



**EMERSON**<sup>™</sup>  
Industrial Automation



*User Guide*

# Mentor MP

High Performance DC Drive  
25A to 7400A, 480V to 690V  
two or four quadrant operation

Part Number: 0476-0000-01  
Issue: 1



**CONTROL  
TECHNIQUES**

[www.controltechniques.com](http://www.controltechniques.com)

## General Information

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

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

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## Drive software version

This product is supplied with the latest version of software. If this product is to be used in a new or existing system with other drives, there may be some differences between their software and the software in this product. These differences may cause this product to function differently. This may also apply to drives returned from a Control Techniques Service Centre.

The software version of the drive can be checked by looking at Pr **11.29 (di14/0.49)** and Pr **11.34**. The software version takes the form of zz.yy.xx, where Pr **11.29 (di14/0.49)** displays zz.yy and Pr **11.34** displays xx, i.e. for software version 01.01.00, Pr **11.29 (di14/0.49)** would display 1.01 and Pr **11.34** would display 0.

If there is any doubt, contact a Control Techniques Drive Centre.

## Environmental statement

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

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

Nevertheless, when the products eventually reach the end of their useful life, they can very easily be dismantled into their major component parts for efficient recycling. Many parts snap together and can be separated without the use of tools, while other parts are secured with conventional screws. Virtually all parts of the product are suitable for recycling.

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

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

## REACH legislation

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

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

[http://www.controltechniques.com/CTcom/system\\_pages/environment/reach\\_regulation.aspx](http://www.controltechniques.com/CTcom/system_pages/environment/reach_regulation.aspx)

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# 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 Electrical safety - general warning

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

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

## 1.3 System design and safety of personnel

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

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

System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this guide carefully.

**The STOP and START controls or electrical inputs of the drive must not be relied upon to ensure safety of personnel. They do not isolate dangerous voltages from the output of the drive or from any external option unit. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.**

The drive is not intended to be used for safety-related functions.

Careful consideration must be given to the function of the drive which might result in a hazard, either through its 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.

## 1.4 Environmental limits

Instructions within the supplied data and information within the *Mentor MP User Guide* regarding transport, storage, installation and the use of the drive must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

## 1.5 Access

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

## 1.6 Fire protection

The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.

## 1.7 Compliance with regulations

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

The *Mentor MP User Guide* contains instructions for achieving compliance with specific EMC standards.

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

98/37/EC: Safety of machinery

2004/108/EC: Electromagnetic compatibility

## 1.8 Motor

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

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

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

It is essential that the correct value is entered into Pr **5.07 (SE07, 0.28)**, *Motor rated current*. This affects the thermal protection of the motor.

## 1.9 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.

## 1.10 Electrical installation

### 1.10.1 Electric shock risk

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

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

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

### 1.10.2 Stored charge

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

## 2 Product information

**Table 2-1 Model to frame size cross reference**

Model		Frame size
MP25A4(R)	MP25A5(R)	1A
MP45A4(R)	MP45A5(R)	
MP75A4(R)	MP75A5(R)	
MP105A4(R)	MP105A5(R)	1B
MP155A4(R)	MP155A5(R)	
MP210A4(R)	MP210A5(R)	
MP350A4(R)	MP350A6(R)	2A
MP420A4(R)	MP420A6(R)	
MP550A4(R)	MP550A6(R)	
MP700A4(R)	MP700A6(R)	2B
MP825A4(R)	MP825A6(R)	
MP900A4(R)	MP900A6(R)	
MP1200A4	MP1200A6	2C
MP1850A4	MP1850A6	
MP1200A4(R)	MP1200A6(R)	2D
MP1850A4(R)	MP1850A6(R)	

### 2.1 Ratings

The power ratings for the 480V, 575V and 690V configurations are shown in Table 2-2 , Table 2-3 and Table 2-4 .

The continuous current ratings given are for a maximum ambient temperature of 40°C (104°F) and an altitude of 1000m. For operation at higher temperatures and altitudes de-rating is required.

For further information see Chapter 12 *Technical data* on page 127.

**Table 2-2 480V drive ratings**

Model	AC input current	DC output current		Typical motor power	
	Continuous	Continuous	Overload	@ 400Vdc	@ 500Vdc
	A	A	A	kW	hp
MP25A4(R)	22	25	37.5	9	15
MP45A4(R)	40	45	67.5	15	27
MP75A4(R)	67	75	112.5	27	45
MP105A4(R)	94	105	157.5	37.5	60
MP155A4(R)	139	155	232.5	56	90
MP210A4(R)	188	210	315	75	125
MP350A4(R)	313	350	525	125	200
MP420A4(R)	376	420	630	150	250
MP550A4(R)	492	550	825	200	300
MP700A4(R)	626	700	1050	250	400
MP825A4(R)	738	825	1237.5	300	500
MP900A4(R)	805	900	1350	340	550
MP1200A4(R)	1073	1200	1800	450	750
MP1850A4(R)	1655	1850	2775	700	1150

**Table 2-3 575V drive ratings**

Model	AC input current	DC output current		Typical motor power (with Vdc = 630V)	
	Continuous	Continuous	Overload	kW	hp
	A	A	A		
MP25A5(R)	22	25	37.5	14	18
MP45A5(R)	40	45	67.5	25	33
MP75A5(R)	67	75	112.5	42	56
MP105A5(R)	94	105	157.5	58	78
MP155A5(R)	139	155	232.5	88	115
MP210A5(R)	188	210	315	120	160

**Table 2-4 690V drive ratings**

Model	AC input current	DC output current		Typical motor power (with Vdc = 760V)	
	Continuous	Continuous	Overload	kW	hp
	A	A	A		
MP350A6(R)	313	350	525	240	320
MP420A6(R)	376	420	630	280	380
MP550A6(R)	492	550	825	375	500
MP700A6(R)	626	700	1050	480	640
MP825A6(R)	738	825	1237.5	560	750
MP900A6(R)	805	900	1350	650	850
MP1200A6(R)	1073	1200	1800	850	1150
MP1850A6(R)	1655	1850	2775	1300	1750

#### Maximum continuous input current

The values of maximum continuous input current are given to aid the selection of cables and fuses. These values are stated for worst-case condition.

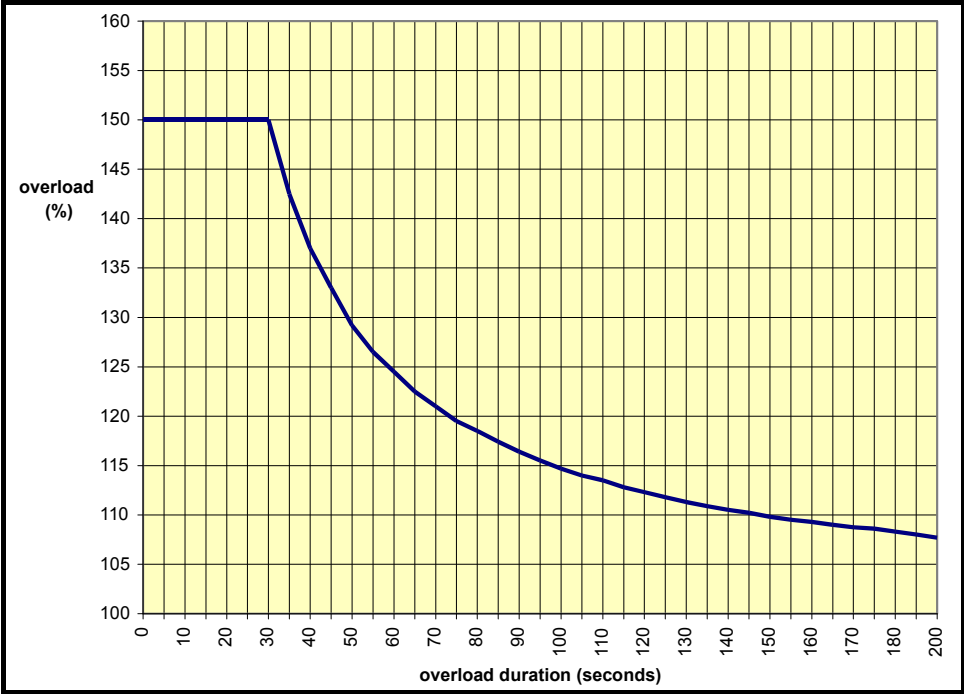
2.1.1 Typical short-term overload limits

The maximum percentage overload limit changes depending on the selected motor

Variations in motor rated current will result in changes in the maximum possible overload as detailed in the *Advanced User Guide*.

Figure 2-1 can be used to determine the maximum overload duration available for overloads between 100% and 150%. For example the maximum overload available for a period of 60 seconds is 124%.

Figure 2-1 Maximum overload duration available



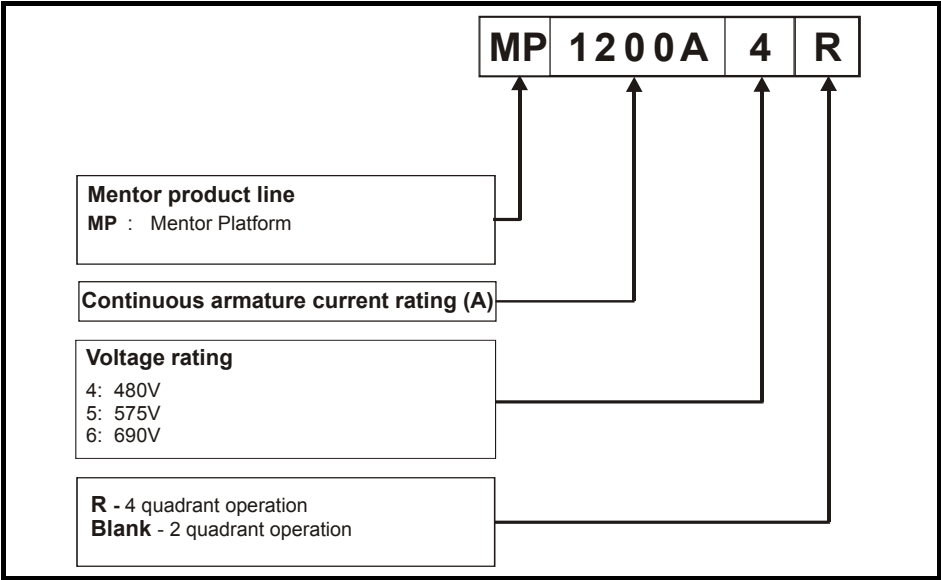
**NOTE**

Overload of 150% for 30s is available with ambient temperature of 40°C (104°F) up to a maximum of 10 repetitions per hour.

2.2 Model number

The way in which the model numbers for the Mentor MP range are formed is described in Figure 2-2.

Figure 2-2 Model number



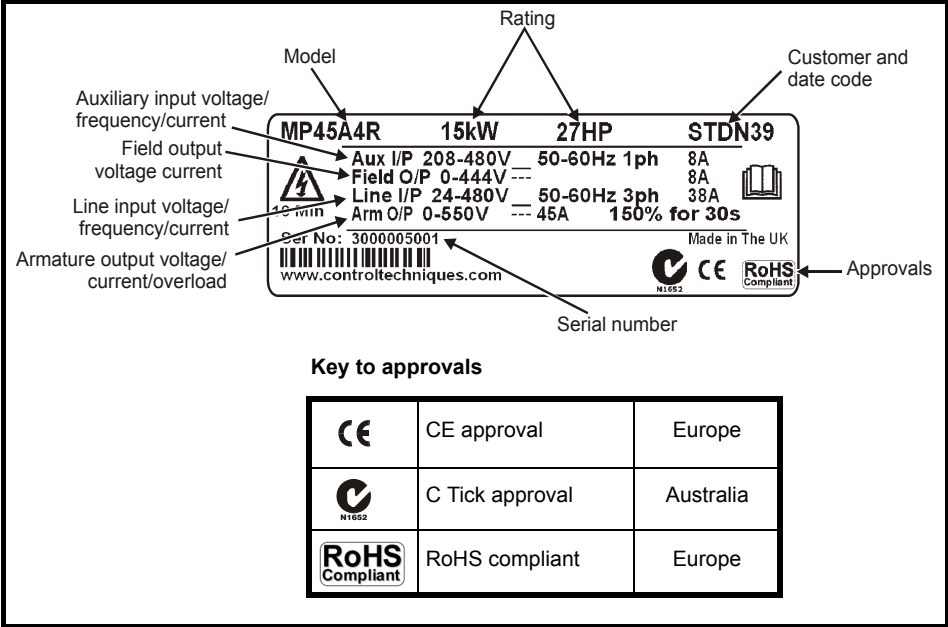
2.3 Compatible encoders

Table 2-5 Encoders compatible with Mentor MP

Encoder type	Pr 3.38 (Fb07, 0.77) setting
Quadrature incremental encoders with or without marker pulse	Ab (0)
Frequency and direction incremental encoders with or without marker pulse	Fd (1)
Forward / reverse incremental encoders with or without marker pulse	Fr (2)

2.4 Nameplate description

Figure 2-3 Typical drive rating label



2.4.1 Output current

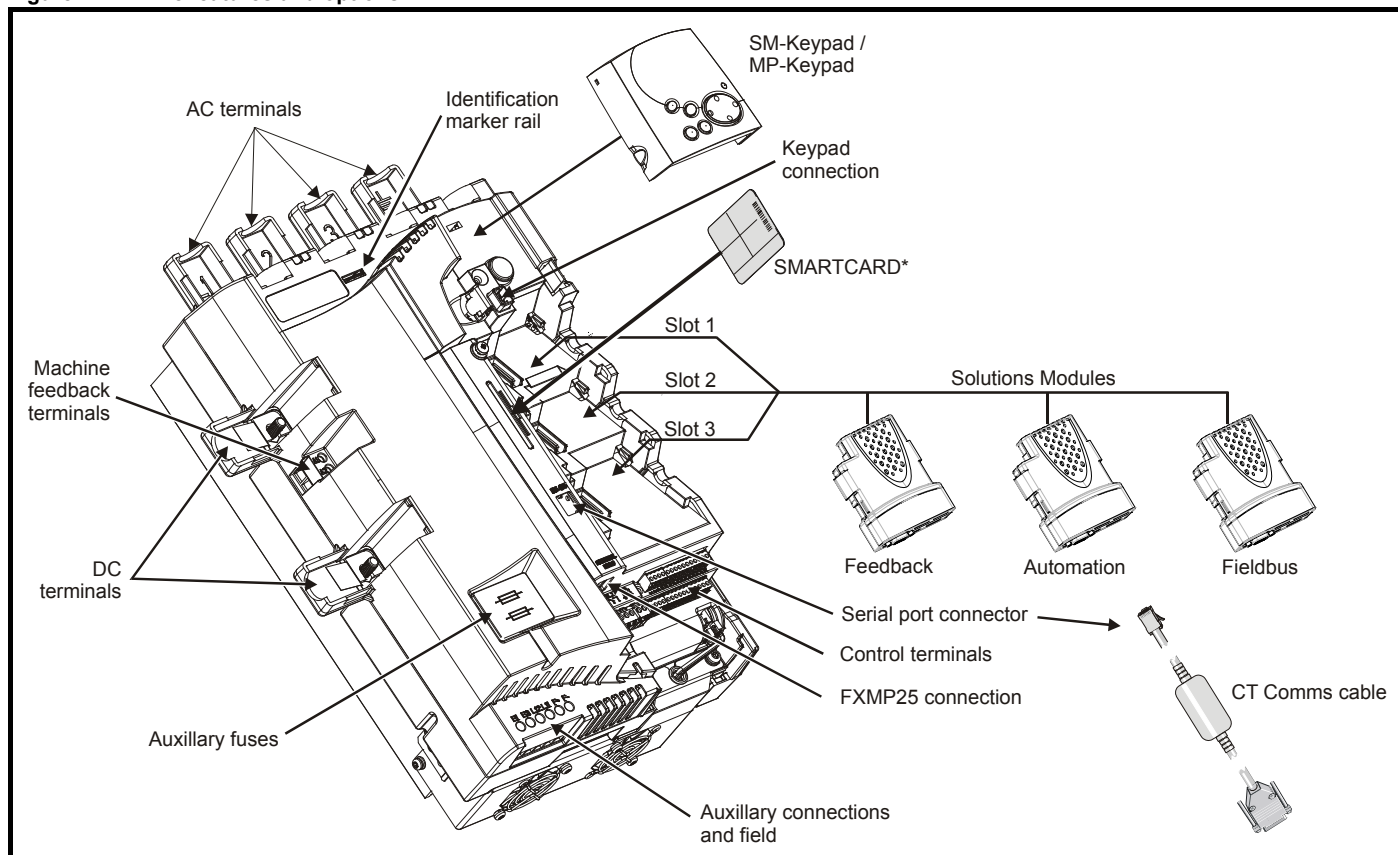
The continuous output current ratings given on the rating label are for maximum 40°C (104°F) and 1000m altitude. Derating is required for higher ambient temperatures >40°C (104°F) and higher altitude. For derating information, refer to section 12.1.10 *Altitude* on page 128.

2.4.2 Input current

The input current is affected by the supply voltage, frequency and load inductance. The input current given on the rating label is the typical input current.

## 2.5 Drive features and options

Figure 2-4 Drive features and options
















\* A SMARTCARD is provided as standard. For further information, refer to Chapter 9 *SMARTCARD operation* on page 64.







## 2.5.1 Options available for Mentor MP

All Solutions Modules are color-coded in order to make identification easy. The following table shows the color-code key and gives further details on their function.


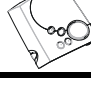
**Table 2-6 Solutions Module identification**

Type	Solutions Module	Color	Name	Further Details
Feedback		Light Green	SM-Universal Encoder Plus	<b>Universal Feedback interface</b> Feedback interface for the following devices: <b>Inputs</b> <ul style="list-style-type: none"> <li>Incremental encoders</li> <li>SinCos encoders</li> <li>SSI encoders</li> <li>EnDat encoders</li> </ul> <b>Outputs</b> <ul style="list-style-type: none"> <li>Quadrature</li> <li>Frequency and direction</li> <li>SSI simulated outputs</li> </ul>
		Brown	SM-Encoder Plus	<b>Incremental encoder interface</b> Feedback interface for incremental encoders without commutation signals. No simulated encoder outputs available
		Dark Brown	SM-Encoder Output Plus	<b>Incremental encoder interface</b> Feedback interface for incremental encoders without commutation signals. Simulated encoder output for quadrature, frequency and direction signals
Automation (I/O Expansion)		Yellow	SM-I/O Plus	<b>Extended I/O interface</b> Increases the I/O capability by adding the following to the existing I/O in the drive: <ul style="list-style-type: none"> <li>Digital inputs x 3</li> <li>Digital I/O x 3</li> <li>Analog inputs (voltage) x 2</li> <li>Analog output (voltage) x 1</li> <li>Relay x 2</li> </ul>
		Yellow	SM-I/O 32	<b>Extended I/O interface</b> Increase the I/O capability by adding the following to the existing I/O in the drive: <ul style="list-style-type: none"> <li>High speed digital I/O x 32</li> <li>+24V output</li> </ul>
		Dark Yellow	SM-I/O Lite	<b>Additional I/O</b> 1 x Analog input ( $\pm 10V$ bi-polar or current modes) 1 x Analog output (0-10V or current modes) 3 x Digital input and 1 x Relay
		Dark Red	SM-I/O Timer	<b>Additional I/O with real time clock</b> As per SM-I/O Lite but with the addition of a Real Time Clock for scheduling drive running
		Turquoise	SM-I/O PELV	<b>Isolated I/O to NAMUR NE37 specifications</b> For chemical industry applications 1 x Analog input (current modes) 2 x Analog outputs (current modes) 4 x Digital input / outputs, 1 x Digital input, 2 x Relay outputs
		Olive	SM-I/O 120V	<b>Additional I/O conforming to IEC 61131-2 120Vac</b> 6 digital inputs and 2 relay outputs rated for 120Vac operation
		Cobalt Blue	SM-I/O 24V Protected	<b>Additional I/O with overvoltage protection up to 48V</b> 2 x Analog outputs (current modes) 4 x Digital input / outputs, 3 x Digital inputs, 2 x Relay outputs
Automation (Applications)		Moss Green	SM-Applications Plus	<b>Applications Processor (with CTNet)</b> 2 <sup>nd</sup> processor for running pre-defined and /or customer created application software with CTNet support. Enhanced performance over SM-Applications
		White	SM-Applications Lite V2	<b>Applications Processor</b> 2 <sup>nd</sup> processor for running pre-defined and /or customer created application software. Enhanced performance over SM-Applications Lite
		Green brown	SM-Register	<b>Applications Processor</b> 2 <sup>nd</sup> processor for running position capture functionality with CTNet support.


**Table 2-6 Solutions Module identification**

Type	Solutions Module	Color	Name	Further Details
Fieldbus		Purple	SM-PROFIBUS DP-V1	<b>Profibus option</b> PROFIBUS DP adapter for communications with the drive
		Medium Grey	SM-DeviceNet	<b>DeviceNet option</b> Devicenet adapter for communications with the drive
		Dark Grey	SM-INTERBUS	<b>Interbus option</b> Interbus adapter for communications with the drive
		Light Grey	SM-CANopen	<b>CANopen option</b> CANopen adapter for communications with the drive
		Beige	SM-Ethernet	<b>Ethernet option</b> 10 base-T / 100 base-T; Supports web pages, SMTP mail and multiple protocols: DHCP IP addressing; Standard RJ45 connection
		Brown Red	SM-EtherCAT	<b>EtherCAT option</b> EtherCAT adapter for communications with the drive

**Table 2-7 Keypad identification**

Type	Keypad	Name	Further Details
Keypad		SM-Keypad	<b>LED keypad option</b> Keypad with a LED display
		MP-Keypad	<b>LCD keypad option</b> Keypad with an alpha-numeric LCD display with Help function

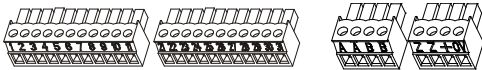

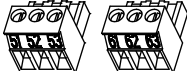


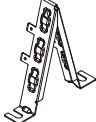
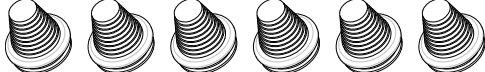

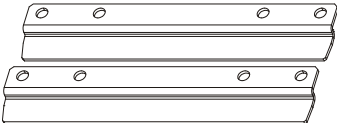
**Table 2-8 Additional options**

Type	Cable	Name	Further Details
Serial comms lead		CT Comms cable	CT EIA232 (4500-0087) CT USB (4500-0096)

## 2.6 Items supplied with the drive

The drive is supplied with a printed manual, a SMARTCARD, a safety information booklet, the Certificate of Quality, an accessory kit box including the items shown in Table 2-9, and a CD ROM containing all related product documentation and software tools.

**Table 2-9 Parts supplied with the drive**

Description	Size 1
Control connectors	
Tacho connector	
Relay connectors	
UL warning label	
UL warning label for heatsink temperature	
Grounding bracket	
Terminal cover grommets	
Terminal shrouds	
Mounting feet bracket	



## 3 Mechanical Installation

### 3.1 Safety



Follow the instructions

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



Competence of the installer

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



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



Enclosure

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



The drive enclosure is not classified as a fire enclosure. A separate fire enclosure must be provided.



Many of the drives in this product range weigh in excess of 15kg (33lb). Use appropriate safeguards when lifting these models.  
See section 12.1.20 *Weights* on page 129

### 3.2 Planning the installation

The following considerations must be made when planning the installation:

#### 3.2.1 Access

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

#### 3.2.2 Environmental protection

The drive must be protected from:

- moisture, including dripping water or spraying water and condensation. An anti-condensation heater may be required, which must be switched off when the drive is running.
- contamination with electrically conductive material.
- contamination with any form of dust which may restrict the fan, or impair airflow over various components.
- temperature beyond the specified operating and storage ranges
- corrosive gasses.

#### 3.2.3 Cooling

The heat produced by the drive must be removed without its specified operating temperature being exceeded. Note that a sealed enclosure gives much reduced cooling compared with a ventilated one, and may need to be larger and/or use internal air circulating fans.

For further information, refer to section 3.6.2 *Enclosure sizing* on page 21.

#### 3.2.4 Electrical safety

The installation must be safe under normal and fault conditions. Electrical installation instructions are given in Chapter 4 *Electrical installation* on page 25.

#### 3.2.5 Electromagnetic compatibility

If it is necessary to meet strict emission limits, or if it is known that electromagnetically sensitive equipment is located nearby, then full precautions must be observed. The use of an external EMC filter may be required at the drive inputs, which must be located very close to the drives.

Space must be made available for the filters and allowance made for carefully segregated wiring. Both levels of precautions are covered in section 12.2.4 *Electromagnetic compatibility (EMC)* on page 134

#### 3.2.6 Hazardous areas

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

## 3.3 Terminal cover removal



### Isolation device

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



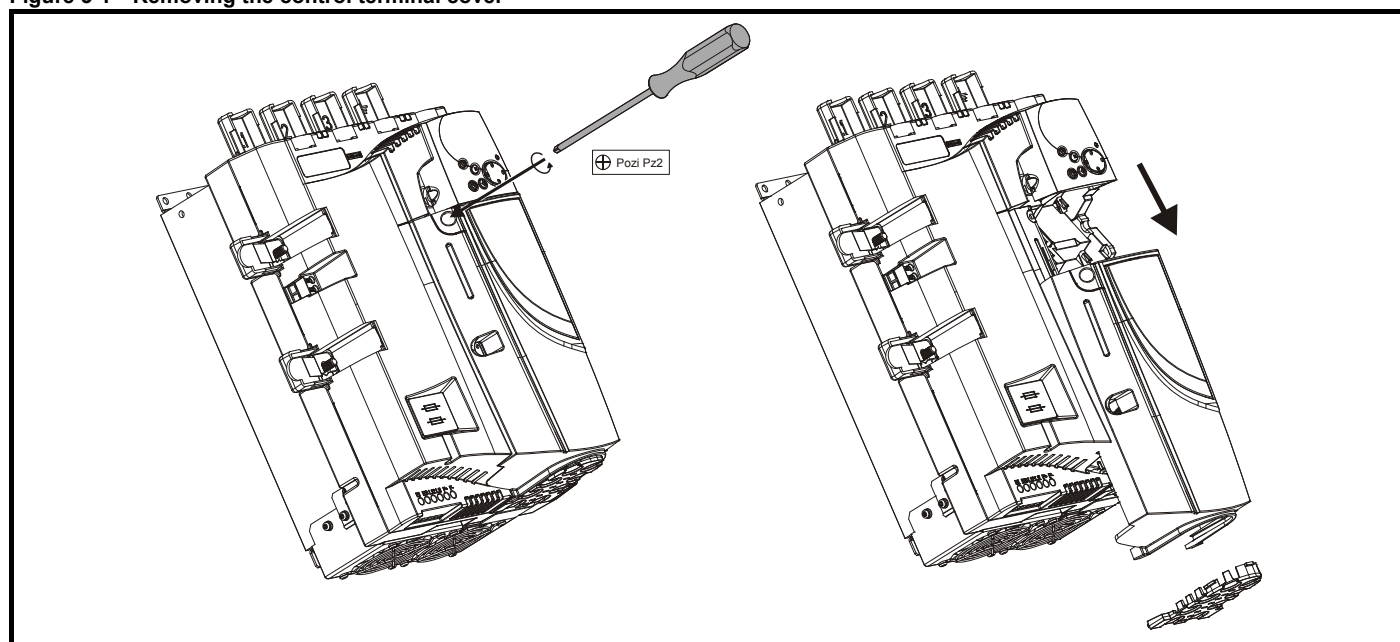
### Stored charge

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

### 3.3.1 Removing the terminal covers

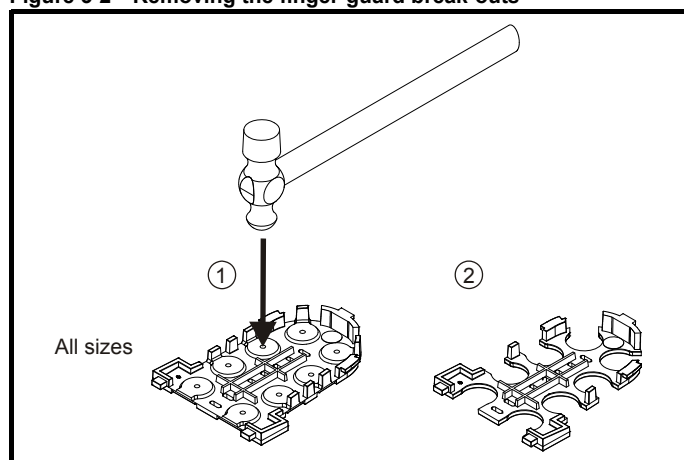
The drive is installed with one control terminal cover.

**Figure 3-1 Removing the control terminal cover**



### 3.3.2 Removing the finger-guard and break-outs

**Figure 3-2 Removing the finger-guard break-outs**



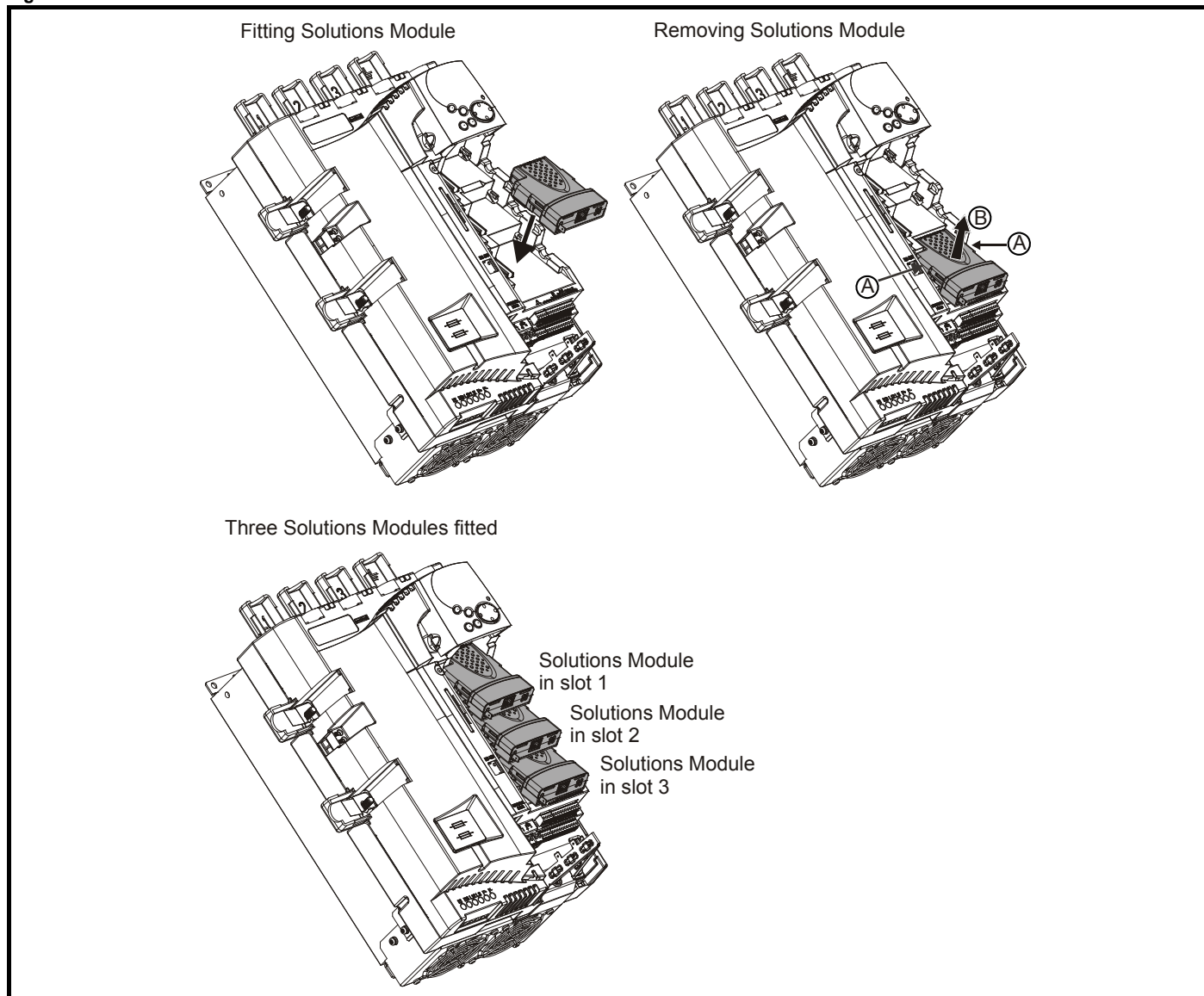
Place finger-guard on a flat solid surface and hit relevant break-outs with hammer as shown (1). Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed.

### 3.3.3 Installation and removal of a Solutions Module



Please power down the drive before removing / installing the Solutions Module. Failure to do so may cause damage to product

**Figure 3-3 Installation and removal of the Solutions Module**



To install the Solutions Module, press down in the direction shown above until it clicks into place.

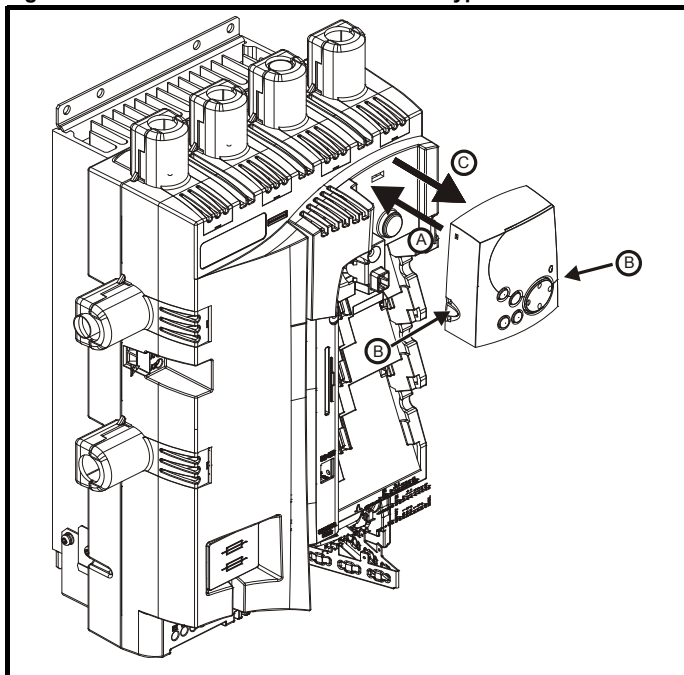
To remove the Solutions Module, press inwards at the points shown (A) and pull in the direction shown (B).

The drive has the facility for all three Solutions Module slots to be used at the same time, as illustrated.

**NOTE**

It is recommended that the Solutions Module slots are used in the following order: slot 3, slot 2 and slot 1.

**Figure 3-4 Removal and installation of a keypad**



To fit, align the MP-Keypad and press gently in the direction shown until it clicks into position (A).

To remove, while pressing the tabs inwards (B), gently lift the MP-Keypad in the direction indicated (C).

**NOTE**

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

### 3.4 Mounting method

The Mentor MP can only be surface mounted.



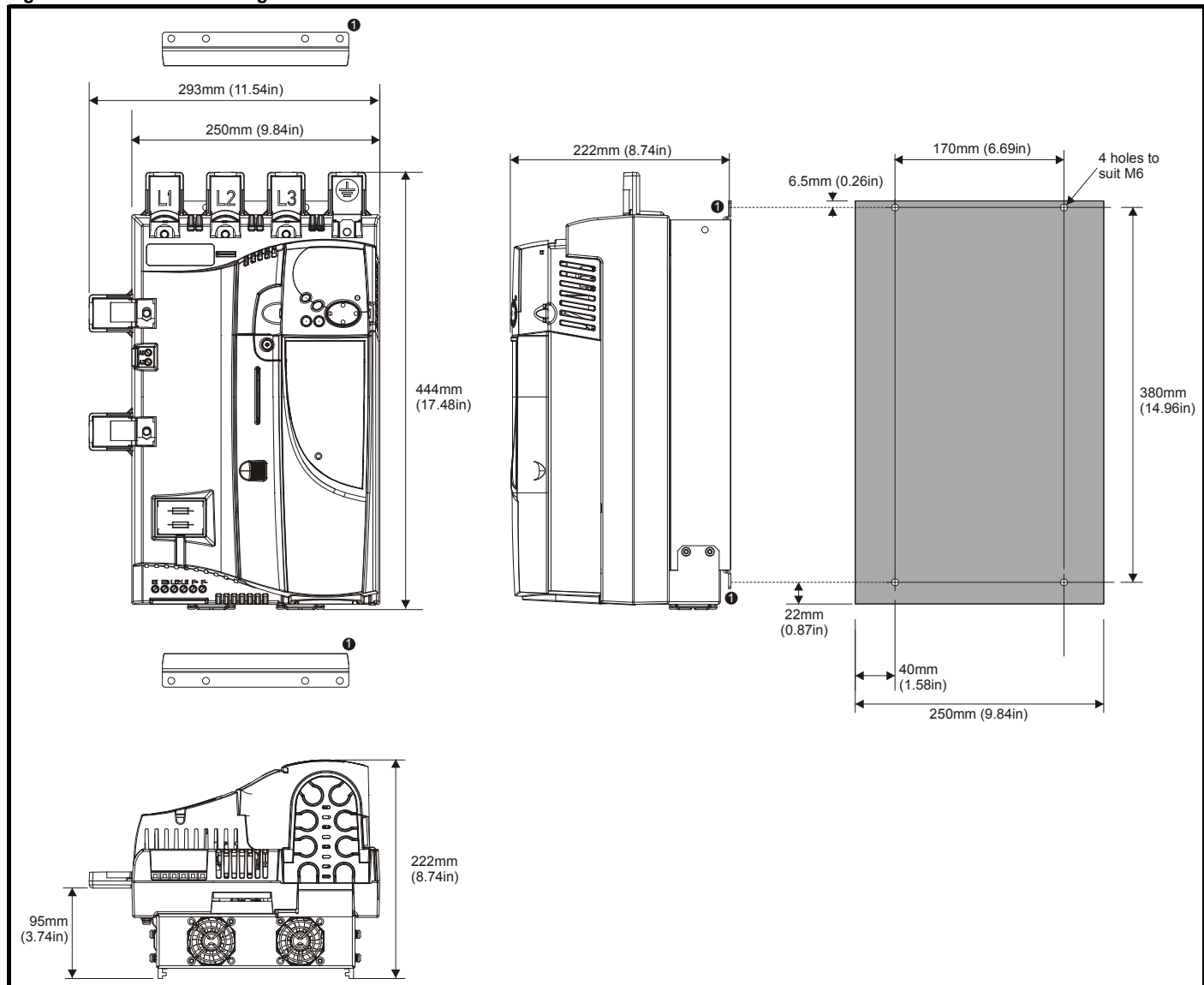
If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70°C (158°F). Human contact with the heatsink should be prevented.



Many of the drives in this product range weigh in excess of 15kg (33lb). Use appropriate safeguards when lifting these models.

See section 12.1.20 *Weights* on page 129

**Figure 3-5 Surface mounting the size 1A drive**

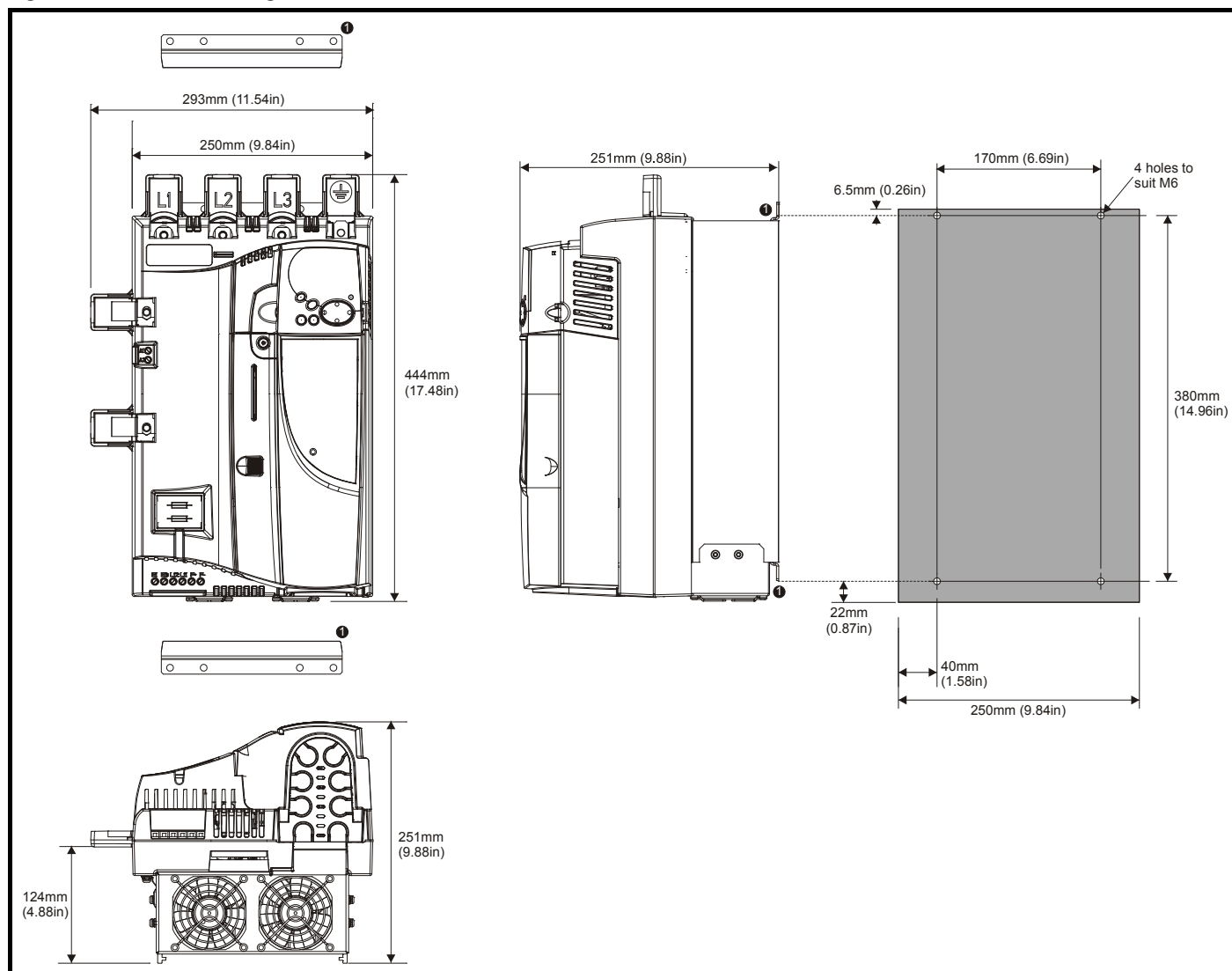


1. The two outer holes must be used for mounting the Mentor MP.

#### NOTE

With the SMARTCARD installed to the drive, the depth measurement increases by 7.6mm (0.30 in).

**Figure 3-6 Surface mounting the size 1B drive**

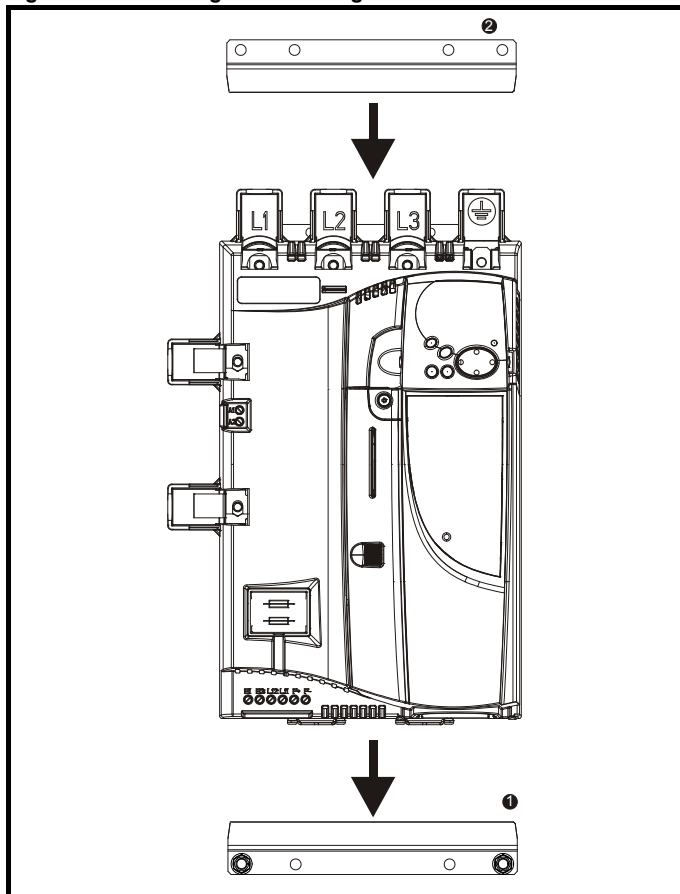


1. The two outer holes must be used for mounting the Mentor MP.

**NOTE**

With the SMARTCARD installed to the drive, the depth measurement increases by 7.6mm (0.30 in).

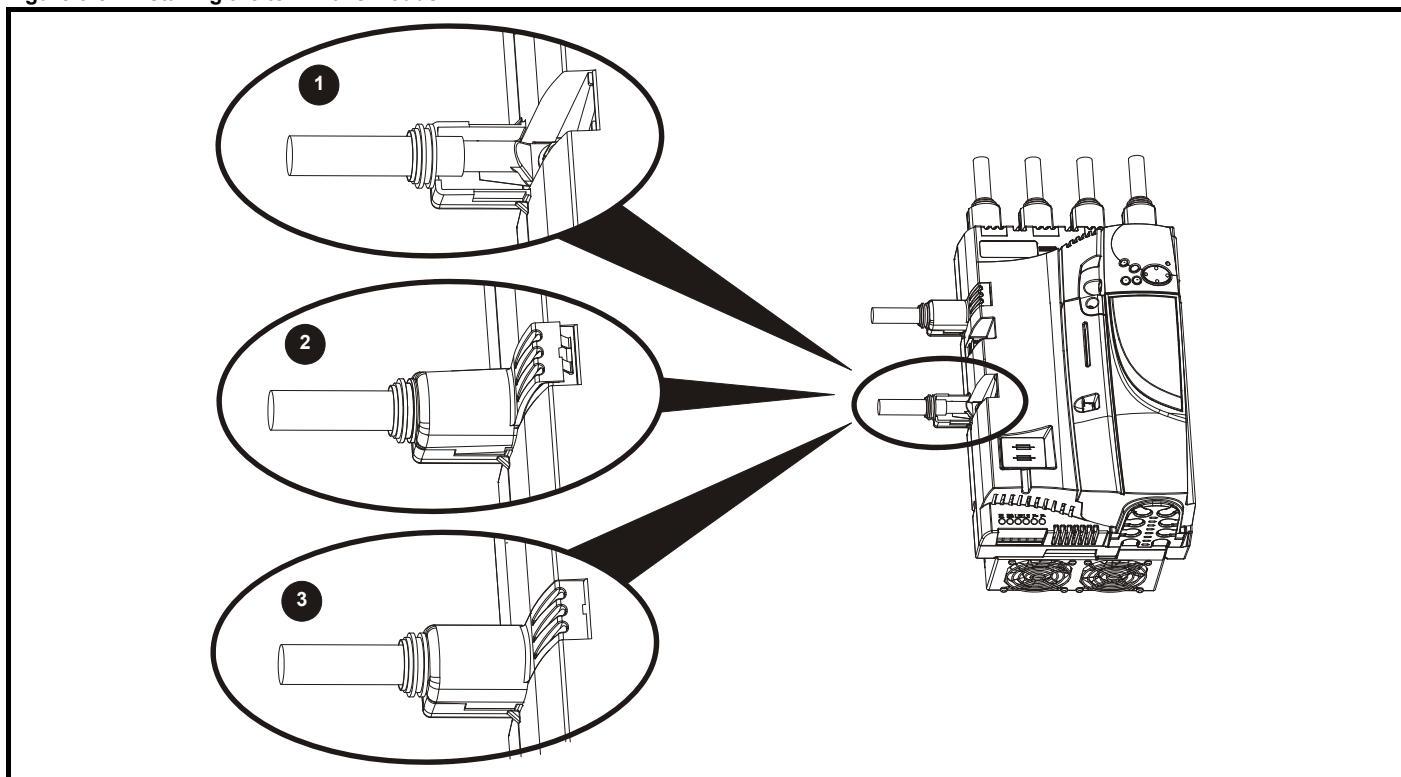
**Figure 3-7 Installing the mounting feet bracket**



The bottom mounting bracket (1) should be installed to the back plate first. The drive should then be lowered onto the bracket and slotted in. The top mounting bracket (2) should then be slotted into the drive and the top holes marked for mounting (380mm [14.96 in] from the centre of the holes on the bottom mounting bracket). Once the holes have been drilled, then fix the top mounting bracket accordingly.

### 3.5 Installing and removing the terminal shrouds

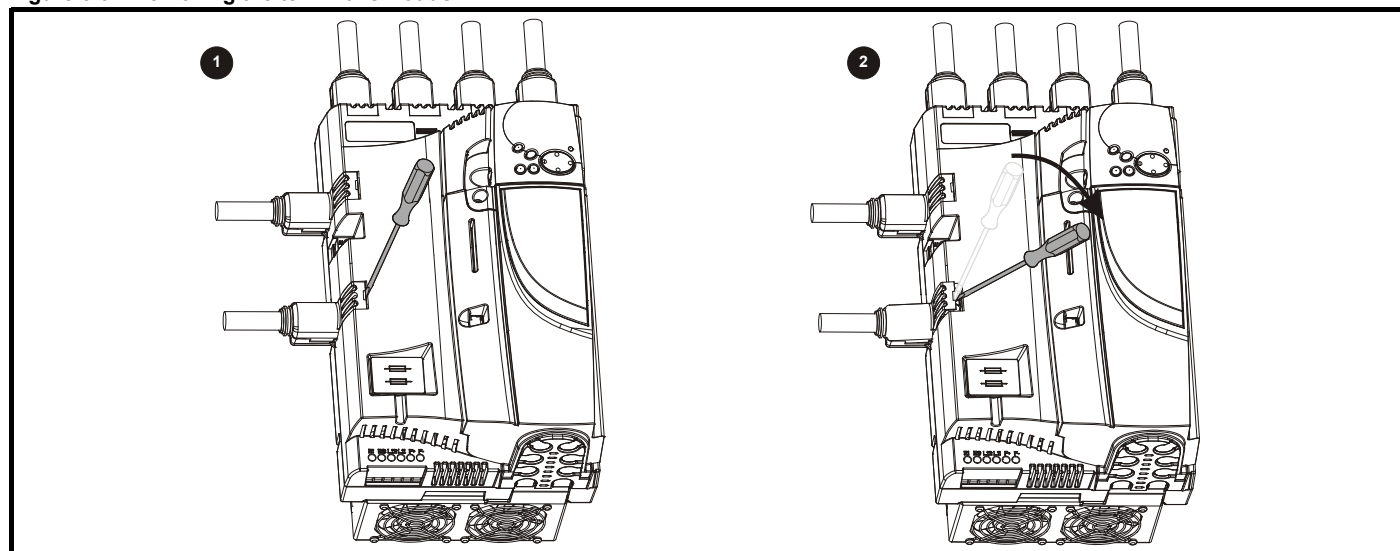
**Figure 3-8 Installing the terminal shrouds**



1. Thread the AC supply and DC output connectors through the grommets provided and connect them to the drive.
2. Place the terminal shroud over the top of the connectors and click into place (3).



**Figure 3-9 Removing the terminal shrouds**



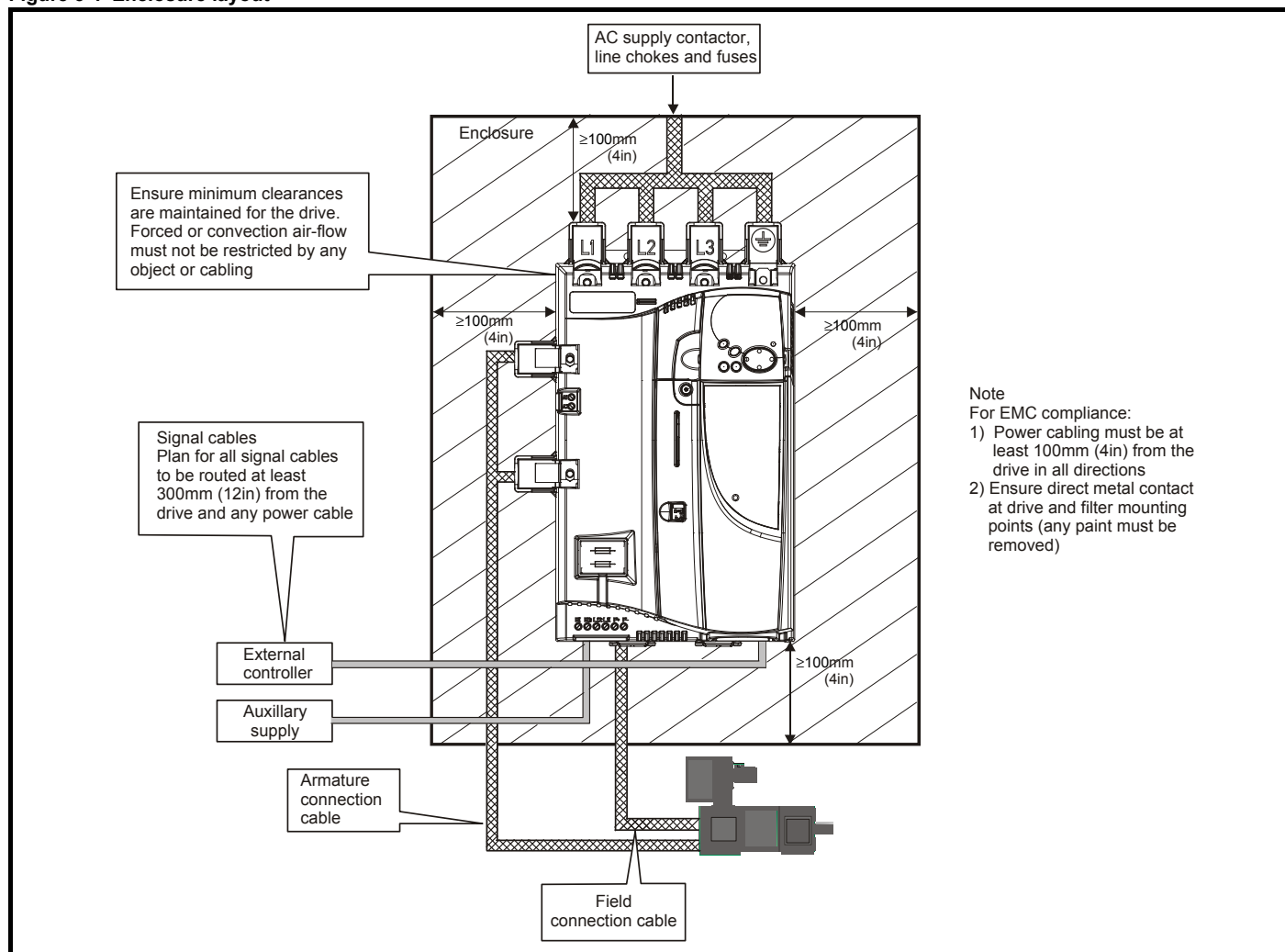
1. Insert the screwdriver as shown.
2. Lever in the direction shown to unclip the terminal shroud and remove.

## 3.6 Enclosure

### 3.6.1 Enclosure layout

Please observe the clearances in the diagram below taking into account any appropriate notes for other devices / auxiliary equipment when planning the installation.

**Figure 3-1 Enclosure layout**





### 3.6.2 Enclosure sizing

Refer to section 12.1.2 *Power dissipation* on page 127 for drive losses.

Add the dissipation figures for each drive that is to be installed in the enclosure.

Add the power dissipation figures for each EMC filter that is to be installed in the enclosure.

Calculate the total heat dissipation (in Watts) of any other equipment to be installed in the enclosure.

Add the figures of all of the above to get a total heat dissipation figure (in Watts) for the equipment in the enclosure.

#### Calculating the size of a sealed enclosure

The enclosure transfers internally generated heat into the surrounding air by natural convection. The larger the surface area of the enclosure walls, the better is the dissipation capability. Only the surfaces of the enclosure that are not in contact with a wall or floor can dissipate heat.

Calculate the minimum required unobstructed surface area  $A_e$  for the enclosure from:

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

Where:

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

#### Example

To calculate the size of an enclosure for the following:

- Two MP25A4 models operating under full load conditions
- Maximum ambient temperature inside the enclosure:  $40^{\circ}C$
- Maximum ambient temperature outside the enclosure:  $30^{\circ}C$

Dissipation of each drive: 125W

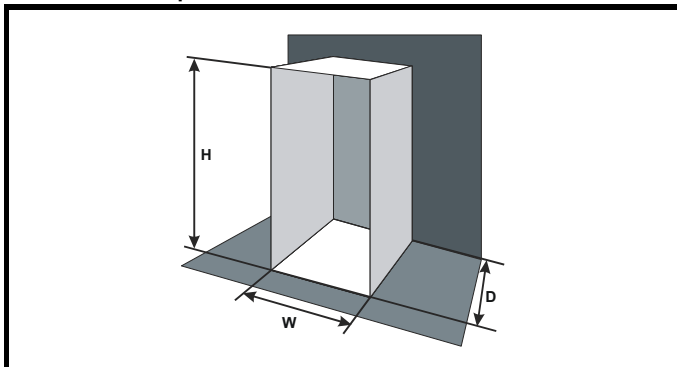
Dissipation from other heat generating equipment in the enclosure. 11W (max).

Total dissipation:  $2 \times (125 + 11) = 272W$

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

The value of  $5.5 W/m^2/^{\circ}C$  can generally be used with a sheet steel enclosure (exact values can be obtained by the supplier of the material). If in any doubt, allow for a greater margin in the temperature rise.

**Figure 3-10 Enclosure having front, sides and top panels free to dissipate heat**



Insert the following values:

- $T_{int}$   $40^{\circ}C$
- $T_{ext}$   $30^{\circ}C$
- $k$  5.5
- $P$  272W

The minimum required heat conducting area is then:

$$A_e = \frac{272W}{5.5(40 - 30)}$$

$$= 4.945 m^2 (53.90 ft^2) \quad (1 m^2 = 10.9 ft^2)$$

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

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

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

$$W = \frac{4.945 - (2 \times 2 \times 0.6)}{2 + 0.6}$$

$$= 0.979 m (38.5 in)$$

If the enclosure is too large for the space available, it can be made smaller only by attending to one or all of the following:

- Reducing the ambient temperature outside the enclosure, and/or applying forced-air cooling to the outside of the enclosure
- Reducing the number of drives in the enclosure
- Removing other heat-generating equipment

#### Calculating the air-flow in a ventilated enclosure

The dimensions of the enclosure are required only for accommodating the equipment. The equipment is cooled by the forced air flow.

Calculate the minimum required volume of ventilating air from:

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

Where:

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

Where:

- $P_o$  is the air pressure at sea level
- $P_i$  is the air pressure at the installation

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

#### Example

To calculate the size of an enclosure for the following:

- Three MP45A4 models operating under full load conditions
- Maximum ambient temperature inside the enclosure:  $40^{\circ}C$
- Maximum ambient temperature outside the enclosure:  $30^{\circ}C$

Dissipation of each drive: 168W

Dissipation from other heat generating equipment. 15 W

Total dissipation:  $3 \times (168 + 15) = 549W$

Insert the following values:

- $T_{int}$   $40^{\circ}C$
- $T_{ext}$   $30^{\circ}C$
- $k$  1.3
- $P$  549W

Then:

$$V = \frac{3 \times 1.3 \times 549}{40 - 30}$$

$$= 214.1 \text{ m}^3/\text{hr} \text{ (126.3 ft}^3/\text{min)} \quad (1 \text{ m}^3/\text{hr} = 0.59 \text{ ft}^3/\text{min)}$$

### 3.7 Heatsink fan operation

Mentor MP drive rated 75A and above are ventilated by internally supplied fans.

Ensure the minimum clearances around the drive are maintained to allow the air to flow freely.

The drive controls the fan operation based on the temperature of the heatsink and the drives thermal model system.

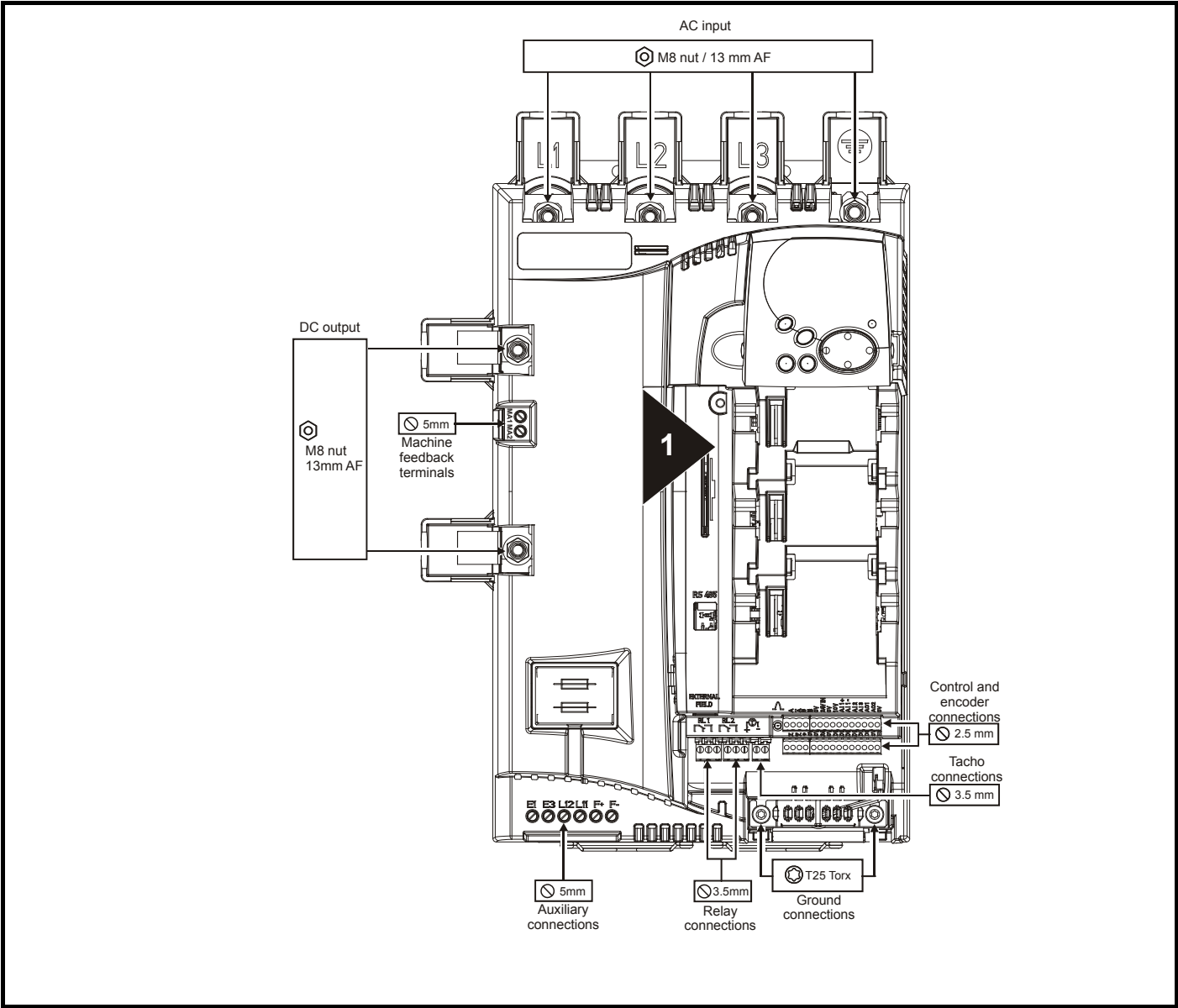
### 3.8 IP Rating (Ingress Protection)

An explanation of IP Rating is provided in section 12.1.11 *IP Rating* on page 128.


3.9 Electrical terminals

3.9.1 Location of the power and ground terminals

Figure 3-11 Location of the power and ground terminals



3.9.2 Terminal sizes and torque settings



**WARNING**

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

3.9.3 Torque settings

Table 3-2 Drive control, status relay and encoder terminal data

Model	Connection type	Torque setting
All	Plug-in terminal block	0.5 Nm 0.4 lb ft

Table 3-3 Drive auxiliary and machine armature terminal data

Model	Connection type	Torque setting
All	Terminal block	0.5 Nm 0.4 lb ft

Table 3-4 Drive power stage terminals

Model	Connection type	Torque setting
All	M8 stud	10 Nm 7.4 lb ft

### 3.10 Routine maintenance

The drive should be installed in a cool, clean, well ventilated location. Contact of moisture and dust with the drive should be prevented.

Regular checks of the following should be carried out to ensure drive / installation reliability are maximized:

Environment	
Ambient temperature	Ensure the enclosure temperature remains at or below maximum specified
Dust	Ensure the drive remains dust free – check that the heatsink and drive fan are not gathering dust. The lifetime of the fan is reduced in dusty environments.
Moisture	Ensure the drive enclosure shows no signs of condensation
Enclosure	
Enclosure door filters	Ensure filters are not blocked and that air is free to flow
Electrical	
Screw connections	Ensure all screw terminals remain tight
Crimp terminals	Ensure all crimp terminals remains tight – check for any discoloration which could indicate overheating
Cables	Check all cables for signs of damage

## 4 Electrical installation

Many cable management features have been incorporated into the product and accessories, this chapter shows how to optimize them. Key features include:

- EMC compliance
- Product rating, fusing and cabling information
- External suppressor resistor details (selection / ratings)



**WARNING**

### Electric shock risk

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

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

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



**WARNING**

### Isolation device

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



**WARNING**

### STOP function

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



**WARNING**

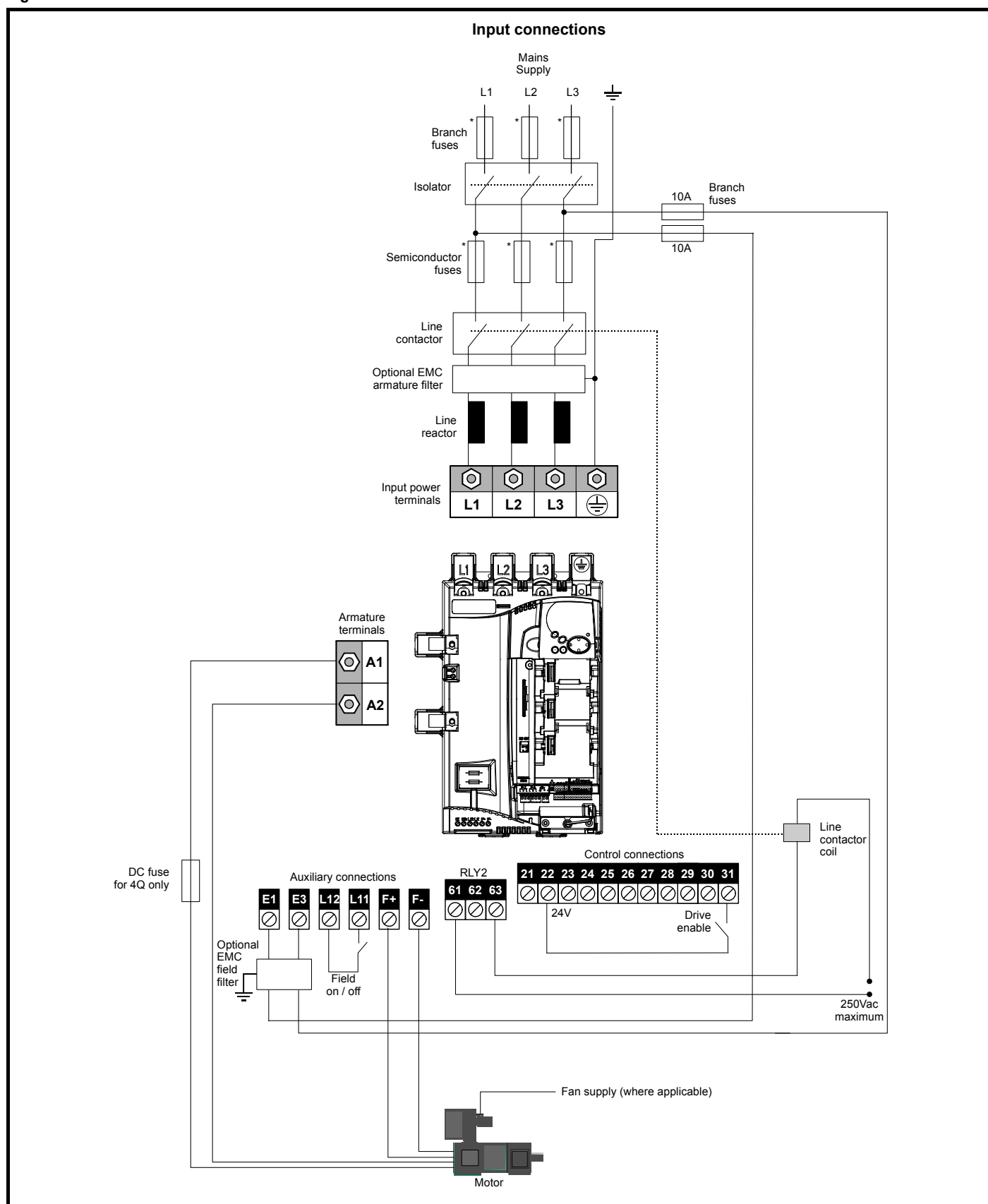
Drives are suitable for use on supplies of installation category III and lower, according to IEC60664-1. This means they may be connected permanently to the supply at its origin in a building, but for outdoor installation additional over-voltage suppression (transient voltage surge suppression) must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

## 4.1 Electrical connections/ Power connections

### 4.1.1 AC and DC connections

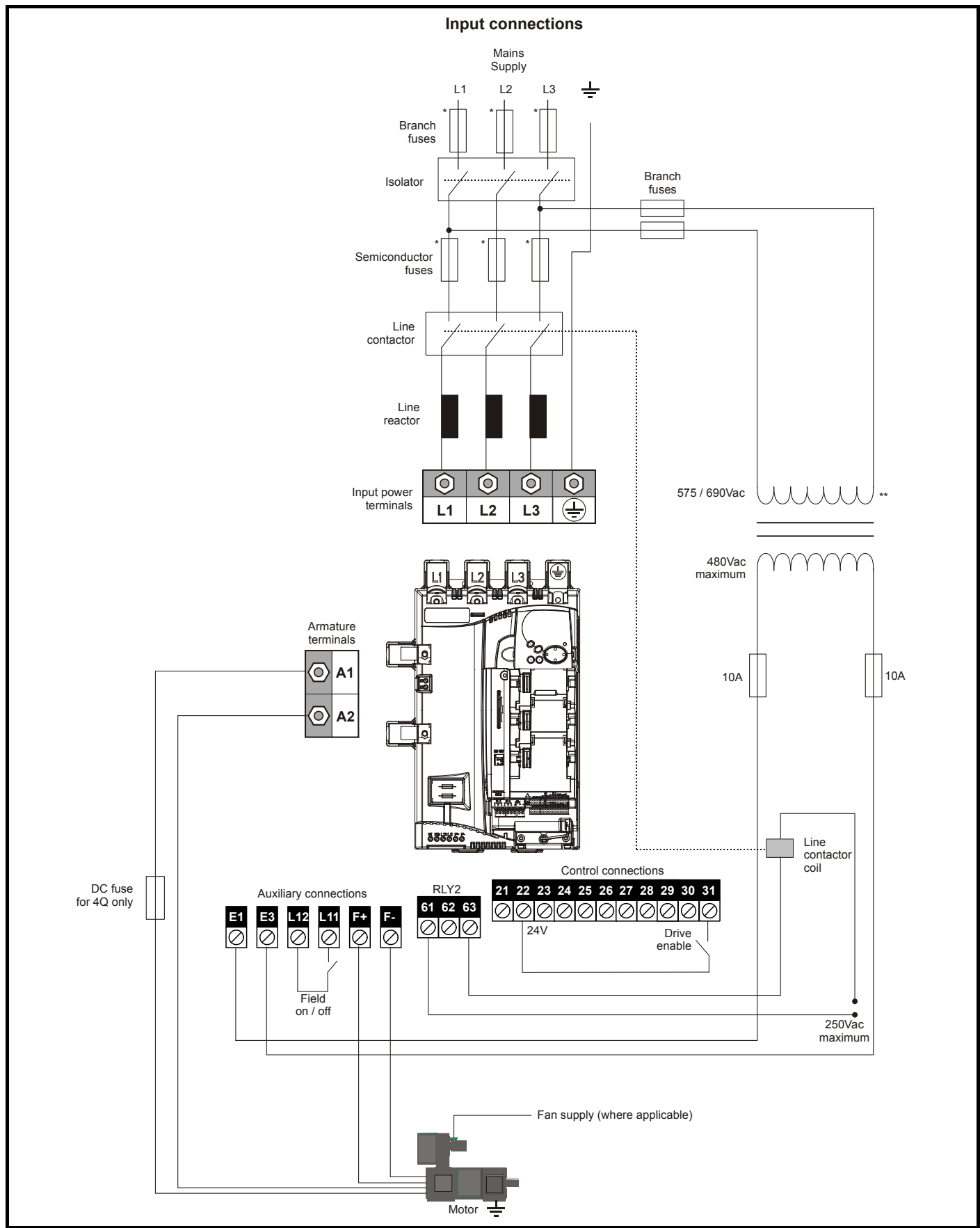
Refer to Figure 4-1 and Figure 4-2 to understand the function of the different power connections

**Figure 4-1 Power connections for 480V drive**



\* For fuse ratings refer to section 4.6 *Cable and fuse size ratings* on page 30.

**Figure 4-2 Power connections for 575V / 690V drive**




\* For fuse ratings refer to section 4.6 *Cable and fuse size ratings* on page 30.


\*\* The transformer must have zero phase delay.

## 4.2 Ground connections

The drive must be connected to the system ground of the AC supply. The ground wiring must conform to local regulations and codes of practice.

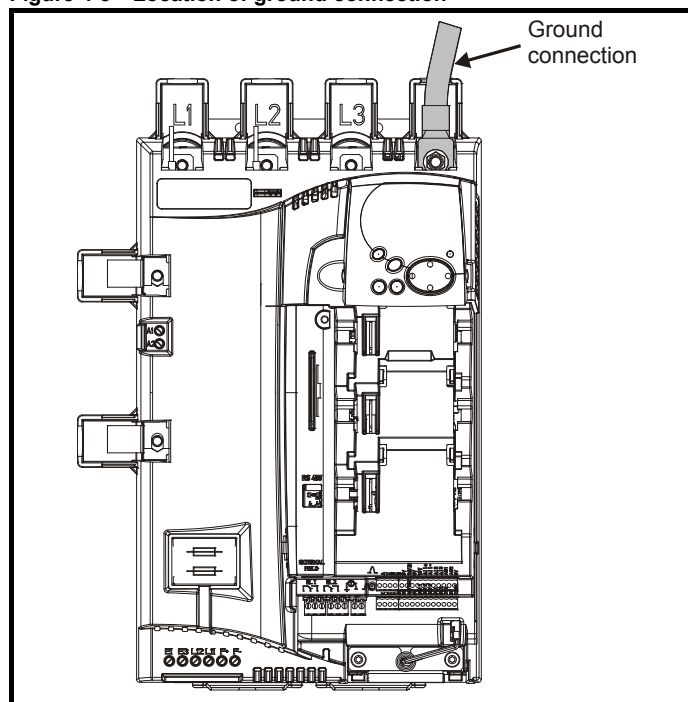


Where there is a possibility of temporary condensation or corrosion occurring, the ground connection should be protected from corrosion by suitable jointing compound.



**Ground loop impedance**  
The ground loop impedance must conform to the requirements of local safety regulations.  
The drive must be grounded by a connection capable of carrying the prospective fault current until the protective device (fuse, etc.) disconnects the AC supply.  
The ground connections must be inspected and tested at appropriate intervals.

**Figure 4-3 Location of ground connection**




## 4.3 AC supply requirements

The standard drive is rated for a nominal supply voltage up to 480Vrms.

An optional rating of 575Vrms is available for drive sizes MP25Ax(R) to MP210Ax(R).

An optional rating of 690Vrms is available for drive sizes MP350Ax(R) and above.



Grounded delta supplies exceeding 575V (nominal) are not permitted.

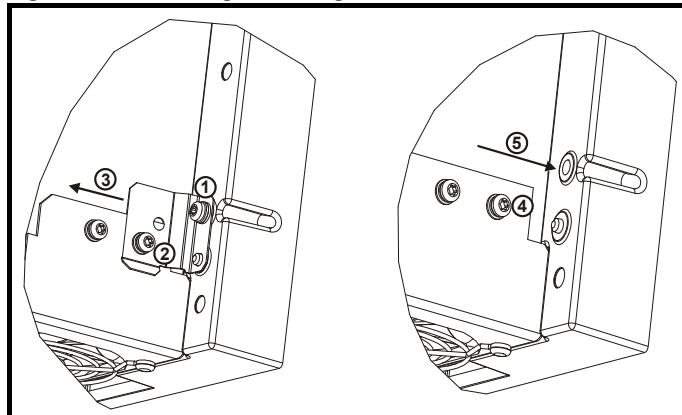
### 4.3.1 Supply types

Drives rated for supply voltage up to 575V are suitable for use with any supply type, i.e. TN-S, TN-C-S, TT, IT, with grounding at any potential, i.e. neutral, centre or corner ("grounded-delta").

### 4.3.2 MOV ground disconnect


The facility for disconnecting the link between varistors and ground is provided for special circumstances, where a sustained high voltage may be present between lines and ground, for example during a high potential test or in certain situations with IT supplies and multiple generators. If the link is disconnected then the immunity of the drive to high voltage impulses is reduced. It is then only suitable for use with supplies having overvoltage category II, i.e. not for connection at the origin of the low voltage supply within a building.

**Figure 4-4 Removing the MOV ground connection**



The method for disconnecting the MOV ground connection is shown below:

1. Remove the M4 x 16 screw using T20 Torx driver.
2. Remove the M4 x 12 screw using T20 Torx driver.
3. Remove the plate.
4. Re-fit the M4 x 12 screw using T20 Torx driver and tighten to a torque of 0.6 Nm (0.44 lb ft).
5. Fit a M4 x 16 **nylon screw** (not supplied) and tighten to a torque of 0.25 Nm (0.18 lb ft).



The M4 x 16 screw (1) should not be re-used if the plate (3) is not re-installed. Instead a nylon screw should be used.

### 4.3.3 Thyristor bridge AC supply

**Table 4-1 Three phase AC supply**

Specification	Product voltage variant		
	480V	575V	690V
Max nominal supply	480V	575V	690V
Tolerance	+10%		
Min nominal supply	24V	500V	
Tolerance	-20%	-10%	

## 4.4 Line reactors

The Mentor MP, in common with all naturally commutated thyristor drives, causes voltage notches at the input supply terminals. In order to avoid disturbance to other equipment using the same supply, the addition of external line inductance is strongly recommended in order to restrict the depth of the notches imposed on the shared supply. This is generally not necessary where a dedicated transformer is used to supply the drive.

The following recommendations for added line inductance, have been calculated based on the power drive systems standard: EN61800-3:2004 "Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods".

#### NOTE

The current ratings specified in Table 4-2 and Table 4-3 are for typical motor currents where the motor current ripple is no more than 50% of drive rating.



**Table 4-2 Minimum values of  $L_{add}$  and inductor current rating - 400V & 575V supply**

Model	$L_{add}$	Typical current rating	Maximum current rating
	$\mu H$	A	A
MP25Ax(R)	220	21	22
MP45Ax(R)	220	38	40
MP75Ax(R)	220	63	67
MP105Ax(R)	220	88	94
MP155Ax(R)	160	130	139
MP210Ax(R)	120	180	188
MP350A4(R)	71	290	313
MP420A4(R)	59	350	376
MP550A4(R)	45	460	492
MP700A4(R)	36	590	626
MP825A4(R)	30	690	738
MP900A4(R)	28	750	805
MP1200A4(R)	21	1000	1073
MP1850A4(R)	18	1600	1655

**Table 4-3 Minimum values of  $L_{add}$  and inductor current rating – 690V supply**

Model	$L_{add}$	Typical current rating	Maximum current rating
	$\mu H$	A	A
MP350A6(R)	120	290	313
MP420A6(R)	100	350	376
MP550A6(R)	79	460	492
MP700A6(R)	62	590	626
MP825A6(R)	53	690	738
MP900A6(R)	48	750	805
MP1200A6(R)	36	1000	1073
MP1850A6(R)	32	1600	1655

#### 4.4.1 Auxiliary AC supply and connections

**Table 4-4 Terminal functions**

Terminals	Function
E1, E3	Supply for control electronics and field controller. These terminals should be in phase with the mains supply to the drive.
L11, L12	Field on / off. When L11 and L12 are open the supply is disconnected to the field regulator so there will be no field current.
F+, F-	Field supply to the motor.
MA1, MA2	These terminals are used to provide feedback from the motor armature terminals. This is required when the user has a contactor in the main DC armature connection. When the contactor is opened the drive will still be receiving armature feedback. This allows the field regulator to function correctly when the contactor is open.

**Table 4-5 One phase line to line supply**

Specification	Value
Max nominal supply	480V
Tolerance	+10%
Min nominal supply	208V
Tolerance	-10%

Each drive has an on-board field controller with the following current ratings.

**Table 4-6 Current ratings**

Model	Maximum continuous field current rating A
MP25Ax(R) MP45Ax(R) MP75Ax(R) MP105Ax(R) MP155Ax(R) MP210Ax(R)	8
MP350Ax(R) MP420Ax(R) MP550Ax(R) MP700Ax(R) MP825Ax(R) MP900Ax(R)	10
MP1200Ax(R) MP1850Ax(R)	20

#### 4.4.2 Supply requirements

Maximum supply in-balance: 2% negative phase sequence (equivalent to 3% voltage in-balance between phases)

Frequency range: 48 to 65 Hz (maximum rate of frequency change is 7Hz/s)

### 4.5 Control 24Vdc supply

The 24Vdc input has three main functions.

- It can be used to supplement the drive's own internal 24V when multiple SM-Universal Encoder Plus, SM-Encoder Output Plus, SM-I/O Plus, or SM-I/O 32 modules are being used and the current drawn by these modules is greater than the drive can supply. (If too much current is drawn from the drive, the drive will initiate a 'PS.24V' trip)
- It can be used as a back-up power supply to keep the control circuits of the drive powered up when the line power supply is removed. This allows any fieldbus modules, application modules, encoders or serial communications to continue to operate.
- It can be used to commission the drive when the line power supply is not available, as the display operates correctly. However, the drive will be in the UV trip state unless the line power supply is enabled, therefore diagnostics may not be possible. (Power down save parameters are not saved when using the 24V back-up power supply input.)

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

Maximum continuous operating voltage:	30.0 V
Minimum continuous operating voltage:	19.2 V
Nominal operating voltage:	24.0 V
Minimum start up voltage:	21.6 V
Maximum power supply requirement at 24V:	60 W
Recommended fuse:	3 A, 50 Vdc

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


#### 4.5.1 Supply fault current

The maximum fault current level of the supply to all circuits is as follows:

Frame size	Supply fault current
1A, 1B, 2A & 2B	30kA
2C & 2D	85kA

See Table 2-1 on page 6 for model to frame size cross reference.

## 4.6 Cable and fuse size ratings



The selection of the correct fuse is essential to ensure the safety of the installation

**WARNING**

Maximum continuous input currents are given in section 2.1 *Ratings* on page 6 to aid the selection of fuses and cabling. The maximum input current is dependent on the ripple content of the output current. A value of 100% ripple has been assumed for the given ratings.

The cable sizing selected when installing a Mentor MP must comply with the local wiring regulations. The information provided in this section is provided for guidance purposes only.

The power terminals on the Mentor MP size 1 have been designed to accommodate a maximum cable size of 150mm<sup>2</sup> (350kcmil) with a temperature rating of 90°C (194°F).

The actual cable size depends on a number of factors including:

- Actual maximum continuous current
- Ambient temperature
- Cable support, method and grouping
- Cable voltage drop

In applications where the motor used is of a reduced rating, the cable sizing selected can be appropriate for that motor. To protect the motor and the output cabling the drive must be programmed with the correct motor rated current.

### NOTE

When using reduced cable sizes, the branch circuit protection fuse rating needs to be reduced in line with the cable size selected.

The following table shows typical cable sizes based on USA and International standards, assuming 3 conductors per raceway/conduit, an ambient temperature of 40°C (104°F) and applications with high output current ripple content.

**Table 4-7 Typical cable sizes**

Model	IEC 60364-5-52 <sup>[1]</sup>		UL508C/NEC <sup>[2]</sup>	
	Input	Output	Input	Output
MP25Ax(R)	2.5mm <sup>2</sup>	4mm <sup>2</sup>	8 AWG	
MP45Ax(R)	10mm <sup>2</sup>		4 AWG	
MP75Ax(R)	16mm <sup>2</sup>	25mm <sup>2</sup>	1 AWG	1/0 AWG
MP105Ax(R)	25mm <sup>2</sup>	35mm <sup>2</sup>	1/0 AWG	
MP155Ax(R)	50mm <sup>2</sup>	70mm <sup>2</sup>	3/0 AWG	4/0 AWG
MP210Ax(R)	95mm <sup>2</sup>		300kcmil	350kcmil

### NOTE

1. The maximum cable size is defined by the power terminal housing using 90°C (194°F) rated cables as per Table A.52-5 of the standard.
2. Assumes the use of 75°C rated cables, as per Table 310.16 of the National Electrical Code.

The use of higher temperature rated cable would allow a reduction on the minimum recommended cable size for Mentor MP shown above. For high temperature cable sizing, please contact the supplier of the drive.

#### 4.6.1 Ferraz Shawmut fuses

Ferraz Shawmut fuses are recommended for the Mentor MP.

**Table 4-8 Ferraz Shawmut semiconductor fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
Auxiliary	10x38mm ferrule	690Vac	12.5A	FR10GB69V12.5	H330011
MP25Ax	22x58mm ferrule	690Vac	32A	FR22GC69V32	A220915
MP45Ax			63A	FR22GC69V63	X220912
MP75Ax			100A	FR22GC69V100	W220911
MP25AxR			32A	FR22GC69V32	A220915
MP45AxR			63A	FR22GC69V63	X220912
MP75AxR			100A	FR22GC69V100	W220911
MP105Ax	Size 30 square body fuse	690Vac	160A	PC30UD69V160EF	M300092
MP155Ax			200A	PC30UD69V200EF	N300093
MP210Ax			315A	PC30UD69V315EF	Q300095
MP105AxR	Size 70 square body fuse	1250Vac	160A	PC70UD13C160EF	T300604
MP155AxR			200A	PC70UD13C200EF	V300605
MP210AxR			280A	PC70UD12C280EF	L300712

**Table 4-9 Ferraz Shawmut branch circuit protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	gG Catalogue number	Ref number	UL Class J alternative
Auxiliary	21x57mm cylindrical	600Vac	10A			AJT10
MP25Ax	22x58mm ferrule	690Vac	25A	FR22GG69V25	N212072	AJT30
MP45Ax			50A	FR22GG69V50	P214626	AJT45
MP75Ax			80A	FR22GG69V80	Q217180	AJT70
MP25AxR			25A	FR22GG69V25	N212072	AJT30
MP45AxR			50A	FR22GG69V50	P214626	AJT45
MP75AxR			80A	FR22GG69V80	Q217180	AJT70
MP105Ax	NH 00 knife blade		100A	NH00GG69V100	B228460	AJT125
MP155Ax	NH 1 knife blade		160A	NH1GG69V160	F228487	AJT175
MP210Ax	NH 1 knife blade		200A	NH1GG69V200	G228488	AJT225
MP105AxR	NH 00 knife blade		100A	NH00GG69V100	B228460	AJT125
MP155AxR	NH 1 knife blade		160A	NH1GG69V160	F228487	AJT175
MP210AxR	NH 1 knife blade		200A	NH1GG69V200	G228488	AJT225

**Table 4-10 Ferraz Shawmut DC protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number	Configuration
MP25AxR	20x127mm cylindrical	1000Vdc	32A	FD20GB100V32T	F089498	single fuse
MP45AxR	36x127mm cylindrical		80A	FD36GC100V80T	A083651	
MP75AxR	20x127mm cylindrical		63A	FD20GC100V63T	F083656	2 in parallel
MP105AxR	Size 120 square body	750Vdc	160A	D120GC75V160TF	R085253	single fuse
MP155AxR	Size 121 square body		250A	D121GC75V250TF	Q085252	
MP210AxR	Size 122 square body		315A	D122GC75V315TF	M085249	

#### 4.6.2 Alternative fusing

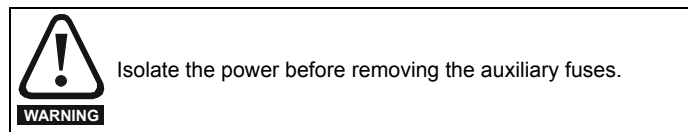
Please refer to section 12.2.2 *Alternative fusing* on page 132.

**Table 4-11 Mentor MP frame 1 drive thyristor  $I^2t$  rating for semiconductor fusing**

Model	Thyristor $I^2t$ (A <sup>2</sup> s)
Auxiliary	400
MP25Ax	1030
MP45Ax	3600
MP75Ax	15000
MP25AxR	1030
MP45AxR	3600
MP75AxR	15000
MP105Ax	80000
MP155Ax	
MP210Ax	
MP105AxR	
MP155AxR	
MP210AxR	

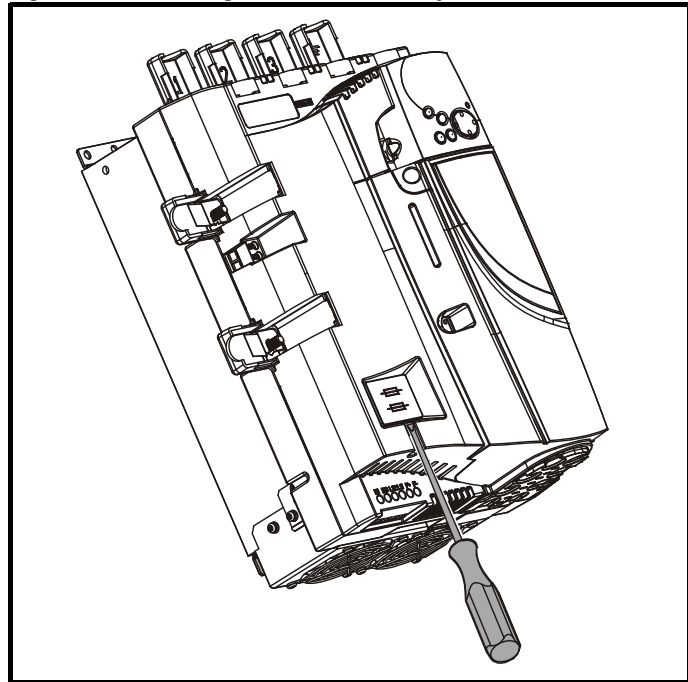
### 4.6.3 Internal auxiliary fuses

The internal auxiliary fuses provide protection to the field controller. The fuses can rupture if there is a fault in the field circuit. The user should check the internal auxiliary fuses if the drive is tripping field loss (FdL) and the field controller is enabled.



Isolate the power before removing the auxiliary fuses.

**Figure 4-5 Removing the internal auxiliary fuses**



Insert the screwdriver into the groove as shown above and lever downwards to remove the fuse cover. Refer to section 4.6.1 for fuse types.

## 4.7 External suppressor resistor

The Mentor MP range of drives provide internal suppression of the voltage overshoots created by commutation of the thyristors in the power stage during the operation of the product. The internal suppression is suitable for typical applications using recommended line reactors as defined in section 4.4 *Line reactors* on page 28. The Mentor MP drives provide the facility to allow for extra suppression for applications at the

boundaries of the drive's operating area. Applications which may require an external suppression resistor to be installed have some or all the following characteristics:

1. Supplies rated  $\geq 10\text{kA}$  with less than the recommend line reactance.
2. High line-to-line voltage

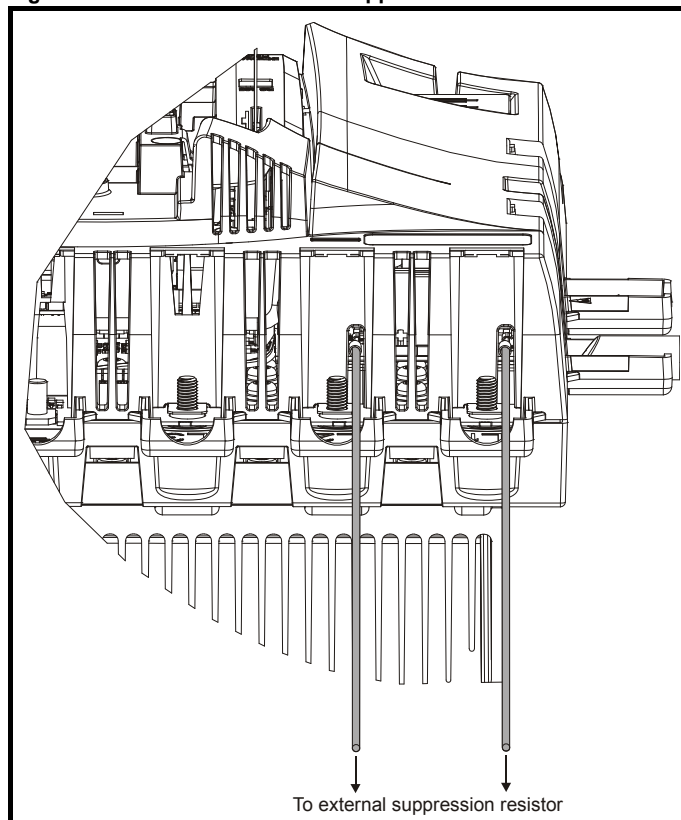
The recommended external suppressor resistor selections are shown in Table 4-12.

**Table 4-12 Recommended external suppressor resistors**

Model	Resistance k $\Omega$	Power rating W	Voltage rating V	Isolation voltage Vrms
MP25A4(R)	8.2	150	1100	2500
MP45A4(R)				
MP75A4(R)				
MP105A4(R)				
MP155A4(R)				
MP210A4(R)				
MP25A5(R)	15	150	1400	2500
MP45A5(R)				
MP75A5(R)				
MP105A5(R)				
MP155A5(R)				
MP210A5(R)				

The following diagram shows the location of the external suppressor resistor terminals above the L1 and L2 terminals:

**Figure 4-6 Location of external suppressor resistor terminals**



For applications where the external suppressor resistance is chosen to be less than the recommended value for reasons of economy, it is essential that the resistance is not less than the minimum resistance shown in Table 4-13. However selecting a resistance less than the recommended value requires a more complex installation. The power rating of the resistor can be selected by the user according to the dissipation required for the application, up to a maximum of 150W.

**Table 4-13 Minimum allowable external suppression resistance**

Model	Resistance $\Omega$
MP25Ax	500 (maximum 150W)
MP45Ax	
MP75Ax	
MP105Ax	
MP155Ax	
MP210Ax	
MP25Ax	
MP45Ax	
MP75Ax	
MP105Ax	
MP155Ax	
MP210Ax	

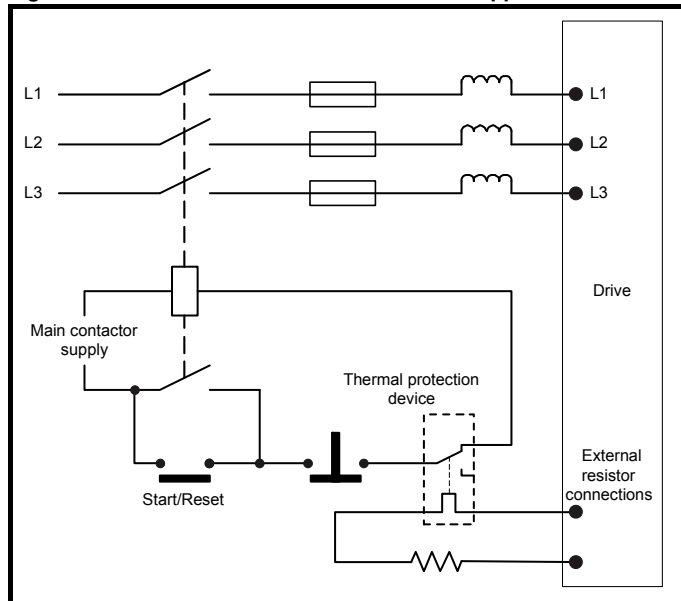


**Overload Protection**  
When using an external suppressor resistor of a resistance or power rating less than the recommended rating, it is essential that an overload protection device is incorporated in the resistor circuit (refer to Figure 4-7).



**External suppressor resistor protection parameter settings**  
The software provided by the Mentor MP provides overload protection. Failure to correctly configure Pr 11.62, Pr 11.63 and Pr 11.64, as described in the *Advanced User Guide* could lead to the resistor being overloaded.

**Figure 4-7 Protection circuit for an external suppression resistor**



## 4.8 Ground leakage

The ground leakage current depends on whether an external EMC filter is installed. Ground leakage currents for external EMC filters can be obtained from the manufacturers data sheet for the filter being used.

**With no external EMC filter:**

<1mA

### 4.8.1 Use of residual current device (RCD)

There are three common types of ELCB / RCD:

1. AC - detects AC fault currents
2. A - detects AC and pulsating DC fault currents (provided the DC current reaches zero at least once every half cycle)
3. B - detects AC, pulsating DC and smooth DC fault currents
  - Type's A and AC should never be used with Mentor MP drives.
  - Type B must be used with all Mentor MP drives.



Only type B ELCB / RCD are suitable for use with Mentor MP drives.

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

#### NOTE

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

## 4.9 EMC (Electromagnetic compatibility)

The Mentor MP meets immunity requirements (specified in section 12.2.4 *Electromagnetic compatibility (EMC)* on page 134 ) with no special precautions.

#### NOTE

Some special measures may be required in certain applications where the control cables are long or pass outside the building. See section 4.9.5 *Surge immunity of control circuits - long cables and connections outside a building* on page 34.

Radio frequency noise emission can occur from any of the power connections i.e. main and auxiliary A.C connections, armature and field output terminals.

For many applications in heavy industrial environments the noise emission is not sufficient to cause interference to other equipment.

When radio frequency emission must be limited the method used should be chosen to suit the situation.

### 4.9.1 Power drive systems standard

Compliance with the EMC standard for power drive systems (PDS) IEC61800-3, EN61800-3 category C3

To meet this standard a standard armature filter and a standard field filter must be installed. See Table 4-14 for EMC filter cross references.

Shielded cables must be used for the field and armature and the shields must be clamped to ground at both ends. The standard is met for cable lengths up to 100m.

### 4.9.2 Generic standard and PDS category C2

Compliance with the EMC standard for generic emission category C2 IEC61000-6-4, EN61000-6-4.

To meet this standard a standard field filter and a high performance armature filter must be installed. See Table 4-14 for EMC filter cross references.

Shielded cables must be used for the field and armature and the shields must be clamped to ground at both ends. The standard is met for cable lengths up to 100m.

### 4.9.3 Other methods

A low cost filter technique is described in the EMC data sheet for the Mentor MP. This requires care in application and is not recommended for general use.

### 4.9.4 EMC filter information

Refer to Figure 4-1 on page 26 for the location of the optional EMC filter. See Table 4-14 for EMC filters that can be sourced directly from Epcos and Schaffner.

**Table 4-14 Mentor MP and EMC filter cross references**

Model	Manufacturers part number				
	Schaffner armature standard	Schaffner armature high performance	Epcos armature high performance	Schaffner standard field filter	Epcos standard field filter
MP25A4(R)	FN3270H-80-35	FN3258-75-52	B84143-A66-R105	FN3280H-8-29	W62400-T1262
MP45A4(R)			*B84143-A90-R105		
MP75A4(R)					
MP105A4(R)	FN3270H-200-99	FN3258H-180-40	B84143BO250S080	FN3280H-8-29	W62400-T1262
MP155A4(R)					
MP210A4(R)					

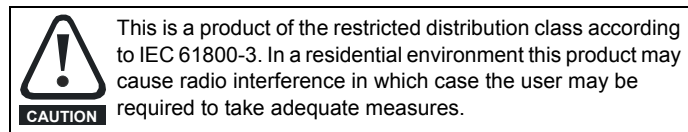
\* This filter is required if the input current to the Mentor MP will be greater than 66Amps.

**Table 4-15 Size 1 emission compliance summary**

Model	Filter		
	None	Field: Standard armature: standard	Field: Standard armature: High performance
MP25A4(R)	C4	C3	C2
MP45A4(R)			
MP75A4(R)			
MP105A4(R)			
MP155A4(R)			
MP210A4(R)			

**Key** (shown in decreasing order of permitted emission level):

- C4 EN 61800-3 second environment, restricted distribution (Additional measures may be required to prevent interference)
- C3 EN 61800-3 second environment, unrestricted distribution
- C2 Industrial generic standard EN 50081-2 (EN 61000-6-4)  
EN 61800-3 first environment restricted distribution (The following caution is required by EN 61800-3)



- C1 Residential generic standard EN 50081-1 (EN 61000-6-3)  
EN 61800-3 first environment unrestricted distribution

EN 61800-3 defines the following:

- The first environment is one that includes residential premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes.
- The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes.
- Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

### 4.9.5 Surge immunity of control circuits - long cables and connections outside a building

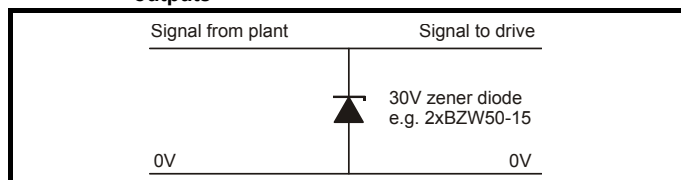
The input/output ports for the control circuits are designed for general use within machines and small systems without any special precautions.

In applications where they may be exposed to high-energy voltage surges, some special measures may be required to prevent malfunction or damage. Surges may be caused by lightning or severe power faults in association with grounding arrangements which permit high transient voltages between nominally grounded points. This is a particular risk where the circuits extend outside the protection of a building.

As a general rule, if the circuits are to pass outside the building where the drive is located, or if cable runs within a building exceed 30m, some additional precautions are advisable. One of the following techniques should be used:

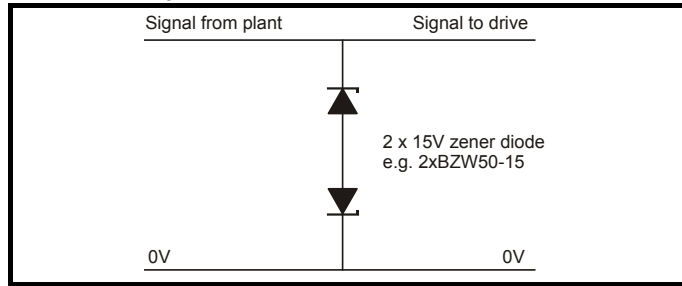
- Galvanic isolation, i.e. do not connect the control 0V terminal to ground. Avoid loops in the control wiring, i.e. ensure every control wire is accompanied by its return (0V) wire.
- Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10mm<sup>2</sup>, or 10 times the area of the signal cable shield, or to suit the electrical safety requirements of the plant. This ensures that fault or surge current passes mainly through the ground cable and not in the signal cable shield. If the building or plant has a well-designed common bonded network this precaution is not necessary.
- Additional over-voltage suppression - for the analog and digital inputs and outputs, a zener diode network or a commercially available surge suppressor may be connected in parallel with the input circuit as shown in Figure 4-8 and Figure 4-9.

**Figure 4-8 Surge suppression for digital and unipolar inputs and outputs**





**Figure 4-9 Surge suppression for analog and bipolar inputs and outputs**



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

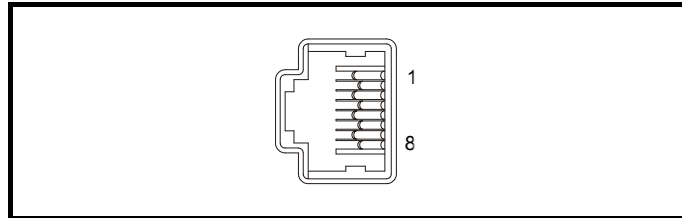
Unipolar TT-UKK5-D/24 DC  
Bipolar TT-UKK5-D/24 AC

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

## 4.10 Serial communications connections

The Mentor MP has a serial communications port (serial port) as standard supporting two wire EIA485 communications. Please see Table 4-16 for the connection details for the RJ45 connector.

**Figure 4-10 Serial communications port**



**Table 4-16 RJ45 connections**

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

The communications port applies a two-unit load to the communications network. Connectors 2, 3, 7 and shield must always be made to the serial communications port. Shielded cable must be used at all times.

### 4.10.1 Isolation of the serial communications port

The serial PC communications port is double insulated and meets the requirements for SELV in EN50178.

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

An isolated serial communications lead has been designed to connect the drive to IT equipment (such as lap-top computers), and is available from the supplier of the drive. See Table 4-17 for details.

**Table 4-17 Isolated serial comms lead details**

Part number	Description
4500-0087	CT EIA232 Comms cable
4500-0096	CT USB Comms cable

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

#### NOTE

When using the CT EIA232 Comms cable the available baud rate is limited to 19.2k baud.

### 4.10.2 Multi-drop network

The drive can be used on a 2 wire EIA485 multi-drop network using the drive's serial communications port when the following guidelines are adhered to.

#### Connections

The network should be a daisy chain arrangement and not a star, although short stubs to the drive are allowed.

The minimum connections are pins 2 (RX TX), 3 (isolated 0V), 7 (RX\ TX\ ) and the shield.

Pin 4 (+24V) on each drive can be connected together but there is no power sharing mechanism between drives and therefore the maximum power available is the same as a single drive. (If pin 4 is not linked to the other drives on the network and has an individual load then the maximum power can be taken from pin 4 of each drive.)

#### Termination resistors

If a drive is on the end of the network chain then pins 1 and 8 should be linked together. This will connect an internal 120Ω termination resistor between RXTX and RX\TX\ . (If the end unit is not a drive or the user wishes to use their own termination resistor, a 120Ω termination resistor should be connected between RXTX and RX\TX\ at the end unit.)

If the host is connected to a single drive then termination resistors should not be used unless the baud rate is high.

#### CT Comms cable

The CT Comms cable can be used on a multi-drop network but should only be used occasionally for diagnostic and set up purposes. The network must also be made up entirely of Mentor MPs.

If the CT Comms cable is to be used, then pin 6 (TX enable) should be connected on all drives and pin 4 (+24V) should be linked to at least 1 drive to supply power to the converter in the cable.

Only one CT Comms cable can be used on a network.

### 4.11 Shield connections

These instructions must be followed to ensure suppression of radio-frequency emission and good noise immunity in the encoder circuit. It is recommended that the instructions for the connection of the encoder cable be followed closely and, to use the grounding bracket and grounding clamp supplied with the drive, to terminate the shields at the drive.

#### 4.11.1 Motor cables

Use of a motor cable with an overall shield for the armature and field circuits may be needed if there is a critical EMC emissions requirement. Connect the shield of the motor cable to the ground terminal of the motor frame using a link that is as short as possible and not exceeding 50mm (2in) long. A full 360° termination of the shield to the terminal housing of the motor is beneficial.

#### 4.11.2 Encoder cable

To get the best results from shielding use cable with an overall shield and separate shields on individual twisted pairs. Refer to section 4.14 *Connecting an encoder* on page 40.

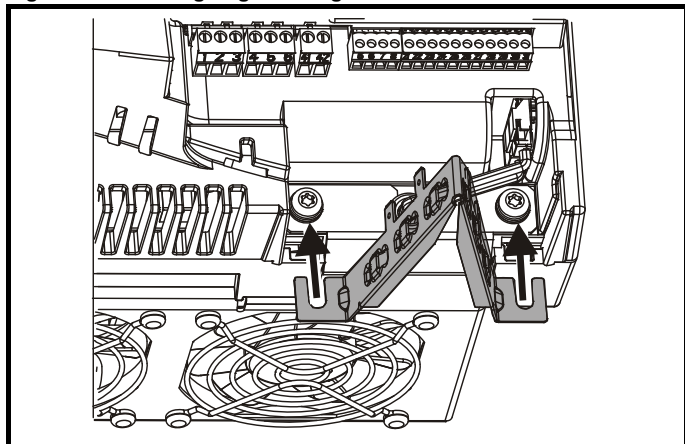
### 4.11.3 Control cables

It is recommended that signal cables should be shielded. This is essential for encoder cables, and strongly recommended for analog signal cables. For digital signals it is not necessary to use shielded cables within a panel, but this is recommended for external circuits, especially for inputs where a momentary signal causes a change of state (i.e. latching inputs).

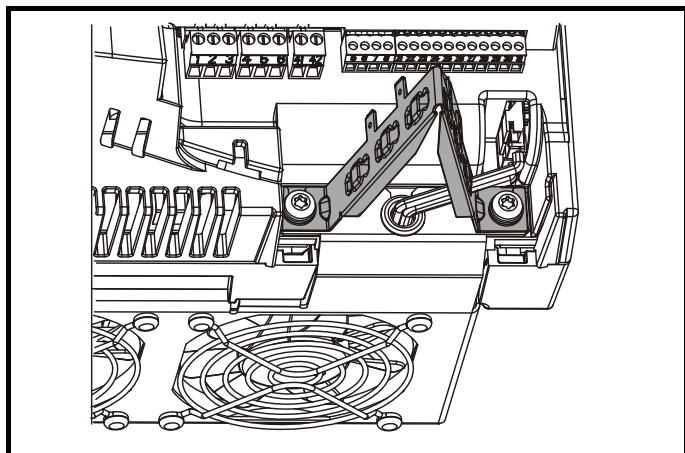
### 4.11.4 Grounding hardware

The drive is supplied with a grounding bracket, to facilitate EMC compliance. This provides a convenient method for direct grounding of cable shields without the use of "pig-tails". Cable shields can be bared and clamped to the grounding bracket using metal clips, clamps or cable ties. Note that the shield must in all cases be continued through the clamp to the intended drive terminal in accordance with the connection details for the specific signal.

**Figure 4-11 Fitting of grounding bracket**

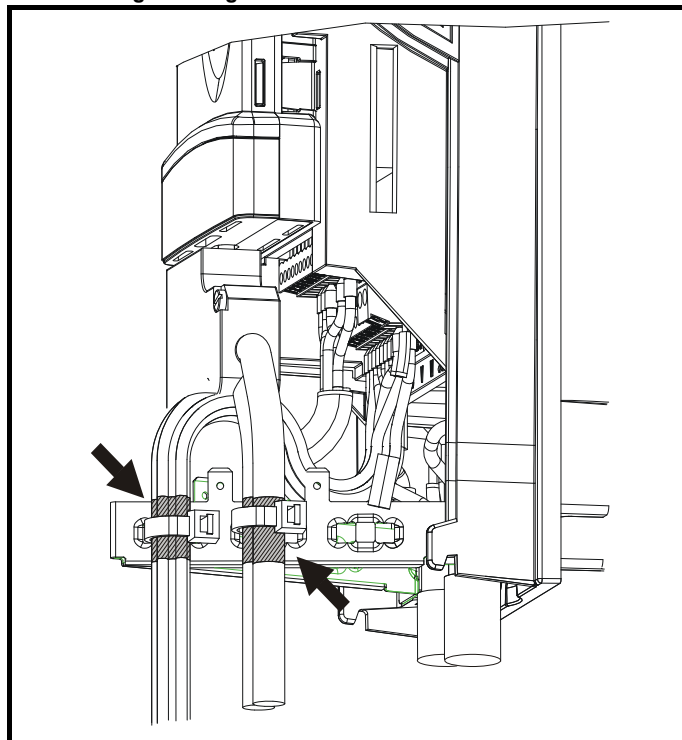


Loosen the ground connection (2 x M5 x 10) screws using T52 Torx driver and slide the grounding bracket in the direction shown. Once in place, re-tighten the ground connection M5 x 10 screws to 3Nm (2.21 lb ft).



A faston tab is located on the grounding bracket for the purpose of connecting the drive 0V to ground should the user wish to do so.

**Figure 4-12 Grounding of signal cable shields using the grounding bracket**



## 4.12 Control connections

Refer to Figure 4-13 to understand the connection of the different power connections.

### 4.12.1 General

**Table 4-18 The control connections consist of:**

Function	Qty	Control parameters available	Terminal number
Differential analog input	1	Destination, offset, invert, scaling	5,6
Single ended analog input	2	Mode, offset, scaling, invert, destination	7,8
Analog output	2	Source, mode, scaling,	9,10
Digital input	3	Destination, invert, logic select	27, 28, 29
Digital input / output	3	Input / output mode select, destination / source, invert, logic select	24, 25, 26
Relay	2	Source, invert	51, 52, 53 61, 62, 63
Drive enable	1	Logic select	31
+10V User output	1		4
+24V User output	1		22
0V common	6		1, 3, 11, 21, 23, 30
+24V External input	1		2

#### Key:

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

**Source parameter:** Indicates the parameter being output by the terminal

**Mode parameter:** Analog - indicates the mode of operation of the terminal, i.e. voltage 0-10V, current 4-20mA etc.  
Digital - indicates the mode of operation of the terminal, i.e. positive / negative logic, open collector.



All analog terminal functions can be programmed in menu 7.

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

The setting of Pr 6.04 can cause the function of digital inputs T25 to T27 to change. For more information, refer to section on page 124.



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 on the drive.



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.



Status relay contacts are over-voltage category II.

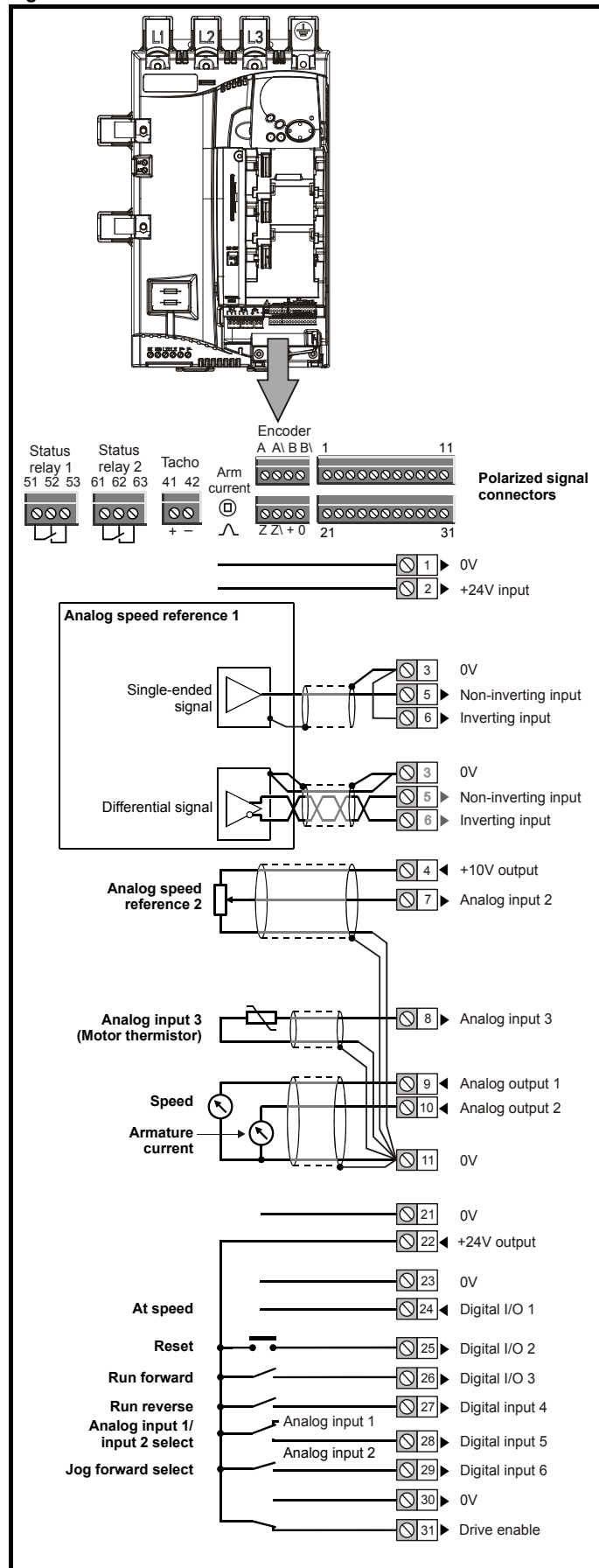


A fuse or other over-current protection should be installed to the relay circuit.

**Table 4-19 Control connection recommended cable sizes**

Terminal	Minimum cable size	Maximum cable size
Machine armature	0.5mm <sup>2</sup> 20 AWG	5mm <sup>2</sup> 10 AWG
Auxiliary		
Control I/O		1.31mm <sup>2</sup> 16 AWG
Encoder		
Tachogenerator		2.5mm <sup>2</sup> 12 AWG
Status relays		

**Figure 4-13 Default terminal functions**



## 4.13 General

### 4.13.1 Control terminal specification

1	0V common
Function	Common connection for all external devices

2	+24V external input
Function	To supply the control circuit without providing a supply to the power stage
Nominal voltage	+24.0Vdc
Minimum continuous operating voltage	+19.2Vdc
Maximum continuous operating voltage	+30.0Vdc
Minimum start-up voltage	21.6Vdc
Recommended power supply	60W 24Vdc nominal
Recommended fuse	3A, 50Vdc

3	0V common
Function	Common connection for all external devices

4	+10V user output
Function	Supply for external analog devices
Voltage tolerance	±1%
Nominal output current	10mA
Protection	Current limit and trip @12mA

	Precision reference analog input 1
5	Non-inverting input
6	Inverting input
Default function	Speed reference
Type of input	Bipolar differential analog (For single-ended use, connect terminal 6 to terminal 3)
Full scale voltage range	±10.0V ±1.5%
Absolute maximum voltage range	+30V, -18V relative to 0V
Working common mode voltage range	±16V
Input resistance	94kΩ
Resolution	14-bit plus sign
Monotonic	Yes
Dead band	None
Jumps	None
Maximum offset	±5mV
Maximum non linearity	±0.05% of Full scale voltage range
Maximum gain asymmetry	±0.2%
Input filter bandwidth single pole	~1kHz
Sampling period	250μs if configured with the destination as Pr 1.36, Pr 1.37, Pr 3.19 and Pr 4.08. 4ms for all other destinations

7	Analog input 2
Default function	Speed reference
Type of input	Unipolar voltage and current
Mode controlled by...	Pr 7.11
Operating in Voltage mode	
Full scale voltage range	±10.0V ±0.5%
Maximum offset	±33mV
Absolute maximum voltage	±36V relative to 0V
Input resistance	>94kΩ
Operating in current mode	
Current ranges	0 to 20mA ±5%, 20 to 0mA ±5%, 4 to 20mA ±5%, 20 to 4mA ±5%
Maximum offset	120μA
Absolute maximum voltage	±36V
Equivalent input resistance	~100Ω
Common to all modes	
Resolution	10 bit plus sign
Sampling period	250μs if configured with the destination as Pr 1.36, Pr 1.37, Pr 3.19 and Pr 4.08. 4ms for all other destinations

8	Analog input 3
Default function	Thermistor
Type of input	Unipolar voltage, unipolar current and thermistor
Input mode controlled by...	Pr 7.15 (in01, 0.81)
Operating in Voltage mode	
Voltage range	±10.0V ±0.5%
Maximum offset	±33mV
Absolute maximum voltage range	±36V relative to 0V
Input resistance	>94kΩ
Operating in current mode	
Current ranges	0 to 20mA ±5%, 20 to 0mA ±5%, 4 to 20mA ±5%, 20 to 4mA ±5%
Maximum offset	120μA
Absolute maximum voltage	±36V max
Equivalent input resistance	~100Ω
Operating in thermistor input mode	
Internal pull-up voltage	<5V
Trip threshold resistance	3.3kΩ ±10%
Reset resistance	1.8kΩ ±10%
Short-circuit detection resistance	50Ω ±40%
Common to all modes	
Resolution	10 bit + sign
Sampling period	250μs if configured with the destination as Pr 1.36, Pr 1.37, Pr 3.19 and Pr 4.08. 4ms for all other destinations

<b>9</b>	<b>Analog output 1</b>
<b>10</b>	<b>Analog output 2</b>
Terminal 9 default function	Speed feedback
Terminal 10 default function	Current feedback
Type of output	Bipolar single-ended voltage or unipolar single-ended current
Mode controlled by...	
<b>Operating in Voltage mode (default)</b>	
Full scale voltage range	$\pm 10V \pm 5\%$
Maximum offset	$\pm 40mV$
Maximum output current	$\pm 35mA$
Load resistance	$1k\Omega$ min
Protection	35mA max. Short circuit protection
<b>Operating in current mode</b>	
Current ranges	0 to 20mA $\pm 5\%$ 4 to 20mA $\pm 5\%$
Maximum offset	350 $\mu A$
Open circuit voltage	+15V
Load resistance	600 $\Omega$ max
<b>Common to all modes</b>	
Resolution	10-bit plus sign
Sampling period	250 $\mu s$ if configured with the destination as Pr 1.36, Pr 1.37, Pr 3.19 and Pr 4.08. 4ms for all other destinations

<b>11</b>	<b>0V common</b>
Function	Common connection for all external devices

<b>21</b>	<b>0V common</b>
Function	Common connection for all external devices

<b>22</b>	<b>+24V user output</b>
Function	Supply for external digital devices
Nominal output current	200mA (including all digital I/O)
Maximum output current	240mA (including all digital I/O)
Protection	Current limit and trip


<b>23</b>	<b>0V common</b>
Function	Common connection for all external devices

<b>24</b>	<b>Digital I/O 1</b>
<b>25</b>	<b>Digital I/O 2</b>
<b>26</b>	<b>Digital I/O 3</b>
Terminal 24 default function	AT SPEED output
Terminal 25 default function	DRIVE RESET input
Terminal 26 default function	RUN FORWARD input
Type	Positive or negative logic digital inputs, positive or negative logic push-pull outputs or open collector outputs
Input / output mode controlled by...	Pr 8.31, Pr 8.32 and Pr 8.33
<b>Operating as an input</b>	
Logic mode controlled by...	Pr 8.29
Absolute maximum applied voltage range	+30V, -18V relative to 0V
Impedance	6k $\Omega$
Input thresholds	10.0V $\pm 0.8V$
<b>Operating as an output</b>	
Open collector outputs selected	Pr 8.30
Nominal maximum output current	200mA (total including terminal 22)
Maximum output current	240mA (total including terminal 22)
<b>Common to all modes</b>	
Voltage range	0V to +24V
Sampling period	250 $\mu s$ if configured with the destination as Pr 6.35 or Pr 6.36. 4ms for all other destinations


<b>27</b>	<b>Digital input 1</b>
<b>28</b>	<b>Digital input 2</b>
<b>29</b>	<b>Digital input 3</b>
Terminal 27 default function	RUN REVERSE input
Terminal 28 default function	LOCAL/REMOTE select
Terminal 29 default function	JOG SELECT input
Type of input	Negative or positive logic digital inputs
Logic mode controlled by...	Pr 8.29
Voltage range	0V to +24V
Absolute maximum applied voltage range	+30V, -18V relative to 0V
Impedance	6k $\Omega$
Input thresholds	10.0V $\pm 0.8V$
Sampling period	250 $\mu s$ if configured with the destination as Pr 6.35 or Pr 6.36. 4ms for all other destinations


<b>30</b>	<b>0V common</b>
<b>Function</b>	<b>Common connection for all external devices</b>

<b>31</b>	<b>ENABLE</b>
<b>Function</b>	<b>Drive enable</b>
Type	Positive or negative logic digital input
Absolute maximum applied voltage range	+30V, -18V relative to 0V
Input threshold	10.0V ±0.8V
Sampling period	4ms

	<b>Drive commissioning output</b>
<b>Function</b>	<b>Instantaneous armature current feedback</b>
Type of output	Unipolar single-ended voltage
Full scale voltage range	10V ±5%
Full scale range	2.3 X Drive Rated Current [Pr 11.32]
Maximum offset	7mV
Protection	~25mA max. Short circuit protection to ground (0V).

<b>41</b>	<b>Tachogenerator positive input</b>
<b>42</b>	<b>Tachogenerator negative input</b>
<b>Function</b>	<b>Speed feedback inputs for tachogenerator feedback device</b>
Maximum voltage	300V
Feedback scaling controlled by	Pr 3.51 (Fb02, 0.72)
Sampling period	4ms

	Status relay contacts are over-voltage category II.
<b>WARNING</b>	

	A fuse or other over-current protection should be installed to the relay circuit.
<b>WARNING</b>	

<b>51</b>	<b>Relay 1 common</b>
<b>52</b>	<b>Relay 1 normally closed</b>
<b>53</b>	<b>Relay 1 normally open</b>
<b>Default function</b>	<b>Drive OK indicator</b>
Contact voltage rating	240Vac, installation over-voltage category II
Contact maximum current rating	5A AC 240V 5A DC 30V resistive load 0.5A DC 30V inductive load (L/R = 40ms)
Contact minimum recommended rating	12V, 100mA
Default contact position	Closed when power on and drive OK
Sampling period	4ms

<b>61</b>	<b>Relay 2 common</b>
<b>62</b>	<b>Relay 2 normally closed</b>
<b>63</b>	<b>Relay 2 normally open</b>
<b>Default function</b>	<b>Contactor enable</b>
Contact voltage rating	240Vac, installation over-voltage category II
Contact maximum current rating	5A AC 240V 5A DC 30V resistive load 0.5A DC 30V inductive load (L/R = 40ms)
Contact minimum recommended rating	12V, 100mA
Default contact position	Closed when AC or DC contactor is required to be closed.
Sampling period	4ms

## Feedback device connections

### Ab, Fd, Fr encoders

<b>A</b>	<b>Channel A, Frequency or Forward inputs</b>
<b>A\</b>	<b>Channel A\, Frequency\ or Forward\ inputs</b>
<b>B</b>	<b>Channel B, Direction or Reverse inputs</b>
<b>B\</b>	<b>Channel B\, Direction\ or Reverse\ inputs</b>
<b>Z</b>	<b>Marker pulse channel Z</b>
<b>Z\</b>	<b>Marker pulse channel Z\</b>
Type	EIA 485 differential receivers
Maximum input frequency	500kHz
Line loading	<2 unit loads
Line termination components	100Ω for 2 - 5V range (switchable)
Working common mode range	+12V to -7V
Absolute maximum applied voltage relative to 0V	±25V
Absolute maximum applied differential voltage	±25V

<b>+</b>	<b>+ supply</b>
<b>0V</b>	<b>0V</b>

## 4.14 Connecting an encoder

Additional measures to prevent unwanted emission of radio frequency noise are only required where the installation is subject to specific requirements for radio frequency emission.

### Encoder connections:

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

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

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

- The shields must be directly clamped to the encoder and to the drives grounding bracket. This may be achieved by clamping of the individual shields or by providing an additional overall shield that is clamped.

**NOTE**

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

**NOTE**

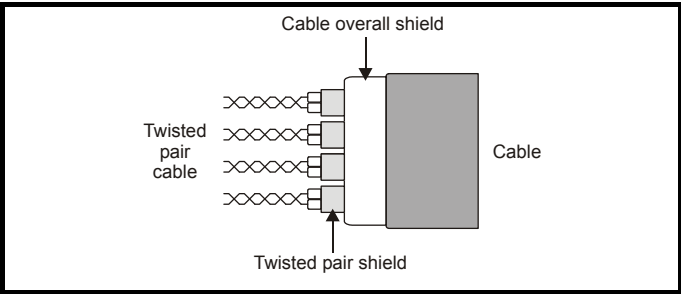
In order to guarantee maximum noise immunity for any application double shielded cable as shown should be used.

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

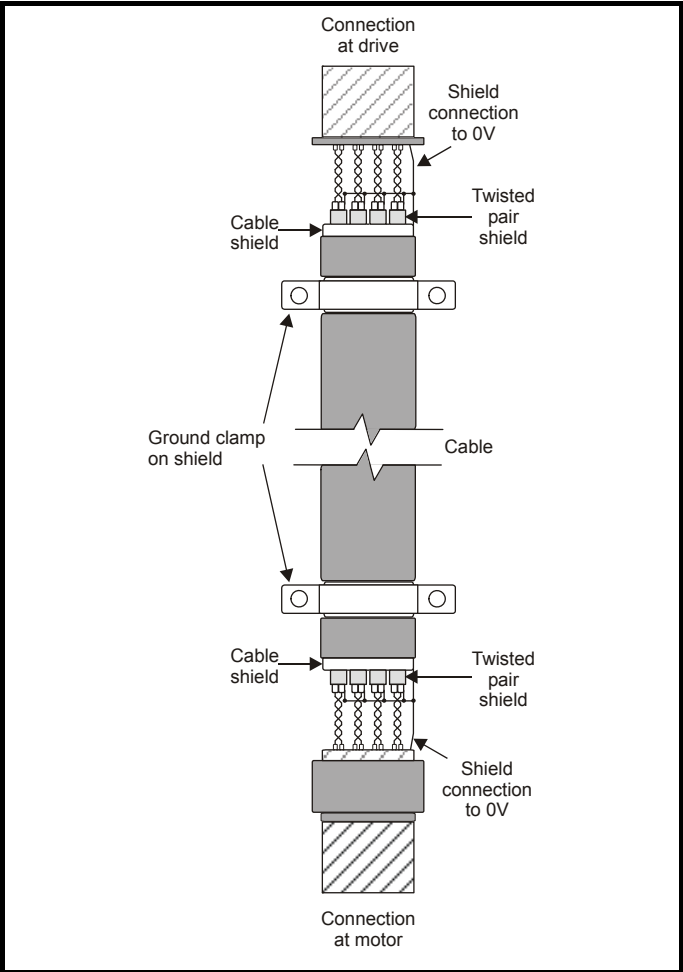
If the 0V is required to be left floating a cable with individual shields and an overall shield must be used.

Figure 4-14 and Figure 4-15 illustrate the preferred construction of cable and the method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or feedback device, with the ground connections made to a ground plate or similar metallic ground surface.

**Figure 4-14 Feedback cable, twisted pair**



**Figure 4-15 Feedback cable connections**



**Table 4-20 Encoder types**

Pr 3.38 (Fb07, 0.77) setting	Description
Ab (0)	Quadrature incremental encoder with or without marker pulse
Fd (1)	Incremental encoder with frequency pulses and direction, with or without marker pulse
Fr (2)	Incremental encoder with forward pulses and reverse pulses, with or without marker pulse

## 5 Getting started

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

### 5.1 Understanding the display

There are two types of keypad available for the Mentor MP. The SM-Keypad has an LED display, and the MP-Keypad has an LCD display.

#### 5.1.1 SM-Keypad (LED)

The display consists of two horizontal rows of 7 segment LED displays.

The upper display shows the drive status or the current menu and parameter number being viewed.

The lower display shows the parameter value or the specific trip type.

Figure 5-1 SM-Keypad

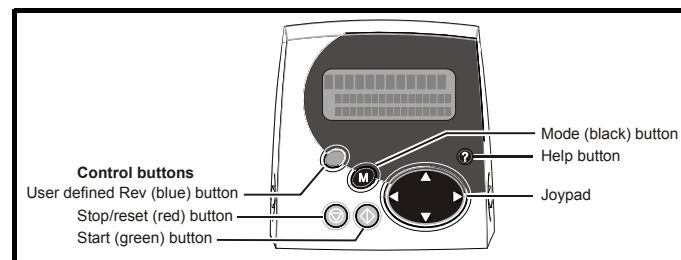
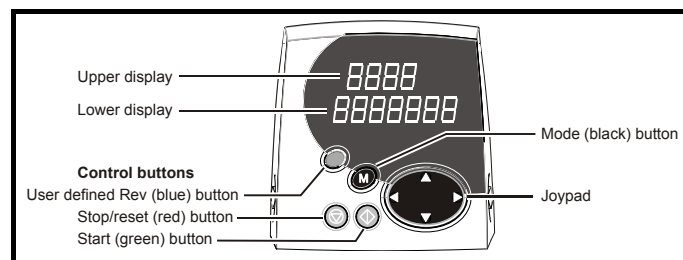
#### 5.1.2 MP-Keypad (LCD)

The display consists of three lines of text.

The top line shows the drive status or the current menu and parameter number being viewed on the left, and the parameter value or the specific trip type on the right.

The lower two lines show the parameter name or the help text.

Figure 5-2 MP-Keypad



#### NOTE

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

### 5.2 Keypad operation

Control buttons

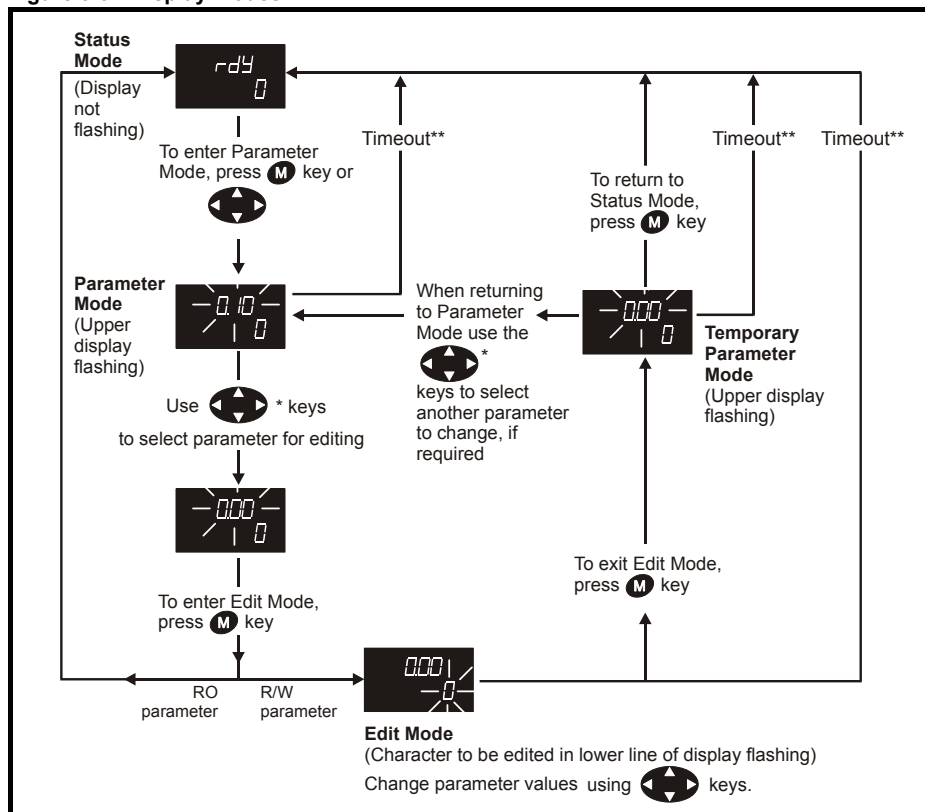
The keypad consists of:

1. Joypad - used to navigate the parameter structure and change parameter values.
2. Mode button - used to change between the display modes – parameter view, parameter edit, status.
3. Three control buttons - used to control the drive if keypad mode is selected.
4. Help button (MP-Keypad only) - displays text briefly describing the selected parameter.

The Help button toggles between other display modes and parameter help mode. The up and down functions on the joypad scroll the help text to allow the whole string to be viewed. The right and left functions on the joypad have no function when help text is being viewed.

The display examples in this section show the SM-Keypad, seven segment, LED display. The examples are the same for the MP-Keypad, The exceptions is that the information displayed on the lower row on the SM-Keypad is displayed on the right hand side of the top row on the MP-Keypad.

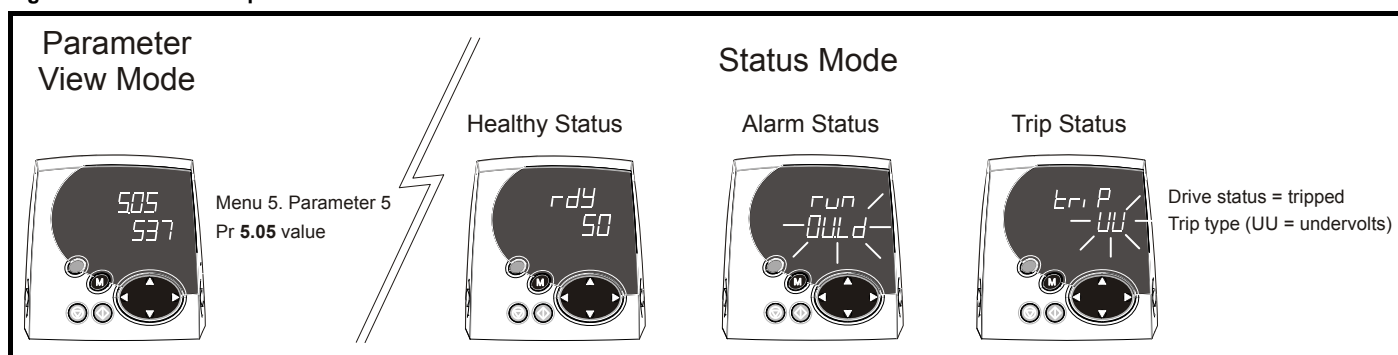
**Figure 5-3 Display modes**



\* can only be used to move between menus if L2 access has been enabled Pr 11.44 (SE14, 0.35)

\*\*Time-out defined by Pr 11.41 (default value = 240s).

**Figure 5-4 Mode examples**



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 AC supply to the drive is interrupted, new values must be saved (section 5.8 *Saving parameters* on page 47).

## 5.3 Menu 0 (sub block)

Menu 0 can be accessed by 2 methods:

1. Pr 11.44 (SE14, 0.35) = 0. Sub block mode.
2. Pr 11.44 (SE14, 0.35) <> 0. Linear mode.

Menu 23 contains the parameters to allow menu 0 to be customized in sub block mode. The first sub block is a user defined area (USER) which is configured by the parameters in menu 22. As default there are no parameters configured to the user sub block and so it is empty. The next 7 sub blocks are pre-defined. Access to the pre-defined blocks is enabled or disabled by Pr 23.03 to Pr 23.09.

Movement between sub blocks is achieved with the left and right keys.

Pr 23.01 contains all the sub block headers.

Table 5-1 and Figure 5-5 show the result of the direction keys when Pr 11.44 (SE14, 0.35) is set to L1 (0). When Pr 11.44 (SE14, 0.35) is not 0 the left and right keys will allow access to the advance parameter set and menu 0 will become a linear menu.

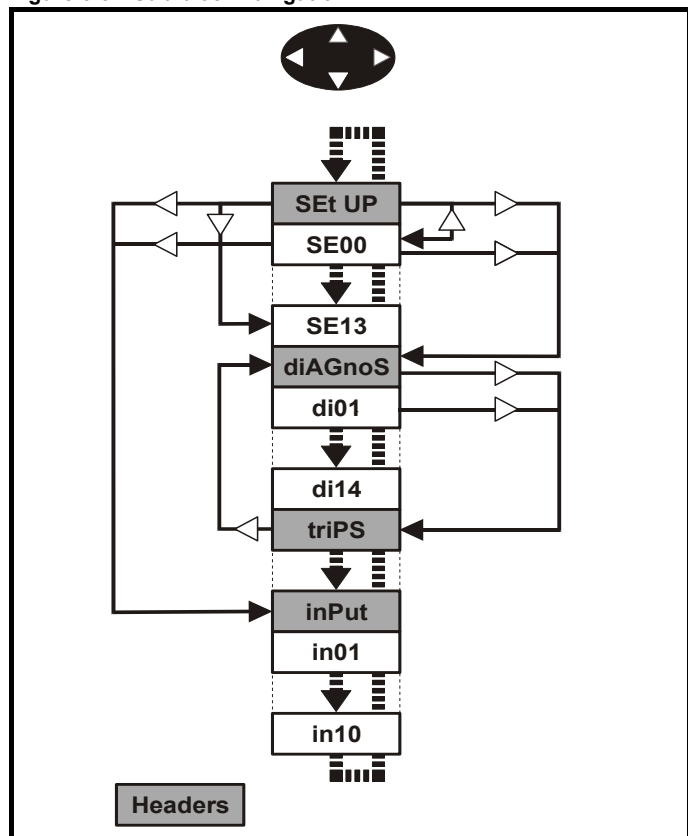
**Table 5-1 Keypad navigation**

Starting location	Action	Finishing location
Header	Right	Next header
	Left	Previous header
	Up	First parameter in header block
	Down	Last parameter in header block
Parameter	Right	Next header
	Left	Previous header
	Up	Next parameter in header block
	Down	Previous parameter in header block

When moving to the user block header, the user block header is only displayed if there are some valid parameters in the block. When moving between pre-defined header blocks the pre-defined header block is only displayed if the pre-defined block is enabled.

When moving between parameters within a block, only valid parameters are displayed.

**Figure 5-5 Sub block navigation**



## Coding

The coding defines the attributes of the parameter as follows.

Coding	Attribute
{X.XX}	Copied Menu 0 or advanced parameter
RW	Read/write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter: 'On' or 'OFF' on the display
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDS when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the value will be transferred if only the current rating is different and the file is a differences from default type file.
NC	Not copied: not transferred to or from SMARTCARDS during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs. Power-down save parameters are also saved in the drive when the user initiates a parameter save.

23.01		Sub block headers								
RO	Txt	NC						PT		BU
↕	USER (0), SEt UP (1), diAGnoS (2), triPS (3), SP LOOP (4), Fb SP (5), SintEr (6), inPut (7)				⇒	USER (0)				

Defines the sub block headers. Can be used by the MP-Keypad to display the same strings as the SM-Keypad.

23.02		OR of pre-defined sub block enables							
RO		NC					PT		BU
↕	0 to 127				⇒	0			

The OR of Pr 23.03 to Pr 23.09. To be used by the MP-Keypad.

Parameter	Value
23.03	1
23.04	2
23.05	4
23.06	8
23.07	16
23.08	32
23.09	64



23.03 - 23.09 Pre-defined sub block enable									
RW	Bit							US	BU
↕	0 to 1				⇒	1			

When this parameter is set to 1 the associated pre-defined sub block is accessible. When this parameter is 0 the associated pre-defined block is bypassed.

Parameter	Description	Display
23.03	Set up	SEt UP
23.04	Diagnostic	diAGnoS
23.05	Trips	triPS
23.06	Speed loop	SP LOOP
23.07	Speed feedback	Fb SP
23.08	Serial interface	SintEr
23.09	IO	InPut

## 5.4 Pre-defined sub blocks

Menu 0	Parameter	Description	Display
0.01 to 0.20		Configured by Pr 22.01 to Pr 22.20	

### Set-up

Menu 0	Parameter	Description	Display
0.21	1.00	Parameter 0	SE00
0.22	1.07	Minimum reference clamp	SE01
0.23	1.06	Maximum reference clamp	SE02
0.24	2.11	Acceleration rate	SE03
0.25	2.21	Deceleration rate	SE04
0.26	1.14	Reference selector	SE05
0.27	5.09	Armature rated voltage	SE06
0.28	5.07	Motor rated current	SE07
0.29	5.08	Base speed	SE08
0.30	11.42	Parameter cloning	SE09
0.31	5.70	Rated field current	SE10
0.32	5.73	Rated field voltage	SE11
0.33	5.77	Enable field control	SE12
0.34	5.12	Autotune	SE13
0.35	11.44	Security status	SE14

## Diagnostic

Menu 0	Parameter	Description	Display
0.36	1.01	Speed reference selected	di01
0.37	1.03	Pre-ramp reference	di02
0.38	2.01	Post ramp reference	di03
0.39	3.01	Final speed reference	di04
0.40	3.02	Speed feedback	di05
0.41	3.04	Speed controller output	di06
0.42	4.03	Torque demand	di07
0.43	4.01	Current Magnitude	di08
0.44	5.56	Field current feedback	di09
0.45	5.02	Armature voltage	di10
0.46	1.11	Reference enabled indicator	di11
0.47	1.12	Reverse selected indicator	di12
0.48	1.13	Jog selected indicator	di13
0.49	11.29	Software version	di14
0.50	0.00	Spare	

### Trips

Menu 0	Parameter	Description	Display
0.51	10.20	Trip 0	tr01
0.52	10.21	Trip 1	tr02
0.53	10.22	Trip 2	tr03
0.54	10.23	Trip 3	tr04
0.55	10.24	Trip 4	tr05
0.56	10.25	Trip 5	tr06
0.57	10.26	Trip 6	tr07
0.58	10.27	Trip 7	tr08
0.59	10.28	Trip 8	tr09
0.60	10.29	Trip 9	tr10

### Speed loop

Menu 0	Parameter	Description	Display
0.61	3.10	Speed controller proportional gain	SP01
0.62	3.11	Speed controller integral gain	SP02
0.63	3.12	Speed controller differential feedback gain	SP03
0.64	0.00	Spare	
0.65	0.00	Spare	

### Serial interface

Menu 0	Parameter	Description	Display
0.66	11.25	Baud rate	SI01
0.67	11.23	Serial address	SI02
0.68	0.00	Spare	
0.69	0.00	Spare	
0.70	0.00	Spare	

## Speed feedback

Menu 0	Parameter	Description	Display
0.71	3.26	Speed feedback selector	Fb01
0.72	3.51	Tachometer rating (V/1000rpm)	Fb02
0.73	3.53	Tachometer input mode	Fb03
0.74	3.52	Tachometer speed feedback	Fb04
0.75	3.34	Drive encoder lines per revolution	Fb05
0.76	3.36	Encoder supply	Fb06
0.77	3.38	Encoder type	Fb07
0.78	3.39	Encoder termination select	Fb08
0.79	3.27	Encoder speed feedback	Fb09
0.80	0.00	Spare	

## IO

Menu 0	Parameter	Description	Display
0.81	7.15	Analog input 3 mode	in01
0.82	7.01	Analog input 1	in02
0.83	7.02	Analog input 2	in03
0.84	7.03	Analog input 3	in04
0.85	8.01	I/O state 1	in05
0.86	8.02	I/O state 2	in06
0.87	8.03	I/O state 3	in07
0.88	8.04	I state 4	in08
0.89	8.05	I state 5	in09
0.90	8.06	I state 6	in10

For more information on the sub block function please refer to the *Mentor MP Advanced User Guide*.

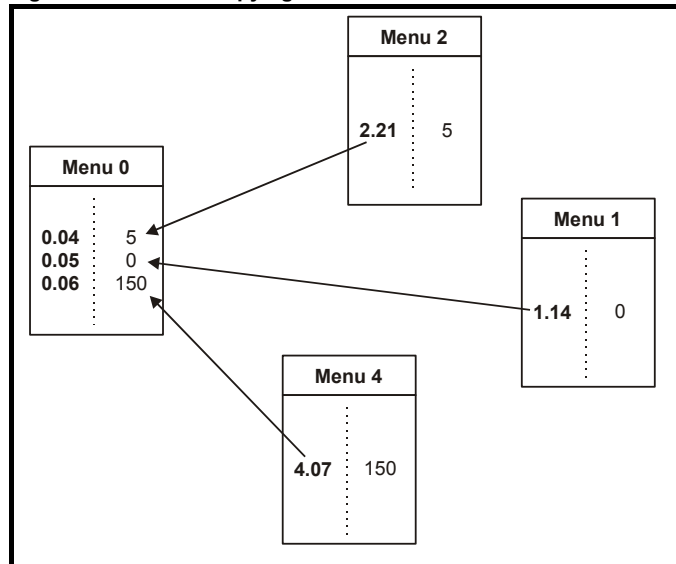
## 5.5 Menu 0 (linear)

Menu 0 is used to bring together various commonly used parameters for basic easy set up of the drive.

Appropriate parameters are copied from the advanced menus into menu 0 and thus exist in both locations.

For further information, refer to section 5.3 *Menu 0 (sub block)* on page 44.

**Figure 5-6 Menu 0 copying**



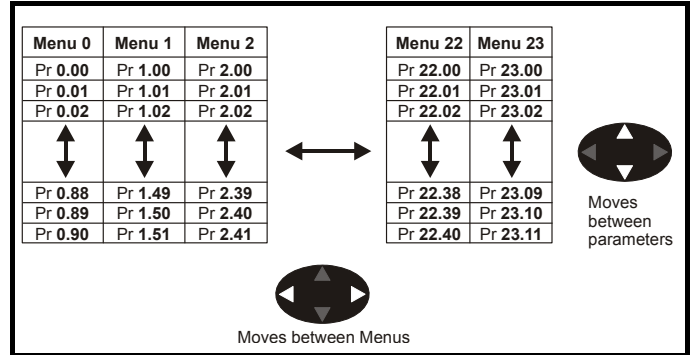
## 5.6 Menu structure

The drive parameter structure consists of menus and parameters.

The drive initially powers up in sub menu mode. Once Level 2 access (L2) has been enabled (refer to Pr 11.44 (SE14, 0.35)) the left and right buttons are used to navigate between numbered menus.

For further information, refer to section 5.12 *Parameter access level and security* on page 48.

**Figure 5-7 Menu structure**



The menus and parameters roll over in both directions.

For example:

- If the last parameter is displayed, a further press will cause the display to roll-over and show the first parameter.
- When changing between menus the drive remembers which parameter was last viewed in a particular menu and will display that parameter. The menus and parameters roll over in both directions.

## 5.7 Advanced menus

The advanced menus consist of groups or parameters appropriate to a specific function or feature of the drive. Menus 0 to 23 can be viewed on both keypads. Menus 40 and 41 are specific to the MP-Keypad (LCD). Menus 70 to 91 can be viewed with an MP-Keypad (LCD) only when an SM-Applications module is installed.

**Table 5-2 Advanced menu descriptions**

Menu	Description	LED	LCD
0	Commonly used basic set up parameters for quick / easy programming	✓	✓
1	Speed reference	✓	✓
2	Ramps	✓	✓
3	Speed feedback and speed control	✓	✓
4	Torque and current control	✓	✓
5	Motor control including field regulator	✓	✓
6	Sequencer and clock	✓	✓
7	Analog I/O	✓	✓
8	Digital I/O	✓	✓
9	Programmable logic, motorized pot and binary sum	✓	✓
10	Status and trips	✓	✓
11	General drive set-up	✓	✓
12	Threshold detectors and variable selectors	✓	✓
13	Position control	✓	✓
14	User PID controller	✓	✓
15	Solutions Module set-up	✓	✓
16	Solutions Module set-up	✓	✓
17	Solutions Module set-up	✓	✓
18	Application menu 1	✓	✓
19	Application menu 2	✓	✓
20	Application menu 3	✓	✓
21	Second motor parameters	✓	✓
22	Menu 0 set-up - user area	✓	✓
23	Menu 0 sub block control	✓	✓
40	Keypad configuration menu	X	✓
41	User filter menu	X	✓
70	PLC registers	X	✓
71	PLC registers	X	✓
72	PLC registers	X	✓
73	PLC registers	X	✓
74	PLC registers	X	✓
75	PLC registers	X	✓
85	Timer function parameters	X	✓
86	Digital I/O parameters	X	✓
88	Status parameters	X	✓
90	General parameters	X	✓
91	Fast access parameters	X	✓

**Table 5-3 Menu 40 parameter descriptions**

Parameter	Range(⇅)
40.00	Parameter 0
	0 to 32767
40.01	Language selection
	English (0), Custom (1), French (2), German (3), Spanish (4), Italian (5)
40.02	Software version
	999999
40.03	Save to flash
	Idle (0), Save (1), Restore (2), Default (3)
40.04	LCD contrast
	0 to 31
40.05	Drive and attribute database upload was bypassed
	Updated (0), Bypass (1)
40.06	Browsing favourites control
	Normal (0), Filter (1)
40.07	Keypad security code
	0 to 999
40.08	Communication channel selection
	Disable (0), Slot1 (1), Slot2 (2), Slot3 (3), Slave (4), Direct (5)
40.09	Hardware key code
	0 to 999
40.10	Drive node ID (Address)
	0 to 255
40.11	Flash ROM memory size
	4Mbit (0), 8Mbit (1)
40.19	String database version number
	0 to 999999
40.20	Shield saver strings and enable
	None (0), Default (1), User (2)
40.21	Shield saver interval
	0 to 600
40.22	Turbo browse time interval
	0 to 200ms

**Table 5-4 Menu 41 parameter descriptions**

Parameter	Range(⇅)
41.00	Parameter 0
	0 to 32767
41.01 to 41.50	Browsing filter source F01 to F50
	Pr 0.00 to Pr 22.99
41.51	Browsing favourites control
	Normal (0), Filter (1)

## 5.8 Saving parameters

When changing a parameter in Menu 0, the new value is saved when pressing the **M** Mode 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

- Enter SAVE in Pr **xx.00**
- Either:
  - Press the red reset button
  - Toggle the reset digital input, or
  - Carry out a drive reset through serial communications by setting Pr **10.38** to 100 (ensure that Pr **xx.00** returns to 0).

## 5.9 Restoring parameter defaults

Restoring parameter defaults by this method saves the default values in the drive's memory. (Pr **11.44** (SE14, 0.35) and Pr **11.30** are not affected by this procedure).

### Procedure

- Ensure the drive is not enabled, i.e. terminal 31 is open or Pr **6.15** is OFF (0)
- Select Eur or USA in Pr **xx.00**.
- Either:
  - Press the red reset button
  - Toggle the reset digital input, or

- Carry out a drive reset through serial communications by setting Pr 10.38 to 100 (ensure that Pr. xx.00 returns to 0).

## 5.10 Displaying parameters with non-default values only

Select dIS.dEf in Pr xx.00, 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. To deactivate this function, return to Pr xx.00 and enter a value of 0.

Please note that this function can be affected by the access level enabled. You must refer to section 5.12 *Parameter access level and security* for more information regarding access level.

## 5.11 Displaying destination parameters only

Select dIS.dEst in Pr xx.00, 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. To deactivate this function, return to Pr xx.00 and enter a value of 0.

Please note that this function can be affected by the access level enabled. You must refer to section 5.12 *Parameter access level and security* for further information regarding access levels.

## 5.12 Parameter access level and security

The parameter access levels determine whether the user has access to Menu 0 (in sub block mode) only or to all of the advanced menus (Menus 1 to 23), in addition to Menu 0 (in linear mode).

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

The user security and the parameter access level can operate independently of each other as shown in Table 5-5.

**Table 5-5 User security and parameter access levels**

Parameter access level	User security	Menu 0 status	Advanced menus status
L1	Open	Sub block RW	Not visible
L1	Closed	Sub block RO	Not visible
L2	Open	Linear RW	RW
L2	Closed	Linear RO	RO

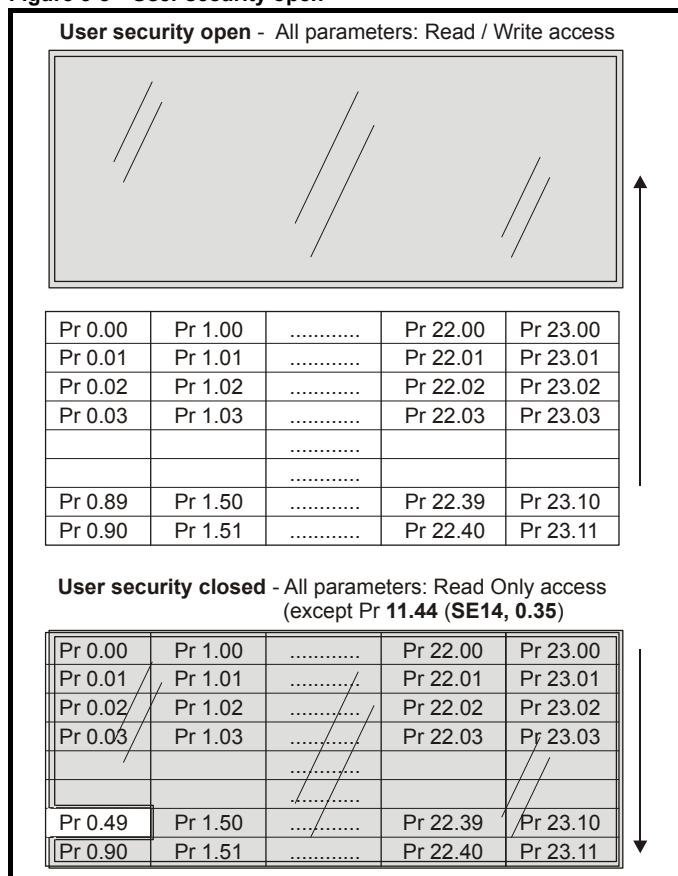
RW = Read / write access RO = Read only access

The default settings of the drive are parameter access level L1 and User Security Open, i.e. read / write access to Menu 0 with the advanced menus, not visible

### 5.12.1 User security

The user security, when set, prevents write access to any of the parameters (other than Pr 11.44 (SE14, 0.35) Access Level) in any menu.

**Figure 5-8 User security open**



### 5.12.2 Setting user security

Enter a value between 1 and 999 in Pr 11.30 and press the **M** button; the security code has now been set to this value. To activate the security, the access level must be set to Loc in Pr 11.44 (SE14, 0.35). When the drive is reset, the security code will have been activated and the drive returns to access level L1. The value of Pr 11.30 will return to 0 in order to hide the security code. At this point, the only parameter that can be changed by the user is the access level Pr 11.44 (SE14, 0.35).

### 5.12.3 Unlocking user security

Select a read write parameter to be edited and press the **M** button; the upper display will now show CodE.

Use the arrow buttons to set the security code and press the **M** 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 display will revert to parameter view mode.

To lock the user security again, set Pr 11.44 (SE14, 0.35) to Loc and press the **M** reset button.

### 5.12.4 Disabling user security

Unlock the previously set security code as detailed above. Set Pr 11.30 to 0 and press the **M** 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.

## 5.13 Serial communications

### 5.13.1 Introduction

The Mentor MP has a standard 2-wire EIA485 interface (serial communications interface) which enables all drive set-up, operation and monitoring to be carried out with a PC or controller if required. Therefore, it is possible to control the drive entirely by serial communications without the need for a keypad or other control cabling. The drive supports two protocols selected by parameter configuration:

- Modbus RTU
- CT ANSI

Modbus RTU has been set as the default protocol, as it is used with the PC-tools commissioning/start-up software as provided on the CD ROM.

The serial communications port of the drive is a RJ45 socket, which is isolated from the power stage and the other control terminals (see section 4.10 *Serial communications connections* on page 35 for connection and isolation details).

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

#### USB/EIA232 to EIA485 Communications

An external USB/EIA232 hardware interface such as a PC cannot be used directly with the 2-wire EIA485 interface of the drive. Therefore a suitable converter is required.

Suitable USB to EIA485 and EIA232 to EIA485 isolated converters are available from Control Techniques as follows:

- CT USB Comms cable (CT Part No. 4500-0096)
- CT EIA232 Comms cable (CT Part No. 4500-0087)

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

### 5.13.2 Serial communications set-up parameters

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

11.24		Serial mode									
RW	Txt									US	
↕		AnSI (0), rU (1), Lcd (2)	⇒								rU (1)

This parameter defines the communications protocol used by the 485 comms port on the drive. This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original protocol. The master should wait at least 20ms before sending a new message using the new protocol. (Note: ANSI uses 7 data bits, 1 stop bit and even parity; Modbus RTU uses 8 data bits, 2 stops bits and no parity.)

Comms value	String	Communications mode
0	AnSI	ANSI
1	rU	Modbus RTU protocol
2	Lcd	Modbus RTU protocol, but with an MP-Keypad only

#### ANSIx3.28 protocol

Full details of the CT ANSI communications protocol are in the *Advanced User Guide*.

Modbus RTU protocol

Full details of the CT implementation of Modbus RTU are given in the *Advanced User Guide*.

#### Modbus RTU protocol, but with an MP-Keypad only

This setting is used for disabling communications access when the MP-Keypad is used as a hardware key.

Si01		Baud rate									
RW	Txt									US	
↕		300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)*, 115200 (9)*	⇒								19200 (6)

Used in all comms modes to define the baud rate.

Parameter value	String/baud rate
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200
7	38400
8*	57600
9*	115200

\* only applicable to Modbus RTU mode

This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20ms before sending a new message using the new baud rate.

#### NOTE

When using the CT EIA232 Comms cable the available baud rate is limited to 19.2k baud.

Si02		Serial address									
RW	Txt									US	
↕		0 to 247	⇒								1

Used to define the unique address for the drive for the serial interface. The drive is always a slave.

#### ANSI

When the ANSI protocol is used the first digit is the group and the second digit is the address within a group. The maximum permitted group number is 9 and the maximum permitted address within a group is 9. Therefore, Pr 11.23 (Si02, 0.67) is limited to 99 in this mode. The value 00 is used to globally address all slaves on the system, and x0 is used to address all slaves of group x, therefore these addresses should not be set in this parameter.

#### Modbus RTU

When the Modbus RTU protocol is used addresses between 0 and 247 are permitted. Address 0 is used to globally address all slaves, and so this address should not be set in this parameter

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	<b>Basic parameters</b>	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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## 6 Basic parameters

The pre-defined sub blocks contain commonly used parameters for basic set-up of the Mentor MP. All parameters in the pre-defined sub blocks appear in other menus in the drive. (Denoted by {x.xx} in Table 6-1.)

**Table 6-1 Pre-defined sub block parameters**

Parameter			Range(⇅)	Default(⇒)	Type					
SE00	Parameter zero	{0.21, x.00}	0 to 32,767	0	RW	Uni				
SE01	Minimum reference clamp	{0.22, 1.07}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT	US
SE02	Maximum reference clamp	{0.23, 1.06}	SPEED_LIMIT_MAX rpm	1000.0	RW	Bi				US
SE03	Acceleration rate	{0.24, 2.11}	0 to MAX_RAMP_RATE s/(SE02 [Pr 0.23, 1.06] or Pr 2.39)	5.000	RW	Uni				US
SE04	Deceleration rate	{0.25, 2.21}	0 to MAX_RAMP_RATE s/(SE02 [Pr 0.23, 1.06] or Pr 2.39)	5.000	RW	Uni				US
SE05	Reference selector	{0.26, 1.14}	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5), PAd rEF (6)	A1.A2 (0)	RW	Txt				US
SE06	Armature rated voltage	{0.27, 5.09}	0 to ARMATURE_VOLTAGE_MAX Vdc	For 480V drive: 440 Eur 500 USA For 575V drive: 630 Eur 630 USA For 690V drive: 760 Eur 760 USA	RW	Uni	RA			US
SE07	Motor rated current	{0.28, 5.07}	0 to RATED_CURRENT_MAX A	RATED_CURRENT_MAX	RW	Uni	RA			US
SE08	Base speed	{0.29, 5.08}	0.0 to 10,000.0 rpm	1000.0	RW	Uni				US
SE09	Parameter copying	{0.30, 11.42}	nonE (0), rEAd (1), ProG (2), Auto (3), boot (4)	nonE (0)	RW	Txt			*	NC
SE10	Rated field current	{0.31, 5.70}	0 to FIELD_CURRENT_SET_MAX	Size 1: 2A Size 2A/B: 3A Size 2C/D: 5A	RW	Uni			PT	US
SE11	Rated field voltage	{0.32, 5.73}	0 to 500 Vdc	Eur: 360, USA: 300	RW	Uni			PT	US
SE12	Enable field control	{0.33, 5.77}	FLd OFF (0), IntrnL (1) and EtrnL (2)	FLd OFF (0)	RW	Txt				US
SE13	Autotune	{0.34, 5.12}	0 to 3	0	RW	Uni			NC	
SE14	Security status	{0.35, 11.44}	L1 (0), L2 (1), Loc (2)	L1 (0)	RW	Txt			PT	US
di01	Speed reference selected	{0.36, 1.01}	±MAX_SPEED_REF rpm		RO	Bi			NC	PT
di02	Pre-ramp reference	{0.37, 1.03}	±MAX_SPEED_REF rpm		RO	Bi			NC	PT
di03	Post ramp reference	{0.37, 1.03}	±SPEED_MAX rpm		RO	Bi			NC	PT
di04	Final speed reference	{0.39, 3.01}	±SPEED_MAX rpm		RO	Bi	FI		NC	PT
di05	Speed feedback	{0.40, 3.02}	±SPEED_MAX rpm		RO	Bi	FI		NC	PT
di06	Speed controller output	{0.41, 3.04}	±TORQUE_PRODUCT_ CURRENT_MAX rpm		RO	Bi	FI		NC	PT
di07	Torque demand	{0.42, 4.03}	±TORQUE_PROD_ CURRENT_MAX %		RO	Bi	FI		NC	PT
di08	Current magnitude	{0.43, 4.01}	0 to DRIVE_CURRENT_MAX A		RO	Uni	FI		NC	PT
di09	Field current feedback	{0.44, 5.56}	±50.00A		RO	Bi	FI		NC	PT
di10	Armature voltage	{0.45, 5.02}	±ARMATURE_VOLTAGE_ MAX V		RO	Bi	FI		NC	PT
di11	Reference enabled indicator	{0.46, 1.11}	OFF (0) or On (1)		RO	Bit			NC	PT
di12	Reverse selected indicator	{0.47, 1.13}	OFF (0) or On (1)		RO	Bit			NC	PT
di13	Jog selected indicator	{0.48, 1.14}	OFF (0) or On (1)		RO	Bit			NC	PT
di14	Software version	{0.49, 11.29}	1.00 to 99.99		RO	Uni			NC	PT
tr01	Trip 0	{0.51, 10.20}	0 to 229		RO	Txt			NC	PT
tr02	Trip 1	{0.52, 10.21}			RO	Txt			NC	PT
tr03	Trip 2	{0.53, 10.22}			RO	Txt			NC	PT
tr04	Trip 3	{0.54, 10.23}			RO	Txt			NC	PT
tr05	Trip 4	{0.55, 10.24}			RO	Txt			NC	PT
tr06	Trip 5	{0.56, 10.25}			RO	Txt			NC	PT
tr07	Trip 6	{0.57, 10.26}			RO	Txt			NC	PT
tr08	Trip 7	{0.58, 10.27}			RO	Txt			NC	PT
tr09	Trip 8	{0.59, 10.28}			RO	Txt			NC	PT
tr10	Trip 9	{0.60, 10.29}			RO	Txt			NC	PT
SP01	(Kp1) Speed controller proportional gains	{0.61, 3.10}	0.0000 to 6.5535 (1 / (rad/s))	0.0300	RW	Uni				US
SP02	(Ki1) Speed controller integral gains	{0.62, 3.11}	0.00 to 655.35 (s / (rad/s))	0.10	RW	Uni				US
SP03	(Kd1) Speed controller differential feedback gains	{0.63, 3.12}	0.00000 to 0.65535 (1/s / (rad/s))	0.00000	RW	Uni				US
Si01	Serial comms baud rate	{0.61, 11.25}	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)**, 115200 (9)**	19200 (6)	RW	Txt				US
Si02	Serial comms address	{0.67, 11.23}	0 to 247	1	RW	Uni				US
Fb01	Speed feedback selector	{0.71, 3.26}	drv (0), Slot1 (1), Slot2 (2), Slot3 (3), tACHO (4), Est SPEED (5)	Est SPEED (5)	RW	Txt				US
Fb02	Tachometer voltage rating	{0.72, 3.51}	0 to 300.00 V/1000 rpm	Eur: 60.00, USA: 50.00	RW	Uni				US
Fb03	Tachometer input mode	{0.73, 3.53}	DC (0), DC Filtr (1), AC (2)	DC (0)	RW	Txt				US
Fb04	Tachometer speed feedback	{0.74, 3.52}	±SPEED_MAX rpm		RO	Bi	FI		NC	PT
Fb05	Drive encoder lines per revolution	{0.75, 3.34}	1 to 50,000	1,024	RW	Uni				US

Parameter			Range(⇅)	Default(⇒)	Type					
<b>Fb06</b>	Drive encoder supply voltage	{0.76, 3.36}	5V (0), 8V (1), 15V (2), 24V (3)	5V (0)	RW	Txt				US
<b>Fb07</b>	Drive encoder type	{0.77, 3.38}	Ab (0), Fd (1), Fr (2)	Ab (0)	RW	Txt				US
<b>Fb08</b>	Drive encoder termination select	{0.78, 3.39}	0 to 2	1	RW	Uni				US
<b>Fb09</b>	Drive encoder speed feedback	{0.79, 3.27}	±10,000.0 rpm		RW	Bi	FI	NC	PT	US
<b>in01</b>	Analog input 3 mode	{0.81, 7.15}	0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), VOLt (6), th.SC (7), th (8), th.diSp (9)	th (8)	RW	Txt				US
<b>in02</b>	Analog input 1	{0.82, 7.01}	±100.00 %		RO	Bi		NC	PT	
<b>in03</b>	Analog input 2	{0.83, 7.02}	±100.0 %		RO	Bi		NC	PT	
<b>in04</b>	Analog input 3	{0.84, 7.03}	±100.0 %		RO	Bi		NC	PT	
<b>in05</b>	T24 digital I/O 1 state	{0.85, 8.01}	OFF (0) or On (1)		RO	Bit		NC	PT	
<b>in06</b>	T25 digital I/O 2 state	{0.86, 8.02}			RO	Bit		NC	PT	
<b>in07</b>	T26 digital I/O 3 state	{0.87, 8.03}			RO	Bit		NC	PT	
<b>in08</b>	T27 digital input 4 state	{0.88, 8.04}			RO	Bit		NC	PT	
<b>in09</b>	T28 digital input 5 state	{0.89, 8.05}			RO	Bit		NC	PT	
<b>in10</b>	T29 digital input 6 state	{0.90, 8.06}			RO	Bit		NC	PT	

\* Modes 1 and 2 are not user saved, Modes 0, 3 and 4 are user saved.

\*\* Only applicable to Modbus RTU mode.

Key:

Coding	Attribute
{X.XX}	Copied Menu 0 or advanced parameter
RW	Read/write: can be written by the user
RO	Read only: can only be read by the user
Bit	1 bit parameter: 'On' or 'OFF' on the display
Bi	Bipolar parameter
Uni	Unipolar parameter
Txt	Text: the parameter uses text strings instead of numbers.
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination: This parameter selects the destination of an input or logic function.
RA	Rating dependent: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by SMARTCARDS when the rating of the destination drive is different from the source drive and the file is a parameter file. However, the value will be transferred if only the current rating is different and the file is a differences from default type file.
NC	Not copied: not transferred to or from SMARTCARDS during copying.
PT	Protected: cannot be used as a destination.
US	User save: parameter saved in drive EEPROM when the user initiates a parameter save.
PS	Power-down save: parameter automatically saved in drive EEPROM when the under volts (UV) trip occurs. Power-down save parameters are also saved in the drive when the user initiates a parameter save.

## 6.1 Full descriptions

### 6.1.1 Parameter x.00

SE00 {x.00}	Parameter zero
RW	Uni
⇅	0 to 32,767
⇒	0

Pr **x.00** is available in all menus and has the following functions.

Value	Action
1000	Save parameters when under voltage is not active (Pr <b>10.16</b> = 0) and low voltage DC supply is not active (Pr <b>6.44</b> = 0).
1001	Save parameters under all conditions
1070	Reset all option modules
1233	Load standard defaults
1244	Load US defaults
1253	Change drive mode with standard defaults
1254	Change drive mode with US defaults
1255	Change drive mode with standard defaults (excluding menus 15 to 20)
1256	Change drive mode with US defaults (excluding menus 15 to 20)
2001*	Transfer drive parameters as difference from default to a bootable SMARTCARD block in data block number 001
3yyy*	Transfer drive EEPROM data to a SMART Card block number yyy
4yyy*	Transfer drive data as difference from defaults to SMART Card block number yyy
5yyy*	Transfer drive ladder program to SMART Card block number yyy
6yyy*	Transfer SMART Card data block number yyy to the drive
7yyy*	Erase SMART Card data block number yyy
8yyy*	Compare drive parameters with SMART Card data block number yyy
9555*	Clear SMARTCARD warning suppression flag
9666*	Set SMARTCARD warning suppression card
9777*	Clear SMARTCARD read-only flag
9888*	Set SMARTCARD read-only flag
9999*	Erase SMARTCARD data block 1 to 499
110zy	Transfer electronic nameplate parameters to/from drive from/to encoder. See the <i>Advanced User Guide</i> for more information on this function.
12000**	Display non-default values only
12001**	Display destination parameters only

\* See Chapter 9 *SMARTCARD operation* on page 64 for more information of these functions.

\*\* These functions do not require a drive reset to become active. All other functions require a drive reset to initiate the function.

## 6.1.2 Set-up

SE01 {0.22, 1.07}		Minimum reference clamp									
RW	Bi							PT	US		
⇅	±SPEED_LIMIT_MAX rpm						⇒	0.0			

(When the drive is jogging, this parameter has no effect.)

Set **SE01** (Pr 0.22, 1.07) at the required minimum motor speed for both directions of rotation. The drive speed reference is scaled between **SE01** (Pr 0.22, 1.07) and **SE02** (Pr 0.23, 1.06).

SE02 {0.23, 1.06}		Maximum reference clamp									
RW	Bi								US		
⇅	SPEED_LIMIT_MAX rpm						⇒	1000.0			

(The drive has additional over-speed protection.)

Set **SE02** (Pr 0.23, 1.06) at the required maximum motor speed for both directions of rotation. The drive speed reference is scaled between **SE01** (Pr 0.22, 1.07) and **SE02** (Pr 0.23, 1.06).

SE03 {0.24, 2.11}		Acceleration rate									
RW	Uni								US		
⇅	0 to MAX_RAMP_RATE s/(SE02 [Pr 0.23, 1.06] or Pr 2.39)						⇒	5.000			

Set **SE03** (Pr 0.03, 2.11) at the required rate of acceleration.

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

SE04 {0.25, 2.21}		Deceleration rate									
RW	Uni								US		
⇅	0 to MAX_RAMP_RATE s/(SE02 [Pr 0.23, 1.06] or Pr 2.39)						⇒	5.000			

Set **SE04** (Pr 0.25, 2.21) at the required rate of deceleration.

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

SE05 {0.26, 1.14}		Reference selector									
RW	Txt								US		
⇅	A1.A2 (0), A1.Pr (1), A2.Pr (2), Pr (3), PAd (4), Prc (5), PAd rEF (6)						⇒	A1.A2 (0)			

Defines how the value of Pr 1.49 is derived as follows:

Value of Pr 1.14	Display String	Pr 1.49
0	A1.A2 (Analog ref 1. Analog ref 2)	*Selected by terminal input
1	A1.Pr (Analog ref 1. Preset speeds)	1
2	A2.Pr (Analog ref 2. Preset speeds)	2
3	Pr (Preset speeds)	3
4	PAd (Keypad reference)	4
5	Prc (Precision reference)	5
6	Pad rEF	6

\*Pr 1.41 to Pr 1.44 and Pr 1.52 can be controlled by digital inputs to force the value of Pr 1.49:

all bits equal to zero gives 1,

Pr 1.41 = 1 then Pr 1.49 = 2

Pr 1.42 = 1 then Pr 1.49 = 3

Pr 1.43 = 1 then Pr 1.49 = 4

Pr 1.44 = 1 then Pr 1.49 = 5

Pr 1.52 = 1 then Pr 1.49 = 6

The bit parameters with lower numbers have priority over those with higher numbers.

Pr 1.49 and Pr 1.50 then define the reference as follows:

Pr 1.49	Pr 1.50	Reference
1	1	Analog reference 1 (Pr 1.36)
1	>1	Preset defined by Pr 1.50 (Pr 1.21 to Pr 1.28)
2	1	Analog reference 2 (Pr 1.37)
2	>1	Preset defined by Pr 1.50 (Pr 1.21 to Pr 1.28)
3	x	Preset defined by Pr 1.50 (Pr 1.21 to Pr 1.28)
4	x	Keypad reference (Pr 1.17)
5	x	Precision reference (Pr 1.18 and Pr 1.19)
6	x	Keypad reference only

x = any value

### Keypad reference

If Keypad reference is selected the drive sequencer is controlled directly by the keypad keys and the keypad reference parameter (Pr 1.17) is selected. The sequencing bits, Pr 6.30 to Pr 6.34, have no effect and jog is disabled.

SE06 {0.27, 5.09}		Armature rated voltage									
RW	Uni					RA			US		
⇅	0 to ARMATURE_VOLTAGE_MAX Vdc						⇒	For 480V drive: 440 Eur, 500 USA For 575V drive: 630 Eur, 630 USA For 690V drive: 760 Eur, 760 USA			

SE07 {0.28, 5.07}		Motor rated current									
RW	Uni					RA			US		
⇅	0 to RATED_CURRENT_MAX A						⇒	RATED_CURRENT_MAX			

The rated current should be set at the motor nameplate value for rated current. The value of this parameter is used in the following:

- Current limits
- Motor thermal protection

SE08 {0.29, 5.08}		Base speed									
RW	Uni								US		
⇅	0.0 to 10,000.0 rpm						⇒	1000.0			

The rated speed defines the base speed of the motor. It is also to determine the speed used in the auto tuning inertia test (see **SE13** [Pr 0.34, 5.12]).



SE09 {0.30, 11.42}		Parameter copying											
RW	Txt							NC		*			
↕	nonE (0), rEAd (1), ProG (2), Auto (3), boot (4)						⇒	nonE (0)					

\* Modes 1 and 2 are not user saved, Modes 0, 3 and 4 are user saved.

If **SE09** (Pr 0.30, 11.42) is equal to 1 or 2 this value is not transferred to the EEPROM or the drive. If **SE09** (Pr 0.30, 11.42) 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 SMARTCARD
ProG	2	Programming a parameter set to the SMARTCARD
Auto	3	Auto save
boot	4	Boot mode

For further information, refer to Chapter 9 *SMARTCARD operation* on page 64.

SE10 {0.31, 5.70}		Rated field current											
RW	Uni							PT	US				
↕	0 to FIELD_CURRENT_SET_MAX						⇒	Size 1: 2A Size 2A/B: 3A Size 2C/D: 5A					

This parameter will be set to the field current of the motor and will define the rated field current for the field controller.

SE11 {0.32, 5.73}		Rated field voltage											
RW	Uni							PT	US				
↕	0 to 500 Vdc						⇒	Eur: 360, USA: 300					

The maximum voltage the field controller is allowed to generate.

SE12 {0.33, 5.77}		Enable field control											
RW	Txt									US			
↕	FLd OFF (0), IntrnL (1) and EtrnL (2)						⇒	FLd OFF (0)					

This parameter should be set as follows:

- 0: The internal and external field controllers are disabled.
- 1: The internal field controller is enabled. When the internal field controller is enabled then it will control **di09** (Pr 0.44, 5.56), Pr 5.57 and Pr 5.58.
- 2: The external field controller is enabled. When the external field controller is enabled then it will control Pr 5.54 and **di09** (Pr 0.44, 5.56). If no signal is received from the external field controller the drive will trip field loss.

SE13 {0.34, 5.12}		Autotune											
RW	Uni							NC					
↕	0 to 3						⇒	0					

If this parameter is set to a non-zero value, the drive is enabled and a run command is applied in either direction the drive performs an autotune test. All tests that rotate the motor are carried out in the forward direction if **di12** (Pr 0.47, 1.12) = 0 or the reverse direction if **di12** (Pr 0.47, 1.12) = 1. For example, if the test is initiated by applying run

reverse (Pr 6.32 = 1) the test is performed in the reverse direction. The test will not start unless the drive is disabled before the test is initiated by applying the enable or run, i.e. it will not start if the drive is in the stop state. It is not possible to go into the stop state if **di12** (Pr 0.47, 1.12) has a non-zero value.

When the test is completed successfully the drive is disabled and will enter the inhibit state. The motor can only be restarted if the enable is removed either from the enable input, or Pr 6.15 is set to zero or from the control word (Pr 6.42) if it is active.

Value	Autotune function
0	None
1	Static autotune for current loop gains
2	Spinning autotune for motor saturation break points
3	Spinning autotune for speed loop gains

#### Static autotune for current loop gains

When this operation is performed, the drive will estimate the following, with respect to the selected motor map, and store the values:

- Motor constant (Pr 5.15)
- Continuous proportional gain (Pr 4.13)
- Continuous integral gain (Pr 4.14)
- Discontinuous integral gain (Pr 4.34)
- Back EMF set point (Pr 5.59)
- Armature resistance (Pr 5.61)
- Flux loop I gain (Pr 5.72)

#### Spinning autotune for motor saturation break points

When this operation is performed, the drive will estimate the following, with respect to the selected motor map, and store the values:

- Motor saturation break points (Pr 5.29, Pr 5.30), by spinning the motor at 25% of it's base speed (Pr 5.06)
- Field current compensation factor (Pr 5.74)

SE14 {0.35, 11.44}		Security status											
RW	Txt									PT	US		
↕	L1 (0), L2 (1), Loc (2)						⇒	L1 (0)					

This parameter controls access via the drive keypad as follows:

Value	String	Action
0	L1	Only menu 0 can be accessed
1	L2	All menus can be accessed
2	Loc	Lock user security when drive is reset. (This parameter is set to L1 after reset.)

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

### 6.1.3 Diagnostic

di01 {0.36, 1.01}		Speed reference selected											
RO	Bi							NC	PT				
↕	±MAX_SPEED_REF rpm						⇒						

di02 {0.37, 1.03}		Pre-ramp reference											
RO	Bi							NC	PT				
↕	±MAX_SPEED_REF rpm						⇒						

di03 {0.38, 2.01}		Post ramp reference											
RO	Bi							NC	PT				
↕		±SPEED_MAX rpm						⇒					

di04 {0.39, 3.01}		Final speed reference											
RO	Bi	FI						NC	PT				
↕		±SPEED_MAX rpm						⇒					

This is the final speed demand at the input to the speed regulator formed by the sum of the ramp output and the hard speed reference (if the hard speed reference is enabled). If the drive is disabled this parameter will show 0.0.

di05 {0.40, 3.02}		Speed feedback											
RO	Bi	FI						NC	PT				
↕		±SPEED_MAX rpm						⇒					

The speed feedback can be taken from the drive encoder port or tachometer or armature voltage or a position feedback module installed in any slot as selected with **Fb01** (Pr 0.71, 3.26). **di05** (Pr 0.40, 3.02) shows the level of the speed feedback selected for the speed controller. Display filtering is active when this parameter is viewed with one of the drive keypads. The value held in the drive parameter (accessible via comms or an option module) does not include this filter, but is a value that is obtained over a sliding 16ms period to limit the ripple seen in this parameter value. The speed feedback value includes encoder quantisation ripple given by the following equation:

$$\text{Ripple in di05 (Pr 0.40, 3.02)} = 60 / 16\text{ms} / (\text{ELPR} \times 4)$$

Where ELPR is the equivalent encoder lines per revolution as defined below:

Position feedback device	ELPR
Ab	number of lines per revolution
Fd, Fr	number of lines per revolution / 2

For example a 4096 line Ab type encoder gives a ripple level of 0.23rpm.

**The 16ms sliding window filter is always applied to the value shown in di05 (Pr 0.40, 3.02), but this sliding window filter is not normally applied to the actual speed feedback used by the speed controller or the drive encoder reference system (Pr 3.43 to Pr 3.46).** The user may apply a filter to the speed controller input and the drive encoder reference system input if required by setting Pr 3.42 to the required filter time. The encoder ripple seen by the speed controller is given by:

$$\text{Encoder speed ripple} = 60 / \text{Filter time} / (\text{ELPR} \times 4)$$

If Pr 3.42 is set to zero (no filter) the ripple seen by the speed controller and drive encoder reference system is given by:

$$\text{Encoder speed ripple} = 60 / 250\mu\text{s} / (\text{ELPR} \times 4)$$

Figure 6-1

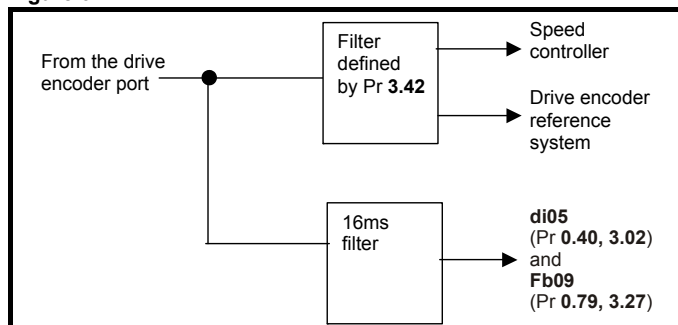


Figure 6-1 shows the filter arrangement. It should be noted that the same filtering is provided at the speed controller input and for **di05** (Pr 0.40, 3.02) when the feedback is obtained from an option module, but the variable length window filter is controlled by Pr x.19.

It is not advisable to set the speed feedback filter too high unless it is specifically required for high inertia applications with high controller gains because the filter has a non-linear transfer function. It is preferable to use the current demand filters (see Pr 4.12 or Pr 4.23) as these are linear first order filters that provide filtering on noise generated from both the speed reference and the speed feedback. It should be noted that any filtering included within the speed controller feedback loop, either on the speed feedback or the current demand, introduces a delay and limits the maximum bandwidth of the controller for stable operation.

The speed ripple can be quite high, for example with a 4096 line encoder the speed ripple is 14.6rpm, but this does not define the resolution of the speed feedback which is normally much better and depends on the length of the measuring period used to obtain the feedback. This is shown in the improved resolution of the value accessible in **di05** (Pr 0.40, 3.02) which is measured over 16ms, i.e. a resolution of 0.23rpm with a 4096 line encoder. The speed controller itself accumulates all pulses from the encoder, and so the speed controller resolution is not limited by the feedback, but by the resolution of the speed reference. If a SINCOS encoder is used from an option the encoder speed ripple is reduced by a factor of  $2^{(2-\text{Interpolation bits})}$ . For example with the nominal 10 bits of interpolation information, the speed ripple is reduced by a factor of 256. This shows how a SINCOS encoder can reduce noise caused by encoder quantisation without any filtering in the speed feedback or the current demand, so that high gains may be used to give high dynamic performance and a very stiff system.

di06 {0.41, 3.04}		Speed controller output											
RO	Bi	FI						NC	PT				
↕		±TORQUE_PRODUCT_CURRENT_MAX rpm						⇒					

The output of the speed regulator is a torque demand given as a percentage of rated motor torque. This is then modified to account for changes in motor flux if field weakening is active, and then used as the torque producing current reference.

di07 {0.42, 4.03}		Torque demand											
RO	Bi	FI						NC	PT				
↕		±TORQUE_PROD_CURRENT_MAX %						⇒					

The torque demand can be derived from the speed controller and/or the torque reference and offset. The units of the torque demand are a % of rated torque.

di08 {0.43, 4.01}		Current magnitude											
RO	Uni	FI					NC	PT					
⇅	0 to DRIVE_CURRENT_MAX A												⇒

The current feedback signal is derived from internal current transformers. It is used for closed loop control and indication of the armature current, and to initiate motor protection.

di09 {0.44, 5.56}		Field current feedback											
RO	Bi	FI					NC	PT					
⇅	±50.00A												⇒

Indicates the field current feedback in 0.01 amperes.

di10 {0.45, 5.02}		Armature voltage											
RO	Bi	FI					NC	PT					
⇅	±ARMATURE_VOLTAGE_MAX V												⇒

The average measured DC output voltage seen across the drive A1 and A2 terminals or the average measured DC output voltage seen across the motor. Selected by Pr 5.14.

The armature voltage feedback has a resolution of 10-bit plus sign.

di11 {0.46, 1.11}		Reference enabled indicator											
di12 {0.47, 1.13}		Reverse selected indicator											
di13 {0.48, 1.14}		Jog selected indicator											
RO	Bit						NC	PT					
⇅	OFF (0) or On (1)												⇒

These parameters are controlled by the drive sequencer as defined in Menu 6. They select the appropriate reference as commanded by the drive logic. di11 (Pr 0.46, 1.11) will be active if a run command is given, the drive is enabled and the drive is ok. This parameter can be used as an interlock in a Onboard PLC or SM-Applications program to show that the drive is able to respond to a speed or torque demand.

di14 {0.49, 11.29}		Software version											
RO	Uni						NC	PT					
⇅	1.00 to 99.99												⇒

The parameter displays the software version of the drive.

## 6.1.4 Trips

tr01 {0.51, 10.20}		Trip 0											
tr02 {0.52, 10.21}		Trip 1											
tr03 {0.53, 10.22}		Trip 2											
tr04 {0.54, 10.23}		Trip 3											
tr05 {0.55, 10.24}		Trip 4											
tr06 {0.56, 10.25}		Trip 5											
tr07 {0.57, 10.26}		Trip 6											
tr08 {0.58, 10.27}		Trip 7											
tr09 {0.59, 10.28}		Trip 8											
tr10 {0.60, 10.29}		Trip 9											
RO	Txt							NC	PT			PS	
⇅	0 to 229												⇒

Contains the last 10 drive trips. tr01 (Pr 0.51, 10.20) is the most recent trip and tr10 (Pr 0.60, 10.29) the oldest. When a new trip occurs all the parameters move down one, the current trip is put in tr01 (Pr 0.51, 10.20) and the oldest trip is lost from the bottom of the log. Descriptions of the trips are given in Table 13-1 on page 137. All trips are stored, including HF trips numbered from 20 to 29. (HF trips with numbers from 1 to 16 are not stored in the trip log.) Any trip can be initiated by the actions described or by writing the relevant trip number to Pr 10.38. If any trips shown as user trips are initiated the trip string is "txxx", where xxx is the trip number.

## 6.1.5 Speed loop

SP01 {0.61, 3.10}		(Kp1) Speed controller proportional gains											
RW	Uni											US	
⇅	0.0000 to 6.5535 (1 / (rad/s))												0.0300

SP01 (Pr 0.61/3.10) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-3 on page 86 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 62.

SP02 {0.62, 3.11}		(Ki1) Speed controller integral gains											
RW	Uni											US	
⇅	0.00 to 655.35 (s / (rad/s))												0.1

SP02 (Pr 0.62, 3.11) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-3 on page 86 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 62.

SP03 {0.63, 3.12}		(Kd1) Speed controller differential feedback gains											
RW	Uni											US	
⇅	0.00000 to 0.65535 (1/s / (rad/s))						⇒	0.00000					

**SP03** (Pr **0.63, 3.12**) operates in the feed-forward path of the speed-control loop in the drive. See Figure 11-3 on page 86 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 62.

## 6.1.6 Serial interface

Si01 {0.61, 11.25}		Serial comms baud rate											
RW	Txt											US	
⇅	300 (0), 600 (1), 1200 (2), 2400 (3), 4800 (4), 9600 (5), 19200 (6), 38400 (7), 57600 (8)*, 115200 (9)*						⇒	19200 (6)					

\* only applicable to Modbus RTU mode

This parameter can be changed via the drive keypad, via a Solutions Module or via the comms interface itself. If it is changed via the comms interface, the response to the command uses the original baud rate. The master should wait at least 20ms before send a new message using the new baud rate.

Si02 {0.67, 11.23}		Serial comms address											
RW	Uni											US	
⇅	0 to 247						⇒	1					

Used to define the unique address for the drive for the serial interface. The drive is always a slave.

### Modbus RTU

When the Modbus RTU protocol is used addresses between 0 and 247 are permitted. Address 0 is used to globally address all slaves, and so this address should not be set in this parameter

### ANSI

When the ANSI protocol is used the first digit is the group and the second digit is the address within a group. The maximum permitted group number is 9 and the maximum permitted address within a group is 9. Therefore, **Si02** (Pr **0.67, 11.23**) is limited to 99 in this mode. The value 00 is used to globally address all slaves on the system, and x0 is used to address all slaves of group x, therefore these addresses should not be set in this parameter.

## 6.1.7 Speed feedback

Fb01 {0.71, 3.26}		Speed feedback selector											
RW	Txt											US	
⇅	drv (0), Slot1 (1), Slot2 (2), Slot3 (3), tACHO (4), Est SPEED (5)						⇒	Est SPEED (5)					

**0, drv:** Drive encoder

The position feedback from the encoder connected to the drive itself is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position.

**1, Slot1:** Solutions Module in slot 1

The position feedback from the Solutions Module in Solutions Module slot 1 is used to derive the speed feedback for the speed controller and to calculate the motor rotor flux position. If a position

feedback category Solutions Module is not installed in slot 1 the drive produces an EnC9 trip.

**2, Slot2:** Solutions Module in slot 2

**3, Slot3:** Solutions Module in slot 3

**4, tACHO:** Tachometer

**5, Est.SPEED:** Estimated speed

Fb02 {0.72, 3.51}		Tachometer voltage rating											
RW	Uni											US	
⇅	0 to 300.00 V/1000 rpm						⇒	Eur: 60.00, USA: 50.00					

Defines the rating of the tachometer installed to the motor. This parameter should be set slightly above or below the nominal value if the user wishes to trim out the tolerance build ups in the feedback electronics.

Fb03 {0.73, 3.53}		Tachometer input mode											
RW	Txt											US	
⇅	DC (0), DC Filt (1), AC (2)						⇒	DC (0)					

The input electronics for the tachometer input can be configured in 3 ways.

Value	Text	Action
0	DC	DC tachometer
1	DC Filt	DC tachometer with input filter
2	AC	AC tachometer

Fb04 {0.74, 3.52}		Tachometer speed feedback											
RO	Bi	FI						NC	PT				
⇅	±SPEED_MAX rpm						⇒						

Provided the tachometer voltage rating parameter for the tachometer is correct this parameter shows the tachometer speed in rpm.

Fb05 {0.75, 3.34}		Drive encoder lines per revolution											
RW	Uni											US	
⇅	1 to 50,000						⇒	1,024					

When Ab, Fd, Fr are used the equivalent number of encoder lines per revolution must be set-up correctly in **Fb05** (Pr **0.75, 3.34**) to give the correct speed and position feedback. This is particularly important if the encoder is selected for speed feedback with Fb01 (Pr **0.71, 3.26**). The equivalent number of encoder lines per revolution (ELPR) is defined as follows.:

Position feedback device	ELPR
Ab	number of lines per revolution
Fd, Fr	number of lines per revolution / 2

The incremental (A/B) signal frequency should not exceed 500kHz. If **Fb05** is changed the encoder is re-initialized.

Fb06 {0.76, 3.36}		Drive encoder supply voltage											
RW	Txt											US	
⇅	5V (0), 8V (1), 15V (2), 24V (3)						⇒	5V (0)					

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
--------------------	---------------------	-------------------------	-------------------------	-----------------	------------------	-------------------	--------------	---------------------	-------------	---------------------	----------------	-------------	----------------

The encoder supply voltage present on the drive encoder connector is defined by this parameter as 0 (5V), 1 (8V), 2 (15V) or 3 (24V)

Fb07 {0.77, 3.38}		Drive encoder type									
RW	Txt									US	
⇅	Ab (0), Fd (1), Fr (2)					⇒	Ab (0)				

The following encoders can be connected to the drive encoder port.

**0, Ab:** Quadrature incremental encoder, with or without marker pulse.

**1, Fd:** Incremental encoder with frequency and direction outputs, with or without marker pulse.

**2, Fr:** Incremental encoder with forward and reverse outputs, with or without marker pulse.

Fb08 {0.78, 3.39}		Drive encoder termination select									
RW	Uni									US	
⇅	0 to 2					⇒	1				

The terminations may be enabled/disabled by this parameter as follows:

Encoder input	Fb08 {0.78, 3.39} = 0	Fb08 {0.78, 3.39} = 1	Fb08 {0.78, 3.39} = 2
A-A\	Disabled	Enabled	Enabled
B-B\	Disabled	Enabled	Enabled
Z-Z\	Disabled	Disabled	Enabled

Fb09 {0.79, 3.27}		Drive encoder speed feedback									
RW	Bi	FI				NC	PT	US			
⇅	±10,000.0 rpm					⇒					

Provided the set-up parameters for the drive encoder are correct this parameter shows the encoder speed in rpm.

It should be noted that the value shown by this parameter is measured over a 16ms sliding window period (in the same way as **di05** (Pr **0.40, 3.02**)), and so the ripple in this parameter accessible via comms or by an option module is as defined for **di05** (Pr **0.40, 3.02**). The FI attribute for this parameter is set, and so further filtering is applied when this parameter is viewed with one of the drive keypads.

### 6.1.8 I/O

in01 {0.81, 7.15}		Analog input 3 mode									
RW	Txt									US	
⇅	0-20 (0), 20-0 (1), 4-20.tr (2), 20-4.tr (3), 4-20 (4), 20-4 (5), VOLT (6), th.SC (7), th (8), th. diSp (9)					⇒	th (8)				

The following modes are available for the analog input 3. A current loop loss trip is generated if the input current falls below 3mA. In modes 4 and 5 the analog input level goes to 0.0% if the input current falls below 3mA.

Parameter value	Parameter string	Mode	Comments
0	0-20	0 - 20mA	
1	20-0	20 - 0mA	
2	4-20.tr	4 -20mA with trip on loss	Trip if I < 3mA
3	20-4.tr	20 - 4mA with trip on loss	Trip if I < 3mA
4	4-20	4 - 20mA with no trip on loss	
5	20-4	20 - 4mA with no trip on loss	0.0% if I < 4mA
6	VOLT	Voltage mode	
7	th.SC	Thermistor with short circuit detection	TH trip if R > 3k3 TH reset if R < 1k8 THS trip if R < 50R
8	th	Thermistor without short circuit detection	TH trip if R > 3k3 TH reset if R < 1k8
9	th.diSp	Thermistor display only with no trip	

In modes 2 and 4 the destination parameter is at a value equivalent to 0.0% when the input current is less than 4mA. In modes 3 and 5 the destination parameter is at a value equivalent to 100.0% when the input current is less than 4mA.

in02 {0.82, 7.01}		Analog input 1									
RO	Bi						NC	PT			
⇅	±100.00 %					⇒					

in03 {0.83, 7.02}		Analog input 2									
RO	Bi						NC	PT			
⇅	±100.0 %					⇒					

in04 {0.84, 7.03}		Analog input 3									
RO	Bi						NC	PT			
⇅	±100.0 %					⇒					

When analog input 3 is in thermistor mode the display indicates the resistance of the thermistor as a percentage of 10kΩ.


in05 {0.85, 8.01}		T24 digital I/O 1 state									
in06 {0.86, 8.02}		T25 digital I/O 2 state									
in07 {0.87, 8.03}		T26 digital I/O 3 state									
in08 {0.88, 8.04}		T27 digital input 4 state									
in09 {0.89, 8.05}		T28 digital input 5 state									
in10 {0.90, 8.06}		T29 digital input 6 state									
RO	Bit						NC	PT			
⇅	OFF (0) or On (1)					⇒					

OFF (0) = Terminal inactive


On (1) = Terminal active

# 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.





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



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 **5.07 (SE07, 0.28) Motor rated current**. This affects the thermal protection of the motor.



If the keypad mode has been used previously, ensure that the keypad reference has been set to 0 using the  buttons as if the drive is started using the keypad it will run to the speed defined by the keypad reference (Pr **0.35**).



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




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

Drive control method	Requirements
Terminal mode	Drive enable Speed reference Run forward or run reverse command
Keypad mode	Drive enable
Serial communications	Drive enable Serial communications link

Refer to Figure 4-1 on page 26 for minimum connections to get a motor running.

## 7.1 Quick start commissioning

Action	Detail	
Before power-up	Ensure: <ul style="list-style-type: none"> <li>Drive Enable signal is not given (terminal 31)</li> <li>Run signal is not given</li> <li>Motor connected</li> <li>Tacho connected if one is being used</li> <li>Encoder connected if one is being used</li> </ul>	
Power-up the drive	Ensure: <ul style="list-style-type: none"> <li>Drive displays 'inh'</li> </ul> If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 137	
Enter motor nameplate details	Enter: <ul style="list-style-type: none"> <li>Motor rated voltage in Pr <b>5.09 (SE06, 0.27)</b> (V)</li> <li>Motor rated current in Pr <b>5.07 (SE07, 0.28)</b> (A)</li> <li>Motor rated speed (base speed) in Pr <b>5.08 (SE08, 0.29)</b> (rpm)</li> <li>Field rated current in Pr <b>5.70 (SE10, 0.31)</b> (A)</li> <li>Field rated voltage in Pr <b>5.73 (SE11, 0.32)</b> (V)</li> </ul>	
Set motor feedback parameters	<p><b>Incremental encoder basic set-up</b></p> <p>Enter:</p> <ul style="list-style-type: none"> <li>Drive encoder type in Pr <b>3.38 (Fb07, 0.77)</b> = Ab (0): Quadrature encoder</li> </ul> <div style="border: 1px solid black; padding: 5px; margin: 10px 0;"> <p>Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.</p> <p><b>CAUTION</b></p> </div> <ul style="list-style-type: none"> <li>Encoder power supply in Pr <b>3.36 (Fb06, 0.76)</b> = 5V (0), 8V (1), 15V (2) or 24V (3)</li> </ul> <p><b>NOTE</b> If output voltage from the encoder is &gt;5V, then the termination resistors must be disabled Pr <b>3.39 (Fb08, 0.78)</b> to 0.</p> <ul style="list-style-type: none"> <li>Drive encoder lines per revolution (LPR) in Pr <b>3.34 (Fb05, 0.75)</b> (set according to encoder)</li> <li>Drive encoder termination resistor setting in Pr <b>3.39 (Fb08, 0.78)</b> <ul style="list-style-type: none"> <li>0 = A-AI, B-BI, Z-ZI termination resistors disabled</li> <li>1 = A-AI, B-BI, termination resistors enabled, Z-ZI termination resistors disabled</li> <li>2 = A-AI, B-BI, Z-ZI termination resistors enabled</li> </ul> </li> </ul> <p><b>Tachometer set-up</b></p> <p>Enter:</p> <ul style="list-style-type: none"> <li>Tachometer voltage rating Pr <b>3.51 (Fb02, 0.72)</b> (V/1000 rpm)</li> <li>Tachometer input mode Pr <b>3.53 (Fb03, 0.73)</b></li> </ul>	
Set maximum speed	Enter: <ul style="list-style-type: none"> <li>Maximum speed in Pr <b>1.06 (SE02, 0.23)</b> (rpm)</li> </ul>	
Set acceleration / deceleration rates	Enter: <ul style="list-style-type: none"> <li>Acceleration rate in Pr <b>2.11 (SE03, 0.24)</b> (time to accelerate to maximum speed)</li> <li>Deceleration rate in Pr <b>2.21 (SE04, 0.25)</b> (time to decelerate from maximum speed)</li> </ul>	
Enable the field controller	<p><b>Field controller set-up</b></p> <p>To enable the internal field controller:</p> <ul style="list-style-type: none"> <li>Set Pr <b>5.77 (SE12, 0.33)</b> = IntrnL</li> </ul> <p>To enable the external field controller:</p> <ul style="list-style-type: none"> <li>Set Pr <b>5.77 (SE12, 0.33)</b> = EtrnL</li> </ul>	
Static autotune	<p>Mentor MP is able to perform either a static, rotating or continuous autotune. The motor must be at a standstill before an autotune is enabled.</p> <p><b>Static autotune for current loop gains</b></p> <p>When this operation is performed the drive will perform an estimation of <i>Motor constant</i> (Pr <b>5.15</b>), <i>Continuous proportional gain</i> (Pr <b>4.13</b>), <i>Continuous integral gain</i> (Pr <b>4.14</b>), <i>Discontinuous integral gain</i> (Pr <b>4.34</b>), <i>Back EMF set point</i> (Pr <b>5.59</b>), <i>Armature resistance</i> (Pr <b>5.61</b>) and <i>Flux loop I gain</i> (Pr <b>5.72</b>) with respect to the selected motor map and store the values.</p> <p>To perform a static autotune:</p> <ul style="list-style-type: none"> <li>Set Pr <b>5.12 (SE13, 0.34)</b> = 1</li> <li>Close the Drive Enable signal (terminal 31). The drive will display 'rdY'</li> <li>Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune</li> <li>Remove the enable signal when the autotune has finished</li> <li>Remove the run signal</li> </ul>	

Action	Detail
Checking speed feedback	<ul style="list-style-type: none"> <li>Close the enable signal. Close the run signal (terminal 26 or 27). Provide speed reference to run the drive up to a low speed, the drive will regulate its own estimated speed</li> <li>Check that the feedback device is functioning correctly by checking tacho input (Pr 3.52 (Fb04, 0.74)) or encoder input (Pr 3.27 (Fb09, 0.79)).</li> </ul> <p>If tacho input is being used, any small error in tacho feedback (Pr 3.52 (Fb04, 0.74)) can be trimmed out by adjusting Pr 3.51 (Fb02, 0.72) up or down.</p> <ul style="list-style-type: none"> <li>When the feedback device being used is seen to be functioning correctly, stop the drive and select the correct feedback device using Pr 3.26 (Fb01, Pr 0.71)</li> </ul> <p><b>NOTE</b></p> <p>Because field current name plate values are normally for a cold field, the estimated speed will not be very accurate unless a rotating autotune is carried out. If reasonably accurate estimated speed, or reasonably accurate torque control is required in the field weakening range, a rotating autotune will be required to determine the motor flux characteristics Pr 5.12 (SE13, Pr 0.34) = 2</p>
Rotating autotune	<p>Mentor MP is able to perform either a static, rotating or continuous autotune. The motor must be at a standstill before an autotune is enabled.</p> <p><b>NOTE</b></p> <p>A rotating autotune cannot be carried out in Estimated speed mode.</p> <div style="border: 1px solid black; padding: 5px;">  <p>A rotating autotune will cause the motor to accelerate up to <math>\frac{1}{4}</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.</p> <p><b>WARNING</b> The drive can be stopped at any time by removing the run signal or removing the drive enable.</p> </div> <p><b>Rotating autotune for motor field flux set-up</b></p> <p>When selected the drive will determine the rated field compensation factor (Pr 5.74) for rated flux and the motor field winding saturation break-points (Pr 5.29), (Pr 5.30) by spinning the motor at 25% of its base speed (Pr 5.06) with respect to the selected motor map and store the values.</p> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr 5.12 (SE13, 0.34) = 2 for a rotating autotune</li> <li>Close the Drive Enable signal (terminal 31). The drive will display 'rdY'</li> <li>Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune</li> <li>Wait for the drive to display 'rdY' or 'inh' and for the motor to come to a standstill</li> </ul> <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 137.</p> <p>Remove the drive enable and run signal from the drive.</p> <p><b>Rotating autotune for speed loop set-up</b></p> <p>When selected the drive will calculate suitable values for the speed loop gains Kp (Pr 3.10 (SP01, 0.61), Ki (Pr 3.11 (SP02, 0.62), and Kd (Pr 3.12 (SP03, 0.63).</p> <p>To perform an autotune:</p> <ul style="list-style-type: none"> <li>Set Pr 5.12 (SE13, 0.34) = 3 for a rotating autotune</li> <li>Close the Drive Enable signal (terminal 31). The drive will display 'rdY'</li> <li>Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune</li> <li>Wait for the drive to display 'rdY' or 'inh' and for the motor to come to a standstill</li> </ul> <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 137.</p> <p>Remove the drive enable and run signal from the drive.</p>
Save parameters	<p>Select SAVE in Pr 1.00 (SE00, 0.21)</p> <p>Press the red  reset button or toggle the reset digital input (ensure Pr xx.00 returns to 0)</p>
Run	<p>Drive is now ready to run</p> <ul style="list-style-type: none"> <li>Close enable signal</li> <li>Close run signal</li> <li>Provide speed reference</li> </ul> 



## 7.2 CTSOFT software commissioning tool

CTSOFT can be used for commissioning and monitoring, drive parameters can be uploaded, downloaded and compared, and simple or custom menu listings can be created. Drive menus can be displayed in standard list format or as live block diagrams. CTSOFT includes a migration wizard that allows Mentor II parameters to be migrated to the Mentor MP. CTSOFT is able to communicate with a single drive or a network.

CTSOFT can be found on the CD which is supplied with the drive and is also available for download from the website [www.controltechniques.com](http://www.controltechniques.com) (file size approximately 100MB).

### 7.2.1 CTSOFT system requirements:

1. Pentium IV 1000MHz or better recommended.
2. Windows Vista, Windows XP or Windows 2000 (Including the latest Service Packs) only.
3. Internet Explorer V5 or later should also be installed.
4. Microsoft .Net Framework 2.0 must also be installed.
5. Absolute minimum of 800x600 screen resolution. A resolution of 1024x768 or above is recommended.
6. Adobe Acrobat 5.05 or later (for parameter help).
7. 256MB RAM

#### NOTE

You must have administration rights under Windows NT/2000/XP/Vista to install.

### 7.2.2 To install CTSOFT from the CD

1. Ensure that any previous copies of CTSOFT have been uninstalled before proceeding with the installation (existing projects will not be lost).
2. Insert the CD. The auto-run software should start up the front-end screen from which CTSOFT can be selected. User guides for the supported drive models are included with CTSOFT application. When help is requested, CTSOFT links to the parameter in the *Advanced User Guide*.

## 7.3 Setting up a feedback device

This section shows more detailed information on parameter settings that must be made to each of the compatible encoder types with Mentor MP. For more information on the parameters listed here please refer to the *Mentor MP Advanced User Guide*.

### 7.3.1 Detailed feedback device commissioning/start-up information

#### Standard quadrature encoder with or without marker pulse

Encoder type	Pr 3.38 (Fb07, 0.77)	Ab (0) Standard quadrature incremental encoder with or without marker pulse
Encoder power supply voltage	Pr 3.36 (Fb06, 0.76)	5V (0), 8V (1) or 15V (2) or 24V (3) <b>NOTE</b> If the voltage from the encoder is >5V, then the termination resistors must be disabled Pr 3.39 (Fb08, 0.78) to 0
Encoder number of lines per revolution	Pr 3.34 (Fb05, 0.75)	Set to the number of lines per revolution of the encoder
Encoder marker mode	Pr 3.35	0 = The marker system operates in a conventional manner, 1 = the marker causes a full position reset.
Encoder termination selection	Pr 3.39 (Fb08, 0.78)	0 = A, B, Z termination resistors disabled, 1 = A, B termination resistors enabled and Z termination resistors disabled, 2 = A, B, Z termination resistors enabled
Encoder error detection level	Pr 3.40	0 = No wire break detect, 1 = Wire break detect on A and B (need termination enabled for 5V signals), 2 = Wire break detect on A, B and Z (need termination enabled for 5V signals)

#### Incremental encoder with frequency and direction, or forward reverse signals, with or without marker pulse

Encoder type	Pr 3.38 (Fb07, 0.77)	Fd (2) Incremental encoder with frequency and direction outputs, with or without marker pulse, Fr (3) Incremental encoder with forward and reverse outputs, with or without marker pulse
Encoder power supply voltage	Pr 3.36 (Fb06, 0.76)	5V (0), 8V (1) or 15V (2) or 24V (3) <b>NOTE</b> If the voltage from the encoder is >5V, then the termination resistors must be disabled Pr 3.39 (Fb08, 0.78) to 0
Encoder number of lines per revolution	Pr 3.34 (Fb05, 0.75)	Set to the number of lines per revolution of the encoder divide by 2
Encoder marker mode	Pr 3.35	0 = The marker system operates in a conventional manner, 1 = the marker causes a full position reset.
Encoder termination selection	Pr 3.39 (Fb08, 0.78)	0 = A, B, Z termination resistors disabled, 1 = A, B termination resistors enabled and Z termination resistors disabled, 2 = A, B, Z termination resistors enabled
Encoder error detection level	Pr 3.40	0 = No wire break detect, 1 = Wire break detect on A and B (need termination enabled for 5V signals), 2 = Wire break detect on A, B and Z (need termination enabled for 5V signals)

## 8 Optimization

Before attempting to tune the drive the following data is required

- Armature full load current
- Armature voltage
- Field current
- Field voltage
- Base speed
- Maximum speed

In the following worked example the data below has been used

- Armature full load current = 67A with an overload of 90A for up to 30 seconds
- Armature voltage = 500V
- Field current = 1.85A
- Field voltage = 300V
- Base speed = 1750 rpm
- Maximum speed = 2500rpm

### 8.1 Armature current

- Set the motor rated current in Pr 5.07 (SE07, 0.28) to 67A.
- Set current limits in Pr 4.05 and Pr 4.06 to  $90/67 \times 100 = 134\%$
- Set the motor thermal time constant in Pr 4.15 =  $-30 / \ln(1 - (1.05 / 1.34)^2) = 31.5$

### 8.2 Speed feedback

#### 8.2.1 Estimated speed feedback

For estimated speed feedback set Pr 3.26 (Fb01, 0.71) to Est SPd. This uses an estimated speed feedback based on the motor back emf, motor rated speed, motor rated voltage, armature resistance, armature current and field flux feedback.

#### 8.2.2 Tachometer speed feedback

For tachometer speed feedback set Pr 3.26 (Fb01, 0.71) to tACHO. Set the tachometer voltage rating in V/1000rpm in Pr 3.51 (Fb02, 0.72) and the tachometer input mode Pr 3.53 (Fb03, 0.73) to suit the type of tachometer used.

#### 8.2.3 Encoder speed feedback

For encoder speed feedback set Pr 3.26 (Fb01, 0.71) to drv. Set the lines per revolution (Pr 3.34 (Fb05, 0.75)), encoder supply voltage (Pr 3.36 (Fb06, 0.76)) and encoder type (Pr 3.38 (Fb07, 0.77)).

#### 8.2.4 Solutions Module speed feedback

If an Solutions Module is being used to provide speed feedback then Pr 3.26 (Fb01, 0.71) should be set to SLOt1, SLOt2, or SLOt3.

### 8.3 Field current

The rated field current is set in Pr 5.70 (SE10, 0.31). When the field current feedback equals the compensated rated field current, 100% field flux is produced.

If field weakening is required, as in the case in the worked example, the minimum flux must be adjusted and the voltage at which field weakening is required to begin must be set.

In the example

- Set Pr 5.70 (SE10, 0.31) to 1.85A
- Set Pr 5.69 to  $1750/2500 \times 100\% = 70\%$
- Pr 5.59 should be set based on the rated armature voltage and the IR drop due to the armature resistance. This is set by the static autotune. Pr 5.59 =  $V_a - I_{rated} R_a$ .

Field economy can be used to keep the field energized, at a low level of current (to prevent overheating), when the motor is not running to prevent condensation forming in the motor. The field economy level and the timeout can be adjusted.

To use this function it is necessary to set:

- Set Pr 5.65 to enable the field economy timeout
- Set Pr 5.67 to the percentage of full field that you want to use in economy mode e.g 10%.

- Set Pr 5.64 to the time after the drive enable signal is removed to the field current reducing to the economy level.

### 8.4 Current loop gains self-tuning

For optimum performance the current loop must be set-up. The dynamics of the current loop are principally a function of the electrical characteristics of a particular motor.

The drive determines the electrical characteristics of the motor by injecting current into the armature winding.

#### 8.4.1 Static autotune for current loop gains

If Pr 5.12 (SE13, 0.34) is set to a 1, the drive is enabled and a run command is applied in either direction the drive performs a static autotune test. The test will not start unless the drive is disabled and before the test is initiated by applying the enable or run, i.e. it will not start unless the drive is in a stop state.

When this operation is performed the drive will determine the *Motor constant* (Pr 5.15), *Continuous proportional gain* (Pr 4.13), *Continuous integral gain* (Pr 4.14), *Discontinuous integral gain* (Pr 4.34), *Back EMF set point* (Pr 5.59), *Armature resistance* (Pr 5.60) and *Flux loop I gain* (Pr 5.72) with respect to the selected motor map and store the values.

#### 8.4.2 Continuous autotune for current loop gains

In the static autotune the armature current loop gains are set up with no flux in the motor. In some motors the inductance of the armature charges significantly when flux is present in the machine. If this is the case, a continuous autotune can be enabled to correct the gains for the fluxed machine.

When Pr 5.26 is set to On, the continuous autotune is enabled which continuously monitors the motor ripple and adjusts *Motor constant* (Pr 5.15), *Continuous proportional gain* (Pr 4.13) and *Discontinuous integral gain* (Pr 4.34) for optimum performance.

The static autotune should still be carried out because *Continuous integral gain* (Pr 4.14) is not set by the continuous autotune.

Calculation of the gains is suspended when the voltage spill over loop becomes active so that the gains are not increased when the field is weakened (less flux in the machine).

This function does not operate when the drives are set-up in serial 12 pulse.

#### 8.4.3 Drive commissioning output

The Mentor MP has a test pin that gives instantaneous armature current feedback. The pin is identified by a half sign wave symbol and is located to the right of the tachometer terminals. An Oscilloscope probe can be attached to this pin to monitor the armature current.

### 8.5 Speed loop gains tuning

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 3.16

Pr 3.16 may be changed when the drive is enabled or disabled.

- If Pr 3.16 = 0 - gains Kp1, Ki1 and Kd1 are used
- If Pr 3.16 = 1 - gains Kp2, Ki2 and Kd2 are used

#### 8.5.1 Proportional gain (Kp) Pr 3.10 (SP01, 0.61) and Pr 3.13

If Kp has a value and the integral gain Ki 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.

## 8.5.2 Integral gain (Ki) Pr 3.11 (SP02, 0.62) and Pr 3.14

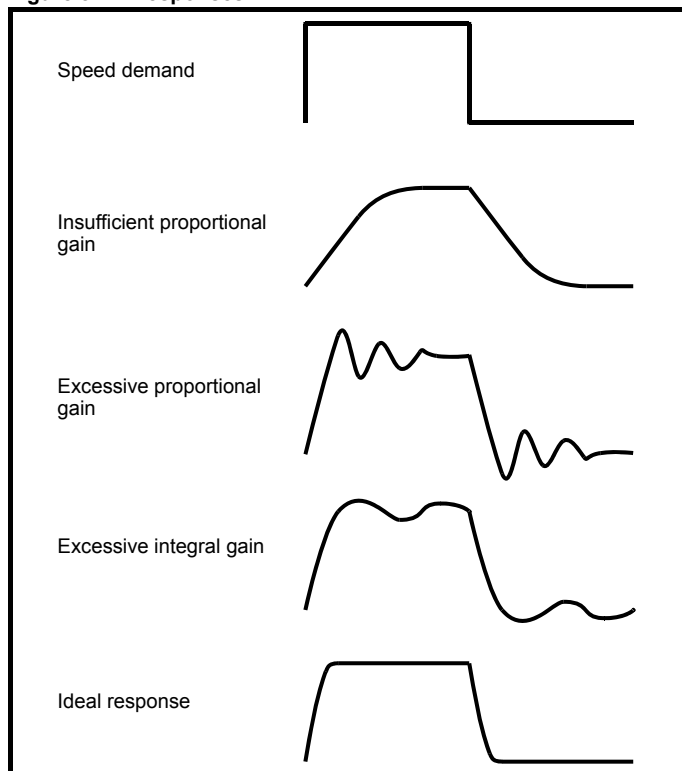
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of 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. The term is implemented in the form of  $\Sigma(K_i \times \text{error})$ , and so the integral gain can be changed when the controller is active without causing large torque demand transients.

## 8.5.3 Differential gain (Kd) Pr 3.12 (SP03, 0.63) and Pr 3.15

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

## 8.5.4 Manually setting up the speed loop gains

Figure 8-1 Responses



There are two methods of tuning the speed loop gains dependant on the setting of Pr 3.17:

### 1. Pr 3.17 = 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 ( $K_p$ ) 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 ( $K_i$ ) 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.

Figure 8-1 shows the effect of incorrect P and I gain settings as well as the ideal response.

### 2. Pr 3.17 = 1, Bandwidth set-up

If bandwidth based set-up is required, the drive can calculate  $K_p$  and  $K_i$  if the following parameters are set up correctly:

Pr 3.18 - Motor and load inertia - it is possible to measure the load inertia as part of the auto-tuning process (see Pr 5.12 (SE13, 0.34)).

Pr 3.20 - Required bandwidth,

Pr 3.21 - Required damping factor,

Pr 5.32 - Motor torque per amp (Kt).

## 8.5.5 Speed loop gains for very high inertia

Pr 3.17 = 2 -  $K_p$  gain times 16

If this parameter is set to 2 the  $K_p$  gain (from whichever source), is multiplied by 16. This is intended to boost the range of  $K_p$  for applications with very high inertia. It should be noted that if high values of  $K_p$  are used it is likely that the speed controller output will need to be filtered, see (Pr 3.42). If the feedback is not filtered it is possible that the output of the speed controller will be a square wave that changes between the current limits causing the integral term saturation system to malfunction.

## 8.6 Current limit tapers

With some motors the commutation limit of the motor requires that the maximum armature current be reduced at higher speeds, the current limit tapers can be used to provide this speed dependent current limit.

For more information refer to section on page 124.

## 9 SMARTCARD operation

### 9.1 Introduction

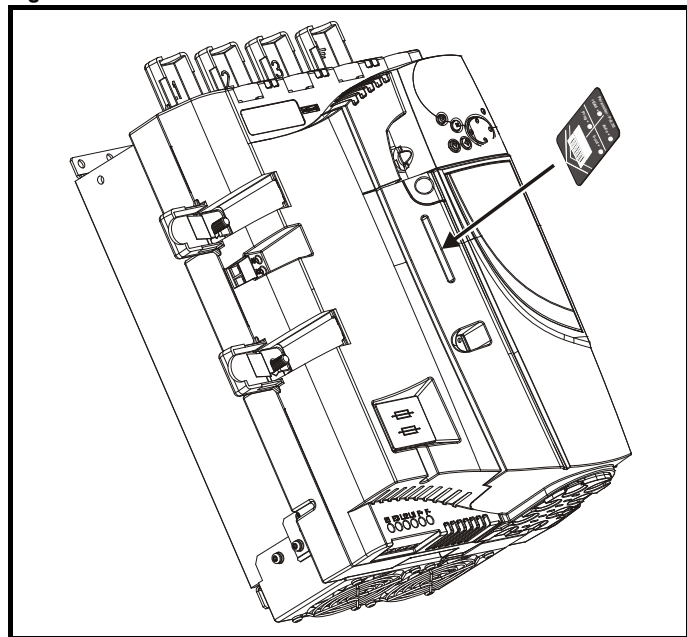
This is a standard feature that enables simple configuration of parameters in a variety of ways. The SMARTCARD can be used for:

- Parameter copying between drives
- Saving whole drive parameter sets
- Saving 'differences from default' parameter sets
- Storing Onboard PLC programs
- Automatically saving all user parameter changes for maintenance purposes
- Loading complete motor map parameters.

Refer to Figure 9-1 for installing the SMARTCARD. Ensure the SMARTCARD is inserted with the MP arrow pointing upwards.

The drive only communicates with the SMARTCARD when commanded to read or write, this means that the card may be 'hot swapped'.

**Figure 9-1 Installation of the SMARTCARD**



### 9.2 Easy saving and reading

The SMARTCARD has 999 individual data block locations. Each individual location from 1 to 499 can be used to store data.

The drive can support SMARTCARDS that have a capacity of between 4kB and 512kB.

The usage of the data block locations in the SMARTCARD are shown in Table 9-1.

**Table 9-1 SMARTCARD data blocks**

Data block	Type	Example of usage
1 to 499	Read / Write	Application Setup
500 to 599	Read Only	Macros

Parameter sets labelled as 'Differences from default' will be much smaller than whole parameter sets. Therefore they use a lot less memory because most applications only require a few parameters to be changed from the default setting.

The whole card may be protected from writing or erasing by setting the read-only flag as shown in section 9.3.9 9888 / 9777 - Set / clear the SMARTCARD read only flag on page 66.

Either of these indications will tell the user that data is being transferred to or from the SMARTCARD:

- SM-Keypad: The decimal point after the fourth digit in the upper display will flash.
- MP-Keypad: The symbol 'CC' will appear in the lower left hand corner of the display.

The card should not be removed during data transfer because the drive will trip. If a trip occurs you must either try to transfer the data again or, in the case of a card-to-drive transfer, the default parameters should be loaded.

### 9.3 Transferring data

When a code is entered into Pr **xx.00** and the drive is subsequently reset, the drive will carry out the actions listed in Table 9-2.

**Table 9-2 Transferring data**

Codes	Actions
Pr <b>x.00</b> = rEAd 1	Transfer SMARTCARD data block 1 to the drive.
Pr <b>x.00</b> = rEAd 2	Transfer SMARTCARD data block 2 to the drive.
Pr <b>x.00</b> = rEAd 3	Transfer SMARTCARD data block 3 to the drive.
Pr <b>x.00</b> = PrOg 1	Transfer drive parameters as difference from default to SMARTCARD data block number 1.
Pr <b>x.00</b> = PrOg 2	Transfer drive parameters as difference from default to SMARTCARD data block number 2.
Pr <b>x.00</b> = PrOg 3	Transfer drive parameters as difference from default to SMARTCARD data block number 3.
Pr <b>x.00</b> = 2001	Transfer drive parameters as difference from defaults to a bootable SMARTCARD data block with block number 1. This will clear data block 1 on the card if it already exists.
Pr <b>x.00</b> = 3yyy	Transfer drive parameters to a SMARTCARD data block number yyy.
Pr <b>x.00</b> = 4yyy	Transfer drive data as difference from defaults to SMARTCARD data block number yyy.
Pr <b>x.00</b> = 5yyy	Transfer drive user program to SMARTCARD data block number yyy.
Pr <b>x.00</b> = 6yyy	Transfer SMARTCARD data block yyy to the drive.
Pr <b>x.00</b> = 7yyy	Erase SMARTCARD data block yyy.
Pr <b>x.00</b> = 8yyy	Compare drive parameters with data block yyy.
Pr <b>x.00</b> = 9555	Clear SMARTCARD warning suppression flag.
Pr <b>x.00</b> = 9666	Set SMARTCARD warning suppression flag.
Pr <b>x.00</b> = 9777	Clear SMARTCARD read-only flag.
Pr <b>x.00</b> = 9888	Set SMARTCARD read-only flag.
Pr <b>x.00</b> = 9999	Erase SMARTCARD.
Pr <b>11.42 (SE09, 0.30)</b> = Read	Transfer SMARTCARD data block 1 to the drive provided it is a parameter file.
Pr <b>11.42 (SE09, 0.30)</b> = Prog	Transfer drive parameters to a SMARTCARD data block number 1.
Pr <b>11.42 (SE09, 0.30)</b> = Auto	Transfer drive parameters to a SMARTCARD data block with data block number 1 provided.
Pr <b>11.42 (SE09, 0.30)</b> = boot	Pr <b>11.42 (SE09, 0.30)</b> has been changed since power-up.

Where yyy indicates the data block number 001 to 999, refer to Table 9-2 for restrictions on data block numbers.

#### NOTE

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

#### 9.3.1 Writing to the SMARTCARD

##### 3yyy - Transfer data to the SMARTCARD

The data block contains the complete parameter data from the drive, i.e. all user-save (US) parameters except parameters with the NC coding bit set. Power-down save (PS) parameters are not transferred to the SMARTCARD.

#### 4yyy - Write default differences to a SMARTCARD

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

Six bytes are required for each parameter difference. The data density is not as high as when using the 3yyy transfer method as described in the section *3yyy - Transfer data to the SMARTCARD* but in most cases the number of differences from default is small and the data blocks are therefore smaller. This method can be used for creating drive macros. PS parameters are not transferred to the SMARTCARD.

#### Writing a parameter set to the SMARTCARD

Setting Pr 11.42 (SE09, 0.30) to Prog (2) and resetting the drive will save the parameters to the SMARTCARD, i.e. this is equivalent to writing 3001 to Pr xx.00. All SMARTCARD trips apply except 'C.Chg'. If the data block already exists it is automatically overwritten.

When the action is complete this parameter is automatically reset to nonE (0).

### 9.3.2 Reading from the SMARTCARD

#### 6yyy - Read default differences from a SMARTCARD

When the data is transferred back to a drive, using 6yyy in Pr xx.00, it is transferred to the drive RAM and the drive EEPROM. A parameter save is not required to retain the data after power-down. Set-up data for any Solutions Modules installed are stored on the card and are transferred to the destination drive. If the Solutions Modules are different between the source and destination drive, the menus for the slots where the Solutions 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 'C.Optn' trip if the Solutions Modules installed to the source and destination drive are different or are in different slots. If the data is being transferred to a drive of a different voltage or current rating a 'C.rtg' trip will occur.

Table 9-3 lists the rating dependent parameters (RA coding bit set) that will not be written to the destination drive and will contain their default values after the copying action.

**Table 9-3 Rating dependent parameters**

Parameter	Function
4.05	Current limit
4.06	Current limit
4.07	Current limit
4.24	User current maximum scaling
5.07 (SE07, 0.28)	Motor rated current
5.09 (SE06, 0.27)	Motor rated voltage

#### Reading a parameter set from the SMARTCARD

Setting Pr 11.42 (SE09, 0.30) 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 xx.00. All SMARTCARD trips apply. Once the parameters are successfully copied this parameter is automatically reset to nonE (0). Parameters are saved to the drive EEPROM after this action is complete.

#### NOTE

This operation is only performed if data block 1 on the card is a full parameter set (3yyy transfer) and not a default difference file (4yyy transfer). If data block 1 does not exist a 'C.dAt' trip occurs.

### 9.3.3 Auto saving parameter changes

This setting causes the drive to automatically save any changes made to Menu 0 parameters on the drive to the SMARTCARD. The latest Menu 0 parameter set in the drive is therefore always backed up on the SMARTCARD.

Changing Pr 11.42 (SE09, 0.30) to Auto (3) and resetting the drive will immediately save the complete parameter set from the drive to the card, i.e. all User Save (US) 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 card when Pr xx.00 is set to a 1000 and the drive reset.

All SMARTCARD trips apply, except 'C.Chg'. If the data block already contains information it is automatically overwritten.

If the card is removed when Pr 11.42 (SE09, 0.30) is set to 3, Pr 11.42 (SE09, 0.30) is then automatically set to nonE (0).

When a new SMARTCARD is installed Pr 11.42 (SE09, 0.30) must be set back to Auto (3) by the user and the drive reset so the complete parameter set is rewritten to the new SMARTCARD if auto mode is still required.

When Pr 11.42 (SE09, 0.30) is set to Auto (3) and the parameters in the drive are saved, the SMARTCARD is also updated, therefore the SMARTCARD becomes a copy of the drives stored configuration.

At power up, if Pr 11.42 (SE09, 0.30) is set to Auto (3), the drive will save the complete parameter set to the SMARTCARD. The drive will display 'cArd' during this operation. This is done to ensure that if a user puts a new SMARTCARD in during power down the new SMARTCARD will have the correct data.

#### NOTE

When Pr 11.42 (SE09, 0.30) is set to Auto (3) the setting of Pr 11.42 (SE09, 0.30) itself is saved to the drive EEPROM but NOT to the SMARTCARD.

### 9.3.4 Booting up from the SMARTCARD on every power up (Pr 11.42 (SE09, 0.30) = boot (4))

When Pr 11.42 (SE09, 0.30) is set to boot (4) the drive operates the same as Auto mode, except when the drive is powered up. The parameters on the SMARTCARD will be automatically transferred to the drive at power-up if the following are true:

- A card is inserted in the drive
- Parameter data block 1 exists on the card
- The data in block 1 is type 1 to 5 (as defined in Pr 11.38)
- Pr 11.42 (SE09, 0.30) on the card set to boot (4)

The drive will display 'boot' during this operation. If the drive mode is different from that on the card, the drive gives a 'C.Type' trip and the data is not transferred.

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

If data block 1 contains a bootable parameter set and data block 2 contains an Onboard PLC program (type 17 as defined in Pr 11.38), then the onboard PLC program will be transferred to the drive at power up along with the parameter set in data block 1.

#### NOTE

'Boot' mode is saved to the card, but when the card is read, the value of Pr 11.42 (SE09, 0.30) is not transferred to the drive.

### 9.3.5 Booting up from the SMARTCARD on every power up (Pr xx.00 = 2001)

It is possible to create a difference from default bootable file by setting Pr xx.00 to 2001 and resetting the drive. This type of file causes the drive to behave in the same way at power-up as a file created with boot mode set up with Pr 11.42 (SE09, 0.30). The difference from the default file is that it has the added advantage of including Menu 20 parameters.

Setting Pr xx.00 to 2001 will overwrite data block 1 on the card, if it already exists.

If a data block 2 exists and contains an Onboard PLC program (type 17 as defined in Pr 11.38), this will also be loaded after the parameters have been transferred.

A bootable difference from default file can only be created in one operation and parameters cannot be added as they are saved via Menu 0.

### 9.3.6 Comparing drive full parameter set with the SMARTCARD values

Setting 8yyy in Pr xx.00, will compare the SMARTCARD file with the data in the drive:

- If the compare is successful Pr xx.00 is simply set to 0
- If the compare fails a 'C.cpr' trip is initiated

### 9.3.7 7yyy / 9999 - Erasing data from the SMARTCARD

Data can be erased from the SMARTCARD one data block at a time or with data blocks 1 to 499 in selected together.

- Setting 7yyy in Pr **xx.00** will erase SMARTCARD data block yyy
- Setting 9999 in Pr **xx.00** will erase SMARTCARD data blocks 1 to 499

### 9.3.8 9666 / 9555 - Set / clear SMARTCARD warning suppression flag

- If the Solutions Module(s) installed to the source and destination drive are different, or are in different slots, the drive will produce a 'C.Optn' trip.
- If the data is being transferred to a drive of a different voltage or current rating a 'C.rtg' 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 Solutions Module(s) or drive ratings are different between the source and the destination drives. The Solutions Module or rating dependent parameters will not be transferred.

- Setting 9666 in Pr **xx.00** will set the warning suppression flag
- Setting 9555 in Pr **xx.00** will clear the warning suppression flag

### 9.3.9 9888 / 9777 - Set / clear the SMARTCARD read only flag

The SMARTCARD may be protected from writing or erasing by setting the read only flag. If an attempt is made to write or erase a data block when the read only flag is set, a 'C.rdo' trip is initiated.

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

- Setting 9888 in Pr **xx.00** will set the read only flag
- Setting 9777 in Pr **xx.00** will clear the read only flag

## 9.4 Data block header information

Each data block stored on a SMARTCARD has header information detailing the following:

- A number which identifies the data block (Pr **11.37**)
- Type of data stored in the data block (Pr **11.38**)
- Drive mode if the data is parameter data (Pr **11.38**)
- Version number (Pr **11.39**)
- Checksum (Pr **11.40**)
- Read-only flag
- Warning suppression flag

The header information for each data block that has been used can be viewed in Pr **11.38** to Pr **11.40** by increasing or decreasing the data block number set in Pr **11.37**.

If Pr **11.37** is set to 1000: the checksum parameter (Pr **11.40**) shows the number of bytes left on the card in 16 byte pages.

If Pr **11.37** is set to 1001: the checksum parameter (Pr **11.40**) shows the total capacity of the card in 16 byte pages. Therefore, for a 4kB card this parameter would show 254.

If Pr **11.37** is set to 1002: the checksum parameter (Pr **11.40**) shows the state of the read-only (bit 0) and warning suppression flags (bit 1).

If there is no data on the card: Pr **11.37** can only have values of 0 or 1000 to 1002.

## 9.5 SMARTCARD parameters

11.36		SMARTCARD parameter data previously loaded							
RO	Uni	NC					PT	US	
⇅	0 to 999						⇒	0	

This parameter shows the number of the data block last parameter or difference from default data block transferred from a SMARTCARD to the drive.

11.37		SMARTCARD data number							
RW	Uni	NC							
⇅	0 to 1002						⇒	0	

This parameter shows the data blocks that are stored on a SMARTCARD with header information, including a number to identify the data block.

11.38		SMARTCARD data type/mode							
RO	Txt	NC					PT		
⇅	0 to 18						⇒		

This parameter gives the type/mode of the data block selected with Pr **11.37** as shown in the following table.

**Table 9-4 Pr 11.38 types and modes**

Pr 11.38	String	Type/Mode
0	FrEE	Value when Pr <b>11.37</b> = 0
1	3C.SE	Commander SE mode parameter file (not used)
2	3OpEn.LP	Open-loop mode parameter file
3	3CL.VEct	Closed-loop vector mode parameter file
4	3SErVO	Servo mode parameter file
5	3REGEEn	Regen mode parameter file
6	3DC	DC mode parameter file
7	3Un	Unused
8	3Un	Unused
9	4C.SE	Commander SE mode difference from default file (not used)
10	4OpEn.LP	Open-loop mode difference from default file
11	4CL.VEct	Closed-loop vector mode difference from default file
12	4SErVO	Servo mode difference from default file
13	4REGEEn	Regen mode difference from default file
14	4DC	DC Mode difference from default file
15 & 16	4Un	Unused
17	LAddEr	Onboard Application Lite user program file
18	Option	A file containing user defined data (the file is normally created by an SM-Applications Solutions Module)

11.39		SMARTCARD data version							
RW	Uni	NC							
⇅	0 to 9999						⇒	0	

This parameter gives the version number of the data block.

11.40		SMARTCARD data checksum							
RO	Uni	NC					PT		
⇅	0 to 65335						⇒	0	

This parameter gives the checksum of the data block, space left on the card, the total space on the card or the card flags. Refer to Pr **11.37** for information.

11.42 (SE09, 0.30)		Parameter copying											
RW	Txt	NC								US*			
↕	0 to 4					⇒	0						

**NOTE**

\* Mode 1 and Mode 2 are not saved when the drive parameters are saved. This parameter can only be saved to EEPROM if it has a value of 0, 3 or 4.

**Table 9-5 Pr 11.38 actions**

Actions	Value	Result
None	0	Inactive
Reading	1	Read parameter set from SMARTCARD
Programming	2	Program parameter set to the SMARTCARD
Auto	3	Auto save
Boot	4	Boot mode

## 9.6 SMARTCARD trips

After an attempt to read, write or erase data to or from a SMARTCARD a trip may occur if there has been a problem with the command. Table 9-6 lists the trip indications and conditions that will cause the SMARTCARD to trip,

**Table 9-6 Trip conditions**

Trip	Condition
<b>C.boot</b>	<b>SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD</b>
177	A write to a Menu 0 parameter has been initiated with the keypad by exiting edit mode and Pr <b>11.42 (SE09, 0.30)</b> is set for auto or boot mode. However the necessary boot file has not been created on the SMARTCARD to take the new parameter value. This occurs when Pr <b>11.42 (SE09, 0.30)</b> is changed to auto or boot mode, but the drive is not subsequently reset.
<b>C.BUSy</b>	<b>SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module</b>
178	An attempt has been made to access a SMARTCARD. However an Solutions Module is already accessing the SMARTCARD.
<b>C.Chg</b>	<b>SMARTCARD trip: Data location already contains data</b>
179	An attempt has been made to store data in a SMARTCARD data block that already exists.
<b>C.Optn</b>	<b>SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive</b>
180	Parameter data or default difference data is being transferred from a SMARTCARD to the drive, but the Solutions 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 Solutions 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>C.Rdo</b>	<b>SMARTCARD trip: SMARTCARD has the Read Only bit set</b>
181	An attempt has been made to modify a read-only SMARTCARD (i.e. erase the card, erase a file or create a file). A SMARTCARD is read-only if the read-only flag has been set or the card contains data blocks with numbers from 500 to 999. Attempting to create data blocks with numbers from 500 to 999 will always cause a trip.
<b>C.Err</b>	<b>SMARTCARD trip: SMARTCARD data is corrupted</b>
182	An attempt has been made to transfer a data block from a SMARTCARD to the drive or to compare a SMARTCARD data block and the checksum is incorrect or the data structure on the card is incorrect.
<b>C.dat</b>	<b>SMARTCARD trip: Data location specified does not contain any data</b>
183	An attempt has been made to transfer a data block from a SMARTCARD to the drive or to compare a SMARTCARD data block and the block does not exist.
<b>C.FULL</b>	<b>SMARTCARD trip: SMARTCARD full</b>
184	An attempt has been made to create a data block on a SMARTCARD, but there is not enough space on the card.
<b>C.Acc</b>	<b>SMARTCARD trip: SMARTCARD Read / Write fail</b>
185	An attempt has been made to access a SMARTCARD, but a card is not present or communications failure has occurred between the drive and the card. This trip is also produced if an attempt is made to access a data block that has already been opened by an Solutions Module.
<b>C.rtg</b>	<b>SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different</b>
186	Parameter data or default difference data is being transferred from a SMARTCARD to the drive, but the current and /or voltage ratings are different between source and destination drives. This trip does not stop the data transfer, but is a warning that the data for the Solutions 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>C.Typ</b>	<b>SMARTCARD trip: SMARTCARD parameter set not compatible with drive</b>
187	This trip is produced during a compare if the drive mode in the data block is different from the current drive mode and the file is a parameter or defaults differences file. This trip is also produced if an attempt is made to transfer parameters from a parameter or default difference to the drive if the drive mode in the data block is outside the allowed range of drive modes for the drive.
<b>C.cpr</b>	<b>SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different</b>
188	A compare has been carried out between a data block on a SMARTCARD and the drive and the compare has failed. This trip only occurs if the compare has not already failed with the following trips: C.Typ, C.rtg, C.Optn, C.BUSy, C.Acc or C.Err.



**Table 9-7 SMARTCARD status indications**

Lower display	Description
<b>boot</b>	A parameter set is being transferred from the SMARTCARD to the drive during power-up. For further information please refer to <i>section 9.3.4 Booting up from the SMARTCARD on every power up (Pr 11.42 (SE09, 0.30) = boot (4))</i> on page 65.
<b>cArd</b>	The drive is writing a parameter set to the SMARTCARD during power-up. For further information please refer to <i>section 9.3.3 Auto saving parameter changes</i> on page 65.

## 10 Onboard PLC

### 10.1 Onboard PLC and SYPT Lite

The Mentor MP has the ability to store and execute a 6kB Onboard PLC ladder logic program without the need for additional hardware in the form of a Solutions Module.

The ladder logic program is written using SYPT Lite, a Windows™ based ladder diagram editor allowing the development of programs for execution in SM-Applications Plus.

Advantages of SYPT Lite:

- SYPT Lite is designed to be easy to use and to make program development as simple as possible. The features provided are a sub-set of those in the SYPT program editor.
- SYPT Lite programs are developed using ladder logic, a graphical language widely used to program PLCs (IEC61131-3).
- SYPT Lite allows the user to draw a ladder diagram representing a program.
- SYPT Lite provides a complete environment for the development of ladder diagrams. Ladder diagrams can be created, compiled into user programs and downloaded to SM-Applications Plus for execution, via the RJ45 serial communications port on the front of the drive.
- The run-time operation of the compiled ladder diagram on the target can also be monitored using SYPT Lite and facilities are provided to interact with the program on the target by setting new values for target parameters.
- SYPT Lite is available on the CD that is supplied with the drive.

### 10.2 Benefits

The combination of the Onboard PLC and SYPT Lite means that Mentor MP can replace nano and some micro PLCs in many applications. The Onboard PLC programs can consist of up to a maximum of 50 ladder logic rungs (up to 7 function blocks and 10 contacts per rung). The Onboard PLC program can also be transferred to and from a SMARTCARD for backup or quick commissioning.

In addition to the basic ladder symbols, SYPT Lite contains a sub-set of the function from the full version of SYPT. These include:

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

Typical applications for the Onboard PLC include,

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

### 10.3 Limitations

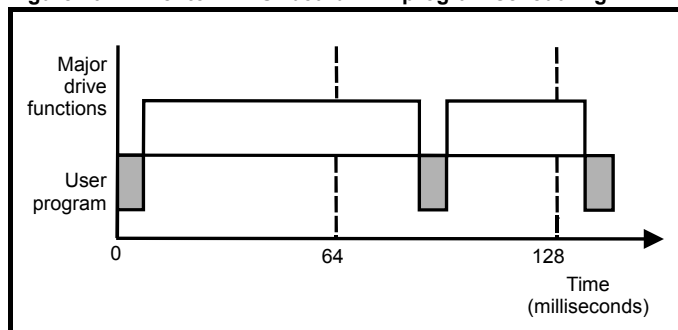
Compared with the SM-Applications Plus or SM-Applications Lite V2 modules when programmed with SYPT, the Onboard PLC program has the following limitations:

- The maximum program size is 6080 bytes including header and optional source code.
- The Mentor MP is rated for 100 program downloads. This limitation is imposed by the flash memory used to store the program within the drive.
- The user cannot create user variables. The user is only able to manipulate the drive parameter set.
- The program cannot be downloaded or monitored over CTNet. The program is only accessible via the drives RJ45 serial communications port.

- There are no real-time tasks, i.e. the scheduling rate of the program cannot be guaranteed. SM-Applications Plus tasks such as Clock, Event, Pos0 or Speed are not available.
- The Onboard PLC should not be used for time-critical applications. For time-critical applications either the SM-Applications Plus or SM-Applications Lite V2 Solutions Modules should be used.

The program runs at a low priority. The Mentor MP provides a single background task in which to run a ladder diagram. The drive is prioritized to perform its major functions first, e.g. motor control, and will use any remaining processing time to execute the ladder diagram as a background activity. As the drive's processor becomes more heavily loaded, less time is spent executing the program.

**Figure 10-1 Mentor MP Onboard PLC program scheduling**



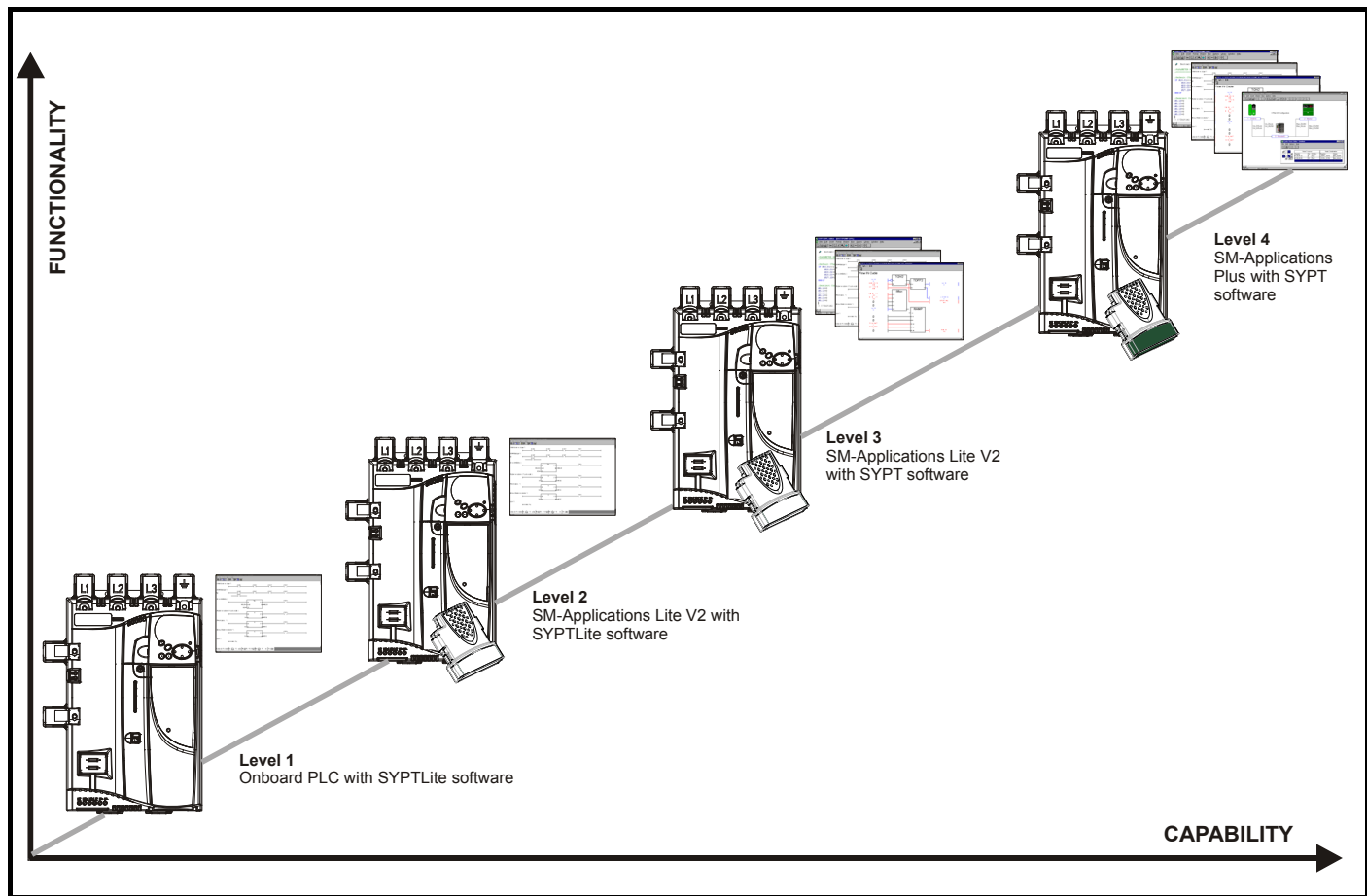
The user program is scheduled for a short period approximately once every 64ms. The time for which the program is scheduled will vary between 0.2ms and 2ms depending on the loading of the drive's processor.

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. SYPT Lite displays the average execution time calculated over the last 10 scans of the user program.

The Onboard PLC and SYPT Lite form the first level of functionality in a range of programmable options for Mentor MP.

- SYPT Lite can be used with either the Onboard PLC or with SM-Applications Lite V2 to create ladder logic programs.
- SYPT can be used with either the SM-Applications Lite V2 or SM-Applications Plus to create fully flexible programs using ladder logic, function blocks or DPL script.

**Figure 10-2 Programming options for Mentor MP**



## 10.4 Getting started

SYPTLite can be found on the CD which is supplied with the drive.

### SYPTLite system requirements

- Windows 2000/XP/Vista. **Windows 95/98/98SE/Me/NT4 are not supported**
- Pentium III 500MHz or better recommended
- 128MB RAM
- Minimum of 800x600 screen resolution. 1024x768 is recommended
- Adobe Acrobat 5.10 or later (for viewing User Guides)
- Microsoft Internet Explorer V5.0 or later
- RS232 to RS485, RJ45 communications lead to connect the PC to the drive
- Administrator rights are required to install the software

To install SYPTLite, insert the CD and the auto-run facility should start up the front-end screen, from which SYPTLite can be selected.

See the SYPTLite help file for more information regarding using SYPTLite, creating ladder diagrams and the available function blocks.

## 10.5 Onboard PLC parameters

The following parameters are associated with the Onboard PLC program.

11.47 Drive Onboard PLC program enable									
RW	Uni							US	
⇅	0 to 2						⇒	2	

This parameter is used to start and stop the drive Onboard PLC program.

Value	Description
0	Halt the drive Onboard PLC program.
1	Run the drive Onboard PLC program (if installed). Any out-of-range parameter writes attempted will be clipped to the maximum / minimum values valid for that parameter before being written.
2	Run the drive Onboard PLC program (if installed). Any out-of-range parameter writes attempted will cause a 'UP ovr' trip.

11.48 Drive Onboard PLC program status									
RO	Bi					NC	PT		
⇅	-128 to +127						⇒		

The drive Onboard PLC program status parameter indicates to the user the actual state of the drive Onboard PLC program.

Value	Description
-n	Onboard PLC program caused a drive trip due to an error condition while running rung n. Note that the rung number is shown on the display as a negative number.
0	Onboard PLC program is not installed.
1	Onboard PLC program is installed but stopped.
2	Onboard PLC program is installed and running.

When an Onboard PLC program is installed and running, the lower display of the drive flashes 'PLC' once every 10s.

11.49 Drive Onboard PLC programming events									
RO	Uni					NC	PT		PS
↕	0 to 65,535				⇒				

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

11.50 Drive Onboard PLC program average scan time									
RO	Uni					NC	PT		
↕	0 to 65,535 ms				⇒				

This parameter is updated once per second or once per Onboard PLC program scan whichever is the longest. If more than one program scan occurs within the one second update period the parameter shows the average scan time. If the program scan time is longer than one second the parameter shows the time for the last program scan.

11.51 Drive Onboard PLC program first run									
RO	Bit					NC	PT		
↕	OFF (0) or On (1)				⇒				

The Drive Onboard PLC program first run parameter is set for the duration of program scan from the stopped state. This enables the user to perform any required initialisation every time the program is run. This parameter is set every time the program is stopped.

## 10.6 Onboard PLC trips

The following trips are associated with the Onboard PLC program.

Trip	Diagnosis
<b>UP ACC</b>	<b>Onboard PLC program: Cannot access Onboard PLC program file on drive</b>
<b>98</b>	Disable drive - write access is not allowed when the drive is enabled. Another source is already accessing Onboard PLC program - retry once the other action is complete.
<b>UP div0</b>	<b>Onboard PLC program attempted divide by zero</b>
<b>90</b>	Check program
<b>UP OFL</b>	<b>Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow)</b>
<b>95</b>	Check program
<b>UP ovr</b>	<b>Onboard PLC program attempted out of range parameter write</b>
<b>94</b>	Check program
<b>UP PAr</b>	<b>Onboard PLC program attempted access to a non-existent parameter</b>
<b>91</b>	Check program
<b>UP ro</b>	<b>Onboard PLC program attempted write to a read-only parameter</b>
<b>92</b>	Check program
<b>UP So</b>	<b>Onboard PLC program attempted read of a write-only parameter</b>
<b>93</b>	Check program
<b>UP udF</b>	<b>Onboard PLC program undefined trip</b>
<b>97</b>	Check program
<b>UP uSer</b>	<b>Onboard PLC program requested a trip</b>
<b>96</b>	Check program

## 10.7 Onboard PLC and the SMARTCARD

The Onboard PLC program in a drive may be transferred from the drive to a SMARTCARD and vice versa.

- To transfer an Onboard PLC program from the drive to a SMARTCARD, set Pr **xx.00** to 5yyy and reset the drive
- To transfer an Onboard PLC program from the SMARTCARD to a drive, set Pr **xx.00** to 6yyy and reset the drive.

(Where yyy is the data block location, see Table 9-1 *SMARTCARD data blocks* on page 64 for restrictions on block numbers).

If an attempt is made to transfer an Onboard PLC program from a drive to the SMARTCARD when the drive contains no program, the block is still created on the SMARTCARD but it will contain no data. If this data block is then transferred to a drive, the destination drive will then have no Onboard PLC program.

The smallest SMARTCARD compatible with Mentor MP has a capacity of 4064 bytes and each block can be up to 4064 bytes in size. The maximum size of a user program is 4032 bytes so it is guaranteed that any Onboard PLC program downloaded to a Mentor MP will fit on an empty SMARTCARD. A SMARTCARD can contain a number of Onboard PLC programs until the capacity of the card is used.

# 11 Advanced parameters

This is a quick reference to all parameters in the drive showing units, ranges, limits etc, with block diagrams to illustrate their function. Full parameter descriptions can be found in the Advanced User Guide on the supplied CD ROM.

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

**Table 11-1 Menu descriptions**

Menu	Function
1	Speed reference selection, limits and filters
2	Ramps
3	Speed feedback and speed control
4	Torque and current control
5	Motor and field control
6	Sequencer and clock
7	Analog I/O
8	Digital I/O
9	Programmable logic and motorized pot
10	Drive status and trip information
11	General drive set-up
12	Threshold detectors, variable selectors and brake control function
13	Position control
14	User PID controller
15	Slot 1 Solutions Module menu
16	Slot 2 Solutions Module menu
17	Slot 3 Solutions Module menu
18	User application menu 1 (saved in drive EEPROM)
19	User application menu 2 (saved in drive EEPROM)
20	User application menu 3 (not saved in drive EEPROM)
21	Second motor parameters
22	Additional Menu 0 set up
23	Header selections

## Default abbreviations:

EUR> European default value  
USA> USA default value

### NOTE

Parameter numbers shown in brackets {...} are the equivalent sub block/ Menu 0 parameters.

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 such parameters.

## Coding

The coding defines the attributes of the parameter as follows.

**Table 11-2 Key to parameter table coding**

Coding	Attribute
Bit	1 bit parameter
SP	Spare: not used
FI	Filtered: some parameters which can have rapidly changing values are filtered when displayed on the drive keypad for easy viewing.
DE	Destination pointer parameter: This parameter can be used to set up the location (i.e. menu/parameter number) where the destination data is to be routed.
Txt	Text: the parameter uses text strings instead of numbers.
VM	Variable maximum: the maximum of this parameter can vary.
DP	Decimal place: indicates the number of decimal places used by this parameter.
ND	No default: when defaults are loaded (except when the drive is manufactured or on EEPROM failure) this parameter is not modified.
RA	Rating dependant: this parameter is likely to have different values and ranges with drives of different voltage and current ratings. Parameters with this attribute will not be transferred to the destination drive by a SMART card when the rating of the destination drive is different from the source drive if the drive voltage ratings are different or the file is a parameter file. However, the value will be transferred if only the current rating is different and the file is a differences from default type file.
NC	Not copied: not transferred to or from smart cards during cloning.
NV	Not visible: not visible on the keypad.
PT	Protected: cannot be used as a destination.
US	User save: saved in drive EEPROM when the user initiates a parameter save.
RW	Read/write: can be written by the user.
BU	Bit default one/unsigned: Bit parameters with this flag set to one have a default of one (all other bit parameters have a default of zero. Non-bit parameters are unipolar if this flag is one.
PS	Power-down save: automatically saved in drive EEPROM on UU trip.

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**Table 11-3 Feature look-up table**

Feature	Related parameters (Pr)													
Acceleration rates	2.10	2.11 to 2.19	2.32	2.33	2.34	2.02								
Analog speed reference 1	1.36	7.10	7.01	7.07	7.08	7.09	7.25	7.26	7.30					
Analog speed reference 2	1.37	7.14	1.41	7.02	7.11	7.12	7.13	7.28	7.31					
Analog I/O	Menu 7													
Analog input 1	7.01	7.07	7.08	7.09	7.10	7.25	7.26	7.30						
Analog input 2	7.02	7.11	7.12	7.13	7.14	7.28	7.31							
Analog input 3	7.03	7.15	7.16	7.17	7.18	7.29	7.32							
Analog output 1	7.19	7.20	7.21	7.33										
Analog output 2	7.22	7.23	7.24											
Application menu	Menu 18		Menu 19		Menu 20									
At speed indicator bit	3.06	3.07	3.09	10.06	10.05	10.07								
Auto reset	10.34	10.35	10.36	10.01										
Autotune	4.13	4.14	4.34	5.12	5.15	5.23	5.24	5.29	5.30	5.59	5.61	5.70	5.72	5.74
Binary sum	9.29	9.30	9.31	9.32	9.33	9.34								
Bipolar speed	1.10													
Brake control	12.40 to 12.49													
Catch a spinning motor	6.09													
Coast to stop	6.01													
Comms	11.23 to 11.26													
Copying	11.42	11.36 to 11.40												
Cost - per kWh electricity	6.16	6.17	6.24	6.25	6.26	6.40								
Current controller	4.13	4.14	4.34	5.15										
Current feedback	4.01	4.02	4.16	4.19	4.20	4.27	4.28	4.29	4.30	4.31	4.32	10.08	10.17	
Current limits	4.05	4.06	4.07	4.18	5.07	10.09								
Deceleration rates	2.20	2.21 to 2.29	2.04	2.35 to 2.37	2.02	2.08	6.01							
Defaults	11.46													
Digital I/O	Menu 8													
Digital I/O read word	8.20													
Digital I/O T24	8.01	8.11	8.21	8.31										
Digital I/O T25	8.02	8.12	8.22	8.32										
Digital I/O T26	8.03	8.13	8.23	8.33										
Digital input T27	8.04	8.14	8.24											
Digital input T28	8.05	8.15	8.25	8.39										
Digital input T29	8.06	8.16	8.26	8.39										
Digital lock	13.10	13.01 to 13.09	13.11	13.12	13.16	3.22	3.23	13.19 to 13.23						
Direction	10.13	6.30	6.31	3.01	3.02	10.14	8.03	8.04						
Display timeout	11.41													
Drive active	10.02													
Drive OK	10.01	8.27	8.07	8.17	10.36									
Electronic nameplate	3.49													
Enable	6.15	8.09	8.10											
Encoder reference	3.43	3.44	3.45	3.46										
Encoder set up	3.33	3.34 to 3.42	3.47	3.48										
External trip	10.32	8.10	8.07											
Fan speed	6.45													
Filter change	6.19	6.18												
Hard speed reference	3.22	3.23												
I/O sequencer	6.04	6.30	6.31	6.32	6.33	6.34	6.42	6.43	6.40					
Inertia compensation	2.38	5.12	4.22	3.18										
Jog reference	1.05	2.19	2.29											
Keypad reference	1.17	1.14	1.43	1.51	6.12	6.13								
Limit switches	6.35	6.36												
Line power supply loss	6.03	5.05												
Local position reference	13.20 to 13.23													
Logic function 1	9.01	9.04	9.05	9.06	9.07	9.08	9.09	9.10						
Logic function 2	9.02	9.14	9.15	9.16	9.17	9.18	9.19	9.20						
Marker pulse	3.32	3.31												
Maximum speed	1.06													
Menu 0 set up	22.01 to 22.21		Menu 22											
Minimum speed	1.07	10.04												
Modules - number of	11.35													

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Feature	Related parameters (Pr)												
Motor map	5.07	5.08	5.09	5.70	5.73								
Motor map 2	Menu 21		11.45										
Motorized potentiometer	9.21	9.22	9.23	9.24	9.25	9.26	9.27	9.28					
Offset speed reference	1.04	1.38	1.09										
Onboard PLC	11.47 to 11.51												
Open collector digital outputs	8.30												
Orientation	13.10	13.13 to 13.15											
Output	5.01	5.02	5.03										
Overspeed threshold	3.08												
PID controller	Menu 14												
Position feedback - drive	3.28	3.29	3.30	3.50									
Positive logic	8.29												
Power up parameter	11.22	11.21											
Precision reference	1.18	1.19	1.20	1.44									
Preset speeds	1.15	1.21 to 1.28		1.16	1.14	1.42	1.45 to 1.48		1.50				
Programmable logic	Menu 9												
Regenerating	10.10												
Relative jog	13.17 to 13.19												
Relay output	8.07	8.17	8.27	8.40	8.50	8.60							
Reset	10.33	8.02	8.22	10.34	10.35	10.36	10.01						
S ramp	2.06	2.07											
Security code	11.30	11.44											
Serial comms	11.23 to 11.26												
Skip speeds	1.29	1.30	1.31	1.32	1.33	1.34	1.35						
SMARTCARD	11.36 to 11.40		11.42										
Software version	11.29	11.34											
Speed controller	3.10 to 3.17		3.20	3.21									
Speed feedback	3.02	3.03											
Speed feedback - drive	3.26	3.27	3.28	3.29	3.31	3.42	3.52	3.55	3.56	3.57	3.58		
Speed reference selection	1.14	1.15	1.49	1.50	1.01								
Status word	10.40												
Supply	5.05												
Thermal protection - drive	7.04	7.34	10.18										
Thermal protection - motor	4.15	5.07	4.19	4.16	4.25	7.15							
Thermistor input	7.15	7.03											
Threshold detector 1	12.01	12.03 to 12.07											
Threshold detector 2	12.02	12.23 to 12.27											
Time - filter change	6.19	6.18											
Time - powered up log	6.20	6.21	6.28										
Time - run log	6.22	6.23	6.28										
Torque	4.03	4.26	5.32										
Torque mode	4.08	4.11	4.09	4.10									
Trip detection	10.20 to 10.29												
Trip log	10.20 to 10.29		10.41 to 10.51		6.28								
Under voltage	5.05												
Variable selector 1	12.08 to 12.15												
Variable selector 2	12.28 to 12.35												
Velocity feed forward	1.39	1.40											
Voltage rating	11.33	5.09	5.05										
Warning	10.19	10.17	10.18	10.40									
Zero speed indicator bit	3.05	10.03											

## Parameter ranges and variable maximums:

The two values provided define the minimum and maximum values for the given parameter. In some cases the parameter range is variable and dependant on either:

- other parameters
- the drive rating
- or a combination of these

The values given in Table 11-4 are the variable maximums used in the drive.

**Table 11-4 Definition of parameter ranges & variable maximums**

Maximum	Definition
MAX_SPEED_REF [10000.0rpm]	<b>Maximum speed reference</b> If Pr 1.08 = 0: MAX_SPEED_REF = Pr 1.06 (SE02, 0.23) If Pr 1.08 = 1: MAX_SPEED_REF is Pr 1.06 (SE02, 0.23) or – Pr 1.07 (SE01, 0.22) whichever is the largest (If the second motor map is selected Pr 21.01 is used instead of Pr 1.06 (SE02, 0.23) and Pr 21.02 instead of Pr 1.07 (SE01, 0.22))
SPEED_LIMIT_MAX [10000.0rpm]	<b>Maximum applied to speed reference limits</b> A maximum limit may be applied to the speed reference to prevent the nominal encoder frequency from exceeding 500kHz. The maximum is defined by $SPEED\_LIMIT\_MAX \text{ (in rpm)} = 500\text{kHz} \times 60 / ELPR = 3.0 \times 10^7 / ELPR$ subject to an absolute maximum of 10,000 rpm. ELPR is 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 This maximum is defined by the device selected with the speed feedback selector (Pr 3.26 (Fb01, 0.71)) and the ELPR set for the position feedback device.
SPEED_MAX [10000.0rpm]	<b>Maximum speed</b> This maximum is used for some speed related parameters in menu 3. To allow headroom for overshoot etc. the maximum speed is twice the maximum speed reference. $SPEED\_MAX = 2 \times MAX\_SPEED\_REF$
MAX_RAMP_RATE MAX_RAMP_RATE_M2 [3200.000]	<b>Maximum ramp rate</b> If (Pr 1.06 (SE02, 0.23) [Pr 21.01] >= 1000 and Pr 2.39 = 0) or Pr 2.39 >= 1000 then MAX_RAMP_RATE = 3200.000 Else if Pr 2.39 = 0 MAX_RAMP_RATE = 3200 * Pr 1.06 (SE02, 0.23) [Pr 21.01] / 1000.0 Else MAX_RAMP_RATE = 3200 * Pr 2.39 / 1000.0 <b>End if</b>
RATED_CURRENT_MAX [9999.99A]	<b>Maximum motor rated current</b>
DRIVE_CURRENT_MAX [9999.99A]	<b>Maximum drive current</b> The maximum drive current is the current at the over current trip level and is given by: $DRIVE\_CURRENT\_MAX = RATED\_CURRENT\_MAX \times 2$
MOTOR1_CURRENT_LIMIT_MAX [1000.0%]	<b>Maximum current limit settings for motor map 1</b> This maximum current limit setting is the maximum applied to the current limit parameters in motor map 1. See introduction to Menu 4 for the definition.
MOTOR2_CURRENT_LIMIT_MAX [1000.0%]	<b>Maximum current limit settings for motor map 2</b> This maximum current limit setting is the maximum applied to the current limit parameters in motor map 2. See introduction to Menu 4 for the definition.
TORQUE_PROD_CURRENT_MAX [1000.0%]	<b>Maximum torque producing current</b> This is used as a maximum for torque and torque producing current parameters. It is MOTOR1_CURRENT_LIMIT_MAX or MOTOR2_CURRENT_LIMIT_MAX depending on which motor map is currently active.
USER_CURRENT_MAX [1000.0%]	<b>Current parameter limit selected by the user</b> The user can select a maximum for Pr 4.08 (torque reference) and Pr 4.20 (percentage load) to give suitable scaling for analog I/O with Pr 4.24. This maximum is subject to a limit of CURRENT_LIMIT_MAX. $USER\_CURRENT\_MAX = Pr 4.24$



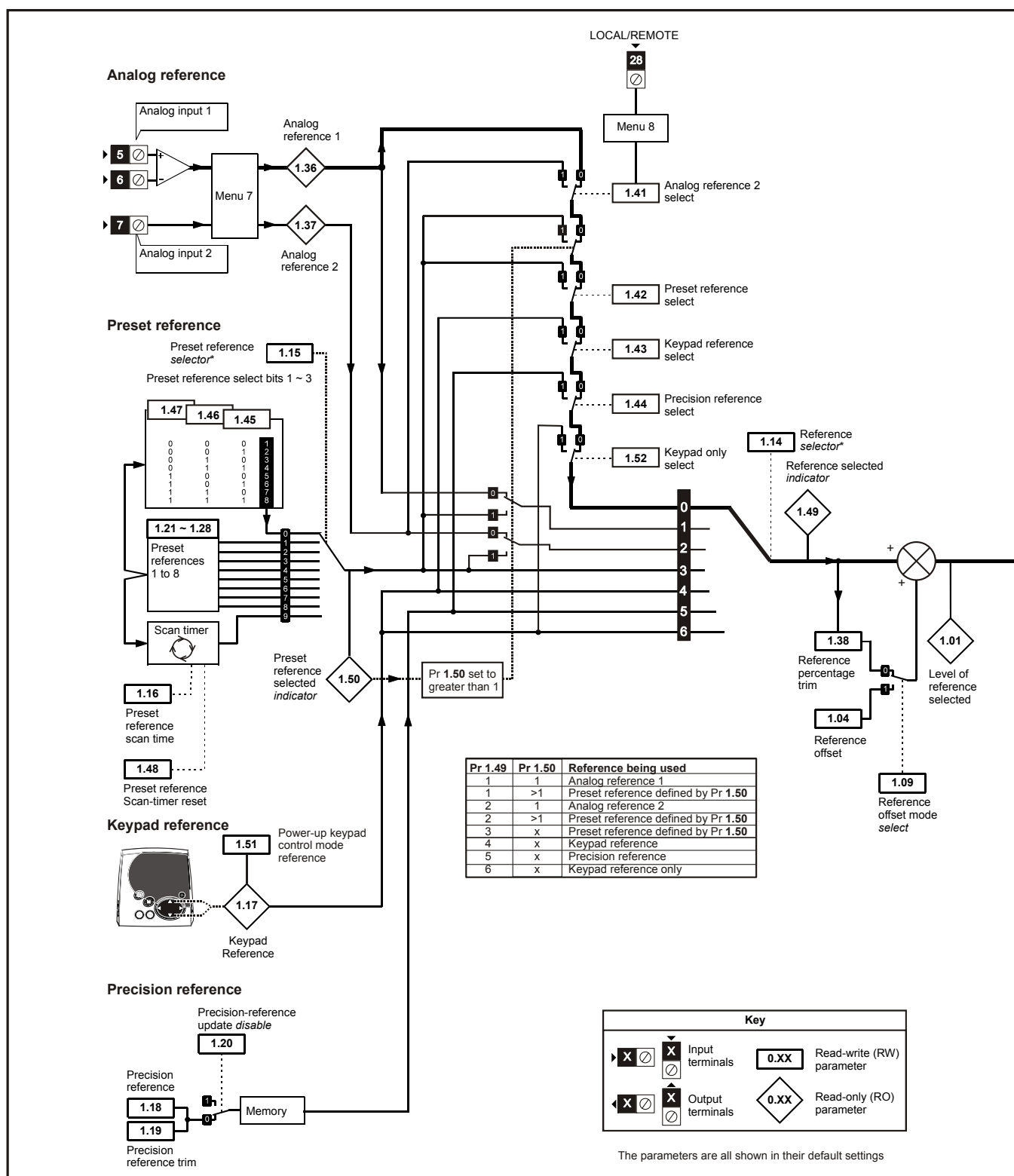
Maximum	Definition
ARMATURE_VOLTAGE_MAX [1025]	<b>Maximum armature voltage</b> $V_{ac} \times 1.35 (\sqrt{2} \times 3 / \pi)$ 480 +10% drive: 720 575 +10% drive: 860 690 +10% drive: 1025 <b>NOTE</b> For 4 quadrant drives maximum armature voltage = $V_{ac} \times 1.15$
QUADRANT_MAX	<b>Quadrant maximum</b> 0 for a 2 quadrant drive. 1 for a 4 quadrant drive.
POWER_MAX [9999.99kW]	<b>Maximum power in kW</b> The maximum power has been chosen to allow for the maximum power that can be output by the drive with maximum DC output voltage and maximum controlled current. Therefore: $POWER\_MAX = ARMATURE\_VOLTAGE\_MAX \times DRIVE\_CURRENT\_MAX$

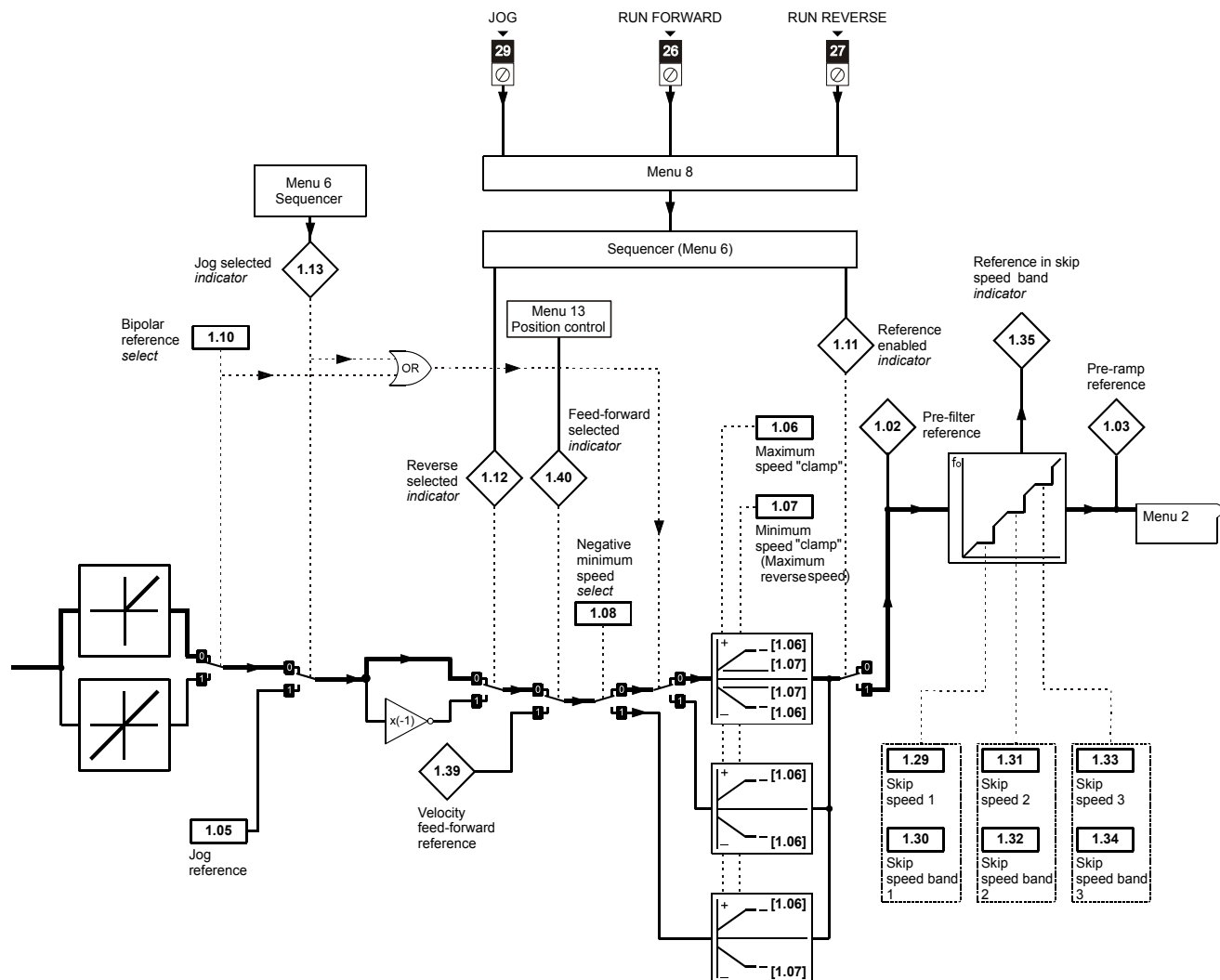
The values given in square brackets indicate the absolute maximum value allowed for the variable maximum.

## 11.1 Menu 1: Speed reference

Menu 1 controls the main reference selection.

Figure 11-1 Menu 1 logic diagram





\*Refer to Pr 1.14 (SE05, 0.26)

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Parameter			Range(↕)	Default(⇒)	Type				
1.01	Speed reference selected	{di01, 0.36}	±MAX_SPEED_REF rpm		RO	Bi		NC	PT
1.02	Pre-skip filter reference		±MAX_SPEED_REF rpm		RO	Bi		NC	PT
1.03	Pre-ramp reference	{di02, 0.37}	±MAX_SPEED_REF rpm		RO	Bi		NC	PT
1.04	Reference offset		±10,000.0 rpm	0.0	RW	Bi			US
1.05	Jog reference		0 to 1,000.0 rpm	0.0	RW	Uni			US
1.06	Maximum reference clamp	{SE02, 0.23}	SPEED_LIMIT_MAX rpm	1,000.0	RW	Uni			US
1.07	Minimum reference clamp	{SE01, 0.22}	±SPEED_LIMIT_MAX rpm	0.0	RW	Bi			PT US
1.08	Negative minimum reference clamp enable		OFF (0) or On (1)	OFF (0)	RW	Bit			US
1.09	Reference offset select		OFF (0) or On (1)	OFF (0)	RW	Bit			US
1.10	Bipolar reference enable		OFF (0) or On (1)	OFF (0)	RW	Bit			US
1.11	Reference enabled indicator	{di11, 0.46}	OFF (0) or On (1)		RO	Bit		NC	PT
1.12	Reverse selected indicator	{di12, 0.47}	OFF (0) or On (1)		RO	Bit		NC	PT
1.13	Jog selected indicator	{di13, 0.48}	OFF (0) or On (1)		RO	Bit		NC	PT
1.14	Reference selector	{SE05, 0.26}	0 to 6	0 (A1.A2)	RW	Txt			US
1.15	Preset selector		0 to 9	0	RW	Uni			US
1.16	Preset reference selector timer		0 to 400.0s	10.0	RW	Uni			US
1.17	Keypad control reference		±MAX_SPEED_REF rpm	0.0	RO	Bi		NC	PT PS
1.18	Precision reference coarse		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.19	Precision reference fine		0.0 to 0.099 rpm	0.000	RW	Uni			US
1.20	Precision reference update disable		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.21	Preset reference 1		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.22	Preset reference 2		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.23	Preset reference 3		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.24	Preset reference 4		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.25	Preset reference 5		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.26	Preset reference 6		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.27	Preset reference 7		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.28	Preset reference 8		±MAX_SPEED_REF rpm	0.0	RW	Bi			US
1.29	Skip reference 1		0 to 10,000 rpm	0	RW	Uni			US
1.30	Skip reference band 1		0 to 250 rpm	5	RW	Uni			US
1.31	Skip reference 2		0 to 10,000 rpm	0	RW	Uni			US
1.32	Skip reference band 2		0 to 250 rpm	5	RW	Uni			US
1.33	Skip reference 3		0 to 10,000 rpm	0	RW	Uni			US
1.34	Skip reference band 3		0 to 250 rpm	5	RW	Uni			US
1.35	Reference in rejection zone		OFF (0) or On (1)		RO	Bit		NC	PT
1.36	Analog reference 1		±MAX_SPEED_REF rpm	0	RO	Bi		NC	
1.37	Analog reference 2		±MAX_SPEED_REF rpm	0	RO	Bi		NC	
1.38	Percentage trim		±100.00%	0.00	RW	Bi		NC	
1.39	Velocity feed forward		±10,000.0 rpm		RO	Bi		NC	PT
1.40	Velocity feed forward select		OFF (0) or On (1)		RO	Bit		NC	PT
1.41	Reference select flag 1		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.42	Reference select flag 2		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.43	Reference select flag 3		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.44	Reference select flag 4		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.45	Reference select flag 5		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.46	Reference select flag 6		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.47	Reference select flag 7		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.48	Reference timer reset flag		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
1.49	Reference selected indicator		1 to 6		RO	Uni		NC	
1.50	Preset reference selected indicator		1 to 8		RO	Uni		NC	PT
1.51	Power-up keyboard control mode reference		0 to 2	0	RW	Txt			US
1.52	Reference select flags		OFF (0) or On (1)	OFF (0)	RW	Bit		NC	

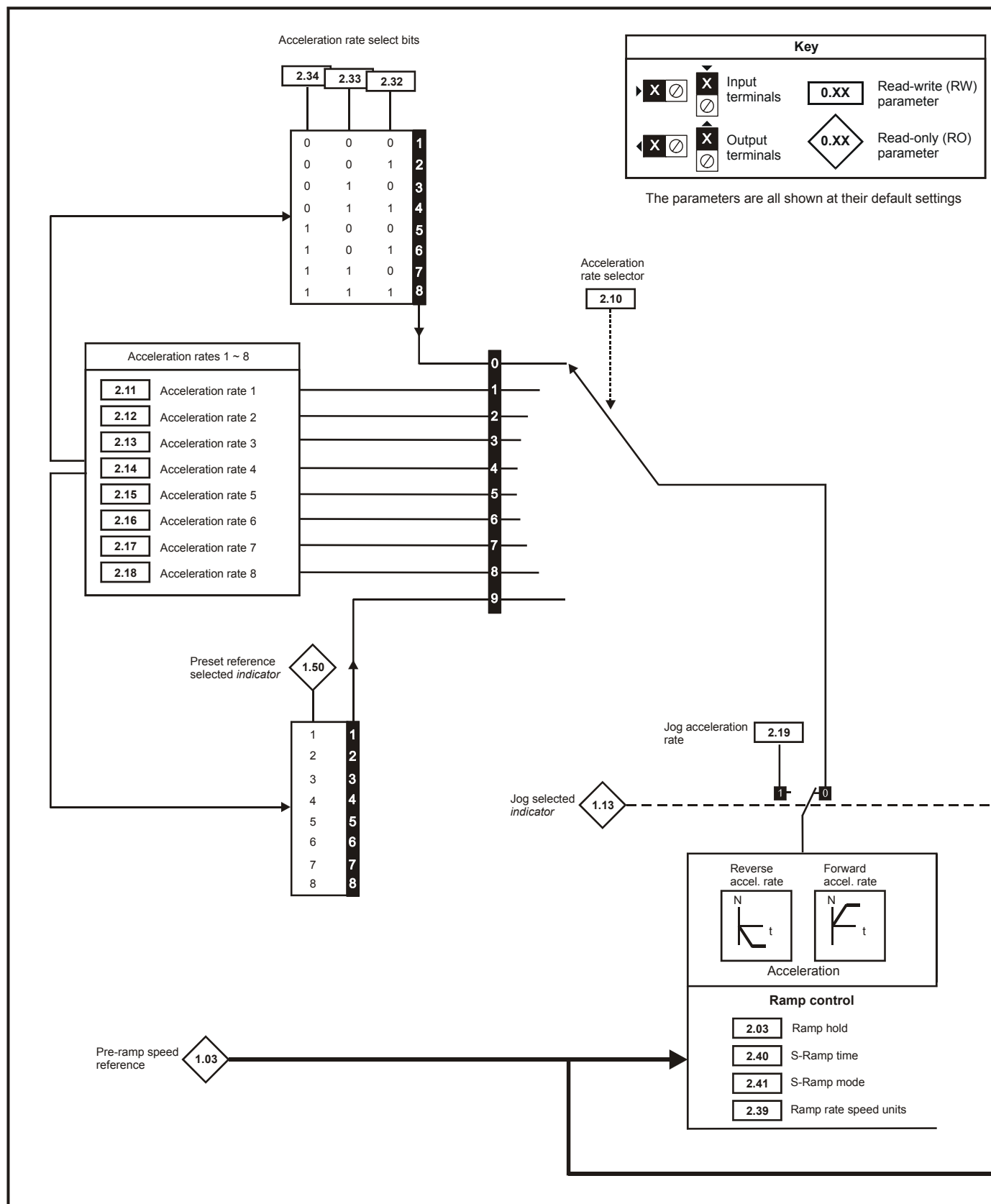
RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

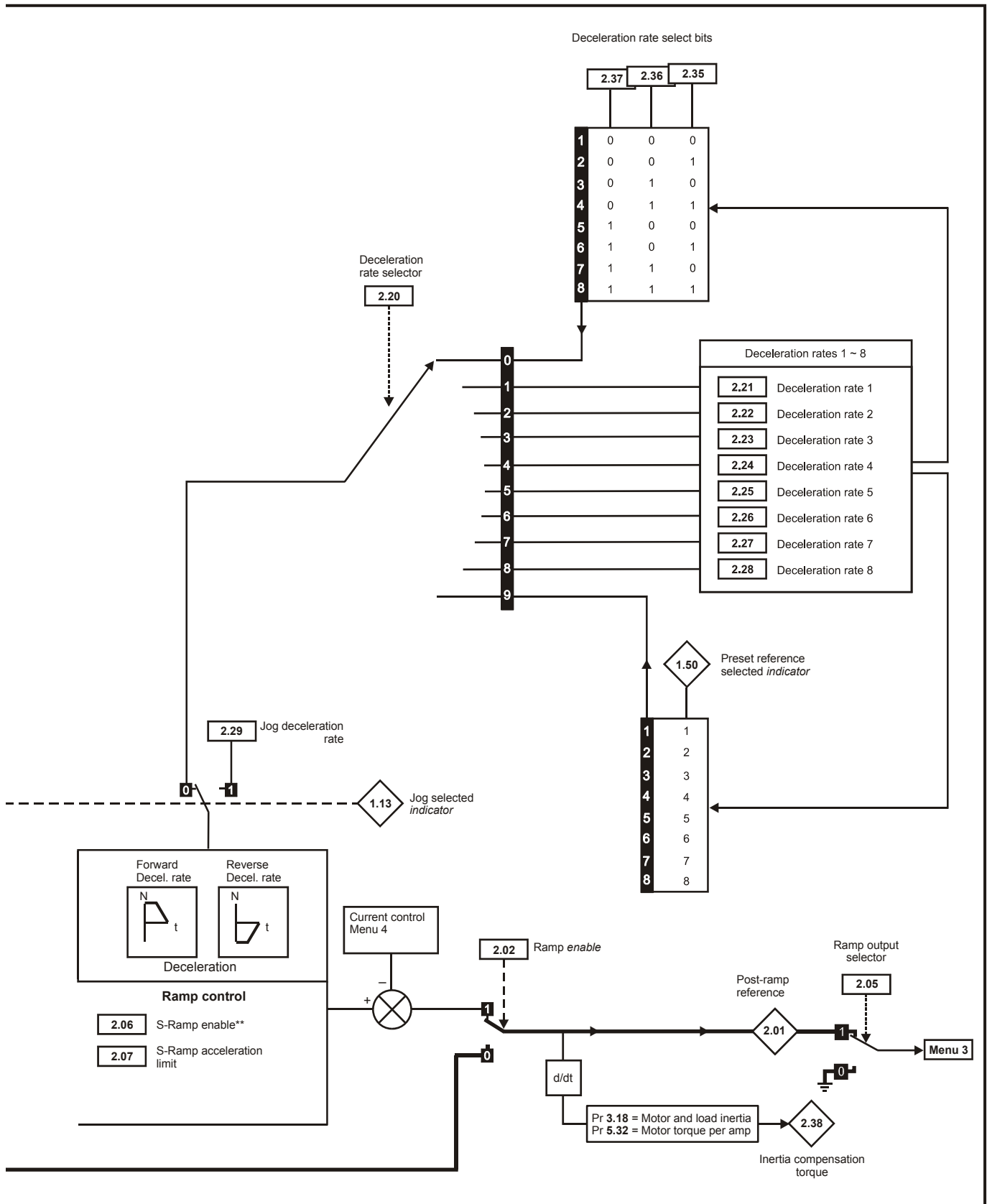
Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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## 11.2 Menu 2: Ramps

The pre-ramp speed reference passes through the ramp block controlled by menu 2 before being used by the drive to produce input to the speed controller. The ramp block includes: linear ramps, and an S ramp function for ramped acceleration and deceleration.

Figure 11-2 Menu 2 logic diagram





Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter		Range(⇅)	Default(⇨)	Type				
2.01	Post ramp reference {di03, 0.38}	±SPEED_MAX rpm		RO	Bi		NC	PT
2.02	Ramp enable	OFF (0) or On (1)	On (1)	RW	Bit			US
2.03	Ramp hold	OFF (0) or On (1)	0	RW	Bit			US
2.05	Ramp output selector	OFF (0) or On (1)	On (1)	RW	Bit			US
2.06	S ramp enable	OFF (0) or On (1)	0 Eur: 0, USA: 1	RW	Bit			US
2.07	S ramp acceleration limit	0 to 100.000 s <sup>2</sup> /1000rpm	3.600	RW	Uni			US
2.10	Acceleration rate selector	0 to 9	0	RW	Uni			US
2.11	Acceleration rate 1 {SE03, 0.24}	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.12	Acceleration rate 2	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.13	Acceleration rate 3	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.14	Acceleration rate 4	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.15	Acceleration rate 5	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.16	Acceleration rate 6	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.17	Acceleration rate 7	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.18	Acceleration rate 8	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.19	Jog acceleration rate	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.20	Deceleration rate selector	0 to 9	0	RW	Uni			US
2.21	Deceleration rate 1 {SE04, 0.25}	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.22	Deceleration rate 2	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.23	Deceleration rate 3	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.24	Deceleration rate 4	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.25	Deceleration rate 5	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.26	Deceleration rate 6	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.27	Deceleration rate 7	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.28	Deceleration rate 8	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	5.000	RW	Uni			US
2.29	Jog deceleration rate	0 to MAX_RAMP_RATE s / (Pr 1.06 OR Pr 2.39)	10.000	RW	Uni			US
2.30	Actual ramp rate selected	1 to 8		RO	Uni		NC	PT
2.31	Actual ramp rate selected	1 to 8		RO	Uni		NC	PT
2.32	Acceleration select bit 0	OFF (0) or On (1)		RW	Bit		NC	
2.33	Acceleration select bit 1	OFF (0) or On (1)		RW	Bit		NC	
2.34	Acceleration select bit 2	OFF (0) or On (1)		RW	Bit		NC	
2.35	Deceleration select bit 0	OFF (0) or On (1)		RW	Bit		NC	
2.36	Deceleration select bit 1	OFF (0) or On (1)		RW	Bit		NC	
2.37	Deceleration select bit 2	OFF (0) or On (1)		RW	Bit		NC	
2.38	Inertia compensation torque	± 1,000.0 %		RO	Bi		NC	PT
2.39	Ramp rate speed units	0 to 10000rpm	0	RW	Uni			US
2.40	Time of S ramp	0 to 100.000s	1.250	RW	Uni			US
2.41	S ramp mode	OFF (0) or On (1)	On (1)	RW	Bit			US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save



## 11.3 Menu 3: Speed feedback and speed control

### Speed accuracy and resolution

#### Digital reference resolution

When a preset speed is used the reference resolution is 0.1rpm. Improved resolution can be obtained by using the precision reference (0.001rpm).

#### Analog reference resolution

The analog input has a maximum resolution of 14bits plus sign. The resolution of the reference from analog inputs 2 or 3 is 10bits plus sign.

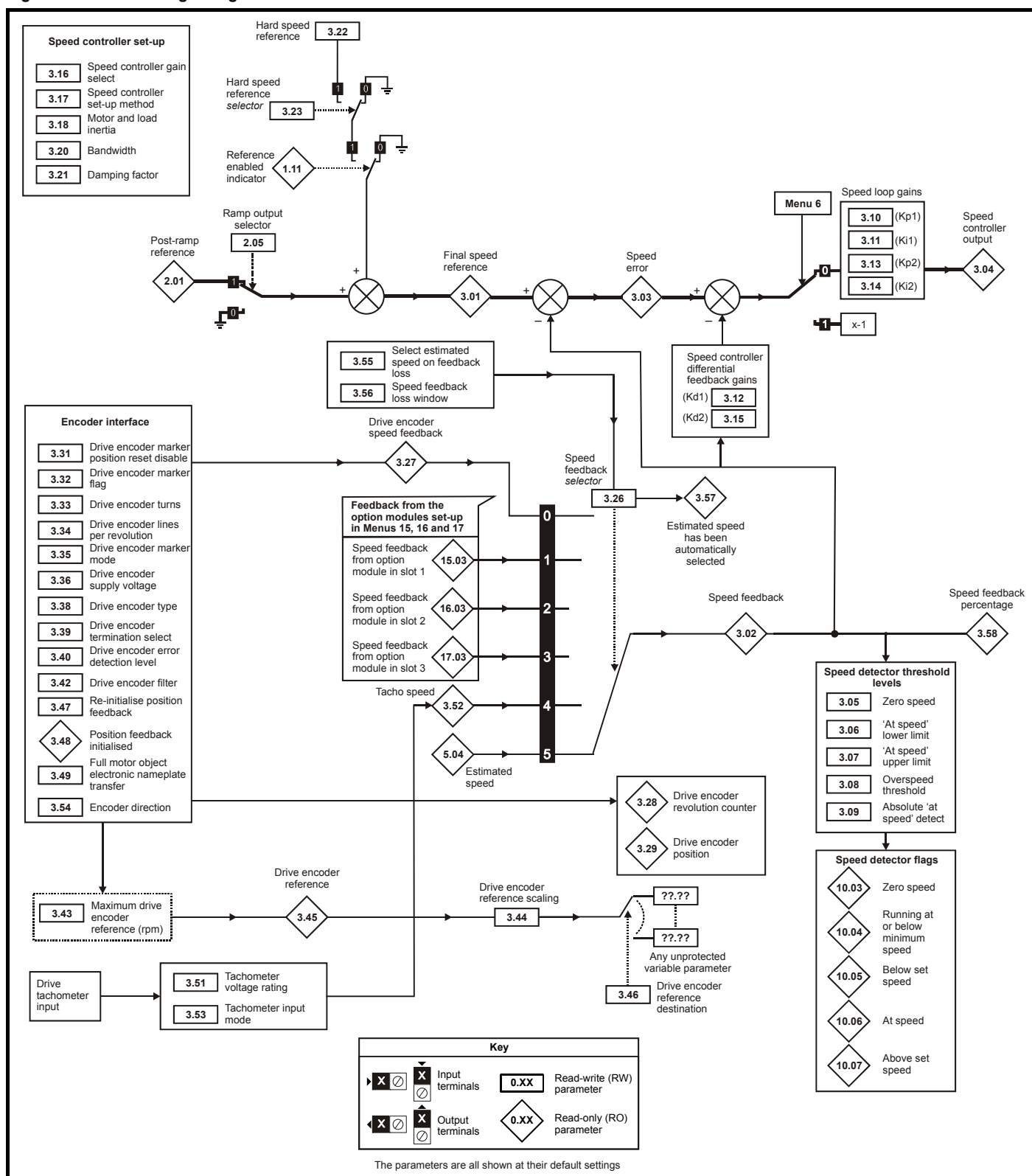
#### Analog feedback resolution

The resolution for both Armature voltage and tachogenerator feedback is 10bit plus sign.

#### Accuracy

With encoder feedback the absolute speed accuracy depends on the accuracy of the crystal used with the drive microprocessor. The accuracy of the crystal is 100ppm, and so the absolute speed accuracy is 100ppm (0.01%) of the reference, when a preset speed is used. If an analog input is used the absolute accuracy is further limited by the absolute accuracy and non-linearity of the analog input. If analog feedback is used the accuracy is even further limited.

**Figure 11-3 Menu 3 logic diagram**



Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter			Range(⇅)		Default(⇒)		Type					
3.01	Final speed reference	{di04, 0.39}	±SPEED_MAX rpm				RO	Bi	FI	NC	PT	
3.02	Speed feedback	{di05, 0.40}	±SPEED_MAX rpm				RO	Bi	FI	NC	PT	
3.03	Speed error		±SPEED_MAX rpm				RO	Bi	FI	NC	PT	
3.04	Speed controller output	{di06, 0.41}	±Torque_prod_current_max %				RO	Bi	FI	NC	PT	
3.05	Zero speed threshold		0 to 200 rpm		30		RW	Uni				US
3.06	At speed lower limit		0 to 10,000 rpm		5		RW	Uni				US
3.07	At speed upper limit		0 to 10,000 rpm		5		RW	Uni				US
3.08	Overspeed threshold		0 to 10,000 rpm		0		RW	Uni				US
3.09	Absolute 'at speed' detect		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.10	Speed controller proportional gain (Kp1)	{SP01, 0.61}	0.0 to 6.5535 (1 / rad/s))		0.0300		RW	Uni				US
3.11	Speed controller integral gain (Ki1)	{SP02, 0.62}	0 to 655.35 (s / rad/s))		0.10		RW	Uni				US
3.12	Speed controller differential feedback gain (Kd1)	{SP03, 0.63}	0 to 0.65535 (1/s / rad/s))		0.00000		RW	Uni				US
3.13	Speed controller proportional gain (Kp2)		0.0 to 6.5535 (1 / rad/s))		0.0300		RW	Uni				US
3.14	Speed controller integral gain (Ki2)		0 to 655.35 (s / rad/s))		0.10		RW	Uni				US
3.15	Speed controller differential feedback gain (Kd2)		0 to 0.65535 (1/s / rad/s))		0.00000		RW	Uni				US
3.16	Speed controller gain select		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.17	Speed controller set-up method		0 to 2		0		RW	Uni				US
3.18	Motor and load inertia		0.0 to 90.00000 kg m <sup>2</sup>		0.00000		RW	Uni				US
3.20	Bandwidth		0 to 50 Hz		1		RW	Uni				US
3.21	Damping factor		0.0 to 10.0		1.0		RW	Uni				US
3.22	Hard speed reference		-MAX_SPEED_REF to MAX_SPEED_REF rpm		0.0		RW	Bi				US
3.23	Hard speed reference selector		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.26	Speed feedback selector	{Fb01, 0.71}	0 to 5		5		RW	Txt				US
3.27	Drive encoder speed feedback	{Fb09, 0.79}	±10,000.0 rpm				RO	Bi	FI	NC	PT	
3.28	Drive encoder revolution counter		±32,768 revolutions				RO	Bi	FI	NC	PT	
3.29	Drive encoder position		0 to 65,535 1/2 <sup>16</sup> ths of a revolution				RO	Uni	FI	NC	PT	
3.31	Drive encoder marker position reset disable		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.32	Drive encoder marker flag		OFF (0) or On (1)		OFF (0)		RW	Bit		NC		
3.33	Drive encoder turn bits		0 to 16		16		RW	Uni				US
3.34	Drive encoder lines per revolution	{Fb05, 0.75}	1 to 50,000		1024		RW	Uni				US
3.35	Drive encoder marker mode		0 to 1		0		RW	Uni				US
3.36	Drive encoder supply voltage	{Fb06, 0.76}	0 to 3		0		RW	Txt				US
3.38	Drive encoder type	{Fb07, 0.77}	0 to 2		0		RW	Txt				US
3.39	Drive encoder termination select	{Fb08, 0.78}	0 to 2		1		RW	Uni				US
3.40	Drive encoder error detection level		0 to 2		0		RW	Uni				US
3.42	Drive encoder filter		0 to 5 (0 to 16ms)		2		RW	Txt				US
3.43	Maximum drive encoder reference		0 to 10,000 rpm		1000		RW	Uni				US
3.44	Drive encoder reference scaling		0 to 4.000		1.000		RW	Uni				US
3.45	Drive encoder reference		±100.0%				RO	Bi	FI	NC	PT	
3.46	Drive encoder reference destination		0 to 22.99		0.00		RW	Uni		DE	PT	US
3.47	Re-initialise position feedback		OFF (0) or On (1)				RW	Bit		NC		
3.48	Position feedback initialised		OFF (0) or On (1)				RO	Bit		NC	PT	
3.49	Full motor object electronic nameplate transfer		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.50	Position feedback lock		OFF (0) or On (1)		OFF (0)		RW	Bit		NC		
3.51	Tachometer voltage rating	{Fb02, 0.72}	0 to 300.00 v/1000rpm		Eur:60.00, USA 50.00		RW					US
3.52	Tachometer speed feedback	{Fb04, 0.74}	±SPEED_MAX rpm				RO	Bi	FI	NC	PT	
3.53	Tachometer input mode	{Fb03, 0.73}	0 to 2		0 (DC)		RW	Txt				US
3.54	Encoder direction		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.55	Select estimated speed on feedback loss		OFF (0) or On (1)		OFF (0)		RW	Bit				US
3.56	Speed feedback loss window		0 to 100.0%		20.0%		RW					US
3.57	Estimated speed has been automatically selected		OFF (0) or On (1)				RO	Bit				
3.58	Speed feedback percentage		±100.0%				RO			NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.4 Menu 4: Torque and current control

MOTOR1\_CURRENT\_LIMIT\_MAX is used as the maximum for some parameters such as the user current limits. The current maximum current limit is defined as follows (with a maximum of 1000%):

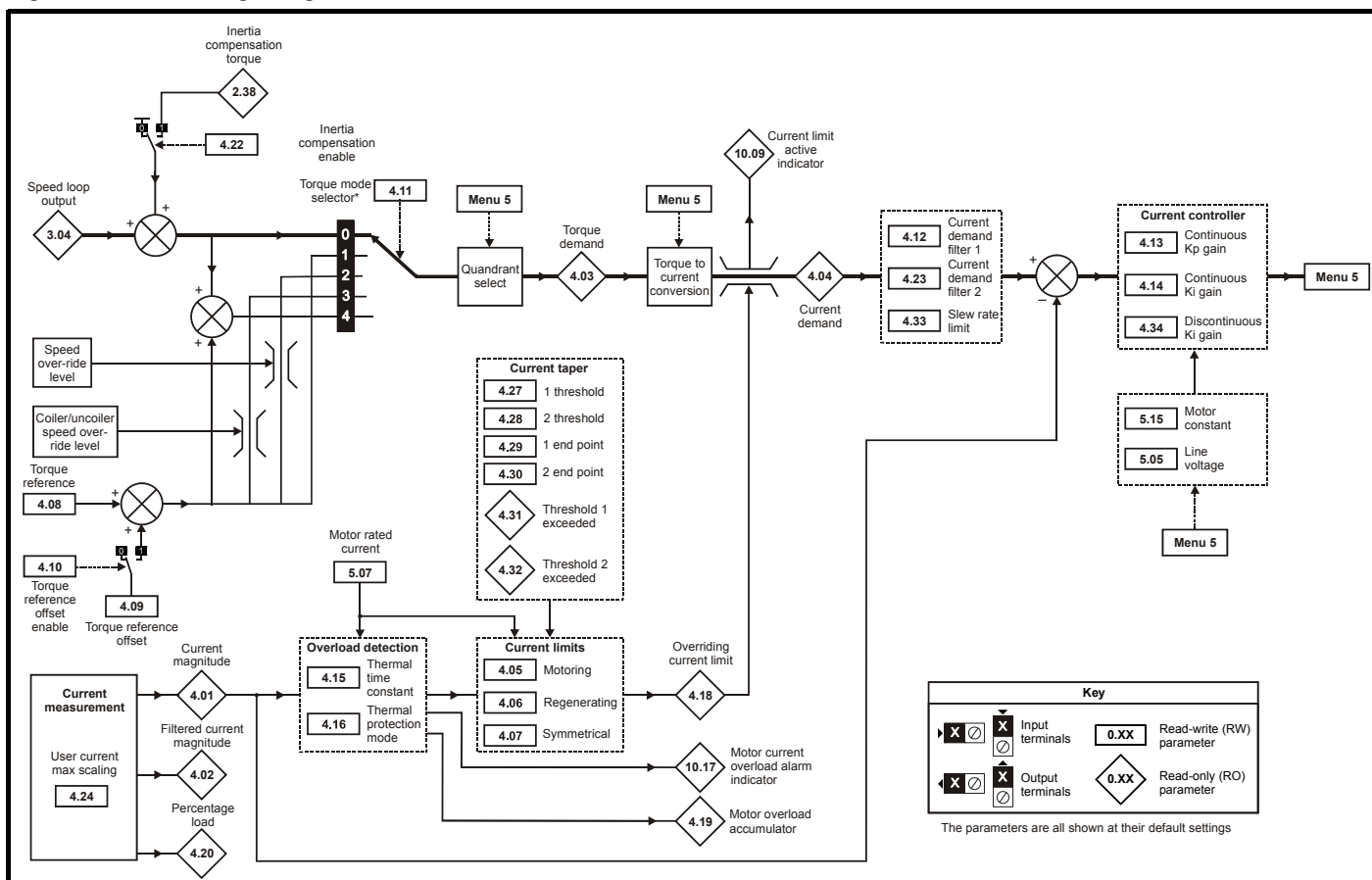
$$\text{CURRENT\_LIMIT\_MAX} = \left[ \frac{\text{Maximum current}}{\text{Motor rated current}} \right] \times 100\%$$

Where:

Motor rated current is given by Pr 5.07 (SE07, 0.28)

(MOTOR2\_CURRENT\_LIMIT\_MAX is calculated from the motor map 2 parameters). The maximum current is 1.5 x drive rating.

Figure 11-4 Menu 4 logic diagram



Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter			Range(⇅)		Default(⇔)		Type					
4.01	Current magnitude	{di08, 0.43}	0 to DRIVE_CURRENT_MAX A				RO	Uni	FI	NC	PT	
4.02	Filtered current magnitude		0 to DRIVE_CURRENT_MAX A				RO	Uni	FI	NC	PT	
4.03	Torque demand	{di07, 0.42}	±TORQUE_PROD_CURRENT_MAX %				RO	Bi	FI	NC	PT	
4.04	Current demand		±TORQUE_PROD_CURRENT_MAX %				RO	Bi	FI	NC	PT	
4.05	Motoring current limit		0 to MOTOR1_CURRENT_LIMIT_MAX %		150.0		RW	Uni		RA		US
4.06	Regen current limit		0 to MOTOR1_CURRENT_LIMIT_MAX %		150.0		RW	Uni		RA		US
4.07	Symmetrical current limit		0 to MOTOR1_CURRENT_LIMIT_MAX %		150.0		RW	Uni		RA		US
4.08	Torque reference		±USER_CURRENT_MAX %		0.0		RW	Bi				US
4.09	Torque offset		±USER_CURRENT_MAX %		0.0		RW	Bi				US
4.10	Torque offset select		OFF (0) or On (1)		OFF (0)		RW	Bit				US
4.11	Torque mode selector		0 to 4		0		RW	Uni				US
4.12	Current demand filter 1		0 to 25.0 ms		0.0		RW	Uni				US
4.13	Continuous current controller Kp gain		0 to 4,000		100		RW	Uni				US
4.14	Continuous current controller Ki gain		0 to 4,000		50		RW	Uni				US
4.15	Thermal time constant		0 to 3000.0		89.0		RW	Uni				US
4.16	Thermal protection mode		0 to 1		0		RW	Bit				US
4.18	Overriding current limit		0 to TORQUE_PROD_CURRENT_MAX %				RO	Uni		NC	PT	
4.19	Overload accumulator		0 to 100.0 %				RO	Uni		NC	PT	
4.20	Percentage load		±USER_CURRENT_MAX %				RO	Bi	FI	NC	PT	
4.22	Inertia compensation enable		OFF (0) or On (1)		OFF (0)		RW	Bit				US
4.23	Current demand filter 2		0.0 to 25.0 ms		0.0		RW	Uni				US
4.24	User current maximum scaling		0.0 to TORQUE_PROD_CURRENT_MAX %		150.0		RW	Uni		RA		US
4.27	Current taper 1 threshold		0 to 10,000.0 rpm		10,000.0 rpm		RW	Uni				US
4.28	Current taper 2 threshold		0 to 10,000.0 rpm		10,000.0 rpm		RW	Uni				US
4.29	Current taper 1 end point		0 to 1,000.0%		1,000.0%		RW	Uni				US
4.30	Current taper 2 end point		0 to 1,000.0%		1,000.0%		RW	Uni				US
4.31	Taper threshold 1 exceeded		OFF (0) or On (1)				RO	Bit				
4.32	Taper threshold 2 exceeded		OFF (0) or On (1)				RO	Bit				
4.33	Slew rate limit		0.0 to 60,000 %s <sup>-1</sup>		7,000		RW	Uni				US
4.34	Discontinuous current controller Ki gain		0 to 4,000		200		RW	Uni				US
4.35	Extra safe bridge change		OFF (0) or On (1)		OFF (0)		RW	Bit				US
4.36	Reduced hysteresis for bridge change over		OFF (0) or On (1)		OFF (0)		RW	Bit				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save



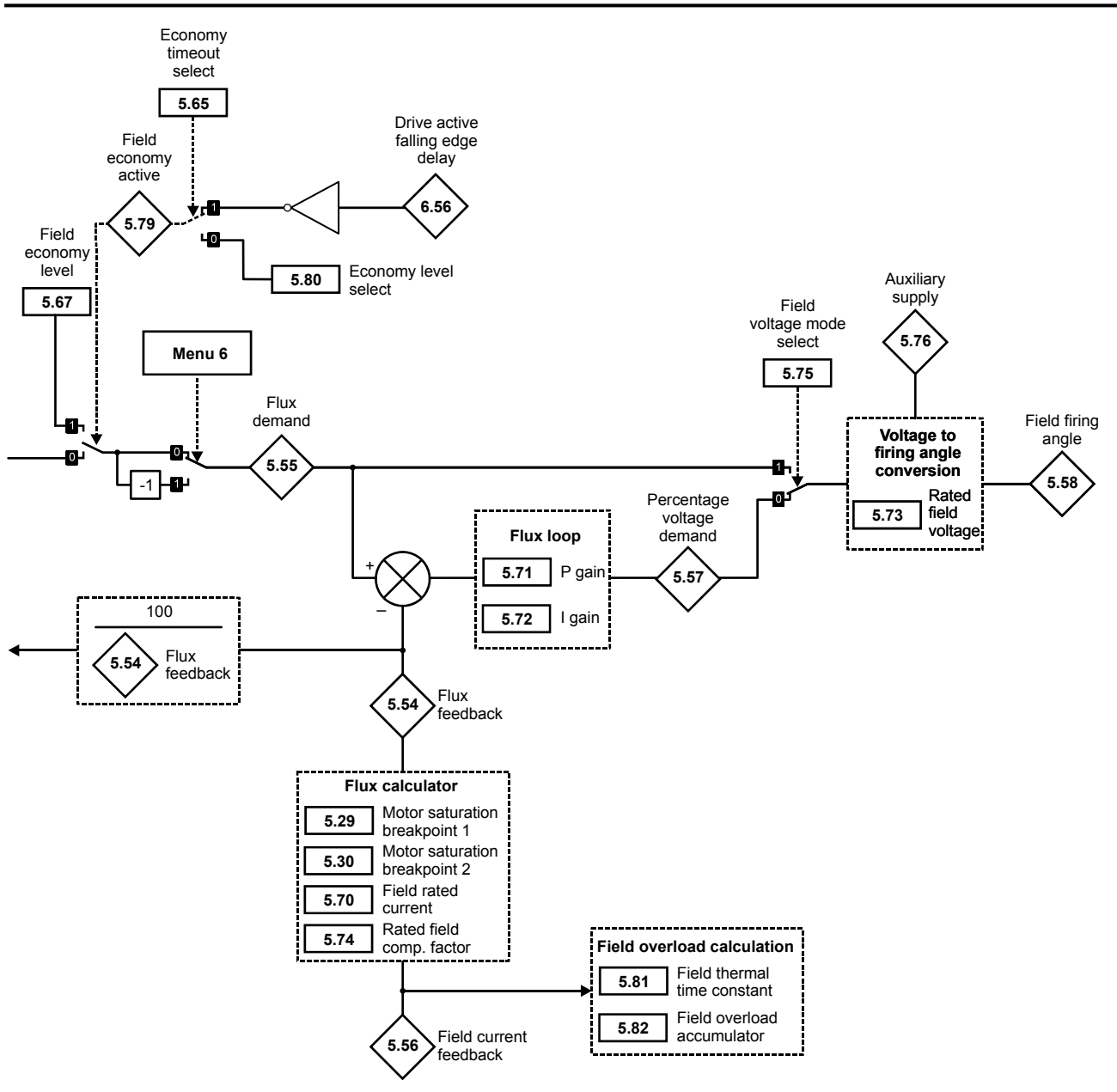
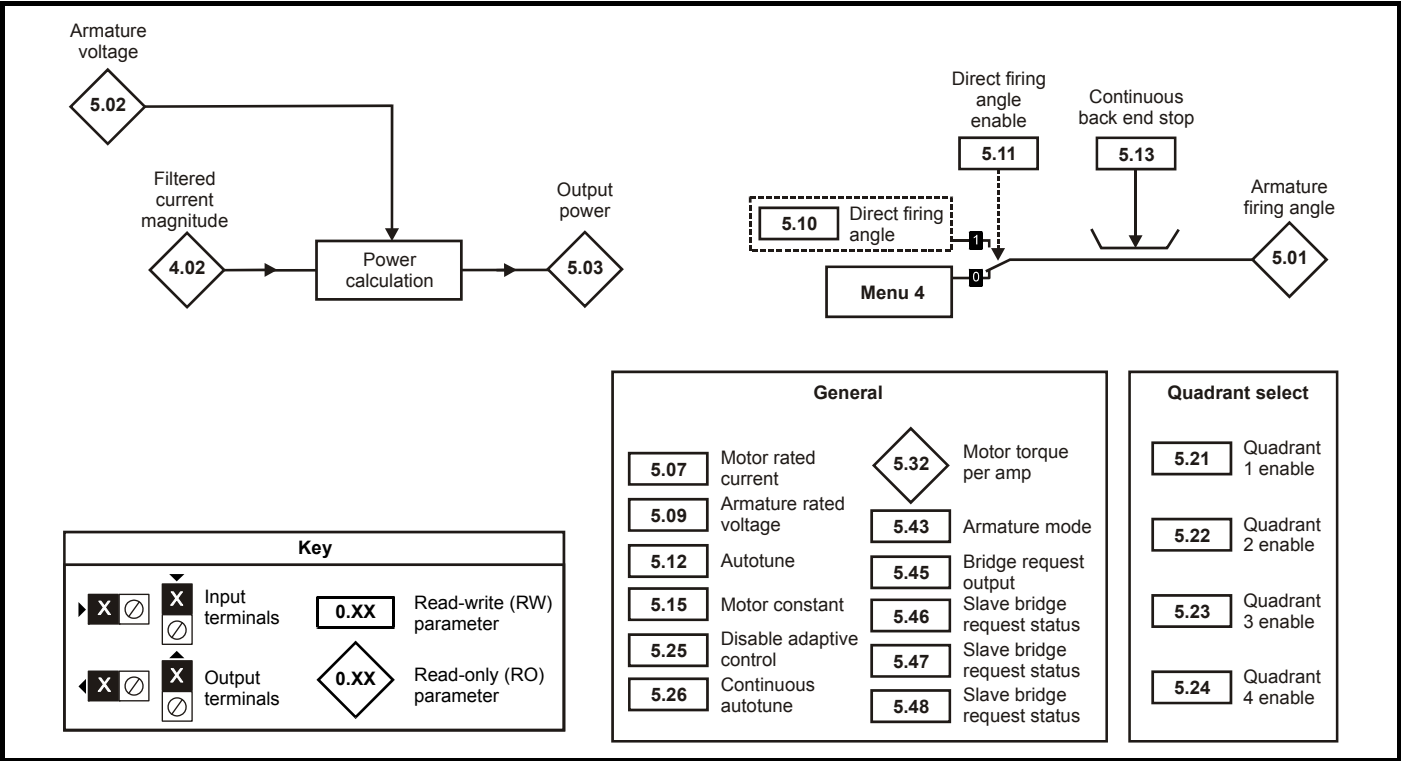


Figure 11-6 Menu 5 armature control logic diagram





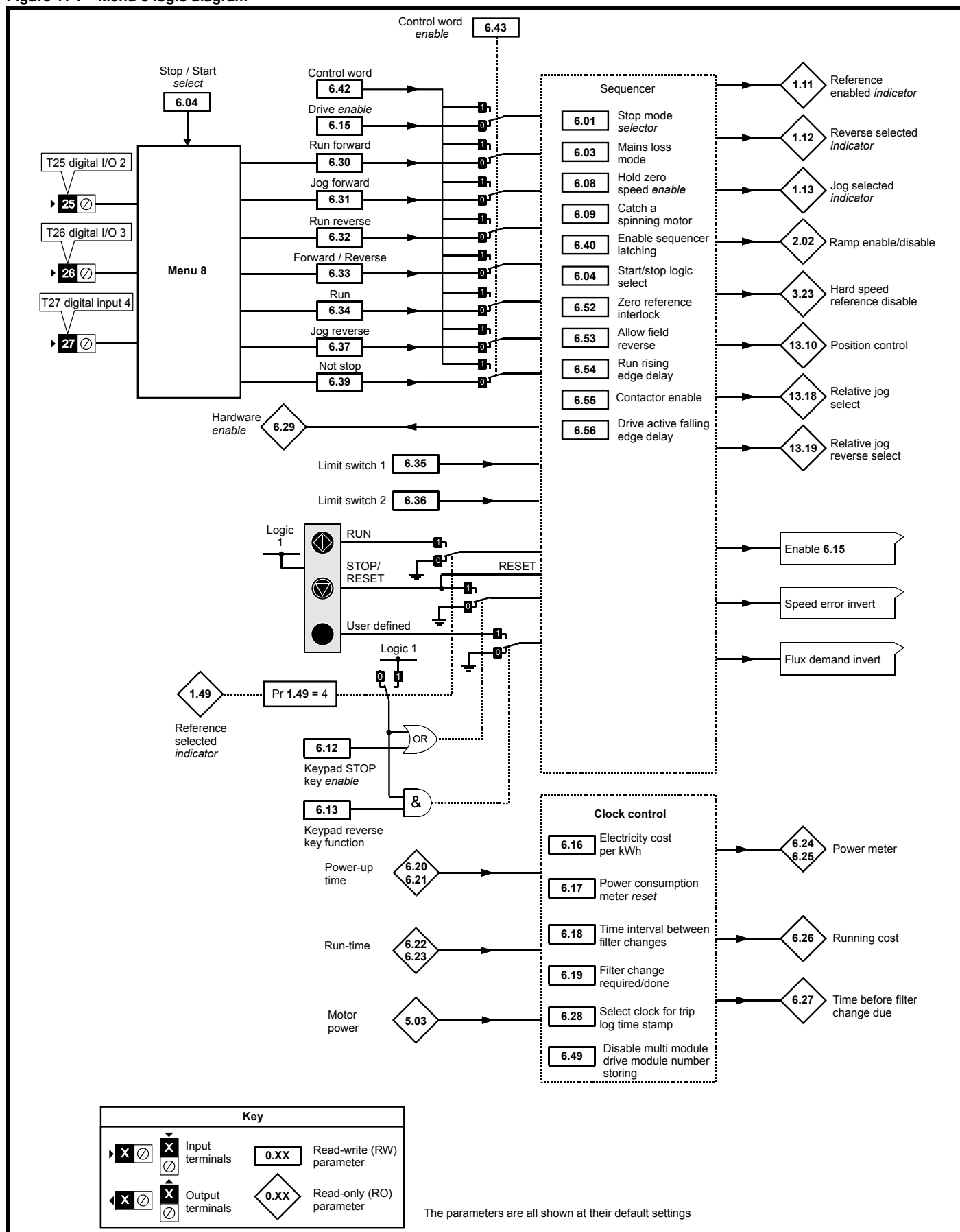
Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter		Range(⇅)	Default(⇒)	Type					
5.01	Armature firing angle	0 to 175.0 °		RO	Uni	FI	NC	PT	
5.02	Armature voltage {di10, 0.45}	±ARMATURE_VOLTAGE_MAX V		RO	Bi	FI	NC	PT	
5.03	Output power	±POWER_MAX kW		RO	Bi	FI	NC	PT	
5.04	Estimated speed	±10,000.0 rpm		RO	Bi	FI	NC	PT	
5.05	Line voltage	0 to 1000V rms AC		RO	Uni	FI	NC	PT	
5.07	Motor rated current {SE07, 0.28}	0 to RATED_CURRENT_MAX A	RATED_CURRENT_MAX	RW	Uni		RA		US
5.08	Base speed {SE08, 0.29}	0.0 to 10,000.0 rpm	1,000.0	RW	Uni				US
5.09	Armature rated voltage {SE06, 0.27}	0 to ARMATURE_VOLTAGE_MAX Vdc	For 480V drive: 440 Eur 500 USA For 575V drive: 630 Eur 630 USA For 690V drive: 760 Eur 760 USA	RW	Uni		RA		US
5.10	Direct firing angle	0 to 165.0 °	165.0	RW	Uni				
5.11	Direct firing angle enable	OFF (0) or On (1)	OFF (0)	RW	Uni				US
5.12	Autotune {SE13, 0.34}	0 to 3	0	RW	Uni		NC		
5.13	Continuous Back End Stop	0 to 165.0 °	165.0	RW	Uni				US
5.14	Armature voltage select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.15	Motor constant	0 to 100.0%	50.0%	RW	Uni				US
5.16	DC contactor	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.21	Quadrant 1 Enable	0 to 1	1	RW	Uni				US
5.22	Quadrant 2 Enable	0 to 1	1	RW	Uni		RA		US
5.23	Quadrant 3 Enable	0 to QUADRANT_MAX	1	RW	Uni				US
5.24	Quadrant 4 Enable	0 to QUADRANT_MAX	1	RW	Uni		RA		US
5.25	Disable adaptive control	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.26	Continuous auto tune	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.28	Field weakening compensation disable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.29	Motor saturation breakpoint 1	0 to 100% of rated flux	50	RW	Uni				US
5.30	Motor saturation breakpoint 2	0 to 100% of rated flux	75	RW	Uni				US
5.32	Motor torque per amp	0.000 to 50.000 NmA <sup>-1</sup>		RO	Uni				
5.43	Armature mode	0 to 6	0	RW	Txt				US
5.45	Bridge request output	0 to 1		RW	Bit				
5.46				RW	Bit				
5.47	Slave bridge request status	0 to 1		RW	Bit				
5.48				RW	Bit				
5.50	Security unlock	0 to 999		RW	Uni		NC	PT	
5.52	IR drop	±ARMATURE_VOLTAGE_MAX Vdc		RO	Bi	FI	NC	PT	
5.53	Back emf	±ARMATURE_VOLTAGE_MAX Vdc		RO	Bi	FI	NC	PT	
5.54	Flux feedback	±150%		RO	Bi	FI	NC	PT	
5.55	Flux demand	±120%		RW	Bi	FI	NC	PT	
5.56	Field current feedback {di09, 0.44}	±50.00 A		RO	Bi	FI	NC	PT	
5.57	Percentage voltage demand	±150.0%		RO	Bi	FI	NC	PT	
5.58	Field firing angle	0 to 180.0 °		RO	Uni	FI	NC	PT	
5.59	Back emf set point	0 to ARMATURE_VOLTAGE_MAX Vdc	For 480V Drive: 440 Eur 500 USA For 575V Drive: 630 Eur 630 USA For 690V Drive: 760 Eur 760 USA	RW	Uni				US
5.61	Armature Resistance	0 to 6.0000Ω	0.0000	RW	Uni				US
5.62	Spill over loop P gain	0 to 300.00	0.40	RW	Uni				US
5.63	Spill over loop I gain	0 to 300.00	5.00	RW	Uni				US
5.65	Enable economy timeout	0 to 1	Eur: 0, USA: 1	RW	Bit				US
5.67	Field economy level	0 to 120.0%	25.0%	RW	Uni				US
5.68	Maximum flux	0 to 120.0%	100.0%	RW	Uni				US
5.69	Minimum flux	0 to 120.0%	50.0%	RW	Uni				US
5.70	Rated field current {SE10, 0.31}	0 to FIELD_CURRENT_SET_MAX	Size 1 - 2A Size 2A & B - 3A Size 2C & D - 5A	RW	Uni		RA	PT	US
5.71	Flux loop P gain	0 to 300.00	3.00	RW	Uni			PT	US
5.72	Flux loop I gain	0 to 300.00	60.00	RW	Uni				US
5.73	Rated field voltage {SE11, 0.32}	0 to 500.0 Vdc	Eur: 360, USA: 300	RW	Uni				US
5.74	Rated field compensation factor	0 to 100%	100%	RW	Uni			PT	US
5.75	Field voltage mode select	OFF (0) or On (1)	Eur: 0, USA: 1	RW	Bit				US
5.76	Auxiliary supply	0 to 550 rms Vac		RO	Uni	FI	NC	PT	
5.77	Enable field control {SE12, 0.33}	0 to 2 (FLd OFF, IntrnL and EtrnL)	0	RW	Txt				US
5.78	Full control enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.79	Economy active	OFF (0) or On (1)		RO	Bit				
5.80	Economy level select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
5.81	Field thermal time constant	0 to 3000.0	41.0	RW	Uni				US
5.82	Field overload accumulator	0 to 100.0%		RO	Uni		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.6 Menu 6: Sequencer and clock

Figure 11-7 Menu 6 logic diagram



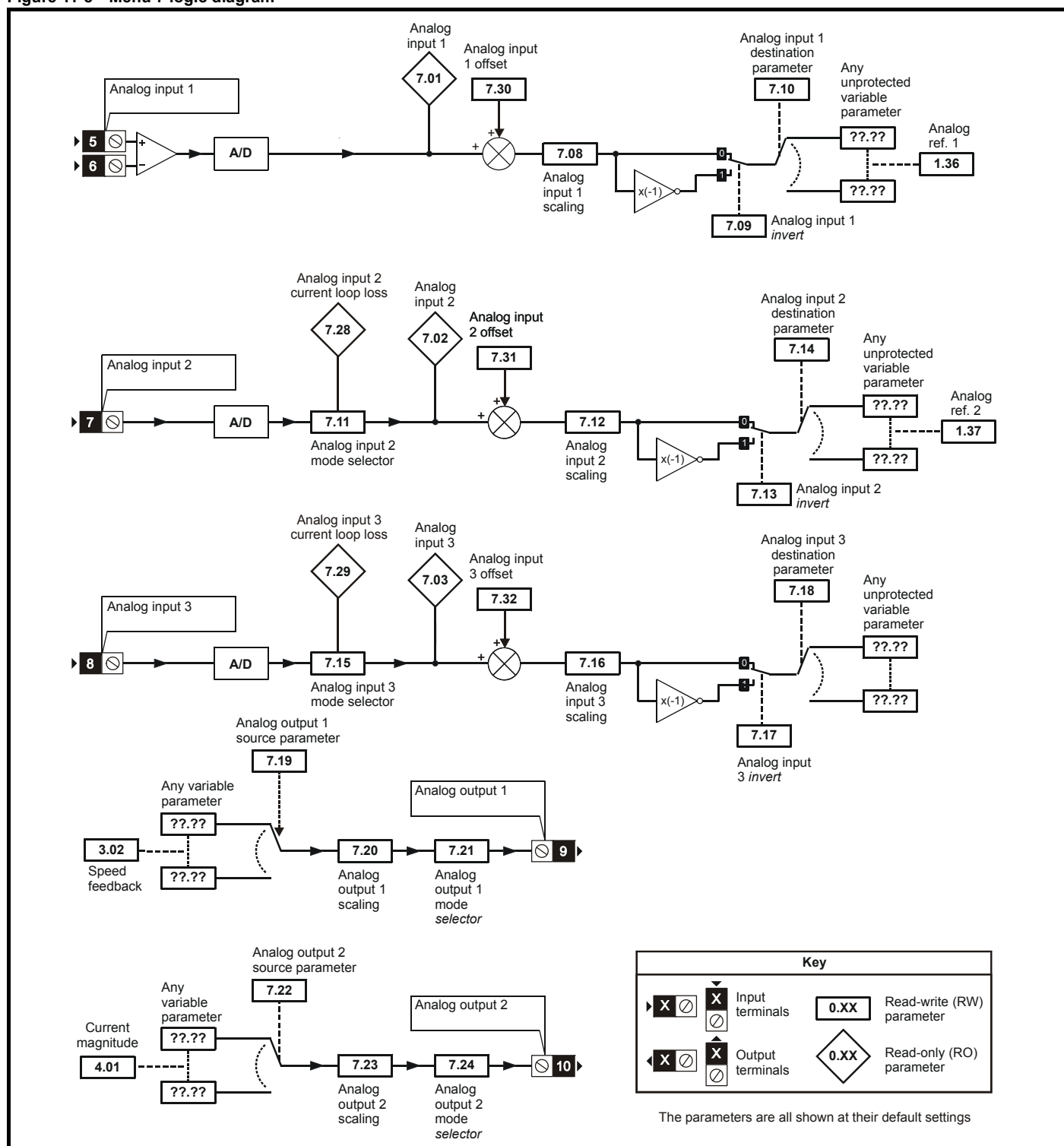
Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter	Range(⇅)	Default(⇌)	Type				
6.01 Stop mode	0 to 2	1	RW	Uni			US
6.03 Main loss ride through	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.04 Start/stop logic select	0 to 4	4	RW	Uni			US
6.08 Hold zero speed	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.09 Catch a spinning motor	0 to 1	1	RW	Uni			US
6.12 Enable stop key	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.13 Enable forward/reverse key	0 to 2	0	RW	Uni			US
6.15 Drive enable	OFF (0) or On (1)	On (1)	RW	Bit			US
6.16 Electricity cost per kWh	0 to 600.0 currency units per kWh	0.0	RW	Uni			US
6.17 Reset energy meter	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.18 Time between filter changes	0 to 30,000 hrs	0	RW	Uni			US
6.19 Filter change required / change done	OFF (0) or On (1)	OFF (0)	RW	Bit		PT	
6.20 Powered-up time: years.days	0 to 9.364 Years.Days		RW	Uni		NC PT	
6.21 Powered-up time: hours.minutes	0 to 23.59 Hours.Minutes		RW	Uni		NC PT	
6.22 Run time: years.days	0 to 9.364 Years.Days		RO	Uni		NC PT PS	
6.23 Run time: hours.minutes	0 to 23.59 Hours.Minutes		RO	Uni		NC PT PS	
6.24 Energy meter: MWh	±9999 MWh		RO	Bi		NC PT PS	
6.25 Energy meter: kWh	±999 kWh		RO	Bi		NC PT PS	
6.26 Running cost	±32000		RO	Bi	FI	NC PT	
6.27 Time before filter change due	0 to 30,000 hrs		RO	Uni		NC PT PS	
6.28 Select clock for trip log time stamping	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.29 Hardware enable	OFF (0) or On (1)		RO	Bit		NC PT	
6.30 Sequencing bit: Run forward	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.31 Sequencing bit: Jog	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.32 Sequencing bit: Run/reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.33 Sequencing bit: Forward/reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.34 Sequencing bit: Run	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.35 Forward limit switch	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.36 Reverse limit switch	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.37 Sequencing bit: Jog reverse	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.39 Sequencing bit: Not stop	OFF (0) or On (1)	OFF (0)	RW	Bit		NC	
6.40 Enable sequencer latching	OFF (0) or On (1)	On (1)	RW	Bit			US
6.41 Drive event flags	0 to 65535	0	RW	Uni		NC	
6.42 Control word	0 to 32767	0	RW	Uni		NC	
6.43 Control word enable	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.45 Force cooling fan to run at full speed	OFF (0) or On (1)		RW	Bit			US
6.50 Drive comms state	0 to 3		RO	Txt		NC PT	
6.52 Zero reference interlock	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.53 Allow field reverse	OFF (0) or On (1)	OFF (0)	RW	Bit			US
6.54 Run rising edge delay	0 to 25.0s	0.0	RW	Uni			US
6.55 Contactor enable	OFF (0) or On (1)		RO	Bit		NC PT	
6.56 Drive active falling edge delay	0 to 255	30s	RW	Uni			US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.7 Menu 7: Analog I/O

Figure 11-8 Menu 7 logic diagram

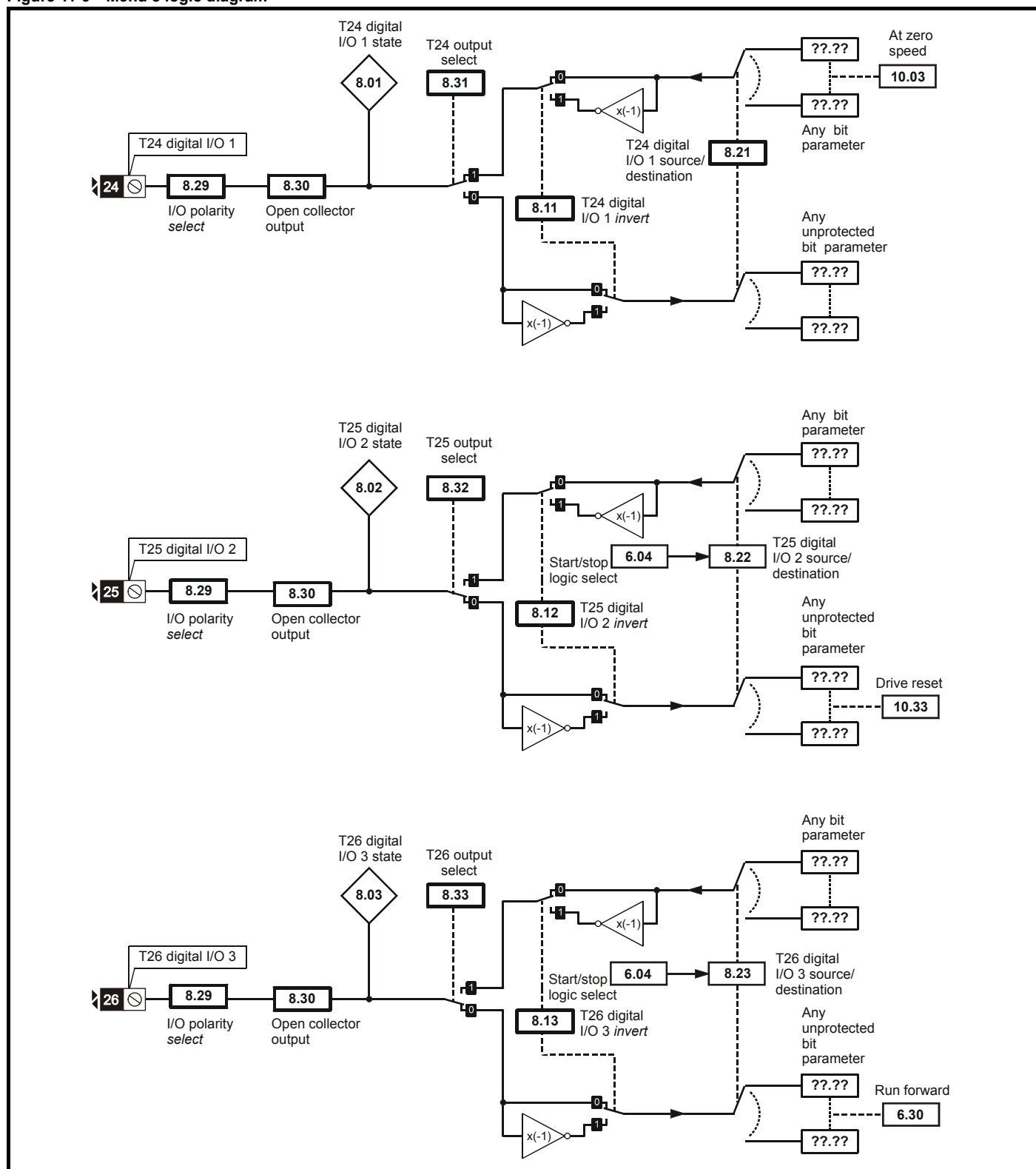


Parameter			Range(↕)		Default(⇒)		Type				
7.01	Analog input 1	{in02, 0.82}	±100.00%				RO	Bi		NC	PT
7.02	Analog input 2	{in03, 0.83}	±100.0%				RO	Bi		NC	PT
7.03	Analog input 3	{in04, 0.84}	±100.0%				RO	Bi		NC	PT
7.04	Power circuit temperature		-128°C to 127°C				RO	Bi		NC	PT
7.08	Analog input 1 scaling		0 to 40.000		1.000		RW	Uni			US
7.09	Analog input 1 invert		OFF (0) to On (1)		OFF (0)		RW	Bit			US
7.10	Analog input 1 destination		0 to 22.99		1.36		RW	Uni			PT US
7.11	Analog input 2 mode		0 to 9		6		RW	Uni			US
7.12	Analog input 2 scaling		0 to 40.000		1.000		RW	Uni			US
7.13	Analog input 2 invert		OFF (0) to On (1)		OFF (0)		RW	Bit			US
7.14	Analog input 2 destination		00.00 to 22.99		1.37		RW	Uni			PT US
7.15	Analog input 3 mode	{in01, 0.81}	0 to 9		8		RW	Txt			US
7.16	Analog input 3 scaling		0 to 40.000		1.000		RW	Uni			US
7.17	Analog input 3 invert		OFF (0) to On (1)		OFF (0)		RW	Bit			US
7.18	Analog input 3 destination		00.00 to 22.99		00.00		RW	Uni			PT US
7.19	Analog output 1 source		00.00 to 22.99		3.02		RW	Uni			PT US
7.20	Analog output 1 scaling		0.000 to 40.000		1.000		RW	Uni			US
7.21	Analog output 1 mode		0 to 3		0		RW	Txt			US
7.22	Analog output 2 source		00.00 to 22.99		4.01		RW	Uni			PT US
7.23	Analog output 2 scaling		0.000 to 40.000		1.000		RW	Uni			US
7.24	Analog output 2 mode		0 to 3		0		RW	Txt			US
7.28	Analog input current loop loss 2		OFF (0) to On (1)				RO	Bit		NC	PT
7.29	Analog input current loop loss 3		OFF (0) to On (1)				RO	Bit		NC	PT
7.30	Analog input 1 offset		±100.00%		0.00		RW	Bi			US
7.31	Analog input 2 offset		±100.0%		0.0		RW	Bi			US
7.32	Analog input 3 offset		±100.0%		0.0		RW	Bi			US
7.34	Thyristor junction temperature		0 to 150°C				RO	Uni		NC	PT

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.8 Menu 8: Digital I/O

Figure 11-9 Menu 8 logic diagram



**Figure 11-10 Menu 8 logic diagram (cont)**

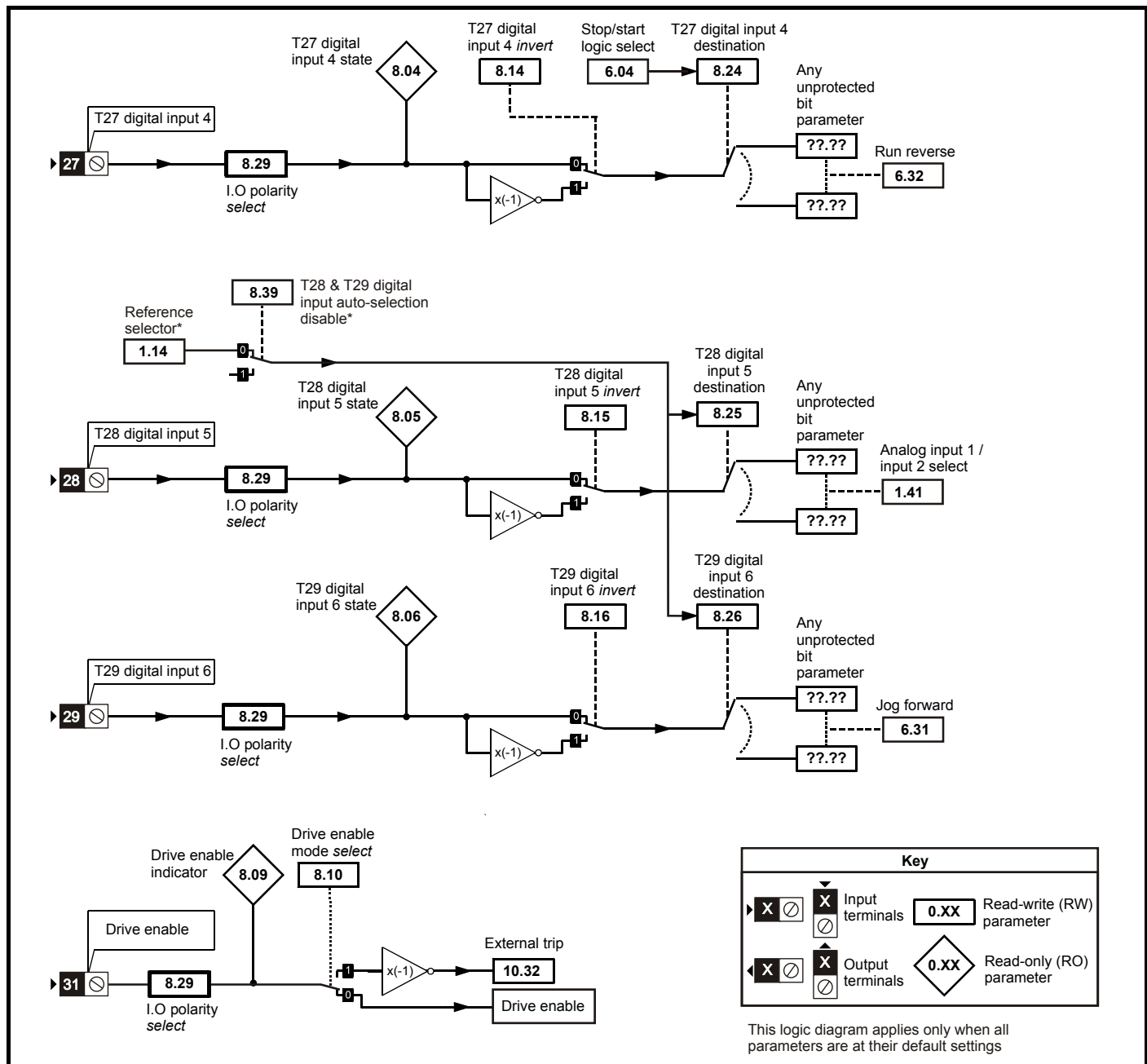
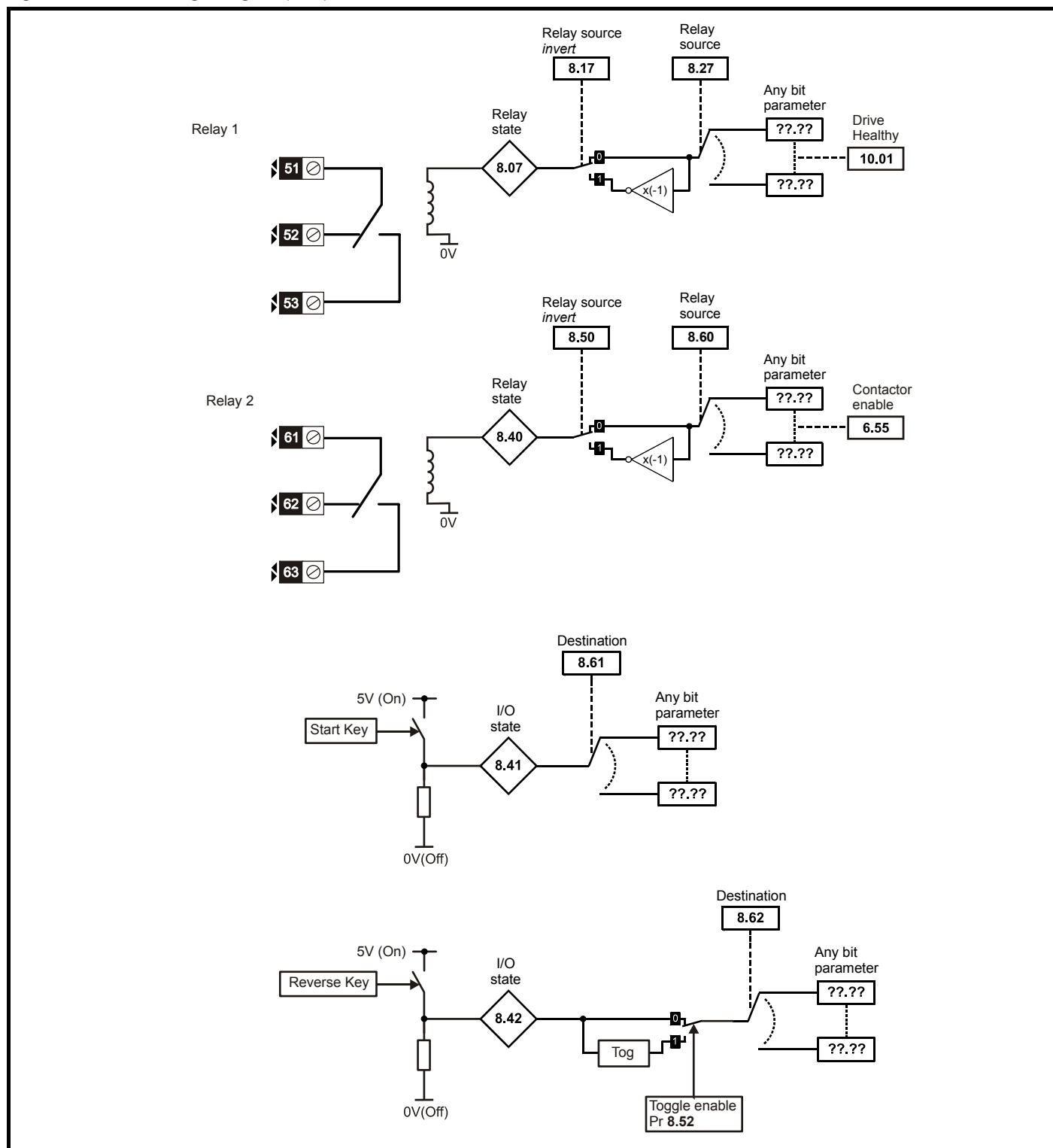


Figure 11-11 Menu 8 logic diagram (cont)





Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter			Range(⇅)		Default(⇒)		Type				
8.01	T24 digital I/O 1 state	{in05, 0.85}	OFF (0) or On (1)				RO	Bit		NC	PT
8.02	T25 digital I/O 2 state	{in06, 0.86}	OFF (0) or On (1)				RO	Bit		NC	PT
8.03	T26 digital I/O 3 state	{in07, 0.87}	OFF (0) or On (1)				RO	Bit		NC	PT
8.04	T27 digital input 4 state	{in08, 0.88}	OFF (0) or On (1)				RO	Bit		NC	PT
8.05	T28 digital input 5 state	{in09, 0.89}	OFF (0) or On (1)				RO	Bit		NC	PT
8.06	T29 digital input 6 state	{in10, 0.90}	OFF (0) or On (1)				RO	Bit		NC	PT
8.07	T51, 52, 53 relay state		OFF (0) or On (1)				RO	Bit		NC	PT
8.09	T31 drive enable state		OFF (0) or On (1)				RO	Bit		NC	PT
8.10	Enable mode select		0 to 2		0		RW	Uni			US
8.11	T24 digital I/O 1 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.12	T25 digital I/O 2 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.13	T26 digital I/O 3 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.14	T27 digital input 4 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.15	T28 digital input 5 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.16	T29 digital input 6 invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.17	T51, 52, 53 relay invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.20	Digital I/O read word		0 to 4095				RO	Uni		NC	PT
8.21	T24 digital I/O 1 source/ destination		Pr 0.00 to 22.99		Pr 10.06		RW	Uni	DE		PT US
8.22	T25 digital I/O 2 source/ destination		Pr 0.00 to 22.99		Pr 10.33		RW	Uni	DE		PT US
8.23	T26 digital I/O 3 source/ destination		Pr 0.00 to 22.99		Pr 6.30		RW	Uni	DE		PT US
8.24	T27 digital input 4 destination		Pr 0.00 to 22.99		Pr 6.32		RW	Uni	DE		PT US
8.25	T28 digital input 5 destination		Pr 0.00 to 22.99		Pr 1.41		RW	Uni	DE		PT US
8.26	T29 digital input 6 destination		Pr 0.00 to 22.99		Pr 6.31		RW	Uni	DE		PT US
8.27	T51, 52, 53 relay source		Pr 0.00 to 22.99		Pr 10.01		RW	Uni			PT US
8.29	I/O polarity select		2		1		RW	Uni			PT US
8.30	Open collector output		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.31	T24 digital I/O 1 output select		OFF (0) or On (1)		On (1)		RW	Bit			US
8.32	T25 digital I/O 2 output select		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.33	T26 digital I/O 3 output select		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.40	T61, 62, 63 relay state		OFF (0) or On (1)				RO	Bit		NC	PT
8.41	Start button state		OFF (0) or On (1)				RO	Bit		NC	PT
8.42	Forward/reverse button state		OFF (0) or On (1)				RO	Bit		NC	PT
8.48	24V input state		OFF (0) or On (1)				RO	Bit		NC	PT
8.50	T61, 62, 63 relay invert		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.52	Toggle enable		OFF (0) or On (1)		OFF (0)		RW	Bit			US
8.60	T61, 62, 63 relay destination		Pr 0.00 to 22.99		Pr 6.55		RW	Uni	DE		PT US
8.61	Start button destination		Pr 0.00 to 22.99		Pr 0.00		RW	Uni	DE		PT US
8.62	Forward/reverse button destination		Pr 0.00 to 22.99		Pr 0.00		RW	Uni	DE		PT US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

11.9 Menu 9: Programmable logic, motorized pot and binary sum

Figure 11-12 Menu 9 logic diagram: Programmable logic

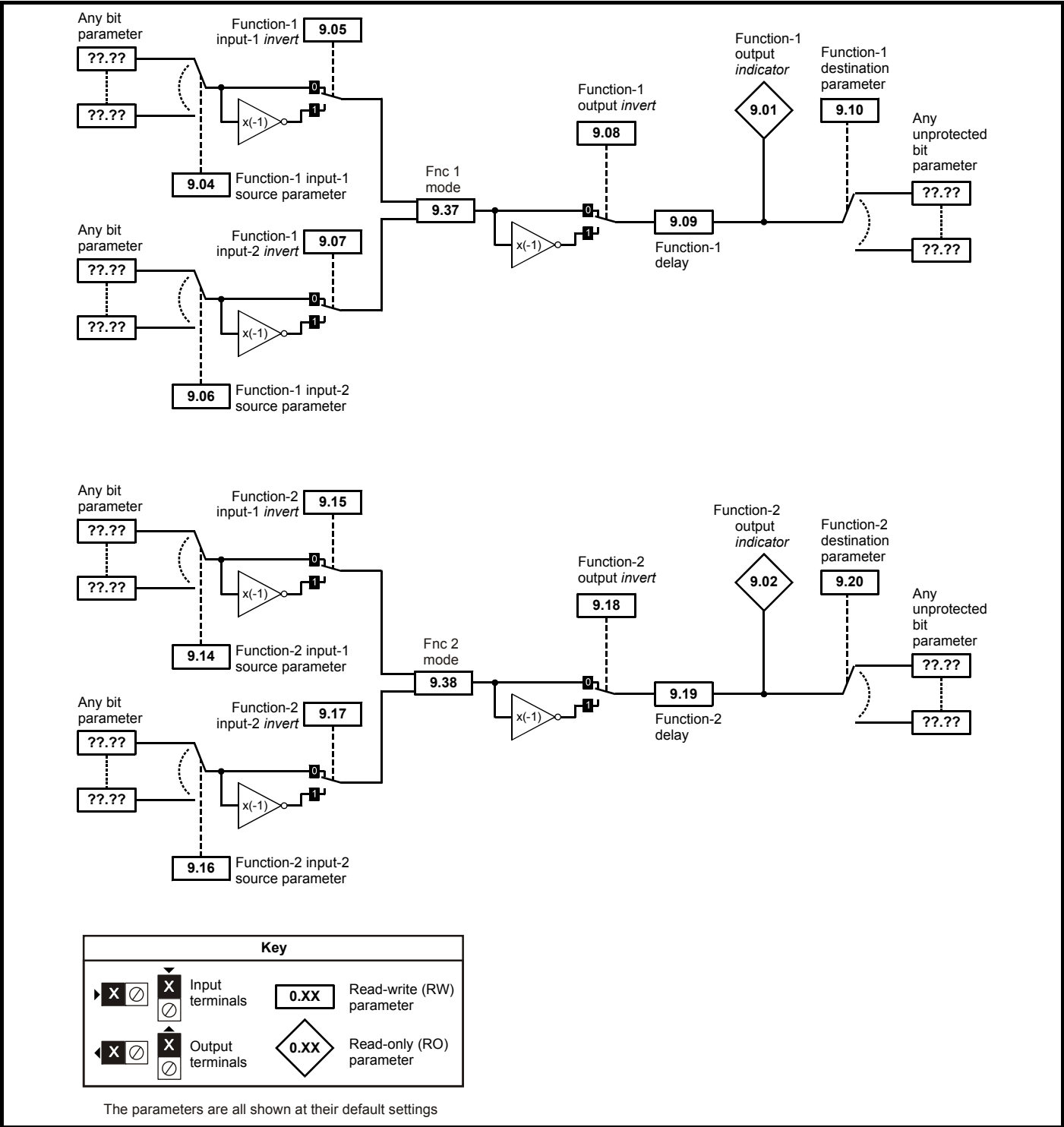
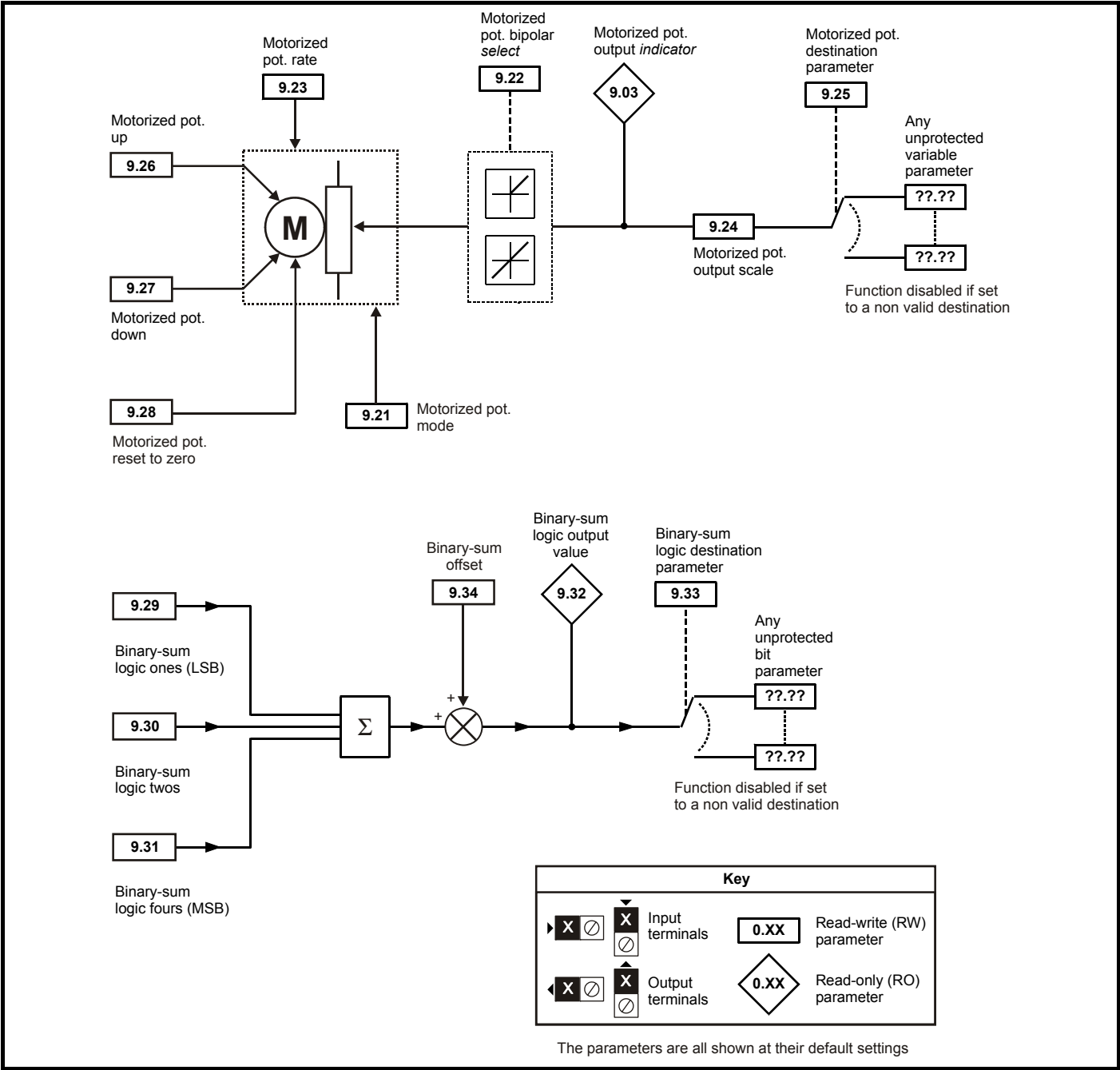


Figure 11-13 Menu 9 logic diagram: Motorized pot and binary sum



Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter		Range(↕)	Default(⇒)	Type					
9.01	Logic function 1 output	OFF (0) or On (1)		RO	Bit		NC	PT	
9.02	Logic function 2 output	OFF (0) or On (1)		RO	Bit		NC	PT	
9.03	Motorized pot output	±100.00%		RO	Bit		NC	PT	PS
9.04	Logic function 1 source 1	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.05	Logic function 1 source 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.06	Logic function 1 source 2	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.07	Logic function 1 source 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.08	Logic function 1 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.09	Logic function 1 delay	±25.0s	0.0	RW	Bi				US
9.10	Logic function 1 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.14	Logic function 2 source 1	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.15	Logic function 2 source 1 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.16	Logic function 2 source 2	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.17	Logic function 2 source 2 invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.18	Logic function 2 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.19	Logic function 2 delay	±25.0s	0.0	RW	Bi				US
9.20	Logic function 2 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.21	Motorized pot mode	0 to 3	2	RW	Uni				US
9.22	Motorized pot bipolar select	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.23	Motorized pot rate	0 to 250s	20	RW	Uni				US
9.24	Motorized pot scale factor	0 to 4.000	1.000	RW	Uni				US
9.25	Motorized pot destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.26	Motorized pot up	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.27	Motorized pot down	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.28	Motorized pot reset	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.29	Binary sum ones input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.30	Binary sum twos input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.31	Binary sum fours input	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
9.32	Binary sum output	0 to 255		RO	Uni		NC	PT	
9.33	Binary sum destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.34	Binary sum offset	0 to 248	0	RW	Uni				US
9.35	Up down disable source	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
9.36	Up down disable invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
9.37	Logic block 1 mode	0 to 4	0	RW	Uni				US
9.38	Logic block 2 mode	0 to 4	0	RW	Uni				US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.10 Menu 10: Status and trips

Parameter		Range(⇅)	Default(⇒)	Type			
10.01	Drive ok	OFF (0) or On (1)		RO	Bit	NC	PT
10.02	Drive active	OFF (0) or On (1)		RO	Bit	NC	PT
10.03	Zero speed	OFF (0) or On (1)		RO	Bit	NC	PT
10.04	Running at or below min speed	OFF (0) or On (1)		RO	Bit	NC	PT
10.05	Below set speed	OFF (0) or On (1)		RO	Bit	NC	PT
10.06	At speed	OFF (0) or On (1)		RO	Bit	NC	PT
10.07	Above set speed	OFF (0) or On (1)		RO	Bit	NC	PT
10.08	Load reached	OFF (0) or On (1)		RO	Bit	NC	PT
10.09	Drive output is at current limit	OFF (0) or On (1)		RO	Bit	NC	PT
10.10	Regenerating	OFF (0) or On (1)		RO	Bit	NC	PT
10.13	Direction command	OFF (0) or On (1)		RO	Bit	NC	PT
10.14	Direction running	OFF (0) or On (1)		RO	Bit	NC	PT
10.17	Overload arm	OFF (0) or On (1)		RO	Bit	NC	PT
10.18	Drive over temperature alarm	OFF (0) or On (1)		RO	Bit	NC	PT
10.19	Drive warning	OFF (0) or On (1)		RO	Bit	NC	PT
10.20	Trip 0 {tr01, 0.51}	0 to 229		RW	Txt	NC	PT PS
10.21	Trip 1 {tr02, 0.52}	0 to 229		RW	Txt	NC	PT PS
10.22	Trip 2 {tr03, 0.53}	0 to 229		RW	Txt	NC	PT PS
10.23	Trip 3 {tr04, 0.54}	0 to 229		RW	Txt	NC	PT PS
10.24	Trip 4 {tr05, 0.55}	0 to 229		RW	Txt	NC	PT PS
10.25	Trip 5 {tr06, 0.56}	0 to 229		RW	Txt	NC	PT PS
10.26	Trip 6 {tr07, 0.57}	0 to 229		RW	Txt	NC	PT PS
10.27	Trip 7 {tr08, 0.58}	0 to 229		RW	Txt	NC	PT PS
10.28	Trip 8 {tr09, 0.59}	0 to 229		RW	Txt	NC	PT PS
10.29	Trip 9 {tr10, 0.60}	0 to 229		RW	Txt	NC	PT PS
10.32	External trip	OFF (0) or On (1)	OFF (0)	RW	Bit	NC	
10.33	Drive reset	OFF (0) or On (1)	OFF (0)	RW	Bit	NC	
10.34	No. of auto-reset attempts	0 to 5	0	RW	Uni		US
10.35	Auto-reset delay	0 to 25.0s	1.0	RW	Uni		US
10.36	Hold drive ok until last attempt	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.38	User trip	0 to 255	0	RW	Uni	NC	
10.40	Status word	0 to 32767		RO	Uni	NC	PT
10.41	Trip 0 time: Years.Days	0 to 9.364 Years.Days		RO	Uni	NC	PT PS
10.42	Trip 0 time: Hours.Minutes	0 to 23.59 Hours.Minutes		RO	Uni	NC	PT PS
10.43	Trip 1 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.44	Trip 2 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.45	Trip 3 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.46	Trip 4 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.47	Trip 5 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.48	Trip 6 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.49	Trip 7 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.50	Trip 8 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.51	Trip 9 time: Hours.Minutes	0 to 600.00 Hours.Minutes		RO	Uni	NC	PT PS
10.52	Trip mask 0	0 to 217	0	RW	Uni		US
10.53	Trip mask 1	0 to 217	0	RW	Uni		US
10.54	Trip mask 2	0 to 217	0	RW	Uni		US
10.55	Trip mask 3	0 to 217	0	RW	Uni		US
10.56	Trip mask 4	0 to 217	0	RW	Uni		US
10.57	Trip mask 5	0 to 217	0	RW	Uni		US
10.58	Trip mask 6	0 to 217	0	RW	Uni		US
10.59	Trip mask 7	0 to 217	0	RW	Uni		US
10.60	Trip mask 8	0 to 217	0	RW	Uni		US
10.61	Trip mask 9	0 to 217	0	RW	Uni		US
10.62	Stop on trip mask 0	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.63	Stop on trip mask 1	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.64	Stop on trip mask 2	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.65	Stop on trip mask 3	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.66	Stop on trip mask 4	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.67	Stop on trip mask 5	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.68	Stop on trip mask 6	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.69	Stop on trip mask 7	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.70	Stop on trip mask 8	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.71	Stop on trip mask 9	OFF (0) or On (1)	OFF (0)	RW	Bit		US
10.72	Trip mask active	OFF (0) or On (1)		RO	Bit	NC	
10.73	Bridge active	0 to 2		RO	Txt	NC	
10.74	Electrical phase lock	OFF (0) or On (1)		RO	Bit	NC	
10.75	Armature voltage clamp active	OFF (0) or On (1)		RO	Bit	NC	
10.76	Phase rotation	0 to 15		RO	Txt	NC	
10.77	Input frequency	0 to 100.00		RO	Uni	NC	

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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## 11.11 Menu 11: General drive set-up

Parameter	Range(⇅)	Default(⇒)	Type			
11.21 Parameter scaling	0 to 9.999	1.000	RW	Uni		US
11.22 Parameter displayed at power-up	0 to 00.90	00.40	RW	Uni		PT US
11.23 Serial address {Si02, 0.67}	0 to 247	1	RW	Uni		US
11.24 Serial mode	0 to 2	1	RW	Txt		US
11.25 Baud rate {Si01, 0.66}	0 to 9	6	RW	Txt		US
11.26 Minimum comms transmit delay	0 to 250ms	2	RW	Uni		US
11.29 Software version {di14, 0.49}	1.0 to 99.99		RO	Uni	NC	PT
11.30 User security code	0 to 999	0	RW	Uni	NC	PT PS
11.32 Current rating	0 to 10,000.0A		RO	Uni	NC	PT
11.33 Drive voltage rating	0 (480), 1 (575), 2 (690)		RO	Txt	NC	PT
11.34 Software sub-version	0 to 99		RO	Uni	NC	PT
11.35 Number of modules	0 to 4		RW	Uni		PT US
11.36 Smart card parameter data previously loaded	0 to 999	0	RO	Uni	NC	PT US
11.37 Smart card data number	0 to 1003	0	RW	Uni	NC	
11.38 Smart card data type/mode	0 to 18		RO	Uni	NC	PT
11.39 Smart card data version	0 to 9999	0	RW	Uni	NC	
11.40 Smart card data checksum	0 to 65335		RO	Uni	NC	PT
11.41 Status mode timeout	0 to 250s	240	RW	Uni		US
11.42 Parameter cloning {SE09, 0.30}	0 to 4	0	RW	Txt	NC	*
11.44 Security status {SE14, 0.35}	0 to 2	0	RW	Txt		PT US
11.45 Select motor 2 parameters	OFF (0) or On (1)	OFF (0)	RW	Bit		US
11.46 Defaults previously loaded	0 to 2	Eur: or USA: 0	RO	Txt		PT US
11.47 Drive Onboard Application Lite Ladder Program Enable	0 to 2	2	RW	Uni		US
11.48 Drive Onboard Application Lite Ladder Program Status	-128 to +127		RO	Bi	NC	PT
11.49 Drive Onboard Application Lite Ladder Program Events	0 to 65535		RO	Uni	NC	PT PS
11.50 Drive Onboard Application Lite Ladder Program Maximum Scan Time	0 to 65335ms		RO	Uni	NC	PT
11.51 Drive Onboard Application Lite Ladder Program First Run	OFF (0) or On (1)		RO	Bit	NC	PT
11.52 Drive serial number	0 to 999 999 999		RO	Uni	NC	PT
11.53 Build location	0 to 255		RO	Uni	NC	PT
11.55 Drive rating number	0 to 56		RO	Uni	NC	PT
11.56 Power PCB software version	1.00 to 99.99		RO	Uni	NC	PT
11.57 Serial programmable source	Pr 0.00 to 22.99	Pr 0.00	RW	Uni		PT US
11.58 Serial scaling	0 to 1999	1000	RW	Uni		US
11.59 Mentor II Parameter Emulator Module Control	0 to 3	0	RW	Uni		US
11.60 Application parameters	16000 to -16000		RW	Uni	NC	
11.61 Application parameters	16000 to -16000		RW	Uni	NC	
11.62 Full power discharge time	0 to 25.0s	0.0	RW	Uni		US
11.63 Full power discharge period	0 to 1500.0s	0.0	RW	Uni		US
11.64 External discharge resistance	0 to 9999Ω	0	RW	Uni		US
11.65 External resistor temperature	0 to 100%		RO		NC	PT
11.66 Suppressor voltage	0 to 2000V		RO		NC	PT

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

\* Modes 1 and 2 are not US (i.e. not saved when drive parameters are saved), mode 3 and 4 are US. Therefore this parameter can only be saved to EEPROM if it has a value of 0, 3 or 4.

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

Figure 11-14 Menu 12 logic diagram

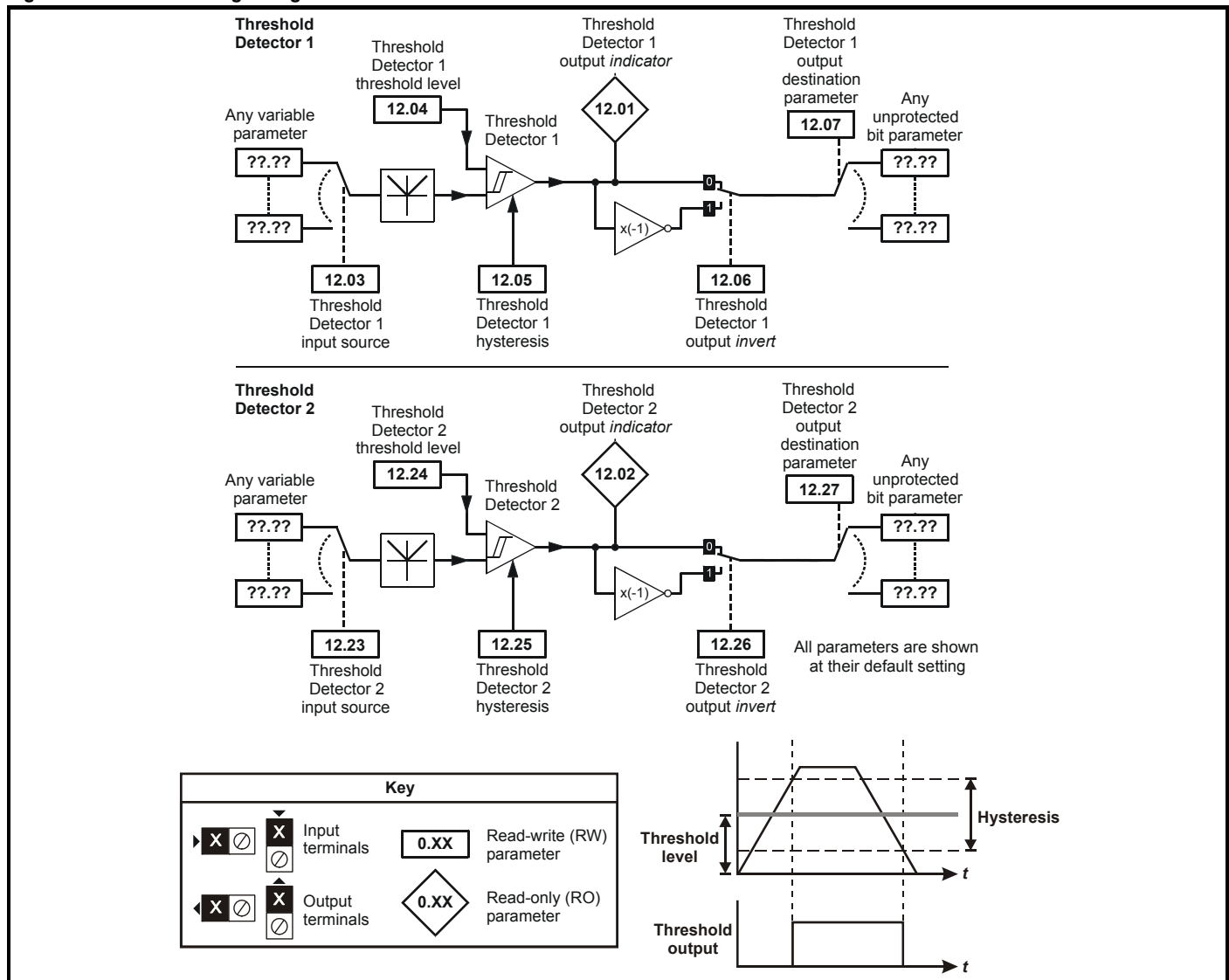
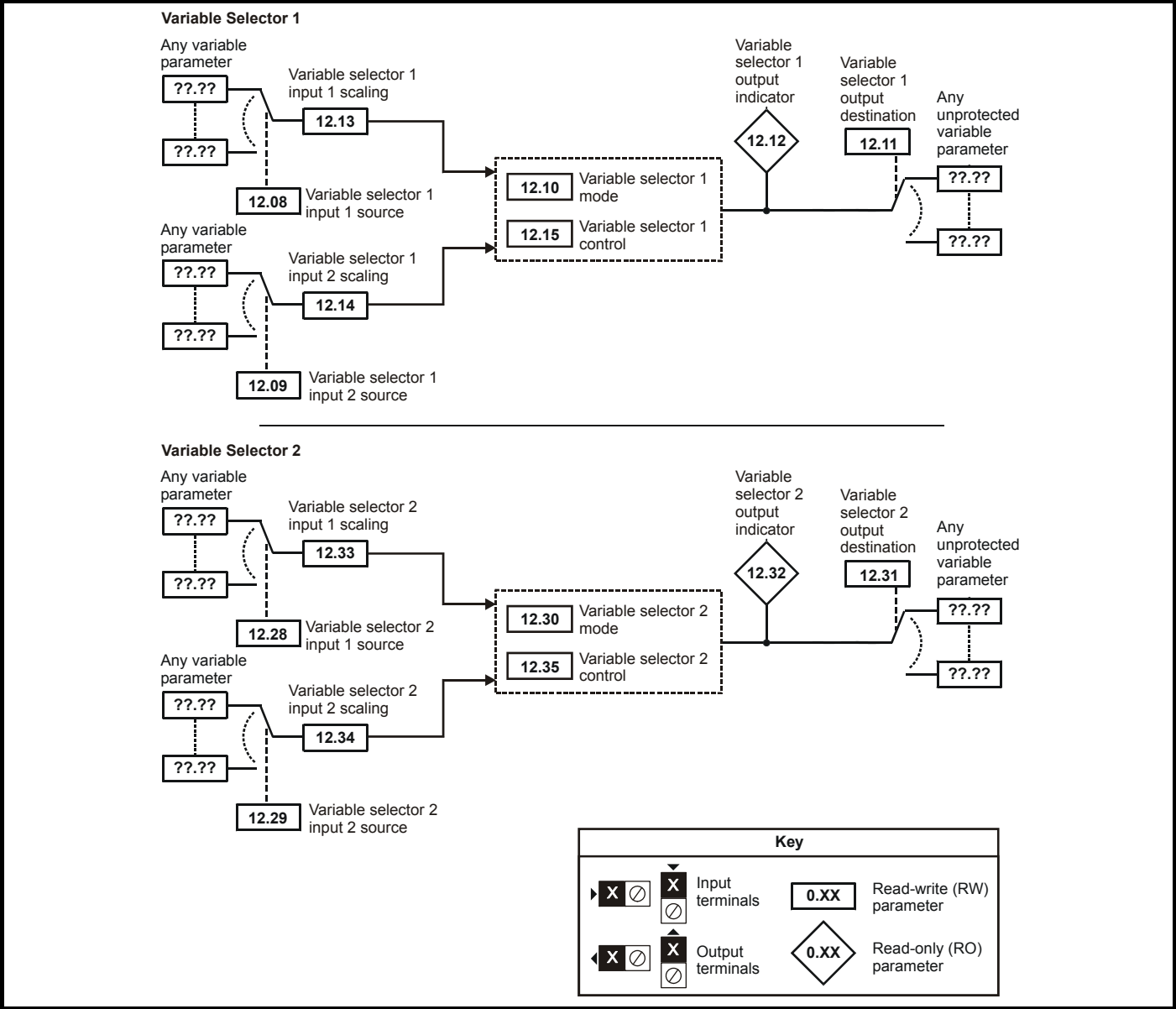
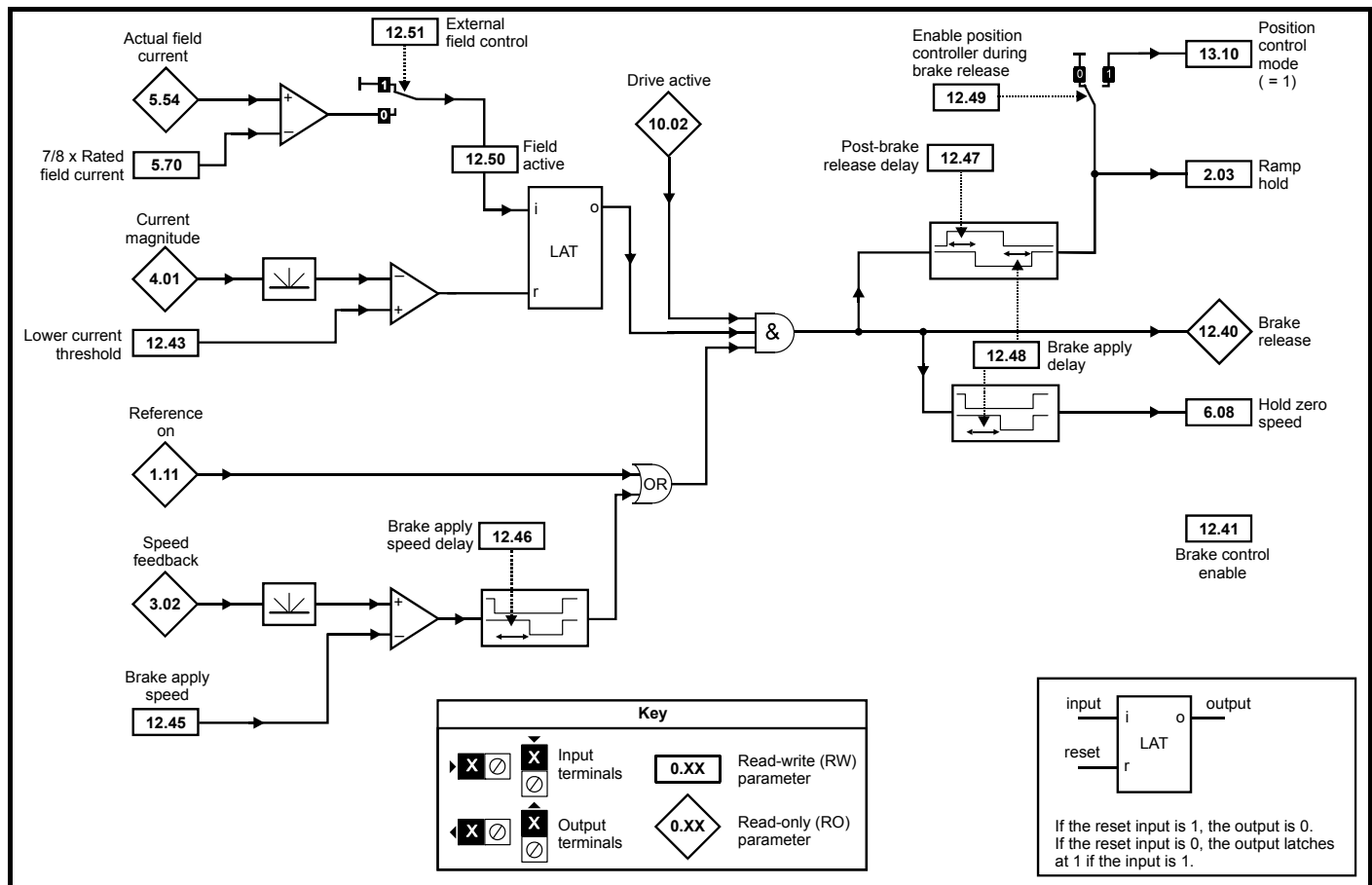


Figure 11-15 Menu 12 logic diagram (continued)





**Figure 11-16 Menu 12 Brake control function**



Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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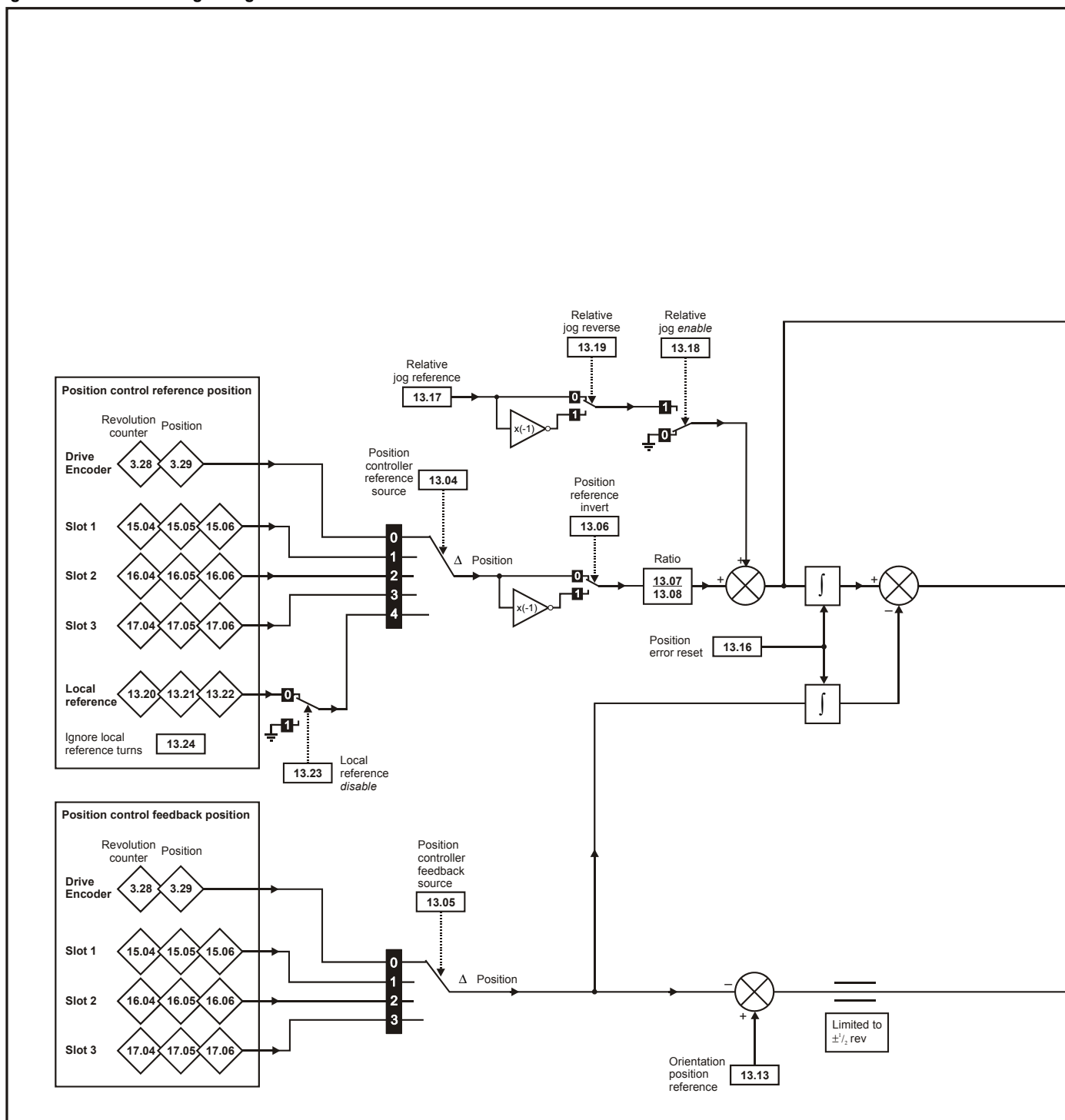
Parameter		Range(⇅)	Default(⇒)	Type					
12.01	Threshold detector 1 output	OFF (0) or On (1)		RO	Bit		NC	PT	
12.02	Threshold detector 2 output	OFF (0) or On (1)		RO	Bit		NC	PT	
12.03	Threshold detector 1 source	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.04	Threshold detector 1 level	0 to 100.00%	0.00	RW	Uni				US
12.05	Threshold detector 1 hysteresis	0 to 25.00%	0.00	RW	Uni				US
12.06	Threshold detector 1 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.07	Threshold detector 1 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.08	Variable selector 1 source 1	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.09	Variable selector 1 source 2	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.10	Variable selector 1 mode	0 to 10	0	RW	Uni				US
12.11	Variable selector 1 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.23	Threshold detector 2 source	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.12	Variable selector 1 output	±100.00%		RO	Uni		NC	PT	
12.13	Variable selector 1 source 1 scaling	±4.000	1.000	RW	Uni				US
12.14	Variable selector 1 source 2 scaling	±4.000	1.000	RW	Uni				US
12.15	Variable selector 1 control	0 to 100.00	0.00	RW	Uni				US
12.24	Threshold detector 2 level	0 to 100.00%	0.00	RW	Uni				US
12.25	Threshold detector 2 hysteresis	0 to 25.00%	0.00	RW	Uni				US
12.26	Threshold detector 2 output invert	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.27	Threshold detector 2 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.28	Variable selector 2 source 1	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.29	Variable selector 2 source 2	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.30	Variable selector 2 mode	0 to 10	0	RW	Uni				US
12.31	Variable selector 2 destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
12.32	Variable selector 2 output	±100.00%		RO	Uni		NC	PT	
12.33	Variable selector 2 source 1 scaling	±4.000	1.000	RW	Uni				US
12.34	Variable selector 2 source 2 scaling	±4.000	1.000	RW	Uni				US
12.35	Variable selector 2 control	0 to 100.00	0.00	RW	Uni				US
12.40	Brake release	OFF (0) or On (1)		RO	Uni		NC	PT	
12.41	Brake controller enable	0 to 3	0	RW	Txt				US
12.43	Lower current threshold	0 to 150%	10%	RW	Uni				US
12.45	Brake apply speed	0 to 200rpm	5rpm	RW	Uni				US
12.46	Brake apply speed delay	0 to 25.0s	1.0s	RW	Uni				US
12.47	Post-brake release delay	0 to 25.0s	1.0s	RW	Uni				US
12.48	Brake apply delay	0 to 25.0s	1.0s	RW	Uni				US
12.49	Enable position controller during brake release	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.50	Field active	OFF (0) or On (1)	OFF (0)	RW	Bit				US
12.51	External field control	OFF (0) or On (1)	OFF (0)	RW	Bit				US

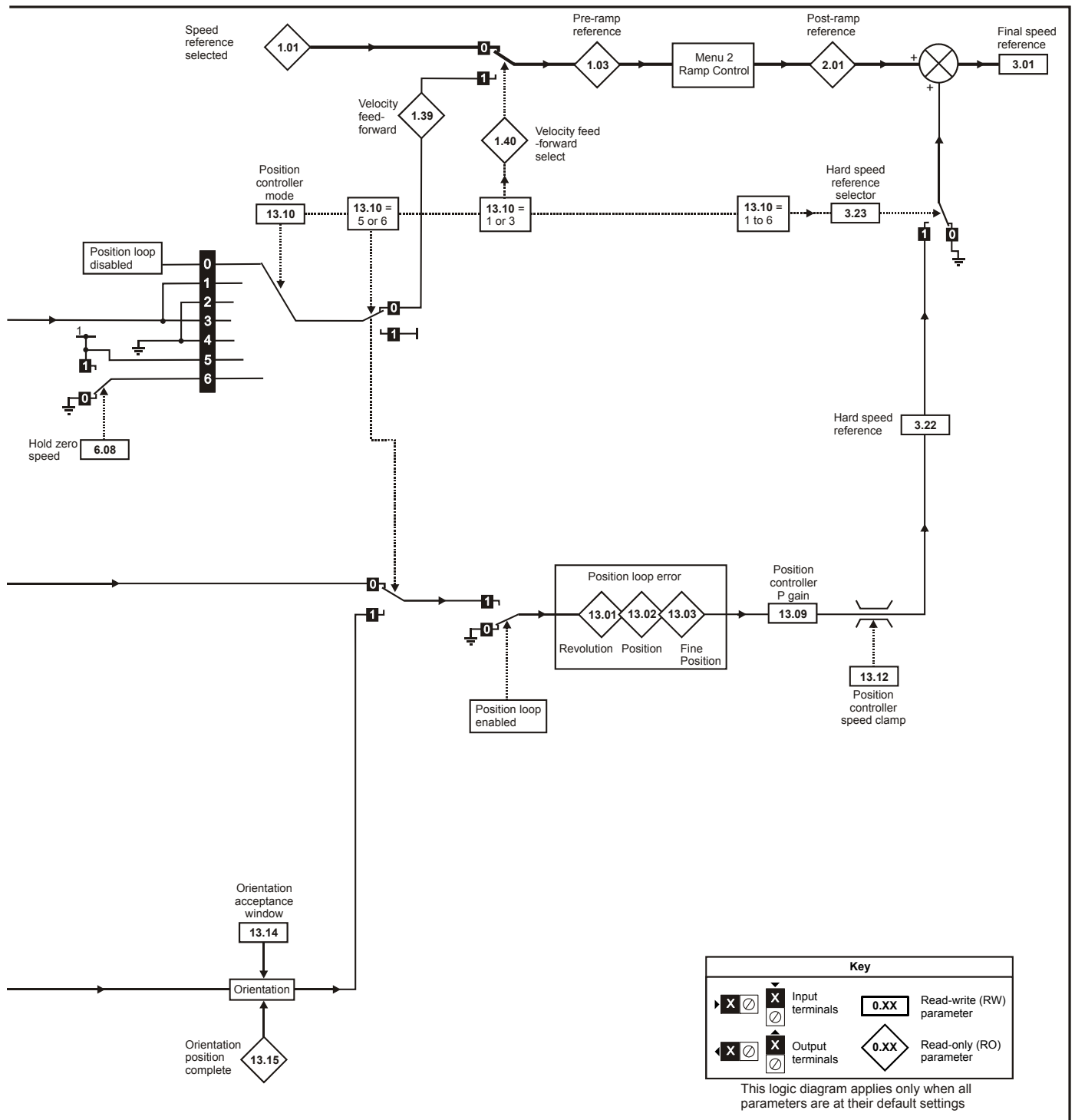
RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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## 11.13 Menu 13: Position control

Figure 11-17 Menu 13 logic diagram





Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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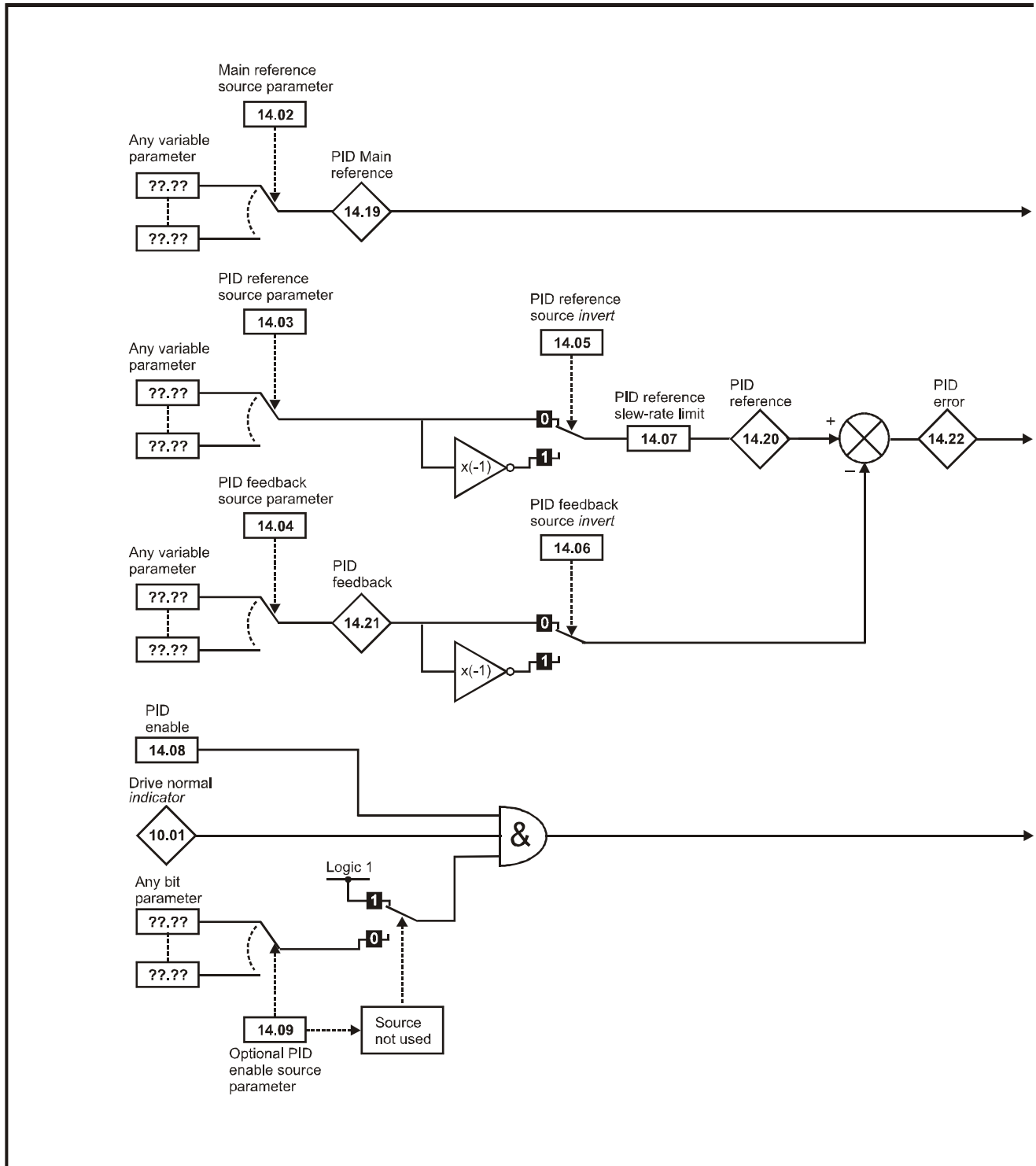
Parameter		Range(⇅)	Default(⇄)	Type				
13.01	Revolutions error	-32768 to +32767		RO	Uni		NC	PT
13.02	Position error	-32768 to +32767		RO	Uni		NC	PT
13.03	Fine position error	-32768 to +32767		RO	Uni		NC	PT
13.04	Position controller reference source	0 to 4	0	RW	Txt			US
13.05	Position controller feedback source	0 to 3	0	RW	Txt			US
13.06	Position reference invert	OFF (0) or On(1)	OFF (0)	RW	Bit			US
13.07	Ratio numerator	0 to 4.000	1.000	RW	Uni			US
13.08	Ration denominator	0 to 1.000	1.000	RW	Uni			US
13.09	Position controller P gain	0 to 100.00 rads <sup>-1</sup> /rad	25.00	RW	Uni			US
13.10	Position controller mode	0 to 6	0	RW	Uni			US
13.11	Absolute mode enable	OFF (0) or On(1)	OFF (0)	RW	Bit			US
13.12	Position controller speed clamp	0 to 250	150	RW	Uni			US
13.13	Orientation position reference	0 to 65535	0	RW	Uni			US
13.14	Orientation acceptance window	0 to 4096	256	RW	Uni			US
13.15	Orientation position complete	OFF (0) or On(1)		RO	Bit		NC	PT
13.16	Position error reset	OFF (0) or On(1)	OFF (0)	RW	Bit		NC	
13.17	Relative jog reference	0 to 4000.0rpm	0.0	RW	Uni			US
13.18	Relative jog enable	OFF (0) or On(1)	OFF (0)	RW	Bit		NC	
13.19	Relative jog reverse	OFF (0) or On(1)	OFF (0)	RW	Bit		NC	
13.20	Local reference turns	0 to 65535	0	RW	Uni		NC	
13.21	Local reference position	0 to 65535	0	RW	Uni		NC	
13.22	Local reference fine position	0 to 65535	0	RW	Uni		NC	
13.23	Local reference disable	OFF (0) or On(1)	OFF (0)	RW	Bit		NC	
13.24	Ignore local reference turns	OFF (0) or On(1)	OFF (0)	RW	Bit			US

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

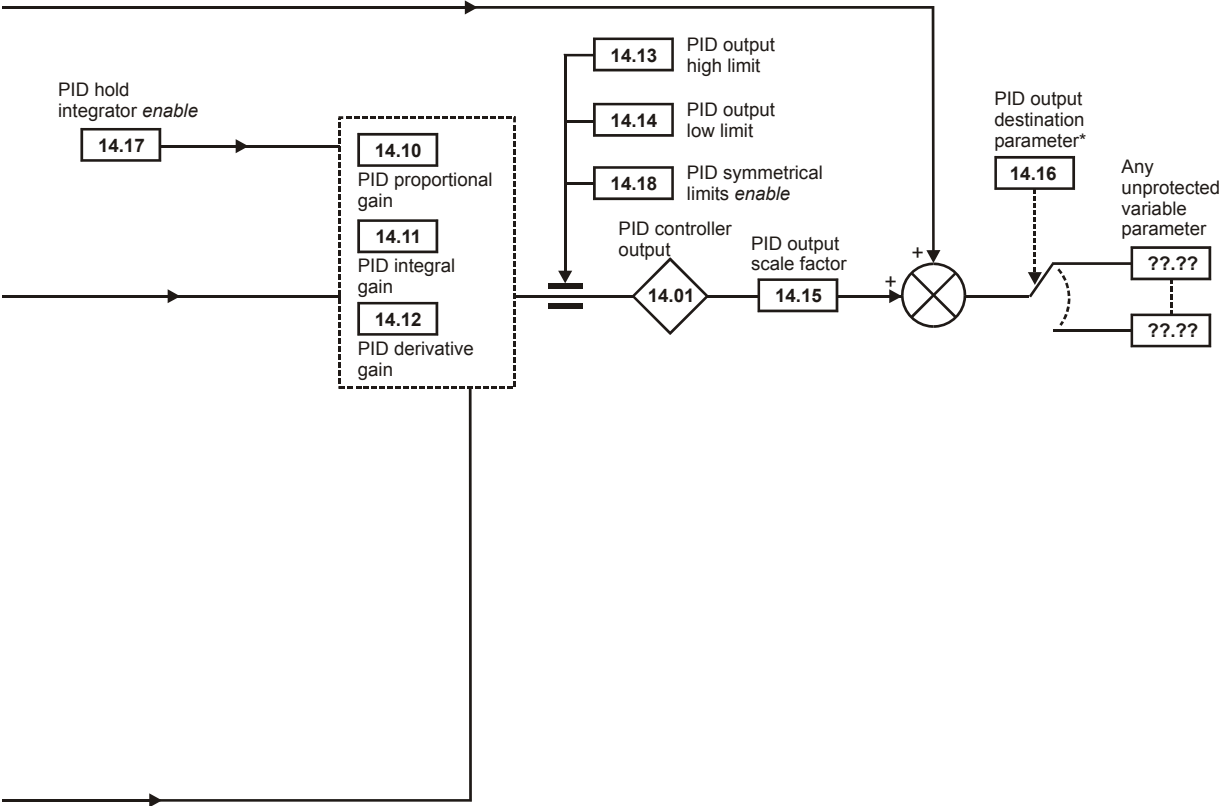
Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	<b>Advanced parameters</b>	Technical data	Diagnostics	UL information
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## 11.14 Menu 14: User PID controller

Figure 11-18 Menu 14 logic diagram







Key			
	Input terminals		Read-write (RW) parameter
	Output terminals		Read-only (RO) parameter

The parameters are all shown at their default settings

\*The PID controller is only enabled if Pr **14.16** is set to a non Pr **xx.00** and unprotected destination parameter.

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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Parameter		Range(⇅)	Default(⇌)	Type					
14.01	PID output	±100.00%		RO	Uni		NC	PT	
14.02	PID source1	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
14.03	PID source 2	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
14.04	PID source 3	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
14.05	PID source invert 1	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.06	PID source invert 2	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.07	PID reference slew rate limit	0 to 3200.0s	0.0	RW	Uni				US
14.08	PID enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.09	PID optional enable source	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
14.10	PID P gain	0 to 4.000	1.000	RW	Uni				US
14.11	PID I gain	0 to 4.000	0.500	RW	Uni				US
14.12	PID D gain	0 to 4.000	0.000	RW	Uni				US
14.13	PID upper limit	0 to 100.00%	100.00	RW	Uni				US
14.14	PID lower limit	±100.00%	-100.00	RW	Bi				US
14.15	PID scaling	0 to 4.000	1.000	RW	Uni				US
14.16	PID destination	Pr 0.00 to 22.99	Pr 0.00	RW	Uni			PT	US
14.17	PID hold integrator	OFF (0) or On (1)	OFF (0)	RW	Bit		NC		
14.18	PID symmetrical limit enable	OFF (0) or On (1)	OFF (0)	RW	Bit				US
14.19	PID main reference	±100.00%		RO	Bi		NC	PT	
14.20	PID reference	±100.00%		RO	Bi		NC	PT	
14.21	PID feedback	±100.00%		RO	Bi		NC	PT	
14.22	PID error	±100.00%		RO	Bi		NC	PT	

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.15 Menus 15, 16 and 17: Solutions Module slots

Pr **x.00** and Pr **x.01** are always present in menus 15, 16 and 17. Pr **x.01** indicates which type of module is present (0 = no module installed). When a module is installed the drive provides the relevant menu (menu 15 for slot 1, 16 for slot 2 and 17 for slot 3) depending on the Solutions Module installed. The possible categories are shown below.

Solutions Module ID	Module	Category
0	No module installed	
102	SM-Universal Encoder Plus	Feedback
104	SM-Encoder Plus and SM-Encoder Output Plus	
201	SM-I/O Plus	Automation (I/O Expansion)
203	SM-I/O Timer	
204	SM-I/O PELV	
205	SM-I/O24V Protected	
206	SM-I/O120V	
207	SM-I/O Lite	
208	SM-I/O 32	
304	SM-Applications Plus	Automation (Applications)
305	SM-Applications Lite V2	
306	SM-Register	
403	SM-PROFIBUS DP-V1	Fieldbus
404	SM-INTERBUS	
407	SM-DeviceNet	
408	SM-CANopen	
410	SM-Ethernet	
421	SM-EtherCAT	

Refer to the specific Solutions Module User Guide for more information.

Most modules include a processor and parameters are updated by the processor in the Solutions Module. However, dumb modules do not contain a processor and all parameters are updated by the drive processor.

Dumb Solutions Module parameters are read/written by the drive background task or at the combined update time for time critical parameters. The combined update time depends on the number and type of dumb Solutions Modules installed to the drive. For each Solutions Module the update rate of these parameters is specified as 4ms, 8ms, etc. The combined update time is the total of the update times for all dumb Solutions Modules installed.

For example, if a module with 4ms update time and a module with 8ms are installed to the drive, then the combined update time for the time critical parameters of each module is 12ms.

In the parameter tables the update time added by the type of module is given, for example 4ms for the SM-Encoder Plus or 8ms for the SM-I/O Plus.

When parameters are saved by the user in the drive EEPROM the option code of the currently installed module is saved in EEPROM. If the drive is subsequently powered-up with a different module installed, or no module installed where a module was previously installed, the drive gives a Slot.dF trip. The menu for the relevant slot appears for the new module category with the default parameter values for the new category. The new parameters values are not stored in EEPROM until the user performs a parameter save.

### Parameters common to all categories

Parameter	Range	Default	Type					
<b>x.01</b> Solutions Module ID	0 to 599		RO	Uni			PT	US
<b>x.50</b> Solutions Module error status	0 to 255		RO	Uni		NC	PT	

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
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## 11.16 Menu 18: Application menu 1

Parameter		Range(⇅)	Default(⇒)	Type				
18.01	Application menu 1 power-down saved integer	-32,768 to +32,767	0	RW	Bi		NC	PS
18.02 to 18.10	Application menu 1 read-only integer	-32,768 to +32,767	0	RO	Bi		NC	
18.11 to 18.30	Application menu 1 read-write integer	-32,768 to +32,767	0	RW	Bi			US
18.31 to 18.50	Application menu 1 read-write bit	OFF (0) or On (1)	0	RW	Bit			US

## 11.17 Menu 19: Application menu 2

Parameter		Range(⇅)	Default(⇒)	Type				
19.01	Application menu 2 power-down saved integer	-32,768 to +32,767	0	RW	Bi		NC	PS
19.02 to 19.10	Application menu 2 read-only integer	-32,768 to +32,767	0	RO	Bi		NC	
19.11 to 19.30	Application menu 2 read-write integer	-32,768 to +32,767	0	RW	Bi			US
19.31 to 19.50	Application menu 2 read-write bit	OFF (0) or On (1)	0	RW	Bit			US

## 11.18 Menu 20: Application menu 3

Parameter		Range(⇅)	Default(⇒)	Type				
20.01 to 20.20	Application menu 3 read-write integer	-32,768 to +32,767	0	RW	Bi		NC	
20.21 to 20.40	Application menu 3 read-write long integer	-2 <sup>31</sup> to 2 <sup>31</sup> -1	0	RW	Bi		NC	

All menu 20 parameters are transferred to the SMARTCARD when a 4yyy transfer is performed. See section 9.3.1 *Writing to the SMARTCARD* on page 64 for more information.

RW	Read / Write	RO	Read only	Uni	Unipolar	Bi	Bi-polar	Bit	Bit parameter	Txt	Text string		
FI	Filtered	DE	Destination	NC	Not copied	RA	Rating dependent	PT	Protected	US	User save	PS	Power down save

## 11.19 Menu 21: Second motor parameters

Parameter		Range(⇅)	Default(⇒)	Type				
21.01	Maximum reference clamp	SPEED_LIMIT_MAX rpm	1000.0	RW	Uni			US
21.02	Minimum reference clamp	-SPEED_LIMIT_MAX to SPEED_LIMIT_MAX rpm*	0.0	RW	Bi		PT	US
21.03	Reference selector	0 to 6	0 (A1.A2)	RW	Txt			US
21.04	Acceleration rate	0 to MAX_RAMP_RATE_M2	5.000	RW	Uni			US
21.05	Deceleration rate	0 to MAX_RAMP_RATE_M2	5.000	RW	Uni			US
21.06	Base speed	0 to 10000.0 rpm	1000.0	RW	Uni			US
21.07	Rated current	0 to RATED_CURRENT_MAX A	RATED_CURRENT_MAX	RW	Uni			US
21.08	Back emf set point	0 to ARMATURE_VOLTAGE_MAX V DC	For 480V drive: 440 Eur, 500 USA For 575V drive: 630 Eur, 630 USA For 690V drive: 760 Eur, 760 USA	RW	Uni			US
21.09	Rated voltage	0 to ARMATURE_VOLTAGE_MAX V DC	For 480V drive: 440 Eur, 500 USA For 575V drive: 630 Eur, 630 USA For 690V drive: 760 Eur, 760 USA	RW	Uni			US
21.10	Armature resistance	0 to 6.0000Ω	0.0000	RW	Uni			US
21.11	Motor constant	0 to 100.0%	90.0	RW	Uni			US
21.12	Discontinuous current controller Ki gain	0 to 4000	200	RW	Uni			US
21.13	Continuous current controller Kp gain	0 to 4000	100	RW	Uni			US
21.14	Continuous current controller Ki gain	0 to 4000	50	RW	Uni			US
21.15	Motor 2 active	OFF (0) or On (1)		RO	Bit		NC	PT
21.16	Thermal time constant	0 to 3000.0	89.0	RW	Uni			US
21.17	Speed controller Kp gain	0.00 to 6.5535(1 / (rad/s))	0.0300	RW	Uni			US
21.18	Speed controller Ki gain	0.00 to 655.35(s / (rad/s))	0.10	RW	Uni			US
21.19	Speed controller Kd gain	0.00000 to 0.65535(1/s / (rad/s))	0.00000	RW	Uni			US
21.21	Speed feedback selector	0 to 5	5	RW	Txt			US
21.23	Rated field voltage	0 to 500 Vdc	Eur: 360, USA: 300	RW	Uni			US
21.24	Rated field current	0 to FIELD_CURRENT_SET_MAX	Size 1 - 2A. Size 2A&B - 3A. Size 2C&D - 5A	RW	Uni		NC	PT
21.25	Motor saturation breakpoint 1	0 to 100% of rated flux	50	RW	Uni			US
21.26	Motor saturation breakpoint 2	0 to 100% of rated flux	75	RW	Uni			US
21.27	Motoring current limit	0 to MOTOR2_CURRENT_LIMIT_MAX %	150.0*	RW	Uni		RA	US
21.28	Regen current limit	0 to MOTOR2_CURRENT_LIMIT_MAX %	150.0*	RW	Uni		RA	US
21.29	Symmetrical current limit	0 to MOTOR2_CURRENT_LIMIT_MAX %	150.0*	RW	Uni		RA	US
21.30	Field thermal time constant	0.0 to 3000.0	41.0	RW	Uni			US
21.31	Flux loop P gain	0 to 300.00	3.00	RW	Uni			US
21.32	Flux loop I gain	0 to 300.00	60.00	RW	Uni			US
21.33	Spill over P gain	0 to 300.00	0.40	RW	Uni			US
21.34	Spill over I gain	0 to 300.00	5.00	RW	Uni			US
21.35	Rated field compensation factor	0 to 100%	100%	RW	Uni		PT	US

\* These are the maximum default values. If the variable maximum of this parameter (MOTOR2\_CURRENT\_LIMIT\_MAX) gives a lower value with the default value of Motor rated current (Pr 21.07) the default of this parameter is at the lower value.

## 11.20 Menu 22: Additional Menu 0 set-up

Parameter		Range(⇅)	Default(⇒)		Type					
22.01 to 22.20	Parameter 00.xy setup	Pr 0.00 to 22.99	Pr 0.00		RW	Uni			PT	US

## 11.21 Menu 23: Header selections

Parameter		Range(⇅)	Default(⇒)		Type					
23.01	Sub block headers	0 to 7 (USEr, SET UP, diAGnoS, triPS, SP LOOP, Fb SP, SintEr and InPut)			RO	Uni		NC	PT	
23.02	Or of per defined sub block enables	0 to 127			RO	Uni		NC	PT	
23.03 to 23.09	Pre defined sub block enable	OFF (0) or On (1)	On (1)		RW	Bit				US

## 11.22 Advanced features

This section gives information on some of the advanced functions of the drive. For additional information see the *Advanced User Guide*.

Reference modes	Pr 1.14 (SE05, 0.26), Pr 1.15
S ramps	Pr 2.06 and Pr 2.07
Torque modes	Pr 4.08 and Pr 4.11
Current limit tapers	Pr 4.27, Pr 4.28, Pr 4.29, Pr 4.30, Pr 4.31, Pr 4.32
Start/stop logic modes	Pr 6.04 and Pr 6.40
Catch a spinning motor	Pr 6.09
Position modes	Pr 13.10

### 11.22.1 Reference modes

1.14 (SE05, 0.26)		Reference selector									
RW	Txt							NC		US	
↕	A1.A2 (0), A1.Pr (2), A2.Pr (2), Pr (3), PAd (4), Prc (5), Pad rEF (6)						⇒	A1.A2 (0)			

1.15		Preset reference selector									
RW	Uni							NC		US	
↕	0 to 9						⇒	0			

Table 11-5 Active reference

Pr 1.14 (SE05, 0.26)	Pr 1.15	Digital Input T28		Digital Input T29		Pr 1.49	Pr 1.50	Active Reference	
		State	Function	State	Function				
A1.A2 (0)	0 or 1	0	Local Remote		Jog forward**	1	1	Analog input 1	
		1				2	1	Analog input 2	
	2 to 8		No function			1 or 2	2 to 8	Preset reference 2 to 8	
	9 *	0	Local Remote			1	1	Analog input 1	
		1				2	1	Analog input 2	
						No function	1 or 2	2 to 8	Preset reference 2 to 8
A1.Pr (1)	0	0	Preset select bit 0	0	Preset select bit 1	1	1	Analog input 1	
		1		1			2	Preset reference 2	
		0					3	Preset reference 3	
		1					4	Preset reference 4	
	1		No function	No function			1	Analog input 1	
	2 to 8						2 to 8	Preset reference 2 to 8	
	9 *						1	Analog input 1	
							2 to 8	Preset reference 2 to 8	
A2.Pr (2)	0	0	Preset select bit 0	0	Preset select bit 1	2	1	Analog input 2	
		1		1			2	Preset reference 2	
		0					3	Preset reference 3	
		1					4	Preset reference 4	
	1		No function	No function			1	Analog input 2	
	2 to 8						2 to 8	Preset reference 2 to 8	
	9 *						1	Analog input 2	
							2 to 8	Preset reference 2 to 8	
Pr (3)	0	0	Preset select bit 0	0	Preset select bit 1	3	1	Preset reference 1	
		1		1			2	Preset reference 2	
		0					3	Preset reference 3	
		1					4	Preset reference 4	
	1 to 8		No function	No function			1 to 8	Preset reference 1 to 8	
	9 *						1 to 8	Preset reference 1 to 8	
PAd (4)			No function		No function	4		Keypad reference	
Prc (5)			No function		No function	5		Precision reference	
Pad rEF (6)			No function		Jog forward**	6		Keypad reference	

\* Setting Pr 1.15 to 9 enables the Preset reference scan timer. With the scan timer enabled analog 1 and preset references 2 to 8 are selected automatically in turn. Pr 1.16 defines the time between each change.

\*\* Jog forward can only be selected when the drive is in either the ready (rdy), inhibit (inh) or trip states.

#### Preset references

Preset references 1 to 8 are contained in Pr 1.21 to Pr 1.28.

#### Keypad reference

If Keypad reference is selected the drive sequencer is controlled directly by the keypad keys and the keypad reference parameter (Pr 1.17) is selected. The sequencing bits, Pr 6.30 to Pr 6.34, and Pr 6.37 have no effect and jog is disabled.

#### Precision reference

If Precision reference is selected the speed reference is given Pr 1.18 and Pr 1.19.

## 11.22.2 S ramps

2.06		S ramp enable											
RW	Bit											US	
↕	OFF (0) or On (1)						⇒	EUR: OFF (0), USA: On (1)					

Setting this parameter enables the S ramp function.

2.07		S ramp acceleration limit											
RW	Bit											US	
↕	0.000 to 100.000 s <sup>2</sup> /1,000rpm						⇒	3.600					

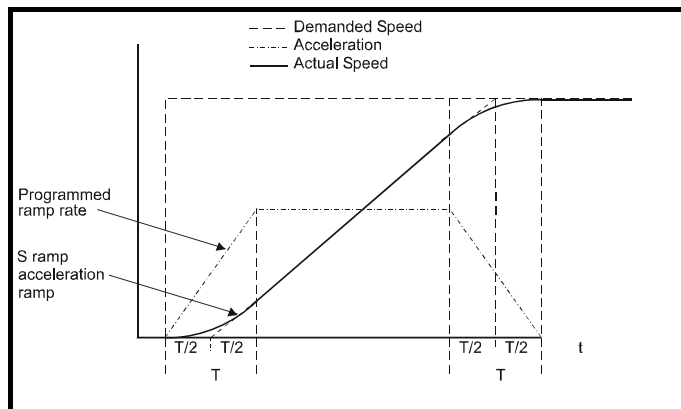
This parameter defines the maximum rate of change of acceleration/ deceleration. If the S ramp is disabled (Pr 2.06 = 0) a linear ramp is used and the time in seconds taken for the ramp output to change by speed ( $\Delta w^*$ ) is given by:

### Speed

$$T_{\text{Ramp}} = \Delta w^* \times A / \text{See Pr 2.39}$$

Where A is the selected ramp rate in s / See Pr 2.39

If the S ramp is enabled (Pr 2.06 = 1) then the ramp time is extended as shown in the diagram below.



The time taken in seconds for the ramp output to change by speed ( $\Delta w^*$ ) is given below. Two cases are given because the total ramp time must be calculated with a different equation depending on whether the acceleration is able to reach the selected ramp rate (A1) or not. If the required change is small the selected ramp rate is not reached and the ramp does not include the central linear region. If the required change is larger the ramp does include the central linear region as shown in the diagram above.

### Speed

$$\Delta w^*_{\text{linear}} = 1000 \times J / A1^2$$

where:

A = selected ramp rate

J = Pr 2.07

If the required change is less than  $\Delta w^*_{\text{linear}}$  then  $T_{\text{Ramp1}}$  should be used, but if the speed change is greater or equal to  $\Delta w^*_{\text{linear}}$   $T_{\text{Ramp2}}$  should be used.

$$T_{\text{Ramp1}} = 2 \sqrt{(\Delta w^* \times \text{Pr 2.07} / 1000)}$$

$$T_{\text{Ramp2}} = (\Delta w^* \times A / 1000) + (\text{Pr 2.07} / A)$$

The default values for the ramp rate and S ramp acceleration limit have been chosen such that for the default maximum speed, the curved parts of the S ramp are 25% of the original ramp if S ramp is enabled.

Therefore the ramp time is increased by a factor of 1.5.

## 11.22.3 Torque modes

4.08		Torque reference											
RW	Bi											US	
↕	±USER_CURRENT_MAX %						⇒	0.00					

4.11		Torque mode selector											
RW	Uni											US	
↕	0 to 4						⇒	0					

The value of this parameter refers to switches TM0 to TM3 on Menu 4 diagram.

When this parameter is set to 1, 2 or 3 the ramps are not active while the drive is in the run state. When the drive is taken out of the run state, but not disabled, the appropriate stopping mode is used. It is recommended that coast stopping or stopping without ramps are used. However, if ramp stop mode is used the ramp output is pre-loaded with the actual speed at the changeover point to avoid unwanted jumps in the speed reference.

### 0: Speed control mode

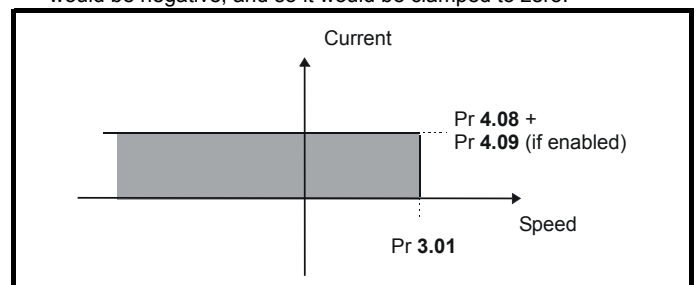
The torque demand is equal to the speed loop output.

### 1: Torque control

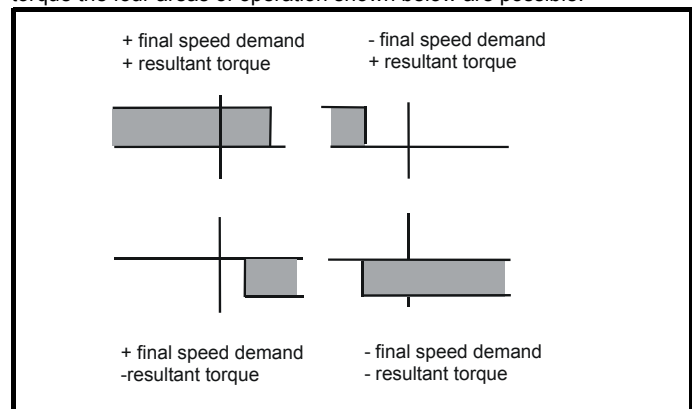
The torque demand is given by the sum of the torque reference and the torque offset, if enabled. The speed is not limited in any way, however, the drive will trip at the overspeed threshold if runaway occurs.

### 2: Torque control with speed override

The output of the speed loop defines the torque demand, but is limited between 0 and the resultant torque reference (Pr 4.08 + Pr 4.09 (if enabled)). The effect is to produce an operating area as shown below if the final speed demand and the resultant torque reference are both positive. The speed controller will try and accelerate the machine to the final speed demand level with a torque demand defined by the resultant torque reference. However, the speed cannot exceed the reference because the required torque would be negative, and so it would be clamped to zero.



Depending on the sign of the final speed demand and the resultant torque the four areas of operation shown below are possible.



This mode of operation can be used where torque control is required, but

the maximum speed must be limited by the drive.

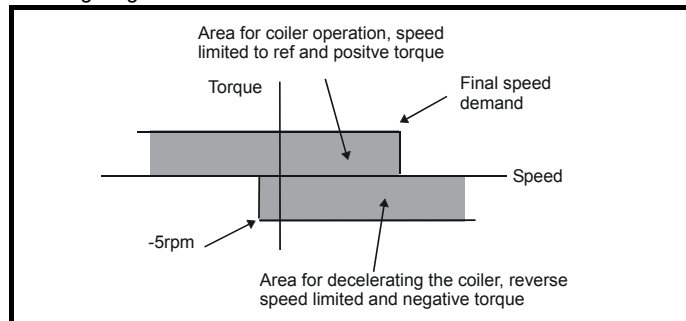
### 3: Coiler/uncoiler mode

**Positive final speed demand:** a positive resultant torque will give torque control with a positive speed limit defined by the final speed demand. A negative resultant torque will give torque control with a negative speed limit of -5rpm.

**Negative final speed demand:** a negative resultant torque will give torque control with a negative speed limit defined by the final speed demand. A positive resultant torque will give torque control with a positive speed limit of +5rpm.

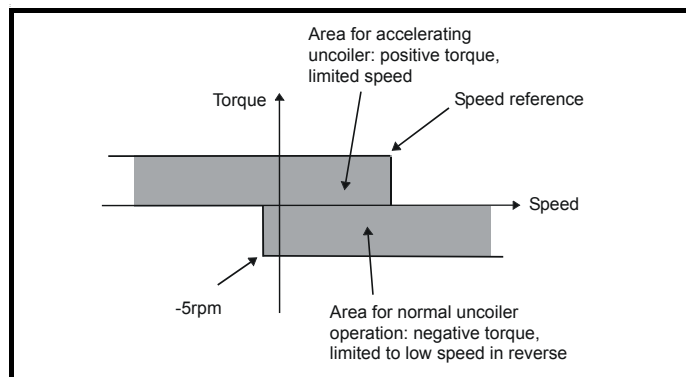
#### Example of coiler operation:

This is an example of a coiler operating in the positive direction. The final speed demand is set to a positive value just above the coiler reference speed. If the resultant torque demand is positive the coiler operates with a limited speed, so that if the material breaks the speed does not exceed a level just above the reference. It is also possible to decelerate the coiler with a negative resultant torque demand. The coiler will decelerate down to -5rpm until a stop is applied. The operating area is shown in the following diagram:



#### Example of uncoiler operation:

This is an example for an uncoiler operating in the positive direction. The final speed demand should be set to a level just above the maximum normal speed. When the resultant torque demand is negative the uncoiler will apply tension and try to rotate at 5rpm in reverse, and so take up any slack. The uncoiler can operate at any positive speed applying tension. If it is necessary to accelerate the uncoiler a positive resultant torque demand is used. The speed will be limited to the final speed demand. The operating area is the same as that for the coiler and is shown below:



### 4: Speed control with torque feed-forward

The drive operates under speed control, but a torque value may be added to the output of the speed controller. This can be used to improve the regulation of systems where the speed loop gains need to be low for stability.

## 11.22.4 Current limit tapers

With some motors the commutation limit of the motor requires that the maximum armature current be reduced at higher speeds, the current limit tapers can be used to provide this speed dependent current limit.

4.27		Current taper 1 threshold									
RW	Uni									US	
↕		0.0 to 10,000.0 rpm					⇒	10,000 rpm			

Sets a threshold value of speed feedback, beyond which Pr 4.31 changes to 1 to indicate that the threshold has been exceeded, and is the starting point for taper 2, if implemented. The current limit reduces, as a function of speed, to an end point defined by Pr 4.29.

The output of the taper block controls Pr 4.18.

If only 1 taper is used, it must be Taper 1. If both are used, Taper 1 must be first. Refer to Figure 11-19.

4.28		Current taper 2 threshold									
RW	Uni									US	
↕		0.0 to 10,000.0 rpm					⇒	10,000 rpm			

Sets a threshold value of speed feedback, beyond which Pr 4.32 changes to 1 to indicate that the threshold has been exceeded, and is the starting point for taper 2, if implemented. The current limit reduces, as a function of speed, to an end point defined by Pr 4.30.

The output of the taper block controls Pr 4.18.

If only one taper is used, it must be Taper 1. If both are used, Taper 1 must be first. Refer to Figure 11-19.

4.29		Current taper 1 end point									
RW	Uni									US	
↕		0 to 1000.0 %					⇒	1000.0 %			

Defines the current at the end of taper 1.

4.30		Current taper 2 end point									
RW	Uni									US	
↕		0 to 1000.0 %					⇒	1000.0 %			

Defines the current at the end of taper 2.

4.31		Taper threshold 1 exceeded									
RO	Bit										
↕		OFF (0) or On (1)					⇒				

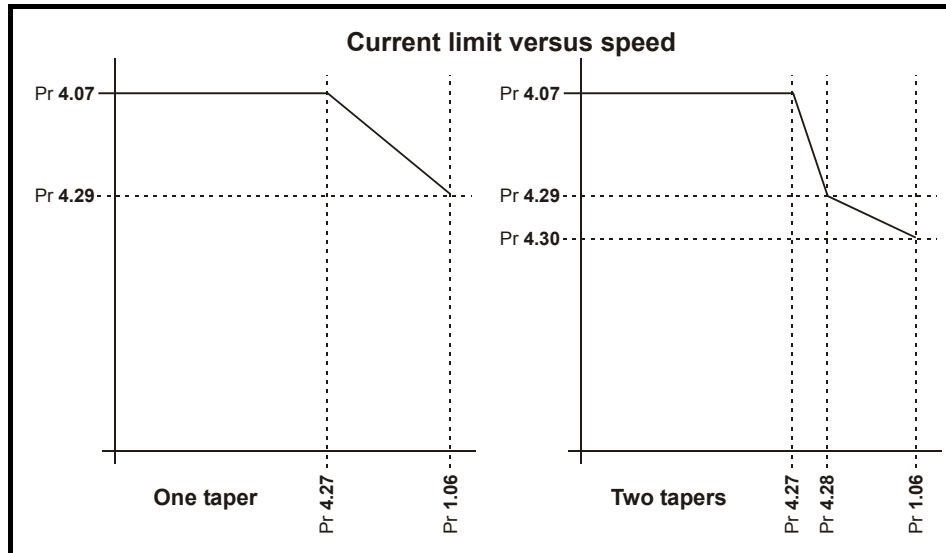
Indicates when speed feedback has exceeded threshold 1.

4.32		Taper threshold 2 exceeded									
RO	Bit										
↕		OFF (0) or On (1)					⇒				

Indicates when speed feedback has exceeded threshold 2.



**Figure 11-19 Current limit versus speed**



### 11.22.5 Start / stop logic modes

6.04		Start / stop logic select							
RW	Uni							US	
		0 to 4					0		

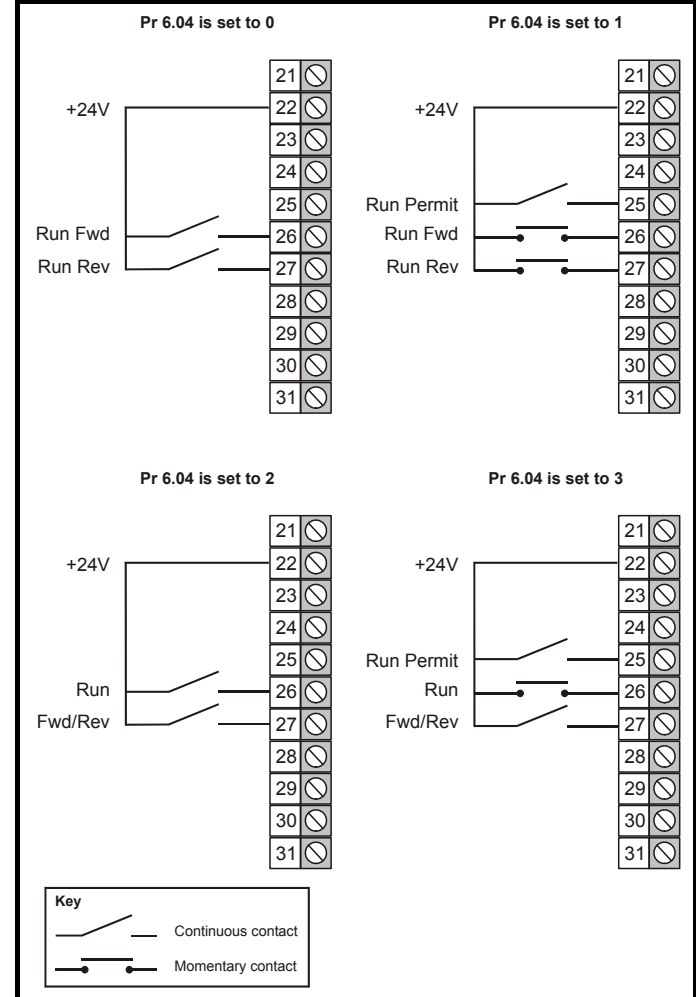
This parameter is provided to allow the user to select several predefined digital input routing macros to control the sequencer. When a value between 0 and 3 is selected the drive processor continuously updates the destination parameters for digital I/O T25, T26 and T27, and the enable sequencer latching bit (Pr 6.40). When a value of 4 is selected the destination parameters for these digital I/O and Pr 6.40 can be modified by the user.

If Pr 6.04 is changed then a drive reset is required before the function of T25, T26 or T27 will become active.

If Pr 6.04 has been set to a value of 0 to 3, then setting Pr 6.04 to 4 does not automatically reconfigure terminals T25, T26 and T27 to their default functions. To return terminals T25, T26 and T27 to their default functions, one of the following operations should be performed.

- Drive defaults should be restored. See section 5.9 *Restoring parameter defaults* on page 47 for details.
- Manually set Pr 6.04 to 4, Pr 6.40 to 0, Pr 8.22 to 10.33, Pr 8.23 to 6.30, and Pr 8.24 to 6.32.

**Figure 11-20 Digital input connections when Pr 6.04 is set to 0 to 3**



6.40		Enable sequencer latching										
RW	Bit											US
↕	OFF (0) or On (1)						⇒	OFF (0)				

This parameter enables sequencer latching. When sequencer latching is used, a digital input must be used as a run permit or not stop input. The digital input should write to Pr 6.39. The run permit or not stop input must be made active to allow the drive to run. Making the run permit or not stop input inactive resets the latch and stops the drive.

### 11.22.6 Catch a spinning motor

6.09		Catch a spinning motor										
RW	Uni											US
↕	0 to 1						⇒	1				

When the drive is enabled with this parameter at zero, the post ramp reference (Pr 2.01 (di03, 0.38)) starts at zero and ramps to the required reference. When the drive is enabled with this parameter at one, the post ramp reference is set to the motor speed.

### 11.22.7 Position modes

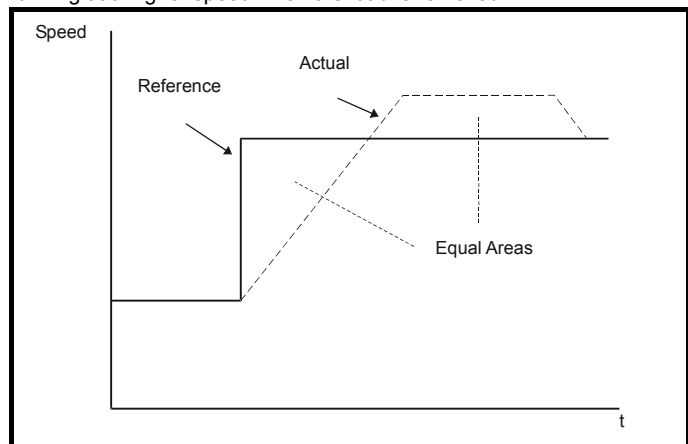
13.10		Position controller mode										
RW	Uni											US
↕	0 to 6						⇒	0				

This parameter is used to set the position controller mode as shown in the following table.

Parameter value	Mode	Feed forward active
0	Position controller disabled	
1	Rigid position control	√
2	Rigid position control	
3	Non-rigid position control	√
4	Non-rigid position control	
5	Orientation on stop	
6	Orientation on stop and when drive enabled	

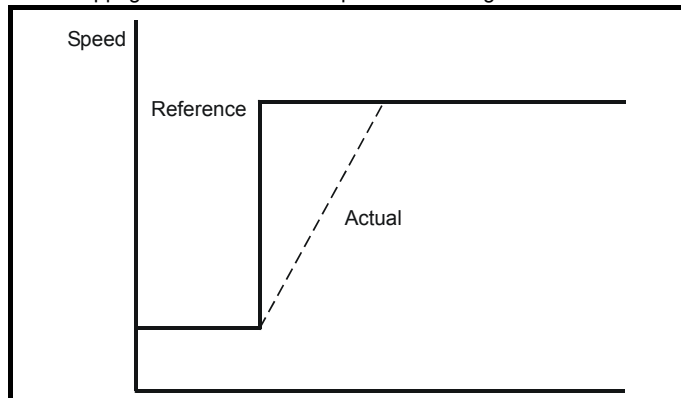
### Rigid position control

In rigid position control the position error is always accumulated. This means that, if for example, the slave shaft is slowed down due to excessive load, the target position will eventually be recovered by running at a higher speed when the load is removed.



### Non-rigid position control

In non-rigid position control the position loop is only active when the 'At Speed' condition is met (see Pr 3.06 in the *Advanced User Guide*). This allows slippage to occur while the speed error is high.



### Velocity feed forward

The position controller can generate a velocity feed forward value from the speed of the reference encoder. The feed-forward value is passed to menu 1, and so ramps may be included if required. Because the position controller only has a proportional gain, it is necessary to use velocity feed-forward to prevent a constant position error that would be proportional to the speed of the reference position.

If for any reason the user wishes to provide the velocity feed forward from a source other than the reference position, the feed forward system can be made inactive, i.e. Pr 13.10 = 2 or 4. The external feed forward can be provided via Menu 1 from any of the frequency/speed references. However, if the feed forward level is not correct a constant position error will exist.

### Relative jogging

If relative jogging is enabled the feedback position can be made to move relative to the reference position at the speed defined by Pr 13.17.

### Orientation

If Pr 13.10 is 5 the drive orientates the motor following a stop command. If hold zero speed is enabled (Pr 6.08 = 1) the drive remains in position control when orientation is complete and holds the orientation position. If hold zero speed is not enabled the drive is disabled when orientation is complete.

If Pr 13.10 is 6 the drive orientates the motor following a stop command and whenever the drive is enabled provided that hold zero speed is enabled (Pr 6.08 = 1). This ensures that the spindle is always held in the same position following the drive being enabled.

When orientating from a stop command the drive goes through the following sequence:

1. The motor is decelerated or accelerated to the speed limit programmed in Pr 13.12, using ramps if these are enabled, in the direction the motor was previously running.
2. When the ramp output reaches the speed set in Pr 13.12, ramps are disabled and the motor continues to rotate until the position is found to be close to the target position (i.e. within 1/32 of a revolution). At this point the speed demand is set to 0 and the position loop is closed.
3. When the position is within the window defined by Pr 13.14, the orientation complete indication is given in Pr 13.15.

The stop mode selected by Pr 6.01 has no effect if orientation is enabled.

## 12 Technical data

### 12.1 Drive technical data

#### 12.1.1 Power and current ratings

The power ratings for the 480V, 575V and 690V configurations are shown in Table 12-1, Table 12-2 and Table 12-3.

The continuous current ratings given are for a maximum ambient temperature of 40°C and an altitude of 1000m. For operation at higher temperatures and altitudes de-rating is required.

The maximum continuous output current rating of the drive should be 'de-rated' for operation at altitudes above 1000m. The de-rating is to be 1% de-rating of rated output current per 100m above 1000m to a maximum de-rating of 20% at 3000m.

**Table 12-1 480V current ratings**

Model	AC input current	DC output current		Typical motor power	
	Continuous A	Continuous A	Overload A	kW @ 400Vdc	hp @ 500Vdc
MP25A4(R)	22	25	37.5	9	15
MP45A4(R)	40	45	67.5	15	27
MP75A4(R)	67	75	112.5	27	45
MP105A4(R)	94	105	157.5	37.5	60
MP155A4(R)	139	155	232.5	56	90
MP210A4(R)	188	210	315	75	125
MP350A4(R)	313	350	525	125	200
MP420A4(R)	376	420	630	150	250
MP550A4(R)	492	550	825	200	300
MP700A4(R)	626	700	1050	250	400
MP825A4(R)	738	825	1237.5	300	500
MP900A4(R)	805	900	1350	340	550
MP1200A4(R)	1073	1200	1800	450	750
MP1850A4(R)	1655	1850	2775	700	1150

**Table 12-2 575V current ratings**

Model	AC input current	DC output current		Typical motor power (with Vdc = 630V)	
	Continuous A	Continuous A	Overload A	kW	hp
MP25A5(R)	22	25	37.5	14	18
MP45A5(R)	40	45	67.5	25	33
MP75A5(R)	67	75	112.5	42	56
MP105A5(R)	94	105	157.5	58	78
MP155A5(R)	139	155	232.5	88	115
MP210A5(R)	188	210	315	120	160

**Table 12-3 690V current ratings**

Model	AC input current	DC output current		Typical motor power (with Vdc = 760V)	
	Continuous A	Continuous A	Overload A	kW	hp
MP350A6(R)	313	350	525	240	320
MP420A6(R)	376	420	630	280	380
MP550A6(R)	492	550	825	375	500
MP700A6(R)	626	700	1050	480	640
MP825A6(R)	738	825	1237.5	560	750
MP900A6(R)	805	900	1350	650	850
MP1200A6(R)	1073	1200	1800	850	1150
MP1850A6(R)	1655	1850	2775	1300	1750

#### 12.1.2 Power dissipation

The table below shows the maximum drive losses, assuming high output current ripple content.

**Table 12-4 Drive losses**

Model	Loss @ 40°C W	Loss @ 50°C W	Loss @ 55°C W
MP25Ax(R)	125	TBC	TBC
MP45Ax(R)	168	119	-
MP75Ax(R)	218	195	183
MP105Ax(R)	280	TBC	TBC
MP155Ax(R)	407	TBC	TBC
MP210Ax(R)	567	TBC	TBC

TBC: To be confirmed

#### 12.1.3 AC Supply requirements

The standard drive is rated for a nominal supply voltage up to 480Vrms.

An optional rating of 575Vrms is available for drive sizes MP25Ax(R) to MP210Ax(R).

An optional rating of 690Vrms is available for drive sizes MP350Ax(R) and above.



Grounded delta supplies exceeding 575V (nominal) are not permitted.

#### 12.1.4 Supply types

Drives rated for supply voltage up to 575V are suitable for use with any supply type, i.e. TN-S, TN-C-S, TT, IT, with grounding at any potential, i.e. neutral, centre or corner ("grounded-delta").

#### 12.1.5 Thyristor bridge AC Supply

**Table 12-5 Three phase AC supply**

Specification	Product voltage variant		
	480V	575V	690V
Max nominal supply	480V	575V	690V
Tolerance	+10%		
Min nominal supply	24V	500V	
Tolerance	-20%	-10%	

## 12.1.6 Auxiliary AC supply

**Table 12-6 One phase line to line supply**

Specification	Value
Max nominal supply	480V
Tolerance	+10%
Min nominal supply	208V
Tolerance	-10%
Max supply AC rms.	528V
Min supply AC rms	187V

## 12.1.7 Line reactors

The Mentor MP, in common with all naturally commutated thyristor drives, causes voltage notches at the input supply terminals. In order to avoid disturbance to other equipment using the same supply, the addition of external line inductance is strongly recommended in order to restrict the depth of the notches imposed on the shared supply. This is generally not necessary where a dedicated transformer is used to supply the drive.

The following recommendations for added line inductance, have been calculated based on the power drive systems standard: EN61800-3:2004 "Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods".

**Table 12-7 Minimum values of  $L_{add}$  and inductor current rating - 400V & 575V supply**

Model	$L_{add}$ μH	Typical current rating A	Maximum current rating A
MP25Ax(R)	220	21	22
MP45Ax(R)	220	38	40
MP75Ax(R)	220	63	67
MP105Ax(R)	220	88	94
MP155Ax(R)	160	130	139
MP210Ax(R)	120	180	188
MP350A4(R)	71	290	313
MP420A4(R)	59	350	376
MP550A4(R)	45	460	492
MP700A4(R)	36	590	626
MP825A4(R)	30	690	738
MP900A4(R)	28	750	805
MP1200A4(R)	21	1000	1073
MP1850A4(R)	18	1600	1655

**Table 12-8 Minimum values of  $L_{add}$  and inductor current rating – 690V supply**

Model	$L_{add}$ μH	Typical current rating A	Maximum current rating A
MP350A6(R)	120	290	313
MP420A6(R)	100	350	376
MP550A6(R)	79	460	492
MP700A6(R)	62	590	626
MP825A6(R)	53	690	738
MP900A6(R)	48	750	805
MP1200A6(R)	36	1000	1073
MP1850A6(R)	32	1600	1655

## 12.1.8 Temperature, humidity and cooling method

Ambient temperature operating range:

0°C to 55°C (32°F to 131°F).

Output current derating must be applied at ambient temperatures >40°C (104°F).

Minimum temperature at power-up:

The drive will power up at -15°C (5°F)

Cooling method:

MP25Ax(R) and MP45Ax(R) = Natural convection.

MP75Ax(R) upwards = Forced cooling.

Maximum humidity:

The Mentor MP Product range can operate in environments up to 90% relative humidity at 50°C.

## 12.1.9 Storage

-40°C (-40°F) to +55°C (131°F) for long term storage, or to +70°C (158°F) for short term storage.

## 12.1.10 Altitude

Altitude range: 0 to 3,000m (9,900 ft), subject to the following conditions:

1,000m to 3,000m (3,300 ft to 9,900 ft) above sea level: de-rate the maximum output current from the specified figure by 1% per 100m (330 ft) above 1,000m (3,300 ft)

For example at 3,000m (9,900ft) the output current of the drive would have to be de-rated by 20%.

## 12.1.11 IP Rating

The Mentor MP is rated to IP20 pollution degree 2 (dry, non-conductive contamination only).

The IP rating of a product is a measure of protection against ingress and contact to foreign bodies and water. It is stated as IP XX, where the two digits (XX) indicate the degree of protection provided as shown in Table 12-9.

**Table 12-9 IP Rating degrees of protection**

First digit		Second digit	
Protection against contact and ingress of foreign bodies		Protection against ingress of water	
0	No protection	0	No protection
1	Protection against large foreign bodies $\phi > 50\text{mm}$ (large area contact with the hand)	1	Protection against vertically falling drops of water
2	Protection against medium size foreign bodies $\phi > 12\text{mm}$ (finger)	2	Protection against spraywater (up to $15^\circ$ from the vertical)
3	Protection against small foreign bodies $\phi > 2.5\text{mm}$ (tools, wires)	3	Protection against spraywater (up to $60^\circ$ from the vertical)
4	Protection against granular foreign bodies $\phi > 1\text{mm}$ (tools, wires)	4	Protection against splashwater (from all directions)
5	Protection against dust deposit, complete protection against accidental contact.	5	Protection against heavy splash water (from all directions, at high pressure)
6	Protection against dust ingress, complete protection against accidental contact.	6	Protection against deckwater (e.g. in heavy seas)
7	-	7	Protection against immersion
8	-	8	Protection against submersion

### 12.1.12 Corrosive gasses

Concentrations of corrosive gasses must not exceed the levels given in:

- Table A2 of EN 50178
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighbourhood of industrial sources with chemical emissions.

### 12.1.13 RoHS compliance

Mentor MP meets EU directive 2002-95-EC for RoHS compliance.

### 12.1.14 Vibration

Maximum recommended continuous vibration level 0.14 g r.m.s. broad-band 5 to 200 Hz.

#### NOTE

This is the limit for broad-band (random) vibration. Narrow-band vibration at this level which coincides with a structural resonance could result in premature failure.

### Bump Test

Testing in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-29: Test Eb:

Severity: 18g, 6ms, half sine

No. of Bumps: 600 (100 in each direction of each axis)

### Random Vibration Test

Testing in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-64: Test Fh:

Severity:  $1.0 \text{ m}^2/\text{s}^3$  ( $0.01 \text{ g}^2/\text{Hz}$ ) ASD from 5 to 20 Hz

-3 dB/octave from 20 to 200 Hz

Duration: 30 minutes in each of 3 mutually perpendicular axes.

### Sinusoidal Vibration Test

Testing in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-6: Test Fc:

Frequency range: 5 to 500 Hz

Severity: 3.5 mm peak displacement from 5 to 9 Hz

10  $\text{m/s}^2$  peak acceleration from 9 to 200 Hz

15  $\text{m/s}^2$  peak acceleration from 200 to 500 Hz

Sweep rate: 1 octave/minute

Duration: 15 minutes in each of 3 mutually perpendicular axes.

EN 613800-5-1:2007, Section 5.2.6.4. referring to IEC 60068-2-6

Frequency range: 10-150Hz

Amplitude: 10-57Hz @ 0.075mm pk

57-150Hz @ 1g pk

Sweep rate: 1 octave/minute

Duration: 10 sweep cycles per axes in each of 3 mutually perpendicular axes

### Shock Test

BS EN 60068-2-27, Test Ea

Pulse shape: half-sine

Severity: 15g pk acceleration, 11ms pulse duration

No of shocks: 3 in each direction of 3 mutually perpendicular axes (total of 18)

### 12.1.15 Start up time

This is the time taken from the moment of applying power to the drive, to the drive being ready to run a motor:

All sizes: 2s

### 12.1.16 Output speed range

Speed range: 0 to 10,000rpm

### 12.1.17 Accuracy

Estimated speed mode accuracy: Typically 5 to 10%.

Other modes are dependent on feedback device used.

### 12.1.18 Acoustic noise

The heatsink fan generates the majority of the acoustic noise produced by the drive. The heatsink fan on the Mentor MP is a single speed fan.

Table 12-10 gives the acoustic noise produced by the drive.

**Table 12-10 Acoustic noise data**

Model	SPL at 1m (dBA)
MP25Ax(R)	No fans installed
MP45Ax(R)	
MP75Ax(R)	43
MP105 - 210Ax(R)	56

### 12.1.19 Overall dimensions

Refer to section 3.4 *Mounting method* on page 17.

### 12.1.20 Weights

**Table 12-11 Overall drive weights**

Model	kg	lb
MP25 to 45Ax	10	22
MP25 to 45AxR	10.2	22.5
MP75Ax	10.1	22.3
MP75AxR	10.5	23.1
MP105 to 210Ax	12.6	27.8
MP105 to 210AxR	13.0	28.7

## 12.2 Cable and fuse size ratings



The selection of the correct fuse is essential to ensure the safety of the installation

Maximum continuous input currents are given in section 2.1 *Ratings* on page 6 to aid the selection of fuses and cabling. The maximum input current is dependent on the ripple content of the output current. A value of 100% ripple has been assumed for the given ratings.

The cable sizing selected when installing a Mentor MP must comply with the local wiring regulations. The information provided in this section is provided for guidance purposes only.

Safety Information	Product information	Mechanical Installation	Electrical installation	Getting started	Basic parameters	Running the motor	Optimization	SMARTCARD operation	Onboard PLC	Advanced parameters	Technical data	Diagnostics	UL information
--------------------	---------------------	-------------------------	-------------------------	-----------------	------------------	-------------------	--------------	---------------------	-------------	---------------------	----------------	-------------	----------------

The power terminals on the Mentor MP have been designed to accommodate a maximum cable size of 150mm<sup>2</sup> (350kcmil) with a temperature rating of 90°C (194°F).

The actual cable size depends on a number of factors including:

- Actual maximum continuous current
- Ambient temperature
- Cable support, method and grouping
- Cable voltage drop

In applications where the motor used is of a reduced rating, the cable sizing selected can be appropriate for that motor. To protect the motor and the output cabling the drive must be programmed with the correct motor rated current.

#### NOTE

When using reduced cable sizes, the branch circuit protection fuse rating needs to be reduced in line with the cable size selected.

The following table shows typical cable sizes based on USA and International standards, assuming 3 conductors per raceway/conduit, an ambient temperature of 40°C (104°F) and applications with high output current ripple content.

**Table 12-12 Typical cable sizes**

Model		IEC 60364-5-52 <sup>[1]</sup>		UL508C/NEC <sup>[2]</sup>	
		Input	Output	Input	Output
MP25A4(R)	MP25A5(R)	2.5mm <sup>2</sup>	4mm <sup>2</sup>	8 AWG	8 AWG
MP45A4(R)	MP45A5(R)	10mm <sup>2</sup>	10mm <sup>2</sup>	4 AWG	4 AWG
MP75A4(R)	MP75A5(R)	16mm <sup>2</sup>	25mm <sup>2</sup>	1 AWG	1/0 AWG
MP105A4(R)	MP105A5(R)	25mm <sup>2</sup>	35mm <sup>2</sup>	1/0 AWG	1/0 AWG
MP155A4(R)	MP155A5(R)	50mm <sup>2</sup>	70mm <sup>2</sup>	3/0 AWG	4/0 AWG
MP210A4(R)	MP210A5(R)	95mm <sup>2</sup>	95mm <sup>2</sup>	300kcmil	350kcmil

#### NOTE

1. The maximum cable size is defined by the power terminal housing using 90°C (194°F) rated cables as per Table A.52-5 of the standard.
2. Assumes the use of 75°C rated cables, as per Table 310.16 of the National Electrical Code.

The use of higher temperature rated cable would allow a reduction on the minimum recommended cable size for Mentor MP shown above. For high temperature cable sizing, please contact the supplier of the drive.

## 12.2.1 Ferraz Shawmut fuses

Ferraz Shawmut fuses are recommended for the Mentor MP.

**Table 12-13 Ferraz Shawmut semiconductor fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
Auxiliary	10x38mm ferrule	690Vac	12.5A	FR10GB69V12.5	H330011
MP25Ax	22x58mm ferrule	690Vac	32A	FR22GC69V32	A220915
MP45Ax			63A	FR22GC69V63	X220912
MP75Ax			100A	FR22GC69V100	W220911
MP25AxR			32A	FR22GC69V32	A220915
MP45AxR			63A	FR22GC69V63	X220912
MP75AxR			100A	FR22GC69V100	W220911
MP105Ax			Size 30 square body fuse	690Vac	160A
MP155Ax	200A	PC30UD69V200EF			N300093
MP210Ax	315A	PC30UD69V315EF			Q300095
MP105AxR	Size 70 square body fuse	1250Vac	160A	PC70UD13C160EF	T300604
MP155AxR			200A	PC70UD13C200EF	V300605
MP210AxR			280A	PC70UD12C280EF	L300712

**Table 12-14 Ferraz Shawmut branch circuit protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	gG Catalogue number	Ref number	UL Class J alternative
Auxiliary	21x57mm cylindrical	600Vac	10A			AJT10
MP25Ax	22x58mm ferrule	690Vac	25A	FR22GG69V25	N212072	AJT30
MP45Ax			50A	FR22GG69V50	P214626	AJT45
MP75Ax			80A	FR22GG69V80	Q217180	AJT70
MP25AxR			25A	FR22GG69V25	N212072	AJT30
MP45AxR			50A	FR22GG69V50	P214626	AJT45
MP75AxR			80A	FR22GG69V80	Q217180	AJT70
MP105Ax	NH 00 knife blade		100A	NH00GG69V100	B228460	AJT125
MP155Ax	NH 1 knife blade		160A	NH1GG69V160	F228487	AJT175
MP210Ax	NH 1 knife blade		200A	NH1GG69V200	G228488	AJT225
MP105AxR	NH 00 knife blade		100A	NH00GG69V100	B228460	AJT125
MP155AxR	NH 1 knife blade		160A	NH1GG69V160	F228487	AJT175
MP210AxR	NH 1 knife blade		200A	NH1GG69V200	G228488	AJT225

**Table 12-15 Ferraz Shawmut DC protection fusing for 480V and 575V Size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number	Configuration
MP25AxR	20x127mm cylindrical	1000Vdc	32A	FD20GB100V32T	F089498	single fuse
MP45AxR	36x127mm cylindrical		80A	FD36GC100V80T	A083651	
MP75AxR	20x127mm cylindrical		63A	FD20GC100V63T	F083656	2 in parallel
MP105AxR	Size 120 square body	750Vdc	160A	D120GC75V160TF	R085253	single fuse
MP155AxR	Size 121 square body		250A	D121GC75V250TF	Q085252	
MP210AxR	Size 122 square body		315A	D122GC75V315TF	M085249	

**Table 12-16 Ferraz Shawmut German DIN80 blade style semiconductor fuses for 480V and 575V drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
MP105Ax	Size 30 square body	690Vac	160A	PC30UD69V160A	J300112
MP155Ax			200A	PC30UD69V200A	K300113
MP210Ax			315A	PC30UD69V315A	M300115

**Table 12-17 Ferraz Shawmut German DIN110 blade style semiconductor fuses for 480V and 575V drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
MP105Ax	Size 30 square body	690Vac	160A	PC30UD69V160D1A	V300122
MP155Ax			200A	PC30UD69V200D1A	W300123
MP210Ax			315A	PC30UD69V315D1A	Y300125
MP105AxR	Size 70 square body	1250Vac	160A	PC70UD13C160D1A	Z300540
MP155AxR			200A	PC70UD13C200D1A	A300541
MP210AxR			280A	PC70UD12C280D1A	J300710

**Table 12-18 Ferraz Shawmut American blade semiconductor fuses for 480V and 575V drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
MP105Ax	Size 30 square body	690Vac	160A	A070UD30LI160	R300142
MP155Ax			200A	A070UD30LI200	S300143
MP210Ax			315A	A070UD30LI315	V300145
MP105AxR	Size 70 square body	1250Vac	160A	A130UD70LI160	A300656
MP155AxR			200A	A130UD70LI200	B300657
MP210AxR			280A	A130UD70LI315	Q300716

**Table 12-19 Ferraz Shawmut French flat end style semiconductor fuses for 480V and 575V drives**

Model	Fuse type	Rating V	Rating A	Catalogue number	Ref number
MP105Ax	Size 30 square body	690Vac	160A	PC30UD69V125TF	V300053
MP155Ax			200A	PC30UD69V200TF	X300055
MP210Ax			315A	PC30UD69V250TF	Y300056
MP105AxR	Size 70 square body	1250Vac	160A	PC70UD13C160TF	R300487
MP155AxR			200A	PC70UD13C200TF	S300488
MP210AxR			280A	PC70UD12C280TF	N300714

## 12.2.2 Alternative fusing

Cooper Bussmann or Siba fuses are an acceptable alternative.

**Table 12-20 Cooper Bussmann semiconductor fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number
Auxiliary	10.3x38mm ferrule	600Vac	12A	FWC-12A10F
MP25Ax	ET Type BS88 fuse	690Vac	40A	40ET
MP45Ax	FE Type BS88 fuse		80A	80FE
MP75Ax	EET Type BS88 fuse		140A	140EET
MP25AxR	ET Type BS88 fuse		40A	40ET
MP45AxR	FE Type BS88 fuse		80A	80FE
MP75AxR	EET Type BS88 fuse		140A	140EET
MP105Ax	FEE Type BS88 fuse		160A	160FEE
MP155Ax	FM Type BS88 fuse		250A	250FM
MP210Ax	FMM Type BS88 fuse		400A	400FMM
MP105AxR	FEE Type BS88 fuse		160A	160FEE
MP155AxR	FM Type BS88 fuse		250A	250FM
MP210AxR	FMM Type BS88 fuse		400A	400FMM

**Table 12-21 Cooper Bussmann branch circuit protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number
Auxiliary	10.3x38mm ferrule	600Vac	12A	LP-CC-12
MP25Ax	26.9x60.5mm ferrule		30A	LPJ-30SP
MP45Ax	26.9x60.5mm ferrule		60A	LPJ-60SP
MP75Ax	Cylindrical bolt-in type fuse		80A	LPJ-80SP
MP25AxR	26.9x60.5mm ferrule		30A	LPJ-30SP
MP45AxR	26.9x60.5mm ferrule		60A	LPJ-60SP
MP75AxR	Cylindrical bolt-in type fuse		80A	LPJ-80SP
MP105Ax			110A	LPJ-110SP
MP155Ax			175A	LPJ-175SP
MP210Ax			225A	LPJ-225SP
MP105AxR			110A	LPJ-110SP
MP155AxR			175A	LPJ-175SP
MP210AxR			225A	LPJ-225SP

**Table 12-22 Cooper Bussmann DC protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Catalogue number
MP25AxR	Size 1* square body DIN 43 653 fuse	1250Vdc	50A	170M3138
MP45AxR			80A	170M3140
MP75AxR			125A	170M3142
MP105Ax			160A	170M3143
MP155Ax			250A	170M3145
MP210Ax	Size 3 square body DIN 43 653 fuse		350A	170M6139



**Table 12-23 Siba semiconductor fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Description	Part number (with indicator)	Part number (without indicator)
Auxiliary	10x38mm ferrule	660Vac	12A	10x38 cylindrical 660Vac URZ	50 179 06.12	
MP25Ax	22x58mm ferrule	690Vac	32A	22x58 cylindrical 690Vac URZ	50 140 06.32	
MP45Ax			63A		50 140 06.63	
MP75Ax			100A		50 140 06.100	
MP25AxR			32A		50 140 06.32	
MP45AxR			63A		50 140 06.63	
MP75AxR			100A		50 140 06.100	
MP105Ax			Size 000 square body		160A	URB 000 690Vac 160A bolt-type
MP155Ax	200A			URB 000 690Vac 200A bolt-type	20 282 20.200	20 282 21.200
MP210Ax	315A			URB 000 690Vac 315A bolt-type	20 282 20.315	20 282 21.315
MP105AxR	160A			URB 000 690Vac 160A bolt-type	20 282 20.160	20 282 21.160
MP155AxR	200A			URB 000 690Vac 200A bolt-type	20 282 20.200	20 282 21.200
MP210AxR	315A			URB 000 690Vac 315A bolt-type	20 282 20.315	20 282 21.315

**Table 12-24 Siba branch circuit protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Description	Siba part number
Auxiliary	NH 000 knife blade	690Vac	10A	NH 000 gG 690Vac 10A	20 477 13.10
MP25Ax			35A	NH 000 gG 690Vac 35A	20 477 13.35
MP45Ax	NH 00 knife blade		63A	NH 00 gG 690Vac 63A	20 209 13.63
MP75Ax			100A	NH 00 gG 690Vac 100A	20 209 13.100
MP25AxR	NH 000 knife blade		35A	NH 000 gG 690Vac 35A	20 477 13.35
MP45AxR	NH 00 knife blade		63A	NH 00 gG 690Vac 63A	20 209 13.63
MP75AxR			100A	NH 00 gG 690Vac 100A	20 209 13.100
MP105Ax	NH 1 knife blade		160A	NH1 gG 690Vac 160A	20 211 13.160
MP155Ax			200A	NH1 gG 690Vac 200A	20 211 13.200
MP210Ax	NH 2 knife blade		315A	NH2 gG 690Vac 315A	20 212 13.315
MP105AxR	NH 1 knife blade		160A	NH1 gG 690Vac 160A	20 211 13.160
MP155AxR			200A	NH1 gG 690Vac 200A	20 211 13.200
MP210AxR	NH 2 knife blade		315A	NH2 gG 690Vac 315A	20 212 13.315

**Table 12-25 Siba DC protection fusing for 480V and 575V size 1 drives**

Model	Fuse type	Rating V	Rating A	Description	Ref number	Configuration
MP25AxR	20x127mm cylindrical	1000Vdc	32A	20x127 1000Vdc 32A gR	90 080 10.32	single fuse
MP45AxR			50A	20x127 1000Vdc 50A gR	90 080 10.50	single fuse
MP75AxR	36x190mm cylindrical	1500Vdc	80A	36x190 1500Vdc 80A gR	90 094 10.80	single fuse
MP105AxR	SQB-DC2 square body	900Vdc	125A	SQB-DC2 1200V 125A	90 203 25.125	single fuse
MP155AxR			160A	SQB-DC2 1200V 160A	90 203 25.160	single fuse
MP210AxR			250A	SQB-DC2 1200V 250A	90 203 25.250	single fuse

**Table 12-26 Mentor MP frame 1 drive thyristor  $I^2t$  rating for semiconductor fusing**

Model	Thyristor $I^2t$ (A <sup>2</sup> s)
Auxiliary	400
MP25Ax	1030
MP45Ax	3600
MP75Ax	15000
MP25AxR	1030
MP45AxR	3600
MP75AxR	15000
MP105Ax	80000
MP155Ax	
MP210Ax	
MP105AxR	
MP155AxR	
MP210AxR	

### 12.2.3 Torque settings

**Table 12-27 Drive control, status relay and encoder terminal data**

Model	Connection type	Torque setting
All	Plug-in terminal block	0.5 Nm 0.4 lb ft

**Table 12-28 Drive auxiliary and machine armature terminal data**

Model	Connection type	Torque setting
All	Terminal block	0.5 Nm 0.4 lb ft

**Table 12-29 Drive power stage terminals**

Model	Connection type	Torque setting
All	M8 stud	10 Nm 7.4 lb ft

### 12.2.4 Electromagnetic compatibility (EMC)

This is a summary of the EMC performance of the drive. For full details, refer to the Mentor MP EMC data sheet which can be obtained from the supplier of the drive.

**Table 12-30 Immunity compliance**

Standard	Type of immunity	Test specification	Application	Level
IEC61000-4-2 EN61000-4-2	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
IEC61000-4-3 EN61000-4-3	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation	Module enclosure	Level 3 (industrial)
IEC61000-4-4 EN61000-4-4	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
IEC61000-4-5 EN61000-4-5	Surges	Common mode 4kV 1.2/50µs waveshape	AC supply lines: line to ground	Level 4
		Differential mode 2kV 1.2/50µs waveshape	AC supply lines: line to line	Level 3
		Lines to ground	Signal ports to ground <sup>1</sup>	Level 2
IEC61000-4-6 EN61000-4-6	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
IEC61000-4-11 EN61000-4-11	Voltage dips and interruptions	-30% 10ms +60% 100ms -60% 1s <-95% 5s	AC power ports	
EN50082-1 IEC61000-6-1 EN61000-6-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN50082-2 IEC61000-6-2 EN61000-6-2	Generic immunity standard for the industrial environment			Complies
EN61800-3 IEC61800-3 EN61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environments	

<sup>1</sup> See section 4.9.5 *Surge immunity of control circuits - long cables and connections outside a building* on page 34 for control ports for possible requirements regarding grounding and external surge protection.

### Emission

The requirements of the following standards are met for motor cable lengths up to 100m.

**Table 12-31 Size 1 emission compliance**

Model	Filter		
	None	Field: Standard armature: standard	Field: Standard armature: High performance
MP25A4(R)	C4	C3	C2
MP45A4(R)			
MP75A4(R)			
MP105A4(R)			
MP155A4(R)			
MP210A4(R)			

**Key** (shown in decreasing order of permitted emission level):

- C4 EN 61800-3 second environment, restricted distribution  
(Additional measures may be required to prevent interference)
- C3 EN 61800-3 second environment, unrestricted distribution
- C2 Industrial generic standard EN 50081-2 (EN 61000-6-4)  
EN 61800-3 first environment restricted distribution (The following caution is required by EN 61800-3)



This is a product of the restricted distribution class according to IEC 61800-3. In a residential environment this product may cause radio interference in which case the user may be required to take adequate measures.

- C1 Residential generic standard EN 50081-1 (EN 61000-6-3)  
EN 61800-3 first environment unrestricted distribution

EN 61800-3 defines the following:

- The first environment is one that includes residential premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes.
- The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes.
- Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

## 12.3 Optional external EMC filters

EMC filters can be sourced directly from Schaffner and Epcos. See Table 12-32 for details.

**Table 12-32 Mentor MP and EMC filter cross reference**

Model	Manufacturers part number				
	Schaffner armature standard	Schaffner armature high performance	Epcos armature high performance	Schaffner standard field filter	Epcos standard field filter
MP25A4(R)	FN3270H-80-35	FN3258-75-52	B84143-A66-R105	FN3280H-8-29	W62400-T1262
MP45A4(R)			*B84143-A90-R105		
MP75A4(R)					
MP105A4(R)	FN3270H-200-99	FN3258H-180-40	B84143BO250S080		
MP155A4(R)					
MP210A4(R)					

\* This filter is required if the input current to the Mentor MP will be greater than 66Amps.

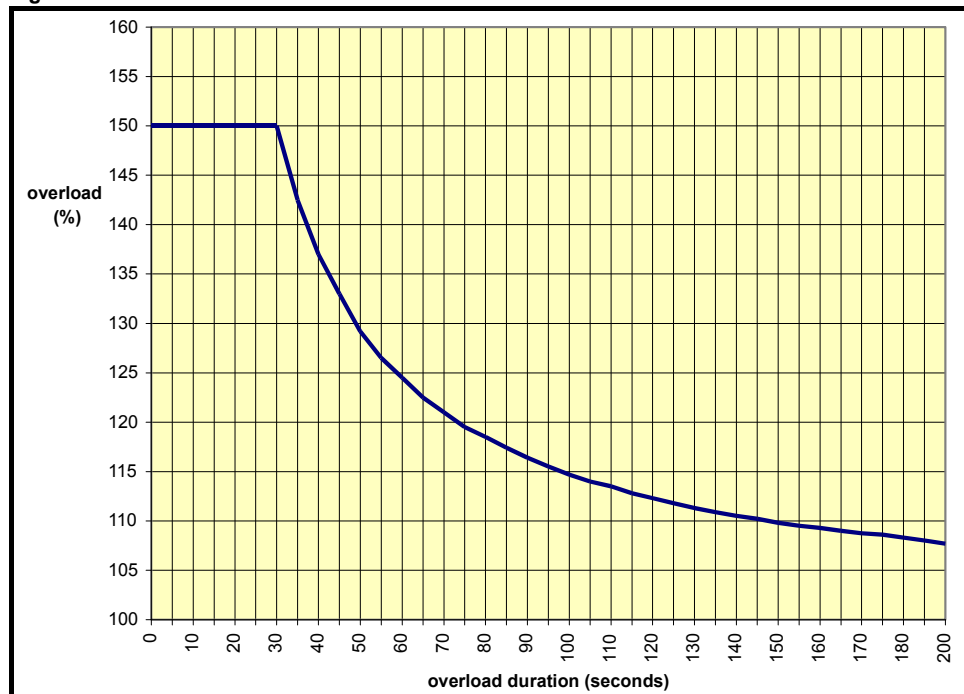
### 12.3.1 Typical short-term overload limits

The maximum percentage overload limit changes depending on the selected motor

Variations in motor rated current will result in changes in the maximum possible overload as detailed in the *Advanced User Guide*.

Figure 12-1 can be used to determine the maximum overload duration available for overloads between 100% and 150%. For example the maximum overload available for a period of 60 seconds is 124%.

**Figure 12-1 Maximum overload duration available**



**NOTE**

Overload of 150% for 30s is available with ambient temperature of 40° C up to a maximum of 10 repetitions per hour.

## 13 Diagnostics

The display on the drive gives various information about the status of the drive. These fall into three categories:

- Trip indications
- Alarm indications
- Status indications



Users must not attempt to repair a drive if it is faulty, nor carry out fault diagnosis other than through the use of the diagnostic features described in this chapter.

If a drive is faulty, it must be returned to an authorized Control Techniques distributor for repair.

### 13.1 Trip indications

If the drive trips, the output of the drive is disabled so that the drive stops controlling the motor. The upper display indicates that a trip has occurred and the lower display shows the trip.

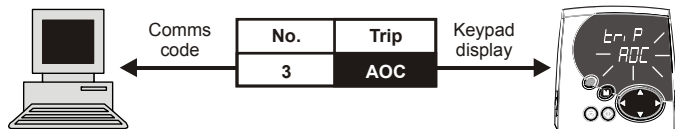
Trips are listed alphabetically in Table 13-1 based on the trip indication shown on the drive display. Refer to Figure 13-1.

If a display is not used, the drive LED Status indicator will flash if the drive has tripped. Refer to Figure 13-2.

The trip indication can be read in Pr 10.20 providing a trip number. Trip numbers are listed in numerical order in Table 13-2 so the trip indication can be cross referenced and then diagnosed using Table 13-1.

#### Example

1. Trip code 3 is read from Pr 10.20 via serial communications.
2. Checking Table 13-2 shows Trip 3 is an AOC trip.



3. Look up AOC in Table 13-1.
4. Perform checks detailed under *Diagnosis*.

### 13.2 Trip indications

Table 13-1 Trip indications

Trip	Diagnosis
<b>AOC</b>	<b>Instantaneous output over current detected: Peak current greater than 225%</b>
<b>3</b>	Check for short circuit on armature cabling Check integrity of motor insulation Check current loop stability
<b>AOP</b>	<b>Voltage has been applied to the armature but no current feedback has been detected</b>
<b>158</b>	Check the armature circuit
<b>C.Acc</b>	<b>SMARTCARD trip: SMARTCARD Read / Write fail</b>
<b>185</b>	Check SMARTCARD is installed / located correctly Ensure SMARTCARD is not writing data to data location 500 to 999 Replace SMARTCARD
<b>C.boot</b>	<b>SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD</b>
<b>177</b>	A write to a menu 0 parameter has been initiated via the keypad with Pr 11.42 (SE09, 0.30) set to auto(3) or boot(4), but the necessary file on the SMARTCARD has not been created Ensure that Pr 11.42 (SE09, 0.30) is correctly set and reset the drive to create the necessary file on the SMARTCARD Re-attempt the parameter write to the menu 0 parameter
<b>C.bUSY</b>	<b>SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module</b>
<b>178</b>	Wait for the Solutions Module to finish accessing the SMARTCARD and then re-attempt the required function
<b>C.Chg</b>	<b>SMARTCARD trip: Data location already contains data</b>
<b>179</b>	Erase data in data location Write data to an alternative data location

Figure 13-1 Keypad status modes

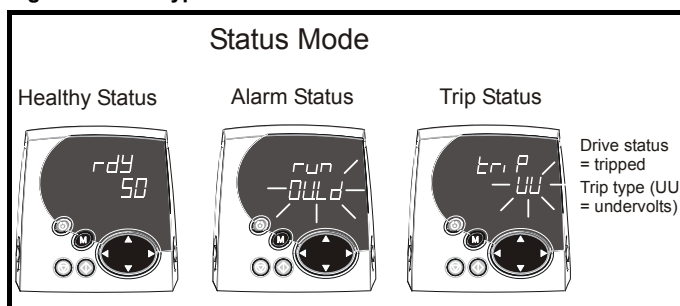
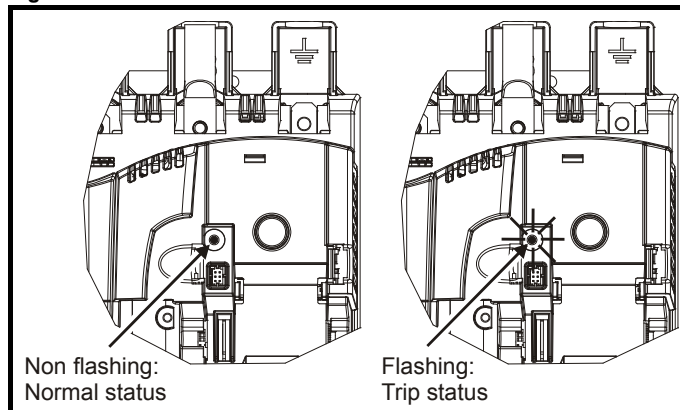




Figure 13-2 Location of the status LED



Trip	Diagnosis
<b>C.cPr</b>	<b>SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different</b>
188	Press the red  reset button
<b>C.dAt</b>	<b>SMARTCARD trip: Data location specified does not contain any data</b>
183	Ensure data block number is correct
<b>C.Err</b>	<b>SMARTCARD trip: SMARTCARD data is corrupted</b>
182	Ensure the card is located correctly Erase data and retry Replace SMARTCARD
<b>C.Full</b>	<b>SMARTCARD trip: SMARTCARD full</b>
184	Delete a data block or use different SMARTCARD
<b>cL2</b>	<b>Analog input 2 current loss (current mode)</b>
28	Check analog input 2 (terminal 7) current signal is present (4-20mA, 20-4mA)
<b>cL3</b>	<b>Analog input 3 current loss (current mode)</b>
29	Check analog input 3 (terminal 8) current signal is present (4-20mA, 20-4mA)
<b>CL.bit</b>	<b>Trip initiated from the control word (Pr 6.42)</b>
35	Disable the control word by setting Pr 6.43 to 0 or check setting of Pr 6.42
<b>C.OPtn</b>	<b>SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive</b>
180	Ensure correct Solutions Modules are installed Ensure Solutions Modules are in the same Solutions Module slot Press the red  reset button
<b>C.Prod</b>	<b>SMARTCARD trip: The data blocks on the SMARTCARD are not compatible with this product</b>
175	Erase all data on the SMARTCARD by setting Pr xx.00 to 9999 and pressing the red  reset button Replace SMARTCARD
<b>C.rdo</b>	<b>SMARTCARD trip: SMARTCARD has the Read Only bit set</b>
181	Enter 9777 in Pr xx.00 to allow SMARTCARD Read / Write access Ensure the drive is not writing to data locations 500 to 999 on the card
<b>C.rtg</b>	<b>SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different</b>
186	Parameter data or default difference data is being transferred from a SMART card to the drive, but the current and /or voltage ratings 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>C.TyP</b>	<b>SMARTCARD trip: SMARTCARD parameter set not compatible with drive</b>
187	Press the reset button Ensure destination drive type is the same as the source parameter file drive type
<b>dESt</b>	<b>Two or more parameters are writing to the same destination parameter</b>
199	Set Pr xx.00 = 2001 check all visible parameters in the menus for duplication
<b>EEF</b>	<b>EEPROM data corrupted - Drive mode becomes open loop and serial comms will timeout with remote keypad on the drive RS485 comms port.</b>
31	This trip can only be cleared by loading default parameters and saving parameters
<b>EnC1</b>	<b>Drive encoder trip: Encoder power supply overload</b>
189	Check encoder power supply wiring and encoder current requirement Maximum current = 200mA @ 15V, or 300mA @ 8V and 5V
<b>EnC2</b>	<b>Drive encoder trip: Wire break</b>
190	Check cable continuity Check wiring of feedback signals is correct Check encoder power supply is set correctly in Pr 3.36 (Fb06, 0.76) Replace feedback device If wire break detection on the main drive encoder input is not required, set Pr 3.40 = 0 to disable the Enc2 trip
<b>EnC3</b>	<b>Drive encoder trip: Overload</b>
191	Overload

Trip	Diagnosis
<b>EnC9</b>	<b>Drive encoder trip: Position feedback selected is selected from a Solutions Module slot which does not have a speed / position feedback Solutions Module installed</b>
<b>197</b>	Check setting of Pr <b>3.26 (Fb01, 0.71)</b> (or Pr <b>21.21</b> if the second motor parameters have been enabled)
<b>EnC10</b>	<b>Drive encoder trip: Termination overload</b>
<b>198</b>	If the voltage from the encoder is >5V, then the termination resistors must be disabled (Pr <b>3.39</b> to 0)
<b>Et</b>	<b>External trip</b>
<b>6</b>	Check terminal 31 signal Check value of Pr <b>10.32</b> Enter 12001 in Pr <b>xx.00</b> and check for parameter controlling Pr <b>10.32</b> Ensure Pr <b>10.32</b> or Pr <b>10.38 (=6)</b> are not being controlled by serial comms
<b>FbL</b>	<b>No feedback from the tachogenerator or encoder</b>
<b>159</b>	If the difference between the estimated speed (Pr <b>5.04</b> ) and the actual speed feedback (Pr <b>3.02 (di05, 0.40)</b> ) exceeds the value set in the speed feedback loss window (Pr <b>3.56</b> ) the drive will trip Feedback loss. Check the feedback device is connected correctly Check motor name plate values have been entered into the drive correctly Check the speed feedback in estimated speed mode - refer to running a motor section checking speed feedback Carry out a rotating autotune
<b>Fbr</b>	<b>The polarity of the feedback tachogenerator or encoder is incorrect</b>
<b>160</b>	Check that the feedback devices are connected correctly
<b>FdL</b>	<b>No current in the field supply circuit</b>
<b>168</b>	Check that the field controller (Pr <b>5.77 (SE12, 0.33)</b> ) is enabled. For the internal field controller check terminals L11, L12 are closed
<b>FOC</b>	<b>Excess current detected in field current feedback</b>
<b>169</b>	Maximum current feedback is present Check Field rated current (Pr <b>5.70 (SE10, 0.31)</b> ) and Field rated voltage (Pr <b>5.73 (SE11, 0.32)</b> ) are set correct to motor nameplate Check for short circuit on field circuit cabling Check integrity of motor insulation
<b>F.OVL</b>	<b>Field I<sup>2</sup>t overload</b>
<b>157</b>	See Pr <b>5.81</b> and Pr <b>5.82</b>
<b>HF01</b>	<b>Data processing error: CPU address error</b>
	Hardware fault - return drive to supplier
<b>HF02</b>	<b>Data processing error: DMAC address error</b>
	Hardware fault - return drive to supplier
<b>HF03</b>	<b>Data processing error: Illegal instruction</b>
	Hardware fault - return drive to supplier
<b>HF04</b>	<b>Data processing error: Illegal slot instruction</b>
	Hardware fault - return drive to supplier
<b>HF05</b>	<b>Data processing error: Undefined exception</b>
	Hardware fault - return drive to supplier
<b>HF06</b>	<b>Data processing error: Reserved exception</b>
	Hardware fault - return drive to supplier
<b>HF07</b>	<b>Data processing error: Watchdog failure</b>
	Hardware fault - return drive to supplier
<b>HF08</b>	<b>Data processing error: Level 4 crash</b>
	Hardware fault - return drive to supplier
<b>HF09</b>	<b>Data processing error: Heap overflow</b>
	Hardware fault - return drive to supplier
<b>HF10</b>	<b>Data processing error: Router error</b>
	Hardware fault - return drive to supplier
<b>HF11</b>	<b>Data processing error: Access to EEPROM failed</b>
	Hardware fault - return drive to supplier

Trip	Diagnosis
<b>HF12</b>	<b>Data processing error: Main program stack overflow</b>
	Hardware fault - return drive to supplier
<b>HF17</b>	<b>Data processing error: No Comms from power processor</b>
<b>217</b>	Hardware fault - return drive to supplier
<b>HF18</b>	<b>Bucket suppressor capacitor failure</b>
<b>218</b>	Hardware fault - return drive to supplier
<b>HF20</b>	<b>Power stage recognition: identification code error</b>
<b>220</b>	Hardware fault - return drive to supplier
<b>HF21</b>	<b>Power processor: Watchdog failure</b>
<b>221</b>	Hardware fault - return drive to supplier
<b>HF22</b>	<b>Power processor: Undefined exception</b>
<b>222</b>	Hardware fault - return drive to supplier
<b>HF23</b>	<b>Power processor: Level overrun</b>
<b>223</b>	Hardware fault - return drive to supplier
<b>HF24</b>	<b>Power processor: No frequency detected at power up</b>
<b>224</b>	Hardware fault - return drive to supplier
<b>HF25</b>	<b>Power processor: Field current set point too high</b>
<b>225</b>	Hardware fault - return drive to supplier
<b>HF26</b>	<b>Power processor: Armature timing error</b>
<b>226</b>	Hardware fault - return drive to supplier
<b>HF27</b>	<b>Power circuit: Thermistor 1 fault</b>
<b>227</b>	Hardware fault - return drive to supplier
<b>HF28</b>	<b>Power software not compatible with user software</b>
<b>228</b>	Hardware fault - return drive to supplier
<b>HF29</b>	<b>User processor: Armature timing error</b>
<b>229</b>	Hardware fault - return drive to supplier
<b>It.AC</b>	<b>I<sup>2</sup>t on drive output current (Refer to Pr 4.16)</b>
<b>20</b>	Ensure the load is not jammed / sticking Check the load on the motor has not changed
<b>O.ht1</b>	<b>Drive overheat (thyristor junction) based on thermal model</b>
<b>21</b>	Reduce ambient temperature Reduce overload cycle
<b>O.ht2</b>	<b>Heatsink over temperature</b>
<b>22</b>	Check enclosure / drive fans are still functioning correctly Check enclosure ventilation paths Check enclosure door filters Increase ventilation Decrease acceleration / deceleration rates Reduce duty cycle Reduce motor load
<b>O.ht3</b>	<b>External discharge resistor over temperature</b>
<b>27</b>	The temperature of the external discharge resistor is monitored by the temperature accumulators. When the resistor temperature (Pr 11.65) reaches 100% the drive will trip See Pr 11.62, Pr 11.63 and Pr 11.64
<b>O.Ld1</b>	<b>Digital output overload: total current drawn from 24V supply and digital outputs exceeds 200mA</b>
<b>26</b>	Check total load on digital outputs (terminals 24,25,26)and +24V rail (terminal 22)
<b>O.SPd</b>	<b>Motor speed has exceeded the over speed threshold</b>
<b>7</b>	If the speed feedback (Pr 3.02 (di05, 0.40)) exceeds the over speed threshold (Pr 3.08) in either direction an over speed trip is produced. If this parameter is set to zero, the over speed threshold is automatically set to 1.2 x Pr 1.06 (SE02, 0.23) or Pr 1.07 (SE01, 0.22). Reduce the speed loop gain (Pr 3.10 (SP01, 0.61)) and speed integral (Pr 3.11 (SP02, 0.62)) to prevent speed overshoot.



Trip	Diagnosis
<b>PAd</b>	<b>Keypad has been removed when the drive is receiving the speed reference from the keypad</b>
<b>34</b>	Install keypad and reset Change speed reference selector to select speed reference from another source
<b>PS</b>	<b>Internal power supply fault</b>
<b>5</b>	Remove any Solutions Modules and reset Hardware fault - return drive to supplier
<b>PS.10V</b>	<b>10V user power supply current greater than 10mA</b>
<b>8</b>	Check wiring to terminal 4 Reduce load on terminal 4
<b>PS.24V</b>	<b>24V internal power supply overload</b>
<b>9</b>	The total user load of the drive and Solutions Modules has exceeded the internal 24V power supply limit. The user load consists of the drive's digital outputs, the SM-I/O Plus digital outputs, the drive's main encoder supply and the SM-Universal Encoder Plus encoder supply. <ul style="list-style-type: none"> <li>• Reduce load and reset</li> <li>• Provide an external 24V &gt;50W power supply</li> <li>• Remove any Solutions Modules and reset</li> </ul>
<b>PSAVE.Er</b>	<b>Power down save parameters in the EEPROM are corrupt</b>
<b>37</b>	Indicates that the power was removed when power down save parameters were being saved. The drive will revert back to the power down parameter set that was last saved successfully. Perform a user save (Pr <b>xx.00</b> to SAVE and reset the drive) or power down the drive normally to ensure this trip does or occur the next time the drive is powered up.
<b>SAVE.Er</b>	<b>User save parameters in the EEPROM are corrupt</b>
<b>36</b>	Indicates that the power was removed when user parameters were being saved. The drive will revert back to the user parameter set that was last saved successfully. Perform a user save (Pr <b>xx.00</b> to SAVE and reset the drive) to ensure this trip does or occur the next time the drive is powered up.
<b>SCL</b>	<b>Drive RS485 serial comms loss to remote keypad</b>
<b>30</b>	Reinstall the cable between the drive and keypad Check cable for damage Replace cable Replace keypad
<b>SL</b>	<b>AC input phase loss</b>
<b>170</b>	Ensure all three thyristor bridge supply phases are present Check input voltage levels are correct (at full load)
<b>SLX.dF</b>	<b>Solutions Module slot X trip: Solutions Module type installed in slot X changed</b>
<b>204,209,214</b>	Save parameters and reset
<b>SLX.Er</b>	<b>Solutions Module slot X trip: Solutions Module in slot X has detected a fault</b>
	<b>Feedback module category</b> See the <i>Diagnostics</i> section in the relevant Solutions Module User Guide for more information.
<b>SLX.HF</b>	<b>Solutions Module slot X trip: Solutions Module X hardware fault</b>
<b>200,205,210</b>	Ensure Solutions Module is installed correctly Return Solutions Module to supplier
<b>SLX.nF</b>	<b>Solutions Module slot X trip: Solutions Module has been removed</b>
<b>203,208,213</b>	Ensure Solutions Module is installed correctly Reinstall Solutions Module Save parameters and reset drive
<b>SL.rtd</b>	<b>Solutions Module trip: Drive mode has changed and Solutions Module parameter routing is now incorrect</b>
<b>215</b>	Press reset. If the trip persists, contact the supplier of the drive.
<b>SLX.tO</b>	<b>Solutions Module slot X trip: Solutions Module watchdog timeout</b>
<b>201,206,211</b>	Press reset. If the trip persists, contact the supplier of the drive.
<b>S.Old</b>	<b>The maximum power the over voltage suppressor can handle has been exceeded</b>
<b>171</b>	Check the recommended line reactors are installed Check the recommended external suppressor resistor is installed

Trip	Diagnosis
<b>S.OV</b>	<b>Excessive suppressor voltage</b>
<b>172</b>	Operation of the drive requires the installation of the external suppressor resistance, see section 4.7 <i>External suppressor resistor</i> on page 32.
<b>t002</b>	<b>Reserved</b>
<b>2</b>	A value of 2 is being written to user trip (Pr <b>10.38</b> ). The drives internal logic, on board or Solutions Module program must be interrogated. The program should be modified so that only trips defined as User trip are used.
<b>t004</b>	<b>Reserved</b>
<b>4</b>	See diagnosis for t002
<b>t010</b>	<b>Reserved</b>
<b>10</b>	See diagnosis for t002
<b>t013 to t017</b>	<b>Reserved</b>
<b>13 to 17</b>	See diagnosis for t002
<b>t019</b>	<b>Reserved</b>
<b>19</b>	See diagnosis for t002
<b>t023</b>	<b>User trip</b>
<b>23</b>	This trip is user defined. The drives internal logic, on board or Solutions module program must be interrogated to find the cause of this trip. A value of 23 is being written to user trip (Pr <b>10.38</b> )
<b>t032</b>	<b>Reserved</b>
<b>32</b>	See diagnosis for t002
<b>t033</b>	<b>Reserved</b>
<b>33</b>	See diagnosis for t002
<b>t038 to t039</b>	<b>Reserved</b>
<b>33</b>	See diagnosis for t002
<b>t040 to t089</b>	<b>User trip</b>
<b>40 to 89</b>	See diagnosis for t023
<b>t099</b>	<b>User trip defined in 2<sup>nd</sup> processor Solutions Module code</b>
<b>99</b>	This solutions module program must be interrogated to find the cause of this trip. A value of 99 is being written to user trip (Pr <b>10.38</b> )
<b>t101</b>	<b>User trip</b>
<b>101</b>	See diagnosis for t023
<b>t102 to t111</b>	<b>Reserved</b>
<b>102 to 111</b>	See diagnosis for t002
<b>t112 to t156</b>	<b>User trip</b>
<b>112 to 156</b>	See diagnosis for t023
<b>t161 to t167</b>	<b>Reserved</b>
<b>161 to 167</b>	See diagnosis for t002
<b>t173 to t174</b>	<b>Reserved</b>
<b>173 to 174</b>	See diagnosis for t002
<b>t176</b>	<b>Reserved</b>
<b>176</b>	See diagnosis for t002
<b>t192</b>	<b>Reserved</b>
<b>192</b>	See diagnosis for t002
<b>t194</b>	<b>Reserved</b>
<b>194</b>	See diagnosis for t002
<b>t195</b>	<b>Reserved</b>
<b>195</b>	See diagnosis for t002
<b>t196</b>	<b>Reserved</b>
<b>196</b>	See diagnosis for t002

Trip	Diagnosis
<b>t216</b>	<b>User trip</b>
<b>216</b>	See diagnosis for t023
<b>th</b>	<b>Motor thermistor trip</b>
<b>24</b>	Check motor temperature Check thermistor continuity Set Pr 7.15 (in01, 0.81) = VOLt and reset the drive to disable this function
<b>thS</b>	<b>Motor thermistor short circuit</b>
<b>25</b>	Check motor thermistor wiring Replace motor / motor thermistor Set Pr 7.15 (in01, 0.81) = VOLt and reset the drive to disable this function
<b>tunE</b>	<b>Autotune stopped before completion</b>
<b>18</b>	The drive has tripped out during the autotune The red stop key has been pressed during the autotune
<b>tunE1*</b>	<b>The position feedback did not change or required speed could not be reached during the inertia test (see Pr 5.12)</b>
<b>11</b>	Ensure the motor is free to turn i.e. brake was released Ensure Pr 3.26 and Pr 3.38 are set correctly Check feedback device wiring is correct Check feedback device coupling to motor
<b>tunE2*</b>	<b>Position feedback direction incorrect or motor could not be stopped during the inertia test (See Pr 5.12)</b>
<b>12</b>	Check motor cable wiring is correct Check feedback device wiring is correct
<b>tunE3*</b>	<b>Field flux has not decayed to zero during autotune</b>
<b>13</b>	Contact the supplier of the drive
<b>tunE4*</b>	<b>Back emf detected during autotune</b>
<b>14</b>	Check that the motor is not spinning when a static autotune is carried out
<b>tunE5*</b>	<b>No field current detected during autotune</b>
<b>15</b>	Reset Pr 5.70 to nameplate value and re-autotune motor
<b>tunE6*</b>	<b>Cannot achieve ¼ rated back emf during autotune</b>
<b>16</b>	Reset Pr 5.70 to nameplate value and re-autotune motor
<b>tunE7*</b>	<b>Rotated autotune initiated with Estimated speed selected</b>
<b>17</b>	Connect a feedback device to carry out a rotating autotune
<b>UP ACC</b>	<b>Onboard PLC program: cannot access Onboard PLC program file on drive</b>
<b>98</b>	Disable drive - write access is not allowed when the drive is enabled Another source is already accessing Onboard PLC program - retry once other action is complete
<b>UP div0</b>	<b>Onboard PLC program attempted divide by zero</b>
<b>90</b>	Check program
<b>UP OFL</b>	<b>Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow)</b>
<b>95</b>	Check program
<b>UP ovr</b>	<b>Onboard PLC program attempted out of range parameter write</b>
<b>94</b>	Check program
<b>UP PAr</b>	<b>Onboard PLC program attempted access to a non-existent parameter</b>
<b>91</b>	Check program
<b>UP ro</b>	<b>Onboard PLC program attempted write to a read-only parameter</b>
<b>92</b>	Check program
<b>UP So</b>	<b>Onboard PLC program attempted read of a write-only parameter</b>
<b>93</b>	Check program
<b>UP udF</b>	<b>Onboard PLC program un-defined trip</b>
<b>97</b>	Check program
<b>UP uSEr</b>	<b>Onboard PLC program requested a trip</b>
<b>96</b>	Check program

Trip	Diagnosis
<b>UU</b>	<b>The drive is running from the external 24V supply</b>
<b>1</b>	The drive is running from the external 24V supply

\*If a tunE through tunE 7 trip occurs, then after the drive is reset the drive cannot be made to run unless it is disabled via the drive enable parameter (Pr 6.15) or the control word (Pr 6.42).

**Table 13-2 Serial communications look-up table**

No.	String	No.	String	No.	String
1	UU	90	UP div0	188	C.cpr
2	t002	91	UP Par	189	EnC1
3	AOC	92	UP ro	190	EnC2
4	t004	93	UP So	191	EnC3
5	PS	94	UP ovr	192-196	t192 - t196
6	Et	95	UP OFL	197	EnC9
7	O.SPd	96	UP uSEr	198	EnC10
8	PS.10V	97	UP udf	199	dESr
9	PS.24V	98	UP ACC	200	SL1.HF
10	t010	99	t99	201	SL1.tO
11	tunE1	100		202	SL1.Er
12	tunE2	101	t101	203	SL1.nF
13	tunE3	102-111	t102 - t111	204	SL1.dF
14	tunE4	112-156	t112 - t156	205	SL2.HF
15	tunE5	157	F.OVL	206	SL2.tO
16	tunE6	158	AOP	207	SL2.Er
17	tunE7	159	FbL	208	SL2.nF
18	tunE	160	Fbr	209	SL2.dF
19	t019	161-167	t161 - t167	210	SL3.HF
20	It.AC	168	FdL	211	SL3.tO
21	O.ht1	169	FOC	212	SL3.Er
22	O.ht2	170	SL	213	SL3.nF
23	t023	171	S.Old	214	SL3.dF
24	Th	172	S.Ov	215	SL.rtd
25	ThS	173-174	t173 - t174	216	t216
26	O.Ld1	175	C.Prod	217-232	HF17 - HF32
27	O.ht3	176	t176		
28	cL2	177	C.Boot		
29	cL3	178	C.BUSy		
30	SCL	179	C.Chg		
31	EEF	180	C.Optn		
32-33	t032 - t033	181	C.RdO		
34	Pad	182	C.Err		
35	CL.bit	183	C.dat		
36	SAVE.Er	184	C.FULL		
37	PSAVE.Er	185	C.Acc		
38-39	t038 - t039	186	C.rtg		
40-89	t040 - t089	187	C.Typ		

### 13.3 Trip Categories

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 13-3 Trip categories**

Priority	Category	Trips	Comments
1	Hardware faults	HF01 to HF16	These indicate fatal problems and cannot be reset. The drive is inactive after one of these trips and the display shows HFxx.
2	Non-resetable trips	HF17 to HF32, SL1.HF, SL2.HF, SL3.HF	Cannot be reset
3	EEF trip	EEF	Cannot be reset unless a code to load defaults is first entered in parameter x.00
4	SMARTCARD trips	C.Boot, C.Busy, C.Chg, C.Optn, C.RdO, C.Err, C.dat, C.FULL, C.Acc, C.rtg, C.Typ, C.cpr,	SMARTCARD trips have priority 5 during power up.
4	Encoder power supply trips	PS.24V, Enc1	These trips can only override the following priority 5 trips: Enc2 or Enc9
5	Normal trips	All other trips not included in this table	Can be reset after 1.0s
6	Self resetting trips	UU	Under voltage trip cannot be reset by the user, but is automatically reset by the drive when the supply voltage is with specification.

Unless otherwise stated, trips cannot be reset until 1.0s after the trip has been accepted by the drive

### 13.4 Alarm indications

In any mode an alarm flashes alternately with the data displayed on the 2nd row when one of the following conditions occur. If action is not taken to eliminate any alarm except "Autotune", and "PLC" the drive may eventually trip. Alarms flash once every 640ms except "PLC" which flashes once every 10s. Alarms are not displayed when a parameter is being edited.

**Table 13-4 Alarm indications**

Lower display	Description
<b>Hot</b>	Heatsink alarm is active
The temperature displayed in Pr 7.04 has exceeded the alarm level (see Pr 7.04).	
<b>OVld</b>	Motor overload
The motor I <sup>2</sup> t accumulator (Pr 4.19) in the drive has reached 75% of the value at which the drive will be tripped and the load on the drive is > motor rated current (Pr 5.07 (SE07, 0.28)).	
<b>Autotune</b>	Autotune in progress
The autotune procedure has been initialised. 'Auto' and 'tunE' will flash alternatively on the display.	
<b>CLt</b>	Current limit is active
Indicates that current limits are active.	
<b>PLC</b>	Onboard PLC program is running
An Onboard PLC program is installed and running. The lower display will flash 'PLC' once every 10s.	
<b>S.OV</b>	Indicated suppressor over voltage
Indicates that the over voltage suppressor voltage is within 30V of the trip level	
<b>S.rS</b>	Suppressor resistor overload
Indicates that the external voltage suppressor resistor is in an overload condition	

### 13.5 Status indications

**Table 13-5 Status indications**

Upper display	Description	Drive output stage
dEC	Decelerating	Enabled
Speed is ramping to zero after a stop		
inh	Inhibited	Disabled
Enable input is inactive		
POS	Position	Enabled
Position control active during orientation stop		
rdY	Ready	Disabled
Enable closed, but drive not active		
run	Running	Enabled
Drive active and motor running		
StoP	Stopped	Enabled
Drive active, but holding zero speed.		
triP	Tripped	Disabled
Drive is tripped.		

### 13.6 Displaying the trip history

The drive retains the last 10 trips that have occurred.

Table 13-6 shows parameters used to store the last 10 trip.

**Table 13-6 Trips**

Menu 0	Parameter	Description	Display
0.51	10.20	Trip 0 (most recent trip)	tr01
0.52	10.21	Trip 1	tr02
0.53	10.22	Trip 2	tr03
0.54	10.23	Trip 3	tr04
0.55	10.24	Trip 4	tr05
0.56	10.25	Trip 5	tr06
0.57	10.26	Trip 6	tr07
0.58	10.27	Trip 7	tr08
0.59	10.28	Trip 8	tr09
0.60	10.29	Trip 9	tr10

## 13.7 Behaviour of the drive when tripped

If the drive trips the output of the drive is disabled so that the drive stops controlling the motor. If any trip occurs (except UU) the following read only parameters are frozen to help in diagnosing the cause of the trip

**Table 13-7 Parameters frozen on trip**

Menu 0	Parameter	Description	Display
0.36	1.01	Speed reference selected	di01
0.37	1.03	Pre-ramp reference	di02
0.38	2.01	Post ramp reference	di03
0.39	3.01	Final speed reference	di04
0.40	3.02	Speed feedback	di05
0.41	3.04	Speed controller output	di06
0.42	4.03	Torque demand	di07
0.43	4.01	Current Magnitude	di08
0.46	1.11	Reference enabled indicator	di11
0.47	1.12	Reverse selected indicator	di12
0.48	1.13	Jog selected indicator	di13
0.49	11.29	Software version	di14
0.50	0.00	Spare	

### Analog and digital I/O

The analog and digital I/O on the drive continue to work correctly if a trip occurs, except the digital outputs will go low if one of the following trips occur: O.Ld1, PS.24V.

### Drive logic functions

The drive logic functions (i.e. PID, variable selectors, threshold detectors, etc.) continue to operate when the drive is tripped.

### Onboard PLC program

The Onboard PLC program continues to run if the drive is tripped, except if one of Onboard PLC program trips occur.

# 14    UL information

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