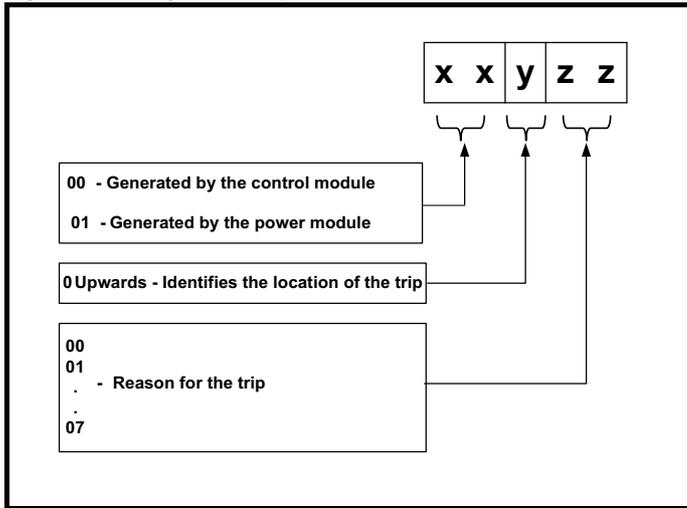
Over Volts	Oht dc bus
OI ac	Phase Loss
OI Brake	Power Comms
PSU	OI Snubber
Oht Inverter	Temp Feedback
Oht Power	Power Data
Oht Control	

The digits xx are 00 for a trip generated by the control system. For a single drive (not part of a multi-power module drive), if the trip is related to the power system then xx will have a value of 01, when displayed the leading zeros are suppressed.

The y digit is used to identify the location of a trip which is generated by a rectifier module connected to a power module (if xx is non zero). For a control system trip (xx is zero), the y digit, where relevant is defined for each trip. If not relevant, the y digit will have a value of zero.

The zz digits give the reason for the trip and are defined in each trip description.

**Figure 13-4 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 13-3 below the trip can be interpreted as; an over temperature has been detected; the trip was generated by fault in the control module, the control board thermistor 2 over temperature. For further information on individual sub-trips, refer to the diagnosis column in Table 13-4.

**Table 13-3 Sub-trip identification**

Source	xx	y	zz	Description
Control system	00	0	01	Control board thermistor 1 over temperature
Control system	00	0	02	Control board thermistor 2 over temperature
Control system	00	0	03	Control board thermistor 3 over temperature

## 13.4 Trips, Sub-trip numbers

Table 13-4 Trip indications

Trip	Diagnosis																											
<b>App Menu Changed</b>	<b>Customization table for an application module has changed</b>																											
217	<p>The <i>App Menu Changed</i> trip indicates that the customization table for an application menu has changed. The menu that has been changed can be identified by the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Menu 18</td> </tr> <tr> <td>2</td> <td>Menu 19</td> </tr> <tr> <td>3</td> <td>Menu 20</td> </tr> </tbody> </table> <p>If more than one menu has changed the lowest menu has priority. Drive user parameters must be saved to prevent this trip on the next power-up.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Reset the trip and perform a parameter save to accept the new settings</li> </ul>	Sub-trip	Reason	1	Menu 18	2	Menu 19	3	Menu 20																			
	Sub-trip	Reason																										
	1	Menu 18																										
	2	Menu 19																										
3	Menu 20																											
<b>Autotune 1</b>	<b>Position feedback did not change or required speed could not be reached</b>																											
11	<p>The drive has tripped during an autotune. The cause of the trip can be identified from the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> <th>Recommended actions</th> </tr> </thead> <tbody> <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° 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 <i>AMC Select</i> (31.001) to zero to deselect the AMC.</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the motor is free to turn i.e. mechanical brake was released</li> <li>Ensure Pr <b>03.026</b> and Pr <b>03.038</b> are set correctly (or appropriate 2<sup>nd</sup> motor map parameters)</li> <li>Check feedback device wiring is correct</li> <li>Check encoder mechanical coupling to the motor</li> </ul>	Sub-trip	Reason	Recommended actions	1	The position feedback did not change when position feedback is being used during rotating auto-tune.	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.	2	The motor did not reach the required speed during mechanical load measurement.	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.	3	The required commutation signal edge could not be found during a rotating auto-tune with a Commutation Only position feedback device.	Check that the position feedback signals are connected correctly.	4	The required movement angle cannot be produced during a minimal movement test.	Reduce the angular movement required.	5	The second part of the minimal movement test during auto-tuning cannot locate the motor flux position accurately.	Reduce the angular movement required.	6	The phasing offset angle is measured twice during a stationary auto-tune and the results are not within 30° of each other.	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.	7	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.	Ensure that the motor is stationary before the drive is enabled.	8	An auto-tune has been attempted while the AMC is selected.	Set <i>AMC Select</i> (31.001) to zero to deselect the AMC.
	Sub-trip	Reason	Recommended actions																									
	1	The position feedback did not change when position feedback is being used during rotating auto-tune.	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.																									
	2	The motor did not reach the required speed during mechanical load measurement.	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.																									
	3	The required commutation signal edge could not be found during a rotating auto-tune with a Commutation Only position feedback device.	Check that the position feedback signals are connected correctly.																									
	4	The required movement angle cannot be produced during a minimal movement test.	Reduce the angular movement required.																									
	5	The second part of the minimal movement test during auto-tuning cannot locate the motor flux position accurately.	Reduce the angular movement required.																									
	6	The phasing offset angle is measured twice during a stationary auto-tune and the results are not within 30° of each other.	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.																									
	7	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.	Ensure that the motor is stationary before the drive is enabled.																									
	8	An auto-tune has been attempted while the AMC is selected.	Set <i>AMC Select</i> (31.001) to zero to deselect the AMC.																									
<b>Autotune 2</b>	<b>Position feedback direction incorrect</b>																											
12	<p>The drive has tripped during a rotating autotune. The cause of the trip can be identified from the associated sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The position feedback direction is incorrect when position feedback is being used during a rotating autotune</td> </tr> <tr> <td>2</td> <td>A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position..</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Check motor cable wiring is correct</li> <li>Check feedback device wiring is correct</li> <li>Swap any two motor phases</li> </ul>	Sub-trip	Reason	1	The position feedback direction is incorrect when position feedback is being used during a rotating autotune	2	A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position..																					
	Sub-trip	Reason																										
	1	The position feedback direction is incorrect when position feedback is being used during a rotating autotune																										
2	A SINCOS encoder with comms is being used for position feedback and the comms position is rotating in the opposite direction to the sine wave based position..																											

Trip	Diagnosis								
<b>Autotune 3</b>	<b>Measured inertia has exceeded the parameter range or commutation signals changed in wrong direction</b>								
13	The drive has tripped during a rotating autotune or mechanical load measurement test. The cause of the trip can be identified from the associated sub-trip number.								
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Measured inertia has exceeded the parameter range during a mechanical load measurement</td> </tr> <tr> <td>2</td> <td>The commutation signals changed in the wrong direction during a rotating autotune</td> </tr> <tr> <td>3</td> <td>The mechanical load test has been unable to identify the motor inertia.</td> </tr> </tbody> </table>	Sub-trip	Reason	1	Measured inertia has exceeded the parameter range during a mechanical load measurement	2	The commutation signals changed in the wrong direction during a rotating autotune	3	The mechanical load test has been unable to identify the motor inertia.
	Sub-trip	Reason							
	1	Measured inertia has exceeded the parameter range during a mechanical load measurement							
	2	The commutation signals changed in the wrong direction during a rotating autotune							
3	The mechanical load test has been unable to identify the motor inertia.								
<b>Recommended actions for sub-trip 2:</b>									
<ul style="list-style-type: none"> <li>Check motor cable wiring is correct</li> <li>Check feedback device U,V and W commutation signal wiring is correct</li> </ul>									
<b>Recommended actions for sub-trip 3:</b>									
<ul style="list-style-type: none"> <li>Increase the test level</li> <li>If the test was carried out at standstill repeat the test with the motor rotating within the recommended speed range</li> </ul>									
<b>Autotune 4</b>	<b>Drive encoder U commutation signal fail</b>								
14	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.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check feedback device U commutation signal wiring is correct (Encoder terminals 7 and 8)</li> </ul>								
<b>Autotune 5</b>	<b>Drive encoder V commutation signal fail</b>								
15	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.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check feedback device V commutation signal wiring is correct (Encoder terminals 9 and 10)</li> </ul>								
<b>Autotune 6</b>	<b>Drive encoder W commutation signal fail</b>								
16	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.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check feedback device W commutation signal wiring is correct (Encoder terminals 11 and 12)</li> </ul>								
<b>Autotune 7</b>	<b>Motor number of poles / position feedback resolution set incorrectly</b>								
17	An <i>Autotune 7</i> trip is initiated during a rotating autotune, if the motor poles or the position feedback resolution have been set up incorrectly where position feedback is being used.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check line per revolution for feedback device</li> <li>Check the number of poles in Pr <b>05.011</b></li> </ul>								
<b>Autotune Stopped</b>	<b>Autotune test stopped before completion</b>								
18	The drive was prevented from completing an autotune test, because either the drive enable or the drive run were removed.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check the drive enable signal (terminal 2 &amp;6) were active during the autotune</li> <li>Check the run command was active in Pr <b>08.005</b> during autotune</li> </ul>								
<b>Brake R Too Hot</b>	<b>Braking resistor overload timed out (I<sup>2</sup>t)</b>								
19	The <i>Brake R Too Hot</i> indicates that braking resistor overload has timed out. The value in <i>Braking Resistor Thermal Accumulator</i> (10.039) is calculated using <i>Braking Resistor Rated Power</i> (10.030), <i>Braking Resistor Thermal Time Constant</i> (10.031) and <i>Braking Resistor Resistance</i> (10.061). The <i>Brake R Too Hot</i> trip is initiated when <i>Braking Resistor Thermal Accumulator</i> (10.039) reaches 100 %.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Ensure the values entered in Pr <b>10.030</b>, Pr <b>10.031</b> and Pr <b>10.061</b> are correct</li> <li>If an external thermal protection device is being used and the braking resistor software overload protection is not required, set Pr <b>10.030</b>, Pr <b>10.031</b> or Pr <b>10.061</b> to 0 to disable the trip.</li> </ul>								

Trip	Diagnosis										
<b>CAM</b>	<b>Advanced motion controller CAM failure</b>										
99	The CAM trip indicates that the advanced motion controller CAM has detected a problem.										
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>AMC Cam Start Index (35.001) &gt; AMC Cam Size (35.003) or AMC Cam Start Position In Segment (35.002) &gt; 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> </tbody> </table>	Sub-trip	Reason	1	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	2	AMC CAM Index (35.007) has been made to change by more than 2 in one sample	3	The rate of change at a segment boundary has exceeded the maximum value	4	The sum of the AMC Cam Position In Segment (35.008) and the change of master position has exceeded the maximum value.
	Sub-trip	Reason									
	1	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									
	2	AMC CAM Index (35.007) has been made to change by more than 2 in one sample									
3	The rate of change at a segment boundary has exceeded the maximum value										
4	The sum of the AMC Cam Position In Segment (35.008) and the change of master position has exceeded the maximum value.										
<b>Card Access</b>	<b>SD Card Write fail</b>										
185	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check SD Card is installed / located correctly</li> <li>• Replace the SD Card</li> </ul>										
<b>Card Boot</b>	<b>The Menu 0 parameter modification cannot be saved to the SD Card</b>										
177	<p>Menu 0 changes are automatically saved on exiting edit mode.</p> <p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure that Pr 11.042 is correctly set, and then reset the drive to create the necessary file on the SD Card</li> <li>• Re-attempt the parameter write to the Menu 0 parameter</li> </ul>										
<b>Card Busy</b>	<b>SD Card cannot be accessed as it is being accessed by an option module</b>										
178	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Wait for the option module to finish accessing the SD Card and re-attempt the required function</li> </ul>										
<b>Card Compare</b>	<b>SD Card file/data is different to the one in the drive</b>										
188	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Set Pr mm.000 to 0 and reset the trip</li> <li>• Check to ensure the correct data block on the SD Card has been used for the compare.</li> </ul>										
<b>Card Data Exists</b>	<b>SD Card data location already contains data</b>										
179	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Erase the data in data location</li> <li>• Write data to an alternative data location</li> </ul>										
<b>Card Drive Mode</b>	<b>SD Card parameter set not compatible with current drive mode</b>										
187	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure the destination drive supports the drive operating mode in the parameter file.</li> <li>• Clear the value in Pr mm.000 and reset the drive.</li> <li>• Ensure destination drive operating mode is the same as the source parameter file.</li> </ul>										

Trip	Diagnosis								
<b>Card Error</b>	<b>SD Card data structure error</b>								
182	The <i>Card Error</i> 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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The required folder and file structure is not present</td> </tr> <tr> <td>2</td> <td>The &lt;000&gt; file is corrupted.</td> </tr> <tr> <td>3</td> <td>Two or more files in the &lt;MCDF&gt; folder have the same file identification number.</td> </tr> </tbody> </table>	Sub-trip	Reason	1	The required folder and file structure is not present	2	The <000> file is corrupted.	3	Two or more files in the <MCDF> folder have the same file identification number.
	Sub-trip	Reason							
	1	The required folder and file structure is not present							
2	The <000> file is corrupted.								
3	Two or more files in the <MCDF> folder have the same file identification number.								
<b>Recommended actions:</b>									
	<ul style="list-style-type: none"> <li>Erase all the data blocks and re-attempt the process</li> <li>Ensure the card is located correctly</li> <li>Replace the SD Card</li> </ul>								
<b>Card Full</b>	<b>SD Card full</b>								
184	The <i>Card Full</i> 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.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Delete a data block or the entire SD Card to create space</li> <li>Use a different SD Card</li> </ul>								
<b>Card No Data</b>	<b>SD Card data not found</b>								
183	The <i>Card No Data</i> trip indicates that an attempt has been made to access non-existent file or block on an SD Card. No data is transferred.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Ensure data block number is correct</li> </ul>								
<b>Card Option</b>	<b>SD Card trip; option modules installed are different between source drive and destination drive</b>								
180	The <i>Card Option</i> 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.								
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Ensure the correct option modules are installed.</li> <li>Ensure the option modules are in the same option module slot as the parameter set stored.</li> <li>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</li> <li>This trip can be suppressed by setting Pr <b>mm.000</b> to 9666 and resetting the drive.</li> </ul>								
<b>Card Product</b>	<b>SD Card data blocks are not compatible with the drive derivative</b>								
175	If <i>Drive Derivative</i> (11.028) or <i>Product Type</i> (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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>If <i>Drive Derivative</i> (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 <i>Product Type</i> (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 <b>xx.000</b>, and resetting the drive (this applies the warning suppression flag to the card).</td> </tr> </tbody> </table>	Sub-trip	Reason	1	If <i>Drive Derivative</i> (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).	2	If <i>Product Type</i> (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.	3	A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr <b>xx.000</b> , and resetting the drive (this applies the warning suppression flag to the card).
	Sub-trip	Reason							
	1	If <i>Drive Derivative</i> (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).							
2	If <i>Product Type</i> (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.								
3	A Unidrive SP parameter value was found that has no equivalent parameter on the destination drive. Data is still transferred, since this is a warning trip; the trip can be suppressed by entering code 9666 in Pr <b>xx.000</b> , and resetting the drive (this applies the warning suppression flag to the card).								
<b>Recommended actions:</b>									
	<ul style="list-style-type: none"> <li>Use a different SD Card</li> <li>This trip can be suppressed by setting Pr <b>mm.000</b> to 9666 and resetting the drive</li> </ul>								

Trip	Diagnosis								
<b>Card Rating</b>	<b>SD Card Trip; The voltage and / or current rating of the source and destination drives are different</b>								
186	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Reset the drive to clear the trip</li> <li>Ensure that the drive rating dependent parameters have transferred correctly</li> <li>This trip can be suppressed by setting Pr mm.000 to 9666 and resetting the drive</li> </ul>								
<b>Card Read Only</b>	<b>SD Card has the Read Only bit set</b>								
181	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>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</li> </ul>								
<b>Card Slot</b>	<b>SD Card Trip; Option module application program transfer has failed</b>								
174	<p>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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the source / destination option module is installed on the correct slot</li> </ul>								
<b>Control Word</b>	<b>Trip initiated from the Control Word (06.042)</b>								
35	<p>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).</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Check the value of Pr 06.042.</li> <li>Disable the control word in Control Word Enable (Pr 06.043) <ul style="list-style-type: none"> <li>Bit 12 of the control word set to a one causes the drive to trip on Control Word</li> <li>When the control word is enabled, the trip can only be cleared by setting bit 12 to zero</li> </ul> </li> </ul>								
<b>Current Offset</b>	<b>Current feedback offset error</b>								
225	<p>The current feedback offset is too large to be trimmed correctly. The sub-trip relates to the output phase for which the offset error has been detected.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Phase</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>U</td> </tr> <tr> <td>2</td> <td>V</td> </tr> <tr> <td>3</td> <td>W</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure that there is no possibility of current flowing in the output phases of the drive when the drive is not enabled</li> <li>Hardware fault – Contact the supplier of the drive</li> </ul>	Sub-trip	Phase	1	U	2	V	3	W
Sub-trip	Phase								
1	U								
2	V								
3	W								
<b>Data Changing</b>	<b>Drive parameters are being changed</b>								
97	<p>A user action or a file system write is active that is changing the drive parameters and the drive has been commanded to enable, i.e. 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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the drive is not enabled when one of the following is being carried out <ul style="list-style-type: none"> <li>Loading defaults</li> <li>Changing drive mode</li> <li>Transferring data from SD Card or position feedback device</li> <li>Transferring user programs</li> </ul> </li> </ul>								

Trip	Diagnosis																											
<b>Derivative ID</b>	<b>Derivative identification error</b>																											
247	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 border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>There should be a derivative image in the product but this has been erased.</td> </tr> <tr> <td>2</td> <td>The identifier is out of range.</td> </tr> <tr> <td>3</td> <td>The derivative image has been changed.</td> </tr> </tbody> </table>	Sub-trip	Reason	1	There should be a derivative image in the product but this has been erased.	2	The identifier is out of range.	3	The derivative image has been changed.																			
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<b>Recommended actions:</b>																												
Contact the supplier of the drive																												
<b>Derivative Image</b>	<b>Derivative Image error</b>																											
248	The <i>Derivative Image</i> trip indicates that an error has been detected in the derivative image. The sub-trip number indicates the reason for the trip.																											
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> <th>Comments</th> </tr> </thead> <tbody> <tr> <td>1 to 52</td> <td>An error has been detected in the derivative image, contact the supplier of the drive.</td> <td></td> </tr> <tr> <td>61</td> <td>The option module fitted in slot 1 is not allowed with the derivative image</td> <td rowspan="4">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td> </tr> <tr> <td>62</td> <td>The option module fitted in slot 2 is not allowed with the derivative image</td> </tr> <tr> <td>63</td> <td>The option module fitted in slot 3 is not allowed with the derivative image</td> </tr> <tr> <td>64</td> <td>The option module fitted in slot 4 is not allowed with the derivative image</td> </tr> <tr> <td>70</td> <td>An option module that is required by the derivative image is not fitted in any slot</td> <td rowspan="4">Occurs when the drive powers-up or the image is programmed. The image tasks will not run.</td> </tr> <tr> <td>71</td> <td>An option module specifically required to be fitted in slot 1 not present</td> </tr> <tr> <td>72</td> <td>An option module specifically required to be fitted in slot 2 not present</td> </tr> <tr> <td>73</td> <td>An option module specifically required to be fitted in slot 3 not present</td> </tr> <tr> <td>80 to 81</td> <td>An error has been detected in the derivative image, contact the supplier of the drive.</td> <td></td> </tr> </tbody> </table>	Sub-trip	Reason	Comments	1 to 52	An error has been detected in the derivative image, contact the supplier of the drive.		61	The option module fitted in slot 1 is not allowed with the derivative image	Occurs when the drive powers-up or the image is programmed. The image tasks will not run.	62	The option module fitted in slot 2 is not allowed with the derivative image	63	The option module fitted in slot 3 is not allowed with the derivative image	64	The option module fitted in slot 4 is not allowed with the derivative image	70	An option module that is required by the derivative image is not fitted in any slot	Occurs when the drive powers-up or the image is programmed. The image tasks will not run.	71	An option module specifically required to be fitted in slot 1 not present	72	An option module specifically required to be fitted in slot 2 not present	73	An option module specifically required to be fitted in slot 3 not present	80 to 81	An error has been detected in the derivative image, contact the supplier of the drive.	
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	<b>Recommended action:</b>																											
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<b>Destination</b>	<b>Two or more parameters are writing to the same destination parameter</b>																											
199	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.																											
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Set Pr <b>mm.000</b> to 'Destinations' or 12001 and check all visible parameters in all menus for parameter write conflicts</li> </ul>																											
<b>Drive Size</b>	<b>Power stage recognition: Unrecognized drive size</b>																											
224	The <i>Drive Size</i> trip indicates that the control PCB has not recognized the drive size of the power circuit to which it is connected.																											
	<b>Recommended action:</b> <ul style="list-style-type: none"> <li>Ensure the drive is programmed to the latest firmware version</li> <li>Hardware fault - return drive to supplier</li> </ul>																											

Trip	Diagnosis																				
<b>EEPROM Fail</b>	<b>Default parameters have been loaded</b>																				
31	The <i>EEPROM Fail</i> trip indicates that default parameters have been loaded. The exact cause/reason of the trip can be identified from the sub-trip number.																				
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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 <i>User Save</i> or <i>Power Down Save</i> 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 <b>mm.000</b> (mm.000) is set to 10, 11, 1233 or 1244 or if <i>Load Defaults</i> (11.043) is set to a non-zero value.																					
<b>Recommended actions:</b>																					
<ul style="list-style-type: none"> <li>• Default the drive and perform a reset</li> <li>• Allow sufficient time to perform a save before the supply to the drive is removed</li> <li>• If the trip persists - return drive to supplier</li> </ul>																					
<b>Encoder 1</b>	<b>Drive position feedback interface power supply overload</b>																				
189	The <i>Encoder 1</i> 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.																				
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>• Check encoder power supply wiring</li> <li>• Disable the termination resistors (Pr <b>03.039</b> set to 0) to reduce current consumption</li> <li>• For 5 V encoders with long cables, select 8 V (Pr <b>03.036</b>) and install a 5 V voltage regulator close to the encoder</li> <li>• Check the encoder specification to confirm if it is compatible with the encoder port power supply current capability</li> <li>• Replace the encoder</li> <li>• Use an external power supply with higher current capability</li> </ul>																				
<b>Encoder 2</b>	<b>Drive encoder (Feedback) wire break</b>																				
190	The <i>Encoder 2</i> 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.																				
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Drive position feedback interface 1 on any input</td> </tr> <tr> <td>2</td> <td>Drive position feedback interface 2 on any input</td> </tr> <tr> <td>11</td> <td>Drive position feedback interface 1 on the A channel</td> </tr> <tr> <td>12</td> <td>Drive position feedback interface 1 on the B channel</td> </tr> <tr> <td>13</td> <td>Drive position feedback interface 1 on the Z channel</td> </tr> </tbody> </table>	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								
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13	Drive position feedback interface 1 on the Z channel																				
<b>Recommended actions:</b>																					
<ul style="list-style-type: none"> <li>• Ensure that the position feedback device type selected in Pr <b>03.038</b> is correct for the position feedback device connected to the P1 interface on the drive.</li> <li>• If wire break detection on the drive encoder input is not required, set Pr <b>03.040</b> = XXX0 to disable the Encoder 2 trip</li> <li>• Check cable continuity</li> <li>• Check wiring of feedback signals is correct</li> <li>• Check encoder power supply is set correctly (Pr <b>03.036</b>)</li> <li>• Replace encoder</li> </ul>																					

Trip	Diagnosis						
<b>Encoder 3</b>	<b>Phase offset incorrect while running</b>						
191	The <i>Encoder 3</i> 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.						
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Drive position feedback interface 1</td> </tr> <tr> <td>2</td> <td>Drive position feedback interface 2</td> </tr> </tbody> </table>	Sub-trip	Reason	1	Drive position feedback interface 1	2	Drive position feedback interface 2
	Sub-trip	Reason					
1	Drive position feedback interface 1						
2	Drive position feedback interface 2						
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check encoder shield connections</li> <li>• Ensure the encoder cable is one uninterrupted cable</li> <li>• Check the encoder signal for noise with an oscilloscope</li> <li>• Check the integrity of the encoder mechanical mounting</li> <li>• 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</li> <li>• 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)</li> <li>• Repeat the offset measurement test</li> </ul>							
<b>Encoder 4</b>	<b>Feedback device comms failure</b>						
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.						
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	Sub-trip	Reason					
1	Drive position feedback interface 1						
2	Drive position feedback interface 2						
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure the encoder power supply setting (Pr <b>03.036</b>) is correct</li> <li>• Complete encoder auto-configuration (Pr <b>03.041</b>)</li> <li>• Check the encoder wiring</li> <li>• Replace the feedback device</li> </ul>							
<b>Encoder 5</b>	<b>Checksum or CRC error</b>						
193	The <i>Encoder 5</i> 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.						
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Drive position feedback interface 1</td> </tr> <tr> <td>2</td> <td>Drive position feedback interface 2</td> </tr> </tbody> </table>	Sub-trip	Reason	1	Drive position feedback interface 1	2	Drive position feedback interface 2
	Sub-trip	Reason					
1	Drive position feedback interface 1						
2	Drive position feedback interface 2						
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the encoder cable shield connections</li> <li>• Ensure the cable is one uninterrupted cable - remove any connector blocks or if unavoidable minimise the length of any shield pigtailed to the connector block</li> <li>• Check the encoder signal for noise with an oscilloscope</li> <li>• Check the comms resolution setting (Pr <b>03.035</b>)</li> <li>• If using a Hiperface, EnDat encoder carry out an encoder auto-configuration (Pr <b>03.041</b> = Enabled)</li> <li>• Replace the encoder</li> </ul>							
<b>Encoder 6</b>	<b>Encoder has indicated an error</b>						
194	The <i>Encoder 6</i> trip indicates that the encoder has indicated an error or that the power supply has failed to an SSI encoder. The <i>Encoder 6</i> trip can also indicate a wire break to an SSI encoder.						
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	Sub-trip	Reason					
1	Drive position feedback interface 1						
2	Drive position feedback interface 2						
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• For SSI encoders, check the wiring and encoder power supply setting (Pr <b>03.036</b>)</li> <li>• Replace the encoder / contact the supplier of the encoder</li> </ul>							

Trip	Diagnosis																
<b>Encoder 7</b>	<b>Set-up parameters for position feedback device have changed</b>																
195	The <i>Encoder 7</i> 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.																
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1	Drive position feedback interface 1																
2	Drive position feedback interface 2																
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Reset the trip and perform a save.</li> <li>Ensure Pr <b>3.033</b> and Pr <b>03.035</b> are set correctly or carry out an encoder auto-configuration (Pr <b>03.041</b> = Enabled)</li> </ul>																	
<b>Encoder 8</b>	<b>Position feedback interface has timed out</b>																
196	The <i>Encoder 8</i> trip indicates that Position feedback interface communications time exceeds 250 $\mu$ s. The feedback device which has caused the trip can be identified by the sub-trip number.																
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Drive position feedback interface 1</td> </tr> <tr> <td>2</td> <td>Drive position feedback interface 2</td> </tr> </tbody> </table>	Sub-trip	Reason	1	Drive position feedback interface 1	2	Drive position feedback interface 2										
	Sub-trip	Reason															
1	Drive position feedback interface 1																
2	Drive position feedback interface 2																
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the encoder is connected correctly</li> <li>Ensure that the encoder is compatible</li> <li>Increase baud rate</li> </ul>																	
<b>Encoder 9</b>	<b>Position feedback is selected from a option module slot which does not have a feedback option module installed</b>																
197	The <i>Encoder 9</i> trip indicates that position feedback source selected in Pr <b>03.026</b> (or Pr <b>21.021</b> for the second motor map) is not valid																
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Check the setting of Pr <b>03.026</b> (or Pr <b>21.021</b> if the second motor parameters have been enabled)</li> <li>Ensure that the option slot selected in Pr <b>03.026</b> has a feedback option module installed</li> </ul>																
<b>Encoder 12</b>	<b>Encoder could not be identified during auto-configuration</b>																
162	The <i>Encoder 12</i> trip indicates that the drive is communicating with the encoder but the encoder type is not recognized.																
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Drive position feedback interface 1</td> </tr> <tr> <td>2</td> <td>Drive position feedback interface 2</td> </tr> </tbody> </table>	Sub-trip	Reason	1	Drive position feedback interface 1	2	Drive position feedback interface 2										
	Sub-trip	Reason															
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2	Drive position feedback interface 2																
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Enter the encoder setup parameters manually</li> <li>Check to see the encoder supports auto-configuration</li> </ul>																	
<b>Encoder 13</b>	<b>Data read from the encoder is out of range during auto-configuration</b>																
163	The <i>Encoder 13</i> 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).																
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>x1</td> <td>Rotary lines per revolution error</td> </tr> <tr> <td>x2</td> <td>Linear comms pitch error</td> </tr> <tr> <td>x3</td> <td>Linear line pitch error</td> </tr> <tr> <td>x4</td> <td>Rotary turns bits error</td> </tr> <tr> <td>x5</td> <td>Communications bits error</td> </tr> <tr> <td>x6</td> <td>Calculation time is too long</td> </tr> <tr> <td>x7</td> <td>Line delay measured is longer than 5 <math>\mu</math>s</td> </tr> </tbody> </table>	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 $\mu$ s
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<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Enter the encoder setup parameters manually</li> <li>Check to see the encoder supports auto-configuration</li> </ul>																	

Trip	Diagnosis								
<b>External Trip</b>	<b>An External trip is initiated</b>								
	An <i>External Trip</i> has occurred. The cause of the trip can be identified from the sub trip number displayed after the trip string. See table below. An external trip can also be initiated by writing a value of 6 in Pr <b>10.038</b> .								
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td><i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low</td> </tr> <tr> <td>2</td> <td><i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low</td> </tr> <tr> <td>3</td> <td><i>External Trip</i> (10.032) = 1</td> </tr> </tbody> </table>	Sub-trip	Reason	1	<i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low	2	<i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low	3	<i>External Trip</i> (10.032) = 1
Sub-trip	Reason								
1	<i>External Trip Mode</i> (08.010) = 1 or 3 and Safe Torque Off input 1 is low								
2	<i>External Trip Mode</i> (08.010) = 2 or 3 and Safe Torque Off input 2 is low								
3	<i>External Trip</i> (10.032) = 1								
6	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the Safe Torque Off signal voltage (on terminals 2 &amp; 6) equals to 24 V.</li> <li>• Check the value of Pr <b>08.009</b> which indicates the digital state of terminals 2 &amp; 6, equates to 'on'.</li> <li>• If external trip detection of the Safe Torque Off input is not required, set Pr <b>08.010</b> to OFF (0).</li> <li>• Check the value of Pr <b>10.032</b>.</li> <li>• Select 'Destinations' (or enter 12001) in Pr <b>mm.000</b> and check for a parameter controlling Pr <b>10.032</b>.</li> <li>• Ensure Pr <b>10.032</b> or Pr <b>10.038</b> (= 6) is not being controlled by serial comms</li> </ul>								
<b>HF01</b>	<b>Data processing error: CPU address error</b>								
	The <i>HF01</i> trip indicates that a CPU address error has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF02</b>	<b>Data processing error: DMAC address error</b>								
	The <i>HF02</i> trip indicates that a DMAC address error has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF03</b>	<b>Data processing error: Illegal instruction</b>								
	The <i>HF03</i> trip indicates that an illegal instruction has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF04</b>	<b>Data processing error: Illegal slot instruction</b>								
	The <i>HF04</i> trip indicates that an illegal slot instruction has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF05</b>	<b>Data processing error: Undefined exception</b>								
	The <i>HF05</i> trip indicates that an undefined exception error has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF06</b>	<b>Data processing error: Reserved exception</b>								
	The <i>HF06</i> trip indicates that a reserved exception error has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF07</b>	<b>Data processing error: Watchdog failure</b>								
	The <i>HF07</i> trip indicates that a watchdog failure has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF08</b>	<b>Data processing error: CPU Interrupt crash</b>								
	The <i>HF08</i> trip indicates that a CPU interrupt crash has occurred. This trip indicates that the control PCB on the drive has failed.								
	<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>								

Trip	Diagnosis								
<b>HF09</b>	<b>Data processing error: Free store overflow</b>								
	The <i>HF09</i> trip indicates that a free store overflow has occurred. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF10</b>	<b>Data processing error: Parameter routing system error</b>								
	The <i>HF10</i> trip indicates that a Parameter routing system error has occurred. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF11</b>	<b>Data processing error: Access to EEPROM failed</b>								
	The <i>HF11</i> trip indicates that access to the drive EEPROM has failed. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF12</b>	<b>Data processing error: Main program stack overflow</b>								
	The <i>HF12</i> trip indicates that the main program stack over flow has occurred. The stack can be identified by the sub-trip number. This trip indicates that the control PCB on the drive has failed. <table border="1" data-bbox="354 730 936 873"> <thead> <tr> <th>Sub-trip</th> <th>Stack</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Background tasks</td> </tr> <tr> <td>2</td> <td>Timed tasks</td> </tr> <tr> <td>3</td> <td>Main system interrupts</td> </tr> </tbody> </table> <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>	Sub-trip	Stack	1	Background tasks	2	Timed tasks	3	Main system interrupts
Sub-trip	Stack								
1	Background tasks								
2	Timed tasks								
3	Main system interrupts								
<b>HF13</b>	<b>Data processing error: Firmware incompatible with hardware</b>								
	The <i>HF13</i> trip indicates that the drive firmware is not compatible with the hardware. This trip indicates that the control PCB on the drive has failed. The sub-trip number gives the actual ID code of the control board hardware. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Re-program the drive with the latest version of the drive firmware for <i>Digitax HD M753</i></li> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF14</b>	<b>Data processing error: CPU register bank error</b>								
	The <i>HF14</i> trip indicates that a CPU register bank error has occurred. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF15</b>	<b>Data processing error: CPU divide error</b>								
	The <i>HF15</i> trip indicates that a CPU divide error has occurred. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF16</b>	<b>Data processing error: RTOS error</b>								
	The <i>HF16</i> trip indicates that a RTOS error has occurred. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								
<b>HF17</b>	<b>Data processing error: Clock supplied to the control board is out of specification</b>								
	The <i>HF17</i> trip indicates that the clock supplied to the control board logic is out of specification. This trip indicates that the control PCB on the drive has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>								

Trip	Diagnosis								
<b>HF18</b>	<p><b>Data processing error: Internal flash memory has failed</b></p> <p>The <i>HF18</i> trip indicates that the internal flash memory has failed when writing option module parameter data. The reason for the trip can be identified by the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>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> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Hardware fault - Contact the supplier of the drive.</li> </ul>	Sub-trip	Reason	1	Programming error while writing menu in flash	2	Erase flash block containing setup menus failed	3	Erase flash block containing application menus failed
Sub-trip	Reason								
1	Programming error while writing menu in flash								
2	Erase flash block containing setup menus failed								
3	Erase flash block containing application menus failed								
<b>HF19</b>	<p><b>Data processing error: CRC check on the firmware has failed</b></p> <p>The <i>HF19</i> trip indicates that the CRC check on the drive firmware has failed.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Re-program the drive</li> <li>Hardware fault - Contact the supplier of the drive</li> </ul>								
<b>HF20</b>	<p><b>Data processing error: ASIC is not compatible with the hardware</b></p> <p>The <i>HF20</i> trip indicates that the ASIC version is not compatible with the drive firmware. The ASIC version can be identified from the sub-trip number.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Hardware fault - Contact the supplier of the drive</li> </ul>								
<b>HF23 to HF25</b>	<p><b>Hardware fault</b></p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>If this trip occurs please consult the drive supplier.</li> </ul>								

Trip	Diagnosis																				
<b>Inductance</b>	<b>Inductance measurement out of range or motor saturation not detected</b>																				
8	<p>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.</p> <p>If the inductance ratio or difference is too small this is because one of the following conditions is true:  <math>(No\text{-}load\ Lq\ (05.072) - Ld\ (05.024)) / Ld\ (05.024) &lt; 0.1</math>  <math>(No\text{-}load\ Lq\ (05.072) - Ld\ (05.024)) &lt; (K / Full\ Scale\ Current\ Kc\ (11.061))H</math></p> <p>where:</p> <table border="1"> <thead> <tr> <th>Drive Rated voltage (11.033)</th> <th>K</th> </tr> </thead> <tbody> <tr> <td>200 V</td> <td>0.0073</td> </tr> <tr> <td>400 V</td> <td>0.0146</td> </tr> <tr> <td>575 V</td> <td>0.0174</td> </tr> <tr> <td>690 V</td> <td>0.0209</td> </tr> </tbody> </table> <p>If the saturation characteristic of the motor cannot be measured this is because when the flux in the motor is changed the measured value of Ld does change sufficiently due to saturation to be measured. When half of <i>Rated Current</i> (05.007) is applied in the d axis of the motor in each direction the inductance must fall change at least <math>(K / (2 \times Full\ Scale\ Current\ Kc\ (11.061)))</math>.</p> <p>The specific reasons for each of the sub-trips are given in the table below:</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The inductance ratio or difference is too small when the drive has been started in sensorless mode.</td> </tr> <tr> <td>2</td> <td>The saturation characteristic of the motor cannot be measured when the drive has been started in sensorless mode.</td> </tr> <tr> <td>3</td> <td>The inductance ratio or difference is too small when an attempt is made to determine the location of the motor flux during a stationary auto-tune in RFC-S mode. This trip is also produced when the inductance ratio or inductance difference is too small when carrying out a phasing test on starting in RFC-S mode. If position feedback is being used the measured value for <i>Position Feedback Phase Angle</i> (03.025) may not be reliable. Also the measured values of Ld (05.024) and No-load Lq (05.072) may not correspond to the d and q axis respectively.</td> </tr> <tr> <td>4</td> <td>The direction of the flux in the motor is detected by the change of inductance with different currents. This trip is initiated if the change cannot be detected when an attempt is made to perform a stationary auto-tune when position feedback is being used, or to perform a phasing test on starting in RFC-S mode.</td> </tr> </tbody> </table> <p><b>Recommended actions for sub-trip 1:</b></p> <ul style="list-style-type: none"> <li>Ensure that <i>RFC Low Speed Mode</i> (05.064) is set to Non-salient (1), Current (2) or Current No test (3).</li> </ul> <p><b>Recommended actions for sub-trip 2:</b></p> <ul style="list-style-type: none"> <li>Ensure that <i>RFC Low Speed Mode</i> (05.064) is set to Non-salient (1), Current (2) or Current No test (3).</li> </ul> <p><b>Recommended actions for sub-trip 3:</b></p> <ul style="list-style-type: none"> <li>None. The trip acts as a warning.</li> </ul> <p><b>Recommended actions for sub-trip 4:</b></p> <ul style="list-style-type: none"> <li>Stationary autotune is not possible. Perform a minimal movement or rotating autotune.</li> <li>Phasing test on starting is not possible. Use a position feedback device with commutation signals or absolute position.</li> </ul>	Drive Rated voltage (11.033)	K	200 V	0.0073	400 V	0.0146	575 V	0.0174	690 V	0.0209	Sub-trip	Reason	1	The inductance ratio or difference is too small when the drive has been started in sensorless mode.	2	The saturation characteristic of the motor cannot be measured when the drive has been started in sensorless mode.	3	The inductance ratio or difference is too small when an attempt is made to determine the location of the motor flux during a stationary auto-tune in RFC-S mode. This trip is also produced when the inductance ratio or inductance difference is too small when carrying out a phasing test on starting in RFC-S mode. If position feedback is being used the measured value for <i>Position Feedback Phase Angle</i> (03.025) may not be reliable. Also the measured values of 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.
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<b>I/O Overload</b>	<b>Digital output overload</b>																				
26	<p>The <i>I/O Overload</i> trip indicates that the total current drawn from 24 V user supply or from the digital output has exceeded the limit. A trip is initiated if one or more of the following conditions:</p> <ul style="list-style-type: none"> <li>Maximum output current from one digital output is 100 mA.</li> <li>The combined maximum output current from outputs 1 and 2 is 100 mA</li> <li>The combined maximum output current from output 3 and +24 V output is 100 mA</li> </ul> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Check total loads on digital outputs</li> <li>Check control wiring is correct</li> <li>Check output wiring is undamaged</li> </ul>																				
<b>Keypad Mode</b>	<b>Keypad has been removed when the drive is receiving the speed reference from the keypad</b>																				
34	<p>The <i>Keypad Mode</i> trip indicates that the drive is in keypad mode [<i>Reference Selector</i> (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.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Re-install keypad and reset</li> <li>Change <i>Reference Selector</i> (01.014) to select the reference from another source</li> </ul>																				

Trip	Diagnosis																				
<b>Motor Too Hot</b>	<b>Output current overload timed out (I<sup>2</sup>t)</b>																				
20	<p>The <i>Motor Too Hot</i> trip indicates a motor thermal overload based on the <i>Rated Current</i> (Pr <b>05.007</b>) and <i>Motor Thermal Time Constant</i> (Pr <b>04.015</b>). Pr <b>04.019</b> displays the motor temperature as a percentage of the maximum value. The drive will trip on <i>Motor Too Hot</i> when Pr <b>04.019</b> gets to 100 %.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure the load is not jammed / sticking</li> <li>• Check the load on the motor has not changed</li> <li>• If seen during an auto-tune test in RFC-S mode, ensure the motor <i>Rated Current</i> in Pr <b>05.007</b> is ≤ Heavy duty current rating of the drive</li> <li>• Tune the <i>Rated Speed</i> (Pr <b>05.008</b>) (RFC-A mode only)</li> <li>• Check feedback signal for noise</li> <li>• Ensure the motor rated current is not zero</li> <li>• This trip can be disabled and current limiting activated on the motor overload by setting thermal protection mode Pr <b>04.016</b> to 1.</li> </ul>																				
<b>Name Plate</b>	<b>Electronic nameplate transfer has failed</b>																				
176	<p>The <i>Name Plate</i> trip is initiated if an electronic name plate transfer between the drive and the motor has failed. The exact reason for the trip can be identified from the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Not enough memory space to complete the transfer</td> </tr> <tr> <td>2</td> <td>Communication with encoder failed</td> </tr> <tr> <td>3</td> <td>The transfer has failed</td> </tr> <tr> <td>4</td> <td>The checksum of the stored object has failed</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure that the device encoder memory has at least 128 bytes to store the nameplate data</li> <li>• When writing the motor object (Pr <b>mm.000</b> = 11000), ensure that the device encoder memory has at least 256 bytes to store all the nameplate data.</li> <li>• When transferring between option module and encoder, ensure that the option slot has a feedback option module installed.</li> <li>• Check if the encoder has been initialized in <i>Position Feedback Initialized</i> (03.076).</li> <li>• Verify the encoder wiring.</li> </ul>	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										
Sub-trip	Reason																				
1	Not enough memory space to complete the transfer																				
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<b>Oht Brake</b>	<b>Braking IGBT over-temperature</b>																				
101	<p>The <i>Oht Brake</i> over-temperature trip indicates that braking IGBT over-temperature has been detected based on software thermal model.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check braking resistor value is greater than or equal to the minimum resistance value</li> </ul>																				
<b>Oht Control</b>	<b>Control stage over temperature</b>																				
23	<p>This <i>Oht Control</i> trip indicates that a control stage over-temperature has been detected. From the sub-trip 'xyzz', the Thermistor location is identified by 'zz'.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>01</td> <td>Control board thermistor 1 over temperature</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>02</td> <td>Control board thermistor 2 over temperature</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>03</td> <td>I/O board thermistor over temperature</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check enclosure / drive fans are still functioning correctly</li> <li>• Check enclosure ventilation paths</li> <li>• Check enclosure door filters</li> <li>• Increase ventilation</li> <li>• Reduce the drive switching frequency</li> <li>• Check ambient temperature</li> </ul>	Source	xx	y	zz	Description	Control system	00	0	01	Control board thermistor 1 over temperature	Control system	00	0	02	Control board thermistor 2 over temperature	Control system	00	0	03	I/O board thermistor over temperature
Source	xx	y	zz	Description																	
Control system	00	0	01	Control board thermistor 1 over temperature																	
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Control system	00	0	03	I/O board thermistor over temperature																	

Trip	Diagnosis																				
<b>Oht dc bus</b>	<b>DC bus over temperature</b>																				
27	<p>The <i>Oht dc bus</i> trip indicates a DC bus component over temperature based on a software thermal model. The drive includes a thermal protection system to protect the DC bus components within the drive. This includes the effects of the output current and DC bus ripple. The estimated temperature is displayed as a percentage of the trip level in Pr <b>07.035</b>. If this parameter reaches 100 % then an <i>Oht dc bus</i> 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.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>2</td> <td>00</td> <td>DC bus thermal model gives trip with sub-trip 0</td> </tr> </tbody> </table> <p>It is also possible in a multi-power module system for DC bus over-temperature to be detected from within the power stage. From this source the estimated temperature as a percentage of trip is not available and the trip is indicated as follows:</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>01</td> <td>0</td> <td>00</td> <td>Power stage gives trip with sub-trip 0</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the AC supply voltage balance and levels</li> <li>• Check DC bus ripple level</li> <li>• Reduce duty cycle</li> <li>• Reduce motor load</li> <li>• Check the output current stability. If unstable; <ul style="list-style-type: none"> <li>Check the motor map settings with motor nameplate (Pr <b>05.006</b>, Pr <b>05.007</b>, Pr <b>05.008</b>, Pr <b>05.009</b>, Pr <b>05.010</b>, Pr <b>05.011</b>) – (All Modes)</li> <li>Disable slip compensation (Pr <b>05.027</b> = 0) – (Open loop)</li> <li>Disable dynamic V to F operation (Pr <b>05.013</b> = 0) - (Open loop)</li> <li>Select fixed boost (Pr <b>05.014</b> = Fixed) – (Open loop)</li> <li>Select high stability space vector modulation (Pr <b>05.020</b> = 1) – (Open loop)</li> <li>Disconnect the load and complete a rotating auto-tune (Pr <b>05.012</b>) – (RFC-A, RFC-S)</li> <li>Auto-tune the rated speed value (Pr <b>05.016</b> = 1) – (RFC-A, RFC-S)</li> <li>Reduce speed loop gains (Pr <b>03.010</b>, Pr <b>03.011</b>, Pr <b>03.012</b>) – (RFC-A, RFC-S)</li> <li>Add a speed feedback filter value (Pr <b>03.042</b>) – (RFC-A, RFC-S)</li> <li>Add a current demand filter (Pr <b>04.012</b>) – (RFC-A, RFC-S)</li> <li>Check encoder signals for noise with an oscilloscope (RFC-A, RFC-S)</li> <li>Check encoder mechanical coupling - (RFC-A, RFC-S)</li> </ul> </li> </ul>	Source	xx	y	zz	Description	Control system	00	2	00	DC bus thermal model gives trip with sub-trip 0	Source	xx	y	zz	Description	Control system	01	0	00	Power stage gives trip with sub-trip 0
	Source	xx	y	zz	Description																
	Control system	00	2	00	DC bus thermal model gives trip with sub-trip 0																
	Source	xx	y	zz	Description																
Control system	01	0	00	Power stage gives trip with sub-trip 0																	
<b>Oht Inverter</b>	<b>Inverter over temperature based on thermal model</b>																				
21	<p>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:</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>1</td> <td>00</td> <td>Inverter thermal model</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>3</td> <td>00</td> <td>Braking IGBT thermal model</td> </tr> </tbody> </table> <p><b>Recommended actions with sub-trip 100:</b></p> <ul style="list-style-type: none"> <li>• Reduce the selected drive switching frequency</li> <li>• Ensure <i>Auto-switching Frequency Change Disable</i> (05.035) is set to Off</li> <li>• Reduce duty cycle</li> <li>• Increase acceleration / deceleration rates</li> <li>• Reduce motor load</li> <li>• Check DC bus ripple</li> <li>• Ensure all three input phases are present and balanced</li> </ul> <p><b>Recommended actions with sub-trip 300:</b></p> <ul style="list-style-type: none"> <li>• Reduce the braking load</li> </ul>	Source	xx	y	zz	Description	Control system	00	1	00	Inverter thermal model	Control system	00	3	00	Braking IGBT thermal model					
	Source	xx	y	zz	Description																
	Control system	00	1	00	Inverter thermal model																
	Control system	00	3	00	Braking IGBT thermal model																

Trip	Diagnosis																																																		
<b>Oht Power</b>	<b>Power stage over temperature</b>																																																		
22	<p>This trip indicates that a power stage over-temperature has been detected. From the sub-trip 'xxyz', 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:</p> <p><b>Single module type drive:</b></p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Power system</td> <td>01</td> <td>0</td> <td>zz</td> <td>Thermistor location defined by zz in the power board</td> </tr> <tr> <td>Power system</td> <td>01</td> <td>Rectifier number</td> <td>zz</td> <td>Thermistor location defined by zz in the rectifier</td> </tr> </tbody> </table> <p><b>Multi-module type system:</b></p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>01</td> <td>U phase power device</td> </tr> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>02</td> <td>V phase power device</td> </tr> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>03</td> <td>W phase power device</td> </tr> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>04</td> <td>Rectifier</td> </tr> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>05</td> <td>General power system</td> </tr> <tr> <td>Power system</td> <td>power module number</td> <td>0</td> <td>00</td> <td>Braking IGBT</td> </tr> </tbody> </table> <p>Note that the power module that has caused the trip cannot be identified except for the braking IGBT temperature measurement</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check enclosure / drive fans are still functioning correctly</li> <li>• Force the heatsink fans to run at maximum speed</li> <li>• Check enclosure ventilation paths</li> <li>• Check enclosure door filters</li> <li>• Increase ventilation</li> <li>• Reduce the drive switching frequency</li> <li>• Reduce duty cycle</li> <li>• Increase acceleration / deceleration rates</li> <li>• Use S ramp (Pr <b>02.006</b>)</li> <li>• Reduce motor load</li> <li>• Check the derating tables and confirm the drive is correctly sized for the application.</li> <li>• Use a drive with larger current / power rating</li> </ul>	Source	xx	y	zz	Description	Power system	01	0	zz	Thermistor location defined by zz in the power board	Power system	01	Rectifier number	zz	Thermistor location defined by zz in the rectifier	Source	xx	y	zz	Description	Power system	power module number	0	01	U phase power device	Power system	power module number	0	02	V phase power device	Power system	power module number	0	03	W phase power device	Power system	power module number	0	04	Rectifier	Power system	power module number	0	05	General power system	Power system	power module number	0	00	Braking IGBT
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	Power system	power module number	0	05	General power system																																														
Power system	power module number	0	00	Braking IGBT																																															
<b>OI ac</b>	<b>Instantaneous output over current detected</b>																																																		
3	<p>The instantaneous drive output current has exceeded VM_DRIVE_CURRENT[MAX]. This trip cannot be reset until 10 s after the trip was initiated.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td rowspan="2">00</td> <td rowspan="2">Instantaneous over-current trip when the measured AC current exceeds VM_DRIVE_CURRENT[MAX].</td> </tr> <tr> <td>Power system</td> <td>Power module number</td> <td>0</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Acceleration/deceleration rate is too short</li> <li>• If seen during auto-tune reduce the voltage boost</li> <li>• Check for short circuit on the output cabling</li> <li>• Check integrity of the motor insulation using an insulation tester</li> <li>• Check feedback device wiring</li> <li>• Check feedback device mechanical coupling</li> <li>• Check feedback signals are free from noise</li> <li>• Is motor cable length within limits for the frame size</li> <li>• Reduce the values in the speed loop gain parameters - (Pr <b>03.010, 03.011, 03.012</b>) or (Pr <b>03.013, 03.014, 03.015</b>)</li> <li>• Has the phase angle autotune been completed? (RFC-S mode only)</li> <li>• Reduce the values in current loop gain parameters (RFC-A, RFC-S modes only)</li> </ul>	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																																					
	Source	xx	y	zz	Description																																														
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Power system	Power module number	0																																																	

Trip	Diagnosis												
<b>OI Brake</b>	<b>Braking IGBT over current detected: short circuit protection for the braking IGBT activated</b>												
4	The <i>OI Brake</i> trip indicates that over current has been detected in braking IGBT or braking IGBT protection has been activated. This trip cannot be reset until 10 s after the trip was initiated.												
	<table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Power system</td> <td>Power module number</td> <td>0</td> <td>00</td> <td>Braking IGBT instantaneous over-current trip</td> </tr> </tbody> </table>	Source	xx	y	zz	Description	Power system	Power module number	0	00	Braking IGBT instantaneous over-current trip		
	Source	xx	y	zz	Description								
Power system	Power module number	0	00	Braking IGBT instantaneous over-current trip									
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check brake resistor wiring</li> <li>• Check braking resistor value is greater than or equal to the minimum resistance value</li> <li>• Check braking resistor insulation</li> </ul>													
<b>OI dc</b>	<b>Power module over current detected from IGBT on state voltage monitoring</b>												
109	The <i>OI dc</i> trip indicates that the short circuit protection for the drive output stage has been activated. The table below shows where the trip has been detected. This trip cannot be reset until 10 s after the trip was initiated.												
	<table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>00</td> </tr> <tr> <td>Power system</td> <td>Power module number</td> <td>0</td> <td>00</td> </tr> </tbody> </table>	Source	xx	y	zz	Control system	00	0	00	Power system	Power module number	0	00
	Source	xx	y	zz									
Control system	00	0	00										
Power system	Power module number	0	00										
<p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Disconnect the motor cable at the drive end and check the motor and cable insulation with an insulation tester</li> <li>• Replace the drive</li> </ul>													
<b>OI Snubber</b>	<b>Snubber over-current detected</b>												
92	The <i>OI Snubber</i> trip indicates that an over-current condition has been detected in the rectifier snubber circuit. The reason for the trip can be identified by the sub-trip number.												
	<table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Power system</td> <td>01</td> <td>Rectifier number*</td> <td>00</td> <td>Rectifier snubber over-current trip detected.</td> </tr> </tbody> </table>	Source	xx	y	zz	Description	Power system	01	Rectifier number*	00	Rectifier snubber over-current trip detected.		
	Source	xx	y	zz	Description								
Power system	01	Rectifier number*	00	Rectifier snubber over-current trip detected.									
<p>* For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure the internal EMC Filter is installed</li> <li>• Ensure the motor cable length does not exceed the maximum for selected switching frequency</li> <li>• Check for supply voltage imbalance</li> <li>• Check for supply disturbance such as notching from a DC drive</li> <li>• Check the motor and motor cable insulation with an insulation tester</li> <li>• Install an output line reactor or sinusoidal filter</li> </ul>													
<b>Option Disable</b>	<b>Option module does not acknowledge during drive mode changeover</b>												
215	The <i>Option Disable</i> 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.												
	<p><b>Recommended trip:</b></p> <ul style="list-style-type: none"> <li>• Reset the trip</li> <li>• If the trip persists, replace the option module</li> </ul>												
<b>Out Phase Loss</b>	<b>Output phase loss detected</b>												
98	The <i>Out Phase Loss</i> trip indicates that phase loss has been detected at the drive output.												
	<table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>U phase detected as disconnected when drive enabled to run.</td> </tr> <tr> <td>2</td> <td>V phase detected as disconnected when drive enabled to run.</td> </tr> <tr> <td>3</td> <td>W phase detected as disconnected when drive enabled to run.</td> </tr> <tr> <td>4</td> <td>Output phase loss detected when the drive is running.</td> </tr> </tbody> </table>	Sub-trip	Reason	1	U phase detected as disconnected when drive enabled to run.	2	V phase detected as disconnected when drive enabled to run.	3	W phase detected as disconnected when drive enabled to run.	4	Output phase loss detected when the drive is running.		
	Sub-trip	Reason											
1	U phase detected as disconnected when drive enabled to run.												
2	V phase detected as disconnected when drive enabled to run.												
3	W phase detected as disconnected when drive enabled to run.												
4	Output phase loss detected when the drive is running.												
<p><b>NOTE</b></p> <p>If Pr <b>05.042</b> = 1 the physical output phases are reversed, and so sub-trip 3 refers to physical output phase V and sub-trip 2 refers to physical output phase W.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check motor and drive connections</li> <li>• To disable the trip set <i>Output Phase Loss Detection Enable</i> (06.059) = 0</li> </ul>													

Trip	Diagnosis																											
<b>Over Speed</b>	<b>Motor speed has exceeded the over speed threshold</b>																											
7	<p>In open loop mode, if the <i>Output Frequency</i> (05.001) exceeds the threshold set in <i>Over Speed Threshold</i> (03.008) in either direction an <i>Over Speed</i> trip is produced. In RFC-A and RFC-S mode, if the Speed Feedback (03.002) exceeds the <i>Over Speed Threshold</i> in Pr <b>03.008</b> in either direction an <i>Over Speed</i> trip is produced. If Pr <b>03.008</b> is set to 0.0 the threshold is then equal to 1.2 x the value set in Pr <b>01.006</b>.</p> <p>In RFC-A and RFC-S mode, if an SSI encoder is being used and Pr <b>03.047</b> is set to 0 an <i>Over Speed</i> trip will be produced when the encoder passes through the boundary between its maximum position and zero.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the motor is not being driven by another part of the system</li> <li>• Reduce the <i>Speed Controller Proportional Gain</i> (03.010) to reduce the speed overshoot (RFC-A, RFC-S modes only)</li> <li>• If an SSI encoder is being used set Pr <b>03.047</b> to 1</li> </ul> <p>The above description relates to a standard Over Speed trip, however in RFC-S mode it is possible to produce an <i>Over Speed.1</i> trip. This is caused if the speed is allowed to exceed the safe level in RFC-S mode with flux weakening when <i>Enable High Speed Mode</i> (05.022) is set to -1.</p>																											
<b>Over Volts</b>	<b>DC bus voltage has exceeded the peak level or maximum continuous level for 15 seconds</b>																											
2	<p>The <i>Over Volts</i> trip indicates that the DC bus voltage has exceeded the VM_DC_VOLTAGE[MAX] or VM_DC_VOLTAGE_SET[MAX] for 15 s. The trip threshold varies depending on voltage rating of the drive as shown below.</p> <table border="1"> <thead> <tr> <th>Voltage rating</th> <th>VM_DC_VOLTAGE[MAX]</th> <th>VM_DC_VOLTAGE_SET[MAX]</th> </tr> </thead> <tbody> <tr> <td>200</td> <td>415</td> <td>410</td> </tr> <tr> <td>400</td> <td>830</td> <td>815</td> </tr> <tr> <td>575</td> <td>990</td> <td>970</td> </tr> <tr> <td>690</td> <td>1190</td> <td>1175</td> </tr> </tbody> </table> <p><b>Sub-trip Identification</b></p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Increase deceleration ramp (Pr <b>00.004</b>)</li> <li>• Decrease the braking resistor value (staying above the minimum value)</li> <li>• Check nominal AC supply level</li> <li>• Check for supply disturbances which could cause the DC bus to rise</li> <li>• Check motor insulation using an insulation tester</li> </ul>	Voltage rating	VM_DC_VOLTAGE[MAX]	VM_DC_VOLTAGE_SET[MAX]	200	415	410	400	830	815	575	990	970	690	1190	1175	Source	xx	y	zz	Control system	00	0	01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].	Control system	00	0	02: Time delayed trip indicating that the DC bus voltage is above VM_DC_VOLTAGE_SET[MAX].
Voltage rating	VM_DC_VOLTAGE[MAX]	VM_DC_VOLTAGE_SET[MAX]																										
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Control system	00	0	01: Instantaneous trip when the DC bus voltage exceeds VM_DC_VOLTAGE[MAX].																									
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<b>Phase Loss</b>	<b>Supply phase loss</b>																											
32	<p>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 <i>Action On Trip Detection</i> (10.037) is set to one. When phase loss is detected by monitoring the ripple in the DC bus voltage the xx part of the sub-trip is zero.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>00: Phase loss detected from DC bus ripple</td> </tr> <tr> <td>Power system (1)</td> <td>Power module number</td> <td>Rectifier number (2)</td> <td>00: Phase loss detected directly from the supply</td> </tr> </tbody> </table> <p>(1) Input phase loss detection can be disabled when the drive required to operate from the DC supply or from a single phase supply in <i>Input Phase Loss Detection Mode</i> (06.047).</p> <p>(2) For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.</p> <p>This trip does not occur in regen mode.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the AC supply voltage balance and level at full load</li> <li>• Check the DC bus ripple level with an isolated oscilloscope</li> <li>• Check the output current stability</li> <li>• Check for mechanical resonance with the load</li> <li>• Reduce the duty cycle</li> <li>• Reduce the motor load</li> <li>• Disable the phase loss detection, set Pr <b>06.047</b> to 2.</li> </ul>	Source	xx	y	zz	Control system	00	0	00: Phase loss detected from DC bus ripple	Power system (1)	Power module number	Rectifier number (2)	00: Phase loss detected directly from the supply															
Source	xx	y	zz																									
Control system	00	0	00: Phase loss detected from DC bus ripple																									
Power system (1)	Power module number	Rectifier number (2)	00: Phase loss detected directly from the supply																									

Trip	Diagnosis																																																		
<b>Phasing Error</b>	<b>RFC-S mode phasing failure due to incorrect phase angle</b>																																																		
198	<p>The <i>Phasing Error</i> trip indicates that the phase offset angle in Pr <b>03.025</b> (or Pr <b>21.020</b> if the second motor map is being used) is incorrect if position feedback is being used and the drive is unable to control the motor correctly.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the encoder wiring</li> <li>• Check the encoder signals for noise with an oscilloscope</li> <li>• Check the encoder mechanical coupling</li> <li>• Perform an auto-tune to measure the encoder phase angle or manually enter the correct phase angle into Pr <b>03.025</b></li> <li>• Spurious <i>Phasing Error</i> trips can sometimes be seen in very dynamic applications. This trip can be disabled by setting the over-speed threshold in Pr <b>03.008</b> to a value greater than zero.</li> </ul> <p>If sensorless control is being used this indicates that significant instability has occurred and the motor has accelerated without control.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Ensure that the motor parameters are set-up correctly.</li> <li>• Reduce the speed controller gains.</li> </ul>																																																		
<b>Power Comms</b>	<b>Communication has been lost / errors detected between power, control and rectifier modules</b>																																																		
90	<p>A <i>Power Comms</i> trip indicates a communications problem within the power system of the drive. The reason for the trip can be identified by the sub-trip number.</p> <table border="1"> <thead> <tr> <th>Type of drive</th> <th>xx</th> <th>y</th> <th>zz</th> </tr> </thead> <tbody> <tr> <td>Single power module system</td> <td>01</td> <td>Rectifier number*</td> <td>00: Excessive communications errors detected by the rectifier module.</td> </tr> </tbody> </table> <p>* For a parallel power-module system the rectifier number will be one as it is not possible to determine which rectifier has detected the fault.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>	Type of drive	xx	y	zz	Single power module system	01	Rectifier number*	00: Excessive communications errors detected by the rectifier module.																																										
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220	<p>The <i>Power Data</i> trip indicates that there is an error in the configuration data stored in the power system.</p> <table border="1"> <thead> <tr> <th>Source</th> <th>xx</th> <th>y</th> <th>zz</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>02</td> <td>There is no data table to be uploaded to the control board</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>03</td> <td>The power system data table is bigger than the space available in the control pod to store it.</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>04</td> <td>The size of the table given in the table is incorrect.</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>05</td> <td>Table CRC error.</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>06</td> <td>The version number of the generator software that produced the table is too low. i.e. a table from a newer generator is required that includes features that have been added to the table that may not be present.</td> </tr> <tr> <td>Control system</td> <td>00</td> <td>0</td> <td>07</td> <td>The power board data table does not match the power board hardware identifier.</td> </tr> <tr> <td>Power system</td> <td>01</td> <td>0</td> <td>00</td> <td>The power data table used internally by the power module has an error. (For a multi-power module drive this indicates any error with the code tables in the power system).</td> </tr> <tr> <td>Power system</td> <td>01</td> <td>0</td> <td>01</td> <td>The power data table that should be uploaded to the control system on power up has an error.</td> </tr> <tr> <td>Power system</td> <td>01</td> <td>0</td> <td>02</td> <td>The power data table used internally by the power module does not match the hardware identification of the power module.</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Hardware fault – Contact the supplier of the drive</li> </ul>	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.
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<b>Power Down Save</b>	<b>Power down save error</b>																																																		
37	<p>The <i>Power Down Save</i> trip indicates that an error has been detected in the power down save parameters saved in non-volatile memory.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Perform a 1001 save in Pr <b>mm.000</b> to ensure that the trip doesn't occur the next time the drive is powered up.</li> </ul>																																																		

Trip	Diagnosis				
<b>PSU</b>	<b>Internal power supply fault</b>				
5	The <i>PSU</i> trip indicates that one or more internal power supply rails are outside limits or overloaded.				
	<b>Source</b>	<b>xx</b>	<b>y</b>	<b>zz</b>	<b>Description</b>
	Control system	00	0	00	Internal power supply overload
	Power system	Power module number	Rectifier number*		Rectifier internal power supply overload
* For a parallel power-module system the rectifier number will be zero as it is not possible to determine which rectifier has detected the fault.					
<b>Recommended actions:</b>					
<ul style="list-style-type: none"> <li>Remove any option modules and perform a reset</li> <li>Remove encoder connection and perform a reset</li> <li>Hardware fault within the drive – return the drive to the supplier</li> </ul>					
<b>PSU 24V</b>	<b>24V internal power supply overload</b>				
9	The total user load of the drive and option modules has exceeded the internal 24 V power supply limit. The user load consists of the drive digital outputs and main encoder supply.				
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Reduce the load and reset</li> <li>Provide an external 24 V power supply on control terminal 2</li> <li>Remove all option modules</li> </ul>				
<b>Reserved</b>	<b>Reserved trips</b>				
01 95 104 – 108 170 – 173 228 - 246	These trip numbers are reserved trip numbers for future use. These trips should not be used by the user application programs.				
	<b>Trip Number</b>	<b>Description</b>			
	01	Reserved resettable trip			
	95	Reserved resettable trip			
	104 - 108	Reserved resettable trip			
	170 - 173	Reserved resettable trip			
228 - 246	Reserved non-resettable trip				
<b>Resistance</b>	<b>Measured resistance has exceeded the parameter range</b>				
33	This trip indicates that either the value being used for motor stator resistance is too high or that an attempt to do a test involving measuring motor stator resistance has failed. The maximum for the stator resistance parameters is generally higher than the maximum value that can be used in the control algorithms. If the value exceeds $(V_{FS} / v2) / Full\ Scale\ Current\ Kc$ (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.				
	<b>Sub-trip</b>	<b>Reason</b>			
	1	Measured stator resistance exceeded the allowed range			
	2	It was not possible to measure the inverter characteristic			
3	The stator resistance associated with the presently selected motor map exceeds the allowed range				
<b>Recommended actions:</b>					
<ul style="list-style-type: none"> <li>Check that the value that has been entered in the stator resistance does not exceed the allowed range (for the presently selected motor map)</li> <li>Check the motor cable / connections</li> <li>Check the integrity of the motor stator winding using a insulation tester</li> <li>Check the motor phase to phase resistance at the drive terminals</li> <li>Check the motor phase to phase resistance at the motor terminals</li> <li>Ensure the stator resistance of the motor falls within the range of the drive model</li> <li>Select fixed boost mode (Pr <b>05.014</b> = Fixed) and verify the output current waveforms with an oscilloscope</li> <li>Replace the motor</li> </ul>					

Trip	Diagnosis																						
<b>Slot App Menu</b>	<b>Application menu Customization conflict error</b>																						
<b>216</b>	<p>The Slot App Menu trip indicates that more than one option slot has requested to customize the application menus 18, 19 and 20. The sub-trip number indicates which option slot has been allowed to customize the menus.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure that only one of the Application modules is configured to customize the application menus 18, 19 and 20</li> </ul>																						
<b>SlotX Different</b>	<b>Option module in option slot X has changed</b>																						
<b>204 209 214</b>	<p>The <i>SlotX Different</i> trip indicates that the option module in option slot X on the drive is a different type to that installed when parameters were last saved on the drive. The 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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>No module was installed previously</td> </tr> <tr> <td>2</td> <td>A module with the same identifier is installed, but the set-up menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td> </tr> <tr> <td>3</td> <td>A module with the same identifier is installed, but the applications menu for this option slot has been changed, and so default parameters have been loaded for this menu.</td> </tr> <tr> <td>4</td> <td>A module with the same identifier is installed, but the set-up and applications menu for this option slot have been changed, and so default parameters have been loaded for these menus.</td> </tr> <tr> <td>&gt;99</td> <td>Shows the identifier of the module previously installed.</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Turn off the power, ensure the correct option modules are installed in the correct option slots and re-apply the power.</li> <li>Confirm that the currently installed option module is correct, ensure option module parameters are set correctly and perform a user save in Pr <b>mm.000</b>.</li> </ul>	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.										
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<b>SlotX Error</b>	<b>Option module in option slot X has detected a fault</b>																						
<b>202 207 212</b>	<p>The <i>SlotX Error</i> trip indicates that the option module in option slot X on the drive has detected an error. The reason for the error can be identified by the sub-trip number.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>See the relevant <i>Option Module User Guide</i> for details of the trip</li> </ul>																						
<b>SlotX HF</b>	<b>Option module X hardware fault</b>																						
<b>200 205 210</b>	<p>The <i>SlotX HF</i> 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.</p> <table border="1"> <thead> <tr> <th>Sub-trip</th> <th>Reason</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>The module category cannot be identified</td> </tr> <tr> <td>2</td> <td>All the required customized menu table information has not been supplied or the tables supplied are corrupt</td> </tr> <tr> <td>3</td> <td>There is insufficient memory available to allocate the comms buffers for this module</td> </tr> <tr> <td>4</td> <td>The module has not indicated that it is running correctly during drive power-up</td> </tr> <tr> <td>5</td> <td>Module has been removed after power-up or it has stopped working</td> </tr> <tr> <td>6</td> <td>The module has not indicated that it has stopped accessing drive parameters during a drive mode change</td> </tr> <tr> <td>7</td> <td>The module has failed to acknowledge that a request has been made to reset the drive processor</td> </tr> <tr> <td>8</td> <td>The drive failed to correctly read the menu table from the module during drive power up</td> </tr> <tr> <td>9</td> <td>The drive failed to upload menu tables from the module and timed out (5 s)</td> </tr> <tr> <td>10</td> <td>Menu table CRC invalid</td> </tr> </tbody> </table> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the option module is installed correctly</li> <li>Replace the option module</li> <li>Replace the drive</li> </ul>	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
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<b>SlotX Not Fitted</b>	<b>Option module in option slot X has been removed</b>																						
<b>203 208 213</b>	<p>The <i>SlotX Not Fitted</i> trip indicates that the option module in option slot X on the drive has been removed since the last power up.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>Ensure the option module is installed correctly.</li> <li>Re-install the option module.</li> <li>To confirm that the removed option module is no longer required perform a save function in Pr <b>mm.000</b>.</li> </ul>																						

Trip	Diagnosis																																																								
<b>SlotX Watchdog</b>	<b>Option module watchdog function service error</b>																																																								
201 206 211	The <i>SlotX Watchdog</i> trip indicates that the option module installed in Slot X has started the option watchdog function and then failed to service the watchdog correctly. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Replace the option module</li> </ul>																																																								
<b>Soft Start</b>	<b>Soft start relay failed to close, soft start monitor failed</b>																																																								
226	The <i>Soft Start</i> trip indicates that the soft start relay in the drive failed to close or the soft start monitoring circuit has failed. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>																																																								
<b>Stored HF</b>	<b>Hardware trip has occurred during last power down</b>																																																								
221	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. <b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Enter 1299 in Pr <b>mm.000</b> and press reset to clear the trip</li> </ul>																																																								
<b>Sub-array RAM</b>	<b>RAM allocation error</b>																																																								
227	The Sub-array RAM indicates that an option module, derivative image or user program image has requested more parameter RAM than is allowed. The RAM allocation is checked in order of resulting sub-trip numbers, and so the failure with the highest sub-trip number is given. The sub-trip is calculated as (parameter size) + (parameter type) + sub-array number. <table border="1" style="margin: 10px 0;"> <thead> <tr> <th>Parameter size</th> <th>Value</th> </tr> </thead> <tbody> <tr><td>1 bit</td><td>1000</td></tr> <tr><td>8 bit</td><td>2000</td></tr> <tr><td>16 bit</td><td>3000</td></tr> <tr><td>32 bit</td><td>4000</td></tr> <tr><td>64 bit</td><td>5000</td></tr> </tbody> </table> <table border="1" style="margin: 10px 0;"> <thead> <tr> <th>Parameter type</th> <th>Value</th> </tr> </thead> <tbody> <tr><td>Volatile</td><td>0</td></tr> <tr><td>User save</td><td>100</td></tr> <tr><td>Power-down save</td><td>200</td></tr> </tbody> </table> <table border="1" style="margin: 10px 0;"> <thead> <tr> <th>Sub-array</th> <th>Menus</th> <th>Value</th> </tr> </thead> <tbody> <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> </tbody> </table>	Parameter size	Value	1 bit	1000	8 bit	2000	16 bit	3000	32 bit	4000	64 bit	5000	Parameter type	Value	Volatile	0	User save	100	Power-down save	200	Sub-array	Menus	Value	Applications menus	18-20	1	Derivative image	29	2	User program image	30	3	Option slot 1 set-up	15	4	Option slot 1 applications	25	5	Option slot 2 set-up	16	6	Option slot 2 applications	26	7	Option slot 3 set-up	17	8	Option slot 3 applications	27	9	Option slot 4 set-up	24	10	Option slot 4 applications	28	11
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<b>Temp Feedback</b>	<b>Internal thermistor has failed</b>																																	
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Power system	01	Rectifier number*	Always zero																															
* 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.																																		
<b>Recommended actions:</b>																																		
<ul style="list-style-type: none"> <li>Hardware fault – Contact the supplier of the drive</li> </ul>																																		
<b>Th Brake Res</b>	<b>Brake resistor over temperature</b>																																	
10	The <i>Th Brake Res</i> is initiated, If hardware based braking resistor thermal monitoring is connected and the resistor overheats. If the braking resistor is not used then this trip must be disabled with bit 3 of <i>Action On Trip Detection</i> (10.037) to prevent this trip.																																	
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Check brake resistor wiring</li> <li>Check braking resistor value is greater than or equal to the minimum resistance value</li> <li>Check braking resistor insulation</li> </ul>																																	
<b>Th Short Circuit</b>	<b>Motor thermistor short circuit</b>																																	
25	The <i>Th Short Circuit</i> 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.																																	
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24	The <i>Thermistor</i> 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.																																	
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<b>Undefined</b>	<b>Drive has tripped and the cause of the trip is Undefined</b>																																	
110	The <i>Undefined</i> 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.																																	
	<b>Recommended actions:</b> <ul style="list-style-type: none"> <li>Hardware fault – return the drive to the supplier</li> </ul>																																	

Trip	Diagnosis																																																																																																	
<b>User Program</b>	<b>On board user program error</b>																																																																																																	
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Trip	Diagnosis
<b>User Prog Trip</b>	<b>Trip generated by an onboard user program</b>
<b>96</b>	<p>This trip can be initiated from within an onboard user program using a function call which defines the sub-trip number.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the user program</li> </ul>
<b>User Save</b>	<b>User Save error / not completed</b>
<b>36</b>	<p>The <i>User Save</i> trip indicates that an error has been detected in the user save parameters saved in non-volatile memory. For example, following a user save command, if the power to the drive was removed when the user parameters were being saved.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Perform a user save in Pr <b>mm.000</b> to ensure that the trip doesn't occur the next time the drive is powered up.</li> <li>• Ensure that the drive has enough time to complete the save before removing the power to the drive.</li> </ul>
<b>User Trip</b>	<b>User generated trip</b>
<b>40 -89 112 -159</b>	<p>These trips are not generated by the drive and are to be used by the user to trip the drive through an application program.</p> <p><b>Recommended actions:</b></p> <ul style="list-style-type: none"> <li>• Check the user program</li> </ul>
<b>Watchdog</b>	<b>Control word watchdog has timed out</b>
<b>30</b>	<p>The <i>Watchdog</i> trip indicates that the control word has been enabled and has timed out.</p> <p><b>Recommended actions:</b></p> <p>Once Pr <b>06.042</b> 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.</p>

**Table 13-5 Serial communications look up table**

No	Trip	No	Trip	No	Trip
1	Reserved 001	92	OI Snubber	193	Encoder 5
2	Over Volts	95	Reserved 95	194	Encoder 6
3	OI ac	96	User Prog Trip	195	Encoder 7
4	OI Brake	97	Data Changing	196	Encoder 8
5	PSU	98	Out Phase Loss	198	Phasing Error
6	External Trip	99	CAM	199	Destination
7	Over Speed	100	Reset	200	Slot1 HF
8	Inductance	101	OHT Brake	201	Slot1 Watchdog
9	PSU 24V	102	Reserved 102	202	Slot1 Error
10	Th Brake Res	104 - 108	Reserved 104 - 108	203	Slot1 Not Fitted
11	Autotune 1	109	OI dc	204	Slot1 Different
12	Autotune 2	110	Undefined	205	Slot2 HF
13	Autotune 3	111	Configuration	206	Slot2 Watchdog
14	Autotune 4	112 - 159	User Trip 112 - 159	207	Slot2 Error
15	Autotune 5	161	User Trip 161	208	Slot2 Not Fitted
16	Autotune 6	162	Encoder 12	209	Slot2 Different
17	Autotune 7	163	Encoder 13	210	Slot3 HF
18	Autotune Stopped	164 - 168	Reserved 164 - 168	211	Slot3 Watchdog
19	Brake R Too Hot	170 - 173	Reserved 170 - 173	212	Slot3 Error
20	Motor Too Hot	174	Card Slot	213	Slot3 Not Fitted
21	OHT Inverter	175	Card Product	214	Slot3 Different
22	OHT Power	176	Name Plate	215	Option Disable
23	OHT Control	177	Card Boot	216	Slot App Menu
24	Thermistor	178	Card Busy	217	App Menu Changed
25	Th Short Circuit	179	Card Data Exists	218	Temp Feedback
26	I/O Overload	180	Card Option	220	Power Data
27	OHT dc bus	181	Card Read Only	221	Stored HF
28	An Input Loss 1	182	Card Error	222	Reserved 222
30	Watchdog	183	Card No Data	224	Drive Size
31	EEPROM Fail	184	Card Full	225	Current Offset
32	Phase Loss	185	Card Access	224	Drive Size
33	Resistance	186	Card Rating	225	Current Offset
34	Keypad Mode	187	Card Drive Mode	226	Soft Start
35	Control Word	188	Card Compare	227	Sub-array RAM
36	User Save	189	Encoder 1	228 - 246	Reserved 228 - 246
37	Power Down Save	190	Encoder 2	247	Derivative ID
40 - 89	User Trip 40 - 89	191	Encoder 3	248	Derivative Image
90	Power Comms	192	Encoder 4	249	User Program
				255	Reset Logs

The trips can be grouped into the following categories. It should be noted that a trip can only occur when the drive is not tripped or is already tripped but with a trip with a lower priority number.

**Table 13-6 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 <i>Parameter (mm.000)</i> and a reset is initiated.
2	Non-resettable trips	Trip numbers 218 to 247, {Slot1 HF}, {Slot2 HF}, {Slot3 HF} or {Slot4 HF}	These trips cannot be reset.
3	Volatile memory failure	{EEPROM Fail}	This can only be reset if Parameter <b>mm.000</b> is set to 1233 or 1244, or if <i>Load Defaults</i> (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 <i>Action On Trip Detection</i> (10.037)). The drive will always attempt to stop the motor before tripping if an {Oht dc bus} occurs.
5	Standard trips	All other trips	

### 13.5 Internal / Hardware trips

Trips {HF01} to {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.

## 13.6 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 13-7 Alarm indications**

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

## 13.7 Status indications

**Table 13-8 Status indications**

Upper row string	Description	Drive output stage
<b>Inhibit</b>	The drive is inhibited and cannot be run. The Safe Torque Off signal is not applied to Safe Torque Off terminals or Pr <b>06.015</b> is set to 0.	Disabled
<b>Ready</b>	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
<b>Stop</b>	The drive is stopped / holding zero speed.	Enabled
<b>Run</b>	The drive is active and running.	Enabled
<b>Scan</b>	The drive is enabled in Regen mode and is trying to synchronize to the supply.	Enabled
<b>Supply Loss</b>	Supply loss condition has been detected.	Enabled
<b>Deceleration</b>	The motor is being decelerated to zero speed / frequency because the final drive run has been deactivated.	Enabled
<b>dc injection</b>	The drive is applying dc injection braking.	Enabled
<b>Position</b>	Positioning / position control is active during an orientation stop.	Enabled
<b>Trip</b>	The drive has tripped and no longer controlling the motor. The trip code appears in the lower display.	Disabled
<b>Active</b>	The regen unit is enabled and synchronized to the supply.	Enabled
<b>Under Voltage</b>	The drive is in the under voltage state either in low voltage or high voltage mode.	Disabled
<b>Heat</b>	The motor pre-heat function is active.	Enabled
<b>Phasing</b>	The drive is performing a 'phasing test on enable'.	Enabled

**Table 13-9 Option module and SD Card and other status indications at power-up**

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

## 13.8 Programming error indications

Following are the error message displayed on the drive keypad when an error occurs during programming of drive firmware.

**Table 13-10 Programming error indications**

Error String	Reason	Solution
<b>Error 1</b>	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.
<b>Error 2</b>	At least one option module did not acknowledge the reset request.	Power cycle drive.
<b>Error 3</b>	The boot loader failed to erase the processor flash.	Power cycle drive and try again. If problem persists, return drive.
<b>Error 4</b>	The boot loader failed to program the processor flash.	Power cycle drive and try again. If problem persists, return drive.
<b>Error 5</b>	One option module did not initialize correctly. Option module did not set Ready to Run flag.	Remove faulty option module.

## 13.9 Displaying the trip history

The drive retains a log of the last ten trips that have occurred. *Trip 0* (10.020) to *Trip 9* (10.029) store the most recent 10 trips that have occurred where *Trip 0* (10.020) is the most recent and *Trip 9* (10.029) is the oldest. When a new trip occurs it is written to *Trip 0* (10.020) and all the other trips move down the log, with oldest being lost. The date and time when each trip occurs are also stored in the date and time log, i.e. *Trip 0 Date* (10.041) to *Trip 9 Time* (10.060). The date and time are taken from *Date* (06.016) and *Time* (06.017). Some trips have sub-trip numbers which give more detail about the reason for the trip. If a trip has a sub-trip number its value is stored in the sub-trip log, i.e. *Trip 0 Sub-trip Number* (10.070) to *Trip 9 Sub-trip Number* (10.079). If the trip does not have a sub-trip number then zero is stored in the sub-trip log.

If any parameter between Pr **10.020** and Pr **10.029** inclusive is read by serial communication, then the trip number in Table 13-5 is the value transmitted.

### NOTE

The trip logs can be reset by writing a value of 255 in Pr **10.038**.

## 13.10 Behaviour of the drive when tripped

If the drive trips, the output of the drive is disabled so the load coasts to a stop. If any trip occurs the following read only parameters are frozen until the trip is cleared. This is to help in diagnose the cause of the trip.

Parameter	Description
01.001	Frequency / speed reference
01.002	Pre-skip filter reference
01.003	Pre-ramp reference
02.001	Post-ramp reference
03.001	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**.

## 13.11 EtherCAT Diagnostics

### 13.11.1 EtherCAT interface ID code

Table 13-11 EtherCAT interface ID code

EtherCAT interface ID code		
Pr 17.001	Default	435 (EtherCAT)
	Range	0 to 65535
	Access	RO

This parameter is useful for checking the EtherCAT interface is of the correct type.

### 13.11.2 EtherCAT interface firmware version

Table 13-12 EtherCAT interface firmware version

EtherCAT interface firmware version		
Pr 17.002	Default	N/A
	Range	0 (Display:00.00.00.00) to 99999999 (Display:99.99.99.99)
	Access	RO

Module firmware version in ww.xx.yy.zz format

## 13.12 EtherCAT interface temperature

Table 13-13 EtherCAT interface temperature

EtherCAT interface module temperature		
Pr 3.09.030	Default	N/A
	Range	0 - 255
	Access	RO

This parameter shows the option module temperature reading in degrees Celsius.

## 13.13 Error handling

The following objects are provided to indicate an error condition.

Table 13-14 Error handling objects

Index	Name
0x1001	Error_register
0x603F	Error_code

### 13.13.1 Error register

Table 13-15 Error register

0x1001 Error register			
Access: RO	Range: 0 to 255	Size: Unsigned 8	Unit: N/A
Default: 0			
Description: A non-zero value in this object indicates that an error has occurred. The bit(s) set indicate the type of error present. The following bits are supported: 0: Generic error, 1: Current, 2: Voltage, 3: Temperature When an error is indicated in this object, the particular error code will be contained in object 0x603F (Error code).			

### 13.13.2 Error code

Table 13-16 Error code

0x603F Error code			
Access: RO	Range: 0 to 0xFFFF	Size: 2 bytes	Unit: N/A
Default: 0			
Description: A non-zero value in this object indicates that an error has occurred. The value will be one of the codes described in Table 13-17 below.			

**Table 13-17 Error codes**

Error code	Meaning	Corresponding drive trip Code (if available)
0x0000	Error reset / No error	0 – None
0xFF01	Generic error	(Any trip code not elsewhere in table)
0x2300	Current, device output side	3 – OI ac
0x3130	Phase failure	32 – Phase Loss 98 – Out Phase Loss
0x2230	Short circuit/ground leakage (device internal)	5 – PSU 9 – PSU 24V 92 – Snubber OI
0x3210	DC link over-voltage	2 – Over Volts
0x3230	Load error	38 - Low Load
0x4310	Excess temperature drive	21 – OHT Inverter, 22 – OHT Power 23 – OHT Control, 27 – OHT dc bus 101 – OHT Brake
0x5112	"Supply low voltage" and "U2 = supply +24 V"	91 - User 24V
0x5200	Control device hardware	200 - Slot 1 Hardware Fault 203 - Slot 1 Not Fitted, 204 - Slot 1 Different 205 - Slot 2 Hardware Fault 208 - Slot 2 Not Fitted, 209 - Slot 2 Different 210 - Slot 3 Hardware Fault 213 - Slot 3 Not Fitted, 214 - Slot 3 Different 250 - Slot 4 Hardware Fault 253 - Slot 4 Not Fitted, 254 - Slot 4 Different 221 - Stored HF
0x5400	Power section	111 - Config P 220 - Power Data 223 - Rating Mismatch
0x5510	RAM	227 - Sub Array RAM Allocation
0x5530	Data Storage (Non-volatile data memory)	31 – EEPROM Fail 36 – User Save 37 – Power Down Save
0x5430	Input stages	94 - Rectifier set up
0x5440	Contacts	226 - Soft Start
0x6010	Software reset (watchdog)	30 – Watchdog
0x6320	Parameter Error	199 - Destination 216 - Slot App Menu Crash 217 - App menu changed
0x7112	Brake Chopper (Over current brake chopper)	4 – OI Brake 19 – Brake R Too Hot
0x7113	Protective circuit break chopper	10 - Th Brake Res
0x7120	Motor	11 - Autotune 1, 12 - Autotune 2 13 - Autotune 3, 20 - Motor Too Hot
0x7122	Motor error or commutation malfunc.	14 – Autotune 4, 15 – Autotune 5 16 – Autotune 6, 24 - Thermistor 25 - Th Short Circuit, 33 - Resistance
0x7300	Sensor	17 - Autotune 7 162 to 163 – Encoder 12 to Encoder 13 176 – Name Plate 189 to 198 – Encoder 1 to Encoder 10 218 - Temp Feedback
0x7310	Speed	7 - Over speed
0x7500	Communication	90 - Power Comms 103 - Interconnect
0x7600	Data storage (external)	174 - Card Slot, 175 – Card Product 177 – Card Boot, 178 – Card Busy 179 – Card Data Exists, 180 – Card Option 181 – Card Read Only, 182 – Card Error 183 – Card No Data, 184 – Card Full 185 – Card Access, 186 – Card Rating 187 – Card Drive Mode, 188 – Card Compare

## 13.14 Drive trip display codes

Table 13-18 shows the possible trip codes that will be displayed on the drive when a problem is detected with EtherCAT interface or when the EtherCAT interface initiates a trip.

**Table 13-18 Trip display codes**

Value (Pr 10.070)	Display text	Description
100	Invalid Fdbk Src	An unknown or invalid feedback source has been configured
101	ECAT Init Error	An error occurred whilst initialising the EtherCAT communications
102	TO ECAT PDO	A PDO has not been written for longer than the specified timeout
103	Sync Task Orun	The synchronous task has overrun its allowed interval
104	Scaling Failure	Configured gear ratio or feed constant values fail to be implement in AMC
105	APLS Failure	Configured additional position loop scaling fails to be implement in AMC
106	TO ECAT STOP	The Master has requested a STOP
107	Pre Task Overrun	The Pre critical task has overrun

## 13.15 EtherCAT interface trips

**Table 13-19 EtherCAT interface trips**

Value (Pr 10.070)	Display Text	Description
200	SW fault	Software Fault
201	BG Orun	Background task overrun
202	FW invalid	Invalid firmware for hardware version
203	Drv unknown	Unknown drive type
204	Drv unsupported	Unsupported drive type
205	Mode unknown	Unknown drive mode
206	Mode unsupported	Unsupported drive mode
207	FLASH corrupt	Corrupted non-volatile FLASH
208	Dbase init	Database initialisation error
209	FS init	File system initialisation error
210	Memory alloc	Memory allocation error
211	Filesystem	File system error
212	Configuration	Configuration file save error
213	OHT	Overheated
214	TO drv	The drive has not responded within the watchdog period
215	ECMP	eCMP communication failure
216	TO ECMP slot 1	eCMP communication to slot 1 timeout
217	TO ECMP slot 2	eCMP communication to slot 2 timeout
218	TO ECMP slot 3	eCMP communication to slot 3 timeout
219	TO ECMP slot 4	eCMP communication to slot 4 timeout
220	Reserved	Reserved
221	ERROR_MISSING_FACTORY_SETTINGS	Factory settings file is missing
222	ERROR_FUNCTIONAL_TEST	Functional test failed
223	ERROR_CONFIG_FILE_LOAD	Configuration file failed to load
224	ERROR_POWER_ON_TEST	Power on self test failed
225	ERROR_RUNTIME_CONFIG	Runtime configuration error

## 13.16 Updating the EtherCAT interface firmware

The latest EtherCAT interface firmware is available from your local Drive Centre or supplier.

Updating the EtherCAT interface firmware via the EtherCAT master is not possible. To update the EtherCAT interface firmware it is necessary to connect to the drive via the KI-Compact 485 Adaptor and a USB to EIA-485 or EIA-232 to EIA485 isolated converter. A suitable USB to EIA-485 converter is available from the supplier of the drive (Part number 4500-0096). The EtherCAT interface firmware can then be upgraded using the change firmware function in Connect.

## 13.17 Switching frequency

In applications where greater synchronization is required, it is suggested that the drive's automatic switching frequency option is switched off. If automatic frequency switching is required, then the network will continue to operate, however the synchronization jitter may increase for a short time when the switching frequency changes. To disable the drive's automatic switching frequency control, set the drive Pr **05.035** to Disabled (1).

## 13.18 Sync Task Orun trips

If the EtherCAT interface cannot complete the assigned tasks within its 250  $\mu$ s Synchronous Task, a Sync Task Orun trip will be initiated; a Sync Task Orun trip indicates that the user is trying to accomplish too much within the Synchronous task. The user can influence the Synchronous Task by reducing the amount of cyclic data, or disabling drive control CiA402. To disable drive control set the Pr **3.00.033** to On (1), and perform an option reset via Pr **3.00.007**.

## 13.19 EtherCAT AL status codes

Table 13-20 shows the possible AL (Application Layer) status codes returned to the EtherCAT master controller during configuration or operational mode.

**Table 13-20 Application Layer status codes**

Code (0x)	Meaning	Description	Comment
0000	No error	No error	
0001	Unspecified error	No error code has been defined	Contact supplier
0002	No memory	Insufficient memory for operation	Contact supplier
0011	Invalid requested state changed	Requested state change is invalid	Follow the EtherCAT State Machine sequence to change state
0012	Unknown requested state change	Requested state change is unknown	Use only the EtherCAT State Machine state values
0013	Boot state not supported	Device does not support BOOT state	Contact supplier
0014	No valid firmware	Downloaded firmware application file is invalid	Download correct firmware application file
0015	Invalid mailbox configuration	Mailbox configuration differs from expected settings	Replace network description file with the correct file for device
0016	Invalid mailbox configuration	Slave device changed but network configuration is unchanged	Replace previous network description of old slave with the one of the new slave.
0017	Invalid Sync Manager configuration	PDO length, address or direction mismatch	Issue a re-calculation of the EtherCAT configuration.
0018	No valid inputs available	No valid inputs available on Slave device	Check slave input objects

Code (0x)	Meaning	Description	Comment
0019	No valid outputs available	Slave device cannot receive valid output values	Check slave output objects
001A	Synchronization error	Too many RxPDO toggle errors have occurred	Check configuration
001B	Sync Manager watchdog	No process data received within specified timeout	Check process data configuration
001C	Invalid Sync Manager Types	Specified Sync Manager type is invalid	Use correct Sync Manager
001D	Invalid output configuration	Sync Manager for output process data is invalid	Use correct Sync Manager
001E	Invalid input configuration	Sync Manager for input process data is invalid	Use correct Sync Manager
001F	Invalid watchdog configuration	The watchdog configuration is invalid	Check watchdog setting
0020	Slave needs cold restart	Slave device requires a cold restart or power cycle	Restart the slave device
0021	Slave needs INIT	Slave application requests INIT state	Re-initialise the slave device
0022	Slave needs PREOP	Slave application requests, PREOP state	Instruct slave device to enter PREOP state
0023	Slave needs SAFEOP	Slave application requests SAFEOP state	Instruct slave device to enter SAFEOP state
0024	Invalid input mapping	Invalid input mapping object	Check slave input mapping
0025	Invalid output mapping	Invalid output mapping object	Check slave output mapping
0026	Inconsistent settings	General settings mismatch	Check configuration settings
0027	Freerun not supported	Freerun not supported on slave	
0028	Synchronization not supported	Synchronization not supported on slave	
0029	Freerun needs 3 Buffer Mode	Sync Manager requires 3 Buffer Mode to run	
002A	Background Watchdog	Background task watchdog activated	
002B	No valid inputs and outputs	Slave device does not provide valid inputs and outputs	
002C	Fatal Sync error	The hardware synchronization signal has stopped	Set master to INIT and back to OP so that the DCs are initialized again.
002D	No Sync error	Hardware synchronization signal not detected	
0030	Invalid DC SYNC configuration	Distributed Clocks configuration is invalid	Check DC configuration
0031	Invalid DC Latch configuration	Distributed Clocks Latch configuration is invalid	Check DC configuration
0032	PLL error	Master not synchronized, at least one DC event received	Check wiring and synchronization settings
0033	DC Sync IO error	Multiple sync errors: At least one sync signal was received but the slave is no longer synchronized	Check network jitter Increase cycle time Use Distributed Clocks scheme
0034	DC Sync timeout error	Multiple sync errors: Excessive Sync Manager events missed	Check DC configuration

Code (0x)	Meaning	Description	Comment
0035	DC invalid sync cycle time	DC sync cycle time is invalid	Check DC configuration
0036	DC Sync0 cycle time	DC Sync0 cycle time invalid for application	Check DC configuration
0037	DC Sync1 cycle time	DC Sync1 cycle time invalid for application	Check DC configuration

## 13.20 SDO abort codes

SDO messages use a request-response mechanism and the EtherCAT master will always expect a response from the slave device. If an error occurs with an SDO transfer the EtherCAT interface will return an SDO abort code to indicate the reason for the failure, the SDO abort codes are listed in Table 13-21.

**Table 13-21 SDO abort codes**

Abort code (in hex.)	Description
0x05030000	Toggle bit not alternated
0x05040000	SDO protocol timed out
0x05040001	Client/server command specifier not valid or unknown
0x05040002	Invalid block size (block mode only)
0x05040003	Invalid sequence number (block mode only)
0x05040004	CRC error (block mode only)
0x05040005	Out of memory
0x06010000	Unsupported access to an object
0x06010001	Attempt to read a write only object
0x06010002	Attempt to write a read only object
0x06020000	Object does not exist in the object dictionary
0x06040041	Object cannot be mapped to the PDO
0x06040042	The number and length of the objects to be mapped would exceed PDO length
0x06040043	General parameter incompatibility
0x06040047	General internal incompatibility in the device
0x06060000	Access failed due to a hardware error
0x06070010	Data type does not match, length of service parameter does not match
0x06070012	Data type does not match, length of service parameter too high
0x06070013	Data type does not match, length of service parameter too low
0x06090011	Sub-index does not exist
0x06090030	Value range of parameter exceeded (only for write access)
0x06090031	Value of parameter written too high
0x06090032	Value of parameter written too low
0x06090036	Maximum value is less than minimum value
0x08000000	General error
0x08000020	Data cannot be transferred or stored to the application
0x08000021	Data cannot be transferred or stored to the application because of local control
0x08000022	Data cannot be transferred or stored to the application because of the present device state
0x08000023	Object dictionary dynamic generation fails or no object dictionary is present

## 14 UL listing information

This section is intended to be used in conjunction with the *Digitax HD M75X Series Installation and Technical Guide*.

### 14.1 Scope

All models are cUL Listed to Canadian and US requirements. The UL file reference is: NMMS / 7. E171230.

### 14.2 Applicant and Listee

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

### 14.3 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

### 14.4 Model numbers

Model numbers are listed within the 'Ratings' section (Chapter 2 - Product Information) of the *Digitax HD M75X Series Installation and Technical Guide*.

### 14.5 Safety information

Appropriate installation warnings, cautions and notes are located in the Chapter 1 *Safety information* on page 9.

### 14.6 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*.

### 14.7 Ratings

The electrical ratings are listed within the 'Ratings' section (Chapter 2 - Product Information) of the *Digitax HD M75X Series Installation and Technical Guide*.

### 14.8 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*.

### 14.9 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).

### 14.10 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*.

### 14.11 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*.

### 14.12 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*.

### 14.13 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*.

### 14.14 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*.

### 14.15 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  $\mu$ s. The total trip time is unlikely to exceed 100  $\mu$ s.

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.

## 14.16 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.

## 14.17 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.

## 14.18 Enclosure rating

All drives are Open Type.

## 14.19 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.

## 14.20 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*.

## 14.21 Pollution degree

Drives are designed for operation in a pollution degree 2 environment or better (dry, non-conductive pollution only).

## 14.22 Plenum rating

The drives are not suitable for installation in a compartment (duct) handling conditioned air.

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