

MENTOR MP

User Guide

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 software version. If this drive is to be connected to an existing system or machine, all drive software versions should be verified to confirm the same functionality as drives of the same model already present. This may also apply to drives returned from LEROY-SOMER. If there is any doubt please contact the supplier of the product.

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

Environmental statement

LEROY-SOMER is committed to minimising the environmental impacts of its manufacturing operations. To this end, we operate an Environmental Management System (EMS) which is certified to the International Standard ISO 14001.

The electronic variable-speed drives manufactured by LEROY-SOMER have the potential to save energy and reduce raw material consumption and scrap throughout their long working lifetime (through increased machine/process efficiency).

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

Product packaging is of good quality and can be re-used. Large products are packed in wooden crates, while smaller products come in strong cardboard cartons which themselves have a high recycled fibre content. If not re-used, these containers can be recycled. Polythene, used on the protective film and bags for wrapping product, can be recycled in the same way.

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 LEROY-SOMER products, please approach your usual contact in the first instance.

Issue Number: 4

Software: 01.05.01 onwards

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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.

WARNING



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

CAUTION

NOTE

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

1.2 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 / start-up and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this 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:

2006/42/EC: Safety of machinery

2004/108/EC: Electromagnetic compatibility

1.8 Motor

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

Low speeds may cause the motor to overheat because the cooling fan becomes less effective. The motor should be installed with a protection thermistor. If necessary, an electric forced ventilation 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 |
|-------------------------|---------------------------------|----------------|-------|
| 480V EN/IEC cULus | 575V EN/IEC cULus to 600V | 690V EN/IEC | |
| 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) | MP350A5(R) | MP350A6(R) | 2A |
| MP420A4(R) | | | |
| | MP470A5(R) | MP470A6(R) | |
| MP550A4(R) | | | |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | 2B |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | |
| MP900A4(R) | | | |
| MP1200A4 | MP1200A5 | MP1200A6 | 2C |
| MP1850A4 | MP1850A5 | MP1850A6 | |
| MP1200A4R | MP1200A5R | MP1200A6R | 2D |
| MP1850A4R | MP1850A5R | MP1850A6R | |

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 145.

Table 2-2 480V current ratings

| Model | AC input current | DC output current | | | Typical motor power | |
|-------------|------------------|-------------------|-----------------------|-------------|---------------------|--|
| | Continuous A | Continuous A | 150% overload A | @ 400Vdc | @ 500Vdc | |
| | | | | 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 current ratings

| Model | AC input current | DC output current | | Typical motor power (With Vdc = 630V) | |
|-------------|------------------|-------------------|-----------------------|---------------------------------------|------|
| | Continuous A | Continuous A | 150% overload A | kW | hp |
| | | | | | |
| 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 |
| MP350A5(R) | 313 | 350 | 525 | 195 | 260 |
| MP470A5(R) | 420 | 470* | 705 | 265 | 355 |
| MP700A5(R) | 626 | 700 | 1050 | 395 | 530 |
| MP825A5(R) | 738 | 825* | 1237.5 | 465 | 620 |
| MP1200A5(R) | 1073 | 1200 | 1800 | 680 | 910 |
| MP1850A5(R) | 1655 | 1850 | 2775 | 1045 | 1400 |

* For this rating at 575V, 150% overload time is 20s at 40 C and 30s at 35 C.

Table 2-4 690V current ratings

| Model | AC input current | DC output Current | | Typical motor power (With Vdc = 760V) | |
|-------------|------------------|-------------------|-----------------------|---------------------------------------|------|
| | Continuous A | Continuous A | 150% Overload A | kW | hp |
| | | | | | |
| MP470A6(R) | 420 | 470* | 705 | 320 | 425 |
| MP700A6(R) | 626 | 700 | 1050 | 480 | 640 |
| MP825A6(R) | 738 | 825* | 1237.5 | 650 | 850 |
| MP1200A6(R) | 1073 | 1200 | 1800 | 850 | 1150 |
| MP1850A6(R) | 1655 | 1850 | 2775 | 1300 | 1750 |

* For this rating at 690V, 150% overload time is 20s at 40 C and 30s at 35 C.

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.

NOTE

For current ratings above 1850A then parallel connection of the drives is required. However, this function is not implemented on firmware versions V01.05.01 and earlier.

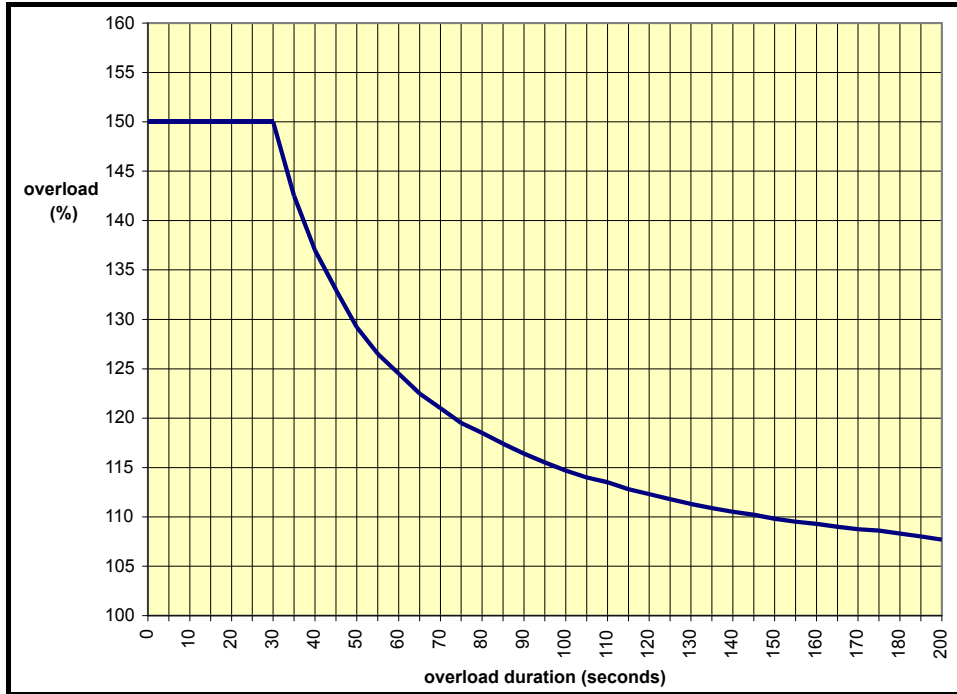
2.1.1 Typical short-term overload limits

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 *Mentor MP 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



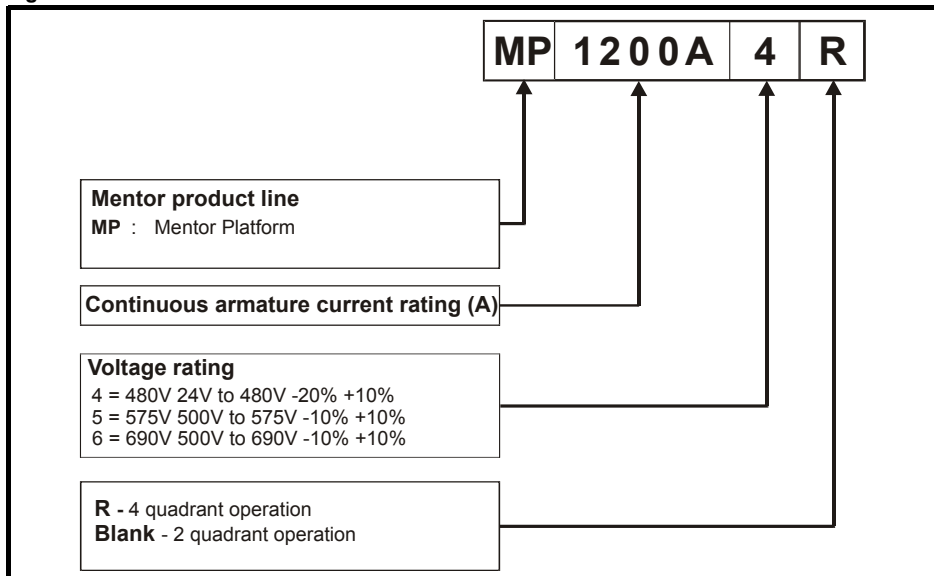
NOTE

Overload of 150% for 30s is available 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

Rating

Model

Customer and date code

Auxiliary input voltage/frequency/current

Field output voltage current

Line input voltage/frequency/current

Armature output voltage/current/overload

Serial number

IP Rating

Approvals

Key to approvals

| | | |
|--|-----------------|-----------|
| | UL approval | Worldwide |
| | CE approval | Europe |
| | C Tick approval | Australia |
| | RoHS compliant | Europe |

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 12.1.12 *Altitude* on page 150.

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 on size 1

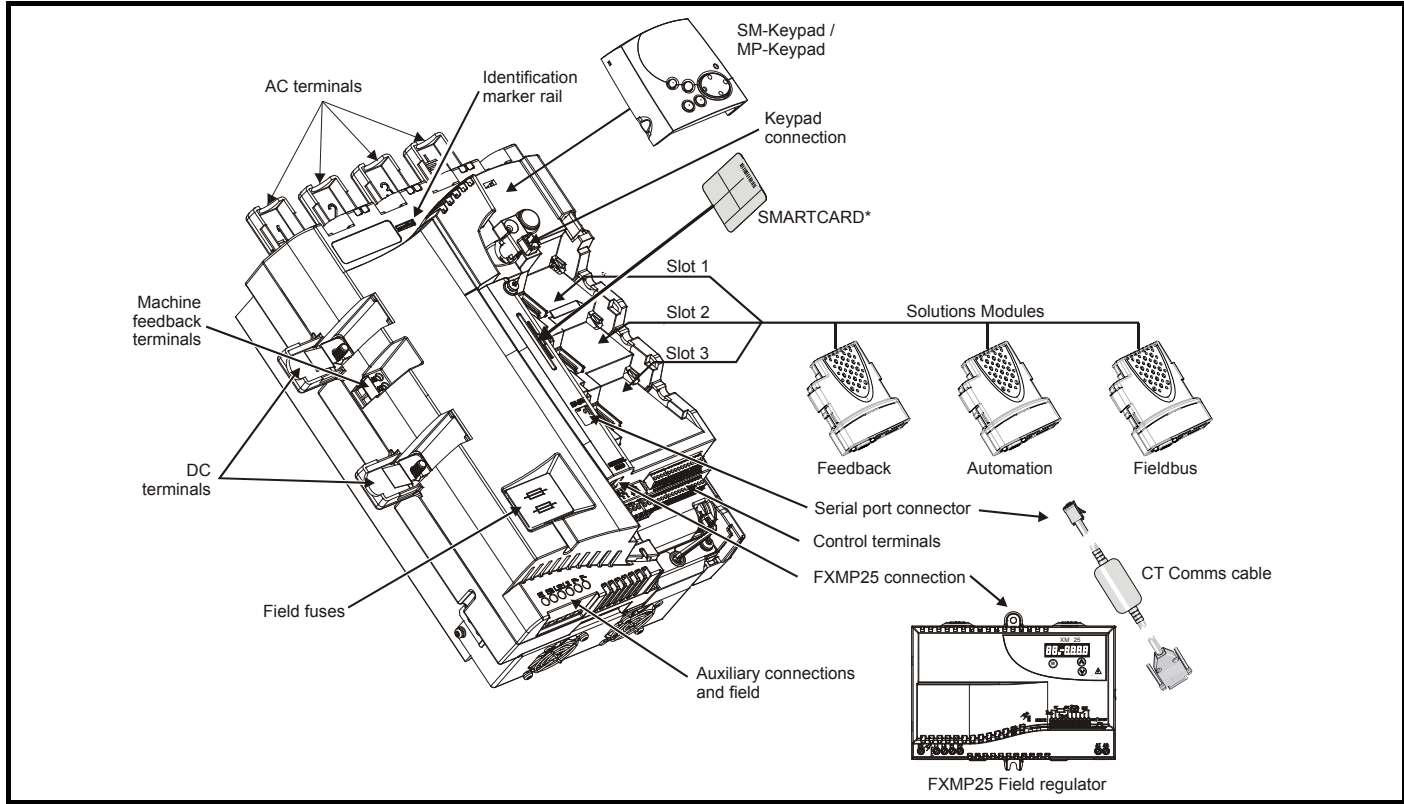
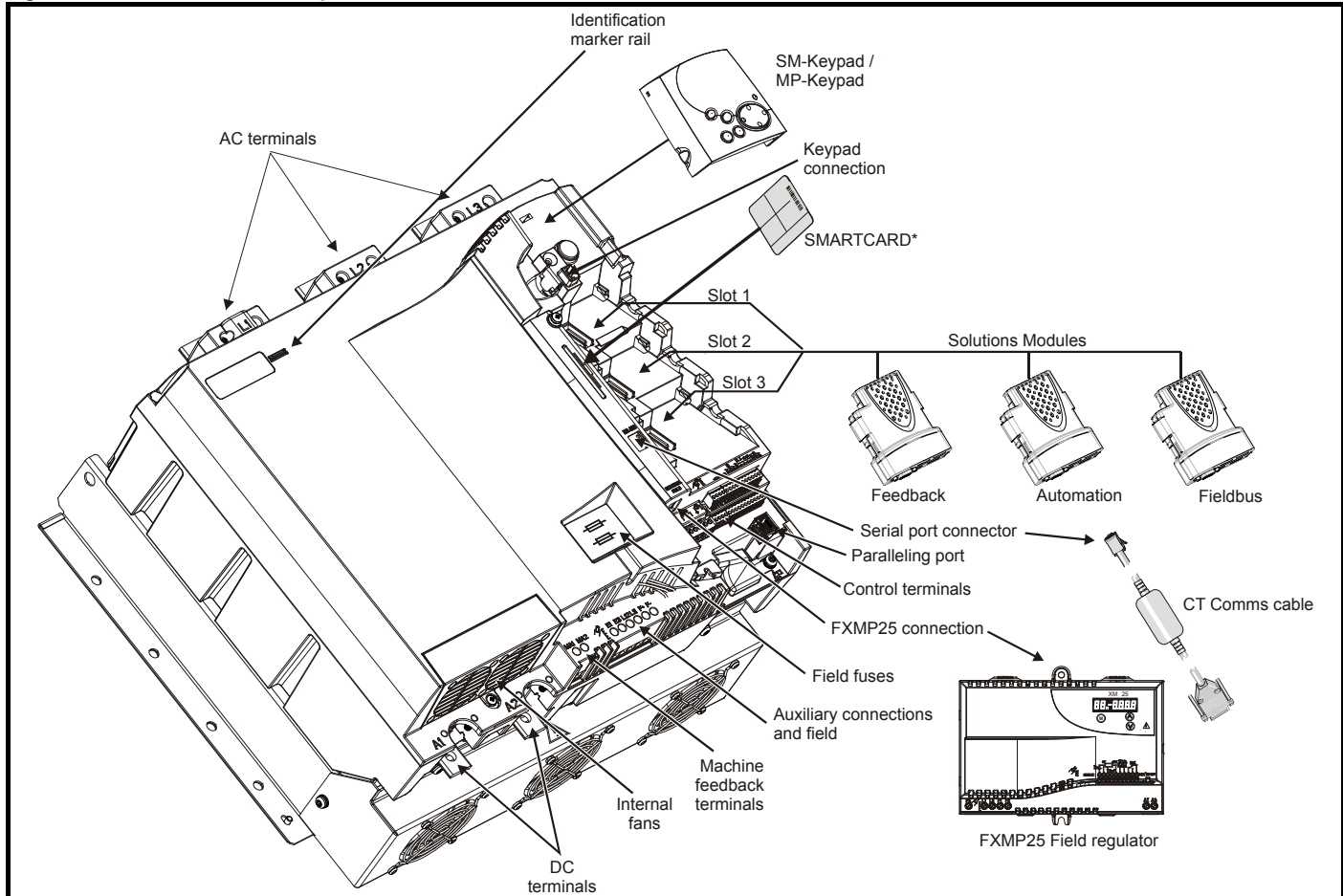


Figure 2-5 Drive features and options for size 2



* A SMARTCARD is provided as standard. For further information, refer to Chapter 9 *SMARTCARD operation* on page 81.

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 | Universal Feedback interface Feedback interface for the following devices: Inputs <ul style="list-style-type: none"> Incremental encoders SinCos encoders SSI encoders EnDat encoders Outputs <ul style="list-style-type: none"> Quadrature Frequency and direction SSI simulated outputs |
| |  | Brown | SM-Encoder Plus | Incremental encoder interface Feedback interface for incremental encoders without commutation signals. No simulated encoder outputs available |
| |  | Dark Brown | SM-Encoder Output Plus | Incremental encoder interface Feedback interface for incremental encoders without commutation signals. Simulated encoder output for quadrature, frequency and direction signals |
| |  | N/A | 15-way D-type converter | Drive encoder input converter Provides screw terminal interface for encoder wiring and spade terminal for shield |
| | | N/A | Single ended encoder interface (15V or 24V) | Single ended encoder interface Provides an interface for single ended ABZ encoder signals, such as those from hall effect sensors. 15V and 24V versions are available. |
| Automation (I/O Expansion) |  | Yellow | SM-I/O Plus | Extended I/O interface Increases the I/O capability by adding the following to the existing I/O in the drive: <ul style="list-style-type: none"> Digital inputs x 3 Digital I/O x 3 Analog inputs (voltage) x 2 Analog output (voltage) x 1 Relay x 2 |
| |  | Yellow | SM-I/O 32 | Extended I/O interface Increase the I/O capability by adding the following to the existing I/O in the drive: <ul style="list-style-type: none"> High speed digital I/O x 32 +24V output |
| |  | Dark Yellow | SM-I/O Lite | Additional I/O 1 x Analog input ($\pm 10V$ bi-polar or current modes) 1 x Analog output (0 to 10V or current modes) 3 x Digital input and 1 x Relay |
| |  | Dark Red | SM-I/O Timer | Additional I/O with real time clock As per SM-I/O Lite but with the addition of a Real Time Clock for scheduling drive running |
| |  | Turquoise | SM-I/O PELV | Isolated I/O to NAMUR NE37 specifications 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 | Additional I/O conforming to IEC 61131-2 120Vac 6 digital inputs and 2 relay outputs rated for 120Vac operation |
| |  | Cobalt Blue | SM-I/O 24V Protected | Additional I/O with overvoltage protection up to 48V 2 x Analog outputs (current modes) 4 x Digital input / outputs, 3 x Digital inputs, 2 x Relay outputs |

Table 2-6 Solutions Module identification








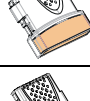

| Type | Solutions Module | Color | Name | Further Details |
|---------------------------|---|--------------|-------------------------|---|
| Automation (Applications) |  | Moss Green | SM-Applications Plus | Applications Processor (with CTNet) 2 nd processor for running pre-defined and /or customer created application software with CTNet support. Enhanced performance over SM-Applications |
| |  | White | SM-Applications Lite V2 | Applications Processor 2 nd processor for running pre-defined and /or customer created application software. Enhanced performance over SM-Applications Lite |
| |  | Golden brown | SM-Register | Applications Processor 2 nd processor for running position capture functionality with CTNet support. |
| Fieldbus |  | Purple | SM-PROFIBUS DP-V1 | Profibus option PROFIBUS DP adapter for communications with the drive |
| |  | Medium Grey | SM-DeviceNet | DeviceNet option Devicenet adapter for communications with the drive |
| |  | Dark Grey | SM-INTERBUS | Interbus option Interbus adapter for communications with the drive |
| |  | Light Grey | SM-CANopen | CANopen option CANopen adapter for communications with the drive |
| |  | Beige | SM-Ethernet | Ethernet option 10 base-T / 100 base-T; Supports web pages, SMTP mail and multiple protocols: DHCP IP addressing; Standard RJ45 connection |
| |  | Brown Red | SM-EtherCAT | EtherCAT option EtherCAT adapter for communications with the drive |

Table 2-7 Keypad identification



| Keypad | Name | Further Details |
|---|-----------|---|
|  | SM-Keypad | LED keypad option Keypad with a LED display |
|  | MP-Keypad | LCD keypad option Keypad with an alpha-numeric LCD display with Help function |

Table 2-8 Serial comms lead


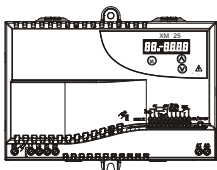
| Serial comms lead | Name | Further Details |
|---|----------------|--|
|  | CT Comms cable | CT EIA (RS) -232 (4500-0087) CT USB (4500-0096) |

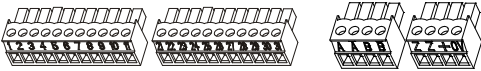

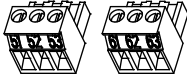


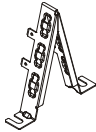
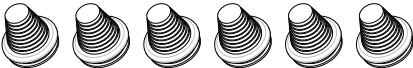
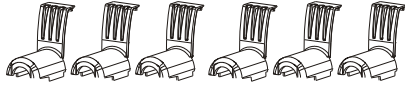
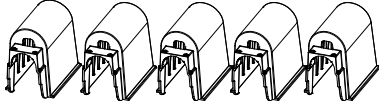


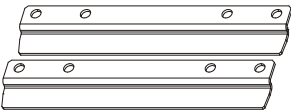
Table 2-9 External field control

| External field controller | Name | Further Details |
|---|--------|--|
|  | FXMP25 | For external control of field windings up to 25A, with field reversal capability. For further information, please see the <i>FXMP25 User Guide</i> . |

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 and an accessory kit box including the items shown in Table 2-10.

Table 2-10 Parts supplied with the drive

| Description | Size 1 | Size 2A / 2B | Size 2C / 2D |
|---|---|--|--------------|
| Control connectors |  | | |
| Tacho connector |  | | |
| Relay connectors |  | | |
| UL warning label |  | | |
| UL warning label for heatsink temperature |  | | |
| Grounding bracket |  | | |
| Terminal cover grommets |  | | |
| Terminal shrouds |  |  | |
| Terminal shroud base covers | |  | |
| M4 Screws | |  | |
| 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 3.4 *Mounting method* on page 17.

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 26.

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 32.

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 Table 12-42 *Drive power stage terminals on size 2 drives* on page 164.


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.

WARNING

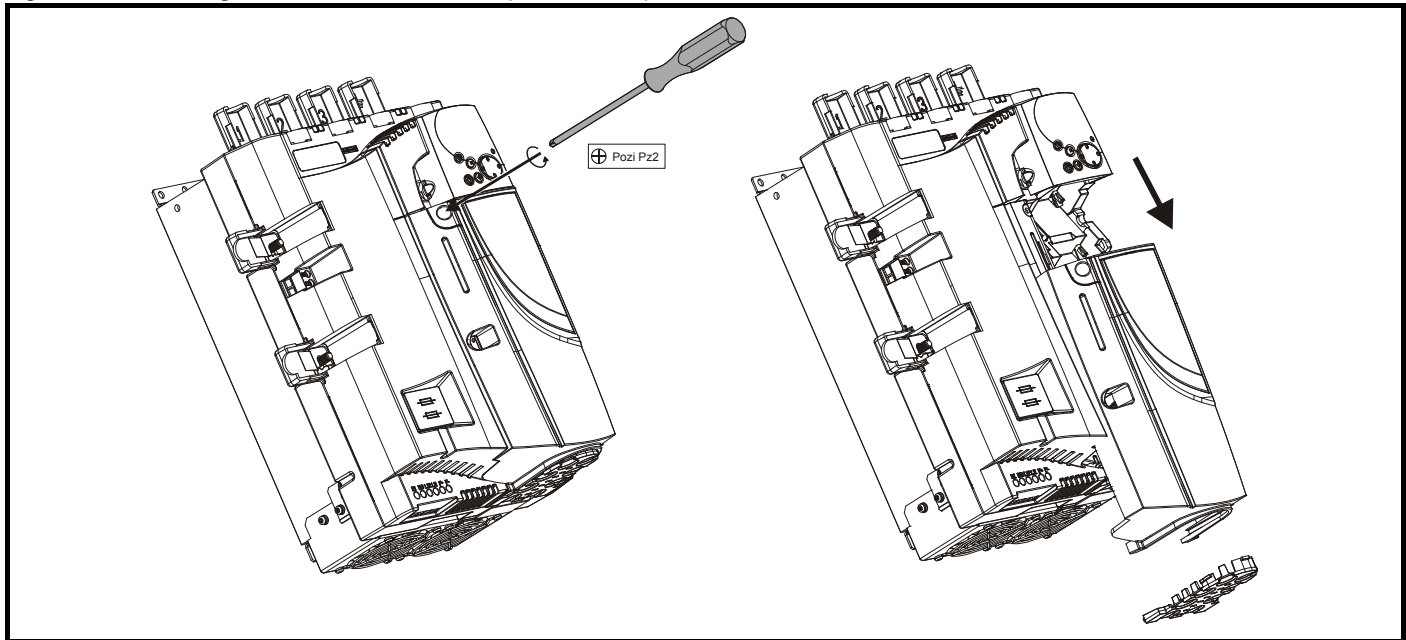
 **Stored charge**
The drive contains capacitors that remain charged to a potentially lethal voltage after the AC supply has been disconnected. If the drive has been energized, the AC supply must be isolated at least ten minutes before work may continue.

WARNING

3.3.1 Removing the terminal covers

The drive is installed with one control terminal cover.

Figure 3-1 Removing the control terminal cover (size 1 shown)

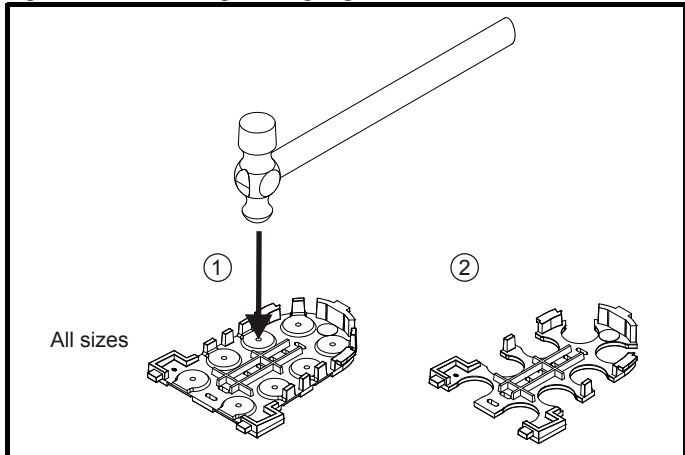


To remove the terminal cover, undo the screw and slide the terminal cover downwards.

When replacing the terminal covers the screw should be tightened with a maximum torque of 1 Nm (0.7 lb ft).

3.3.2 Removing the finger-guard and break-outs

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



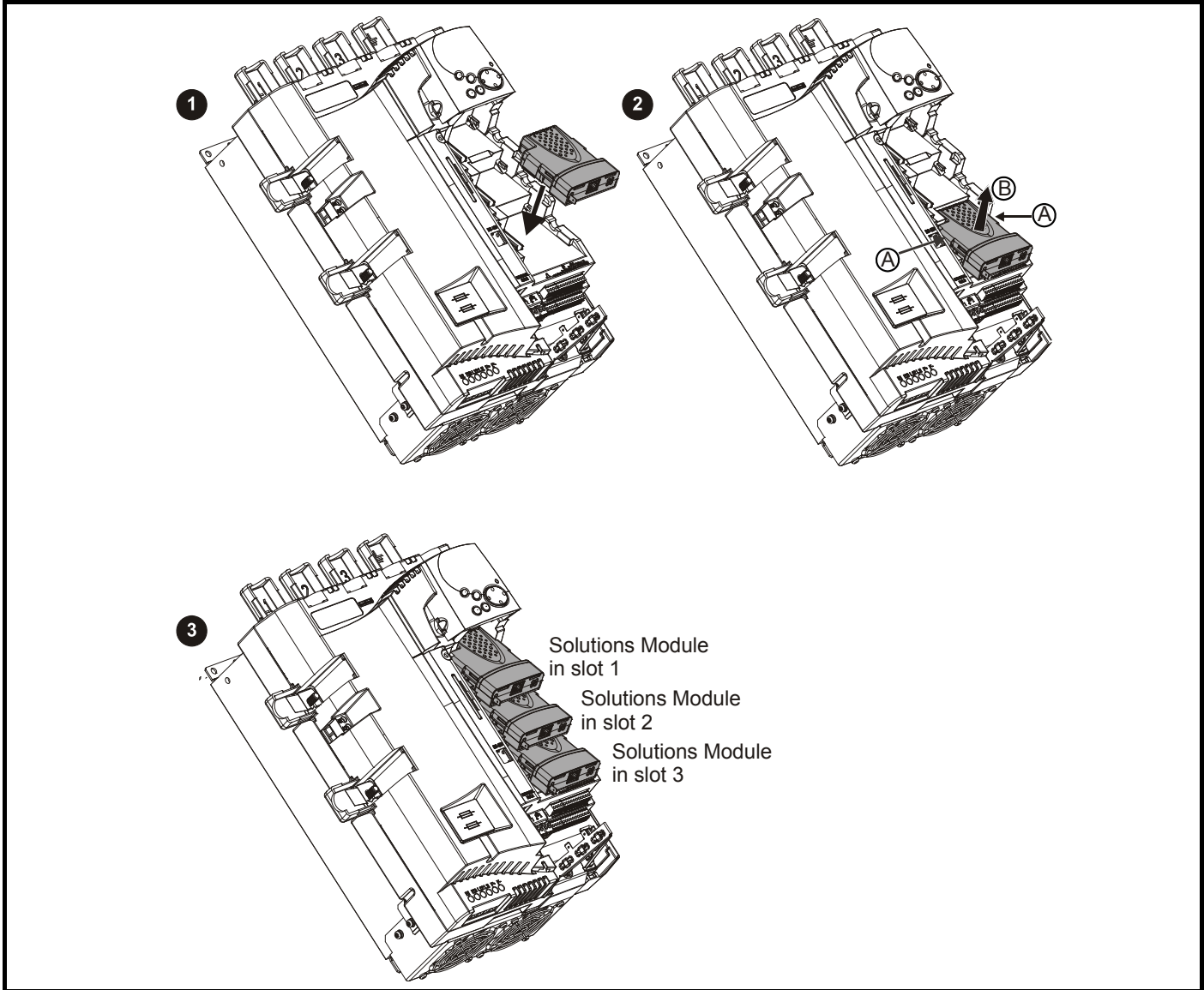
Place finger-guard on a flat solid surface and hit relevant break-outs with hammer as shown (1). Continue until all required break-outs are removed (2). Remove any flash / sharp edges once the break-outs are removed.

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

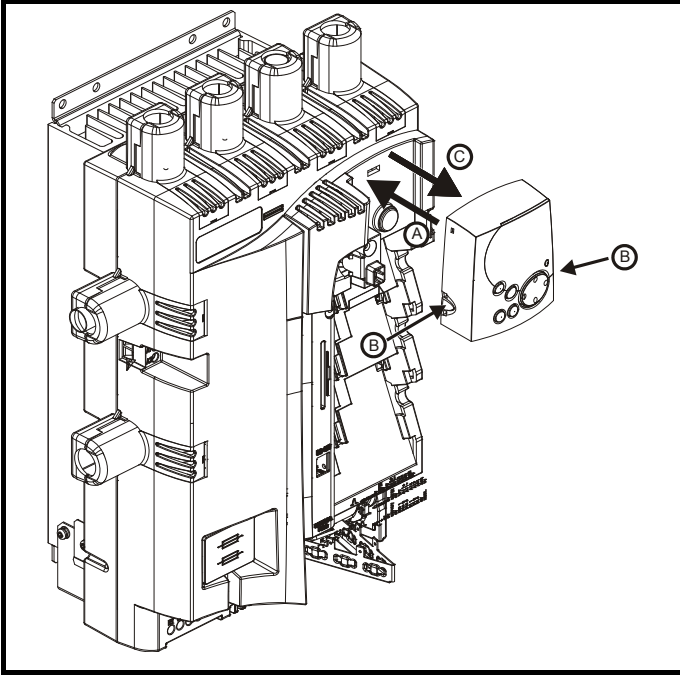


1. To install the Solutions Module, press down in the direction shown above until it clicks into place.
2. To remove the Solutions Module, press inwards at the points shown (A) and pull in the direction shown (B).
3. The drive has the facility for all three Solutions Module slots to be used at the same 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.

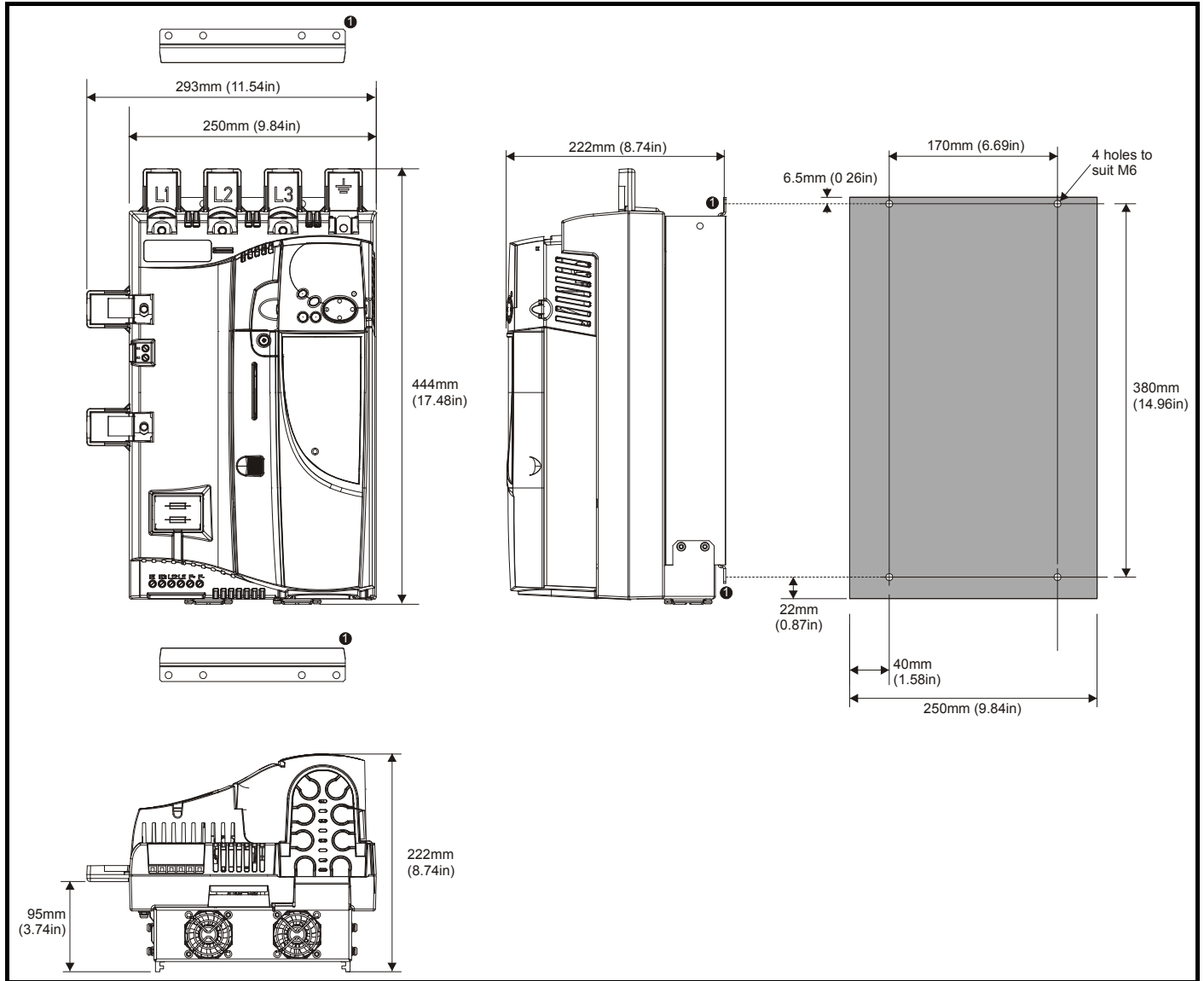


If the drive has been used at high load levels for a period of time, the heatsink can reach temperatures in excess of 70°C (158°F). Human contact with the heatsink should be prevented.



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

Figure 3-5 Overall size 1A dimensions



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

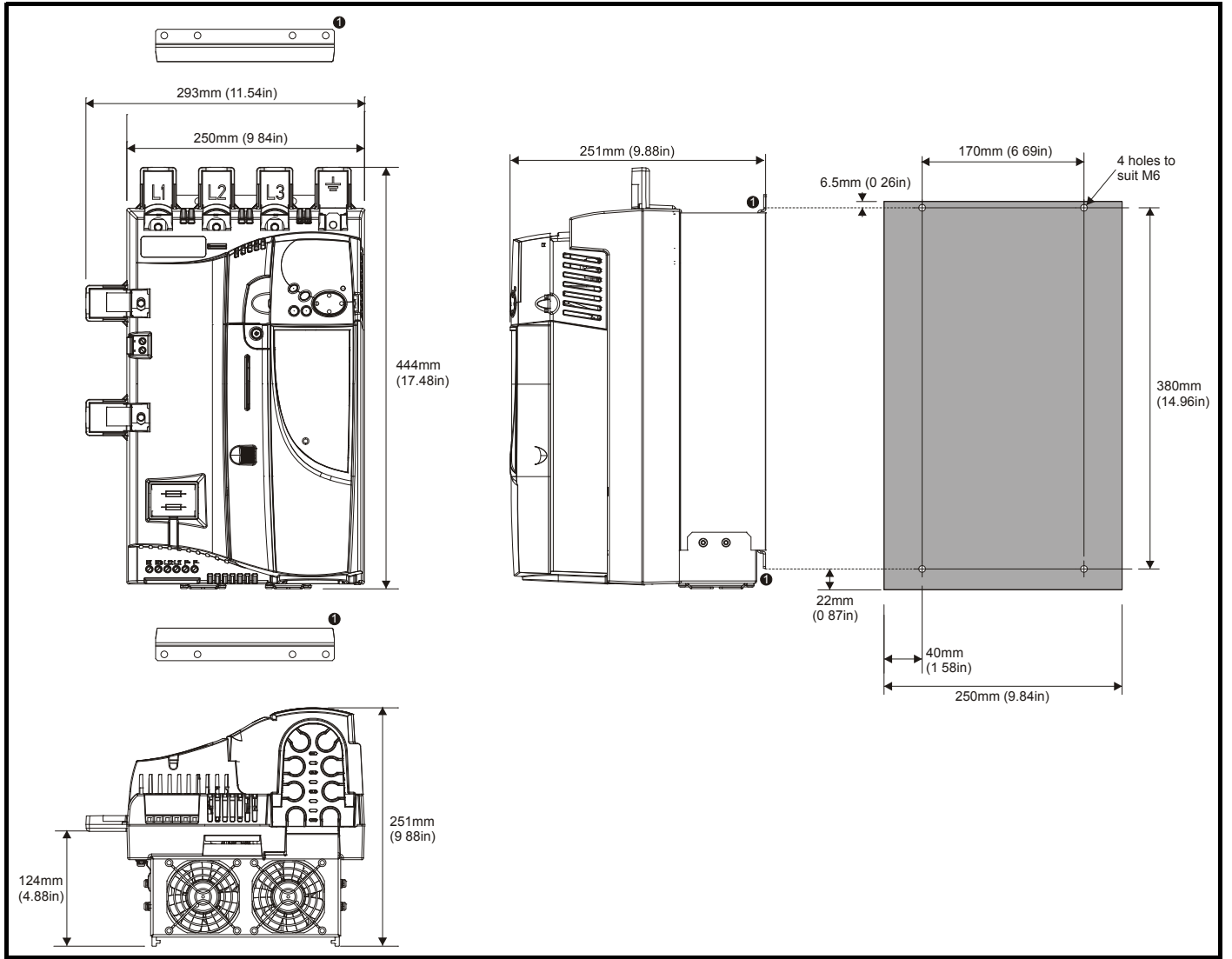
NOTE

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

NOTE

Fans are only installed to the MP75A4(R) and MP75A5(R).

Figure 3-6 Overall size 1B dimensions

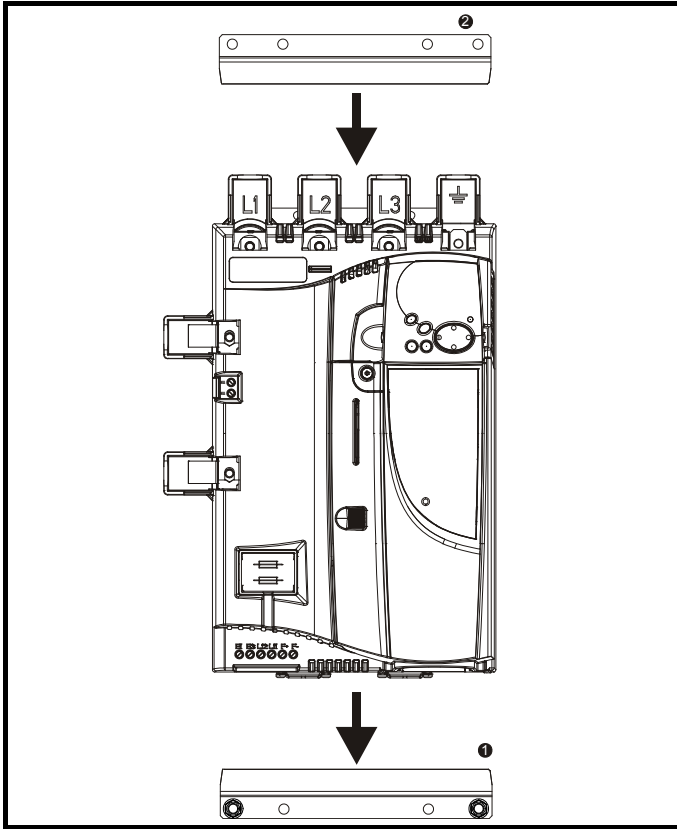


1. The two outer holes must be used for mounting the Mentor MP.

NOTE

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

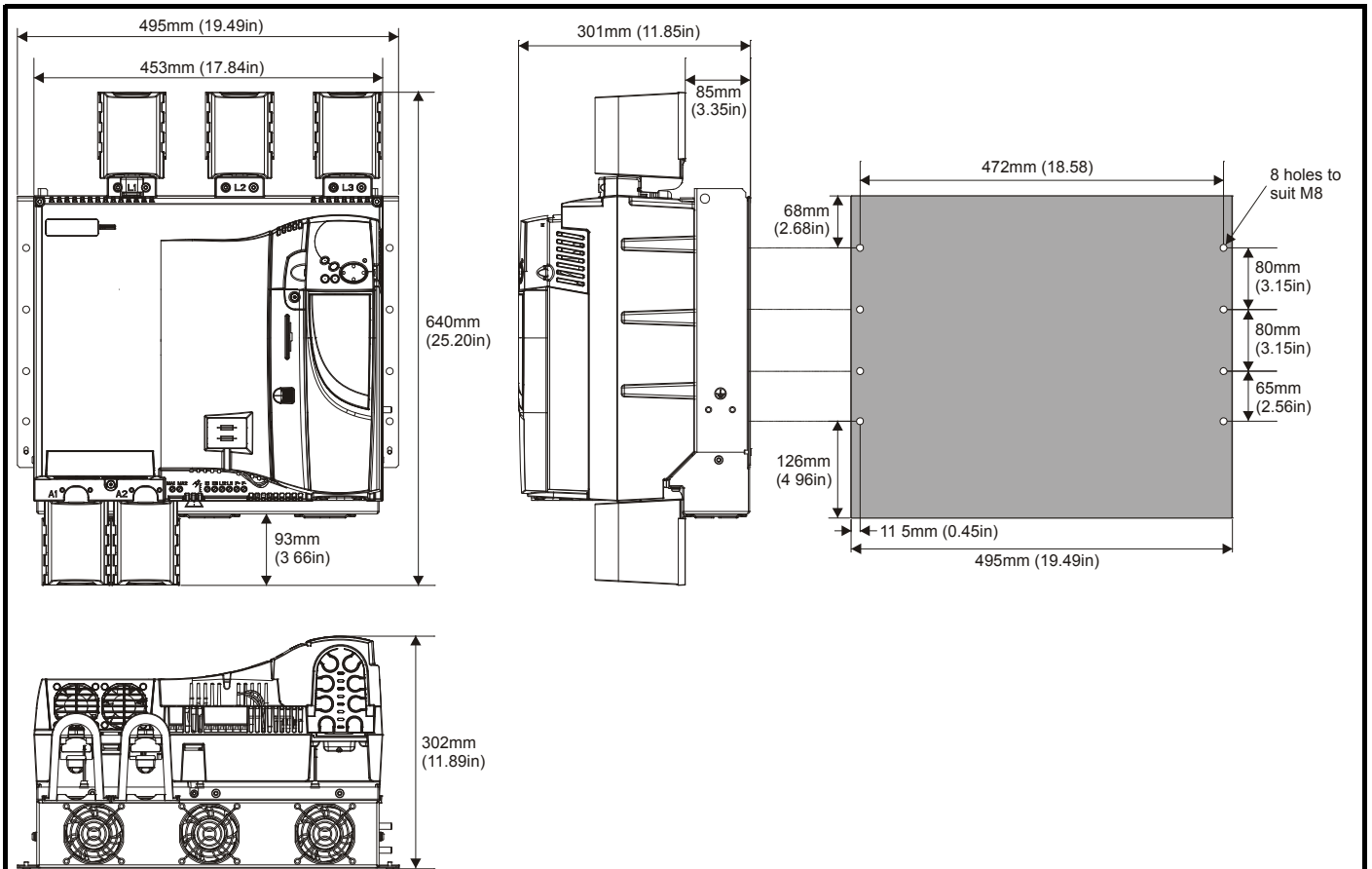
Figure 3-7 Installing the mounting feet bracket on size 1 drives



The bottom mounting bracket (1) should be installed to the back plate first with the screws fully tightened. 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, fix the top mounting bracket accordingly and tighten the screws.

It is not necessary to tighten the bottom mounting brackets with the drive in place. The brackets are designed to clamp the drive heatsink against the back plate.

Figure 3-8 Overall size 2A / 2B dimensions



NOTE

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

Figure 3-9 Size 2C front view and mounting dimensions

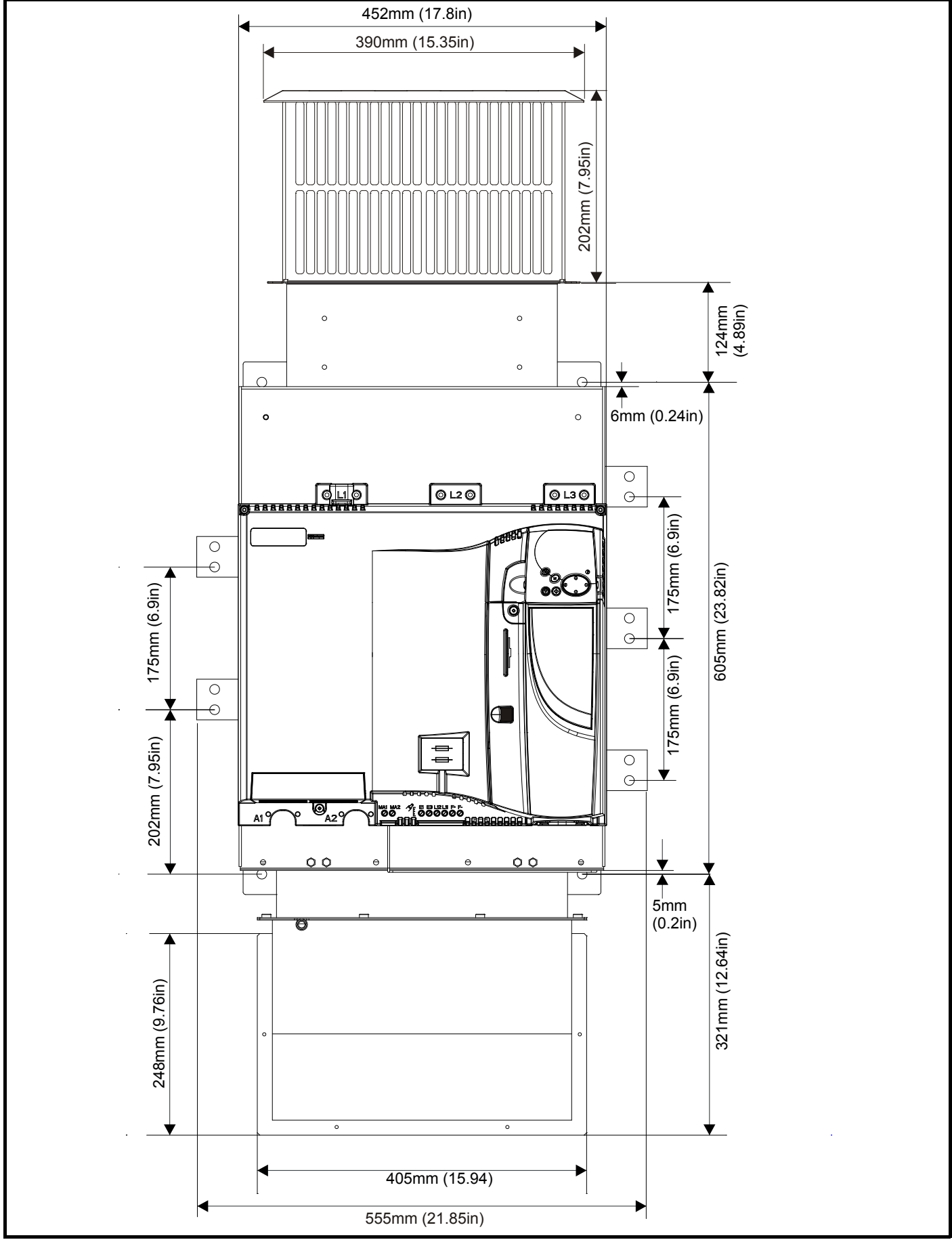
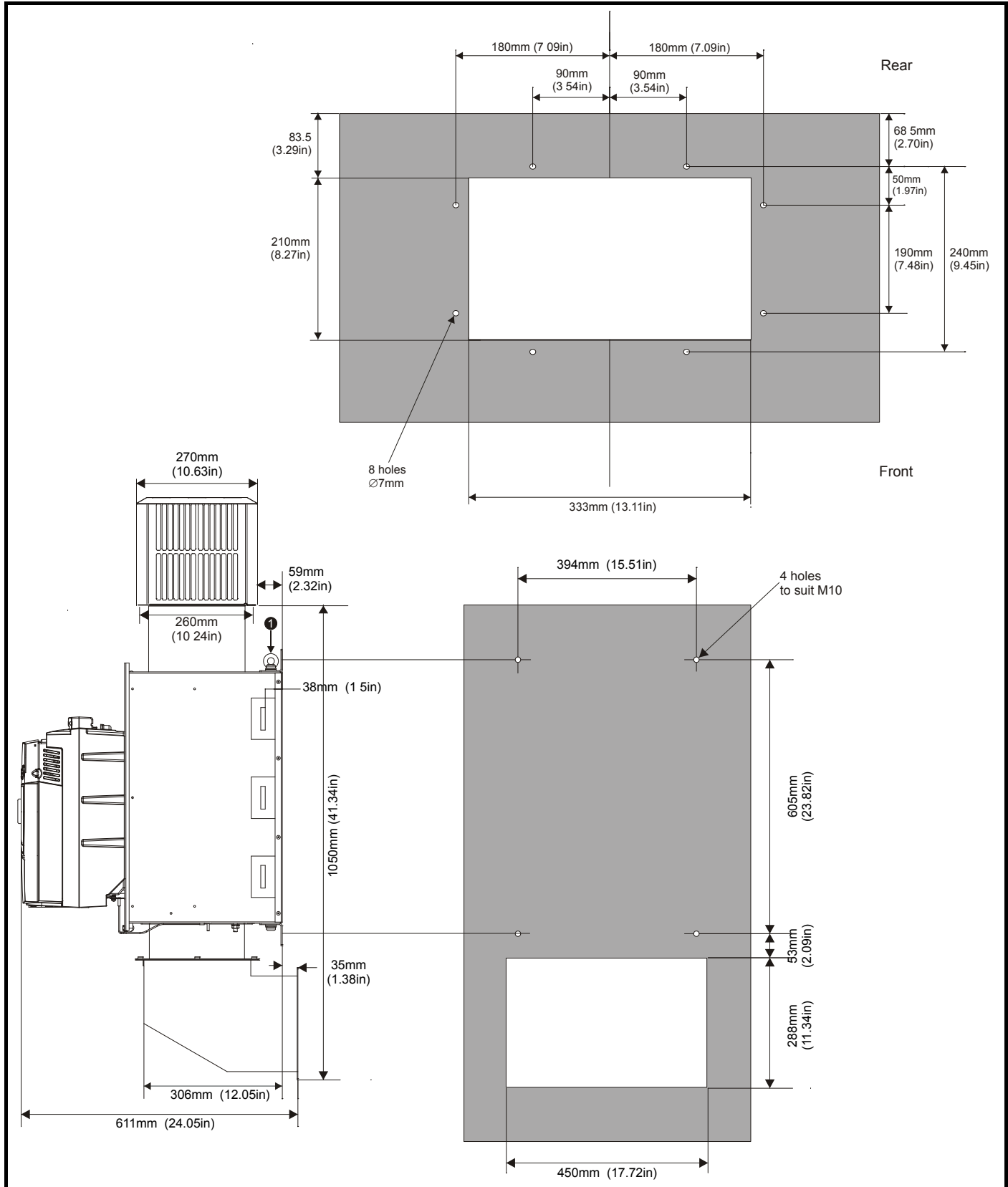


Figure 3-10 Size 2C back-plate and mounting detail



NOTE

1. M10 eye-bolts can be inserted in the location shown for lifting the drive. These are not supplied with the drive.

NOTE

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

Figure 3-11 Size 2D front view and mounting dimensions

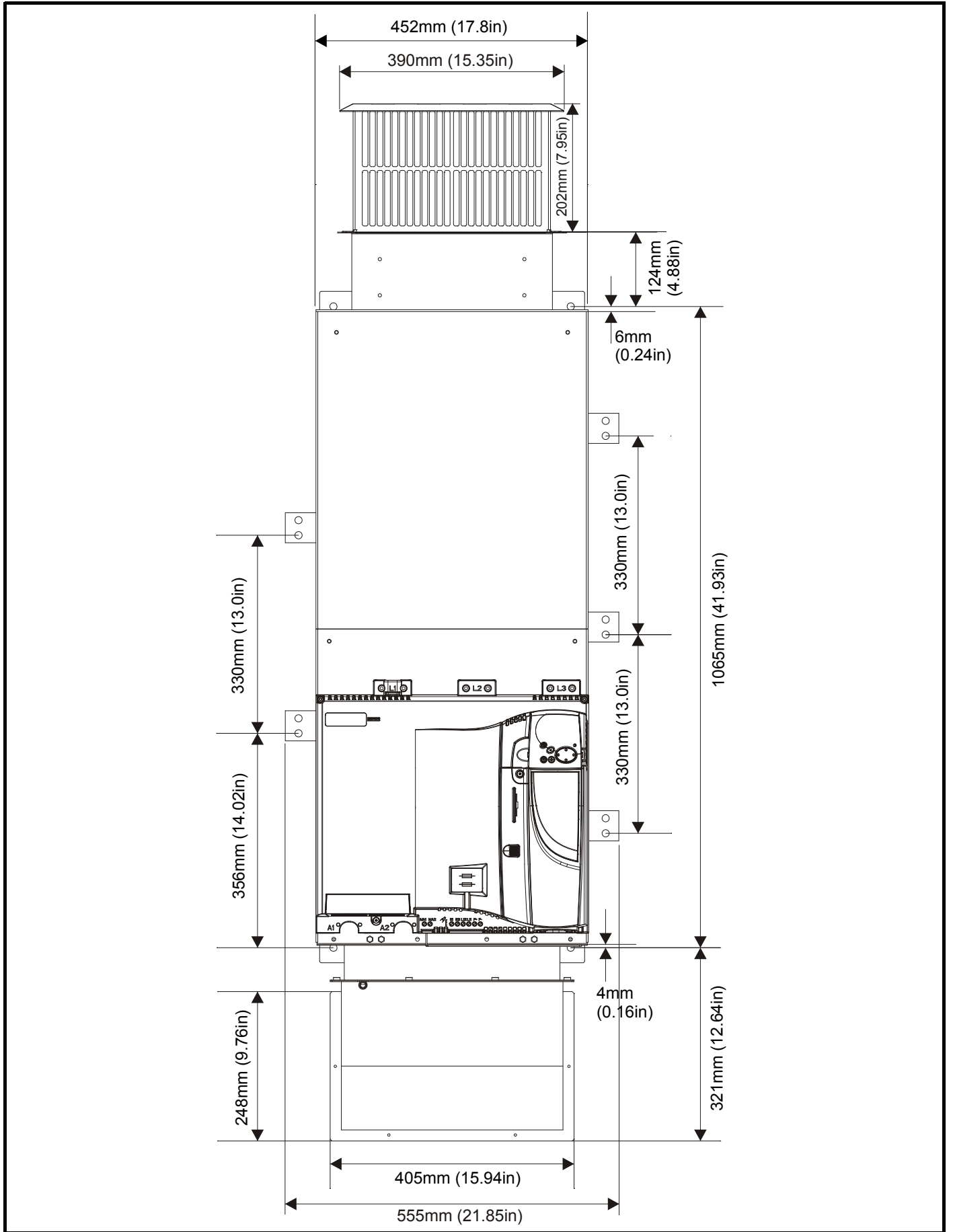
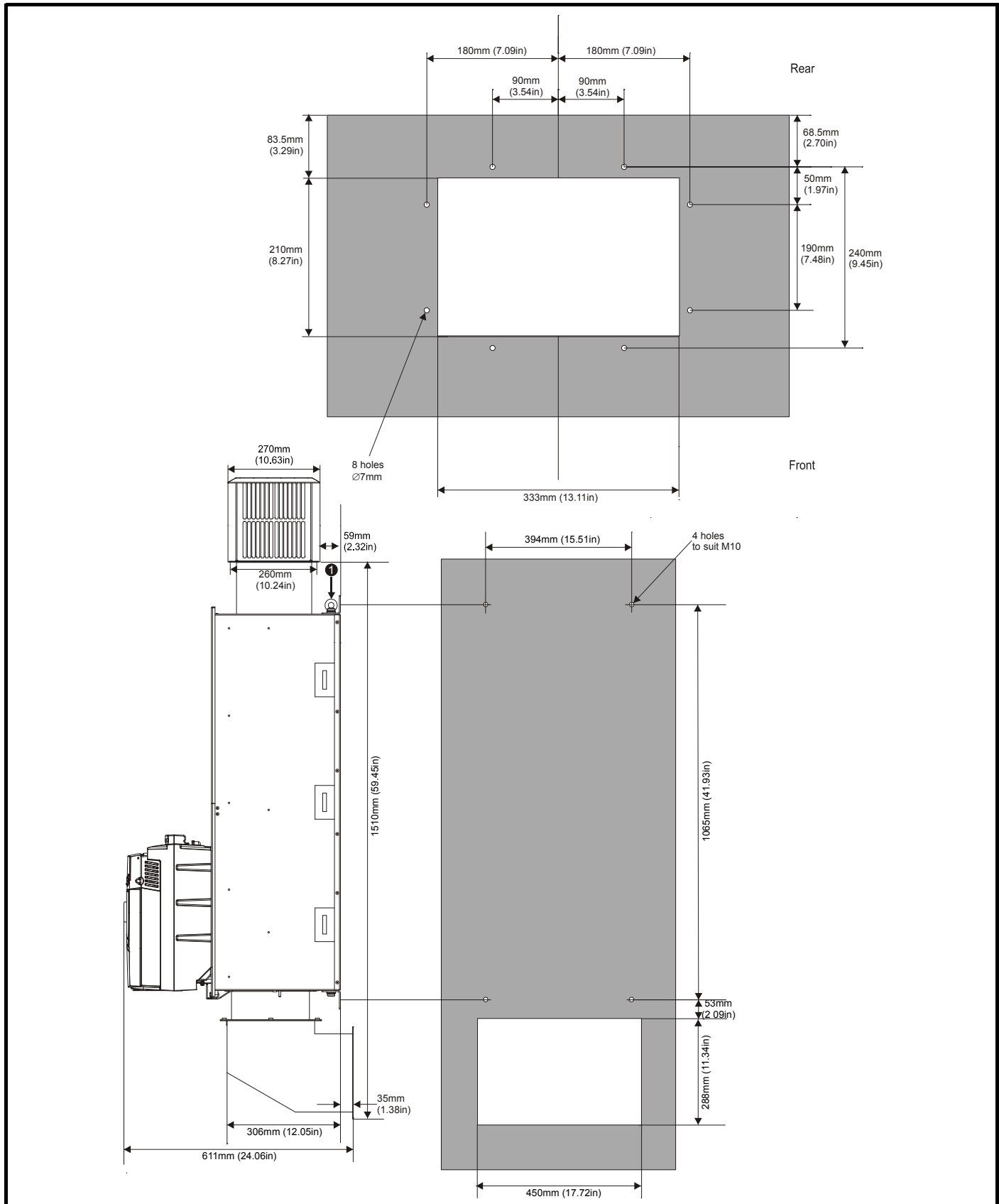


Figure 3-12 Size 2D back-plate and mounting detail



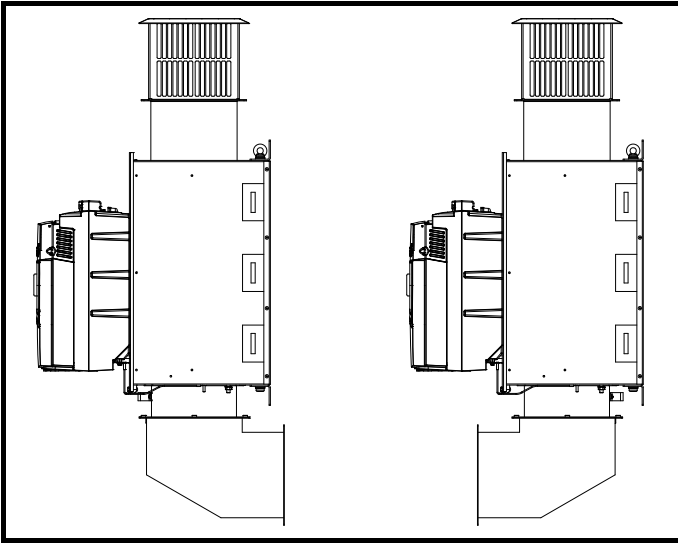
NOTE

1. M10 eye-bolts can be inserted in the location shown for lifting the drive. These are not supplied with the drive.

NOTE

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

Figure 3-13 Mounting methods of size 2C / 2D air duct



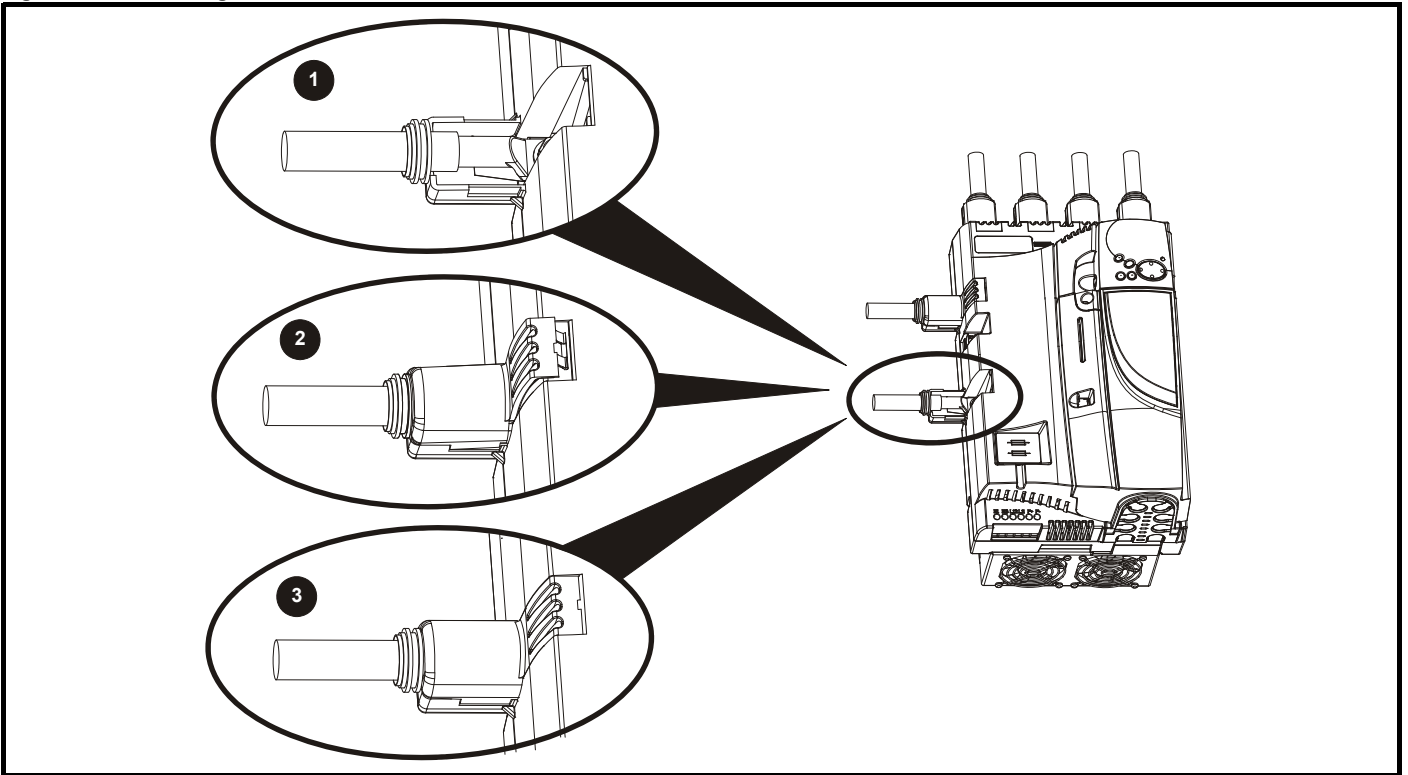
The Mentor MP size 2C and 2D air duct can be turned 180° to suit the customer's infrastructure.

NOTE

There is no seal provided with this product for sealing off the gap around the air duct when mounted.

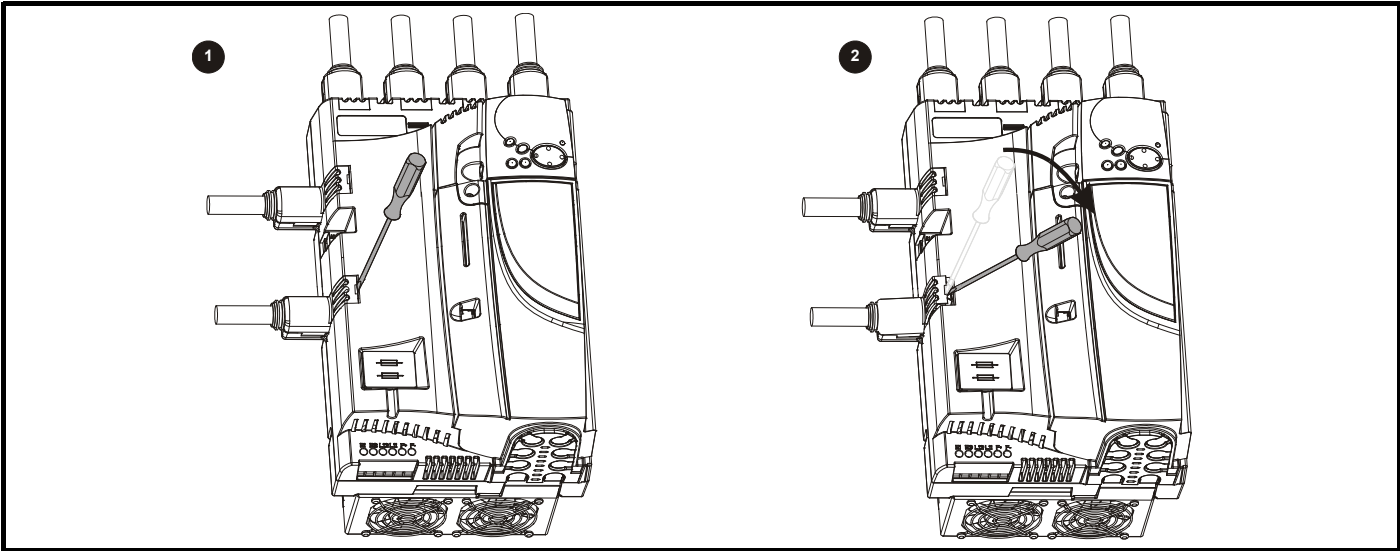
3.5 Installing and removing the terminal shrouds

Figure 3-14 Installing the terminal shrouds on size 1 drives



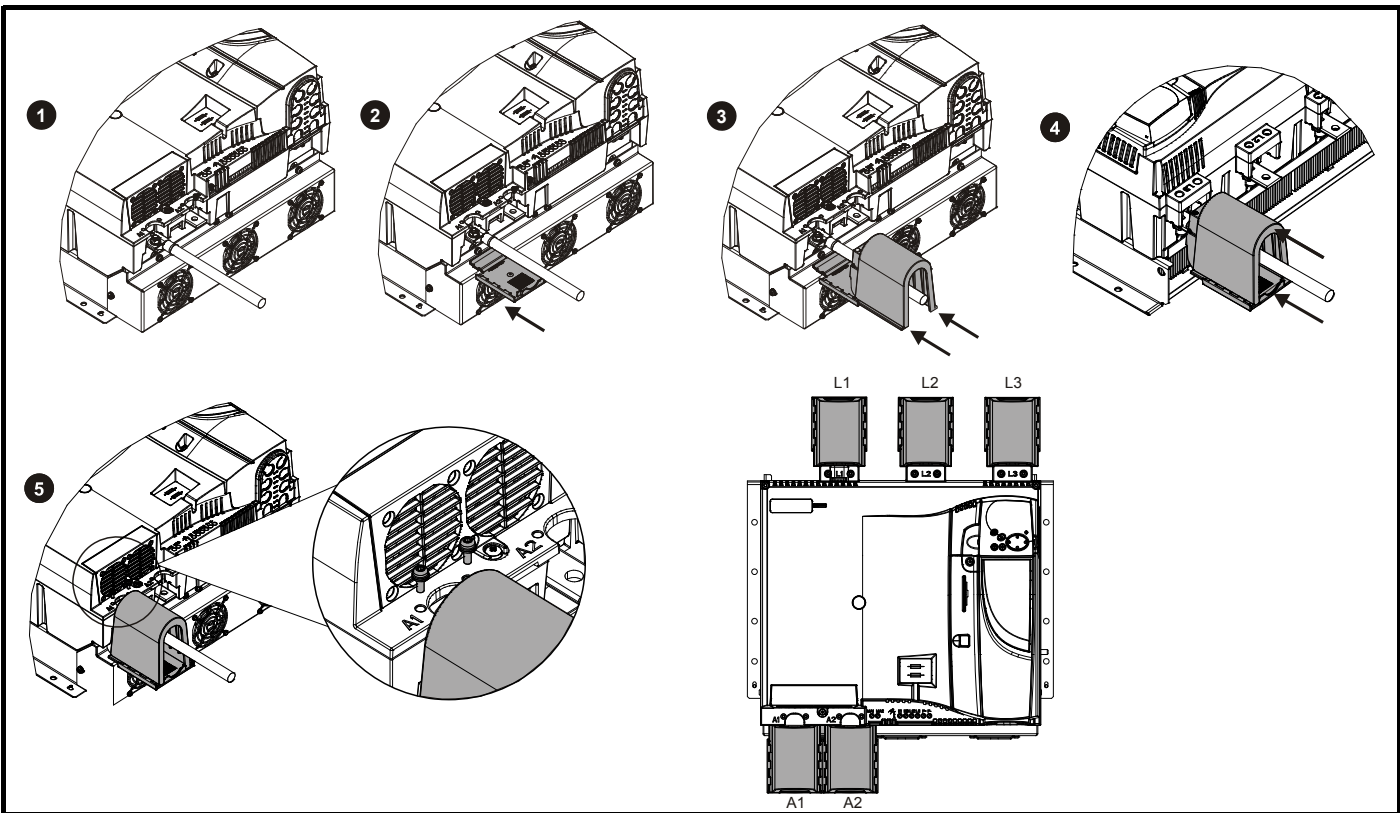
1. Thread the AC supply and DC output connectors through the grommets provided and connect them to the drive.
2. Place the terminal shroud over the top of the connectors and click into place (3).

Figure 3-15 Removing the terminal shrouds on size 1 drives



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

Figure 3-16 Installing the terminal shrouds on size 2 drives



1. Assemble the cable to the busbar.
2. Place the terminal shroud base cover underneath the cable in the orientation shown.
3. Place the terminal shroud over the cable in the orientation shown, slide the terminal shroud on to the base cover in the direction shown until it clicks in to place.
4. For all power connections slide in the terminal shroud sub-assembly in the direction as shown.
5. Insert the 2 x M4 x 16 screws using a pozi drive screwdriver.

NOTE

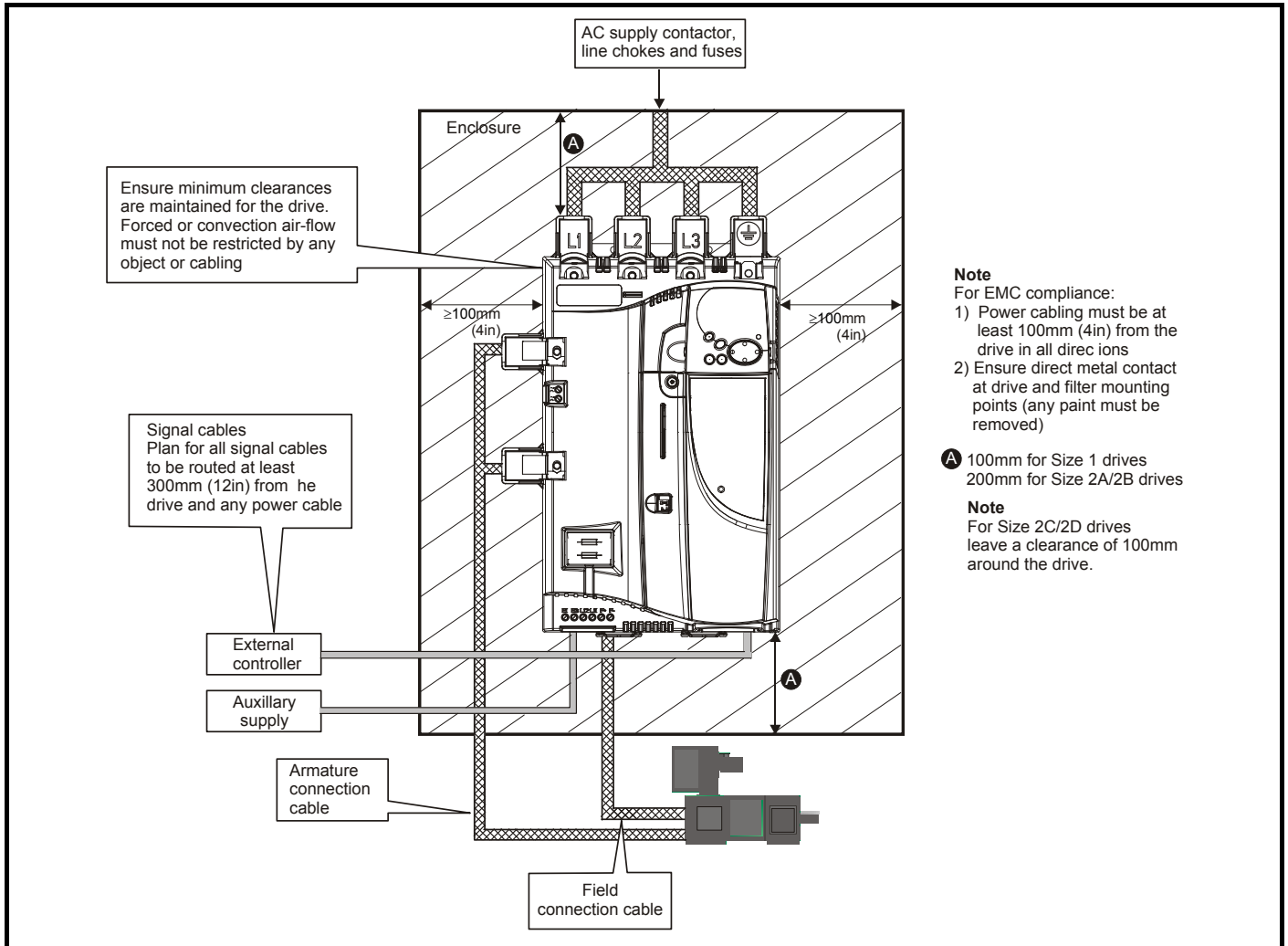
To remove the terminal shrouds, please reverse the process above.

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 3-17 Enclosure layout



3.6.2 Enclosure sizing

Refer to section 12.1.2 *Typical short-term overload limits* on page 145 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

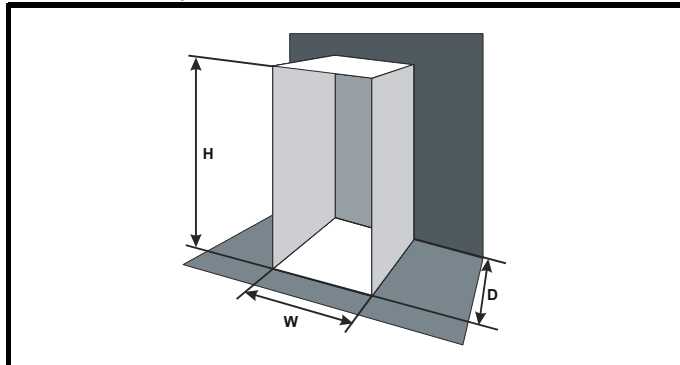
Dissipation from other heat generating equipment in the enclosure: 22W (max).

Total dissipation: $(2 \times 125) + 22 = 272W$

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

The value of $5.5 \text{ W/m}^2\text{/}^\circ\text{C}$ 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 3-18 Enclosure having front, sides and top panels free to dissipate heat



Insert the following values:

| | |
|------------------|------|
| T_{int} | 40 C |
| T_{ext} | 30 C |
| k | 5.5 |
| P | 272W |

The minimum required heat conducting area is then:

$$A_e = \frac{272W}{5,5(40 - 30)}$$

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

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 $H = 2\text{m}$ and $D = 0.6\text{m}$, obtain the minimum width:

$$W = \frac{4,945 - (2 \times 2 \times 0,6)}{2 + 0,6}$$

$$= 0.979 \text{ m (38.5 in)}$$

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:

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

Where:

| | |
|------------------|--|
| V | Air-flow in m^3 per hour ($1 \text{ m}^3/\text{hr} = 0.59 \text{ ft}^3/\text{min}$) |
| T_{ext} | Maximum expected temperature in C <i>outside</i> the enclosure |
| T_{int} | Maximum permissible temperature in C <i>inside</i> the enclosure |
| P | Power in Watts dissipated by <i>all</i> heat sources in the enclosure |
| k | Ratio of $\frac{P_0}{P_1}$ |

Where:

P_0 is the air pressure at sea level

P_1 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 C
- Maximum ambient temperature outside the enclosure: 30 C

Dissipation of each drive: 168W

Dissipation from other heat generating equipment: 15 W

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

Insert the following values:

| | |
|------------------|------|
| T_{int} | 40 C |
| T_{ext} | 30 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)



IP rating

It is the installer's responsibility to ensure that any enclosure which allows access to drives from frame sizes 2A to 2D while the product is energized, provides protection against contact and ingress to the requirements of IP20.

An explanation of IP rating is provided in section 12.1.13 *IP rating* on page 150.

3.9 Electrical terminals

3.9.1 Location of the power and ground terminals

Figure 3-19 Location of the power and ground terminals on size 1 drives

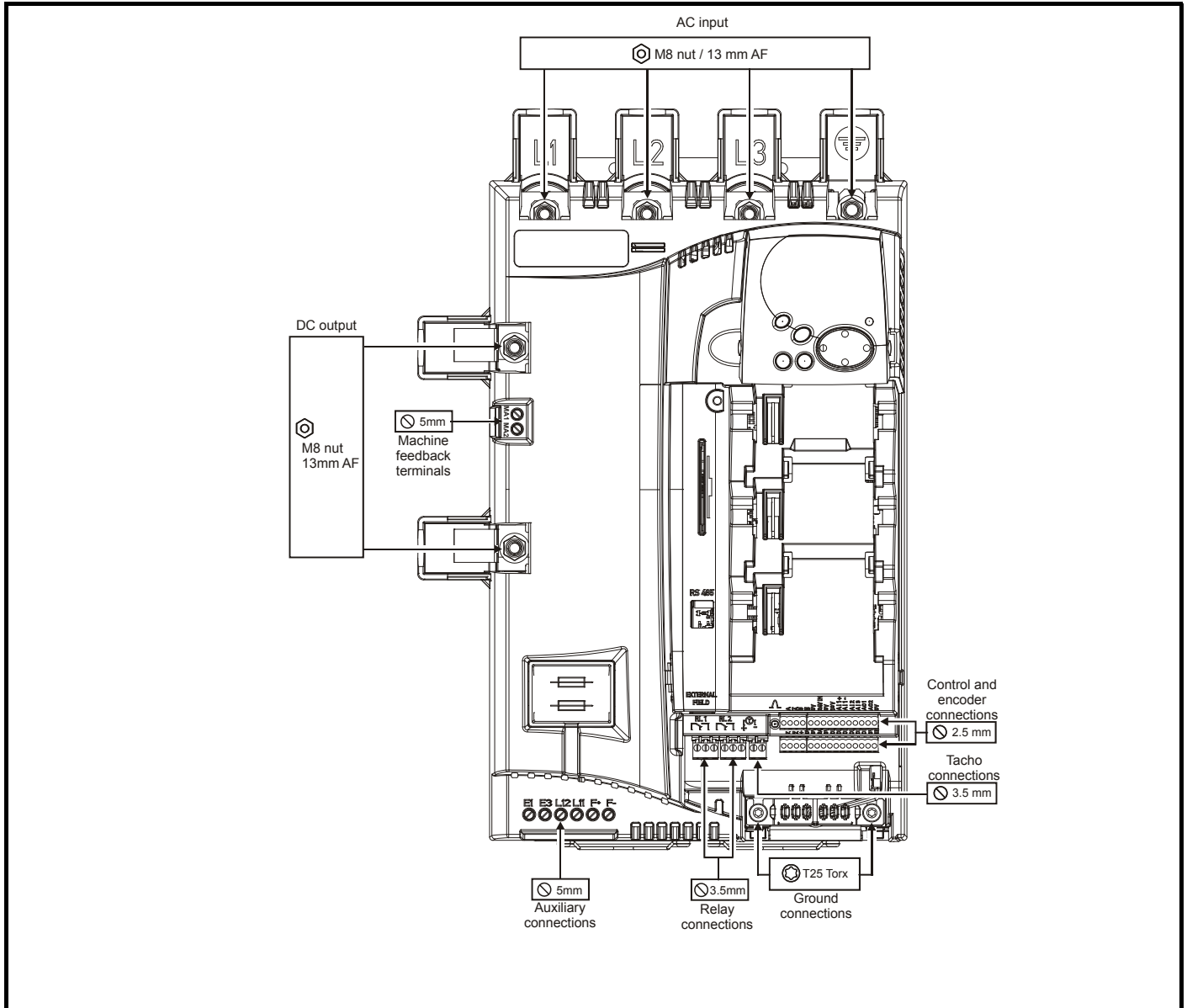


Figure 3-20 Location of the power and ground terminals on size 2A and 2B drives

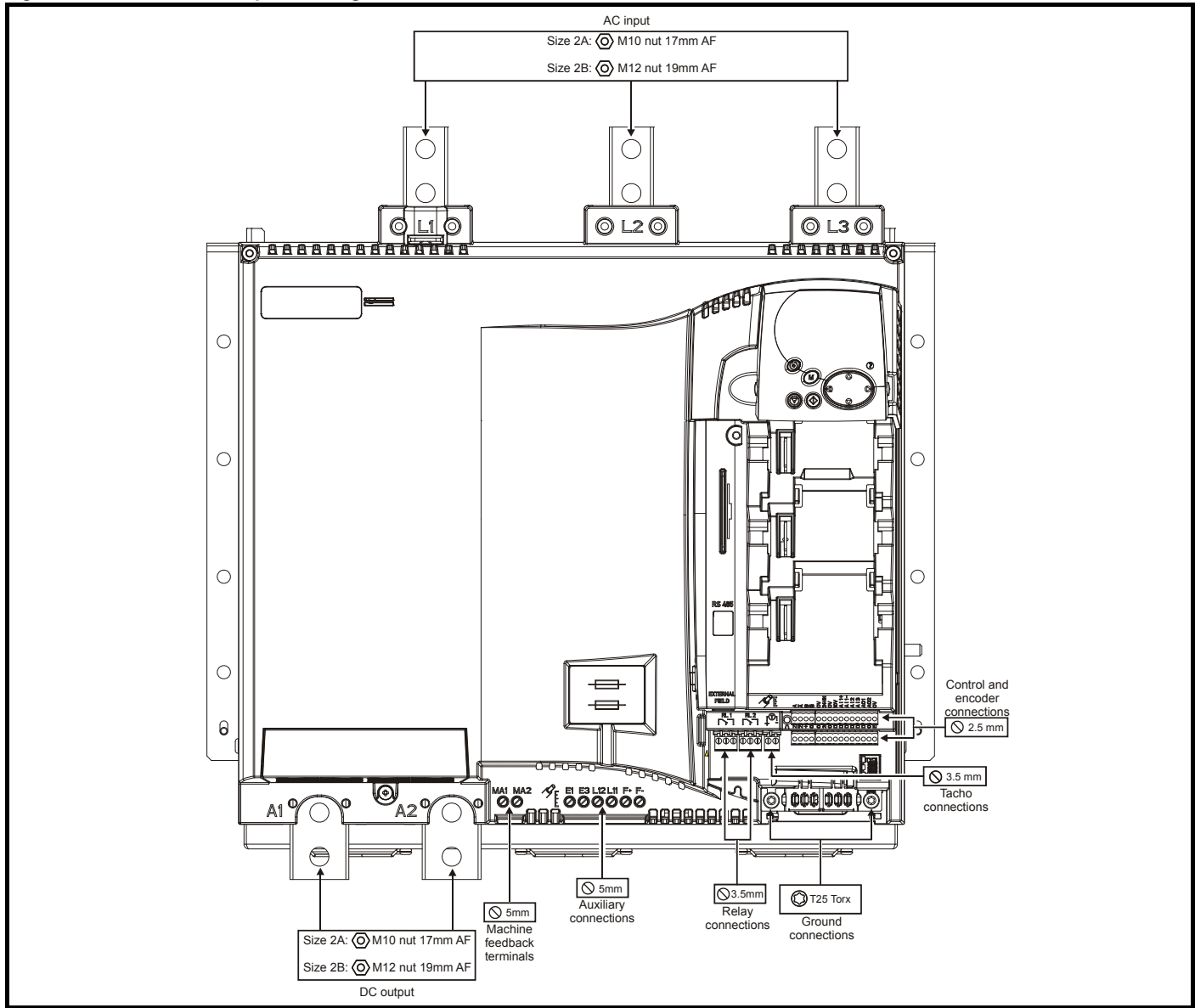
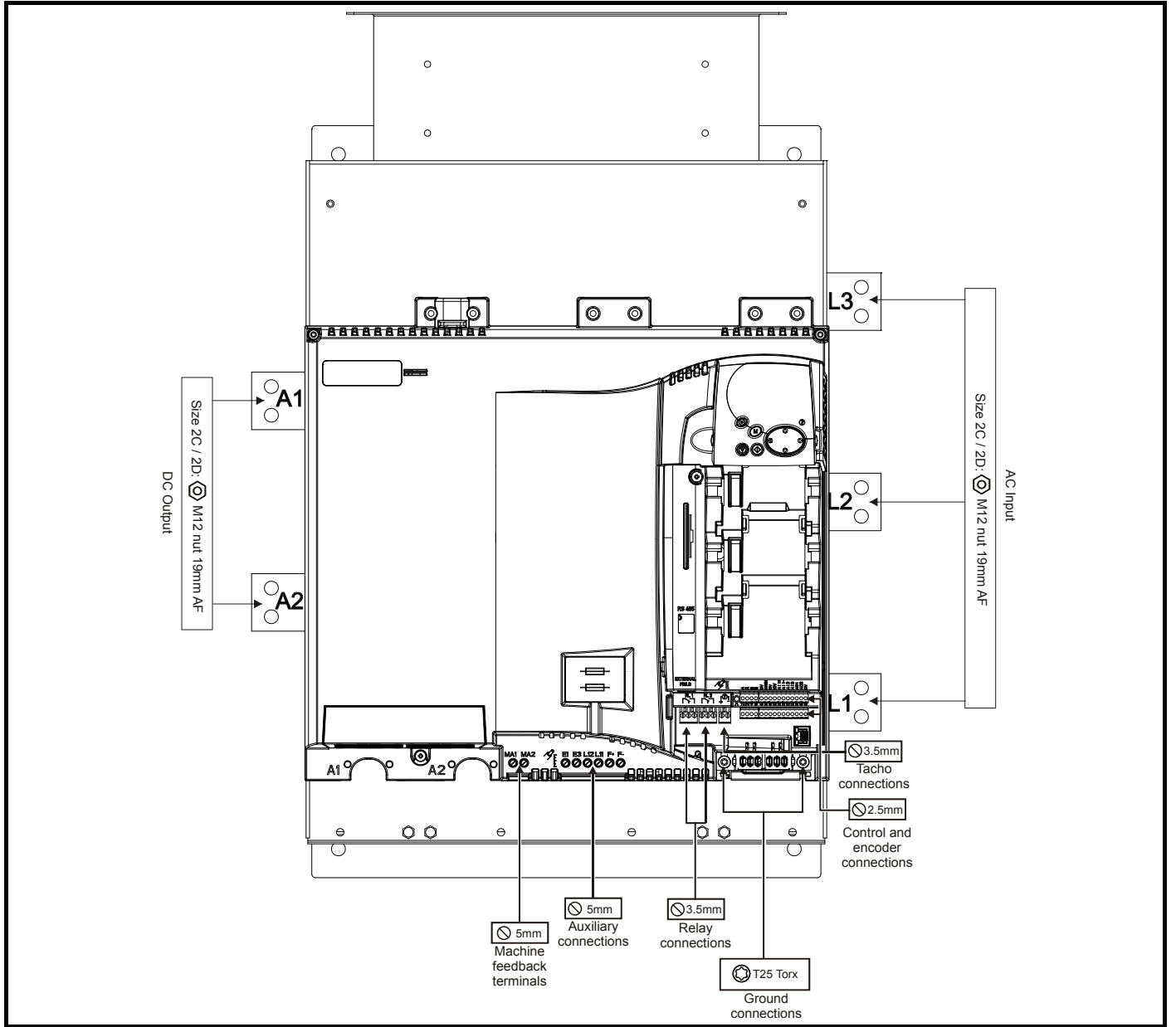


Figure 3-21 Location of the power and ground terminals on size 2C and 2D drives



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 3-1 Drive control, status relay and encoder terminal data

| Model | Connection type | Torque setting |
|-------|------------------------|------------------|
| All | Plug-in terminal block | 0.5 Nm 4.5 lb in |

Table 3-2 Drive auxiliary and machine armature terminal data

| Model | Connection type | Torque setting |
|-------|-----------------|------------------|
| All | Terminal block | 0.5 Nm 4.5 lb in |

Table 3-3 Drive power stage terminals on size 1 drives

| Model | Connection type | Torque setting |
|-------|-----------------|------------------|
| All | M8 stud | 10 Nm 89.0 lb in |

Table 3-4 Drive power stage terminals on size 2 drives

| Model | Connection type | Torque setting |
|---------|-----------------|---------------------|
| Size 2A | M10 stud | 15 Nm (133.0 lb in) |
| Size 2B | M12 stud | 30 Nm (266.0 lb in) |
| Size 2C | | |
| Size 2D | | |

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: |
| | <ul style="list-style-type: none"> • 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. |
|--|---|

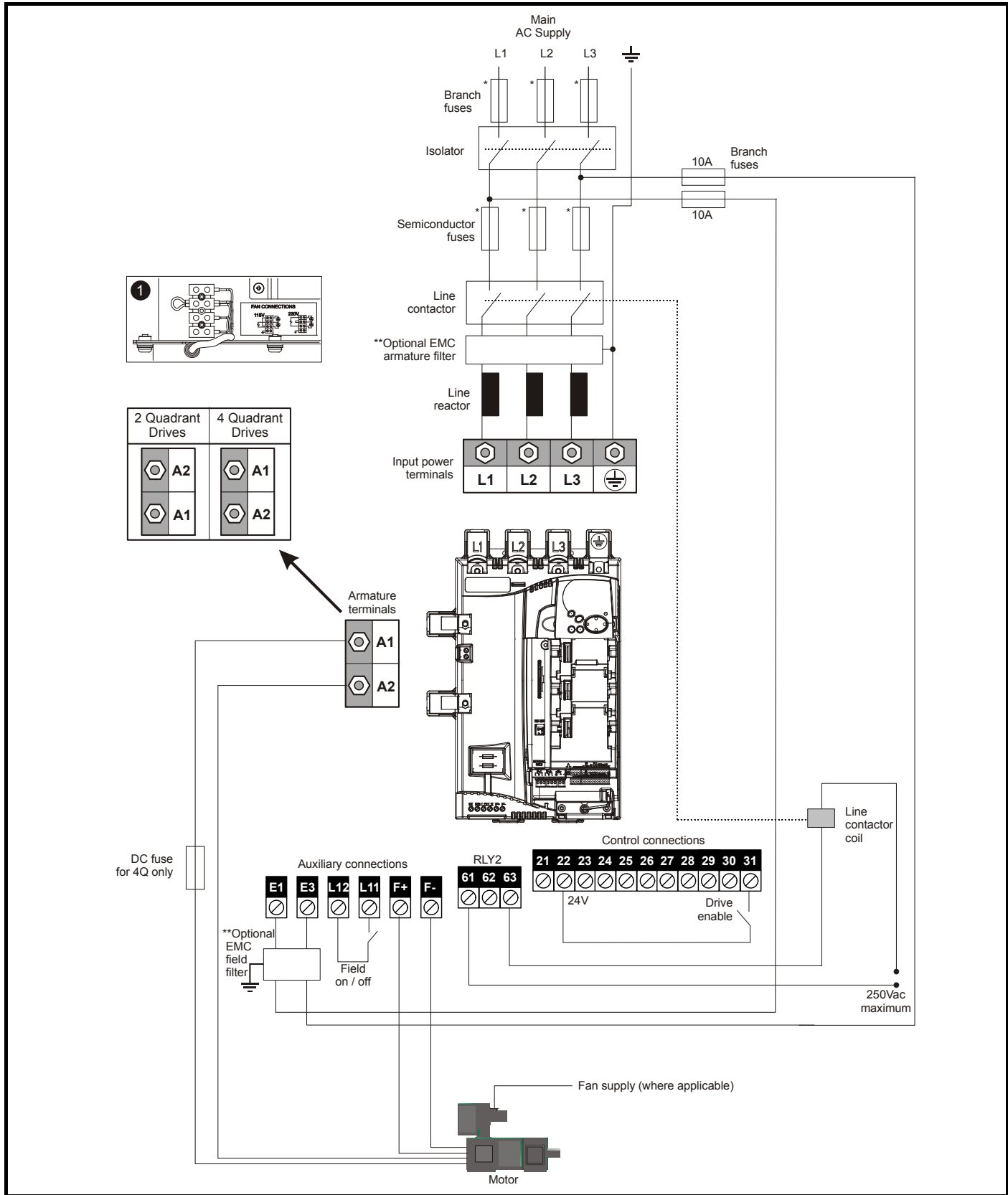
| | |
|--|--|
|  WARNING | STOP function The STOP function does not remove dangerous voltages from the drive, the motor or any external option units. |
|--|--|

| | |
|---|--|
|  WARNING | Drives are suitable for use on supplies of installation category III and lower, according to IEC 60664-1. 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

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

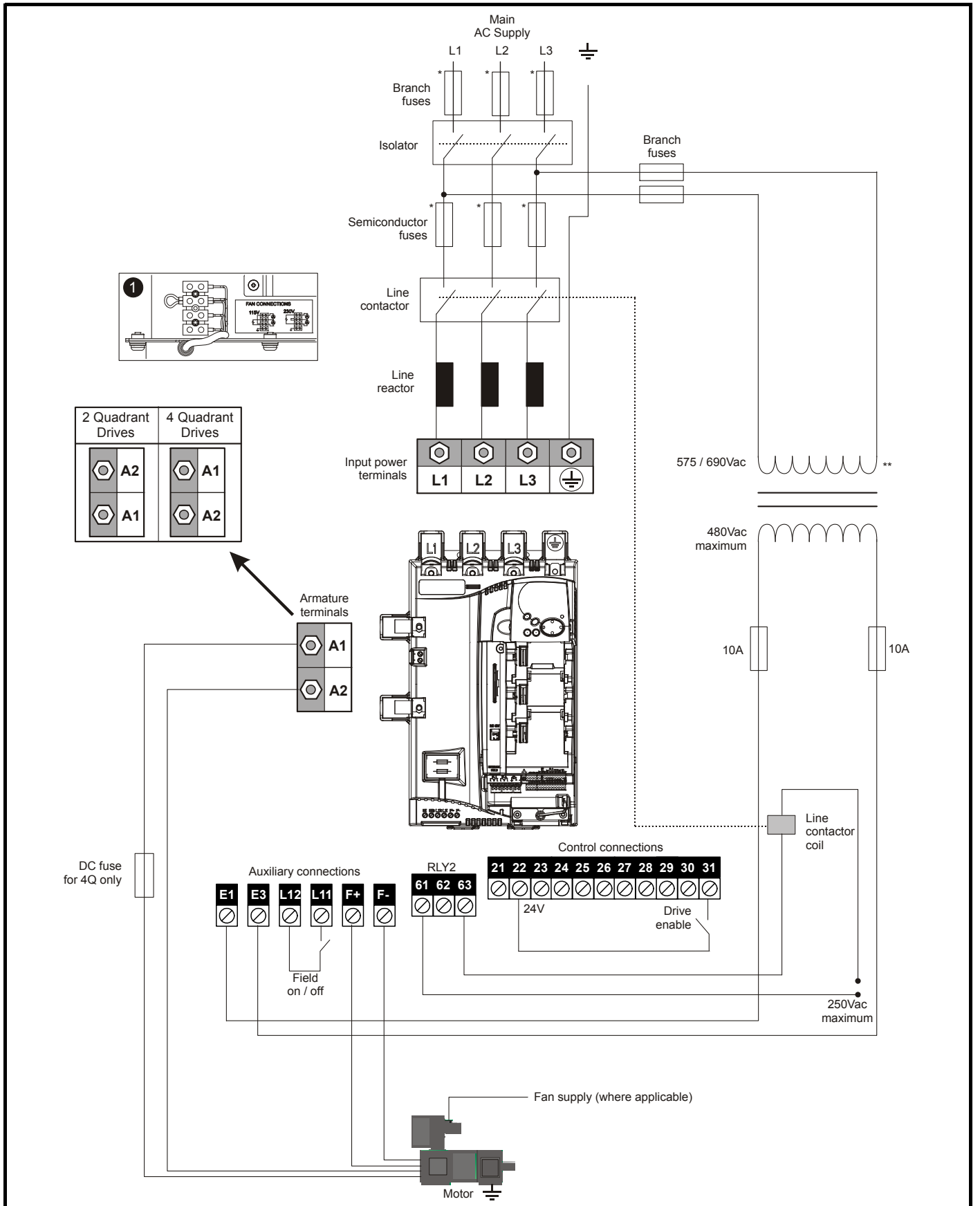


1. End user must provide 230 / 115Vac supply for the internal fans on frame sizes C and D, see section 4.12 on page 49.

* For fuse ratings refer to section 4.6 *Cable and fuse size ratings* on page 38.

**For further information on EMC filters, see section 4.9.3 *EMC filter information* on page 47.

Figure 4-2 Power connections for 575V / 600V / 690V drives



1. End user must provide 230 / 115Vac supply for the internal fans on frame sizes C and D, see section 4.12 on page 49.

* For fuse ratings refer to section 4.6 *Cable and fuse size ratings* on page 38.

** 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 on size 1 drives

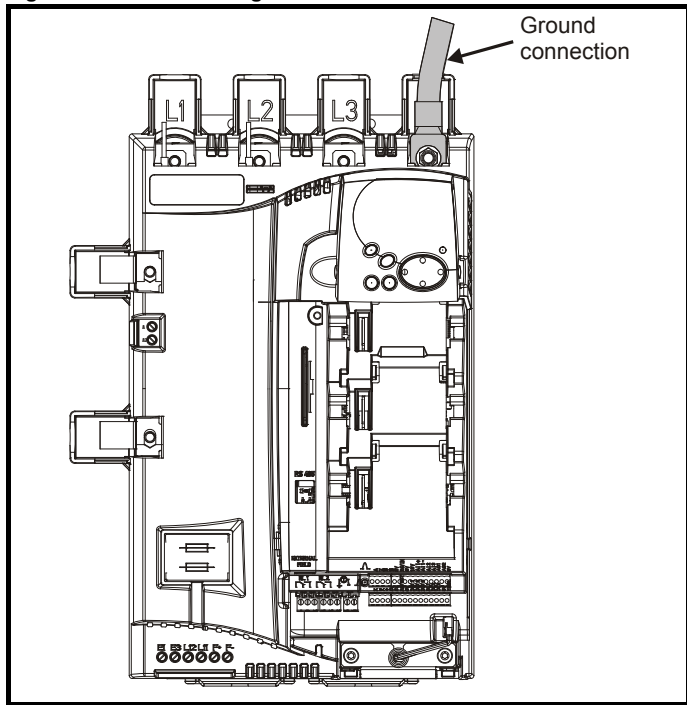


Figure 4-4 Location of ground connections on size 2A / 2B drives

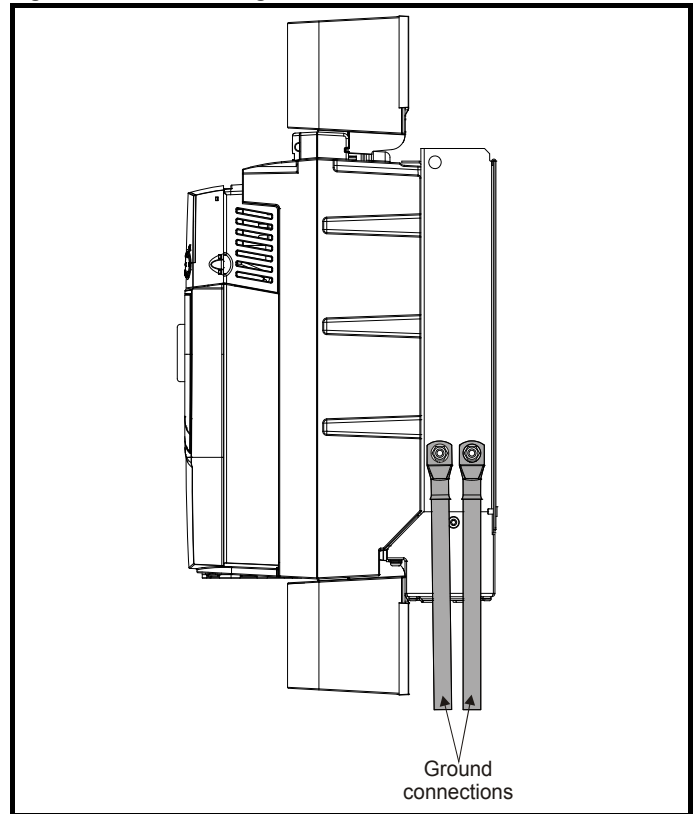
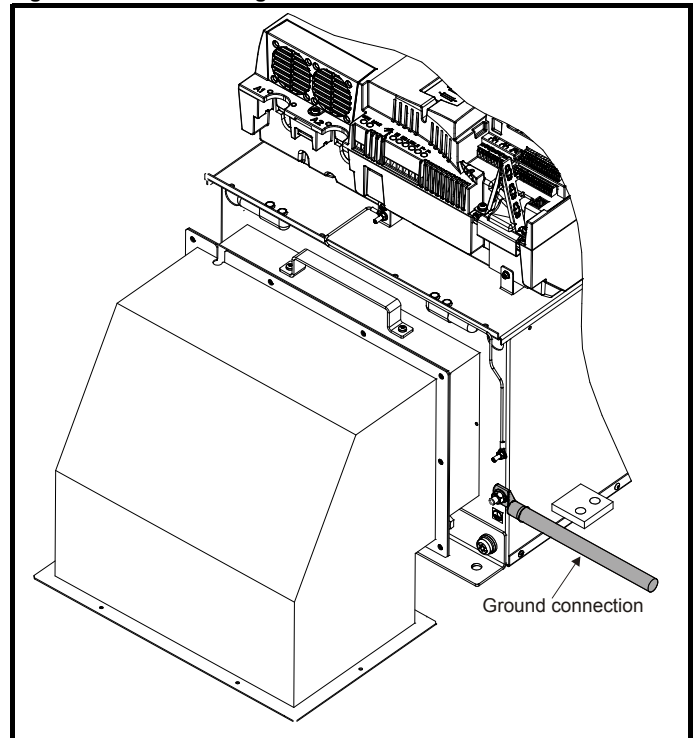



Figure 4-5 Location of ground connections on size 2C / 2D drives



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 size 1 drives. An optional rating of 575Vrms and 690Vrms is available for size 2 drives.



WARNING Grounded delta supplies exceeding 575V are not permitted for drives up to and including 210A. Grounded delta supplies exceeding 600V are not permitted for drives rated 350A and above.

4.3.1 Supply types

Drives rated for supply voltages of up to 575V (rated up to 210A) and 600V (350A and above), 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").

Grounded delta supplies >575V are not permitted for drives rated up to and including 210A. Grounded delta supplies >600V are not permitted for drives rated 350A and above.

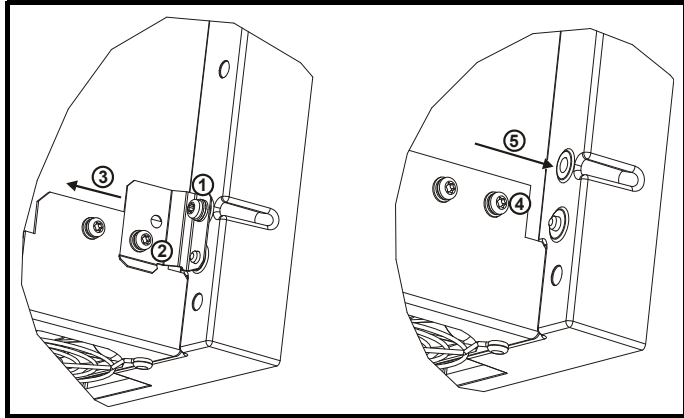
4.3.2 Supply fault current

The maximum fault current level of the supply to all circuits is 100kA subject to the capability of the semiconductor fuse fitted.

4.3.3 MOV ground disconnect


The facility for disconnecting the jumper (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 jumper (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 4-6 Removing the MOV ground connection on size 1 drives



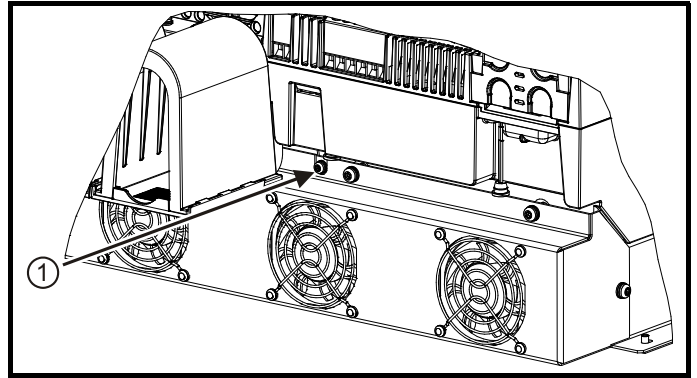
The method for disconnecting the MOV ground connection on size 1 drives is shown below:

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).



WARNING 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.

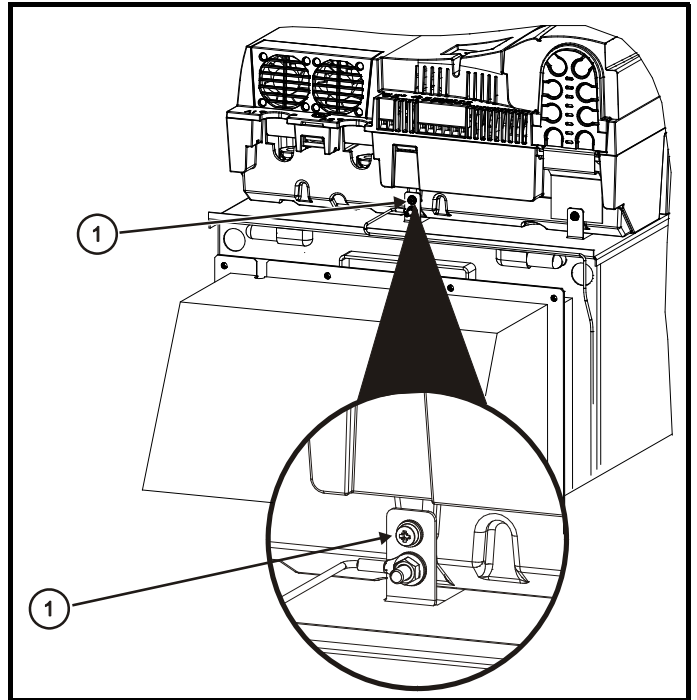
Figure 4-7 Removing the MOV ground connection on size 2A / 2B drives



The method for disconnecting the MOV ground connection on size 2A / 2B drives is shown below:

1. Remove the M4 x 30 screw using T20 Torx driver . If re-fitting the M4 x 30 screw using T20 Torx driver, the screw must be tightened to a torque of 2.5Nm (1.84 lb ft).

Figure 4-8 Removing the MOV ground connection on size 2C / 2D drives



The method for disconnecting the MOV ground connection on size 2C / 2D drives is shown in Figure 4-8 above:

1. Remove the M4 x 30 screw using T20 Torx driver . If re-fitting the M4 x 30 screw using T20 Torx driver, the screw must be tightened to a torque of 2.5Nm (1.84 lb ft).

4.3.4 Main AC supply (L1, L2, L3)

Table 4-1 Three phase AC supply

| Specification | Product voltage variant | | |
|------------------------|-------------------------|------|------|
| | 480V | 575V | 690V |
| Maximum nominal supply | 480V | 575V | 690V |
| Tolerance | +10% | | |
| Minimum 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: EN 61800-3:2004 "Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods".

NOTE

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

Table 4-2 Minimum required line inductance for a typical application (50% ripple content)

| Drive rated current A | System voltage | | | | Typical current rating A | Maximum current rating A |
|--------------------------|----------------|------------|------------|------------|-----------------------------|-----------------------------|
| | 400V μH | 480V μH | 575V μH | 690V μH | | |
| 25 | 220 | 260 | 320 | | 21 | 22 |
| 45 | 220 | 260 | 320 | | 38 | 40 |
| 75 | 220 | 260 | 320 | | 63 | 67 |
| 105 | 220 | 260 | 320 | | 88 | 94 |
| 155 | 160 | 190 | 230 | | 130 | 139 |
| 210 | 120 | 140 | 170 | | 176 | 188 |
| 350 | 71 | 85 | 110 | 120 | 293 | 313 |
| 420 | 59 | 71 | | | 351 | 375 |
| 470 | | | 80 | 91 | 393 | 420 |
| 550 | 45 | 54 | | | 460 | 492 |
| 700 | 36 | 43 | 53 | 61 | 586 | 626 |
| 825 | | | 45 | 52 | 690 | 738 |
| 900 | 28 | 33 | | | 753 | 805 |
| 1200 | 21 | 25 | 31 | 36 | 1004 | 1073 |
| 1850 | 18 | 23 | 29 | 32 | 1548 | 1655 |

NOTE

- The above assumes the supply has 1.5% impedance.
- Assumes a minimum supply rating of 5kA and a maximum rating of 60kA.

4.4.1 Auxiliary AC supply and connections

Table 4-3 Terminal functions

| Terminals | Function |
|-----------|--|
| E1, E3 | Supply for control electronics and field controller. |
| 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 4-4 Line to line supply

| Specification | Value |
|------------------------|-------|
| Maximum nominal supply | 480V |
| Tolerance | +10% |
| Minimum nominal supply | 208V |
| Tolerance | -10% |

Each drive has an onboard field controller with the following current ratings.

Table 4-5 Current ratings

| Model | | | Maximum auxiliary supply input current A | Maximum continuous field current rating A |
|------------|------------|------------|---|--|
| MP25A4(R) | MP25A5(R) | | 13 | 8 |
| MP45A4(R) | MP45A5(R) | | | |
| MP75A4(R) | MP75A5(R) | | | |
| MP105A4(R) | MP105A5(R) | | | |
| MP155A4(R) | MP155A5(R) | | | |
| MP210A4(R) | MP210A5(R) | | | |
| MP350A4(R) | MP350A5(R) | MP350A6(R) | 23 | 20 |
| MP420A4(R) | | | | |
| | MP470A5(R) | MP470A6(R) | | |
| MP550A4(R) | | | | |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | | |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | | |
| MP900A4(R) | | | | |
| MP1200A4 | MP1200A5 | MP1200A6 | | |
| MP1850A4 | MP1850A5 | MP1850A6 | | |
| MP1200A4R | MP1200A5R | MP1200A6R | | |
| MP1850A4R | MP1850A5R | MP1850A6R | | |

4.4.2 Supply requirements

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

Frequency range: 45 to 65Hz (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: | 30.0V |
| Minimum continuous operating voltage: | 19.2V |
| Nominal operating voltage: | 24.0V |
| Minimum start up voltage: | 21.6V |
| Maximum power supply requirement at 24V: | 60W |
| Recommended fuse: | 3 A, 50Vdc |

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

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 Mentor MP frame size 1 drives have been designed to accommodate a maximum cable size of 150mm² (350kcmil) with a temperature of 90°C (194°F).

The power terminals on Mentor MP frame size 2A drives have been designed to accommodate a maximum cable size of 2 x 150mm² (2 x 350kcmil) with a temperature of 75°C (167°F).

The power terminals on Mentor MP frame size 2B drives have been designed to accommodate 2 x 240mm² with a temperature of 90°C (194°F). The use of cables sized using the US national electrical code as shown in Table 4-8 requires the use of a terminal adaptor.

The power terminals on Mentor MP frame size 2C and 2D drives have been designed for use with busbars. The drive can be used with cables as shown in Table 4-8 with the use of a terminal adaptor.

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 4-6 Typical cable sizes for size 1 drives

| Model | | IEC 60364-5-52 ^[1] | | UL508C/NEC ^[2] | |
|------------|------------|-------------------------------|-------------------|---------------------------|----------|
| | | Input | Output | Input | Output |
| MP25A4(R) | MP25A5(R) | 2.5mm ² | 4mm ² | 8 AWG | 8 AWG |
| MP45A4(R) | MP45A5(R) | 10mm ² | 10mm ² | 4 AWG | 4 AWG |
| MP75A4(R) | MP75A5(R) | 16mm ² | 25mm ² | 1 AWG | 1/0 AWG |
| MP105A4(R) | MP105A5(R) | 25mm ² | 35mm ² | 1/0 AWG | 1/0 AWG |
| MP155A4(R) | MP155A5(R) | 50mm ² | 70mm ² | 3/0 AWG | 4/0 AWG |
| MP210A4(R) | MP210A5(R) | 95mm ² | 95mm ² | 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 refer to the data supplied by the manufacturer of the high temperature cable.

Table 4-7 Auxiliary wiring for size 1 drives

| Frame size | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-4 Column B2 | | UL 508C | |
|------------|-----------------------|---------------------------|--|------------------------|-----------------|------------------------|
| | | | Column B2 derated by 0,87 of PVC at 40 | | | |
| | | | E1, E3 size | F+, F-, L11 & L12 size | E1, E3 size | F+, F-, L11 & L12 size |
| | | | A | A | mm ² | mm ² |
| 1 | 13 | 8 | 2.5 | 1.5 | 14 AWG | 14 AWG |

Notes for IEC 60364:

IEC 60364-5-52 use installation method B2, table A.52-4 for three loaded conductors, PVC insulation 30 C and apply derating factor for 40 C from table A.52-14 (0.87 for PVC).

Notes for UL508C:

Either 60 C or 75 C cable can be used. Ampacities as per table 40.3 as described in the UL508C standard.

Table 4-8 Typical cable sizes for size 2 drives

| Model | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-12 Column 5 derated by 0.91 for 40 C XLPE cables (IEC 60364-5-52 table A52-14) and 0.77 for cables bunching (IEC 60364-5-52 table A52-17 item 4) | | | | US National Electrical Code | |
|-------------|-----------------------|---------------------------|---|------|----------------------------|-----------------------------|-----------------------------|---------------------|
| | | | 90 C cables at 40 C ambient | | 75 C cable at 40 C ambient | | | |
| | | | A | A | Input size mm ² | Output size mm ² | Input cables Kcmil | Output cables Kcmil |
| MP350A4(R) | MP350A5(R) | MP350A6(R) | 313 | 350 | 120 | 150 | 350 | 400 |
| MP420A4(R) | | | 375 | 420 | 150 | 185 | 400 | 500 |
| | MP470A5(R) | MP470A6(R) | 420 | 470 | 185 | 240 | 500 | 600 |
| MP550A4(R) | | | 492 | 550 | 300 | 2 x 185 | 2 x 300 | 2 x 350 |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | 626 | 700 | 2 x 150 | 2 x 150 | 2 x 500 | 2 x 600 |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | 738 | 825 | 2 x 185 | 2 x 240 | 2 x 600 | 3 x 350 |
| MP900A4(R) | | | 805 | 900 | 2 x 185 | 2 x 240 | 3 x 350 | 3 x 400 |
| MP1200A4(R) | MP1200A5(R) | MP1200A6(R) | 1073 | 1200 | 2 x 300 | 3 x 240 | 3 x 600 | 4 x 400 |
| MP1850A4(R) | MP1850A5(R) | MP1850A6(R) | 1655 | 1850 | 4 x 240 | 4 x 300 | * | * |

* Values are beyond the mechanical design of the drive. At this power level it may be prudent to consider bus-bars.

Notes for IEC 60364:

NOTE

- IEC 60364-5-52 table A 52-12 F method column 5 = Single core cable in free air.
- IEC 60364-5-52 table A52-14 correction factor for ambient air temperature others than 30 C.
- IEC 60364-5-52 table A52-17 item 4 correction factor for groups of more than one circuit or more than one multi-core cable placed on a single layer on a perforated tray.

NOTE

Notes for US National Electrical Code:

- Table 310.17 allowable ampacities of single-insulated conducted rated 0 through 2000V in free air, based on ambient air temperature of 30 C (87 F).
- Derating factor of 0.88 is applied for 40 C to the 75 C cable column. Table 310.17 is based on 30 C (86 F) ambient air temperature.
- NEC 2005 edition table 310.15(B)(2)(a) shows the adjustment factors for more than three current-carrying conductors in a race way or cable, for 4-6 current-carrying conductors 0.80 derating factor is applied.

Table 4-9 Auxiliary wiring for size 2 drives

| Frame size | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-4 Column B2 | | UL 508C | |
|------------|-----------------------|---------------------------|--|------------------------|-----------------|------------------------|
| | | | Column B2 derated by 0,87 of PVC at 40 | | | |
| | | | E1, E3 size | F+, F-, L11 & L12 size | E1, E3 size | F+, F-, L11 & L12 size |
| | | | A | A | mm ² | mm ² |
| 2 | 23 | 20 | 6 | 4 | 10 AWG | 10 AWG |

Notes for IEC 60364:

IEC 60364-5-52 use installation method B2, table A.52-4 for three loaded conductors, PVC insulation 30 C and apply derating factor for 40 C from table A.52-14 (0.87 for PVC).

Notes for UL508C: Either 60 C or 75 C cable can be used. Ampacities as per table 40.3 as described in the UL508C standard.

4.6.1 Ferraz Shawmut fuses

Ferraz Shawmut fuses are recommended for the Mentor MP.

Table 4-10 Ferraz Shawmut semiconductor fusing for size 1 drives

| Model | International | | | USA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|-------------|-------------------|-------------------|----------------|----------------------------------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|-----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|----------------|---------|----------------------------------|------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Field fuses | 10 x 38mm Ferrule | FR10GB69V12.5 | H330011 | 10 x 38mm Ferrule | FR10GB69V12.5 | H330011 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP25A4 | 22 x 58mm Ferrule | FR22GC69V32 | A220915 | A50QS Series American Round Fuse | A50QS60-4 | A218937 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP25A5 | | 22 x 58mm Ferrule | FR22GC69V63 | X220912 | A50QS Series American Round Fuse | A50QS80-4 | L201513 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP45A4 | | | | | 22 x 58mm Ferrule | FR22GC69V100 | W220911 | A50QS Series American Round Fuse | A50QS125-4 | K218417 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP45A5 | | | | | | | | 22 x 58mm Ferrule | FR22GC69V32 | A220915 | A70QS Series SMARTCARD Round Fuse | A70QS60-4 | H219473 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP75A4 | | | | | | | | | | | 22 x 58mm Ferrule | FR22GC69V63 | X220912 | A70QS Series American Round Fuse | A70QS80-4 | X212816 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP75A5 | | | | | | | | | | | | | | 22 x 58mm Ferrule | FR22GC69V100 | W220911 | A70QS Series American Round Fuse | A70QS125-4 | Q216375 | | | | | | | | | | | | | | | | | | | | | | | |
| MP25A4R | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC30UD69V160EF | M300092 | A50QS Series American Round Fuse | A50QS175-4 | A222663 | | | | | | | | | | | | | | | | | | | | |
| MP25A5R | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC30UD69V200EF | N300093 | A50QS Series American Round Fuse | A50QS250-4 | W211251 | | | | | | | | | | | | | | | | | |
| MP45A4R | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC30UD69V315EF | Q300095 | A50QS Series American Round Fuse | A50QS350-4 | T215343 | | | | | | | | | | | | | | |
| MP45A5R | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | A70QS Series American Round Fuse | A70QS175-4 | A223192 | | | | | | | | | | | |
| MP75A4R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | A70QS Series American Round Fuse | A70QS250-4 | L217406 | | | | | | | | |
| MP75A5R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD12C280EF | L300712 | A70QS Series American Round Fuse | A70QS350-4 | M211266 | | | | | |
| MP210A4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | A70QS Series American Round Fuse | A70QS175-4 | A223192 | | |
| MP210A5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | A70QS Series American Round Fuse | A70QS250-4 |
| MP105A4 | 22 x 58mm Ferrule | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | PC70UD12C280EF | L300712 |
| MP105A5 | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP155A4 | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP155A5 | | | | | | | | 22 x 58mm Ferrule | PC70UD12C280EF | L300712 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP210A4 | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP210A5 | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | | | | | | | | | | | | | | | | | | | | | | | | | | |
| MP105A4R | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD12C280EF | L300712 | | | | | | | | | | | | | | | | | | | | | | | |
| MP105A5R | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | | | | | | | | | | | | | | | | | | | | |
| MP155A4R | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | | | | | | | | | | | | | | | | | |
| MP155A5R | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD12C280EF | L300712 | | | | | | | | | | | | | | |
| MP210A4R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C160EF | T300604 | | | | | | | | | | | |
| MP210A5R | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 22 x 58mm Ferrule | PC70UD13C200EF | V300605 | | | | | | | | |

NOTE

A50QS series are only rated up to 500Vac.

Table 4-11 Ferraz Shawmut branch circuit protection fusing for size 1 drives

| Model | International | | | USA | | | | | |
|-----------|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------|---------|
| | Description | Catalogue number | Ref number | Catalogue number | | | | | |
| Auxiliary | 21 x 57mm Cylindrical | HSJ15 | D235868 | AJT10 | | | | | |
| MP25A4 | 22 x 58mm Ferrule | FR22GG69V25 | N212072 | AJT30 | | | | | |
| MP45A4 | | 22 x 58mm Ferrule | FR22GG69V50 | P214626 | AJT45 | | | | |
| MP75A4 | | | 22 x 58mm Ferrule | FR22GG69V80 | Q217180 | AJT70 | | | |
| MP25A4R | | | | 22 x 58mm Ferrule | FR22GG69V25 | N212072 | AJT30 | | |
| MP45A4R | | | | | 22 x 58mm Ferrule | FR22GG69V50 | P214626 | AJT45 | |
| MP75A4R | | | | | | 22 x 58mm Ferrule | FR22GG69V80 | Q217180 | AJT70 |
| MP105A4 | | | | | | | NH 00 Knife Blade | NH00GG69V100 | B228460 | AJT125 |
| MP155A4 | NH 1 Knife Blade | | | | | | | NH1GG69V160 | F228487 | AJT175 |
| MP210A4 | | NH 1 Knife Blade | | | | | NH1GG69V200 | G228488 | AJT225 |
| MP105A4R | NH 00 Knife Blade | | NH00GG69V100 | | | | B228460 | AJT125 | |
| MP155A4R | | NH 1 Knife Blade | NH1GG69V160 | F228487 | | | AJT175 | | |
| MP210A4R | NH 1 Knife Blade | | NH1GG69V200 | G228488 | AJT225 | | | | |

Table 4-12 Ferraz Shawmut DC protection fusing for size 1 drives

| Model | International | | | USA | | |
|----------|---------------------------|---|---------------------------------------|-------------------------------------|------------------|------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number |
| MP25A4R | 20 x 127mm Cylindrical | FD20GB100V32T | F089498 | A70QS Series American Round Fuse | A70QS60-4 | H219473 |
| MP25A5R | | | | | | |
| MP45A4R | 36 x 127mm Cylindrical | FD36GC100V80T | A083651 | A70QS Series American Round Fuse | A70QS80-4 | X212816 |
| MP45A5R | | | | | | |
| MP75A4R | 20 x 127mm Cylindrical | FD20GC100V63T x 2 connected in parallel. | F083656 x 2 connected in parallel. | A70QS Series American Round Fuse | A70QS125-4 | Q216375 |
| MP75A5R | | | | | | |
| MP105A4R | Size 120 Square Body | D120GC75V160TF | R085253 | A70QS Series American Round Fuse | A70QS175-4 | A223192 |
| MP105A5R | | | | | | |
| MP155A4R | Size 121 Square Body | D121GC75V250TF | Q085252 | A70QS Series American Round Fuse | A70QS250-4 | L217406 |
| MP155A5R | | | | | | |
| MP210A4R | Size 122 Square Body | D122GC75V315TF | M085249 | A70QS Series American Round Fuse | A70QS350-4 | M211266 |
| MP210A5R | | | | | | |

NOTE

DC fusing is required on four quadrant (R) drives only.

Table 4-13 Ferraz Shawmut semiconductor fusing for size 2 drives

| Model | International | | | USA | | |
|----------------------------------|-------------------|-------------------------|------------|---|---|-------------------------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number |
| Field fuses | 10 x 38mm Ferrule | FR10GB69V25 | L330014 | 10 x 38mm Ferrule | FR10GB69V25 | L330014 |
| MP350A4 | Square Body Fuses | PC30UD69V500TF | W300399 | American Round Fuses Form 101 Range A70QS | A50QS450-4 A70QS450-4 | EQ16871 F214848 |
| MP350A4R | | PC71UD11V500TF | F300523 | | A70QS450-4 | F214848 |
| MP350A5 MP350A6 | | PC31UD69V500TF | T300006 | | A70QS450 | F214848 |
| MP350A5R MP350A6R | | PC72UD13C500TF | D300498 | | A50QS600-4 A70QS600-4 | Q219457 Y219993 |
| MP420A4 | | PC32UD69V630TF | M300069 | | A70QS600-4 | Y219993 |
| MP420A4R | | PC272UD13C630TF | W300721 | | 2 x A70QS400 in parallel | J214345 (x2) |
| MP470A5 MP470A6 | | PC272UD13C700TF | X300722 | | A50QS700-4 A70QS700-4 | N223181 E202772 |
| MP470A5R MP470A6R | | | | | A70QS700-4 | E202772 |
| MP550A4 | | PC33UD69V700TF | Y300079 | | A50QS900-4 2 x A70QS500-4 in parallel | R212282 A218431 (x2) |
| MP550A4R | | PC272UD13C700TF | X300722 | | 2 x A70QS500 in parallel. | A218431 (x2) |
| MP700A4 | | PC32UD69V1000TF | S300074 | | A50QS1200-4 2 x A70QS600-4 in parallel | C217904 Y219993 (x2) |
| MP700A4R | | PC72UD10C900TF | G300869 | | 2 x A70QS600-4 in parallel | Y219993 (x2) |
| MP700A5 MP700A6 | | PC32UD69V1000TF | S300074 | | A50QS1200-4 2 x A70QS600-4 in parallel | C217904 Y219993 (x2) |
| MP700A5R MP700A6R | | PC73UD12C900TF | T300512 | | 2 x A70QS600-4 in parallel | Y219993 (x2) |
| MP825A4 | | PC32UD69V1100TF | M300759 | | 2 x A50QS800-4 in parallel. 2 x A70QS800-4 in parallel | C202287 (x2) Z213830 (x2) |
| MP825A5 MP825A6 | | PC33UD69V1100TF | C300083 | | 2 x A70QS800-4 in parallel | Z213830 (x2) |
| MP825A4R MP825A5R MP825A6R | | PC73UD95V800TFB | W300514 | | 2 x A50QS1000-4 in parallel. *3 x A70QS700-4 in parallel | B217391 (x2) *E202772 (x3) |
| MP900A4 | | PC33UD69V1250TF | D300084 | | *3 x A70QS700-4 in parallel | *E202772 (x3) |
| MP900A4R | | PC73UD95V800TFB | W300514 | | | |
| MP1200A4 | | PC33UD60V1600TF | Z300586 | | | |
| MP1200A4R | | PC273UD11C16CTF | J302228 | | | |
| MP1200A5 MP1200A6 | | PC232UD69V16CTD | W300215 | | | |
| MP1200A5R MP1200A6R | | PC273UD11C16CTF | J302228 | | | |
| MP1850A4 | | **7,5 URD 44 PPSAF 2200 | **K235184 | | | |
| MP1850A4R | | | | | | |
| MP1850A5 MP1850A6 | | | | | | |
| MP1850A5R MP1850A6R | | | | | | |

NOTE

A50QS series are only rated up to 500Vac.

*Application overload limited to infrequent overloads to avoid fuse wear out

**Fuse limits applications to those operating at rated current. No cyclic overloads permitted.

Table 4-14 Ferraz Shawmut branch circuit protection fusing for size 2 drives

| Model | International | | | USA | | | |
|-------------------------------------|-----------------------------------|----------------------------------|--------------------|---------------------------------|------------------|------------|---------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number | |
| Auxiliary | 25A 600Vac High Speed Class J | HSJ205 | G235871J | 25A 600Vac High Speed Class J | AJT25R | X21160J | |
| MP350A4(R) MP350A5(R) MP350A6(R) | General purpose IEC (square body) | NH2GG69V355 | Y228503 | General purpose US (round body) | A6D400R | B216776 | |
| MP420A4(R) | | NH3GG69V400 | D228508 | | A6D500R | P217294 | |
| MP470A5(R) MP470A6(R) | | NH4GG69V630-8 NH4AGG69V630-8 | E215537 W222107 | | A6D600R | T217804 | |
| MP550A4 (R) | | NH4GG69V630-8 NH4AGG69V630-8 | E215537 W222107 | | A4BQ800 | Z219373 | |
| MP700A4(R) MP700A5(R) MP700A6(R) | | NH4GG69V800-8 NH4AGG69V800-8 | K216554 M222858 | | | | |
| MP825A4(R) MP825A5(R) MP825A6(R) | | NH4GG69V800-8 NH4AGG69V800-8 | K216554 M222858 | | | | |
| MP900A4(R) | | | | | | | |
| MP1200A4(R) MP1200A5(R) MP1200A6(R) | | General purpose IEC (round body) | MF76GG69V1250 | | E302753 | A4BQ1000 | P216282 |
| MP1850A4(R) MP1850A5(R) MP1850A6(R) | | | MF114GG69V2000 | | G302755 | A4BQ1200 | R216790 |
| | | | | | | A4BQ2000 | B223101 |

NOTE
USA fuses are only rated up to 600Vac.

Table 4-15 Ferraz Shawmut DC protection fusing for size 2 drives

| Model | International | | | USA | | | |
|---------------------|---------------------------------|---------------------|--------------|------------------------------------|------------------------------------|-----------------|--------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number | |
| MP350A4R | Square Body fuse | D123GB75V630TF | C098557 | American round fuse | A70QS600-4 | Y219993 | |
| MP350A5R MP350A6R | | | | | A100P600-4 | A217373 | |
| MP420A4R | | | | | A70QS800-4 | Z213830 | |
| MP470A5R MP470A6R | | D2122GD75V900TF | T220955 | American round fuses 2 in parallel | A100P1000-4 (x2) | Y217371 (x2) | |
| MP550A4R | | | | | A70QS450-4 (x2) | F214848 (x2) | |
| MP700A4R | | D2123GB75V12CTF | D098558 | American round fuse | A70QS600-4 (x2) | Y219993 (x2) | |
| MP700A5R MP700A6R | | | | | A100P1200-4 | N218397 | |
| MP825A4R | | | | | American round fuses 2 in parallel | A70QS800-4 (x2) | Z213830 (x2) |
| MP825A5R MP825A6R | | | | | American round fuse | A100P1200-4 | N218397 |
| MP900A4R | | D2123GB75V14CTF | B090483 | American round fuses 3 in parallel | A70QS600-4 (x3) | Y219993 (x3) | |
| MP1200A4R | Square Body fuses 3 in parallel | PC73UD13C630TF (x3) | Q300509 (x3) | American round fuses 3 in parallel | A70QS700-4 (x3) | E202772 (x3) | |
| MP1200A5R MP1200A6R | | | | | A100P700-4 (x3) | T223163 (x3) | |
| MP1850A4R | Square Body fuses 4 in parallel | PC73UD13C700TF (x4) | R300510 (x4) | American round fuses 5 in parallel | A70QS600-4 (x5) | Y219993 (x5) | |
| MP1850A5R MP1850A6R | | | | | A100P600-4 (x5) | A217373 (x5) | |

NOTE
The use of the A100P series fuses is limited to applications with L/R time constants of 30ms or less.
DC fusing is only required on four quadrant (R) drives.

4.6.2 Alternative fusing

Please refer to section 12.2.2 *Alternative fusing* on page 157.

Table 4-16 Mentor MP size 1 drive thyristor I²t rating for semiconductor fusing

| Model | | Thyristor I ² t (A ² s) |
|-------------|------------|---|
| Field fuses | | 400 |
| MP25A4 | MP25A5 | 1030 |
| MP45A4 | MP45A5 | 3600 |
| MP75A4 | MP75A5 | 15000 |
| MP25A4(R) | MP25A5(R) | 1030 |
| MP45A4(R) | MP45A5(R) | 3600 |
| MP75A4(R) | MP75A5(R) | 15000 |
| MP105A4 | MP105A5 | 80000 |
| MP155A4 | MP155A5 | |
| MP210A4 | MP210A5 | |
| MP105A4(R) | MP105A5(R) | |
| MP155A4(R) | MP155A5(R) | |
| MP210A4(R) | MP210A5(R) | |

Table 4-17 Mentor MP size 2 drive thyristor I²t ratings for semiconductor fusing

| Model | | | Thyristor I ² t (A ² s) |
|-------------|-------------|-------------|---|
| Field fuses | | | 400 |
| MP350A4(R) | MP420A4(R) | MP550A4(R) | 320000 |
| MP350A6(R) | MP470A5(R) | MP470A6(R) | 281000 |
| MP700A4(R) | MP825A4(R) | MP900A4(R) | 1050000 |
| MP700A6(R) | MP825A5(R) | MP825A6(R) | 1200000 |
| MP1200A4(R) | MP1200A5(R) | MP1200A6(R) | 2720000 |
| MP1850A4(R) | MP1850A5(R) | MP1850A6(R) | |

4.6.3 Internal field fuses

The internal field 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 field fuses if the drive is tripping field loss (FdL) and the field controller is enabled.

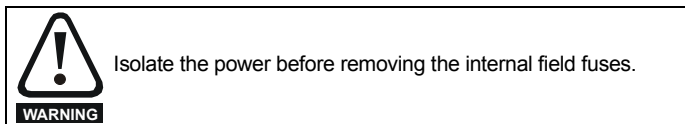
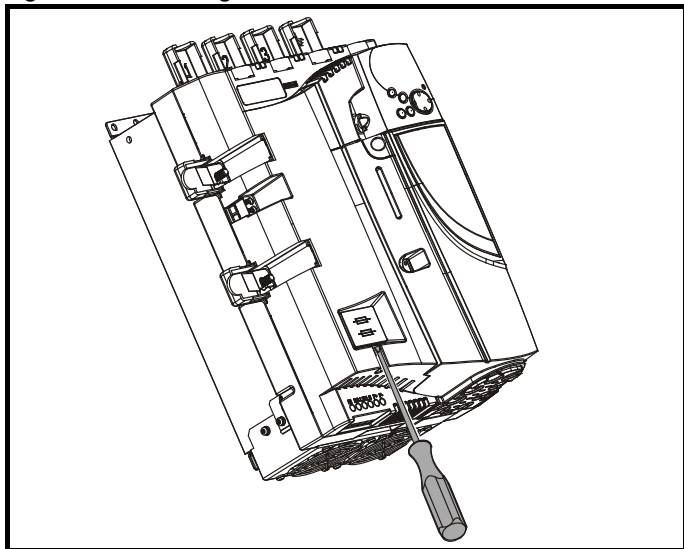


Figure 4-9 Removing the internal field fuses



Insert a flat-head screwdriver into the groove as shown above and lever downwards to remove the fuse cover. Refer to section 4.6.1 *Ferraz Shawmut fuses* on page 40 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 37. 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 4-18.

Table 4-18 Recommended external suppressor resistors

| Model | Resistance k Ω | 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) | | | | |
| MP350A4(R) | 4.1 | 300 | 1100 | 2500 |
| MP420A4(R) | | | | |
| MP550A4(R) | | | | |
| MP700A4(R) | | | | |
| MP825A4(R) | | | | |
| MP900A4(R) | | | | |
| MP1200A4(R) | 8.6 | 300 | 1600 | 2500 |
| MP1850A4(R) | | | | |
| MP350A5(R) | | | | |
| MP350A6(R) | | | | |
| MP470A5(R) | | | | |
| MP470A6(R) | | | | |
| MP700A5(R) | 8.6 | 300 | 1600 | 2500 |
| MP700A6(R) | | | | |
| MP825A5(R) | | | | |
| MP825A6(R) | | | | |
| MP1200A5(R) | | | | |
| MP1200A6(R) | | | | |
| MP1850A5(R) | 8.6 | 300 | 1600 | 2500 |
| MP1850A6(R) | | | | |

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

Figure 4-10 Location of external suppressor resistor terminals on size 1 drives

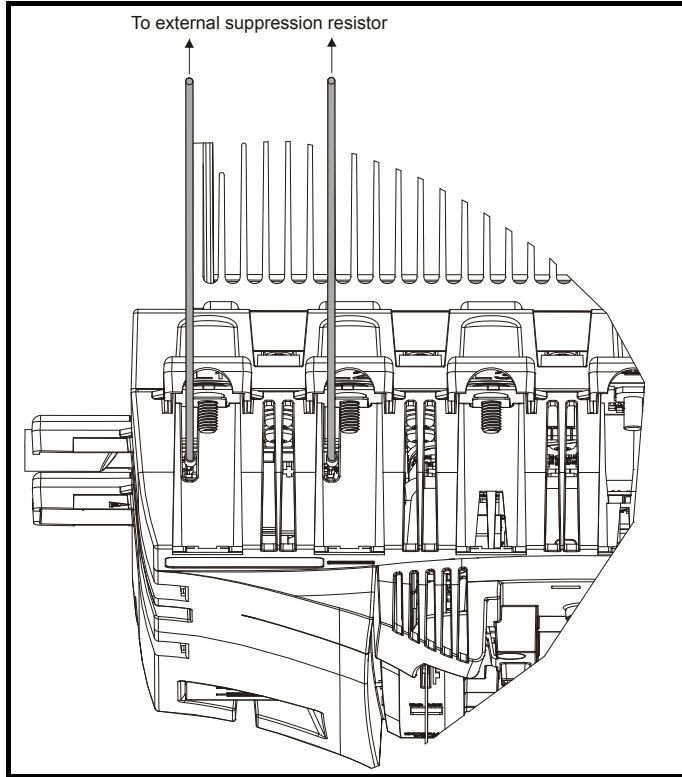


Figure 4-11 Location of external suppressor resistor terminals on size 2 drives

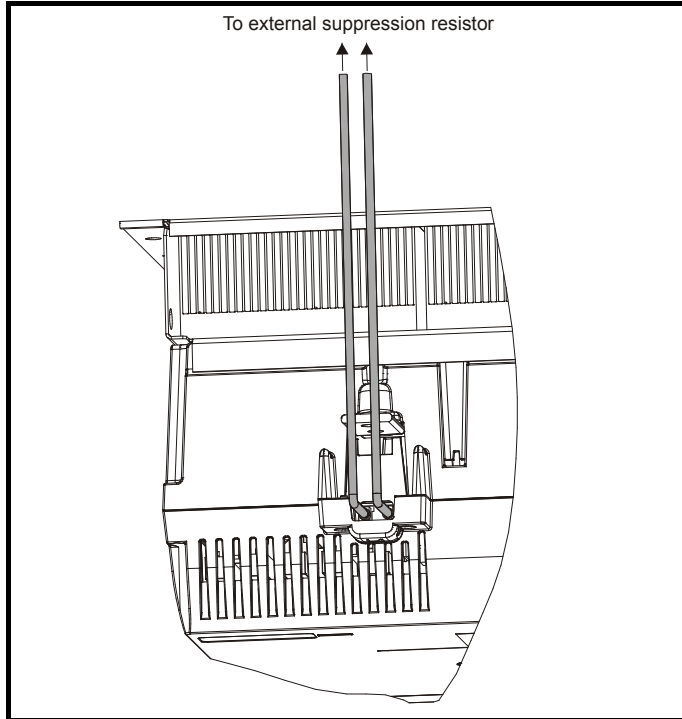
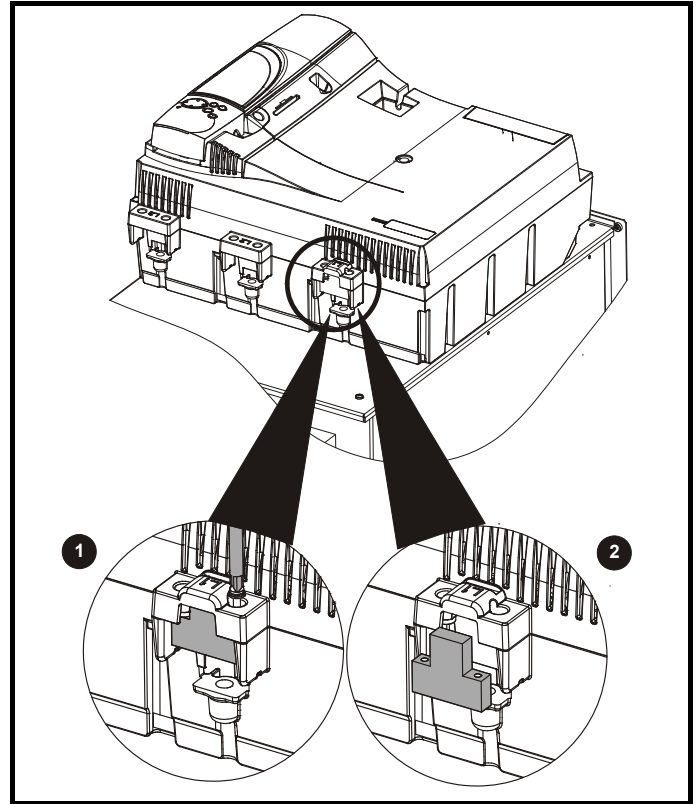


Figure 4-12 Removal of bucket suppressor terminals cover on size 2C and 2D




1. Remove the 2 x M4 x 16 screws using a pozi drive screwdriver.
2. Remove the bucket suppressor terminal cover.

Shielded cable should be used for bucket suppressor connections. For UL applications the cable should comply with UL1063 in accordance with UL508a.

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 4-19. 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 the values specified in Table 4-19.

Table 4-19 Minimum allowable external suppression resistance

| Model | | Resistance Ω |
|-------------|----------------------------|--------------------|
| MP25A4(R) | MP25A5(R) | 500 (maximum 150W) |
| MP45A4(R) | MP45A5(R) | |
| MP75A4(R) | MP75A5(R) | |
| MP105A4(R) | MP105A5(R) | |
| MP155A4(R) | MP155A5(R) | |
| MP210A4(R) | MP210A5(R) | |
| MP350A4(R) | MP350A5(R) MP350A6(R) | 500 (maximum 300W) |
| MP420A4(R) | MP470A5(R) MP470A6(R) | |
| MP550A4(R) | | |
| MP700A4(R) | MP700A5(R) MP700A6(R) | |
| MP825A4(R) | MP825A5(R) MP825A6(R) | |
| MP900A4(R) | | |
| MP1200A4(R) | MP1200A5(R) MP1200A6(R) | |
| MP1850A4(R) | MP1850A5(R) MP1850A6(R) | |

 **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 4-13).


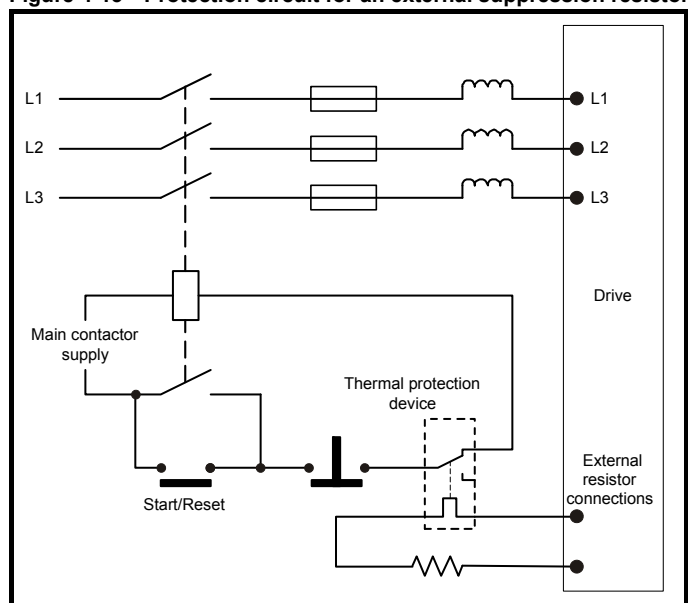
 **External suppressor resistor protection parameter settings**
The software provided by the Mentor MP provides overload protection. Failure to correctly configure Pr **11.62**, Pr **11.63** and Pr **11.64**, as described in the *Mentor MP Advanced User Guide* could lead to the resistor being overloaded.

Figure 4-13 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 Table 12-43 *Immunity compliance* on page 164) 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 4.9.4 *Surge immunity of control circuits - long cables and connections outside a building* on page 47.

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) IEC 61800-3, EN 61800-3:2004 category C3

To meet this standard a standard armature filter and a standard field filter must be installed. See Table 4-20 *Mentor MP and EMC filter cross references* on page 47 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 generic emission standards for industrial environments category IEC 61000-6-4 and EN 61000-6-4:2007, and the PDS standard category C2.

To meet this standard a standard field filter and a high performance armature filter must be installed. See Table 4-20 *Mentor MP and EMC filter cross references* on page 47 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 EMC filter information

Refer to Figure 4-1 on page 33 for the location of the optional EMC filter. See Table 4-20 for EMC filters that can be sourced directly from Epcos and Schaffner.



It is essential that line reactors be connected between the filter terminals and the power input terminals, as shown in Figure 4-1. Failure to observe this requirement could result in destruction of the thyristors.

Table 4-20 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-T1262D004 |
| MP45A4(R) | | | *B84143-A90-R105 | | |
| MP75A4(R) | | | | | |
| MP105A4(R) | FN3270H-200-99 | FN3258H-180-40 | B84143BO250S080 | FN3280H-8-29 | |
| MP155A4(R) | | | | | |
| MP210A4(R) | | | | | |
| MP350A4(R) | | | | | |
| MP420A4(R) | | | | | |
| MP550A4(R) | | | | | |
| MP700A4(R) | | | | | |
| MP825A4(R) | FN3359-800-99 | | | FN3280H-8-29 | |
| MP900A4(R) | | | | | |
| MP1200A4(R) | | | | | |
| MP1850A4(R) | | | | | |
| | | FN3359-1600-99 | | | |

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

Table 4-21 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) | | | |
| MP350A4(R) | | | |
| MP420A4(R) | | | |
| MP550A4(R) | | | |
| MP700A4(R) | | | |
| MP825A4(R) | | | |
| MP900A4(R) | | | |
| MP1200A4(R) | | | |
| MP1850A4(R) | | | |

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

- C4 EN 61800-3:2004 second environment, restricted distribution (Additional measures may be required to prevent interference)
- C3 EN 61800-3:2004 second environment, unrestricted distribution
- C2 Industrial generic standard EN 61000-6-4:2007
EN 61800-3:2004 first environment restricted distribution (The following caution is required by EN 61800-3:2004)



This is a product of the restricted distribution class according to IEC 61800-3. In a residential environment this product may cause radio interference in which case the user may be required to take adequate measures.

- C1 Residential generic standard EN 61000-6-3:2007
EN 61800-3:2004 first environment unrestricted distribution
EN 61800-3:2004 defines the following:
 - The first environment is one that includes residential premises. It also includes establishments directly connected without intermediate transformers to a low-voltage power supply network which supplies buildings used for residential purposes.
 - The second environment is one that includes all establishments other than those directly connected to a low-voltage power supply network which supplies buildings used for residential purposes.
 - Restricted distribution is defined as a mode of sales distribution in which the manufacturer restricts the supply of equipment to suppliers, customers or users who separately or jointly have technical competence in the EMC requirements of the application of drives.

4.9.4 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:

1. 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.
2. Shielded cable with additional power ground bonding. The cable shield may be connected to ground at both ends, but in addition the

ground conductors at both ends of the cable must be bonded together by a power ground cable (equipotential bonding cable) with cross-sectional area of at least 10mm², 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 4-14 and Figure 4-15.

Figure 4-14 Surge suppression for digital and unipolar inputs and outputs

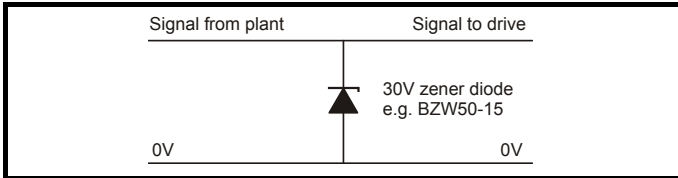
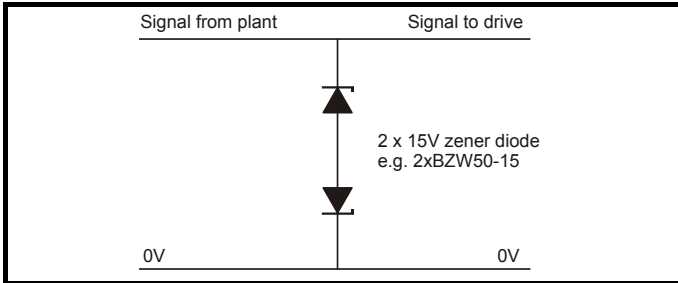


Figure 4-15 Surge suppression for analog and bipolar inputs and outputs



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 EIA(RS)-485 communications. See Table 4-22 for the connection details for the RJ45 connector.

Figure 4-16 Serial communications port

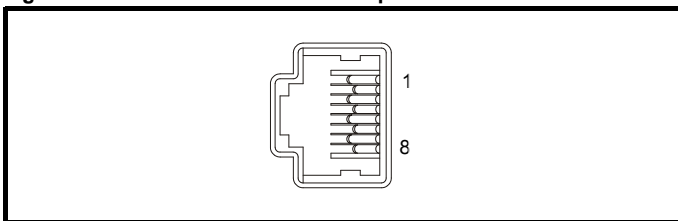


Table 4-22 RJ45 connections

| 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, jumper (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 EN 50178:1998.



In order to meet the requirements for SELV in IEC 60950 (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 4-23 for details.

Table 4-23 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 IEC 60950 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 jumper (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 4.15 *Connecting an encoder* on page 54.

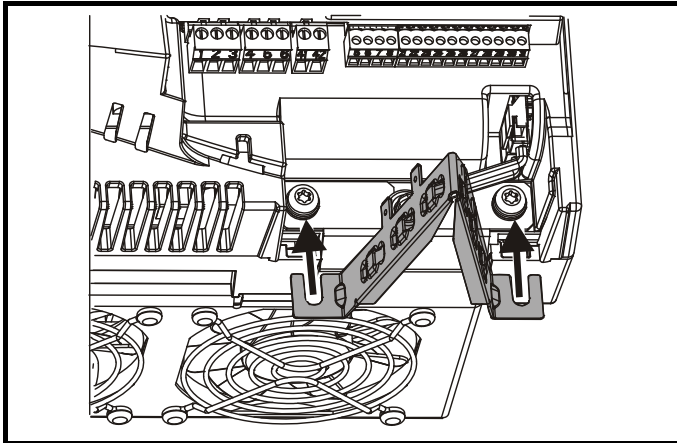
4.11.3 Control cables

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).

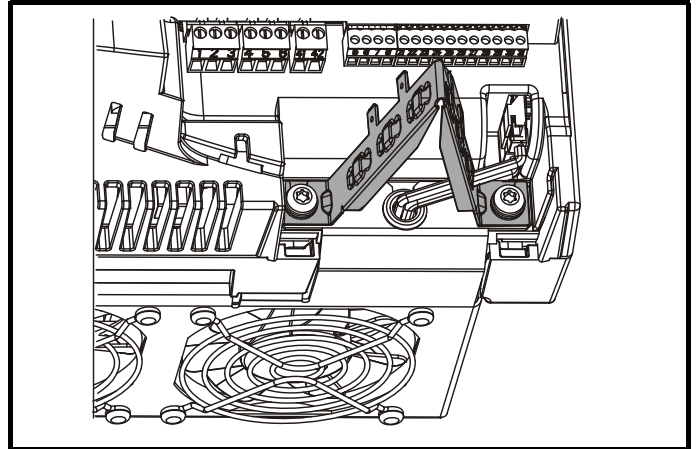
4.11.4 Grounding hardware

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 4-17 Fitting of grounding bracket

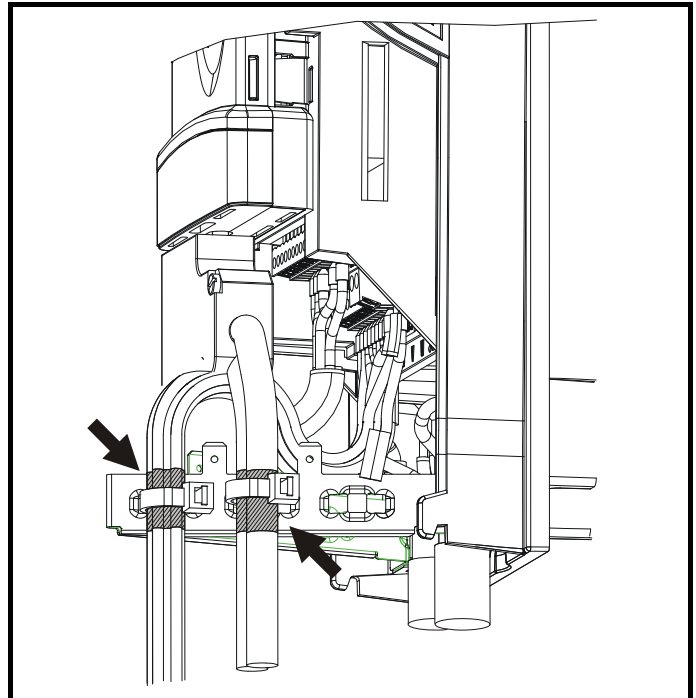


Loosen the ground connection (2 x M5 x 10) screws using T25 Torx driver and slide the grounding bracket in the direction shown. Once in place, re-tighten the ground connection M5 x 10 screws to 3Nm (2.21 lb ft).



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 4-18 Grounding of signal cable shields using the grounding bracket



4.12 Connecting the fan on size 2C and 2D drives

A supply needs to be connected to the dual fan unit enclosed within the lower duct on Mentor MP size 2C and 2D. The fans can be configured for a 230Vac (factory setting) or 115Vac supply as shown below on the label next to the fan connections. When connecting the fan supply, the screws should be tightened with a maximum torque of 1.2 Nm (0.88 lb ft) to 2 Nm (1.47 lb ft).

Figure 4-19 Fan connection

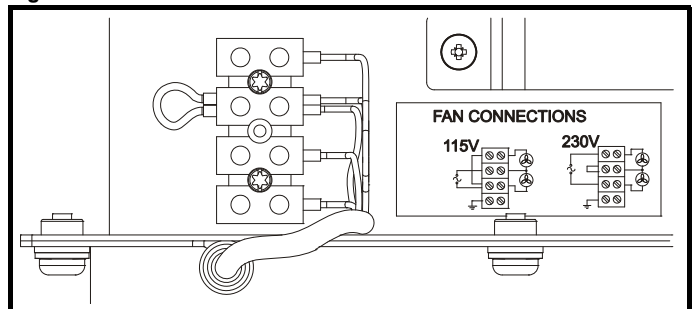


Table 4-24 Fan supply specification

| Fan configuration | Supply specification |
|-------------------|----------------------|
| 230V | 230V ±10% |
| 115V | 115V ±10% |

Cabling should be 300V rated. Rated for at least 3A continuous in line with local wiring regulations. Cabling should be protected 3A non time delay fuses i.e. gG, Class CC or Class J and rated for at least 300V, in accordance with local wiring regulations.

4.13 Control connections

Refer to Figure 4-20 to understand the connection of the different power connections.

4.13.1 General

Table 4-25 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 11.22.5 *Start / stop logic modes* on page 143.

| | |
|--|---|
|  | 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. |
|---|---|


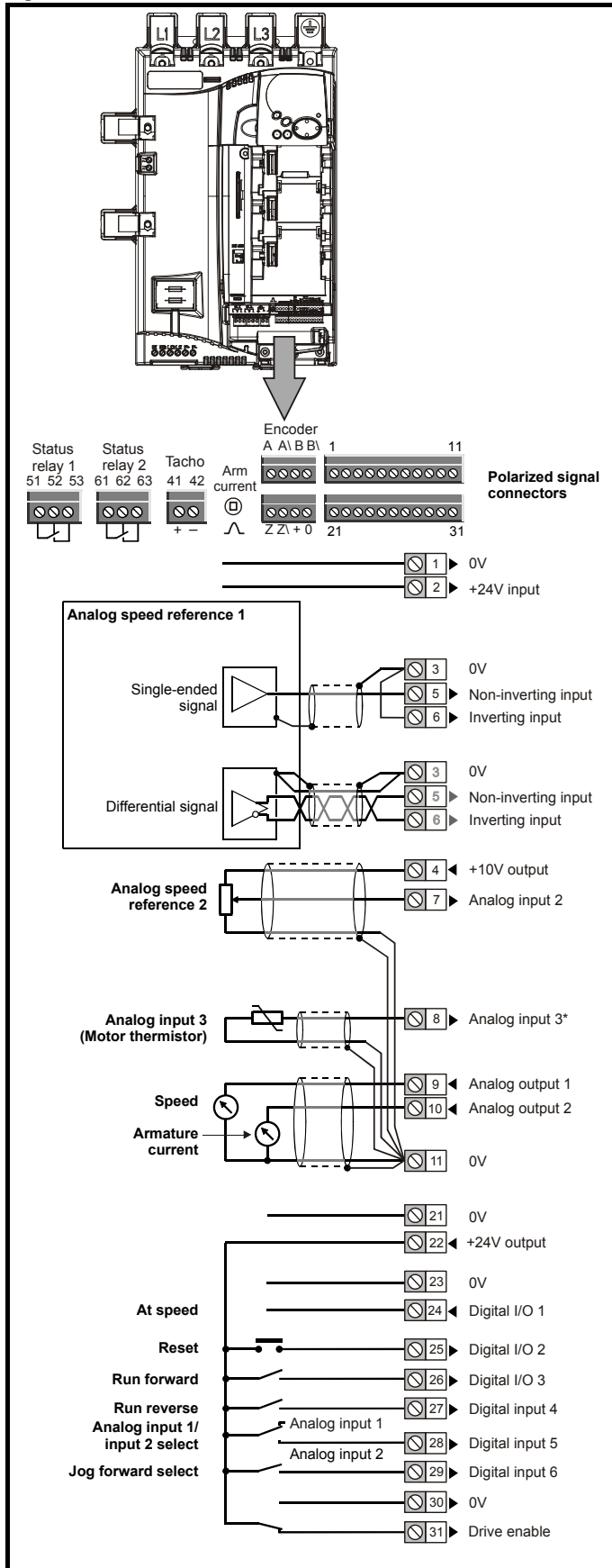
| | |
|---|---|
|  | A fuse or other over-current protection should be installed to the relay circuit. |
|---|---|

Table 4-26 Control connection recommended cable sizes

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

Figure 4-20 Default terminal functions



* Thermistor disabled by USA defaults.

4.14 General

4.14.1 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 |

| 9 Analog output 1 | |
|--|---|
| 10 Analog output 2 | |
| 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... | |
| Operating in Voltage mode (default) | |
| Full scale voltage range | ±10V ±5% |
| Maximum offset | ±40mV |
| Maximum output current | ±35mA |
| Load resistance | 1kΩ min |
| Protection | 35mA max. Short circuit protection |
| Operating in current mode | |
| Current ranges | 0 to 20mA ±5% 4 to 20mA ±5% |
| Maximum offset | 350μA |
| Open circuit voltage | +15V |
| Load resistance | 600Ω max |
| 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 |

| 11 0V common | |
|-----------------|---|
| Function | Common connection for all external devices |

| 21 0V common | |
|-----------------|---|
| Function | Common connection for all external devices |

| 22 +24V user output | |
|------------------------|--|
| 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 |


| 23 0V common | |
|-----------------|---|
| Function | Common connection for all external devices |

| | |
|--|---|
| 24 | Digital I/O 1 |
| 25 | Digital I/O 2 |
| 26 | Digital I/O 3 |
| 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 |
| Operating as an input | |
| Logic mode controlled by... | Pr 8.29 |
| Absolute maximum applied voltage range | +30V, -18V relative to 0V |
| Impedance | 6kΩ |
| Input thresholds | 10 0V ±0.8V |
| Operating as an output | |
| Open collector outputs selected | Pr 8.30 |
| Nominal maximum output current | 200mA (total including terminal 22) |
| Maximum output current | 240mA (total including terminal 22) |
| Common to all modes | |
| Voltage range | 0V to +24V |
| Sampling period | 250μs if configured with the destination as Pr 6.35 or Pr 6.36. 4ms for all other destinations |

| | |
|--|--|
| 27 | Digital input 4 |
| 28 | Digital input 5 |
| 29 | Digital input 6 |
| 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 | 6kΩ |
| Input thresholds | 10 0V ±0.8V |
| Sampling period | 250μs if configured with the destination as Pr 6.35 or Pr 6.36. 4ms for all other destinations |

| | |
|-----------------|---|
| 30 | 0V common |
| Function | Common connection for all external devices |

| | |
|--|--|
| 31 | ENABLE |
| Function | Drive enable |
| 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 |

| | |
|---|---|
|  Drive commissioning output | |
| Function | Instantaneous armature current feedback |
| Type of output | Unipolar single-ended voltage |
| Full scale voltage range | 10V ±5% (10V = 2 x Motor rated current) |
| Maximum offset | 7mV |
| Protection | ~25mA max. Short circuit protection to ground (0V). |

| Model | | | Full scale range of drive commissioning output |
|-------------|-------------|-------------|--|
| MP25A4(R) | MP25A5(R) | | 2.29 x Drive rated current (Pr 11.32) |
| MP45A4(R) | MP45A5(R) | | 2.30 x Drive rated current (Pr 11.32) |
| MP75A4(R) | MP75A5(R) | | 2.42 x Drive rated current (Pr 11.32) |
| MP105A4(R) | MP105A5(R) | | 2.29 x Drive rated current (Pr 11.32) |
| MP155A4(R) | MP155A5(R) | | 2.30 x Drive rated current (Pr 11.32) |
| MP210A4(R) | MP210A5(R) | | 2.41 x Drive rated current (Pr 11.32) |
| MP350A4(R) | MP350A5(R) | MP350A6(R) | 2.73 x Drive rated current (Pr 11.32) |
| MP420A4(R) | | | 2.27 x Drive rated current (Pr 11.32) |
| | MP470A5(R) | MP470A6(R) | 3.34 x Drive rated current (Pr 11.32) |
| MP550A4(R) | | | 2.85 x Drive rated current (Pr 11.32) |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | 2.24 x Drive rated current (Pr 11.32) |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | 2.46 x Drive rated current (Pr 11.32) |
| MP900A4(R) | | | 2.25 x Drive rated current (Pr 11.32) |
| MP1200A4(R) | MP1200A5(R) | MP1200A6(R) | 3.44 x Drive rated current (Pr 11.32) |
| MP1850A4(R) | MP1850A5(R) | MP1850A6(R) | 2.23 x Drive rated current (Pr 11.32) |

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



Status relay contacts are over-voltage category II.

WARNING



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

WARNING

| | |
|------------------------------------|---|
| 51 | Relay 1 common |
| 52 | Relay 1 normally closed |
| 53 | Relay 1 normally open |
| Default function | |
| Drive OK indicator | |
| 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 |

| | |
|------------------------------------|---|
| 61 | Relay 2 common |
| 62 | Relay 2 normally closed |
| 63 | Relay 2 normally open |
| Default function | |
| Contactor enable | |
| 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 |

NOTE

The relays are not UL rated when used with inductive loads.

Feedback device connections

Ab, Fd, Fr encoders

| | |
|---|--|
| A | Channel A, Frequency or Forward inputs |
| A\ | Channel A\, Frequency\ or Forward\ inputs |
| B | Channel B, Direction or Reverse inputs |
| B\ | Channel B\, Direction\ or Reverse\ inputs |
| Z | Marker pulse channel Z |
| Z\ | Marker pulse channel Z\ |
| 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 |

| | |
|-----------|-----------------|
| + | + supply |
| 0V | 0V |

4.15 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 4-21 and Figure 4-22 illustrate the preferred construction of cable and the method of clamping. The outer sheath of the cable should be stripped back enough to allow the clamp to be installed. The shield must not be broken or opened at this point. The clamps should be installed close to the drive or feedback device, with the ground connections made to a ground plate or similar metallic ground surface.

Figure 4-21 Feedback cable, twisted pair

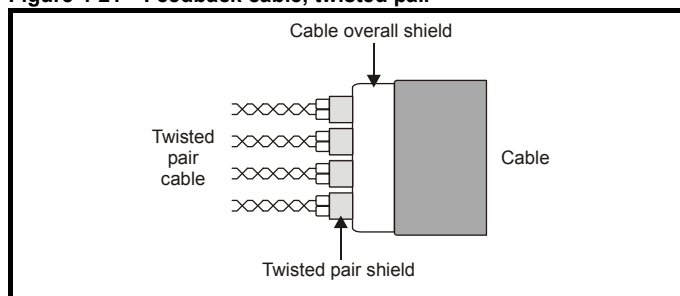


Figure 4-22 Feedback cable connections

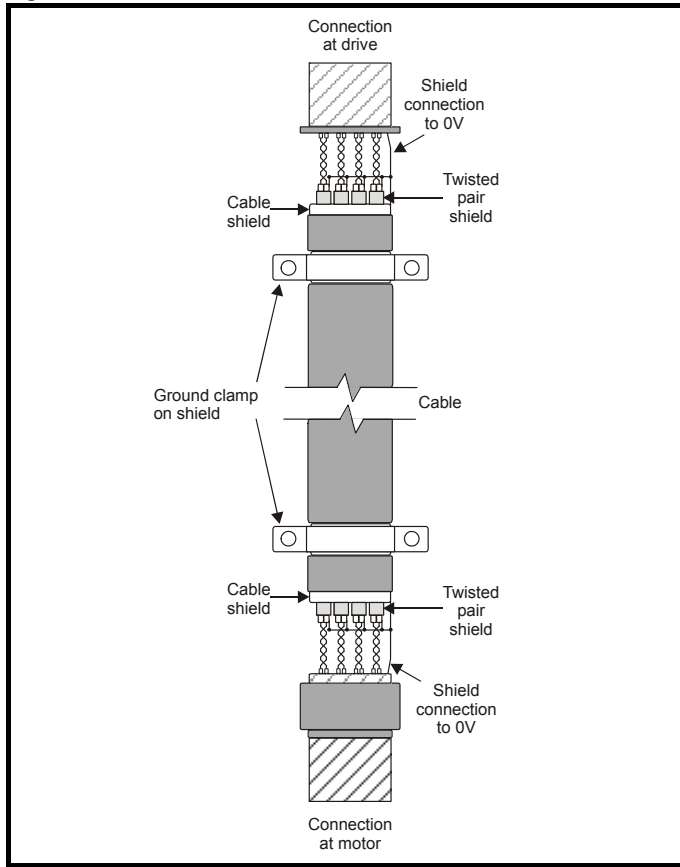


Table 4-27 Encoder types

| 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.

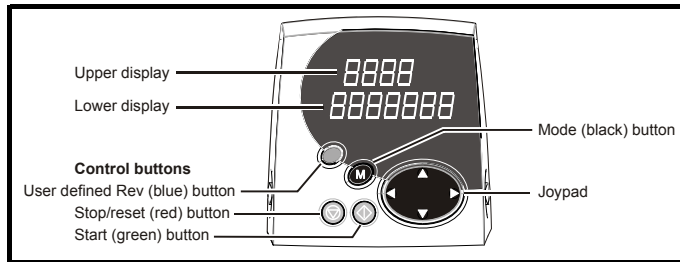
5.1.1 SM-Keypad (LED)

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



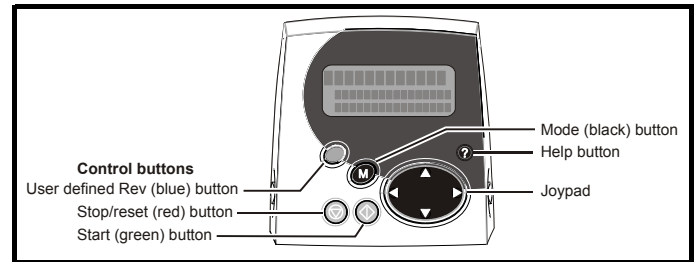
5.1.2 MP-Keypad (LCD)

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

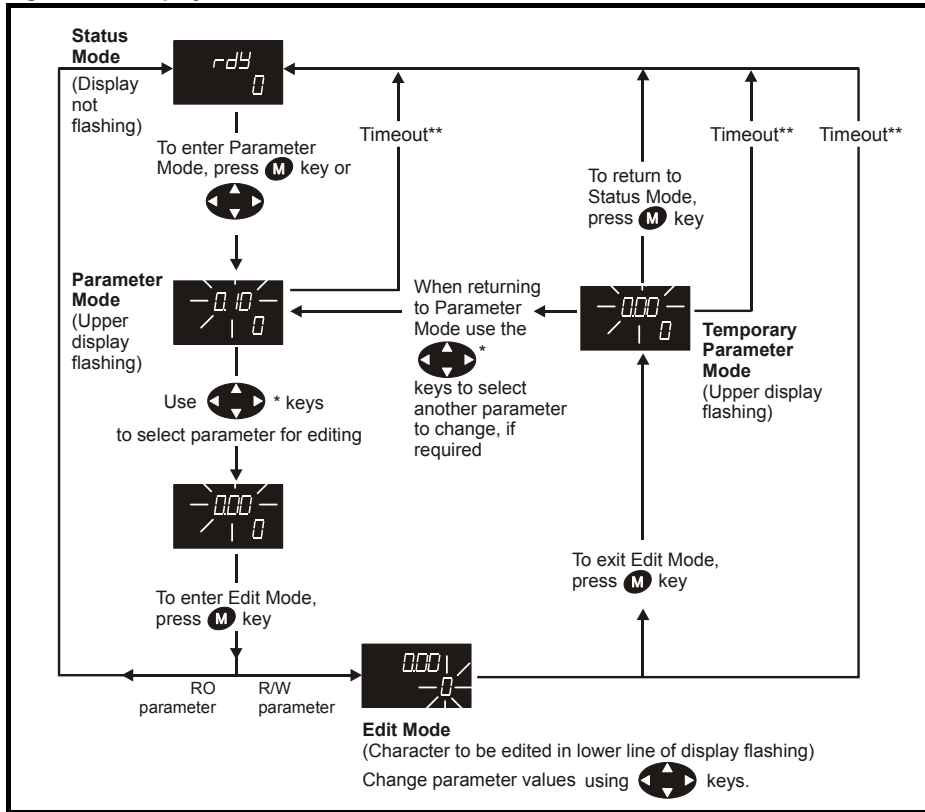
The keypad consists of:

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.

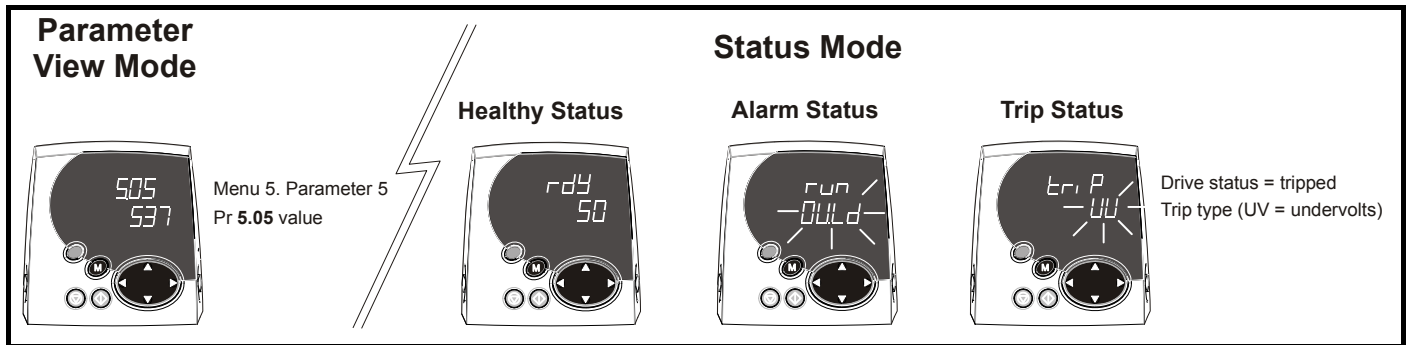
Figure 5-3 Display modes



* 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 61).

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.

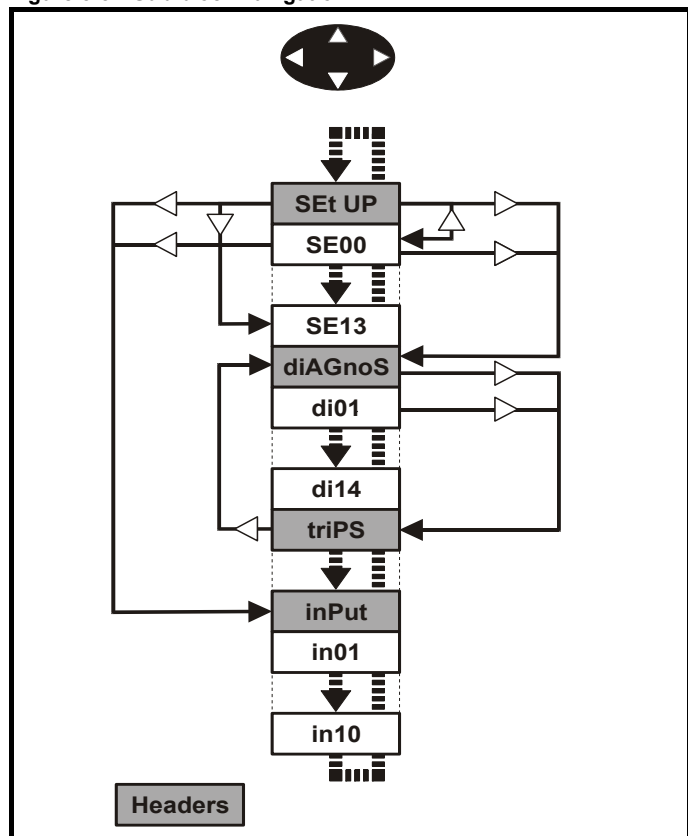
Table 5-1 Keypad navigation

| 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 Mneu 0 or advanced parameter |
| 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. |
| 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. |
| 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 SMARTCARD 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 SMARTCARD during copying. |
| 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. |
| RO | Read only: can only be read 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: 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 | 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 | Bianry sum 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 | Serial interface | SintEr |
| 23.08 | Speed feedback | Fb SP |
| 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 copying | 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*.

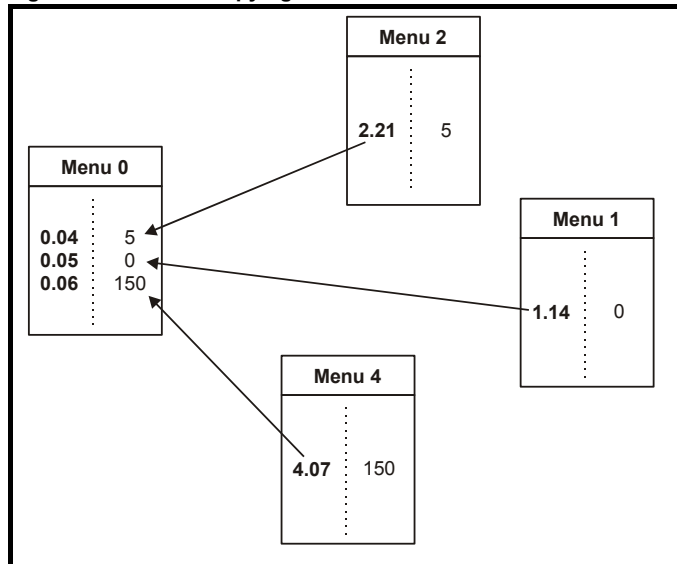
5.5 Menu 0 (linear)

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 58.

Figure 5-6 Menu 0 copying



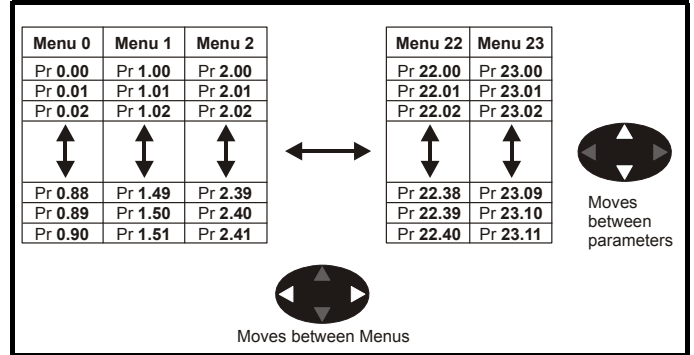
5.6 Menu structure

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 5.13 *Parameter access level and security* on page 62.

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 | ✓ |

Key: ✓ = Available
X = Not available

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 | Screen saver strings and enable | None (0), Default (1), User (2) |
| 40.21 | Screen saver interval | 0 to 600 |
| 40.22 | Turbo browse time interval | 0 to 200ms |
| 40.23 | Product identification | Unidrive SP (0), Digidrive SK (1), Mentor MP (2), Affinity (4), Digitax ST (5) |

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

1. Enter SAVE in Pr **xx.00**
2. Either:
 - Press the red  reset button
 - Toggle the reset digital input, or
 - Carry out a drive reset through serial communications by setting Pr **10.38** 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

1. Ensure the drive is not enabled, i.e. terminal 31 is open or Pr **6.15** is OFF (0)
2. Select Eur or USA in Pr **xx.00**.

3. 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 Differences between European and USA defaults

| Pr | Description | Default |
|-------------|--|---|
| 2.06 | S ramp enable | Eur: OFF (0), USA: On (1) |
| 3.51 | Tachometer voltage rating (Fb02, 0.72) | Eur: 60.00, USA: 50.00 |
| 5.09, 21.09 | Armature rated voltage (SE06, 0.27) | 480V drive Eur: 440, USA:500 |
| 5.28 | Field weakening compensation disable | Eur: OFF (0), USA On (1) |
| 5.59, 21.08 | Back emf set point | 480V drive Eur: 440, USA:500 |
| 5.65 | Economy timeout | Eur: OFF (0), USA: On (1) |
| 5.70, 21.24 | Rated field current (SE10, 0.31) | Size 1: Eur: 2.00, USA: 8.00 Size 2A & B Eur: 3.00, USA: 20.00 Size 2C & D Eur: 5.00, USA 20.00 |
| 5.73, 21.23 | Rated field voltage (SE11, 0.32) | Eur: 360, USA: 300 |
| 5.75 | Field voltage mode | Eur: OFF (0), USA: On (1) |
| 7.15 | Analog input 3 mode (in01, 0.81) | Eur: th (8), USA: VOLT (6) |

5.11 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 5.13 *Parameter access level and security* for more information regarding access level.

5.12 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 5.13 *Parameter access level and security* for further information regarding access levels.

5.13 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

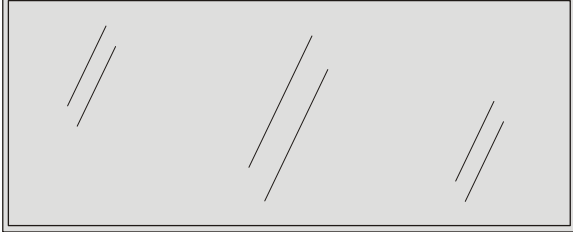
The default settings of the drive are parameter access level L1 and User Security Open, i.e. read / write access to Menu 0 with the advanced menus, not visible

5.13.1 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.

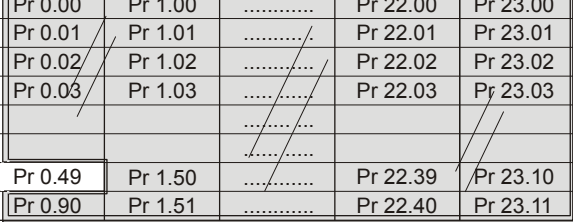
Figure 5-8 User security open

User security open - All parameters: Read / Write access




| | | | | |
|---------|---------|-------|----------|----------|
| Pr 0.00 | Pr 1.00 | ..... | Pr 22.00 | Pr 23.00 |
| Pr 0.01 | Pr 1.01 | ..... | Pr 22.01 | Pr 23.01 |
| Pr 0.02 | Pr 1.02 | ..... | Pr 22.02 | Pr 23.02 |
| Pr 0.03 | Pr 1.03 | ..... | Pr 22.03 | Pr 23.03 |
| | | | | |
| | | | | |
| Pr 0.89 | Pr 1.50 | ..... | Pr 22.39 | Pr 23.10 |
| Pr 0.90 | Pr 1.51 | ..... | Pr 22.40 | Pr 23.11 |

User security closed - All parameters: Read Only access (except Pr 11.44 (SE14, 0.35))





| | | | | |
|---------|---------|-------|----------|----------|
| Pr 0.00 | Pr 1.00 | ..... | Pr 22.00 | Pr 23.00 |
| Pr 0.01 | Pr 1.01 | ..... | Pr 22.01 | Pr 23.01 |
| Pr 0.02 | Pr 1.02 | ..... | Pr 22.02 | Pr 23.02 |
| Pr 0.03 | Pr 1.03 | ..... | Pr 22.03 | Pr 23.03 |
| | | | | |
| | | | | |
| Pr 0.49 | Pr 1.50 | ..... | Pr 22.39 | Pr 23.10 |
| Pr 0.90 | Pr 1.51 | ..... | Pr 22.40 | Pr 23.11 |


5.13.2 Setting user security

Enter a value between 1 and 999 in Pr 11.30 and press the  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).

5.13.3 Unlocking user security

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

Use the arrow buttons to set the security code and press the  button. With the correct security code entered, the display will revert to the parameter selected in edit mode. If an incorrect security code is entered the 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  reset button.

5.13.4 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.

5.14 Serial communications

5.14.1 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 48 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 LEROY-SOMER 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.

5.14.2 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), rtU (1), Lcd (2) | | | | | | | | | | ⇒ | rtU (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 | rtU | Modbus RTU protocol |
| 2 | Lcd | Modbus RTU protocol, but with a MP-Keypad only |

ANSI3.28 protocol

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

Modbus RTU protocol

Full details of the CT implementation of Modbus RTU are given in the *Mentor MP 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 | | | | | | | | | | | |
| {0.66/11.25} | 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 | | | | | | | | | | | |
| {0.67/11.23} | 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.

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: Eur 2A, USA 8A Size 2A/B: Eur 3A, USA 20A Size 2C/D: Eur 5A, USA 20A | 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} | OFF (0) or On (1) | 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, 1.12} | OFF (0) or On (1) | | RO | Bit | | | NC | PT |
| di13 | Jog selected indicator | {0.48, 1.13} | 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} | | | 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} | 0 to 229 | | 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 | | | | | |
|-----------|----------------------------------|--------------|--|------------|------|-----|----|----|----|----|
| Fb06 | Drive encoder supply voltage | {0.76, 3.36} | 5V (0), 8V (1), 15V (2), 24V (3) | 5V (0) | RW | Txt | | | | US |
| Fb07 | Drive encoder type | {0.77, 3.38} | Ab (0), Fd (1), Fr (2) | Ab (0) | RW | Txt | | | | US |
| Fb08 | Drive encoder termination select | {0.78, 3.39} | 0 to 2 | 1 | RW | Uni | | | | US |
| Fb09 | Drive encoder speed feedback | {0.79, 3.27} | ±10,000.0 rpm | | RW | Bi | FI | NC | PT | US |
| in01 | 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 |
| in02 | Analog input 1 | {0.82, 7.01} | ±100.00 % | | RO | Bi | | NC | PT | |
| in03 | Analog input 2 | {0.83, 7.02} | ±100.0 % | | RO | Bi | | NC | PT | |
| in04 | Analog input 3 | {0.84, 7.03} | ±100.0 % | | RO | Bi | | NC | PT | |
| in05 | T24 digital I/O 1 state | {0.85, 8.01} | | | RO | Bit | | NC | PT | |
| in06 | T25 digital I/O 2 state | {0.86, 8.02} | | | RO | Bit | | NC | PT | |
| in07 | T26 digital I/O 3 state | {0.87, 8.03} | | | RO | Bit | | NC | PT | |
| in08 | T27 digital input 4 state | {0.88, 8.04} | OFF (0) or On (1) | | RO | Bit | | NC | PT | |
| in09 | T28 digital input 5 state | {0.89, 8.05} | | | RO | Bit | | NC | PT | |
| in10 | 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 | String | Action |
|---------|----------|--|
| 0 | No Act | No action |
| 1 | SAUE | Save parameters |
| 2 | rEAd 1* | Transfer SMART card data block 1 to the drive |
| 3 | PrOg 1* | Transfer drive parameters as difference from default to SMART card block number 1 |
| 4 | rEAd 2* | Transfer SMART card data block 2 to the drive |
| 5 | PrOg 2* | Transfer drive parameters as difference from default to SMART card block number 2 |
| 6 | rEAd 3* | Transfer SMART card data block 3 to the drive |
| 7 | PrOg 3* | Transfer drive parameters as difference from default to SMART card block number 3 |
| 8 | diS.diFF | Display non-default values only |
| 9 | diS.dESt | Display destination parameters only |
| 10 | Eur | Load European defaults |
| 11 | USA | Load USA defaults |
| 12 | rES OP | Reset all Solution Modules |
| 1000 | 1000 | Save parameters |
| 1070 | 1070 | Reset all Solution Modules |
| 1233 | 1233 | Load European defaults |
| 1244 | 1244 | Load USA defaults |
| 1255 | 1255 | Load European defaults (excluding menus 15 to 20) |
| 1256 | 1256 | Load USA defaults (excluding menus 15 to 20) |
| 2001 | 2001* | Transfer drive parameter to a card and create a bootable difference from default SMART card block with data block number 1 and clear parameter 11.42. If data block 1 exists it is over written. |
| 3yyy | 3yyy* | Transfer drive parameters to SMART card block number yyy |
| 4yyy | 4yyy* | Transfer drive parameters as difference from default to SMART card block number yyy |
| 5yyy | 5yyy* | Transfer Onboard Applications Lite ladder program to SMART card block number yyy |
| 6yyy | 6yyy* | Transfer SMART card data block yyy to the drive |
| 7yyy | 7yyy* | Erase SMART card data block yyy |
| 8yyy | 8yyy* | Compare drive data with SMART card block yyy |
| 9555 | 9555* | Clear SMART card warning suppression flag |
| 9666 | 9666* | Set SMART card warning suppression flag |
| 9777 | 9777* | Clear SMART card read-only flag |
| 9888 | 9888* | Set SMART card read-only flag |
| 9999 | 9999* | Erase SMART card |
| 12000** | 12000** | Display non-default values only |
| 12001** | 12001** | Display destination parameters only |

* See Chapter 9 SMARTCARD operation on page 81 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 Parameter x.00 reset

When an action is started by setting Pr **x.00** to one of the above values and initiating a drive reset this parameter is cleared when the action is completed successfully. If the action is not started, e.g. because the drive is enabled and an attempt is made to load defaults, etc., Pr **x.00** is not cleared and no trip is produced. If the action is started and then fails for some reason a trip is always produced and Pr **x.00** is not cleared. It should be noted that parameter saves etc. can also be initiated with the copying parameter (Pr **11.42** (SE09, 0.30)). If actions that can be initiated by either parameter are started and then completed successfully Pr **x.00** is cleared and Pr **11.42** (SE09, 0.30) is cleared if it has a value of less than 3.

It should be noted that there could be some conflict between the actions of Pr **x.00** and Pr **11.42** (SE09, 0.30) *Parameter copying* when the drive is reset. If Pr **11.42** (SE09, 0.30) has a value of 1 or 2 and a valid action is required from the value of Pr **x.00** then only the action required by Pr **x.00** is performed. Pr **x.00** and Pr **11.42** (SE09, 0.30) are then reset to zero. If Pr **11.42** (SE09, 0.30) has a value of 3 or 4 it will operate correctly causing parameters to be save to a SMARTCARD each time a parameter save is performed.

6.1.3 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 Pr **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**:

When all bits = 0, Pr **1.49** = 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 81.

| | | | | | | | | | | | | | |
|-----------------------------|-------------------------------|----------------------------|--|--|--|---|--|--|--|--|--|----|----|
| SE10 {0.31, 5.70} | | Rated field current | | | | | | | | | | | |
| RW | Uni | | | | | | | | | | | PT | US |
| ⇅ | 0 to FIELD_CURRENT_SET_MAX | | | | | ⇒ | Size 1: Eur 2A, USA 8A Size 2A/B: Eur 3A, USA 20A Size 2C/D: Eur 5A, USA 20A | | | | | | |

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 | |
| ⇅ | OFF (0) or On (1) | | | | | ⇒ | OFF (0) | | | | | | |

When this parameter is set to 0 the internal and external field controllers are disabled. Setting the parameter to 1 enables the internal or external field controller.

| | | | | | | | | | | | | | |
|-----------------------------|--------|-----------------|--|--|--|---|---|--|--|--|----|--|--|
| 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 auto-tune 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 inertia measurement |

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 its base speed (Pr 5.06)
- Field current compensation factor* (Pr 5.74)

Spinning autotune for inertia measurement

The drive can measure the total inertia of the load and motor. This is used to set the speed loop gains. See Pr 3.17 *Speed controller setup method* = 1 (bandwidth setup). During the inertia measurement test the drive attempts to accelerate the motor to $\frac{3}{4}$ rated speed then back to a standstill. Several attempts may be made, starting with rated torque/16, and then increasing the torque progressively to $x^{1/8}$, $x^{1/4}$, $x^{1/2}$, and x 1 rated torque if the motor cannot be accelerated to the required speed. If the required speed is not achieved on the final attempt the test is aborted and a tuNE 1 trip is initiated. If the test is successful the acceleration and deceleration times are used to calculate the motor and load inertia and a value is written to Pr 3.18 *Motor and load inertia*.

| | | | | | | | | | | | | | |
|------------------------------|-------------------------|------------------------|--|--|--|--|---|--------|--|--|--|----|----|
| 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.

6.1.4 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 quantization 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 overleaf:

| 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 Speed feedback filter arrangement

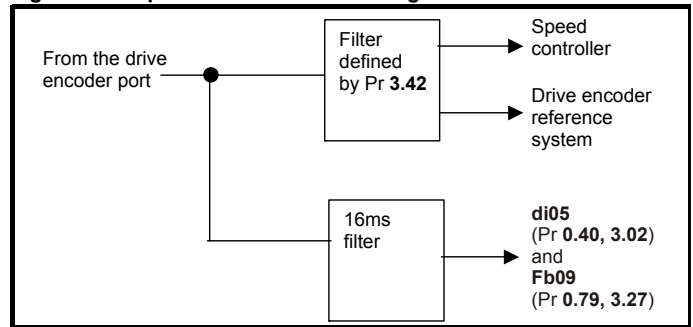


Figure 6-1 shows the filter arrangement. It should be noted that the same filtering is provided at the speed controller input and for **di05** (Pr 0.40, 3.02) when the feedback is obtained from an option module, but the variable length window filter is controlled by Pr x.19.

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 quantization 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.

6.1.5 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 167. 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.

6.1.6 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 102 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 78.

| | | | | | | | | | | | | | |
|-----------------------------|------------------------------|--|--|--|--|--|--|--|--|--|---|-----|--|
| 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 102 for a schematic of

the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 78.

| | | | | | | | | | | | | | | |
|-----------------------------|-----|---|--|--|--|--|--|---|---------|--|--|--|----|--|
| 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 102 for a schematic of the speed controller. For information on setting up the speed controller gains, refer to Chapter 8 *Optimization* on page 78.

6.1.7 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.

6.1.8 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) | | | | | | | | | | | | |

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.

6.1.9 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) ⇒ Eur: th (8), USA: VOLT (6) | | | | | | | | | | | | |

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.


WARNING




The values of the motor parameters affect the protection of the motor.
The default values in the drive should not be relied upon.
It is essential that the correct value is entered in Pr **5.07 (SE07, 0.28) Motor rated current**. This affects the thermal protection of the motor.

CAUTION



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 **1.17**).

CAUTION



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



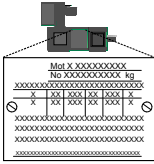

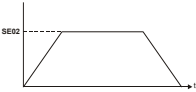
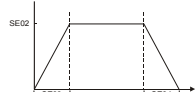
WARNING




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 |



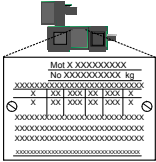

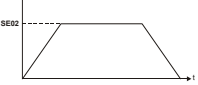
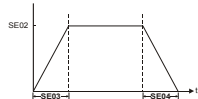
Refer to Figure 4-1 *Power connections for 480V drive* on page 33 for minimum connections to get a motor running.



7.1 Quick start commissioning / start-up (from European defaults)

| Action | Detail | |
|---------------------------------------|---|---|
| Before power-up | <p>Ensure:</p> <ul style="list-style-type: none"> Drive Enable signal is not given (terminal 31) Run signal is not given Motor connected Tacho connected if one is being used Encoder connected if one is being used |  |
| Power-up the drive | <p>Ensure:</p> <ul style="list-style-type: none"> Drive displays 'inh' <p>NOTE</p> <p>The drive will trip 'th' (Motor thermistor trip) if no motor thermistor is connected to analog input 3 (terminal 8). If the motor protection is not connected to the drive, the 'th' trip can be disabled by setting Pr 7.15 (in01, 0.81) (analog input 3 mode) to VOLT.</p> <p>For drive trips, see Chapter 13 <i>Diagnostics</i> on page 167.</p> |  |
| Enter motor nameplate details | <p>Enter:</p> <ul style="list-style-type: none"> Armature rated voltage in Pr 5.09 (SE06, 0.27) (V) Motor rated current in Pr 5.07 (SE07, 0.28) (A) Motor rated speed (base speed) in Pr 5.08 (SE08, 0.29) (rpm) Field rated current in Pr 5.70 (SE10, 0.31) (A) Field rated voltage in Pr 5.73 (SE11, 0.32) (V) |  |
| Set motor feedback parameters | <p>Incremental encoder basic set-up</p> <p>Enter:</p> <ul style="list-style-type: none"> Drive encoder type in Pr 3.38 (Fb07, 0.77) = Ab (0): Quadrature encoder <div style="border: 1px solid black; padding: 5px;">  <p>Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.</p> <p>CAUTION</p> </div> <ul style="list-style-type: none"> Encoder power supply in Pr 3.36 (Fb06, 0.76) = 5V (0), 8V (1), 15V (2) or 24V (3) <p>NOTE If output voltage from the encoder is >5V, then the termination resistors must be disabled Pr 3.39 (Fb08, 0.78) to 0.</p> <ul style="list-style-type: none"> Drive encoder lines per revolution (LPR) in Pr 3.34 (Fb05, 0.75) (set according to encoder) Drive encoder termination resistor setting in Pr 3.39 (Fb08, 0.78) <ul style="list-style-type: none"> 0 = A-A\, B-B\, Z-Z\ termination resistors disabled 1 = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled 2 = A-A\, B-B\, Z-Z\ termination resistors enabled <p>Tachometer set-up</p> <p>Enter:</p> <ul style="list-style-type: none"> Tachometer voltage rating Pr 3.51 (Fb02, 0.72) (V/1000 rpm) Tachometer input mode Pr 3.53 (Fb03, 0.73) | |
| Set maximum speed | <p>Enter:</p> <ul style="list-style-type: none"> Maximum speed in Pr 1.06 (SE02, 0.23) (rpm) Set Pr 5.64 = On If field weakening is required <p>NOTE</p> <p>For field weakening in Estimated Speed Mode please refer to Chapter8 <i>Optimization</i> on page 78</p> |  |
| Set acceleration / deceleration rates | <p>Enter:</p> <ul style="list-style-type: none"> Acceleration rate in Pr 2.11 (SE03, 0.24) (time to accelerate to maximum speed) Deceleration rate in Pr 2.21 (SE04, 0.25) (time to decelerate from maximum speed) |  |
| Enable the field controller | <p>Field controller set-up</p> <ul style="list-style-type: none"> Select field mode by setting Pr 5.78 = IntrnL (Internal field controller is used), Etrnl (External half control), E FULL (External in full control). Set Pr 5.77 (SE12, 0.33) = On to enable the field. | |

| Action | Detail |
|-------------------------|---|
| 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>Static autotune for current loop gains</p> <p>When this operation is performed the drive will perform an estimation of <i>Motor constant</i> (Pr 5.15), <i>Continuous proportional gain</i> (Pr 4.13), <i>Continuous integral gain</i> (Pr 4.14), <i>Discontinuous integral gain</i> (Pr 4.34), <i>Back EMF set point</i> (Pr 5.59), <i>Armature resistance</i> (Pr 5.61) and <i>Flux loop I gain</i> (Pr 5.72) 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"> • Set Pr 5.12 (SE13, 0.34)= 1 • Close the Drive Enable signal (terminal 31). The drive will display 'rdY' • Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune • Remove the enable signal when the autotune has finished • Remove the run signal |
| Checking speed feedback | <ul style="list-style-type: none"> • 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. • Check that the feedback device is functioning correctly: <ul style="list-style-type: none"> For encoder speed feedback - Check encoder speed feedback Pr 3.27 (Fb09, 0.79). For tachometer speed feedback - Check tachometer speed feedback Pr 3.52 (Fb04, 0.74). • 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) <p>NOTE</p> <p>For improved estimated speed accuracy and torque control in the field weakening range a rotating autotune is recommended to determine the motor flux characteristics Pr 5.12 (SE13, 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>NOTE</p> <p>A rotating autotune cannot be carried out in Estimated speed mode.</p> <div style="border: 1px solid black; padding: 5px; margin: 5px 0;">  <p>A rotating autotune will cause the motor to accelerate up to $\frac{1}{4}$ 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>WARNING The drive can be stopped at any time by removing the run signal or removing the drive enable.</p> </div> <p>Rotating autotune for motor field flux set-up</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 and Pr 5.30), by spinning the motor at 25% of its base speed (Pr 5.08) with respect to the selected motor map and store the values.</p> <p>To perform an autotune:</p> <ul style="list-style-type: none"> • Set Pr 5.12 (SE13, 0.34) = 2 for a rotating autotune • Close the Drive Enable signal (terminal 31). The drive will display 'rdY' • Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune • Wait for the drive to display 'inh' and for the motor to come to a standstill <p>If the drive trips, see Chapter 13 <i>Diagnostics</i> on page 167.</p> <ul style="list-style-type: none"> • Remove the drive enable and run signal from the drive. |
| Save parameters | <p>Select SAVE in Pr xx.00 (SE00, 0.21)</p> <p>Press the red  reset button or toggle the reset digital input (ensure Pr xx.00 (SE00, 0.21) returns to 'no Act').</p> |
| Run | <p>Drive is now ready to run</p> <ul style="list-style-type: none"> • Close enable signal • Close run signal • Provide speed reference <div style="text-align: right; margin-top: 20px;">  </div> |

7.2 Quick start commissioning / start-up (from USA defaults)

| Action | Detail | |
|---------------------------------------|---|---|
| Before power-up | <p>Ensure:</p> <ul style="list-style-type: none"> Drive Enable signal is not given (terminal 31) Run signal is not given Motor connected Tacho connected if one is being used Encoder connected if one is being used |  |
| Power-up the drive | <p>Ensure:</p> <ul style="list-style-type: none"> Drive displays 'inh' <p>NOTE</p> <p>Motor thermistor input is disabled by default. If motor thermistor is available the thermistor should be used. The protection is enabled with Pr 7.15 (in01, 0.81).</p> <p>For drive trips, see Chapter 13 <i>Diagnostics</i> on page 167.</p> |  |
| Enter motor nameplate details | <p>Enter:</p> <ul style="list-style-type: none"> Armature rated voltage in Pr 5.09 (SE06, 0.27) (V) Motor rated current in Pr 5.07 (SE07, 0.28) (A) Motor rated speed (base speed) in Pr 5.08 (SE08, 0.29) (rpm) Field rated voltage in Pr 5.73 (SE11, 0.32) (V) |  |
| Set motor feedback parameters | <p>Incremental encoder basic set-up</p> <p>Enter:</p> <ul style="list-style-type: none"> Drive encoder type in Pr 3.38 (Fb07, 0.77) = Ab (0): Quadrature encoder <div style="border: 1px solid black; padding: 5px;">  <p>Setting the encoder voltage supply too high for the encoder could result in damage to the feedback device.</p> <p>CAUTION</p> </div> <ul style="list-style-type: none"> Encoder power supply in Pr 3.36 (Fb06, 0.76) = 5V (0), 8V (1), 15V (2) or 24V (3) <p>NOTE If output voltage from the encoder is >5V, then the termination resistors must be disabled Pr 3.39 (Fb08, 0.78) to 0.</p> <ul style="list-style-type: none"> Drive encoder lines per revolution (LPR) in Pr 3.34 (Fb05, 0.75) (set according to encoder) Drive encoder termination resistor setting in Pr 3.39 (Fb08, 0.78) <ul style="list-style-type: none"> 0 = A-A\, B-B\, Z-Z\ termination resistors disabled 1 = A-A\, B-B\, termination resistors enabled, Z-Z\ termination resistors disabled 2 = A-A\, B-B\, Z-Z\ termination resistors enabled <p>Tachometer set-up</p> <p>Enter:</p> <ul style="list-style-type: none"> Tachometer voltage rating Pr 3.51 (Fb02, 0.72) (V/1000 rpm) Tachometer input mode Pr 3.53 (Fb03, 0.73) | |
| Set maximum speed | <p>Enter:</p> <ul style="list-style-type: none"> Maximum speed in Pr 1.06 (SE02, 0.23) (rpm) <p>NOTE</p> <p>For field weakening the field controller needs to be set-up in current control by setting Pr 5.75 = OFF, setting the rated field current into Pr 5.70 (SE10, 0.31) and setting Pr 5.64 to On.</p> <p>For field weakening in Estimated Speed Mode please refer to Chapter 8 <i>Optimization</i> on page 78.</p> |  |
| Set acceleration / deceleration rates | <p>Enter:</p> <ul style="list-style-type: none"> Acceleration rate in Pr 2.11 (SE03, 0.24) (time to accelerate to maximum speed) Deceleration rate in Pr 2.21 (SE04, 0.25) (time to decelerate from maximum speed) |  |
| Enable the field controller | <p>Field controller set-up</p> <ul style="list-style-type: none"> Select field mode by setting Pr 5.78 = IntrnL (Internal field controller is used), Etrnl (External half control), E FULL (External in full control). Set Pr 5.77 (SE12, 0.33) = On to enable the field. | |

| Action | Detail | |
|-------------------------|--|---|
| 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>Static autotune for current loop gains</p> <p>When this operation is performed the drive will perform an estimation of <i>Motor constant</i> (Pr 5.15), <i>Continuous proportional gain</i> (Pr 4.13), <i>Continuous integral gain</i> (Pr 4.14), <i>Discontinuous integral gain</i> (Pr 4.34), <i>Back EMF set point</i> (Pr 5.59), <i>Armature resistance</i> (Pr 5.61) and <i>Flux loop I gain</i> (Pr 5.72) 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"> Set Pr 5.12 (SE13, 0.34)= 1 Close the Drive Enable signal (terminal 31). The drive will display 'rdY' Close the run signal (terminal 26 or 27). The lower display will flash 'Auto' and 'tunE' alternatively, while the drive is performing the autotune Remove the enable signal when the autotune has finished Remove the run signal <p>NOTE</p> <p>A rotating autotune Pr 5.12 (SE13, 0.34) = 2 should not be carried out when the field controller is in voltage mode, Pr 5.75 = On (USA default).</p> | |
| Checking speed feedback | <ul style="list-style-type: none"> 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. Check that the feedback device is functioning correctly: <ul style="list-style-type: none"> For encoder speed feedback - Check encoder speed feedback Pr 3.27 (Fb09, 0.79). For tachometer speed feedback - Check tachometer speed feedback Pr 3.52 (Fb04, 0.74). 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). | |
| Save parameters | <p>Select SAVE in Pr xx.00 (SE00, 0.21)</p> <p>Press the red  reset button or toggle the reset digital input (ensure Pr xx.00 (SE00, 0.21) returns to 'no Act').</p> | |
| Run | <p>Drive is now ready to run</p> <ul style="list-style-type: none"> Close enable signal Close run signal Provide speed reference |  |

7.3 CTSoft software commissioning / start-up tool

CTSoft can be used for commissioning / start-up 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 DMV 2322/2342 parameters to be migrated to the Mentor MP. CTSoft is able to communicate with a single drive or a network.

CT Soft can be found on the CD which is supplied with the drive and is also available for download from the website www.leroy-somer.com (file size approximately 100MB).

7.3.1 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 800 x 600 screen resolution. A resolution of 1024 x 768 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.

7.3.2 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 *Mentor MP Advanced User Guide*.

7.4 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*.

7.4.1 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) NOTE 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) NOTE 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 equals the compensated rated field current (see Pr 5.74), 100% field flux is produced.

8.3.1 Field weakening with a speed feedback device

If field weakening is required the field compensation factor (Pr 5.74), the motor saturation breakpoints (Pr 5.29, Pr 5.30) and the voltage at which field weakening is required to begin (Pr 5.59) must be set.

Setting up the drive in field weakening is straightforward when a speed feedback device is available. The rotating autotune (Pr 5.12 (SE13, 0.34) = 2) automatically sets up the parameters above. Follow the quick start commissioning / start-up (from European defaults) as shown in Table 6-1 on page 64 to set up the drive. Enable field weakening (Pr 5.64 = On). Save parameters.

NOTE

For field weakening from USA defaults Pr 5.75 *Field voltage mode* should be set to OFF. Pr 5.28 *Field weakening compensation disable* should be set to OFF. Follow the quick start commissioning / start-up (from European defaults) as shown in Table 6-1 on page 64 to set up the drive. Enable field weakening (Pr 5.64 = On). Save parameters.

8.3.2 Field weakening in estimated speed mode (no speed feedback device)

The Rotating Autotune (Pr 5.12 (SE13, 0.34) = 2) sets up the field controller for more accurate flux control and open loop speed accuracy. The rotating autotune needs to know the motor speed and so a speed feedback device has to be connected to the drive before a rotating autotune can be carried out. In some applications a speed feedback device may not be required and so the procedure below allows the user to manually adjust the field controller parameters to achieve better open loop speed control.

- Follow the quick start commissioning / start-up (from European defaults) as shown in Table 6-1 *Pre-defined sub block parameters* on page 64 until a static autotune (Pr 5.12 (SE13, 0.34) = 1) has been carried out.
- Set Pr 5.64 *Field weakening enable* to On.
- Ensure that Pr 5.29, Pr 5.30, Pr 5.68 and Pr 5.74 are set to their default values of 50%, 75%, 100% and 100% respectively.
- Set the speed demand to 1/4 of Base speed (Pr 5.08 (SE08, 0.29)) and run the machine up to speed and check the speed of the machine using a hand held device.
- If the machine speed is lower than 1/4 of base speed (which is normally the case) adjust the *Field compensation factor* (Pr 5.74) down until the correct machine speed is reached. If the machine speed is higher than 1/4 of base speed (only possible if the motor nameplate field current is low), adjust the rated field current (Pr 5.70 (SE10, 0.31)) up until the correct machine speed is reached.
- Set Pr 5.68 *Maximum flux* to 75% and measure the actual speed of the machine (speed 75)
- Set Pr 5.68 *Maximum flux* to 50% and measure the actual speed of the machine (speed 50).
- Stop the machine and set Pr 5.68 *Maximum flux* back to 100%.
- Set Pr 5.29 *Motor saturation breakpoint 1* = 50 x set speed / actual speed (Speed 50)
- Set Pr 5.30 *Motor saturation breakpoint 2* = 75 x set speed / actual speed (speed 75).
- Save parameters.

NOTE

For field weakening from USA defaults Pr 5.75 *Field voltage mode* should be set to OFF. Pr 5.28 *Field weakening compensation disable* should be set to OFF. The procedure above should then be followed to set up the drive for field weakening.

8.3.3 Field economy

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 5.66 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 changes 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 field weakening 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

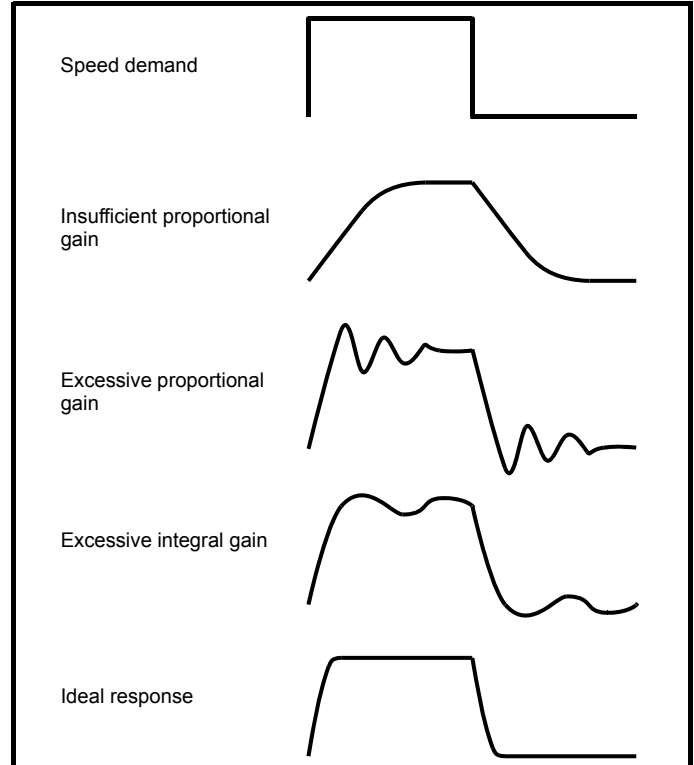
The integral gain is provided to prevent speed regulation. The error is accumulated over a period of time and used to produce the necessary torque demand without any speed error. Increasing the integral gain reduces the time taken for the speed to reach the correct level and increases the stiffness of 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 $\Sigma(Ki \times \text{error})$, 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 (Kp) should be set up initially. The value should be increased up to the point where the speed overshoots and then reduced slightly.

The integral gain (Ki) should then be increased up to the point where the speed becomes unstable and then reduced slightly.

It may now be possible to increase the proportional gain to a higher value and the process should be repeated until the system response matches the ideal response as shown.

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 Kp and Ki 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 - Kp gain times 16

If this parameter is set to 2 the Kp gain (from whichever source), is multiplied by 16. This is intended to boost the range of Kp for applications with very high inertia. It should be noted that if high values of Kp 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 11.22.4 *Current limit tapers* on page 142.

9 SMARTCARD operation

9.1 Introduction

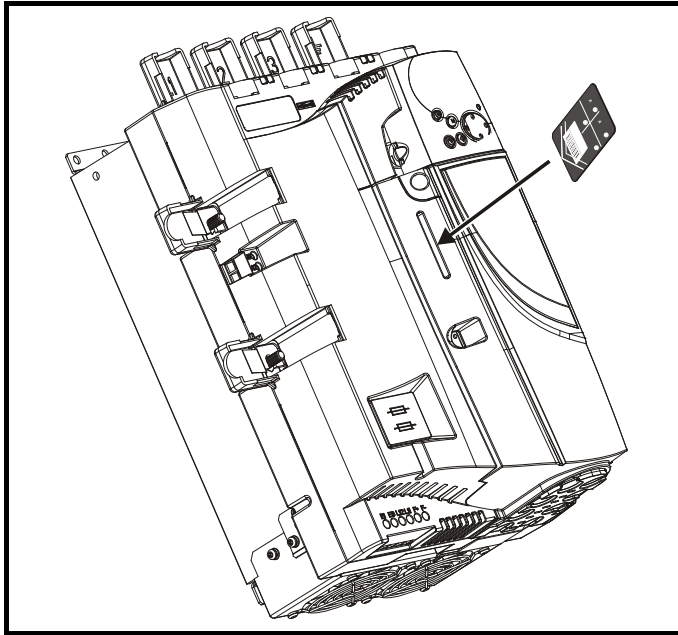
This is a standard feature that enables simple configuration of parameters in a variety of ways. The SMARTCARD can be used for:

- 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 set-up |
| 500 to 999 | 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 83.

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

Where yyy indicates the data block number 001 to 999, refer to Table 9-1 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) | Armature 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.Typ' 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 11.37 = 0 |
| 1 | 3C.SE | Digidrive 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 | 3REGEn | Regen mode parameter file |
| 6 | 3DC | DC mode parameter file |
| 7 | 3Un | Unused |
| 8 | 3Un | Unused |
| 9 | 4C.SE | Digidrive 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 | 4REGEn | 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 |
|---------------|--|
| C.boot | SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD |
| 177 | A write to a Menu 0 parameter has been initiated with the keypad by exiting edit mode and Pr 11.42 (SE09, 0.30) 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 11.42 (SE09, 0.30) is changed to auto or boot mode, but the drive is not subsequently reset. |
| C.BUSy | SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module |
| 178 | An attempt has been made to access a SMARTCARD. However an Solutions Module is already accessing the SMARTCARD. |
| C.Chg | SMARTCARD trip: Data location already contains data |
| 179 | An attempt has been made to store data in a SMARTCARD data block that already exists. |
| C.Optn | SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive |
| 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. |
| C.Rdo | SMARTCARD trip: SMARTCARD has the Read Only bit set |
| 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. |
| C.Err | SMARTCARD trip: SMARTCARD data is corrupted |
| 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. |
| C.dat | SMARTCARD trip: Data location specified does not contain any data |
| 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. |
| C.FULL | SMARTCARD trip: SMARTCARD full |
| 184 | An attempt has been made to create a data block on a SMARTCARD, but there is not enough space on the card. |
| C.Acc | SMARTCARD trip: SMARTCARD Read / Write fail |
| 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. |
| C.rtg | SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different |
| 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. |
| C.Typ | SMARTCARD trip: SMARTCARD parameter set not compatible with drive |
| 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. |
| C.cpr | SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different |
| 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 |
|---------------|---|
| boot | 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 82. |
| cArd | 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 82. |

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 (IEC 61131-3).
- 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 / start-up.

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

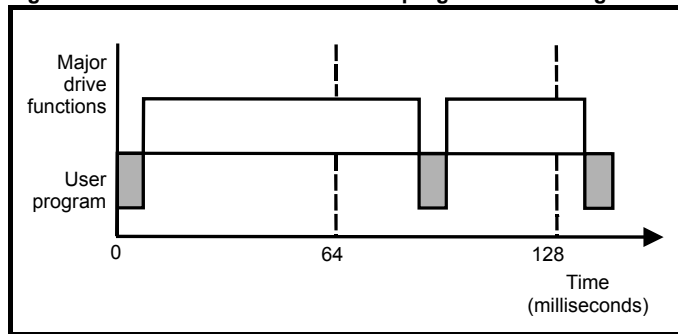
Compared with the SM-Applications Plus or SM-Applications Lite V2 modules when programmed with SYPT, the Onboard PLC program has the following limitations:

- 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



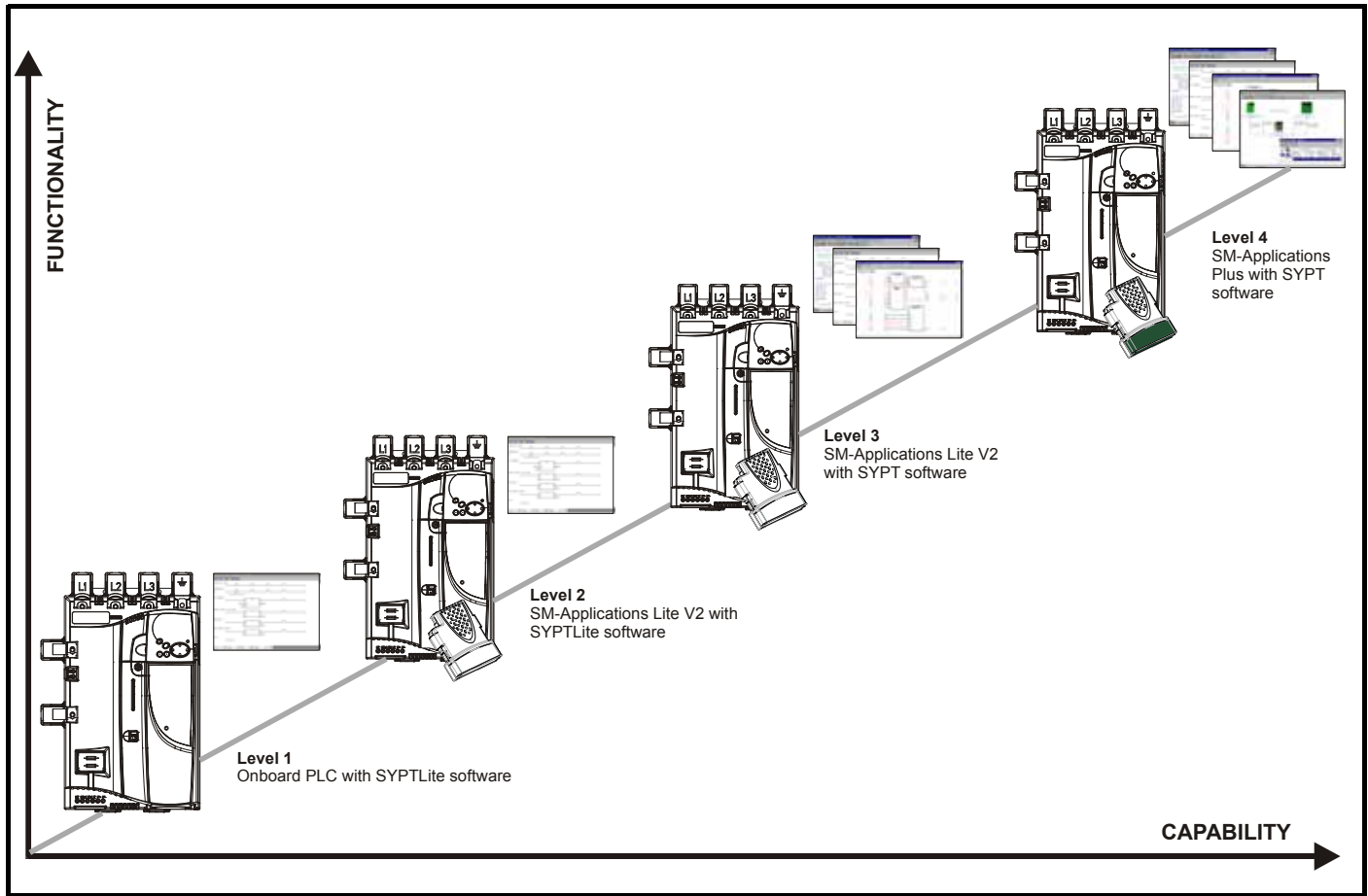
The user program is scheduled for a short period approximately once every 64ms. The time for which the program is scheduled will vary between 0.2ms and 2ms depending on the loading of the drive's processor.

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 800 x 600 screen resolution. 1024 x 768 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 |
|----------------|--|
| UP ACC | Onboard PLC program: Cannot access Onboard PLC program file on drive |
| 98 | 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. |
| UP div0 | Onboard PLC program attempted divide by zero |
| 90 | Check program |
| UP OFL | Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow) |
| 95 | Check program |
| UP ovr | Onboard PLC program attempted out of range parameter write |
| 94 | Check program |
| UP PAr | Onboard PLC program attempted access to a non-existent parameter |
| 91 | Check program |
| UP ro | Onboard PLC program attempted write to a read-only parameter |
| 92 | Check program |
| UP So | Onboard PLC program attempted read of a write-only parameter |
| 93 | Check program |
| UP udF | Onboard PLC program undefined trip |
| 97 | Check program |
| UP uSer | Onboard PLC program requested a trip |
| 96 | 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 81 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 to 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 *Mentor MP 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 *Mentor MP 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 |
|--------|--|
| {X.XX} | Copied Mneu 0 or advanced parameter |
| 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. |
| 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. |
| 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 SMARTCARD 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 SMARTCARD during copying. |
| 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. |
| RO | Read only: can only be read 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: 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. |

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 | | | | | | | | | | | | | |

| 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] | Maximum speed reference 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] | Maximum applied to speed reference limits 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 (in rpm) = 500kHz x 60 / ELPR = 3.0 x 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] | Maximum speed 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 x MAX_SPEED_REF |
| MAX_RAMP_RATE MAX_RAMP_RATE_M2 [3200.000] | Maximum ramp rate 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 End if |
| RATED_CURRENT_MAX [9999.99A] | Maximum motor rated current |
| DRIVE_CURRENT_MAX [9999.99A] | Maximum drive current The maximum drive current is the current at the over current trip level and is given by: DRIVE_CURRENT_MAX = RATED_CURRENT_MAX x 2 |
| MOTOR1_CURRENT_LIMIT_MAX [1000.0%] | Maximum current limit settings for motor map 1 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%] | Maximum current limit settings for motor map 2 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%] | Maximum torque producing current 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%] | Current parameter limit selected by the user 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 |

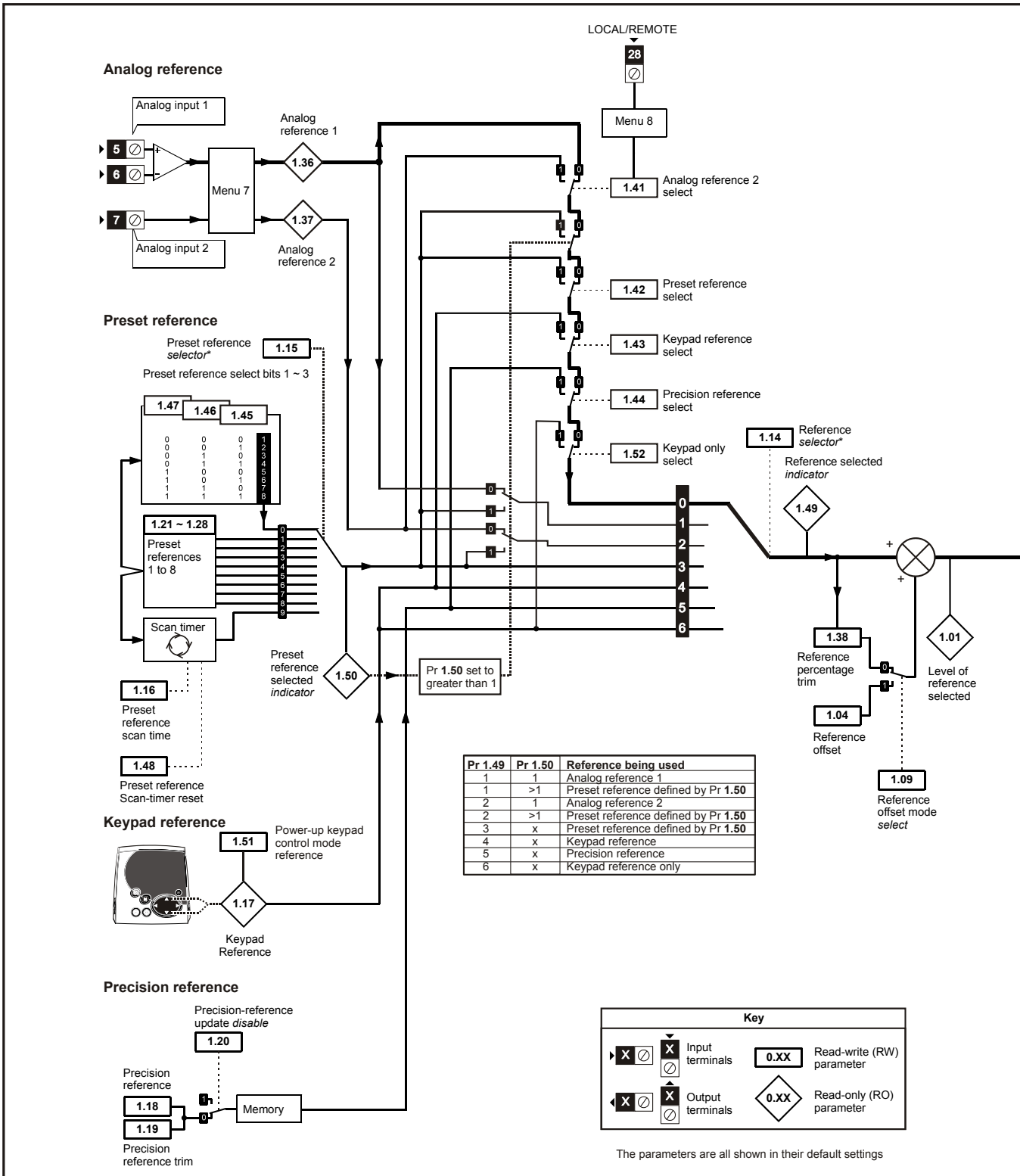
| Maximum | Definition |
|--------------------------------|--|
| ARMATURE_VOLTAGE_MAX [1025] | <p>Maximum armature voltage $V_{ac} \times 1.35 (\sqrt{2} \times 3 / \pi)$ 480 +10% drive: 720 575 +10% drive: 860 690 +10% drive: 1025</p> <p>NOTE For 4 quadrant drives maximum armature voltage = $V_{ac} \times 1.15$</p> |
| QUADRANT_MAX | <p>Quadrant maximum 0 for a 2 quadrant drive. 1 for a 4 quadrant drive.</p> |
| POWER_MAX [9999.99kW] | <p>Maximum power in kW 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: $POWER_MAX = ARMATURE_VOLTAGE_MAX \times DRIVE_CURRENT_MAX$</p> |

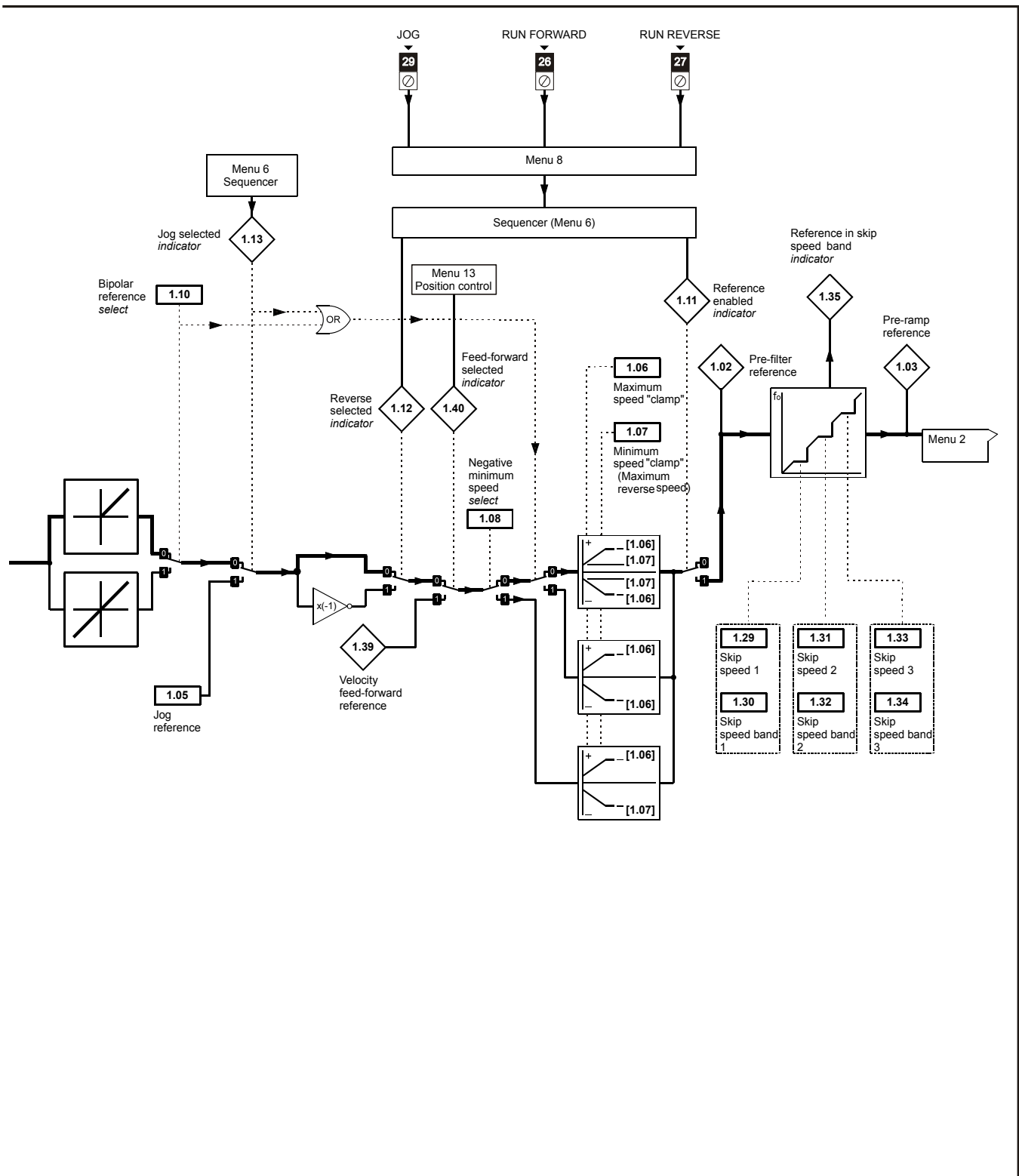
The values given in square brackets indicate the absolute maximum value allowed for the variable maximum.

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)

| Parameter | | Range(⇅) | Default(⇒) | Type | | | | |
|-----------|--|-----------------------|------------|------|-----|----|----|----|
| 1.01 | Speed reference selected {di01, 0.36} | ±MAX_SPEED_REF rpm | 0.0 | RO | Bi | NC | PT | |
| 1.02 | Pre-skip filter reference | | | RO | Bi | NC | PT | |
| 1.03 | Pre-ramp reference {di02, 0.37} | | | 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 | | RW | Uni | | | US |
| 1.06 | Maximum reference clamp {SE02, 0.23} | SPEED_LIMIT_MAX rpm | 1000.0 | 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 | | | RW | Bit | | | US |
| 1.10 | Bipolar reference enable | | | RW | Bit | | | US |
| 1.11 | Reference enabled indicator {di11, 0.46} | | | RO | Bit | NC | PT | |
| 1.12 | Reverse selected indicator {di12, 0.47} | RO | Bit | NC | PT | | | |
| 1.13 | Jog selected indicator {di13, 0.48} | 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 | | RW | Bi | | | US |
| 1.19 | Precision reference fine | 0.0 to 0.099 rpm | | 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 | | | RW | Bi | | | US |
| 1.23 | Preset reference 3 | | | RW | Bi | | | US |
| 1.24 | Preset reference 4 | | | RW | Bi | | | US |
| 1.25 | Preset reference 5 | | | RW | Bi | | | US |
| 1.26 | Preset reference 6 | | | RW | Bi | | | US |
| 1.27 | Preset reference 7 | | | RW | Bi | | | US |
| 1.28 | Preset reference 8 | | | 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 | | | 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) | OFF (0) | RO | Bit | NC | PT | |
| 1.41 | Reference select flag 1 | | | RW | Bit | NC | | |
| 1.42 | Reference select flag 2 | | | RW | Bit | NC | | |
| 1.43 | Reference select flag 3 | | | RW | Bit | NC | | |
| 1.44 | Reference select flag 4 | | | RW | Bit | NC | | |
| 1.45 | Reference select flag 5 | | | RW | Bit | NC | | |
| 1.46 | Reference select flag 6 | | | RW | Bit | NC | | |
| 1.47 | Reference select flag 7 | | | RW | Bit | NC | | |
| 1.48 | Reference timer reset flag | | | 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 | | |

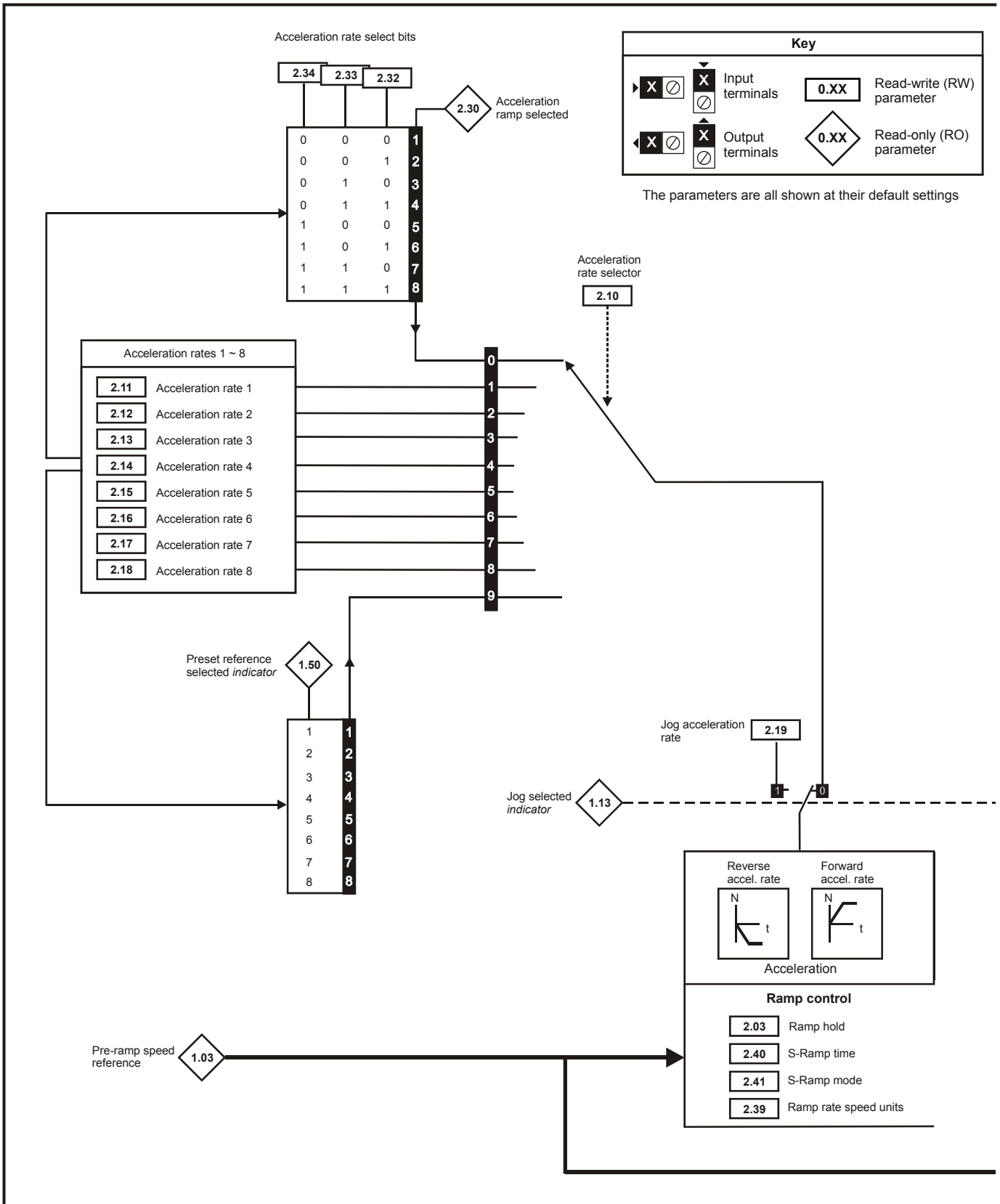
*The range shown for Pr 1.07 shows the range used for scaling purposes (i.e. for routing to an analog output etc.). Further range restrictions are applied depending on the settings of Pr 1.08 and Pr 1.10.

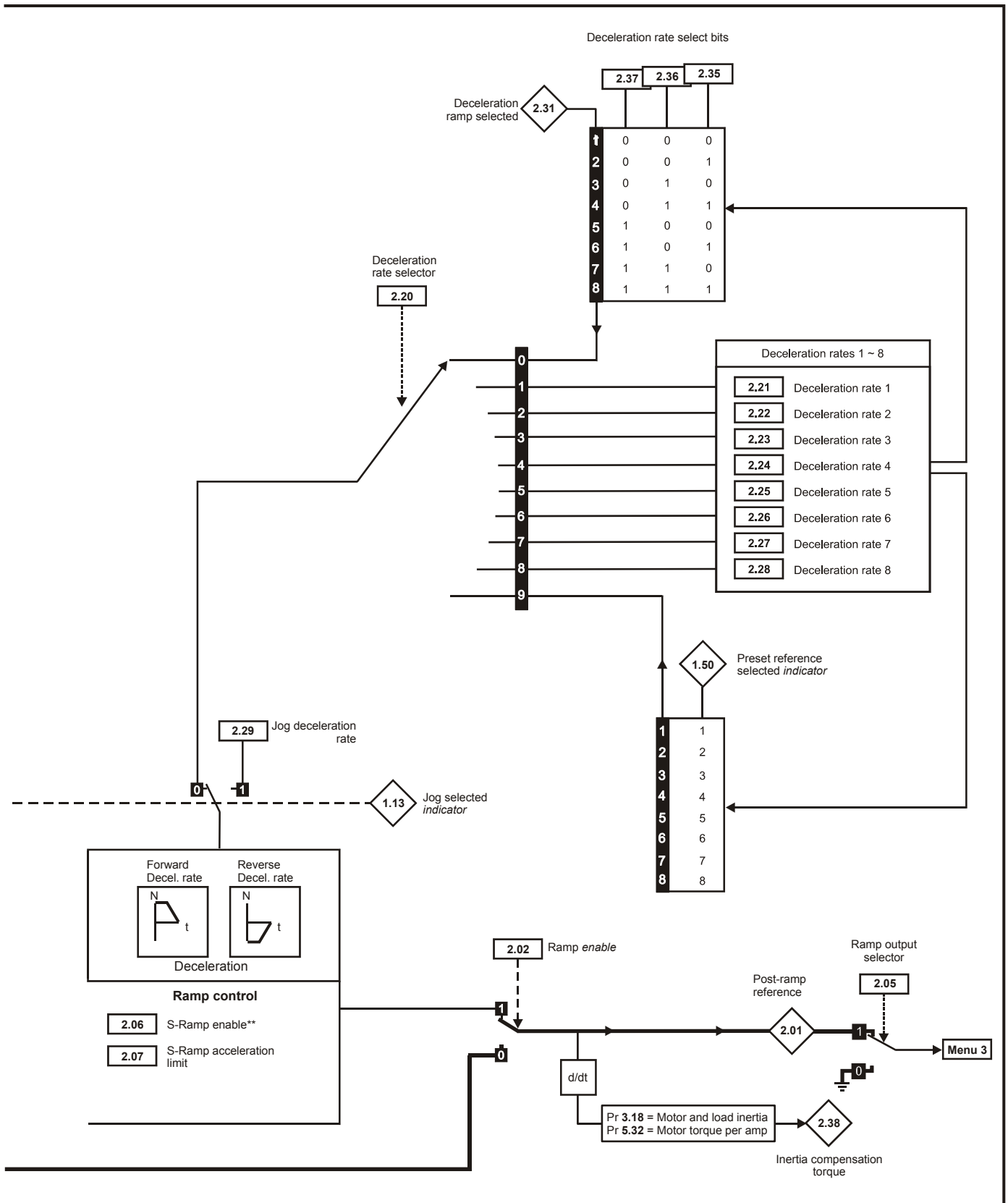
| | | | | | | | | | | | | | |
|----|--------------|----|-------------|-----|------------|----|------------------|-----|---------------|-----|-------------|----|-----------------|
| RW | Read / Write | RO | Read only | Uni | Unipolar | Bi | Bi-polar | Bit | Bit parameter | Txt | Text string | | |
| FI | Filtered | DE | Destination | NC | Not copied | RA | Rating dependent | PT | Protected | US | User save | PS | Power down save |

11.2 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





** For more information refer to Chapter 11.22 *Advanced features* on page 140 section in the *Mentor MP User Guide*.

| 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 | | 0 | RW | Bit | | US |
| 2.05 | Ramp output selector | | On (1) | RW | Bit | | US |
| 2.06 | S ramp enable | | 0 Eur: 0, USA: 1 | RW | Bit | | US |
| 2.07 | S ramp acceleration limit | 0 to 100.000 s ² /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 | | | RW | Uni | | US |
| 2.13 | Acceleration rate 3 | | | RW | Uni | | US |
| 2.14 | Acceleration rate 4 | | | RW | Uni | | US |
| 2.15 | Acceleration rate 5 | | | RW | Uni | | US |
| 2.16 | Acceleration rate 6 | | | RW | Uni | | US |
| 2.17 | Acceleration rate 7 | | | RW | Uni | | US |
| 2.18 | Acceleration rate 8 | | | RW | Uni | | US |
| 2.19 | Jog accelera ion rate | | | 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 | | | RW | Uni | | US |
| 2.23 | Deceleration rate 3 | | | RW | Uni | | US |
| 2.24 | Deceleration rate 4 | | | RW | Uni | | US |
| 2.25 | Deceleration rate 5 | | | RW | Uni | | US |
| 2.26 | Deceleration rate 6 | | | RW | Uni | | US |
| 2.27 | Deceleration rate 7 | | | RW | Uni | | US |
| 2.28 | Deceleration rate 8 | | | RW | Uni | | US |
| 2.29 | Jog deceleration rate | | | 10.000 | RW | Uni |  | US |
| 2.30 | Acceleration ramp selected | 1 to 8 | | RO | Uni | NC | PT |
| 2.31 | Deceleration ramp selected | | | RO | Uni | NC | PT |
| 2.32 | Acceleration select bit 0 | OFF (0) or On (1) | | RW | Bit | NC | |
| 2.33 | Acceleration select bit 1 | | | RW | Bit | NC | |
| 2.34 | Acceleration select bit 2 | | | RW | Bit | NC | |
| 2.35 | Deceleration select bit 0 | | | RW | Bit | NC | |
| 2.36 | Deceleration select bit 1 | | | RW | Bit | NC | |
| 2.37 | Deceleration select bit 2 | | | 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.

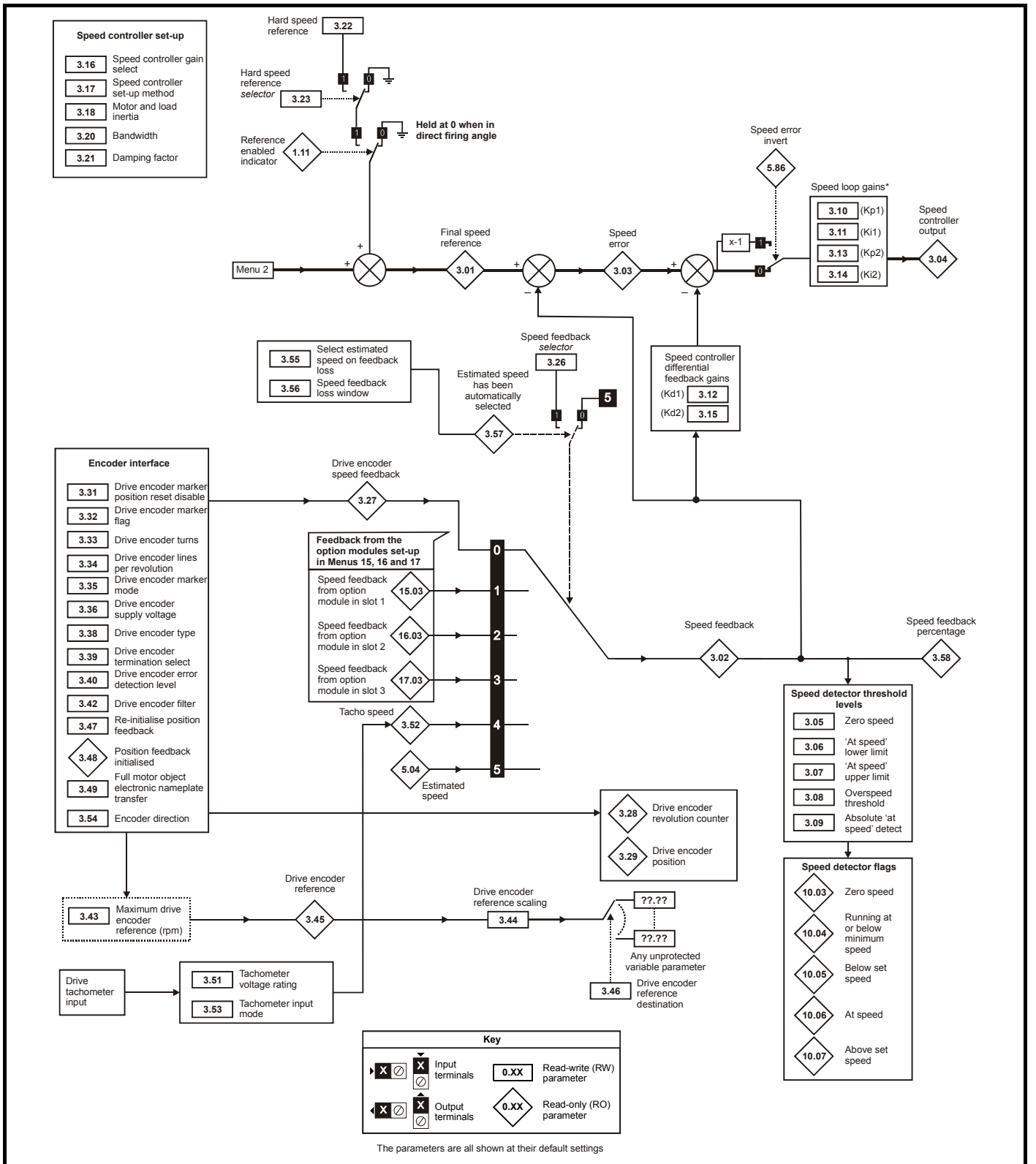
Analog feedback resolution

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



* If Pr 5.28 (Field weakening compensation disable) is set to 'OFF (0)' a multiplication factor is applied to the speed loop gains when the flux is below 100%.

| 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} | | | RO | Bi | FI | NC | PT | |
| 3.03 | Speed error | | | 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 | | | RW | Uni | | | | US |
| 3.08 | Overspeed threshold | | | 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 ² | 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 ¹⁶ 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 | | | 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 | | RW | Txt | | | | US |
| 3.38 | Drive encoder type {Fb07, 0.77} | 0 to 2 | | RW | Txt | | | | US |
| 3.39 | Drive encoder termination select {Fb08, 0.78} | | 1 | RW | Uni | | | | US |
| 3.40 | Drive encoder error detection level | 0 to 5 (0 to 16ms) | 2 | RW | Uni | | | | US |
| 3.42 | Drive encoder filter | | | 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% | 0.00 | RO | Bi | FI | NC | PT | |
| 3.46 | Drive encoder reference destination | 0 to 22 99 | | RW | Uni | | DE | PT | US |
| 3.47 | Re-initialise position feedback | OFF (0) or On (1) | | RW | Bit | | NC | | |
| 3.48 | Position feedback initialised | | RW | Bit | | NC | PT | | |
| 3.49 | Full motor object electronic nameplate transfer | | RW | Bit | | | | US | |
| 3.50 | Position feedback lock | 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 | | | |
| 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 | | | |
| 3.55 | Select estimated speed on feedback loss | | 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%):

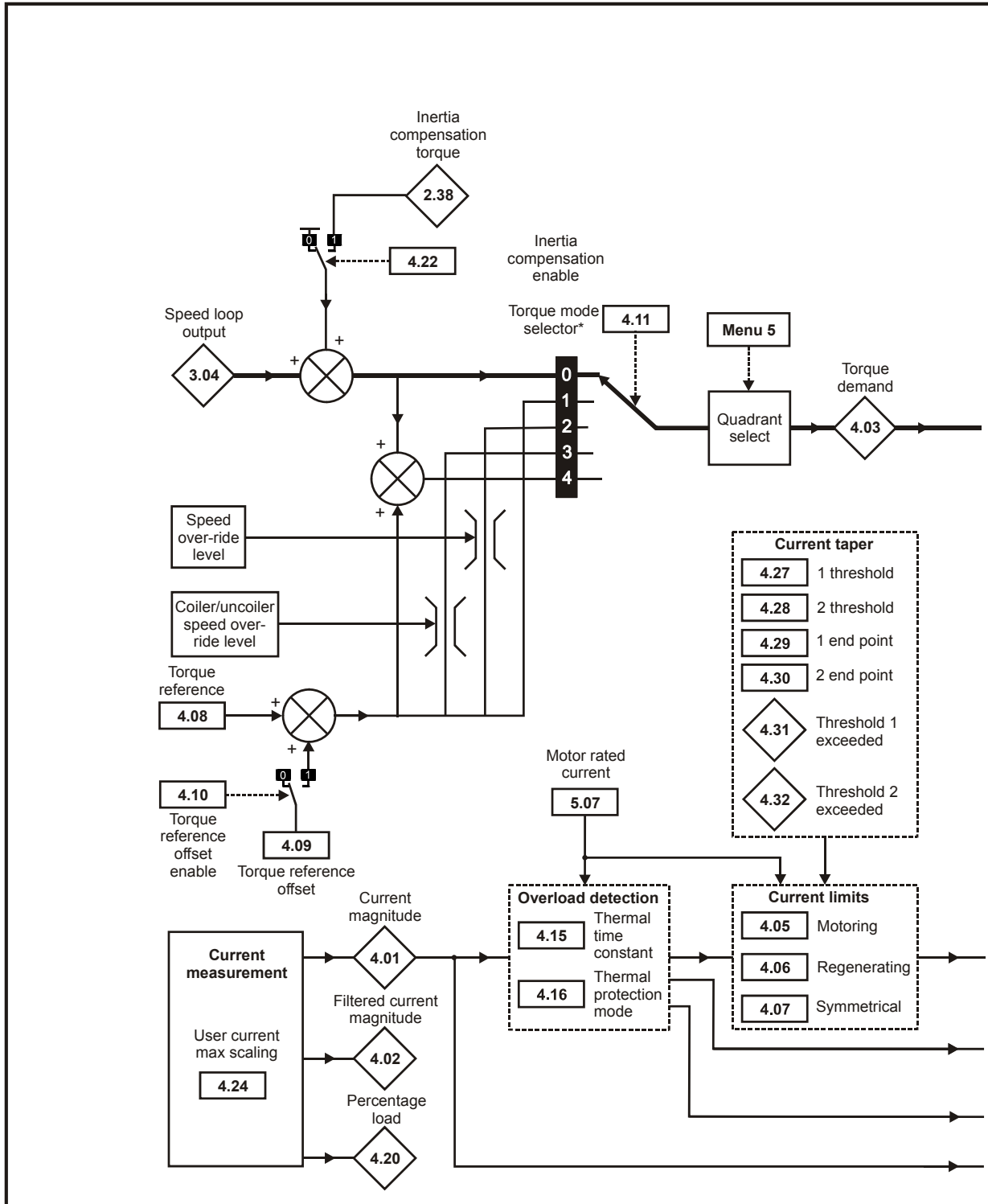
$$\text{CURRENT_LIMIT_MAX} = \left[\frac{\text{Maximum current}}{\text{Motor rated current}} \right] \times 100\%$$

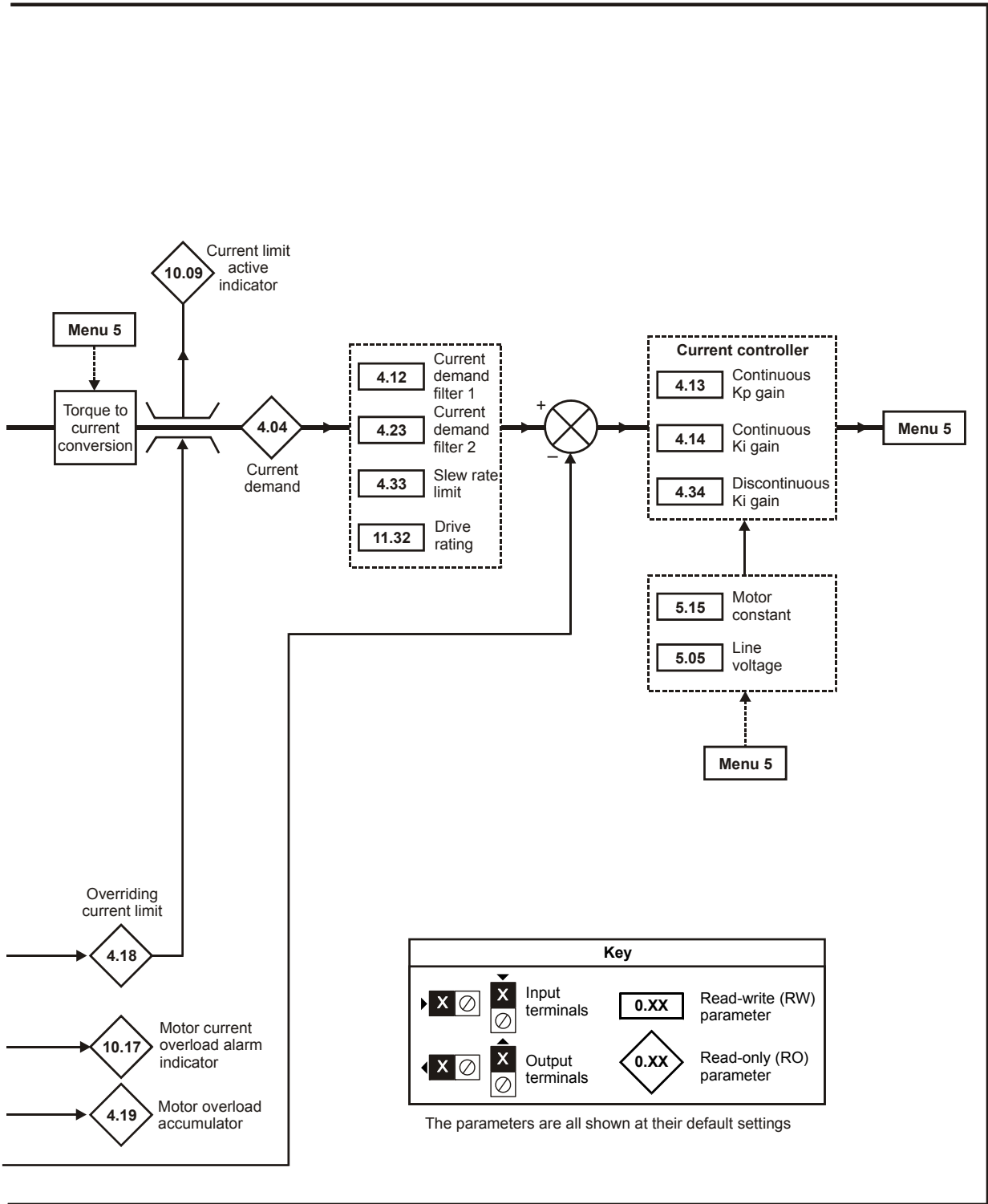
Where:

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



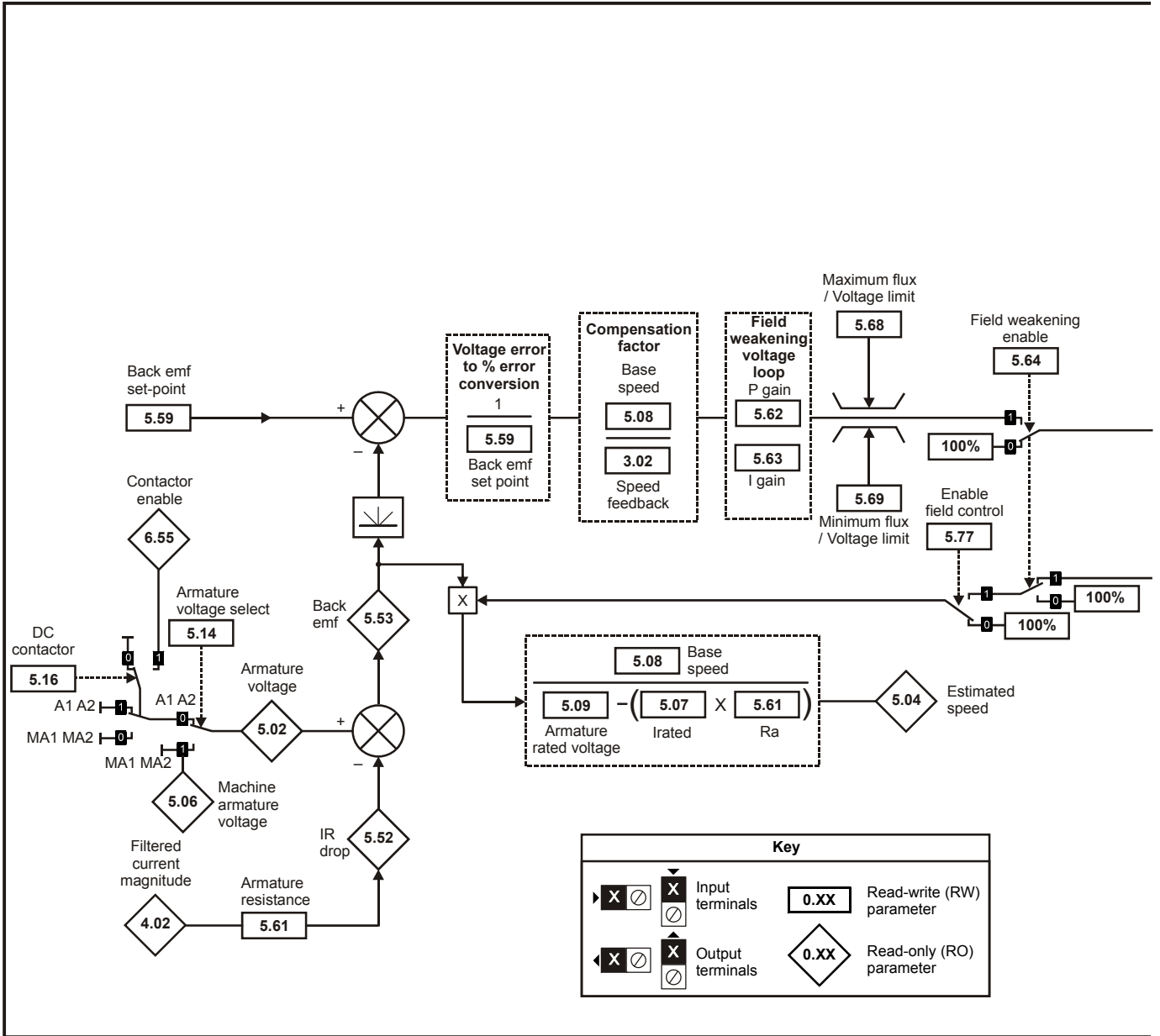


| Parameter | | Range(⇅) | Default(⇔) | Type | | | | | |
|-----------|---|----------------------------------|-------------------|---------|-----|-----|----|----|----|
| 4.01 | Current magnitude {di08, 0.43} | ±DRIVE_CURRENT_MAX A | | RO | Uni | FI | NC | PT | |
| 4.02 | Filtered current magnitude | | | 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 | | | 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 | | | RW | Uni | | RA | | US |
| 4.07 | Symmetrical current limit | | | RW | Uni | | RA | | US |
| 4.08 | Torque reference | | | 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 | 0.0 to 25.0 ms | 6.0 | RW | Uni | | | | US |
| 4.13 | Continuous current controller Kp gain | 0 to 4,000 | 100 | RW | Uni | | RA | | US |
| 4.14 | Continuous current controller Ki gain | | 50 | RW | Uni | | RA | | 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 | 6.0 | 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 | | | RW | Uni | | | | US |
| 4.29 | Current taper 1 end point | | | RW | Uni | | | | US |
| 4.30 | Current taper 2 end point | 0 to 1000.0% | 1000.0% | RW | Uni | | | | US |
| 4.31 | Taper threshold 1 exceeded | OFF (0) or On (1) | | RO | Bit | | | | |
| 4.32 | Taper threshold 2 exceeded | | | RO | Bit | | | | |
| 4.33 | Slew rate limit | 0.0 to 60,000 %s ⁻¹ | 7000 | RW | Uni | | | | US |
| 4.34 | Discontinuous current controller Ki gain | 0 to 4,000 | 200 | RW | Uni | | RA | | 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 | | | 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 |

11.5 Menu 5: Motor and field control

Figure 11-5 Menu 5 field control logic diagram



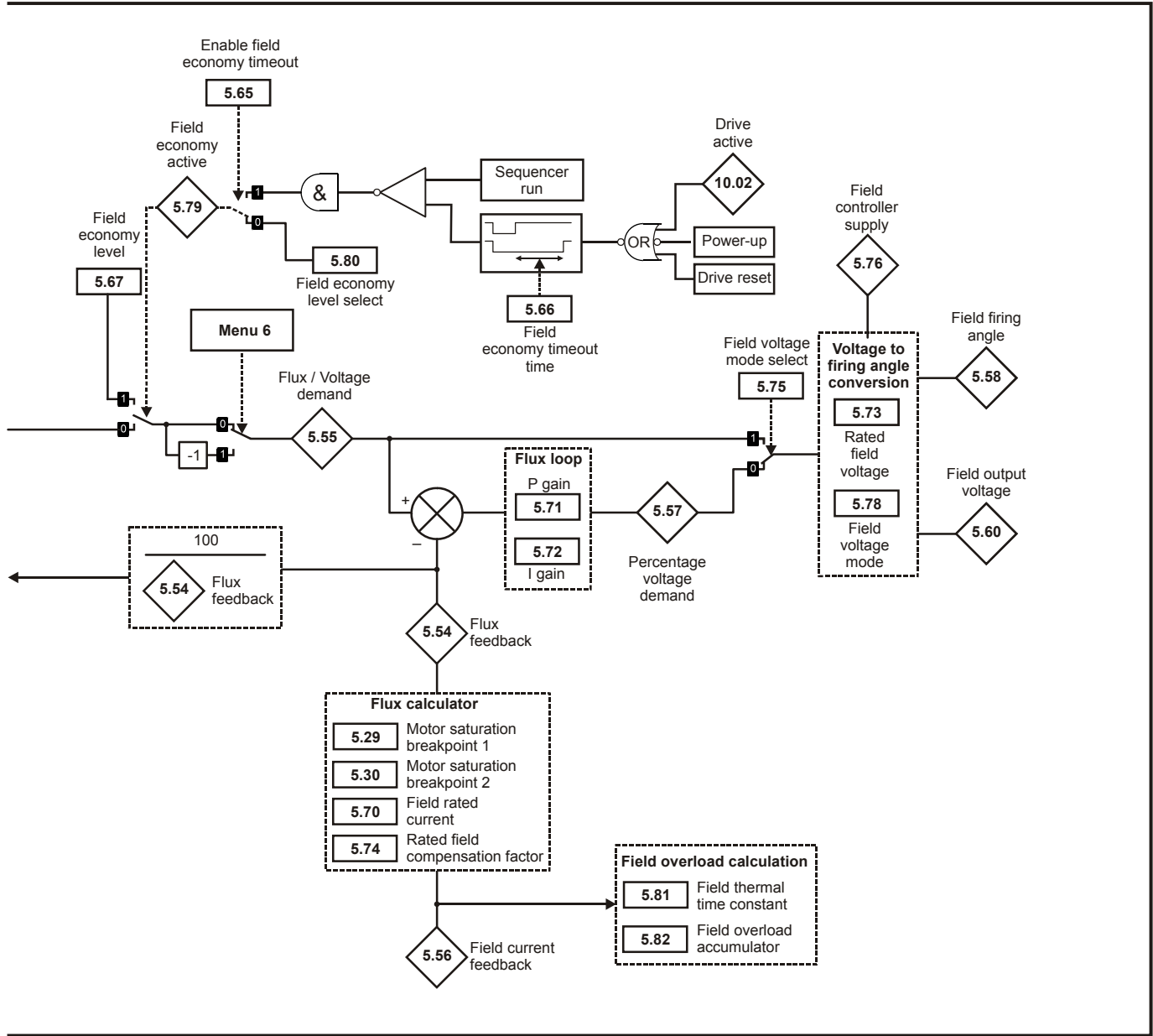
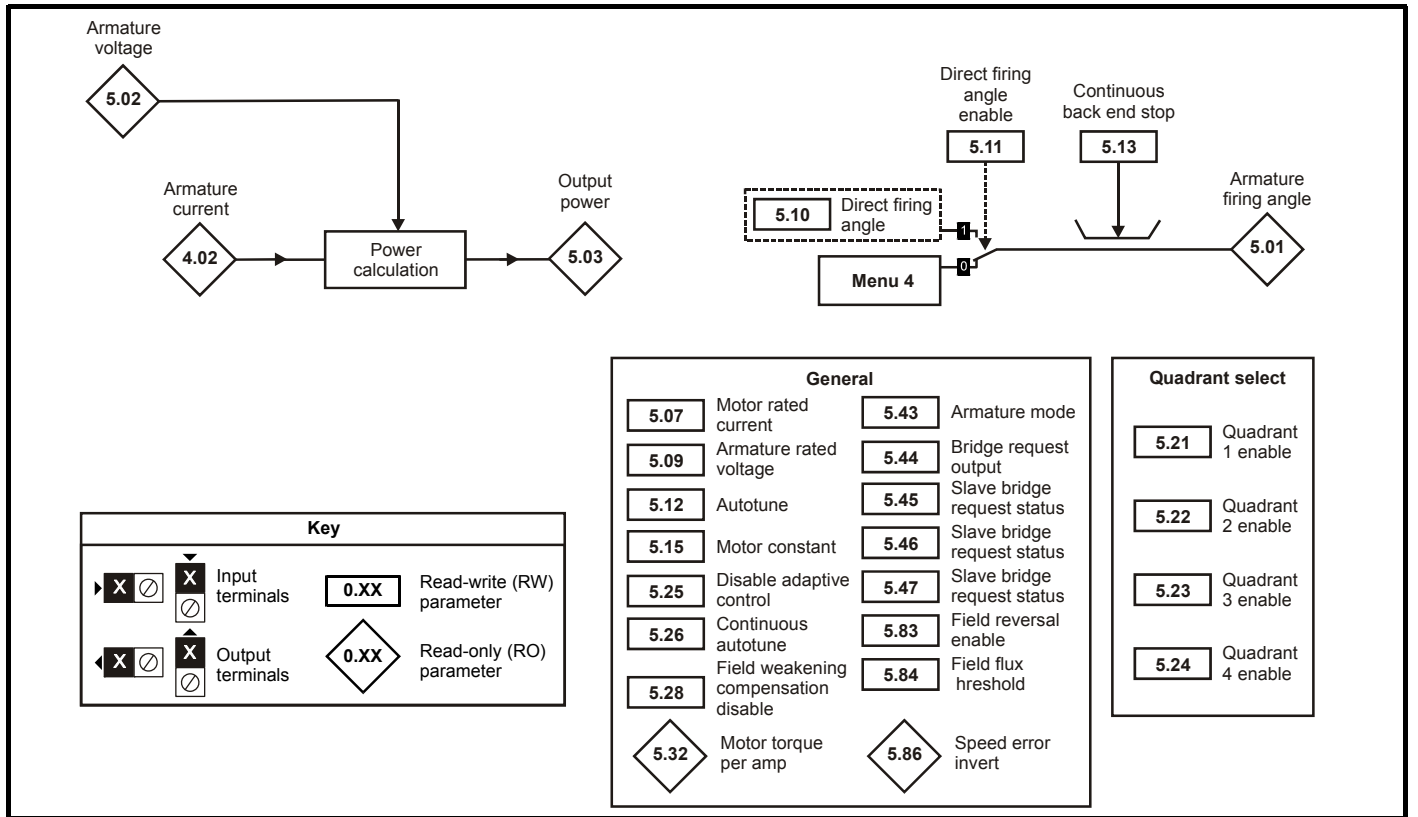


Figure 11-6 Menu 5 armature control logic diagram



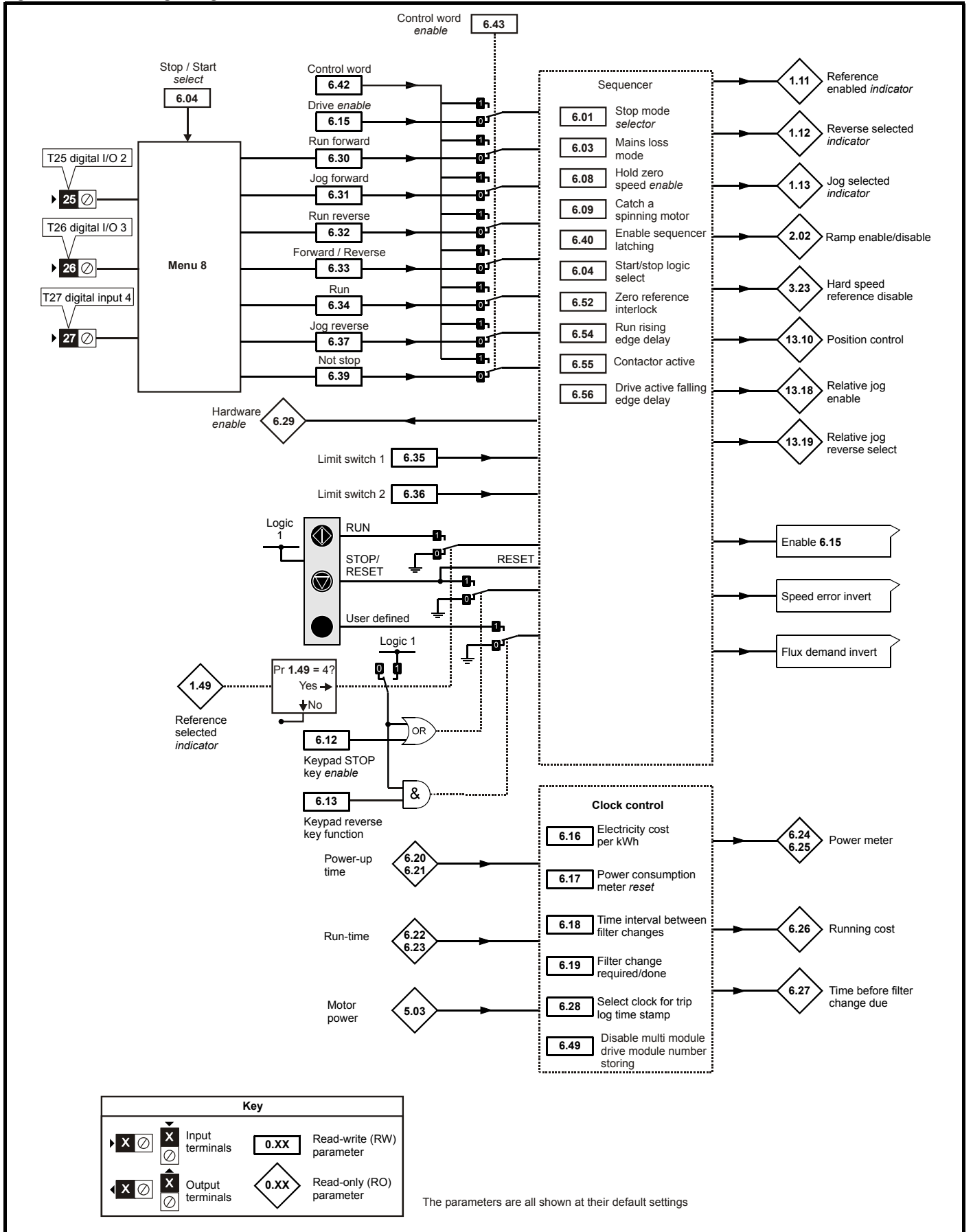
| | | | | | | | | | | | | | |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|---------------------|-------------|---------------------|----------------|-------------|----------------|
| 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 |
|--------------------|---------------------|-------------------------|-------------------------|-----------------|------------------|-------------------|--------------|---------------------|-------------|---------------------|----------------|-------------|----------------|

| 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 | ±SPEED_MAX rpm | | RO | Bi | FI | NC | PT | | |
| 5.05 | Line voltage | 0 to 1000V rms AC | | RO | Uni | FI | NC | PT | | |
| 5.06 | Machine armature voltage | ±ARMATURE_VOLTAGE_MAX V | | RO | Bi | 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 | Bit | | | | | 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 | | RW | Uni | | | | | US |
| 5.22 | Quadrant 2 Enable | | 1 | RW | Uni | | | | | US |
| 5.23 | Quadrant 3 Enable | 0 to QUADRANT_MAX | | RW | Uni | | | | | US |
| 5.24 | Quadrant 4 Enable | 0 to QUADRANT_MAX | | RW | Uni | | RA | | | US |
| 5.25 | Disable adaptive control | | OFF (0) | RW | Bit | | | | | US |
| 5.26 | Continuous auto tune | OFF (0) or On (1) | | RW | Bit | | | | | US |
| 5.28 | Field weakening compensation disable | | Eur: 0, USA: 1 | 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 | | 75 | RW | Uni | | | | | US |
| 5.32 | Motor torque per amp | 0.000 to 50.000 NmA ⁻¹ | | RO | Uni | | | | | |
| 5.43 | Armature mode | 0 to 8 | 0 | RW | Txt | | | | | US |
| 5.44 | Bridge request output | | | RW | Bit | | | | | |
| 5.45 | | | | RW | Bit | | | | | |
| 5.46 | Slave bridge request status | 0 to 1 | | RW | Bit | | | | | |
| 5.47 | | | | RW | Bit | | | | | |
| 5.52 | IR drop | ±ARMATURE_VOLTAGE_MAX Vdc | | RO | Bi | FI | NC | PT | | |
| 5.53 | Back emf | | | RO | Bi | FI | NC | PT | | |
| 5.54 | Flux feedback | ±150% | | RO | Bi | FI | NC | PT | | |
| 5.55 | Flux / Voltage 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 |
| 5.60 | Field output voltage | 0 to 500Vdc | | RO | Uni | FI | NC | PT | | |
| 5.61 | Armature Resistance | 0 to 6.0000Ω | 0.0000 | RW | Uni | | | | | US |
| 5.62 | field weakening loop P gain | 0 to 300.00 | 0.40 | RW | Uni | | | | | US |
| 5.63 | field weakening loop I gain | | 5.00 | RW | Uni | | | | | US |
| 5.64 | Field weakening enable | | 0 | RW | Bit | | | | | US |
| 5.65 | Enable field economy timeout | 0 to 1 | Eur: 0, USA: 1 | RW | Bit | | | | | US |
| 5.66 | Field economy timeout time | 0 to 255s | 30s | RW | Uni | | | | | US |
| 5.67 | Field economy level | 0 to 120.0% | 25.0% | RW | Uni | | | | | US |
| 5.68 | Maximum flux / Voltage limit | 0 to MAX_FIELD_FLUX % | 100.0% | RW | Uni | | | | | US |
| 5.69 | Minimum flux / Voltage limit | 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 - Eur: 2A, USA: 8A Size 2A & B - Eur: 3A, USA: 20A Size 2C & D - Eur: 5A, USA: 20A | RW | Uni | | RA | PT | US | |
| 5.71 | Flux loop P gain | 0 to 30 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 compensa ion factor | 0 to 100% | 100% | RW | Uni | | | PT | US | |
| 5.75 | Field voltage mode select | 0 to 1 | Eur: 0, USA: 1 | RW | Bit | | | | | US |
| 5.76 | Field controller supply | 0 to 550 rms Vac | | RO | Uni | FI | NC | PT | | |
| 5.77 | Enable field control {SE12, 0.33} | 0 to 1 | 0 | RW | Bit | | | | | US |
| 5.78 | Field mode | 0 to 2 (IntrnL (0), EtrnL (1) and E FULL (2)) | IntrnL (0) | RW | Txt | | | | | US |
| 5.79 | Field economy active | 0 to 1 | | RO | Bit | | | | | |
| 5.80 | Field economy level select | OFF (0) or On (1) | OFF (0) | RW | Bit | | | | | US |
| 5.81 | Field thermal time constant | 0.0 to 3000.0 | 24.0 | RW | Uni | | | | | US |
| 5.82 | Field overload accumulator | 0 to 100.0% | | RO | Uni | | NC | PT | | |
| 5.83 | Field reversal enable | 0 to ONLY_2_QUADRANT | 0 | RW | Uni | | RA | | | US |
| 5.84 | Field flux threshold | 0 to 100% | 75% | RW | Uni | | | | | US |
| 5.85 | Flux demand invert | 0 to 1 | | RO | Bit | | | NC | PT | |
| 5.86 | Speed error invert | 0 to 1 | | RO | Bit | | | 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

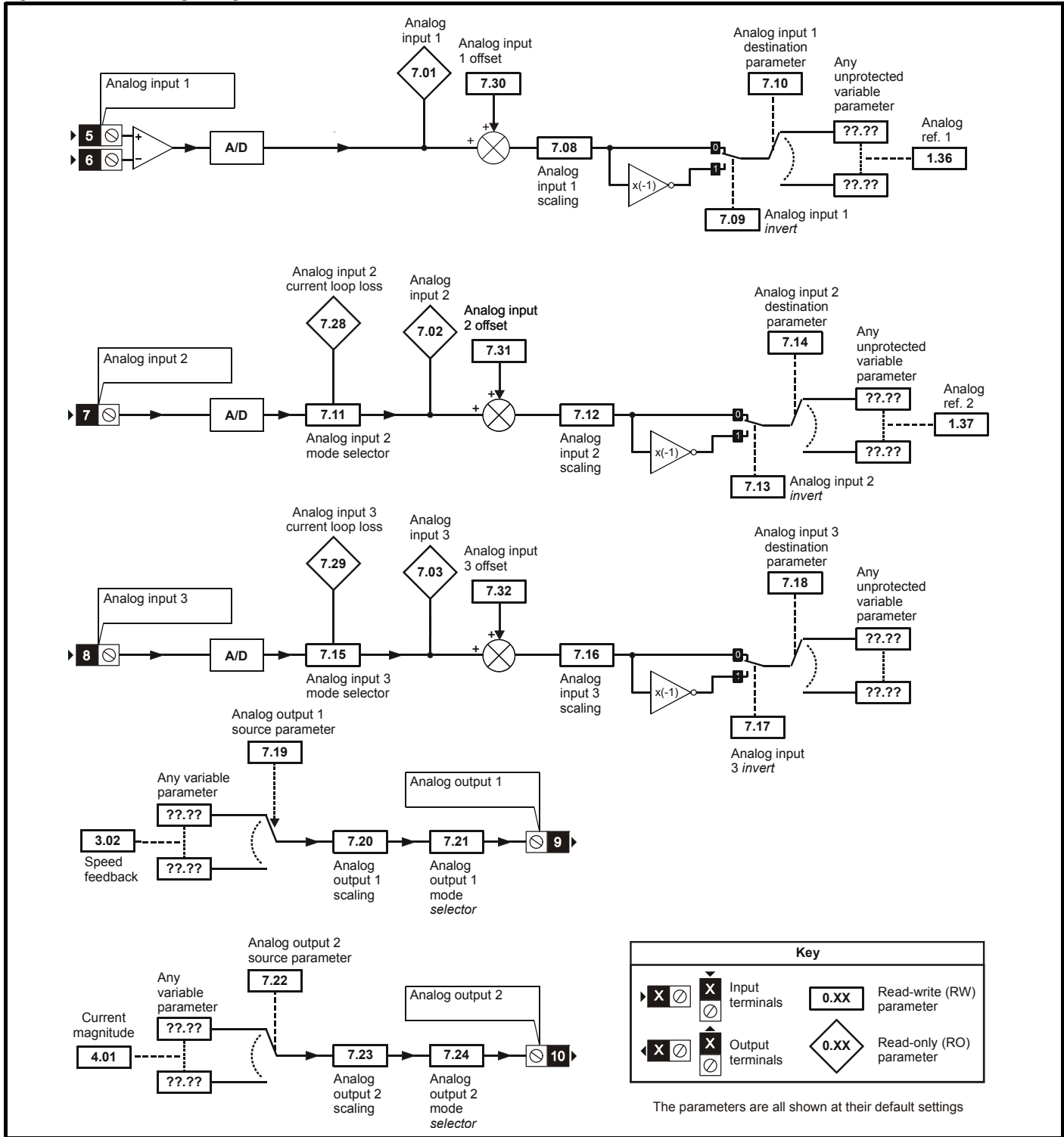


| Parameter | | Range(⇅) | Default(⇔) | Type | | | |
|-----------|--|-------------------------------------|------------|------|-----|----|-------|
| 6.01 | Stop mode | 0 to 2 | 1 | RW | Uni | | US |
| 6.03 | Main loss ride through | OFF (0) or On (1) | OFF (0) | RW | Bit | | US |
| 6.04 | Start/stop 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 | 0.0 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) | RW | Bit | | US |
| 6.29 | Hardware enable | | | RO | Bit | NC | PT |
| 6.30 | Sequencing bit: Run forward | | | RW | Bit | NC | |
| 6.31 | Sequencing bit: Jog | | | RW | Bit | NC | |
| 6.32 | Sequencing bit: Run/reverse | | | RW | Bit | NC | |
| 6.33 | Sequencing bit: Forward/reverse | | | RW | Bit | NC | |
| 6.34 | Sequencing bit: Run | OFF (0) or On (1) | OFF (0) | RW | Bit | NC | |
| 6.35 | Forward limit switch | | | RW | Bit | NC | |
| 6.36 | Reverse limit switch | | | RW | Bit | NC | |
| 6.37 | Sequencing bit: Jog reverse | | | RW | Bit | NC | |
| 6.39 | Sequencing bit: Not stop | | | RW | Bit | NC | |
| 6.40 | Enable sequencer latching | | | 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) | RW | Bit | | US |
| 6.45 | Force cooling fan to run at full speed | OFF (0) or On (1) | | RW | Bit | | US |
| 6.49 | Disable multi-module drive module number storing on trip | OFF (0) or On (1) | OFF (0) | 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 |
| 6.54 | Run rising edge delay | 0 to 25.0s | 0.3 | RW | Uni | | US |
| 6.55 | Contacteur active | OFF (0) or On (1) | | RO | Bit | NC | PT |
| 6.56 | Drive active falling edge delay | 0 to 255s | 0s | 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 | T5/6 analog input 1 | {in02, 0.82} | ±100.00% | | RO | Bi | NC | PT |
| 7.02 | T7 analog input 2 | {in03, 0.83} | ±100.0% | | RO | Bi | NC | PT |
| 7.03 | T8 analog input 3 | {in04, 0.84} | | | RO | Bi | NC | PT |
| 7.04 | Power circuit temperature | | -128°C to 127°C | | RO | Bi | NC | PT |
| 7.08 | T5/6 analog input 1 scaling | | 0 to 40.000 | 1.000 | RW | Uni | | US |
| 7.09 | T5/6 analog input 1 invert | | OFF (0) to On (1) | OFF (0) | RW | Bit | | US |
| 7.10 | T5/6 analog input 1 destination | | Pr 0.00 to 22.99 | Pr 1.36 | RW | Uni | | PT US |
| 7.11 | T7 analog input 2 mode | | 0 to 6 | 6 | RW | Uni | | US |
| 7.12 | T7 analog input 2 scaling | | 0 to 40.000 | 1.000 | RW | Uni | | US |
| 7.13 | T7 analog input 2 invert | | OFF (0) to On (1) | OFF (0) | RW | Bit | | US |
| 7.14 | T7 analog input 2 destination | | Pr 0.00 to 22.99 | Pr 1.37 | RW | Uni | | PT US |
| 7.15 | T8 analog input 3 mode | {in01, 0.81} | 0 to 9 | Eur: 8, USA: 6 | RW | Txt | | US |
| 7.16 | T8 analog input 3 scaling | | 0 to 40.000 | 1.000 | RW | Uni | | US |
| 7.17 | T8 analog input 3 invert | | OFF (0) to On (1) | OFF (0) | RW | Bit | | US |
| 7.18 | T8 analog input 3 destination | | Pr 0.00 to 22.99 | Pr 0.00 | RW | Uni | | PT US |
| 7.19 | T9 analog output 1 source | | | Pr 3.02 | RW | Uni | | PT US |
| 7.20 | T9 analog output 1 scaling | | 0.000 to 40.000 | 1.000 | RW | Uni | | US |
| 7.21 | T9 analog output 1 mode | | 0 to 3 | 0 | RW | Txt | | US |
| 7.22 | T10 analog output 2 source | | Pr 0.00 to 22.99 | Pr 4.02 | RW | Uni | | PT US |
| 7.23 | T10 analog output 2 scaling | | 0.000 to 40.000 | 1.000 | RW | Uni | | US |
| 7.24 | T10 analog output 2 mode | | 0 to 3 | 0 | RW | Txt | | US |
| 7.28 | T7 analog input current loop loss 2 | | OFF (0) to On (1) | | RO | Bit | NC | PT |
| 7.29 | T8 analog input current loop loss 3 | | | | RO | Bit | NC | PT |
| 7.30 | T5/6 analog input 1 offset | | ±100 00% | 0.00 | RW | Bi | | US |
| 7.31 | T7 analog input 2 offset | | ±100.0% | 0.0 | RW | Bi | | US |
| 7.32 | T8 analog input 3 offset | | | | RW | Bi | | US |
| 7.34 | SCR / 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

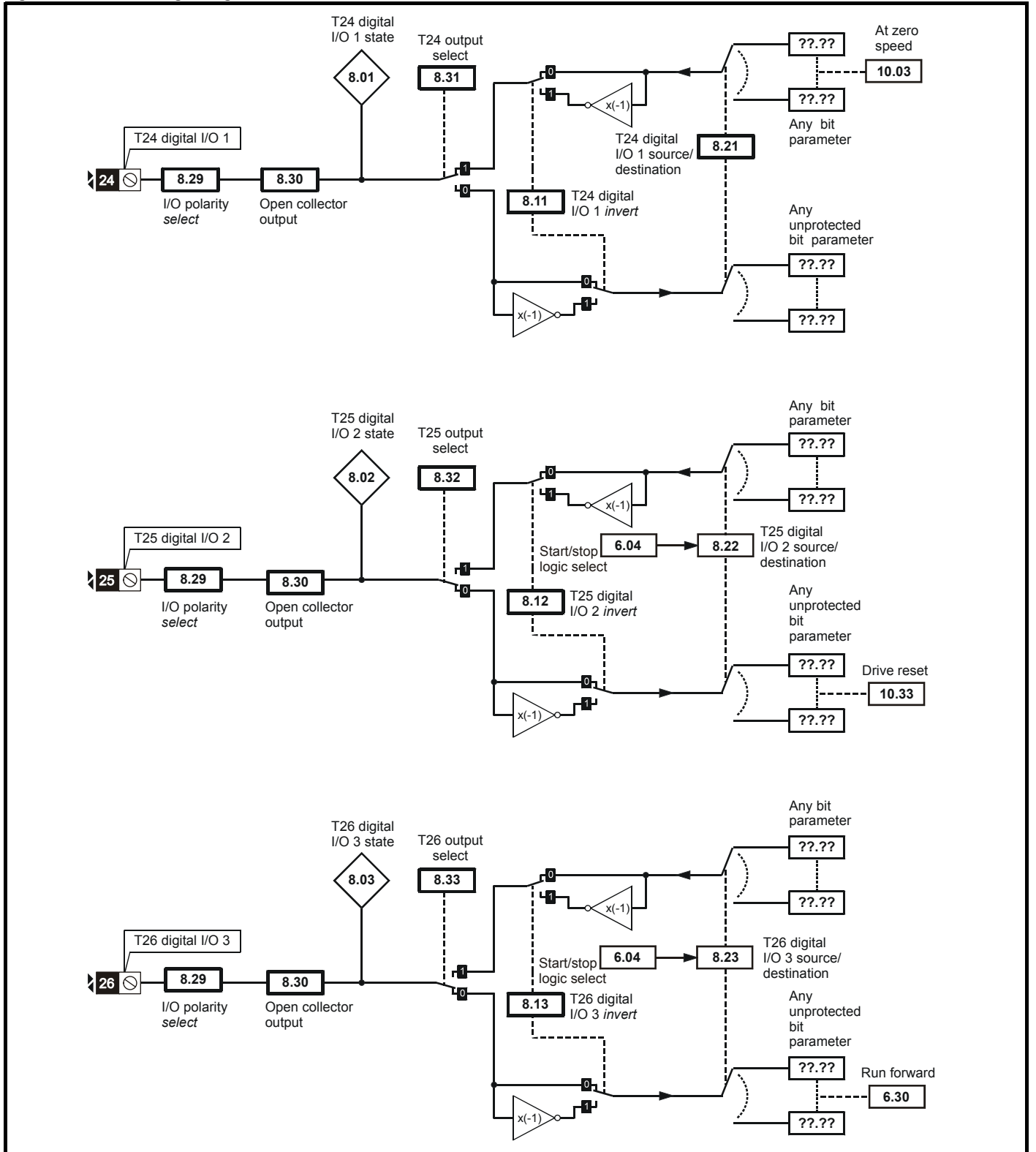


Figure 11-10 Menu 8 logic diagram (cont)

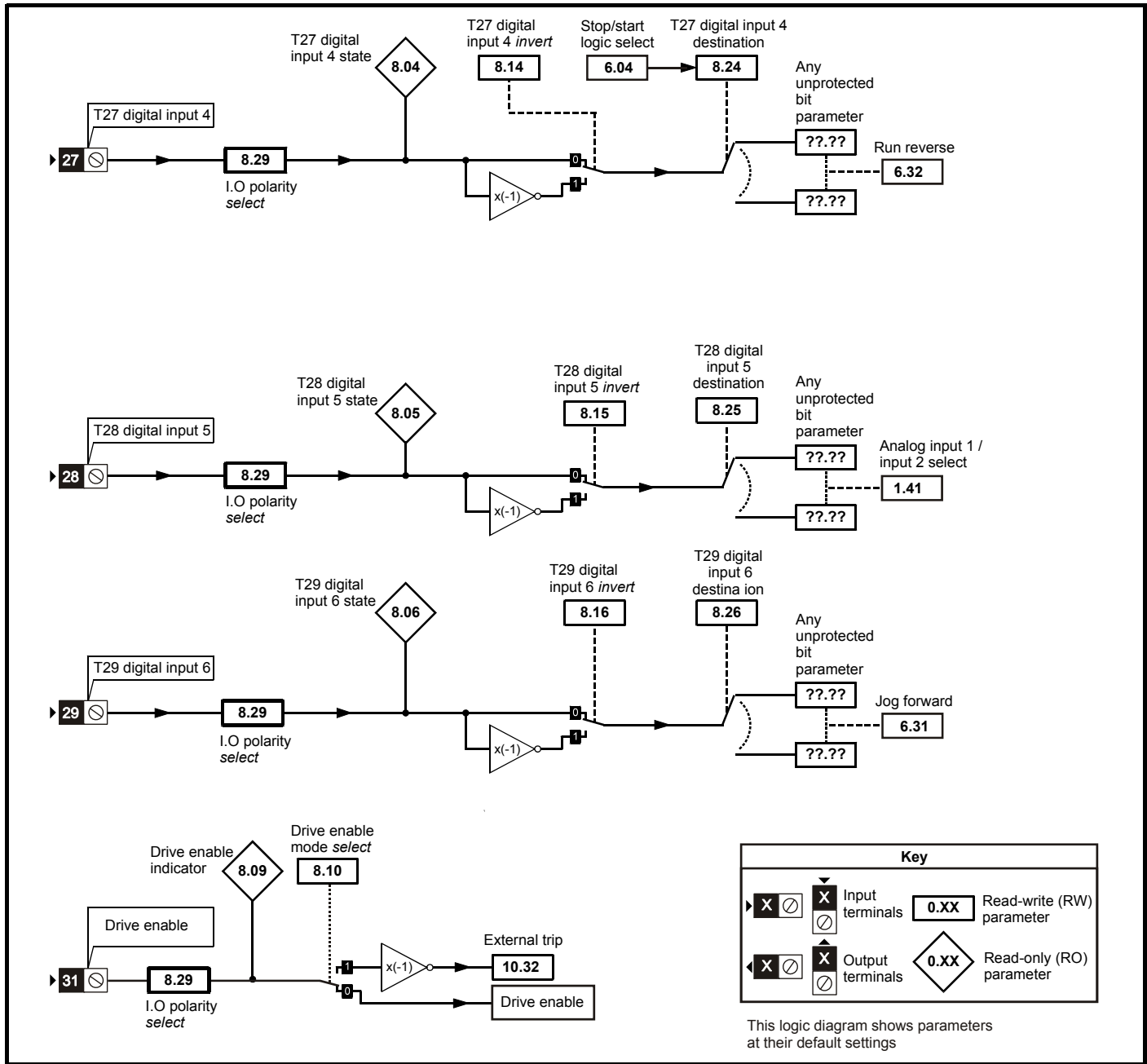
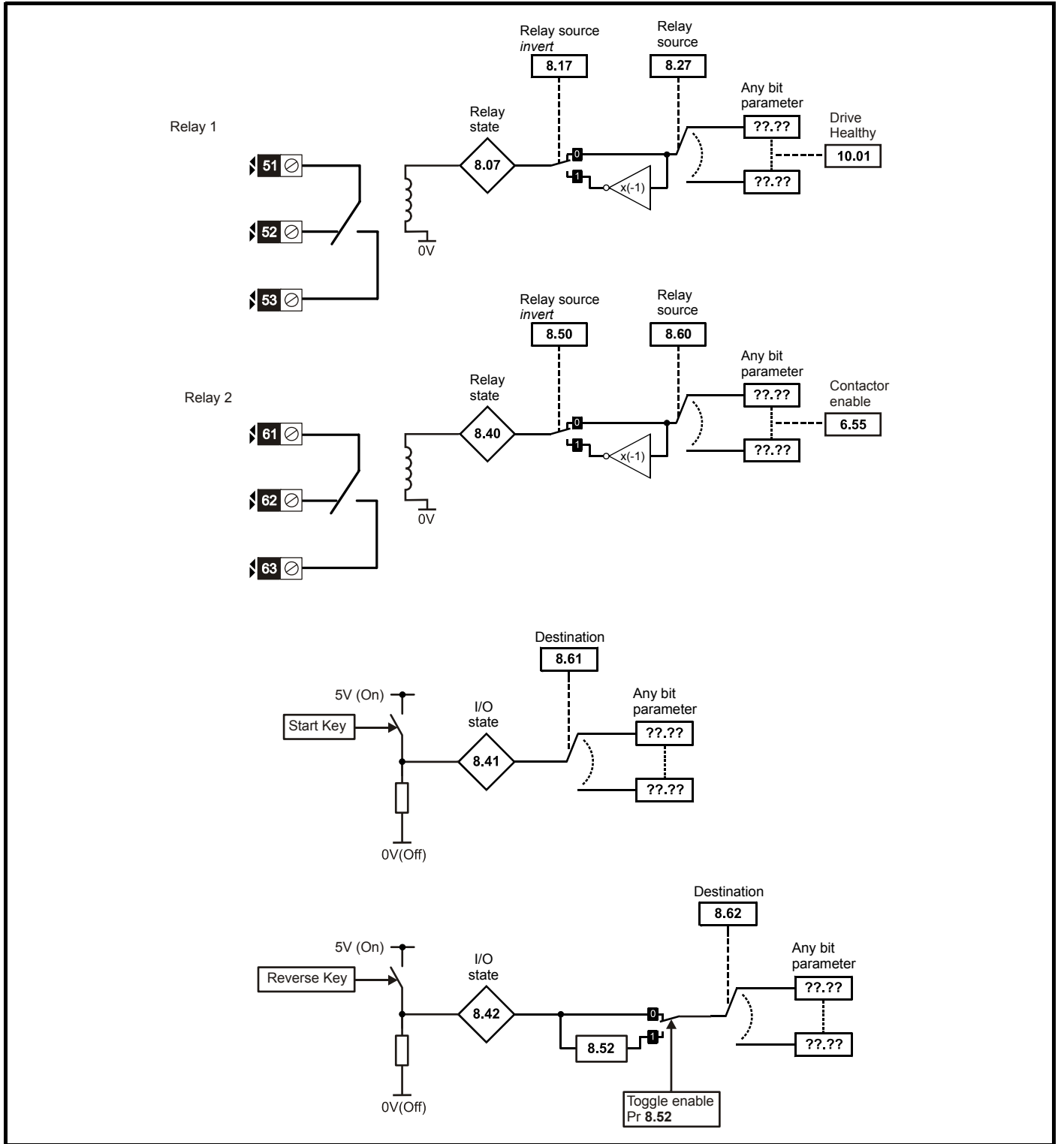


Figure 11-11 Menu 8 logic diagram (cont)



| 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} | | | RO | Bit | | NC | PT | | |
| 8.03 | T26 digital I/O 3 state | {in07, 0.87} | | | RO | Bit | | NC | PT | | |
| 8.04 | T27 digital input 4 state | {in08, 0.88} | | | RO | Bit | | NC | PT | | |
| 8.05 | T28 digital input 5 state | {in09, 0.89} | | | RO | Bit | | NC | PT | | |
| 8.06 | T29 digital input 6 state | {in10, 0.90} | | | RO | Bit | | NC | PT | | |
| 8.07 | T51, 52, 53 relay state | | | | RO | Bit | | NC | PT | | |
| 8.09 | T31 drive enable state | | | | 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 | | RW | Bit | | | | | | US | |
| 8.13 | T26 digital I/O 3 invert | | RW | Bit | | | | | | US | |
| 8.14 | T27 digital input 4 invert | | RW | Bit | | | | | | US | |
| 8.15 | T28 digital input 5 invert | | RW | Bit | | | | | | US | |
| 8.16 | T29 digital input 6 invert | | RW | Bit | | | | | | US | |
| 8.17 | T51, 52, 53 relay invert | | 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 10.33 | RW | Uni | DE | | PT | US | |
| 8.23 | T26 digital I/O 3 source/ destination | | | Pr 6.30 | RW | Uni | DE | | PT | US | |
| 8.24 | T27 digital input 4 destination | | | Pr 6.32 | RW | Uni | DE | | PT | US | |
| 8.25 | T28 digital input 5 destination | | | Pr 1.41 | RW | Uni | DE | | PT | US | |
| 8.26 | T29 digital input 6 destination | | | Pr 6.31 | RW | Uni | DE | | PT | US | |
| 8.27 | T51, 52, 53 relay source | | | 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 | | | On (1) | RW | Bit | | | US | | |
| 8.32 | T25 digital I/O 2 output select | | | OFF (0) | OFF (0) | RW | Bit | | | US | |
| 8.33 | T26 digital I/O 3 output select | | | | | RW | Bit | | | | US |
| 8.40 | T61, 62, 63 relay state | | | | | RO | Bit | | NC | PT | |
| 8.41 | Start button state | | | OFF (0) | OFF (0) | RO | Bit | | NC | PT | |
| 8.42 | Forward/reverse button state | | | | | RO | Bit | | NC | PT | |
| 8.48 | 24V input state | | | | | RO | Bit | | NC | PT | |
| 8.50 | T61, 62, 63 relay invert | | | | | RW | Bit | | | | US |
| 8.52 | Toggle enable | | | Pr 0.00 to 22.99 | Pr 6.55 | RW | Bit | | | US | |
| 8.60 | T61, 62, 63 relay destination | | RW | | | Uni | DE | | PT | US | |
| 8.61 | Start button destination | | RW | | | Uni | DE | | PT | US | |
| 8.62 | Forward/reverse button destination | | 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

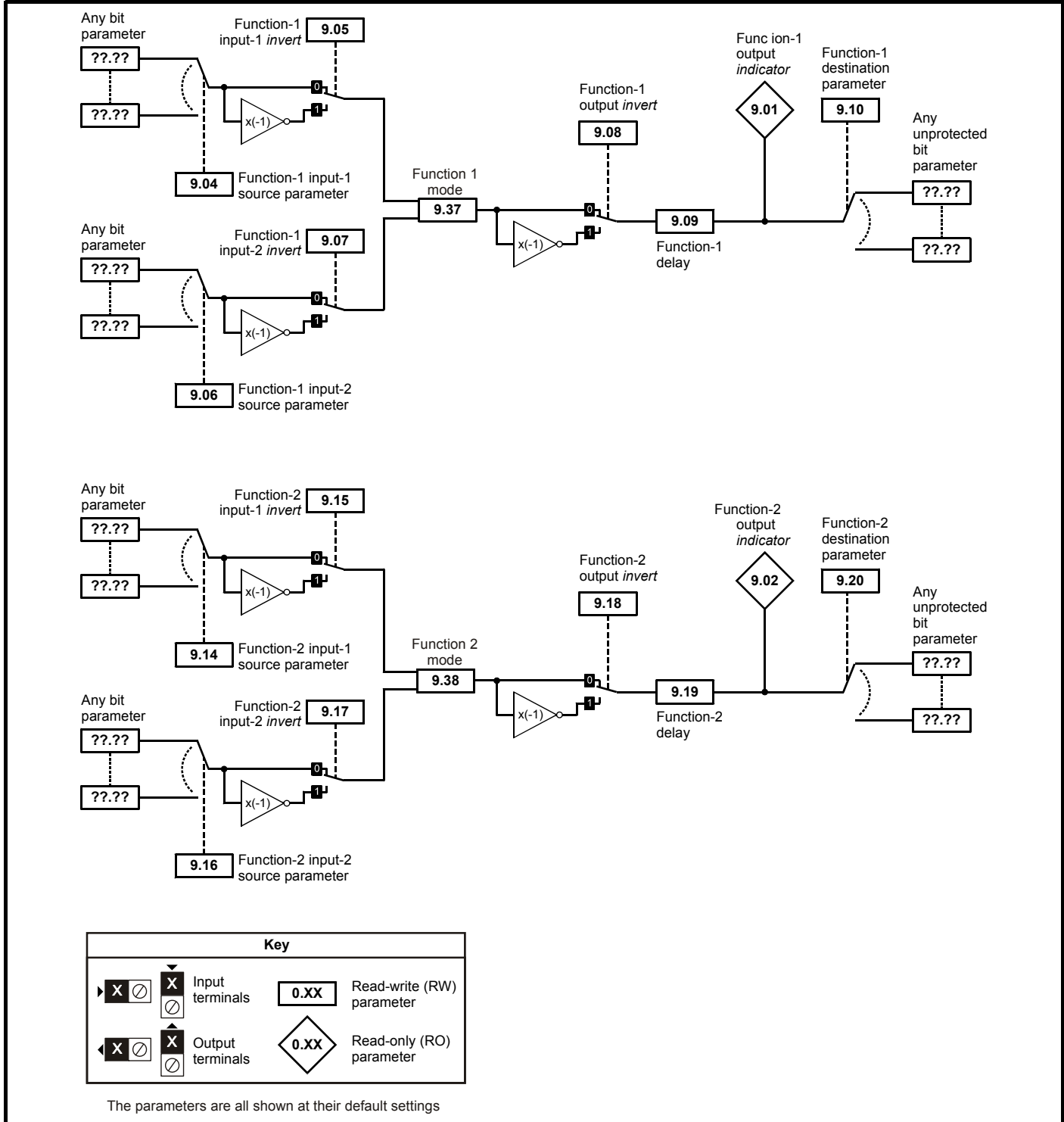
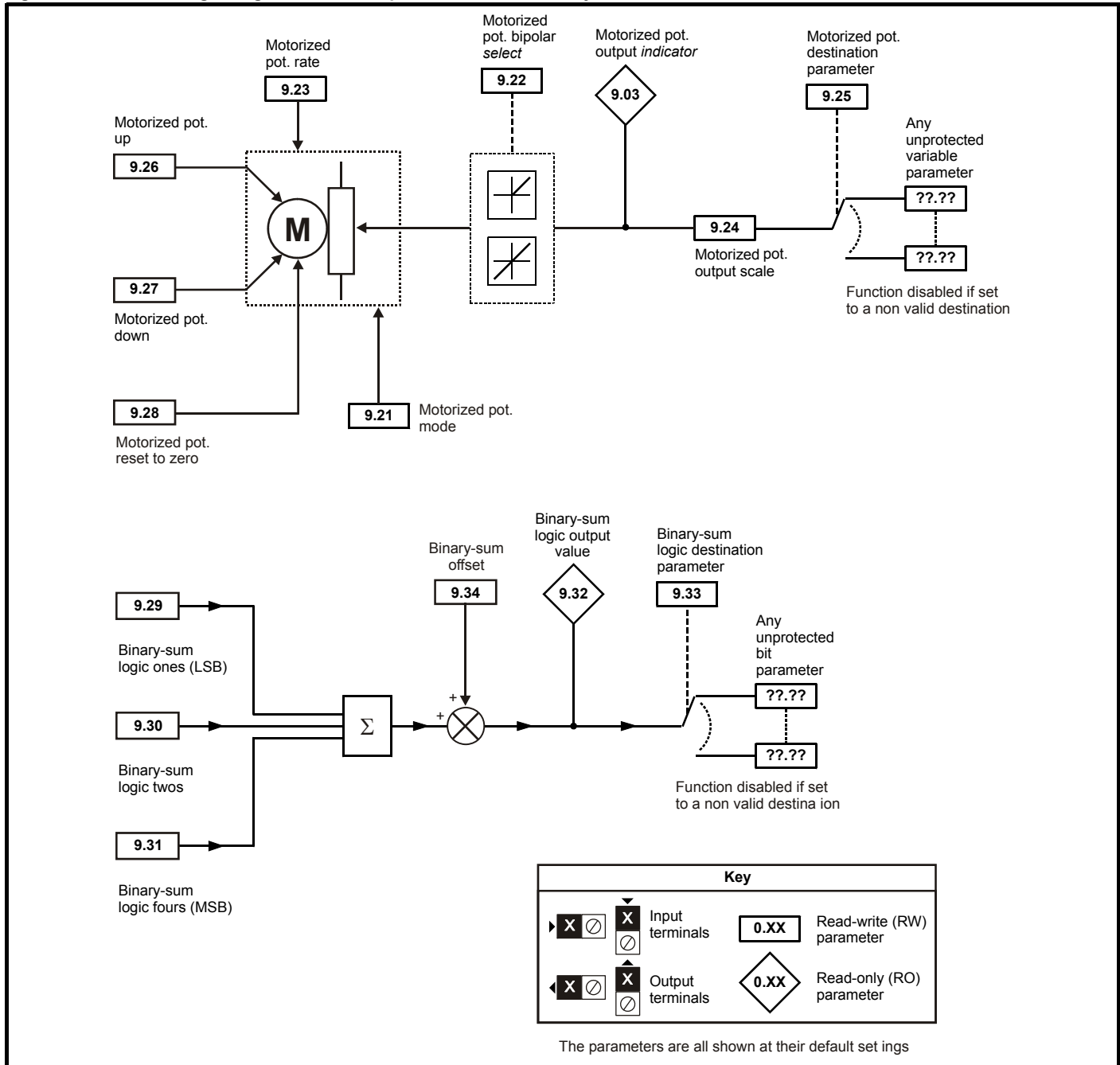


Figure 11-13 Menu 9 logic diagram: Motorized potentiometer and binary sum



| 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 | | | 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 | | | RW | Bit | | NC | | |
| 9.28 | Motorized pot reset | | | RW | Bit | | NC | | |
| 9.29 | Binary sum ones input | | | RW | Bit | | NC | | |
| 9.30 | Binary sum twos input | | | RW | Bit | | NC | | |
| 9.31 | Binary sum fours input | | | 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 | | | 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 | | | RO | Bit | NC | PT | | | |
| 10.03 | Zero speed | | | RO | Bit | NC | PT | | | |
| 10.04 | Running at or below min speed | | | RO | Bit | NC | PT | | | |
| 10.05 | Below set speed | | | RO | Bit | NC | PT | | | |
| 10.06 | At speed | | | RO | Bit | NC | PT | | | |
| 10.07 | Above set speed | | | RO | Bit | NC | PT | | | |
| 10.08 | Load reached | | | RO | Bit | NC | PT | | | |
| 10.09 | Drive output is at current limit | | | RO | Bit | NC | PT | | | |
| 10.10 | Regenerating | | | RO | Bit | NC | PT | | | |
| 10.13 | Direction command | | | RO | Bit | NC | PT | | | |
| 10.14 | Direction running | | | RO | Bit | NC | PT | | | |
| 10.17 | Overload arm | | | RO | Bit | NC | PT | | | |
| 10.18 | Drive over temperature alarm | | | RO | Bit | NC | PT | | | |
| 10.19 | Drive warning | | | RO | Bit | NC | PT | | | |
| 10.20 | Trip 0 | | | {tr01, 0.51} | 0 to 229 | RO | Txt | NC | PT | PS |
| 10.21 | Trip 1 | | | {tr02, 0.52} | | RO | Txt | NC | PT | PS |
| 10.22 | Trip 2 | | | {tr03, 0.53} | | RO | Txt | NC | PT | PS |
| 10.23 | Trip 3 | | | {tr04, 0.54} | | RO | Txt | NC | PT | PS |
| 10.24 | Trip 4 | {tr05, 0.55} | RO | Txt | | NC | PT | PS | | |
| 10.25 | Trip 5 | {tr06, 0.56} | RO | Txt | | NC | PT | PS | | |
| 10.26 | Trip 6 | {tr07, 0.57} | RO | Txt | | NC | PT | PS | | |
| 10.27 | Trip 7 | {tr08, 0.58} | RO | Txt | | NC | PT | PS | | |
| 10.28 | Trip 8 | {tr09, 0.59} | RO | Txt | | NC | PT | PS | | |
| 10.29 | Trip 9 | {tr10, 0.60} | RO | Txt | | NC | PT | PS | | |
| 10.32 | External trip | OFF (0) or On (1) | OFF (0) | RW | Bit | NC | | | | |
| 10.33 | Drive reset | | | RW | Bit | NC | | | | |
| 10.34 | Number 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 | | RO | Uni | NC | PT | PS | | | |
| 10.45 | Trip 3 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.46 | Trip 4 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.47 | Trip 5 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.48 | Trip 6 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.49 | Trip 7 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.50 | Trip 8 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.51 | Trip 9 time: Hours.Minutes | | RO | Uni | NC | PT | PS | | | |
| 10.52 | Trip mask 0 | 0 to 216 | 0 | RW | Uni | | | US | | |
| 10.53 | Trip mask 1 | | | RW | Uni | | | US | | |
| 10.54 | Trip mask 2 | | | RW | Uni | | | US | | |
| 10.55 | Trip mask 3 | | | RW | Uni | | | US | | |
| 10.56 | Trip mask 4 | | | RW | Uni | | | US | | |
| 10.57 | Trip mask 5 | | | RW | Uni | | | US | | |
| 10.58 | Trip mask 6 | | | RW | Uni | | | US | | |
| 10.59 | Trip mask 7 | | | RW | Uni | | | US | | |
| 10.60 | Trip mask 8 | | | RW | Uni | | | US | | |
| 10.61 | Trip mask 9 | RW | Uni | | | US | | | | |
| 10.62 | Stop on trip mask 0 | OFF (0) or On (1) | On (1) | RW | Bit | | | US | | |
| 10.63 | Stop on trip mask 1 | | | RW | Bit | | | US | | |
| 10.64 | Stop on trip mask 2 | | | RW | Bit | | | US | | |
| 10.65 | Stop on trip mask 3 | | | RW | Bit | | | US | | |
| 10.66 | Stop on trip mask 4 | | | RW | Bit | | | US | | |
| 10.67 | Stop on trip mask 5 | | | RW | Bit | | | US | | |
| 10.68 | Stop on trip mask 6 | | | RW | Bit | | | US | | |
| 10.69 | Stop on trip mask 7 | | | RW | Bit | | | US | | |
| 10.70 | Stop on trip mask 8 | | | RW | Bit | | | US | | |
| 10.71 | Stop on trip mask 9 | RW | Bit | | | US | | | | |
| 10.72 | Trip mask active | | | RO | Bit | NC | | | | |
| 10.73 | Bridge ac ive | 0 to 2 | | RO | Txt | NC | | | | |
| 10.74 | Electrical phase back | OFF (0) or On (1) | | RO | Bit | NC | | | | |
| 10.75 | Armature voltage clamp active | | | RO | Bit | NC | | | | |
| 10.76 | Phase rotation | 0 to 15 | | RO | Txt | NC | | | | |
| 10.77 | Input frequency | 0 to 100.00 | | RO | Uni | NC | | | | |

11.11 Menu 11: General drive set-up

| Parameter | Range(⇅) | Default(⇔) | Type | | | |
|-----------|---|---------------------------|------|-----|----|-------|
| 11.21 | Parameter scaling | 0 to 9.999 | RW | Uni | | US |
| 11.22 | Parameter displayed at power-up | 0 to 00.90 | RW | Uni | | PT US |
| 11.23 | Serial address {Si02, 0.67} | 0 to 247 | RW | Uni | | US |
| 11.24 | Serial mode | 0 to 2 | RW | Txt | | US |
| 11.25 | Baud rate {Si01, 0.66} | 0 to 9 | RW | Txt | | US |
| 11.26 | Minimum comms transmit delay | 0 to 250ms | 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 | RW | Uni | NC | PT PS |
| 11.32 | Current rating | 0 to 10000.0A | 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 | SMARTCARD parameter data previously loaded | 0 to 999 | RO | Uni | NC | PT US |
| 11.37 | SMARTCARD data number | 0 to 1003 | RW | Uni | NC | |
| 11.38 | SMARTCARD data type/ mode | 0 to 18 | RO | Uni | NC | PT |
| 11.39 | SMARTCARD data version | 0 to 9999 | RW | Uni | NC | |
| 11.40 | SMARTCARD data checksum | 0 to 65335 | RO | Uni | NC | PT |
| 11.41 | Status mode timeout | 0 to 250s | RW | Uni | | US |
| 11.42 | Parameter copying {SE09, 0.30} | 0 to 4 | RW | Txt | NC | * |
| 11.44 | Security status {SE14, 0.35} | 0 to 2 | RW | Txt | | PT US |
| 11.45 | Select motor 2 parameters | OFF (0) or On (1) | RW | Bit | | US |
| 11.46 | Defaults previously loaded | 0 to 2 | RO | Txt | | PT US |
| 11.47 | Drive Onboard Application Lite Ladder Program Enable | 0 to 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 65535ms | 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 | RW | Uni | | PT US |
| 11.58 | Serial scaling | 0 to 1999 | RW | Uni | | US |
| 11.59 | DMV 2322/2342 Parameter Emulator Module Control | 0 to 3 | RW | Uni | | US |
| 11.60 | Application parameters | 16000 to -16000 | RW | Uni | NC | |
| 11.61 | Application parameters | | RW | Uni | NC | |
| 11.62 | Full power discharge time | 0 to 25.0s | RW | Uni | | US |
| 11.63 | Full power discharge period | 0 to 1500.0s | RW | Uni | | US |
| 11.64 | External discharge resistance | 0 to 9999Ω | 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

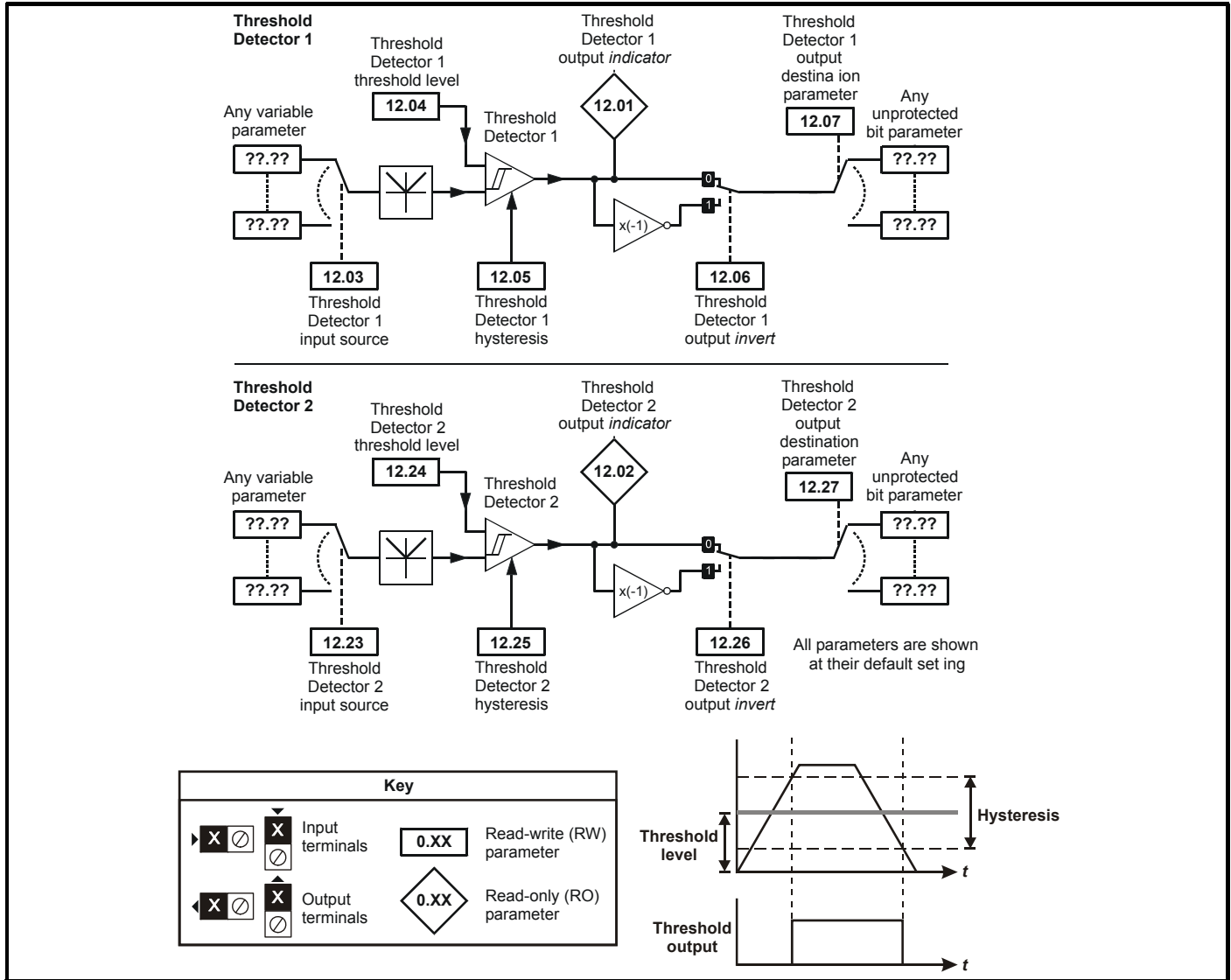


Figure 11-15 Menu 12 logic diagram (continued)

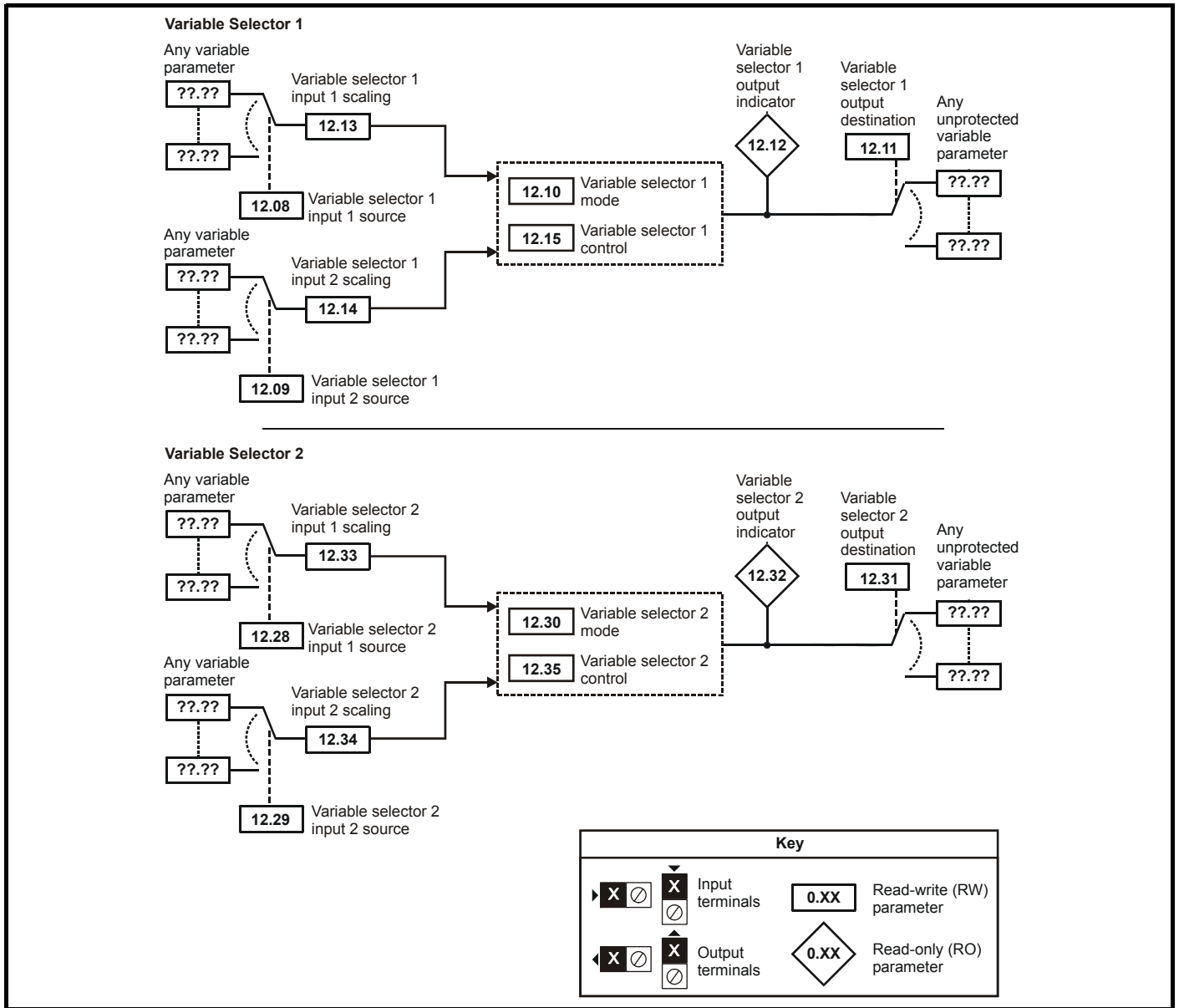


Figure 11-16 Menu 12 Brake control function

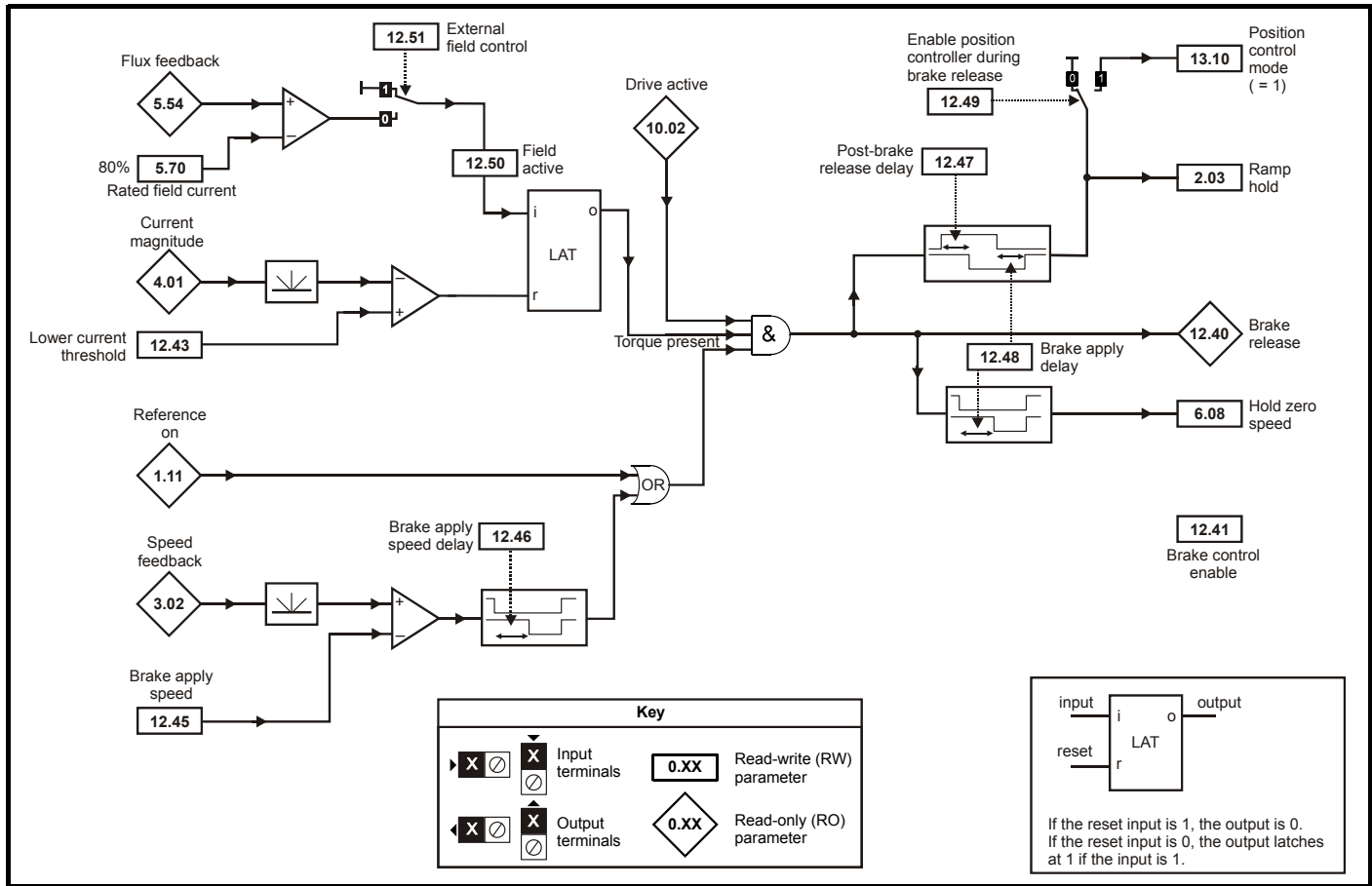
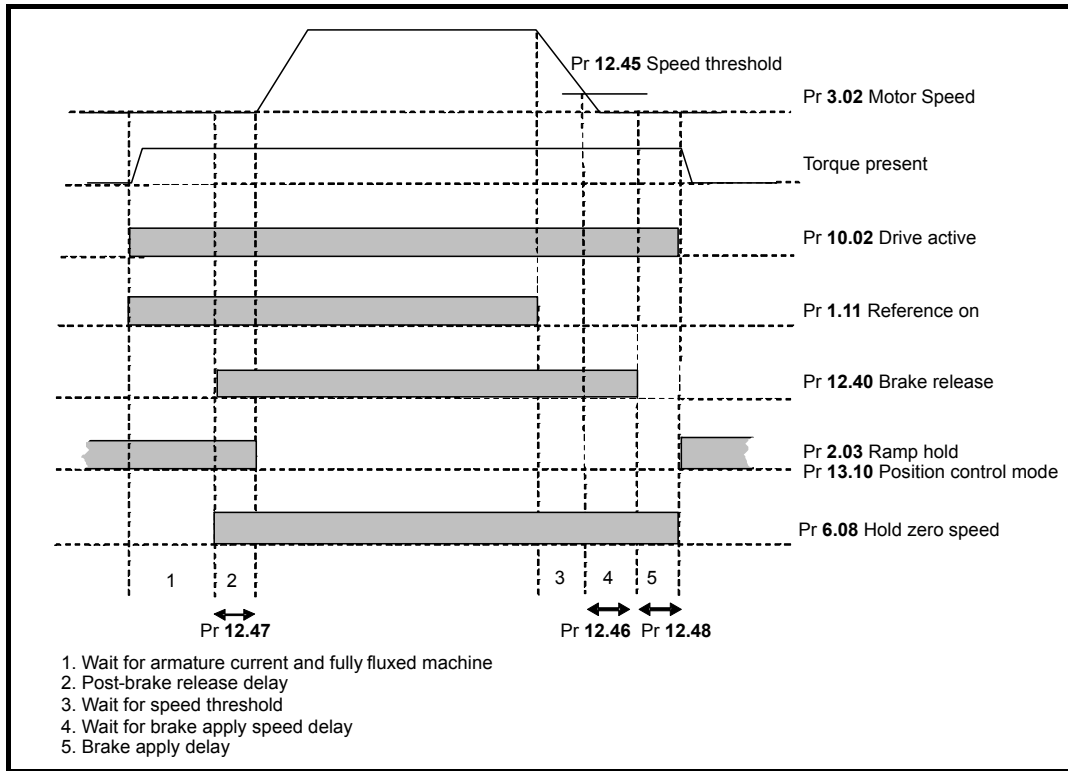


Figure 11-17 Brake sequence

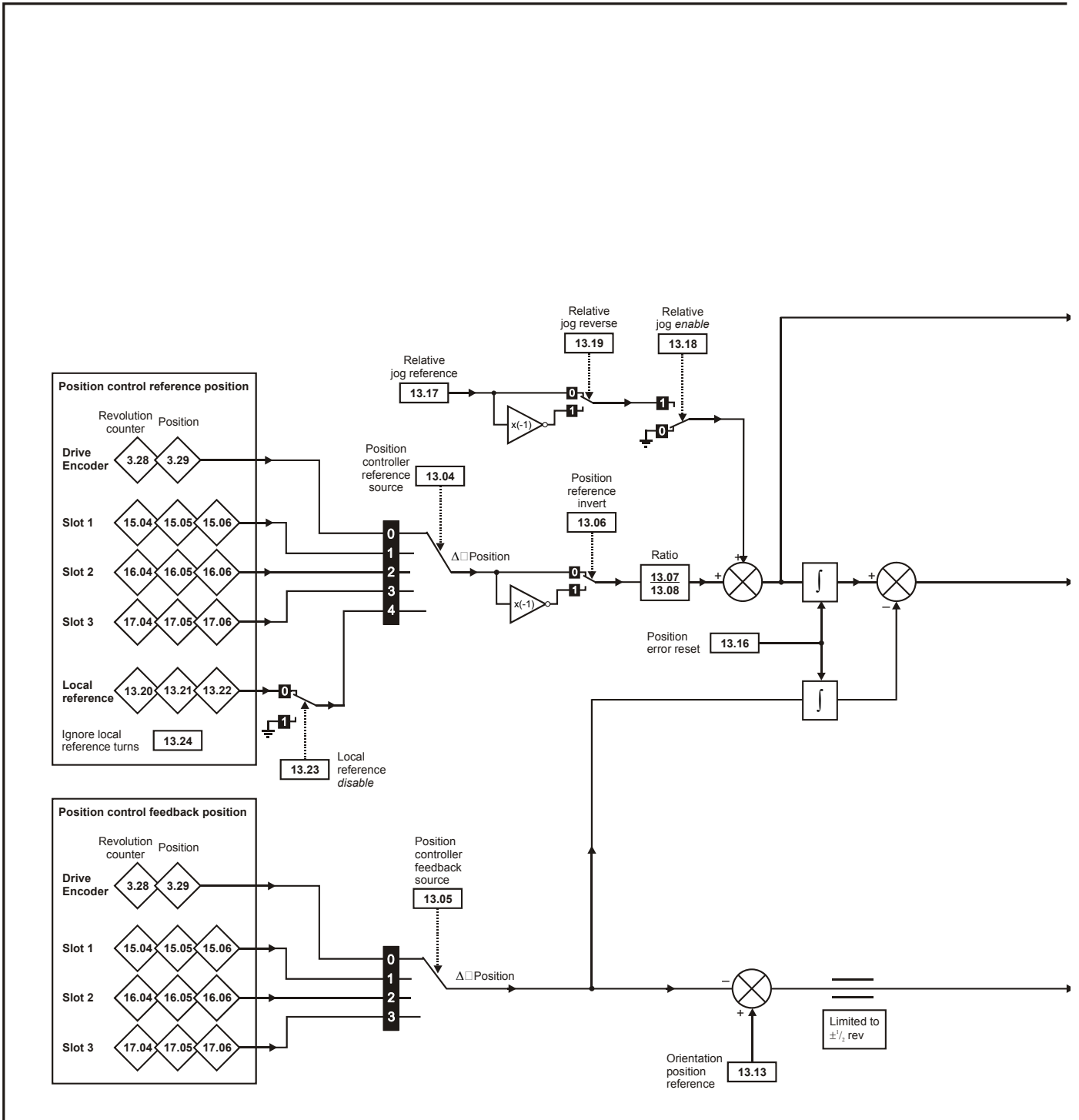


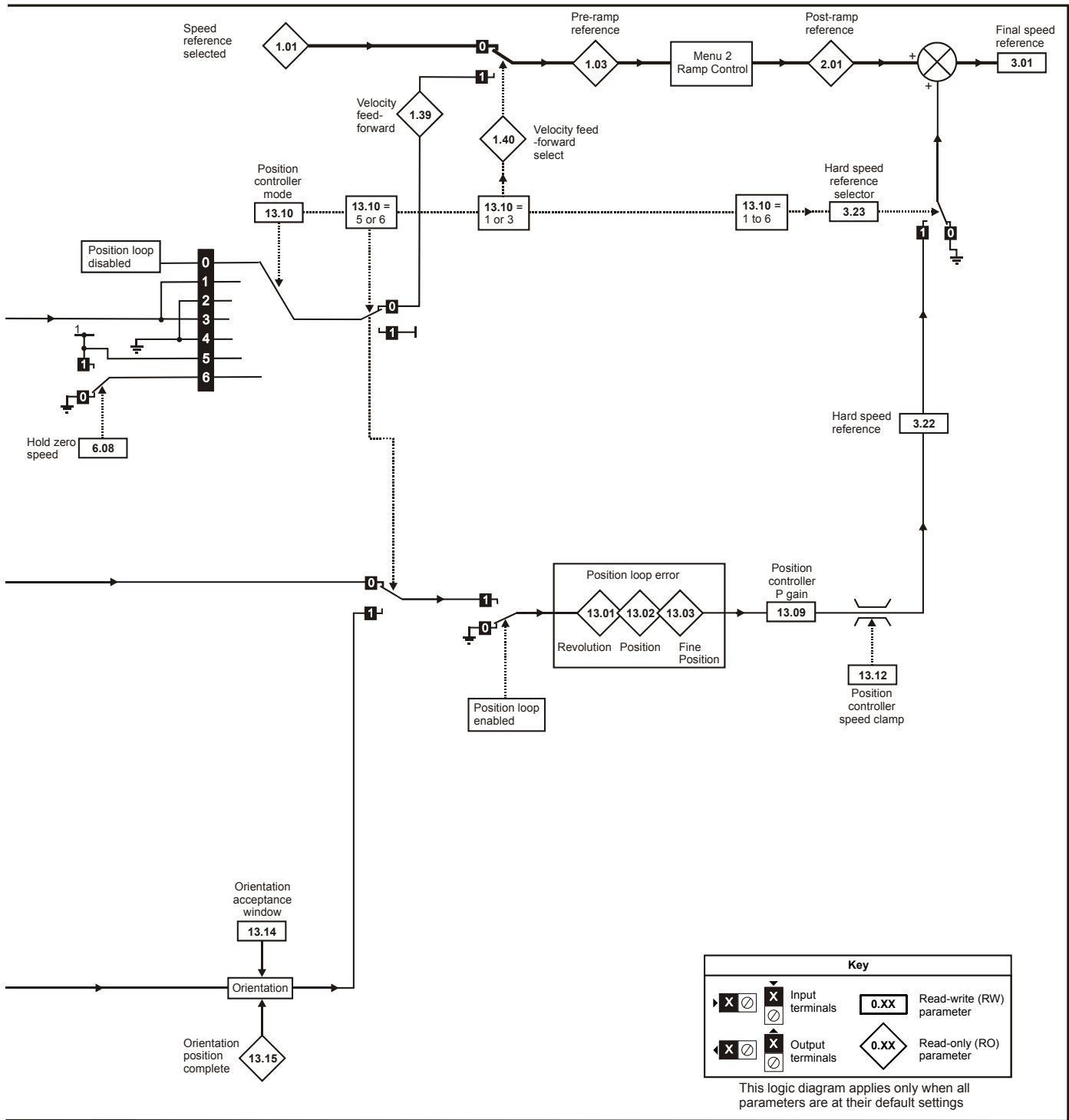
| Parameter | | Range(⇅) | Default(⇄) | Type | | | | | |
|-----------|---|-------------------|------------|------|-----|--|----|----|----|
| 12.01 | Threshold detector 1 output | OFF (0) or On (1) | | RW | Bit | | NC | PT | |
| 12.02 | Threshold detector 2 output | | | RW | Bit | | NC | PT | |
| 12.03 | 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% | | 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 | | | RW | Uni | | | PT | US |
| 12.09 | Variable selector 1 source 2 | | | 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 |
| 12.12 | 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 | | | RW | Uni | | | | US |
| 12.15 | Variable selector 1 control | 0 to 100.00 | 0.00 | RW | Uni | | | | US |
| 12.23 | Threshold detector 2 source | Pr 0.00 to 22.99 | Pr 0.00 | RW | Uni | | | PT | 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% | | 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 | | | RW | Uni | | | PT | US |
| 12.29 | Variable selector 2 source 2 | | | 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 | | | 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 | | | RW | Uni | | | | US |
| 12.48 | Brake apply delay | | | 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 | | | RW | Bit | | | | US |
| 12.51 | External field control | | | 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 |

11.13 Menu 13: Position control

Figure 11-18 Menu 13 logic diagram



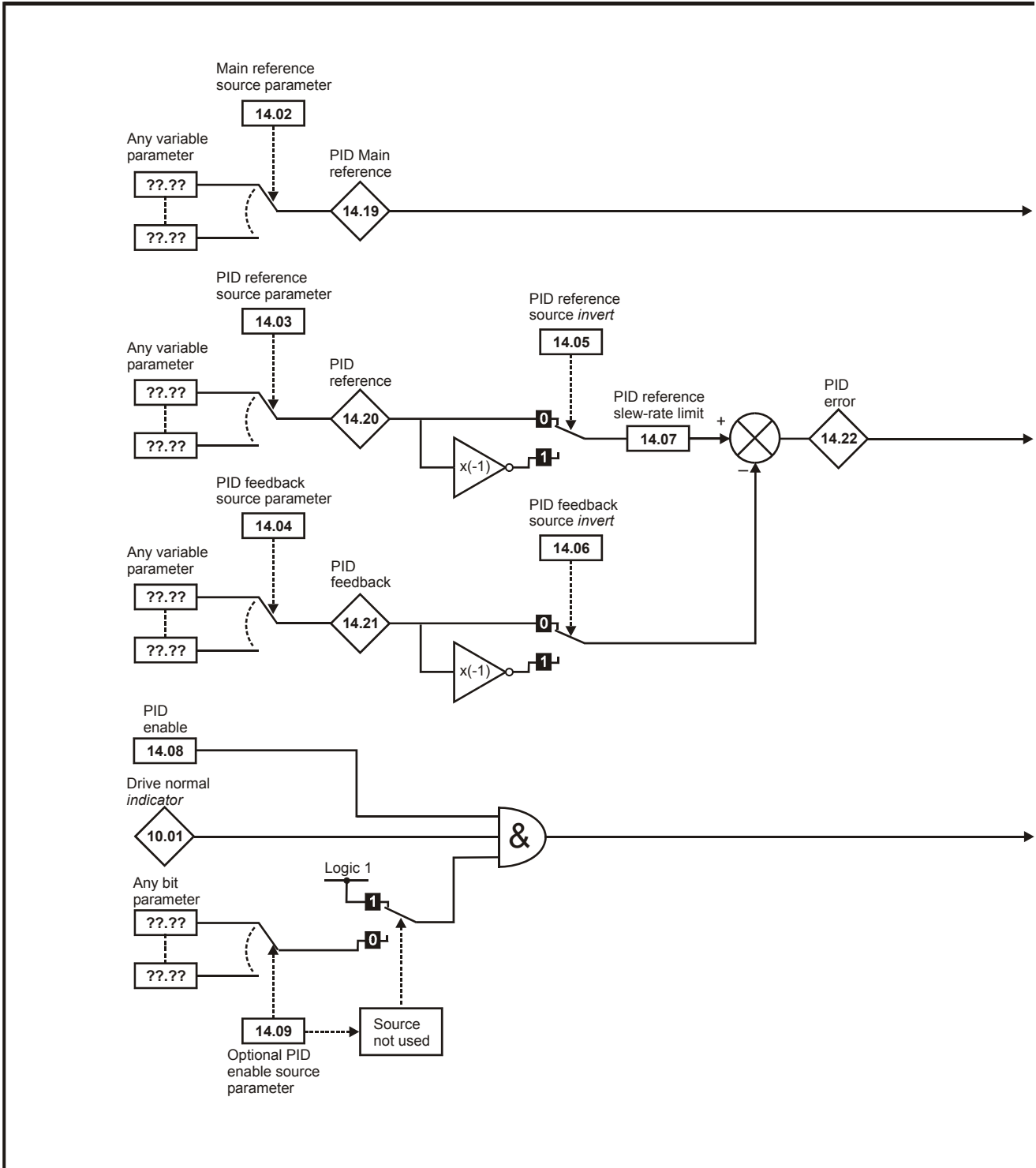


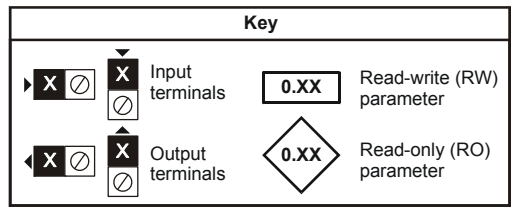
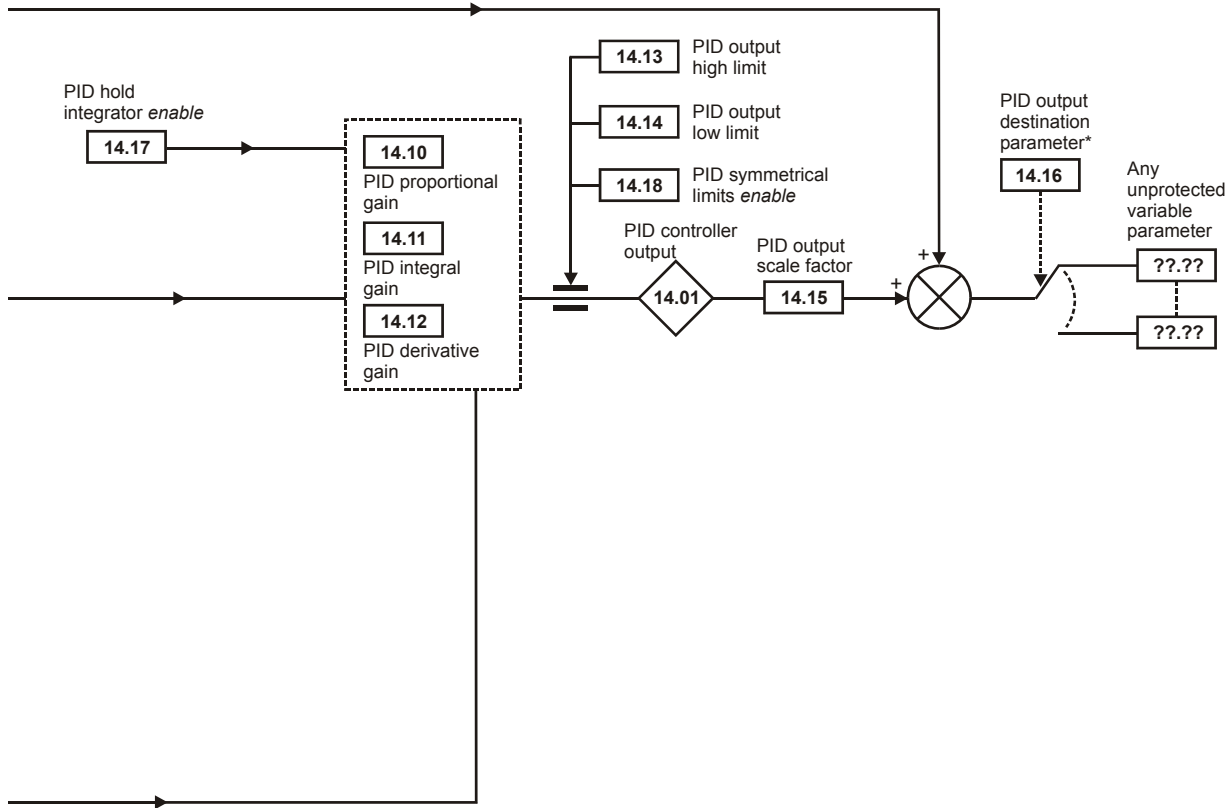
| Parameter | | Range(⇅) | Default(⇔) | Type | | | |
|-----------|--------------------------------------|-------------------------------------|------------|------|-----|----|----|
| 13.01 | Revolutions error | -32768 to +32767 | | RO | Uni | NC | PT |
| 13.02 | Position error | -32768 to +32767 | | RO | 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 ⁻¹ /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 |

11.14 Menu 14: User PID controller

Figure 11-19 Menu 14 logic diagram





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.

| 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 | | | | | |
|-------------|-------------------------------|----------|------|-----|--|----|----|----|
| x.01 | Solutions Module ID | 0 to 599 | RO | Uni | | | PT | US |
| x.50 | Solutions Module error status | 0 to 255 | RO | Uni | | NC | PT | |

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 ³¹ to 2 ³¹ -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 81 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 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 | 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% | 50% | RW | Uni | | RA | | US |
| 21.12 | Discontinuous current controller Ki gain | 0 to 4000 | 200 | RW | Uni | | RA | | US |
| 21.13 | Continuous current controller Kp gain | 0 to 4000 | 100 | RW | Uni | | RA | | US |
| 21.14 | Continuous current controller Ki gain | 0 to 4000 | 50 | RW | Uni | | RA | | 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 Eur, 8A, USA: 8A Size: 2A&B Eur: 3A, USA: 20A Size 2C&D Eur: 5A, USA: 20A | RW | Uni | | RA | PT | US |
| 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 | 24.0 | RW | Uni | | | | US |
| 21.31 | Flux loop P gain | 0 to 30.0 | 3.0 | RW | Uni | | | | US |
| 21.32 | Flux loop I gain | 0 to 300.0 | 60.0 | RW | Uni | | | | US |
| 21.33 | field weakening P gain | 0 to 300.0 | 0.4 | RW | Uni | | | | US |
| 21.34 | field weakening I gain | 0 to 300.0 | 5.0 | RW | Uni | | | | US |
| 21.35 | Rated field compensation factor | 0 to 100% | 100% | RW | Uni | | | PT | US |

*The range shown for Pr 21.02 shows the range used for scaling purposes (i.e. for routing to an analog output etc.). Further range restrictions are applied depending on the settings of Pr 1.08 and Pr 1.10.

**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 (0), SET UP (1), diAGnoS (2), triPS (3), SP LOOP (4), SintEr (5), Fb SP (6), inPut (7)) | | RO | Uni | | NC | PT | |
| 23.02 | Binary sum 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 *Mentor MP 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 | | | | | 2 | Preset reference 2 |
| | | 0 | | 3 | | | Preset reference 3 | |
| | | 1 | | 4 | | | Preset reference 4 | |
| | 1 | No function | | 1 | 1 | Analog input 1 | | |
| 2 to 8 | No function | | 2 to 8 | 2 to 8 | Preset reference 2 to 8 | | | |
| 9 * | No function | | 1 | 1 | Analog input 1 | | | |
| | | No function | 2 to 8 | 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 | | | | | 2 | Preset reference 2 |
| | | 0 | | 3 | | | Preset reference 3 | |
| | | 1 | | 4 | | | Preset reference 4 | |
| | 1 | No function | | 1 | 1 | Analog input 2 | | |
| 2 to 8 | No function | | 2 to 8 | 2 to 8 | Preset reference 2 to 8 | | | |
| 9 * | No function | | 1 | 1 | Analog input 2 | | | |
| | | No function | 2 to 8 | 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 | | | | | 2 | Preset reference 2 |
| | | 0 | | 3 | | | Preset reference 3 | |
| | | 1 | | 4 | | | Preset reference 4 | |
| | 1 to 8 | No function | | 1 to 8 | 1 to 8 | Preset reference 1 to 8 | | |
| 9 * | No function | | 1 to 8 | 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), inh bit (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 ² /1,000rpm | | | | | | ⇒ | 3.600 | | | | | |

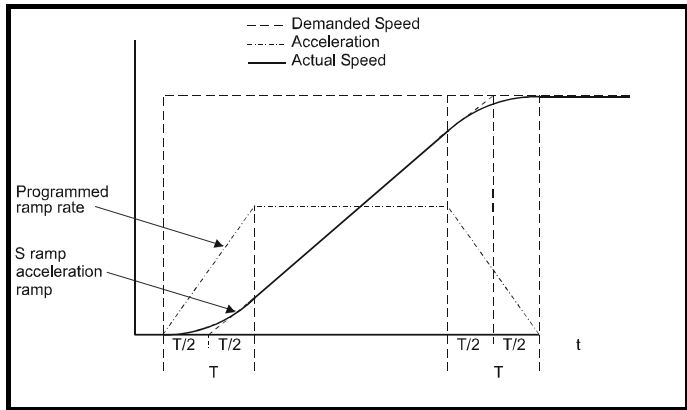
This parameter defines the maximum rate of change of acceleration/ deceleration. If the S ramp is disabled (Pr 2.06 = 0) a linear ramp is used and the time in seconds taken for the ramp output to change by speed ($\Delta\omega^*$) is given by:

Speed

$$T_{\text{Ramp}} = \Delta\omega^* \times A / \text{See Pr 2.39}$$

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 ($\Delta\omega^*$) 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

$$\Delta\omega^*_{\text{linear}} = 1000 \times J / A1^2$$

where:

A = selected ramp rate

J = Pr 2.07

If the required change is less than $\Delta\omega^*_{\text{linear}}$ then T_{Ramp1} should be used, but if the speed change is greater or equal to $\Delta\omega^*_{\text{linear}}$ T_{Ramp2} should be used.

$$T_{\text{Ramp1}} = 2 \sqrt{(\Delta\omega^* \times \text{Pr 2.07} / 1000)}$$

$$T_{\text{Ramp2}} = (\Delta\omega^* \times A / 1000) + (\text{Pr 2.07} / A)$$

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 | |
| ⇅ | | $\pm\text{USER_CURRENT_MAX} \%$ | | | | | | ⇒ | 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

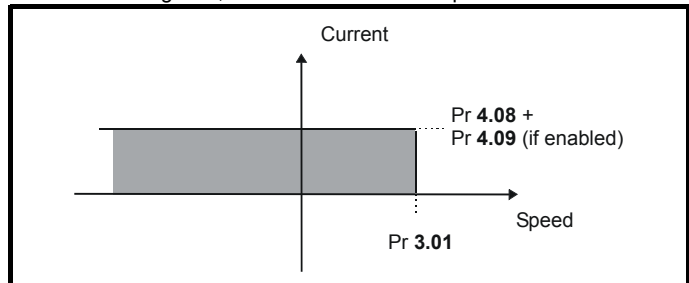
The torque demand is equal to the speed loop output.

1: Torque control

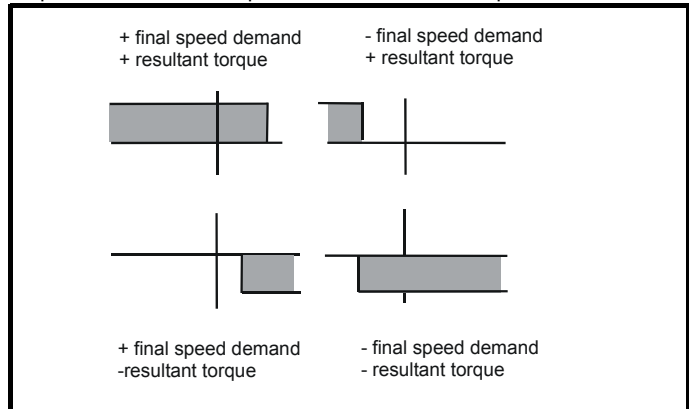
The torque demand is given by the sum of the torque reference and the torque offset, if enabled. The speed is not limited in any way, however, the drive will trip at the overspeed threshold if runaway occurs.

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.

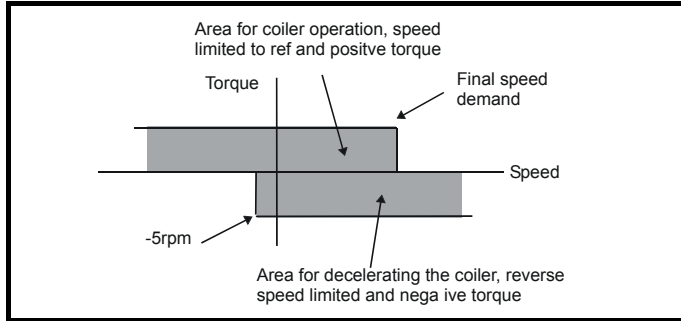
3: Coiler/uncoiler mode

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.

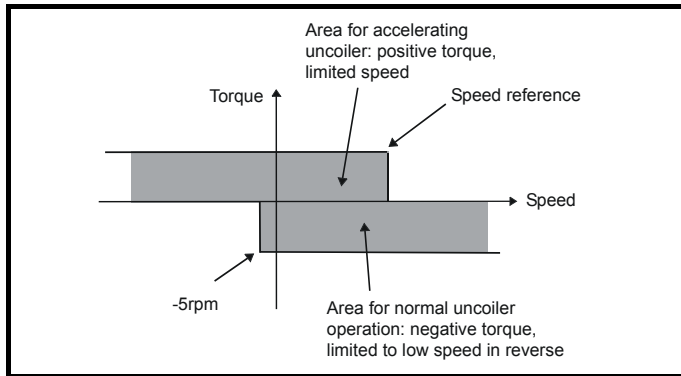
Example of coiler operation:

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 and 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 11-20.

| 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 11-20.

| 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.

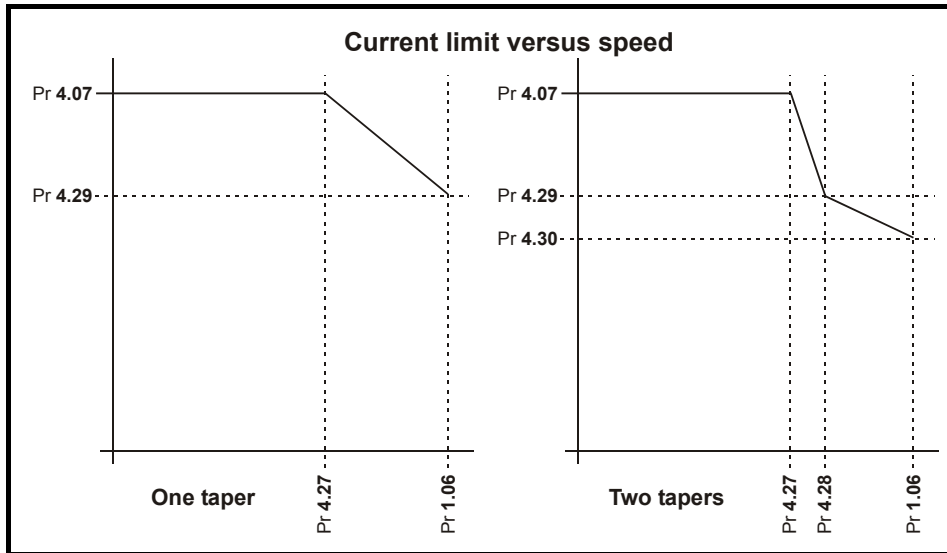
| 4.31 | | Taper threshold 1 exceeded | |
|------|-----|----------------------------|---|
| RO | Bit | | |
| ↕ | | OFF (0) or On (1) | ⇒ |

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 11-20 Current limit versus speed



11.22.5 Start / stop logic modes

| 6.04 | | Start / stop logic select | | | | | |
|------|-----|---------------------------|--|--|--|--|----|
| RW | Uni | | | | | | US |
| | | 0 to 4 | | | | | 0 |

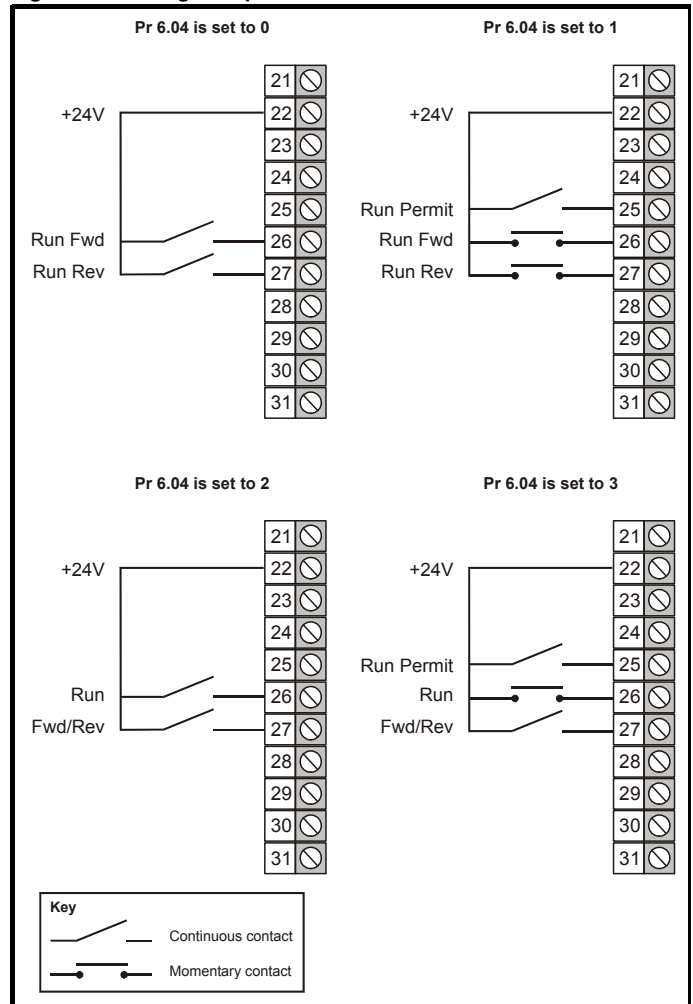
This parameter is provided to allow the user to select several predefined digital input routing macros to control the sequencer. When a value between 0 and 3 is selected the drive processor continuously updates the destination parameters for digital I/O T25, T26 and T27, and the enable sequencer latching 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 61 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 11-21 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

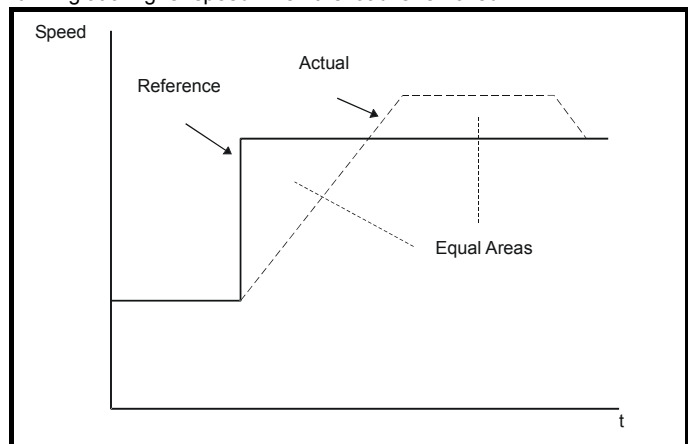
| | | | | | | | | | | | | | |
|--------------|-----|---------------------------------|--|--|--|--|--|---|---|--|--|--|----|
| 13.10 | | Position controller mode | | | | | | | | | | | |
| RW | Uni | | | | | | | | | | | | US |
| ⇅ | | 0 to 6 | | | | | | ⇒ | 0 | | | | |

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 | |

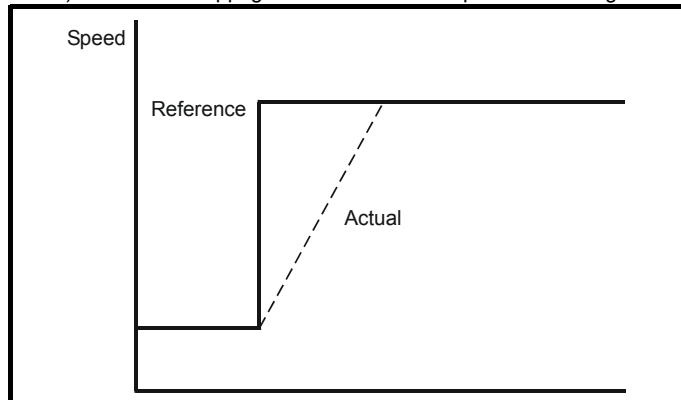
Rigid position control

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 *Mentor MP 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 derating is required.

The maximum continuous output current rating of the drive should be 'derated' for operation at altitudes above 1000m. The derating is to be 1% derating of rated output current per 100m above 1000m to a maximum derating of 20% at 3000m.

Table 12-1 480V current ratings

| Model | AC input current | | DC output current | | Typical motor power | |
|-------------|------------------|------------|-------------------|----------|---------------------|--|
| | Continuous | Continuous | 150% 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 12-2 575V current ratings

| Model | AC input current | | DC output current | | Typical motor power (With Vdc = 630V) | |
|-------------|------------------|------------|-------------------|------|---------------------------------------|--|
| | Continuous | Continuous | 150% 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 | |
| MP350A5(R) | 313 | 350 | 525 | 195 | 260 | |
| MP470A5(R) | 420 | 470* | 705 | 265 | 355 | |
| MP700A5(R) | 626 | 700 | 1050 | 395 | 530 | |
| MP825A5(R) | 738 | 825* | 1237.5 | 465 | 620 | |
| MP1200A5(R) | 1073 | 1200 | 1800 | 680 | 910 | |
| MP1850A5(R) | 1655 | 1850 | 2775 | 1045 | 1400 | |

* For this rating at 575V, 150% overload time is 20s at 40 C and 30s at 35 C

Table 12-3 690V current ratings

| Model | AC input current | | DC output Current | | Typical motor power (With Vdc = 760V) | |
|-------------|------------------|------------|-------------------|------|---------------------------------------|--|
| | Continuous | Continuous | 150% Overload | kW | hp | |
| | A | A* | A | | | |
| MP350A6(R) | 313 | 350 | 525 | 240 | 320 | |
| MP470A6(R) | 420 | 470* | 705 | 320 | 425 | |
| MP700A6(R) | 626 | 700 | 1050 | 480 | 640 | |
| MP825A6(R) | 738 | 825* | 1237.5 | 650 | 850 | |
| MP1200A6(R) | 1073 | 1200 | 1800 | 850 | 1150 | |
| MP1850A6(R) | 1655 | 1850 | 2775 | 1300 | 1750 | |

* For this rating at 690V, 150% overload time is 20s at 40 C and 30s at 35 C

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 conditions.

NOTE

For current ratings above 1850A then parallel connection of the drives is required. However, this function is not implemented on firmware versions V01.05.01 and earlier.

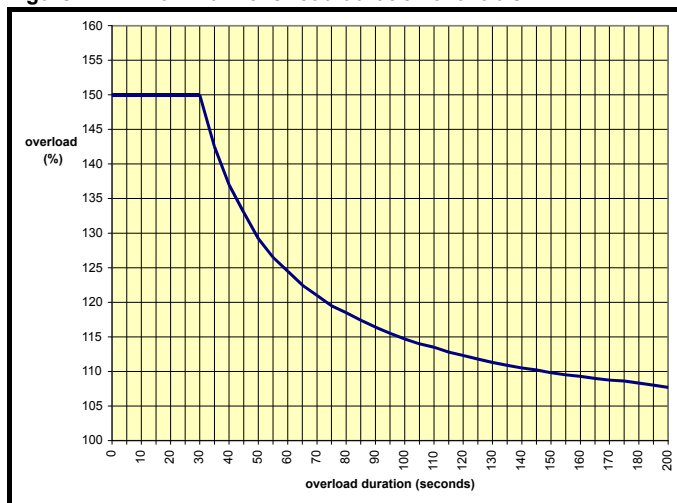
12.1.2 Typical short-term overload limits

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 *Mentor MP 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 up to a maximum of 10 repetitions per hour..

12.1.3 Drive derating for extended ambient operation

Figure 12-2 Mentor MP size 1A derating for extended ambient operation

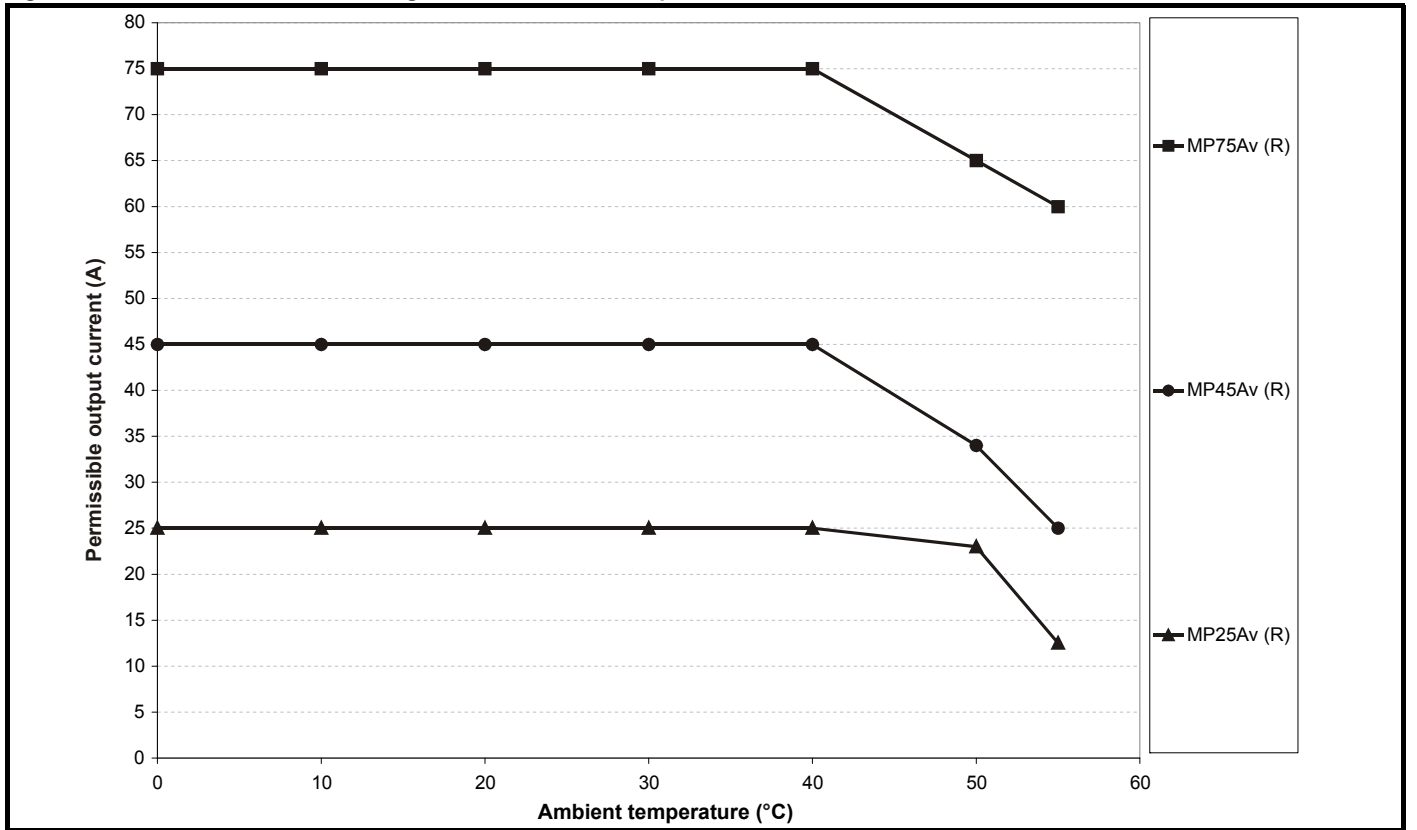


Figure 12-3 Mentor MP size 1B derating for extended ambient operation

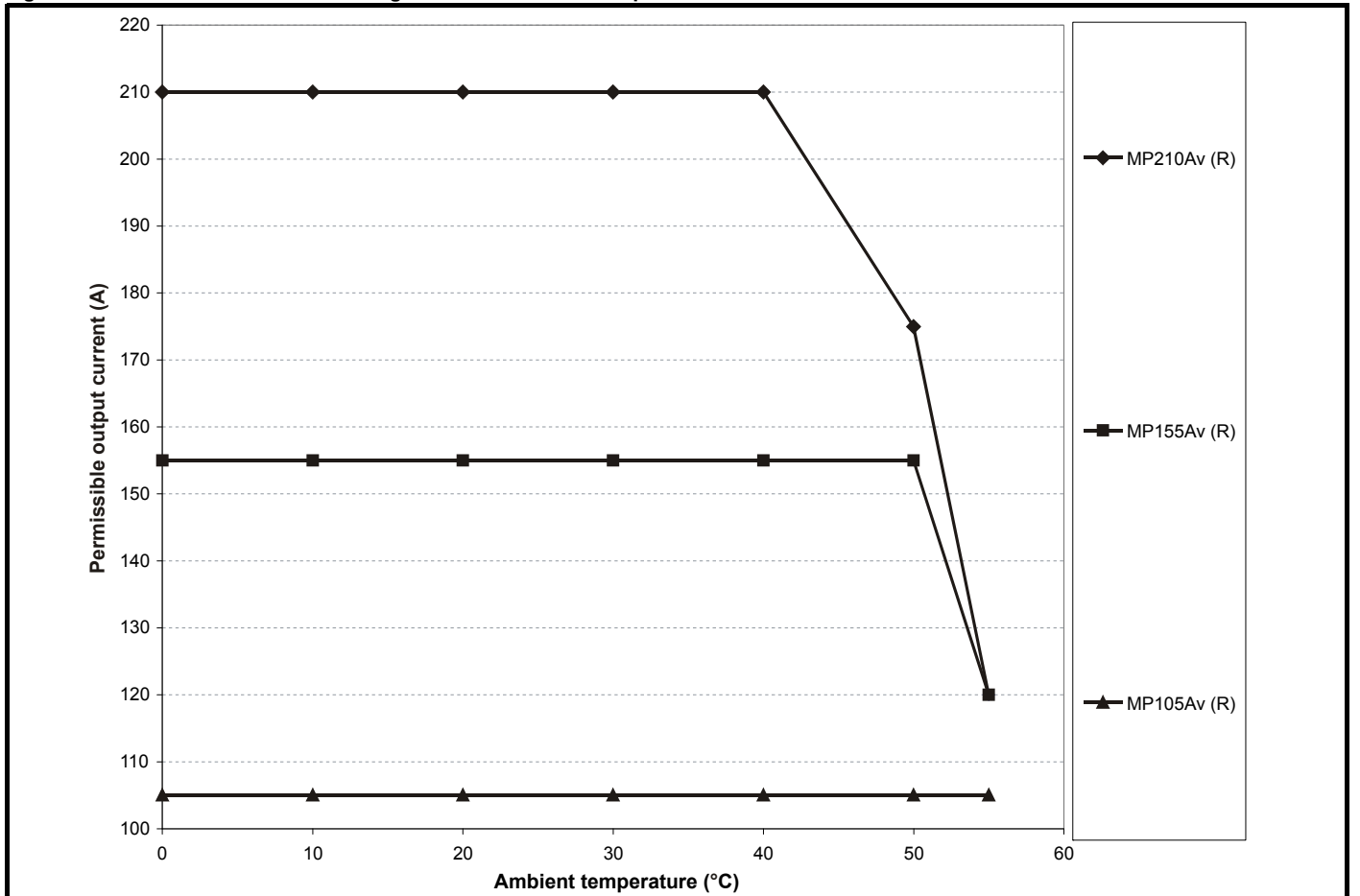


Figure 12-4 Mentor MP size 2A derating for extended ambient operation

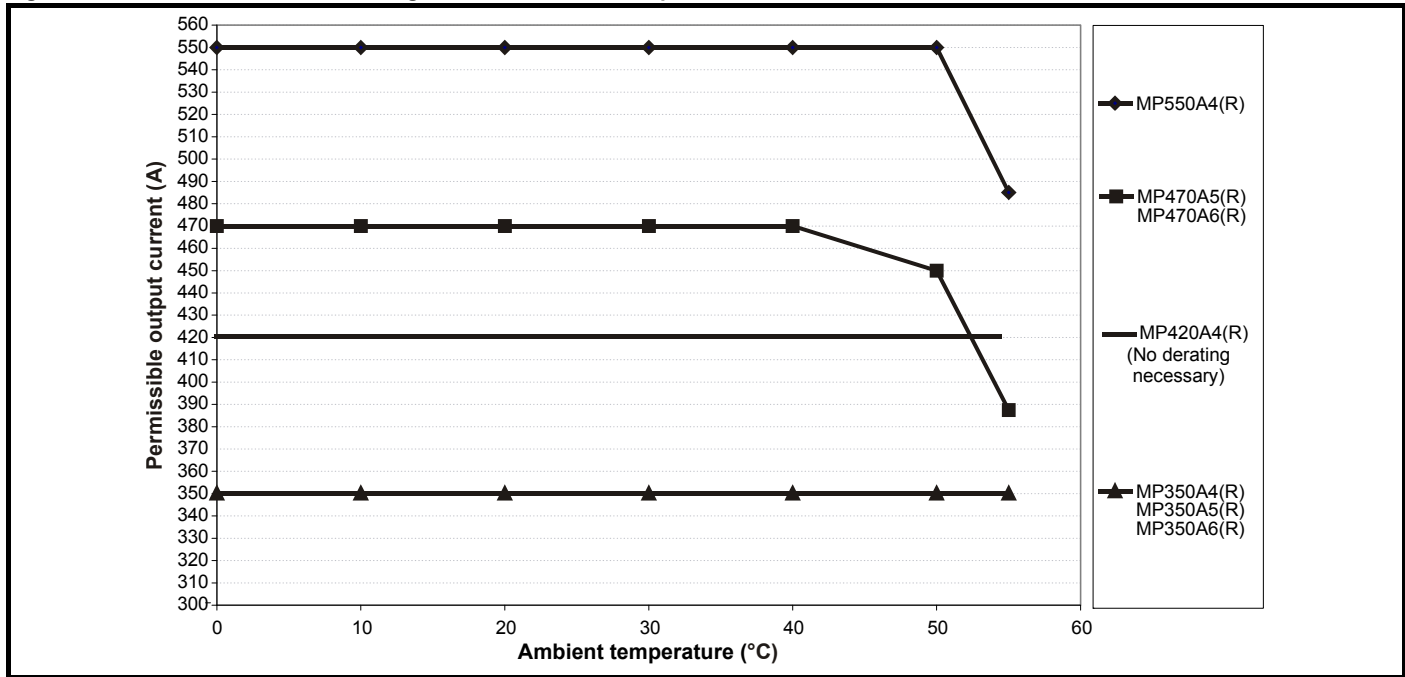


Figure 12-5 Mentor MP size 2B derating for extended ambient operation

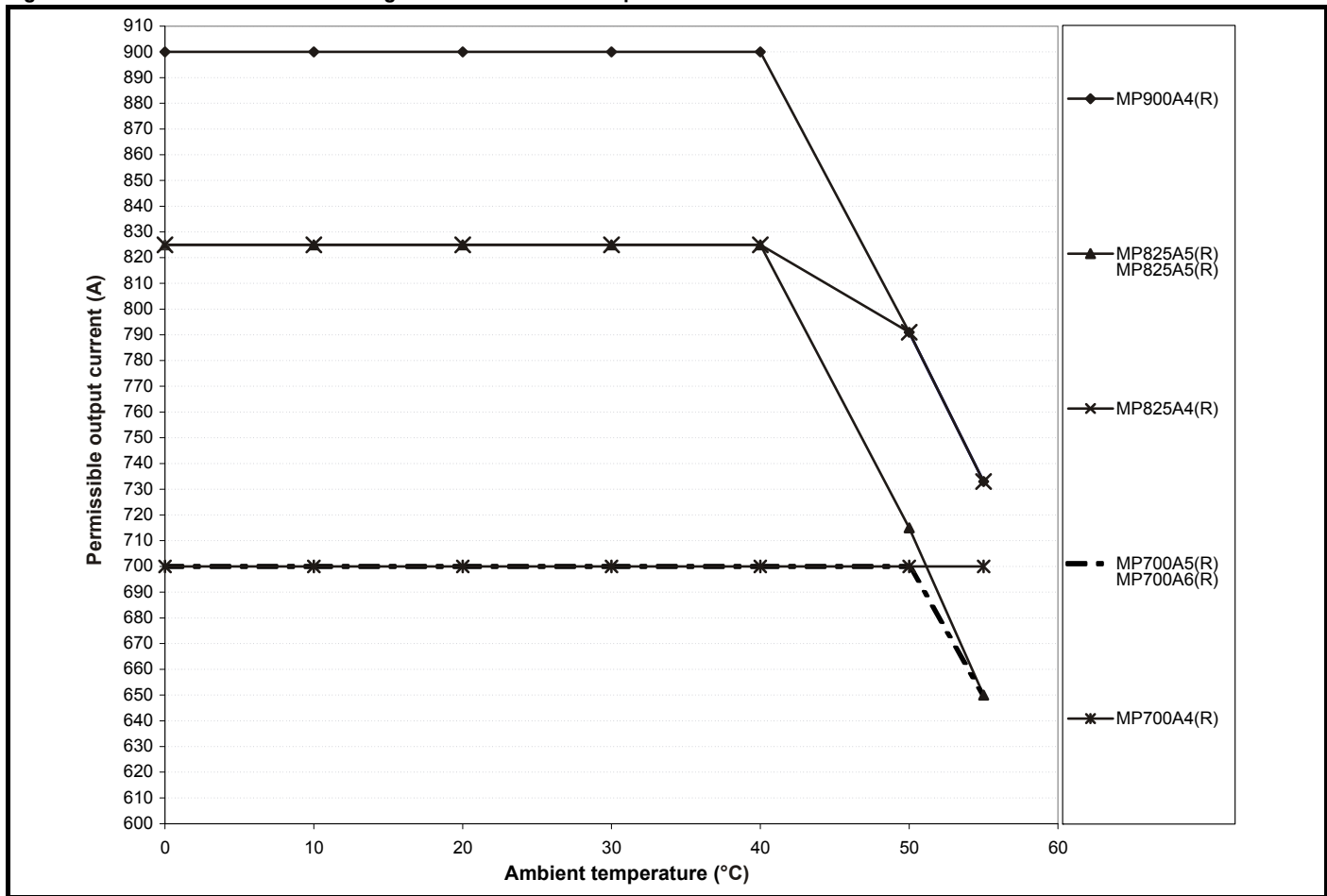
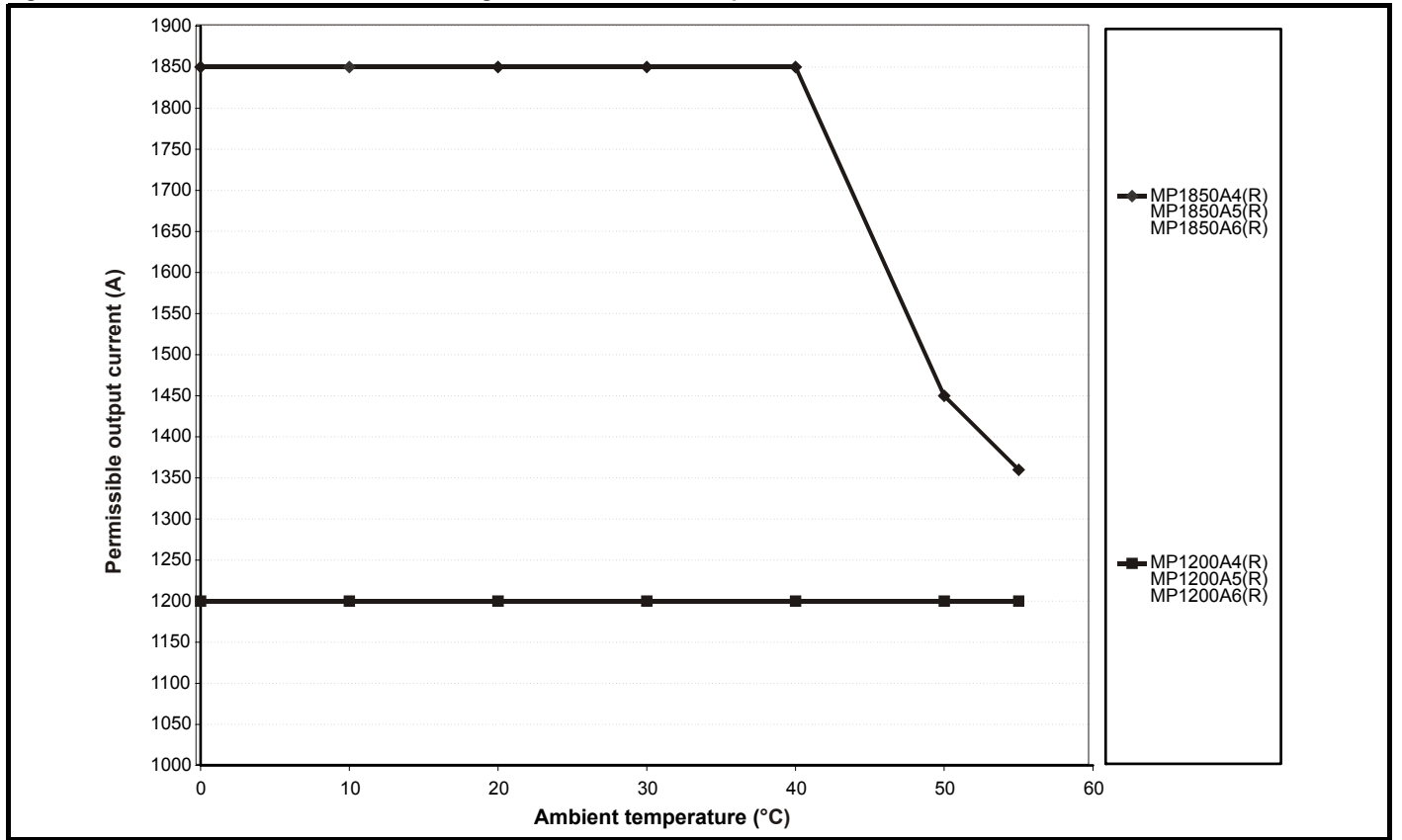


Figure 12-6 Mentor MP Size 2C and 2D derating for extended ambient operation



NOTE

The derating graphs show the derating required for worst-case conditions.

12.1.4 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 |
|----------------------------|------------------|------------------|------------------|
| MP25A4(R) MP25A5(R) | 125 | | 91 |
| MP45A4(R) MP45A5(R) | 168 | 139 | 117 |
| MP75A4(R) MP75A5(R) | 219 | 194 | 183 |
| MP105A4(R) MP105A5(R) | 274 | | |
| MP155A4(R) MP155A5(R) | 400 | | 310 |
| MP210A4(R) MP210A5(R) | 561 | 456 | |
| MP350A4(R) | 954 | | |
| MP350A5(R) MP350A6(R) | 1045 | | |
| MP420A4(R) | 1154 | | |
| MP470A5(R) MP470A6(R) | 1546 | 1268 | 1162 |
| MP550A4(R) | 1568 | | 1354 |
| MP700A4(R) | 1663 | | |
| MP825A4(R) | | | |
| MP700A5(R) MP700A6(R) | 1955 | | 1795 |
| MP825A4(R) | 2160 | 1909 | 1751 |
| MP825A5(R) MP825A6(R) | 2381 | 2004 | 1795 |
| MP900A4(R) | 2220 | 1908 | 1751 |
| MP1200A4(R) | | | |
| MP1200A5(R) MP1200A6(R) | 3635 | 3660 | |
| MP1850A4(R) | | | |
| MP1850A5(R) MP1850A6(R) | 5203 | 4418 | 4139 |

12.1.5 AC Supply requirements

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

An optional rating of 575Vrms is available for size 1 drives.

An optional rating of 575Vrms and 690Vrms is available for size 2 drives.



WARNING Grounded delta supplies exceeding 575V are not permitted for drives up to and including 210A. Grounded delta supplies exceeding 600V are not permitted for drives rated 350A and above.

12.1.6 Supply types

Drives rated for supply voltages of up to 575V (rated up to 210A) and 600V (350A and above), 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").

Grounded delta supplies >575V are not permitted for drives rated up to and including 210A. Grounded delta supplies >600V are not permitted for drives rated 350A and above.

12.1.7 Main AC supply (L1, L2, L3)

Table 12-5 Three phase AC supply

| Specification | Product voltage variant | | |
|------------------------|-------------------------|------|------|
| | 480V | 575V | 690V |
| Maximum nominal supply | 480V | 575V | 690V |
| Tolerance | +10% | | |
| Minimum nominal supply | 24V | 500V | |
| Tolerance | -20% | -10% | |

12.1.8 Auxiliary AC supply

Table 12-6 Line to line supply

| Specification | Value |
|------------------------|-------|
| Maximum nominal supply | 480V |
| Tolerance | +10% |
| Minimum nominal supply | 208V |
| Tolerance | -10% |

12.1.9 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: EN 61800-3:2004 "Adjustable speed electrical power drive systems – Part 3: EMC requirements and specific test methods".

Table 12-7 Minimum required line inductance for a typical application (50% ripple content)

| Drive rated current A | System voltage | | | | Typical current rating A | Maximum current rating A |
|--------------------------|----------------|------------|------------|------------|-----------------------------|-----------------------------|
| | 400V μH | 480V μH | 575V μH | 690V μH | | |
| 25 | 220 | 260 | 320 | | 21 | 22 |
| 45 | 220 | 260 | 320 | | 38 | 40 |
| 75 | 220 | 260 | 320 | | 63 | 67 |
| 105 | 220 | 260 | 320 | | 88 | 94 |
| 155 | 160 | 190 | 230 | | 130 | 139 |
| 210 | 120 | 140 | 170 | | 176 | 188 |
| 350 | 71 | 85 | 110 | 120 | 293 | 313 |
| 420 | 59 | 71 | | | 351 | 375 |
| 470 | | | 80 | 91 | 393 | 420 |
| 550 | 45 | 54 | | | 460 | 492 |
| 700 | 36 | 43 | 53 | 61 | 586 | 626 |
| 825 | | | 45 | 52 | 690 | 738 |
| 900 | 28 | 33 | | | 753 | 805 |
| 1200 | 21 | 25 | 31 | 36 | 1004 | 1073 |
| 1850 | 18 | 23 | 29 | 32 | 1548 | 1655 |

NOTE

- The above assumes the supply has 1.5% impedance.
- Assumes a minimum supply rating of 5kA and a maximum rating of 60kA.

12.1.10 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.

12.1.11 Storage

-40°C (-40°F) to +55°C (131°F) for long term storage, or to +70°C (158°F) for short term storage.

12.1.12 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: derate 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 derated by 20%.

12.1.13 IP rating

The Mentor MP range of drives have the following Ingress Protection rating:

Table 12-8 IP rating

| Frame size | IP Rating |
|------------|--|
| 1A | IP20 Protection against medium size foreign bodies $\varnothing > 12\text{mm}$ (finger) No protection against ingress of water |
| 1B | |
| 2A | IP10 Protection against large foreign bodies $\varnothing > 50\text{mm}$ (large area contact with hand) No protection against ingress of water |
| 2B | |
| 2C | IP00 No protection against contact, ingress of foreign bodies or ingress of water |
| 2D | |



IP rating
It is the installer's responsibility to ensure that any enclosure which allows access to drives from frame sizes 2A to 2D while the product is energized, provides protection against contact and ingress to the requirements of IP20.

The IP rating of a product is a measure of protection against contact and ingress of foreign bodies and water. It is stated as IP XX, where the two digits (XX) indicate the degree of protection.

12.1.14 Corrosive gasses

Concentrations of corrosive gases must not exceed the levels given in:

- Table A2 of EN 50178:1998
- Class 3C2 of IEC 60721-3-3

This corresponds to the levels typical of urban areas with industrial activities and/or heavy traffic, but not in the immediate neighborhood of industrial sources with chemical emissions.

12.1.15 RoHS compliance

Mentor MP meets EU directive 2002/95/EC for RoHS compliance.

12.1.16 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 m²/s³ (0.01 g²/Hz) ASD from 5 to 20 Hz

-3 dB/octave from 20 to 200 Hz

Duration: 30 minutes in each of 3 mutually perpendicular axes.

Sinusoidal vibration test

Testing in each of three mutually perpendicular axes in turn.

Referenced standard: IEC 60068-2-6: Test Fc:

Frequency range: 5 to 500 Hz

Severity: 3.5 mm peak displacement from 5 to 9 Hz

10 m/s² peak acceleration from 9 to 200 Hz

15 m/s² peak acceleration from 200 to 500 Hz

Sweep rate: 1 octave/minute

Duration: 15 minutes in each of 3 mutually perpendicular axes.

EN 61800-5-1:2007, Section 5.2.6.4. referring to IEC 60068-2-6

Frequency range: 10-150Hz

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)

12.1.17 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

12.1.18 Output speed range

Speed range: 0 to 10,000rpm

12.1.19 Accuracy

Accuracy in estimated speed mode: Typically 5 to 10%.

Other modes are dependent on feedback device used.

12.1.20 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 12-9 gives the acoustic noise produced by the drive.

Table 12-9 Acoustic noise data

| Model | | | Frame Size | SPL at 1m (dBA) |
|------------|------------|------------|------------|-------------------|
| MP25A4(R) | MP25A5(R) | | 1A | No fans installed |
| MP45A4(R) | MP45A5(R) | | | 43 |
| MP75A4(R) | MP75A5(R) | | | |
| MP105A4(R) | MP105A5(R) | | 1B | 56 |
| MP155A4(R) | MP155A5(R) | | | |
| MP210A4(R) | MP210A5(R) | | | |
| MP350A4(R) | MP350A5(R) | MP350A6(R) | 2A | 68 |
| MP420A4(R) | MP470A5(R) | MP470A6(R) | | |
| MP550A4(R) | | | | |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | 2B | |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | | |
| MP900A4(R) | | | | |
| MP1200A4 | MP1200A5 | MP1200A6 | 2C | 67* |
| MP1850A4 | MP1850A5 | MP1850A6 | | |
| MP1200A4R | MP1200A5R | MP1200A6R | 2D | |
| MP1850A4R | MP1850A5R | MP1850A6R | | |

NOTE

* The acoustic noise figure for frame sizes 2C and 2D has been taken with the bottom right angle ducting removed.

12.1.21 Overall dimensions


Refer to section 3.4 *Mounting method* on page 17.

12.1.22 Weights

Table 12-10 Overall drive weights

| Model | | | Frame size | kg | lb |
|-----------|-----------|-----------|------------|------|-------|
| MP25A4 | MP25A5 | | 1A | 10 | 22 |
| MP45A4 | MP45A5 | | | 10.1 | 22.3 |
| MP75A4 | MP75A5 | | | 10.2 | 22.5 |
| MP25A4R | MP25A5R | | | | |
| MP45A4R | MP45A5R | | | | |
| MP75A4R | MP75A5R | | | 10.5 | 23.1 |
| MP105A4 | MP105A5 | | 1B | 12.6 | 27.8 |
| MP155A4 | MP155A5 | | | 13.0 | 28.7 |
| MP210A4 | MP210A5 | | | | |
| MP105A4R | MP105A5R | | | | |
| MP155A4R | MP155A5R | | | | |
| MP210A4R | MP210A5R | | | | |
| MP350A4 | MP350A5 | MP350A6 | 2A | 35 | 77.2 |
| MP420A4 | | | | | |
| | MP470A5 | MP470A6 | | 38 | 83.8 |
| MP550A4 | | | | | |
| MP350A4R | MP350A5R | MP350A6R | | | |
| MP420A4R | | | | | |
| | MP470A5R | MP470A6R | 2B | 41 | 90.4 |
| MP550A4R | | | | | |
| MP700A4 | MP700A5 | MP700A6 | | | |
| MP700A4R | MP700A5R | MP700A6R | | 46 | 101.4 |
| MP825A4 | MP825A5 | MP825A6 | | | |
| MP825A4R | MP825A5R | MP825A6R | | | |
| MP900A4 | | | 2C | 100 | 220.5 |
| MP1200A4 | MP1200A5 | MP1200A6 | | | |
| MP1850A4 | MP1850A5 | MP1850A6 | | | |
| MP1200A4R | MP1200A5R | MP1200A6R |  |  |  | 2D | 138 | 304.2 |
| MP1850A4R | MP1850A5R | MP1850A6R | | | |

12.2 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 Mentor MP frame size 1 drives have been designed to accommodate a maximum cable size of 150mm² (350kcmil) with a temperature of 90°C (194°F).

The power terminals on Mentor MP frame size 2A drives have been designed to accommodate a maximum cable size of 2 x 150mm² (2 x 350kcmil) with a temperature of 75°C (167°F).

The power terminals on Mentor MP frame size 2B drives have been designed to accommodate 2 x 240mm² with a temperature of 90°C (194°F). The use of cables sized using the US national electrical code as shown in Table 12-13 requires the use of a terminal adaptor.

The power terminals on Mentor MP frame size 2C and 2D drives have been designed for use with busbars. The drive can be used with cables as shown in Table 12-13 with the use of a terminal adaptor.

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 12-11 Typical cable sizes for size 1 drives

| Model | | IEC 60364-5-52 ^[1] | | UL508C/NEC ^[2] | |
|------------|------------|-------------------------------|-------------------|---------------------------|----------|
| | | Input | Output | Input | Output |
| MP25A4(R) | MP25A5(R) | 2.5mm ² | 4mm ² | 8 AWG | 8 AWG |
| MP45A4(R) | MP45A5(R) | 10mm ² | 10mm ² | 4 AWG | 4 AWG |
| MP75A4(R) | MP75A5(R) | 16mm ² | 25mm ² | 1 AWG | 1/0 AWG |
| MP105A4(R) | MP105A5(R) | 25mm ² | 35mm ² | 1/0 AWG | 1/0 AWG |
| MP155A4(R) | MP155A5(R) | 50mm ² | 70mm ² | 3/0 AWG | 4/0 AWG |
| MP210A4(R) | MP210A5(R) | 95mm ² | 95mm ² | 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.

Table 12-12 Auxiliary wiring for size 1 drives

| Frame size | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-4 Column B2 | | UL 508C | |
|------------|-----------------------|---------------------------|--|------------------------|-----------------|------------------------|
| | | | Column B2 derated by 0,87 of PVC at 40 | | E1, E3 size | F+, F-, L11 & L12 size |
| | E1, E3 size | F+, F-, L11 & L12 size | E1, E3 size | F+, F-, L11 & L12 size | | |
| | A | A | mm ² | mm ² | mm ² | mm ² |
| 1 | 13 | 8 | 2.5 | 1.5 | 14 AWG | 14 AWG |

Notes for IEC 60364:

IEC 60364-5-52 use installation method B2, Table A.52-4 for three loaded conductors, PVC insulation 30 C and apply derating factor for 40 C from Table A.52-14 (0.87 for PVC).

Notes for UL508C:

Either 60 C or 75 C cable can be used. Ampacities as per table 40.3 as described in the UL508C standard.

Table 12-13 Typical cable sizes for size 2 drives

| Model | | | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-12 Column 5 derated by 0.91 for 40 C XLPE cables (IEC 60364-5-52 table A52-14) and 0.77 for cables bunching (IEC 60364-5-52 table A52-17 item 4) | | US National Electrical Code | |
|-------------|-------------|-------------|-----------------------|---------------------------|---|-----------------------------|-----------------------------|---------------------|
| | | | | | 90 C cables at 40 C ambient | | 75 C cable at 40 C ambient | |
| | | | A | A | Input size mm ² | Output size mm ² | Input cables Kcmil | Output cables Kcmil |
| MP350A4(R) | MP350A5(R) | MP350A6(R) | 313 | 350 | 120 | 150 | 350 | 400 |
| MP420A4(R) | | | 375 | 420 | 150 | 185 | 400 | 500 |
| | MP470A5(R) | MP470A6(R) | 420 | 470 | 185 | 240 | 500 | 600 |
| MP550A4(R) | | | 492 | 550 | 300 | 2 x 185 | 2 x 300 | 2 x 350 |
| MP700A4(R) | MP700A5(R) | MP700A6(R) | 626 | 700 | 2 x 150 | 2 x 150 | 2 x 500 | 2 x 600 |
| MP825A4(R) | MP825A5(R) | MP825A6(R) | 738 | 825 | 2 x 185 | 2 x 240 | 2 x 600 | 3 x 350 |
| MP900A4(R) | | | 805 | 900 | 2 x 185 | 2 x 240 | 3 x 350 | 3 x 400 |
| MP1200A4(R) | MP1200A5(R) | MP1200A6(R) | 1073 | 1200 | 2 x 300 | 3 x 240 | 3 x 600 | 4 x 400 |
| MP1850A4(R) | MP1850A5(R) | MP1850A6(R) | 1655 | 1850 | 4 x 240 | 4 x 300 | * | * |

* Values are beyond the mechanical design of the drive. At this power level it may be prudent to consider bus-bars.

Notes for IEC 60364:

NOTE

- IEC 60364-5-52 Table A 52-12 F method column 5 = Single core cable in free air.
- IEC 60364-5-52 table A52-14 correction factor for ambient air temperature others than 30 C.
- IEC 60364-5-52 table A52-17 item 4 correction factor for groups of more than one circuit or more than one multi-core cable placed on a single layer on a perforated tray.

NOTE

Notes for US National Electrical Code:

- Table 310.17 allowable ampacities of single-insulated conducted rated 0 through 2000V in free air, based on ambient air temperature of 30 C (87 F).
- Derating factor of 0.88 is applied for 40 C to the 75 C cable column. Table 310.17 is based on 30 C (86 F) ambient air temperature.
- NEC 2005 edition Table 310.15(B)(2)(a) shows the adjustment factors for more than three current-carrying conductors in a race way or cable, for 4-6 current-carrying conductors 0.80 derating factor is applied.

Table 12-14 Auxiliary wiring for size 2 drives

| Frame size | Maximum input current | Continuous output current | IEC 60364-5-52 Table A52-4 Column B2 | | UL 508C | |
|------------|-----------------------|---------------------------|--|------------------------|-----------------|------------------------|
| | | | Column B2 derated by 0,87 of PVC at 40 | | E1, E3 size | F+, F-, L11 & L12 size |
| | E1, E3 size | F+, F-, L11 & L12 size | E1, E3 size | F+, F-, L11 & L12 size | | |
| | A | A | mm ² | mm ² | mm ² | mm ² |
| 2 | 23 | 20 | 6 | 4 | 10 AWG | 10 AWG |

Notes for IEC 60364:

IEC 60364-5-52 use installation method B2, Table A.52-4 for three loaded conductors, PVC insulation 30 C and apply derating factor for 40 C from Table A.52-14 (0.87 for PVC).

Notes for UL508C: Either 60 C or 75 C cable can be used. Ampacities as per table 40.3 as described in the UL508C standard.

12.2.1 Ferraz Shawmut fuses

Ferraz Shawmut fuses are recommended for the Mentor MP.

Table 12-15 Ferraz Shawmut semiconductor fusing for size 1 drives

| Model | International | | | USA | | | |
|-------------|--------------------------|--------------------------|----------------|----------------------------------|----------------------------------|------------|---------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number | |
| Field fuses | 10 x 38mm Ferrule | FR10GB69V12.5 | H330011 | 10 x 38mm Ferrule | FR10GB69V12.5 | H330011 | |
| MP25A4 | 22 x 58mm Ferrule | FR22GC69V32 | A220915 | A50QS Series American Round Fuse | A50QS60-4 | A218937 | |
| MP25A5 | | | | | | | |
| MP45A4 | | FR22GC69V63 | X220912 | A50QS Series American Round Fuse | A50QS80-4 | L201513 | |
| MP45A5 | | | | | | | |
| MP75A4 | | FR22GC69V100 | W220911 | A50QS Series American Round Fuse | A50QS125-4 | K218417 | |
| MP75A5 | | | | | | | |
| MP25A4R | | FR22GC69V32 | A220915 | A70QS Series American Round Fuse | A70QS60-4 | H219473 | |
| MP25A5R | | | | | | | |
| MP45A4R | | FR22GC69V63 | X220912 | A70QS Series American Round Fuse | A70QS80-4 | X212816 | |
| MP45A5R | | | | | | | |
| MP75A4R | | FR22GC69V100 | W220911 | A70QS Series American Round Fuse | A70QS125-4 | Q216375 | |
| MP75A5R | | | | | | | |
| MP105A4 | | Size 30 Square Body Fuse | PC30UD69V160EF | M300092 | A50QS Series American Round Fuse | A50QS175-4 | A222663 |
| MP105A5 | | | | | | | |
| MP155A4 | PC30UD69V200EF | | N300093 | A50QS Series American Round Fuse | A50QS250-4 | W211251 | |
| MP155A5 | | | | | | | |
| MP210A4 | PC30UD69V315EF | | Q300095 | A50QS Series American Round Fuse | A50QS350-4 | T215343 | |
| MP210A5 | | | | | | | |
| MP105A4R | Size 70 Square Body Fuse | PC70UD13C160EF | T300604 | A70QS Series American Round Fuse | A70QS175-4 | A223192 | |
| MP105A5R | | | | | | | |
| MP155A4R | | PC70UD13C200EF | V300605 | A70QS Series American Round Fuse | A70QS250-4 | L217406 | |
| MP155A5R | | | | | | | |
| MP210A4R | | PC70UD12C280EF | L300712 | A70QS Series American Round Fuse | A70QS350-4 | M211266 | |
| MP210A5R | | | | | | | |

NOTE

A50QS series are only rated up to 500Vac.

Table 12-16 Ferraz Shawmut branch circuit protection fusing for size 1 drives

| Model | International | | | USA |
|-----------|-----------------------|-------------------|--------------|------------------|
| | Description | Catalogue number | Ref number | Catalogue number |
| Auxiliary | 21 x 57mm Cylindrical | HSJ15 | D235868 | AJT10 |
| MP25A4 | 22 x 58mm Ferrule | FR22GG69V25 | N212072 | AJT30 |
| MP45A4 | | FR22GG69V50 | P214626 | AJT45 |
| MP75A4 | | FR22GG69V80 | Q217180 | AJT70 |
| MP25A4R | | FR22GG69V25 | N212072 | AJT30 |
| MP45A4R | | FR22GG69V50 | P214626 | AJT45 |
| MP75A4R | | FR22GG69V80 | Q217180 | AJT70 |
| MP105A4 | | NH 00 Knife Blade | NH00GG69V100 | B228460 | AJT125 |
| MP155A4 | NH 1 Knife Blade | NH1GG69V160 | F228487 | AJT175 |
| MP210A4 | | NH1GG69V200 | G228488 | AJT225 |
| MP105A4R | NH 00 Knife Blade | NH00GG69V100 | B228460 | AJT125 |
| MP155A4R | NH 1 Knife Blade | NH1GG69V160 | F228487 | AJT175 |
| MP210A4R | | NH1GG69V200 | G228488 | AJT225 |

Table 12-17 Ferraz Shawmut DC protection fusing for size 1 drives

| Model | International | | | USA | | |
|----------|---------------------------|---|--|-------------------------------------|------------------|------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number |
| MP25A4R | 20 x 127mm Cylindrical | FD20GB100V32T | F089498 | A70QS Series American Round Fuse | A70QS60-4 | H219473 |
| MP25A5R | | | | | | |
| MP45A4R | 36 x 127mm Cylindrical | FD36GC100V80T | A083651 | A70QS Series American Round Fuse | A70QS80-4 | X212816 |
| MP45A5R | | | | | | |
| MP75A4R | 20 x 127mm Cylindrical | FD20GC100V63T x 2 connected in parallel. | F083656 x 2 connected in parallel. | A70QS Series American Round Fuse | A70QS125-4 | Q216375 |
| MP75A5R | | | | | | |
| MP105A4R | Size 120 Square Body | D120GC75V160TF | R085253 | A70QS Series American Round Fuse | A70QS175-4 | A223192 |
| MP105A5R | | | | | | |
| MP155A4R | Size 121 Square Body | D121GC75V250TF | Q085252 | A70QS Series American Round Fuse | A70QS250-4 | L217406 |
| MP155A5R | | | | | | |
| MP210A4R | Size 122 Square Body | D122GC75V315TF | M085249 | A70QS Series American Round Fuse | A70QS350-4 | M211266 |
| MP210A5R | | | | | | |

NOTE

DC fusing is required on four quadrant (R) drives only.

Table 12-18 Ferraz Shawmut Semiconductor fusing alternatives for size 1 drives

| Model | | Description | German DIN80 Blade | | German DIN110 Blade Style | | American Blade Style | | French Flat End Style | |
|----------|----------|------------------------|-----------------------|---------------|------------------------------|-------------------|-------------------------|--------------------|--------------------------|---------------|
| | | | Catalogue number | Ref number | Catalogue number | Ref number | Catalogue number | Ref number | Catalogue number | Ref number |
| MP105A4 | MP105A5 | Size 30 Square Body | PC30UD6 9V160A | J300112 | PC30UD69 V160D1A | V300122 | A070UD 30LI160 | R300142 | PC30UD6 9V125TF | V300053 |
| MP155A4 | MP155A5 | | PC30UD6 9V200A | K300113 | PC30UD69 V200D1A | W300123 | A070UD 30LI200 | S300143 | PC30UD6 9V200TF | X300055 |
| MP210A4R | MP210A5R | | PC30UD6 9V315A | M300115 | PC30UD69 V315D1A | Y300125 | A070UD 30LI315 | V300145 | PC30UD6 9V250TF | Y300056 |
| MP105A4R | MP105A5R | Size 70 Square Body | | | PC70UD13 C160D1A | Z300540 | A130UD 70LI160 | A300656 | PC70UD1 3C160TF | R300487 |
| MP155A4R | MP155A5R | | PC70UD13 C200D1A | | A300541 | A130UD 70LI200 | B300657 | PC70UD1 3C200TF | S300488 | |
| MP210A4R | MP210A5R | | PC70UD12 C280D1A | | J300710 | A130UD 70LI315 | Q300716 | PC70UD1 2C280TF | N300714 | |

| Model | | Description | NH Style | |
|----------|----------|------------------------|---------------------|---------------|
| | | | Catalogue number | Ref number |
| MP105A4 | MP105A5 | Size 00 Square body | NH00UD6 9V160PV | K320169 |
| MP155A4 | MP155A5 | | NH00UD6 9V200PV | M320171 |
| MP210A4R | MP210A5R | | NH00UD6 9V315PV | W320179 |

Table 12-19 Ferraz Shawmut semiconductor fusing for size 2 drives

| Model | International | | | USA | | |
|----------------------------------|-------------------|-------------------------|------------|---|---|-------------------------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number |
| Field fuses | 10 x 38mm Ferrule | FR10GB69V25 | L330014 | 10 x 38mm Ferrule | FR10GB69V25 | L330014 |
| MP350A4 | Square Body Fuses | PC30UD69V500TF | W300399 | American Round Fuses Form 101 Range A70QS | A50QS450-4 A70QS450-4 | EQ16871 F214848 |
| MP350A4R | | PC71UD11V500TF | F300523 | | A70QS450-4 | F214848 |
| MP350A5 MP350A6 | | PC31UD69V500TF | T300006 | | A70QS450 | F214848 |
| MP350A5R MP350A6R | | PC72UD13C500TF | D300498 | | A50QS600-4 A70QS600-4 | Q219457 Y219993 |
| MP420A4 | | PC32UD69V630TF | M300069 | | A70QS600-4 | Y219993 |
| MP420A4R | | PC272UD13C630TF | W300721 | | 2 x A70QS400 in parallel | J214345 (x2) |
| MP470A5 MP470A6 | | PC272UD13C700TF | X300722 | | A50QS700-4 A70QS700-4 | N223181 E202772 |
| MP470A5R MP470A6R | | | | | A70QS700-4 | E202772 |
| MP550A4 | | PC33UD69V700TF | Y300079 | | A50QS900-4 2 x A70QS500-4 in parallel | R212282 A218431 (x2) |
| MP550A4R | | PC272UD13C700TF | X300722 | | 2 x A70QS500 in parallel. | A218431 (x2) |
| MP700A4 | | PC32UD69V1000TF | S300074 | | A50QS1200-4 2 x A70QS600-4 in parallel | C217904 Y219993 (x2) |
| MP700A4R | | PC72UD10C900TF | G300869 | | 2 x A70QS600-4 in parallel | Y219993 (x2) |
| MP700A5 MP700A6 | | PC32UD69V1000TF | S300074 | | A50QS1200-4 2 x A70QS600-4 in parallel | C217904 Y219993 (x2) |
| MP700A5R MP700A6R | | PC73UD12C900TF | T300512 | | 2 x A70QS600-4 in parallel | Y219993 (x2) |
| MP825A4 | | PC32UD69V1100TF | M300759 | | 2 x A50QS800-4 in parallel. 2 x A70QS800-4 in parallel | C202287 (x2) Z213830 (x2) |
| MP825A5 MP825A6 | | PC33UD69V1100TF | C300083 | | 2 x A70QS800-4 in parallel | Z213830 (x2) |
| MP825A4R MP825A5R MP825A6R | | PC73UD95V800TFB | W300514 | | 2 x A50QS1000-4 in parallel. *3 x A70QS700-4 in parallel | B217391 (x2) *E202772 (x3) |
| MP900A4 | | PC33UD69V1250TF | D300084 | | *3 x A70QS700-4 in parallel | *E202772 (x3) |
| MP900A4R | | PC73UD95V800TFB | W300514 | | | |
| MP1200A4 | | PC33UD60V1600TF | Z300586 | | | |
| MP1200A4R | | PC273UD11C16CTF | J302228 | | | |
| MP1200A5 MP1200A6 | | PC232UD69V16CTD | W300215 | | | |
| MP1200A5R MP1200A6R | | PC273UD11C16CTF | J302228 | | | |
| MP1850A4 | | **7,5 URD 44 PPSAF 2200 | **K235184 | | | |
| MP1850A4R | | | | | | |
| MP1850A5 MP1850A6 | | | | | | |
| MP1850A5R MP1850A6R | | | | | | |

NOTE

A50QS series are only rated up to 500Vac.

*Application overload limited to infrequent overloads to avoid fuse wear out

**Fuse limits applications to those operating at rated current. No cyclic overloads permitted.

Table 12-20 Ferraz Shawmut branch circuit protection fusing for size 2 drives

| Model | International | | | USA | | |
|---|-----------------------------------|----------------------------------|--------------------|---------------------------------|------------------|------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number |
| Auxiliary | 25A 600Vac High Speed Class J | HSJ205 | F235870 | 25A 600Vac High Speed Class J | AJT20R | X21160J |
| MP350A4(R) MP350A5(R) MP350A6(R) | General purpose IEC (square body) | NH2GG69V355 | Y228503 | General purpose US (round body) | A6D400R | B216776 |
| MP420A4(R) | | NH3GG69V400 | D228508 | | A6D500R | P217294 |
| MP470A5(R) MP470A6(R) | | NH4GG69V630-8 NH4AGG69V630-8 | E215537 W222107 | | A6D600R | T217804 |
| MP550A4 (R) | | NH4GG69V630-8 NH4AGG69V630-8 | E215537 W222107 | | A4BQ800 | Z219373 |
| MP700A4(R) MP700A5(R) MP700A6(R) | | NH4GG69V800-8 NH4AGG69V800-8 | K216554 M222858 | | | |
| MP825A4(R) MP825A5(R) MP825A6(R) | | NH4GG69V800-8 NH4AGG69V800-8 | K216554 M222858 | | | |
| MP900A4(R) | | | | | | |
| MP1200A4(R) MP1200A5(R) MP1200A6(R) | | General purpose IEC (round body) | MF76GG69V1250 | | E302753 | A4BQ1000 | P216282 |
| MP1850A4(R) MP1850A5(R) MP1850A6(R) | | MF114GG69V2000 | G302755 | A4BQ1200 | R216790 | |
| | | | | A4BQ2000 | B223101 | |

NOTE

USA fuses are only rated up to 600Vac.

Table 12-21 Ferraz Shawmut DC protection fusing for size 2 drives

| Model | International | | | USA | | | |
|------------------------|------------------------------------|------------------------|--------------|---------------------------------------|---------------------------------------|-----------------|--------------|
| | Description | Catalogue number | Ref number | Description | Catalogue number | Ref number | |
| MP350A4R | Square Body fuse | D123GB75V630TF | C098557 | American round fuse | A70QS600-4 | Y219993 | |
| MP350A5R MP350A6R | | | | | A100P600-4 | A217373 | |
| MP420A4R | | | | | A70QS800-4 | Z213830 | |
| MP470A5R MP470A6R | | D2122GD75V900TF | T220955 | American round fuses 2 in parallel | A100P1000-4 (x2) | Y217371 (x2) | |
| MP550A4R | | | | | A70QS450-4 (x2) | F214848 (x2) | |
| MP700A4R | | D2123GB75V12CTF | D098558 | American round fuse | A70QS600-4 (x2) | Y219993 (x2) | |
| MP700A5R MP700A6R | | | | | A100P1200-4 | N218397 | |
| MP825A4R | | | | | American round fuses 2 in parallel | A70QS800-4 (x2) | Z213830 (x2) |
| MP825A5R MP825A6R | | | | | American round fuse | A100P1200-4 | N218397 |
| MP900A4R | | D2123GB75V14CTF | B090483 | American round fuses 3 in parallel | A70QS600-4 (x3) | Y219993 (x3) | |
| MP1200A4R | Square Body fuses 3 in parallel | PC73UD13C630TF (x3) | Q300509 (x3) | American round fuses 3 in parallel | A70QS700-4 (x3) | E202772 (x3) | |
| MP1200A5R MP1200A6R | | | | | A100P700-4 (x3) | T223163 (x3) | |
| MP1850A4R | Square Body fuses 4 in parallel | PC73UD13C700TF (x4) | R300510 (x4) | American round fuses 5 in parallel | A70QS600-4 (x5) | Y219993 (x5) | |
| MP1850A5R MP1850A6R | | | | | A100P600-4 (x5) | A217373 (x5) | |

NOTE

The use of the A100P series fuses is limited to applications with L/R time constants of 30ms or less.

DC fusing is only required on four quadrant (R) drives.

12.2.2 Alternative fusing

Cooper Bussmann or Siba fuses are an acceptable alternative.

Table 12-22 Cooper Bussmann semiconductor fusing for size 1 two quadrant drives

| Model | | Fuse type | Rating V | Rating A | Catalogue number |
|-----------|---------|---------------------|----------|----------|------------------|
| Auxiliary | | 10.3 x 38mm ferrule | 600Vac | 12 | FWC-12A10F |
| MP25A4 | MP25A5 | ET Type BS88 fuse | 690Vac | 40 | 40ET |
| MP45A4 | MP45A5 | FE Type BS88 fuse | | 80 | 80FE |
| MP75A4 | MP75A5 | EET Type BS88 fuse | | 140 | 140EET |
| MP105A4 | MP105A5 | FEE Type BS88 fuse | | 160 | 160FEE |
| MP155A4 | MP155A5 | FM Type BS88 fuse | | 250 | 250FM |
| MP210A4 | MP210A5 | FMM Type BS88 fuse | | 400 | 400FMM |

Table 12-23 Cooper Bussmann North American alternative semiconductor fusing for size 1 two quadrant 480V drives only

| Model | | Fuse type | Rating V | Rating A | Catalogue number |
|---------|--|--------------------------------|----------|----------|------------------|
| MP25A4 | | FWH series American round fuse | 500Vac | 40 | FWH-40 |
| MP45A4 | | | | 70 | FWH-70 |
| MP75A4 | | | | 125 | FWH-125 |
| MP105A4 | | | | 175 | FWH-175 |
| MP155A4 | | | | 250 | FWH-250 |
| MP210A4 | | | | 350 | FWH-350 |

Table 12-24 Cooper Bussmann North American alternative semiconductor fusing for size 1 two quadrant 480V and 575V drives

| Model | | Fuse type | Rating V | Rating A | Catalogue number |
|---------|---------|--------------------------------|----------|----------|------------------|
| MP25A4 | MP25A5 | FWP series American round fuse | 700Vac | 40 | FWP-40 |
| MP45A4 | MP45A5 | | | 70 | FWP-70 |
| MP75A4 | MP75A5 | | | 125 | FWP-125 |
| MP105A4 | MP105A5 | | | 175 | FWP-175 |
| MP155A4 | MP155A5 | | | 250 | FWP-250 |
| MP210A4 | MP210A5 | | | 300 | FWP-300 |

Table 12-25 Cooper Bussmann North American alternative semiconductor fusing for size 1 two and four quadrant drives

| Model | | Fuse type | Rating V | Rating A | Catalogue number |
|------------|------------|--------------------------------|----------|----------|------------------|
| MP25A4(R) | MP25A5(R) | FWJ series American round fuse | 1000Vac | 40 | FWJ-40 |
| MP45A4(R) | MP45A5(R) | | | 70 | FWJ-70 |
| MP75A4(R) | MP75A5(R) | | | 125 | FWJ-125 |
| MP105A4(R) | MP105A5(R) | | | 175 | FWJ-175 |
| MP155A4(R) | MP155A5(R) | | | 250 | FWJ-250 |
| MP210A4(R) | MP210A5(R) | | | 350 | FWJ-350 |

Table 12-26 Cooper Bussmann branch circuit protection fusing for 480V and 575V size 1 drives

| Model | | Fuse type | Rating V | Rating A | Catalogue number |
|------------|------------|-------------------------------|----------|----------|------------------|
| Auxiliary | | 10.3 x 38mm ferrule | 600Vac | 12 | LP-CC-12 |
| MP25A4(R) | MP25A5(R) | 26.9 x 60.5mm ferrule | | 30 | LPJ-30SP |
| MP45A4(R) | MP45A5(R) | | | 60 | LPJ-60SP |
| MP75A4(R) | MP75A5(R) | | | 80 | LPJ-80SP |
| MP105A4(R) | MP105A5(R) | Cylindrical bolt-in type fuse | | 110 | LPJ-110SP |
| MP155A4(R) | MP155A5(R) | | | 175 | LPJ-175SP |
| MP210A4(R) | MP210A5(R) | | | 225 | LPJ-225SP |

Table 12-27 Cooper Bussmann DC protection fusing for 480V and 575V size 1 drives

| Model | Fuse type | Rating V | Rating A | Catalogue number |
|----------|--------------------------------|----------|----------|------------------|
| MP25A4R | FWJ series American round fuse | 1000Vac | 40 | FWJ-40A |
| MP25A5R | AC fuse provides protection | | | |
| MP45A4R | FWJ series American round fuse | 1000Vac | 70 | FWJ-70A |
| MP45A5R | AC fuse provides protection | | | |
| MP75A4R | FWJ series American round fuse | 1000Vac | 125 | FWJ-125A |
| MP75A5R | AC fuse provides protection | | | |
| MP105A4R | FWJ series American round fuse | 1000Vac | 175 | FWJ-175A |
| MP105A5R | AC fuse provides protection | | | |
| MP155A4R | FWJ series American round fuse | 1000Vac | 250 | FWJ-250A |
| MP155A5R | AC fuse provides protection | | | |
| MP210A4R | FWJ series American round fuse | 1000Vac | 350 | FWJ-350A |
| MP210A5R | AC fuse provides protection | | | |

NOTE

DC protection fusing is only required for 4 quadrant drives.

Table 12-28 Cooper Bussman Semiconductor fusing for size 2 drives

| Model | Description | Catalogue number | Alternative 1 | | Alternative 2 | | Alternative 3 | |
|-------------------------------|---|------------------|-----------------------------|------------------|---|------------------|--|------------------|
| | | | Description | Catalogue number | Description | Catalogue number | Description | Catalogue number |
| Auxiliary | 10 x 38mm Ferrule Fuse | FWC-25A10F | | | | | | |
| MP350A4 | 690V, 500A BS88 Fuse | 500FMM | 700V, 500A FWP Series Fuse | FWP-500A | 1000V, 500A FWJ Series Fuse | FWJ-500A | 500V, 450A FWH Series Fuse | FWH-450A |
| MP350A4R | Size 3 US blade SQ Body | 170M8536 | | | 1000V, 500A FWJ Series Fuse | FWJ-500A | | |
| MP350A5 MP350A6 | 690V, 500A BS88 Fuse | 500FMM | 700V, 500A FWP Series Fuse | FWP-500A | 1000V, 500A FWJ Series Fuse | FWJ-500A | | |
| MP350A5R MP350A6R | Size 2 Square Body DIN 43 653 Fuse | 170M5144 | | | | | | |
| MP420A4 | 690V, 630A BS88 Fuse | 630FMM | 700V, 700A FWP Series Fuse | FWP-700A | 1000V, 600A FWJ Series Fuse | FWJ-600A | 500V, 600A FWH Series Fuse | FWH-600A |
| MP420A4R | Size 2 Square Body DIN 43 653 | 170M5972 | | | 1000V, 600A FWJ Series Fuse | FWJ-600A | | |
| MP470A5 MP470A6 | Size 3 DIN 43 620 Square Body Blade | 170M5139 | 700V, 800A FWP Series Fuse | FWP-800A | 1000V, 800A FWJ Series Fuse | FWJ-800A | | |
| MP470A5R MP470A6R | *2 x Size 2 Square Body DIN 43 653 in parallel. | 170M5139 | | | | | | |
| MP550A4 | 690V, 700A BS88 Fuse | 700FMM | 700V, 800A FWP Series Fuse | FWP-800A | 1000V, 800A FWJ Series Fuse | FWJ-800A | 500V, 700A FWH Series Fuse | FWH-700A |
| MP550A4R | 2 x Size 3 Square Body DIN 43 653 in parallel. | 170M8616 | | | 1000V, 800A FWJ Series Fuse | FWJ-800A | | |
| MP700A4 | Size 1 Square Body Flush End | 170M4419 | 700V, 900A FWP Series Fuse | FWP-900A | 1000V, 1000A FWJ Series Fuse | FWJ-1000A | 500V, 1000A FWH Series Fuse | FWH-1000A |
| MP700A4R | Size 3 Square DIN 43 653 Fuse | 170M6147 | | | 1000V, 1000A FWJ Series Fuse | FWJ-1000A | | |
| MP700A5 MP700A6 | Size 2 Square Body Flush End | 170M5415 | 700V, 900A FWP Series Fuse | FWP-900A | 1000V, 1000A FWJ Series Fuse | FWJ-1000A | | |
| MP700A5R MP700A6R | Square Body Flush End Contact | 170M6726 | | | | | | |
| MP825A4 MP825A5 MP825A6 | Size 2 Square Body Flush End | 170M5417 | 700V, 1200A FWP Series Fuse | FWP-1200A | 1000V, 1200A FWJ Series Fuse | FWJ-1200A | 500V, 1200A FWH Series Fuse | FWH-1200A |
| MP825A4R | 2 x Size 3 Square Body DIN 43 653 in parallel. | 170M6143 | | | *1000V, 1000A FWJ Series Fuse | *FWJ-1000A | | |
| MP825A5R MP825A6R | Square Body Flush End Contact | 170M6024 | | | | | | |
| MP900A4 | Size 3 Square Body Flush End | 170M6416 | 700V, 1200A FWP Series Fuse | FWP-1200A | 1000V, 1200A FWJ Series Fuse | FWJ-1200A | 500V, 1200A FWH Series Fuse | FWH-1200A |
| MP900A4R | *Size 3 Square DIN 43 653 Fuse | *170M6147 | | | *1000V, 1000A FWJ Series Fuse | *FWJ-1000A | | |
| MP1200A4 | Size 4 Square Body Flush End | 170M7061 | | | | | 2 x 500V, 1000A FWH Series Fuse in parallel. | FWH-1000A (x2) |
| MP1200A4R | 2x Size 3 Square Body DIN 43 653 in parallel. | 170M6146 | | | FWJ-1600A | FWJ-1600A | | |
| MP1200A5 MP1200A6 | Size 4 Square Body Flush End | 170M7061 | | | 1000V, 1600A FWJ Series Fuse | FWJ-1600A | | |
| MP1200A5R MP1200A6R | *2 x Square Body Flush End Contact in parallel. | *170M6726 | | | | | | |
| MP1850A4 | 2 x Size 4 Square Body Flush End in parallel. | 170M7059 | | | | | 2 x 500V, 1200A FWH Series Fuse in parallel. | FWH-1200A (x2) |
| MP1850A4R | | | | | *2 x 1000V, 1000A FWJ Series Fuses in parallel. | *FWJ-1000A | | |
| MP1850A5 MP1850A6 | *2 x Size 2 Square Body Flush End in parallel. | *170M5415 | | | | | | |
| MP1850A5R MP1850A6R | *3 x Size 3 Square body DIN 43 653 in parallel. | *170M6143 | | | | | | |

NOTE

*Fusing limits applications to those operating at rated current. No cyclic overloads are permitted.

Table 12-29 Cooper Bussman branch circuit protection fusing for size 2 drives

| Model | | | Description | Catalogue number |
|-----------|-----------|-----------|-----------------------------|------------------|
| Auxiliary | | | Class CC, 600Vac, 20A Fuse | LP-CC-20 |
| MP350A4 | MP350A4R | | Class L, 600Vac, 900A Fuse | KRP-C-900SP |
| MP350A6 | MP350A5R | MP350A6R | | |
| MP420A4 | MP420A4R | | Class L, 600Vac, 1200A Fuse | KRP-C-1200SP |
| MP470A6 | MP470A5R | MP470A6R | | |
| MP550A4 | MP550A4R | | Class L, 600Vac, 1350A Fuse | KRP-C-1350SP |
| MP700A4 | MP700A4R | | Class L, 600Vac, 1600A Fuse | KRPC-1600SP |
| MP700A6 | MP700A5R | MP700A6R | | |
| MP825A4 | MP825A4R | | Class L, 600Vac, 2000A Fuse | KRP-C-2000SP |
| MP825A6 | MP825A5R | MP825A6R | | |
| MP900A4 | MP900A4R | | Class L, 600Vac, 2000A Fuse | KRP-C-2000SP |
| MP1200A4 | MP1200A4R | | Class L, 600Vac, 3000A Fuse | KRP-C-3000SP |
| MP1200A6 | MP1200A5R | MP1200A6R | | |
| MP1850A4 | MP1850A4R | | Class L, 600Vac, 4500A Fuse | KRP-C-4500SP |
| MP1850A6 | MP1850A5R | MP1850A6R | | |

Table 12-30 Cooper Bussmann DC protection fusing for size 2 drives

| Model | Description | Catalogue number | Alternative 1 | | Alternative 2 | |
|------------------------|---|------------------|--|------------------|-----------------------------|------------------|
| | | | Description | Catalogue number | Description | Catalogue number |
| MP350A4R | 1000V, 550A US Square Body Fuse | 170M8536 | 1000V, 600A North American Fuse | FWJ - 600 | 700Vac 450A FWP Series Fuse | FWP 450A |
| MP420A4R | 1000V, 800A North American Fuse | FWJ-800 | | | 700Vac 600A FWP Series Fuse | FWP 600A |
| MP550A4R | 1000V, 900A Square Body End Contact Fuse | 170M6603 | 1000V, 1000A North American Fuse | FWJ - 1000 | 700Vac 700A FWP Series Fuse | FWP 700A |
| MP350A5R MP350A6R | 1500V, 630A Square Body End Contact Fuse | 170M6726 | | | | |
| MP470A5R MP470A6R | 1500V, 900A Square Body End Contact Fuse | 170M6727 | | | | |
| MP700A4R | 1000V, 1200A North American Fuse | FWJ-1200A | 700Vac 900A FWP Series Fuse | FWP 900A | | |
| MP900A4R | 1000V, 1400A North American Fuse | FWJ-1400A | 700Vac 1200A FWP Series Fuse | FWP 1200A | | |
| MP700A5R MP700A6R | 1500V, 1260A Double Body Fuse | 170M6757 | | | | |
| MP825A4R | 1000V, 1400A North American Fuse | FWJ-1400A | 700Vac 1200A FWP Series Fuse | FWP 1200A | | |
| MP825A5R MP825A6R | 1500V, 1260A Double Body Fuse | 170M6757 | | | | |
| MP1200A4R | 1000V, 2000A North American Fuse | FWJ-2000 | 2 x 700Vac, 1000A FWP Fuses in parallel. | FWP 1000A | | |
| MP1850A4R | 1000V, 3000A End Contact Fuse | 170M7680 | 2 x 700Vac, 1200A FWP Fuses in parallel. | FWP 1200A | | |
| MP1200A5R MP1200A6R | 1400V, 2000A Square Body End Contact Fuse | 170M8112 | | | | |
| MP1850A5R MP1850A6R | 1400V, 3000A Square Body End Contact Fuse | 170M8163 | | | | |

NOTE

DC fusing is only required on four quadrant (R) drives.

Table 12-31 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 | | 10 x 38mm ferrule | 660Vac | 12 | 10 x 38 cylindrical 660Vac URZ | 50 179 06.12 | |
| MP25A4 | MP25A5 | 22 x 58mm ferrule | 690Vac | 32 | 22 x 58 cylindrical 690Vac URZ | 50 140 06.32 | |
| MP45A4 | MP45A5 | | | 63 | | 50 140 06.63 | |
| MP75A4 | MP75A5 | | | 100 | | 50 140 06.100 | |
| MP25A4(R) | MP25A5(R) | | | 32 | | 50 140 06.32 | |
| MP45A4(R) | MP45A5(R) | | | 63 | | 50 140 06.63 | |
| MP75A4(R) | MP75A5(R) | | | 100 | | 50 140 06.100 | |
| MP105A4 | MP105A5 | Size 000 square body | 690Vac | 160 | URB 000 690Vac 160A bolt-type | 20 282 20.160 | 20 282 21.160 |
| MP155A4 | MP155A5 | | | 200 | URB 000 690Vac 200A bolt-type | 20 282 20.200 | 20 282 21.200 |
| MP210A4 | MP210A5 | | | 315 | URB 000 690Vac 315A bolt-type | 20 282 20.315 | 20 282 21.315 |
| MP105A4(R) | MP105A5(R) | | | 160 | URB 000 690Vac 160A bolt-type | 20 282 20.160 | 20 282 21.160 |
| MP155A4(R) | MP155A5(R) | | | 200 | URB 000 690Vac 200A bolt-type | 20 282 20.200 | 20 282 21.200 |
| MP210A4(R) | MP210A5(R) | | | 315 | URB 000 690Vac 315A bolt-type | 20 282 20.315 | 20 282 21.315 |

Table 12-32 Siba branch circuit protection fusing for 480V and 575V size 1 drives

| Model | | Fuse type | Rating V | Rating A | Description | Part number |
|------------|------------|--------------------|-------------------|----------|----------------------|---------------|
| Auxiliary | | NH 000 knife blade | 690Vac | 10 | NH 000 gG 690Vac 10A | 20 477 13.10 |
| MP25A4 | MP25A5 | | | 35 | NH 000 gG 690Vac 35A | 20 477 13.35 |
| MP45A4 | MP45A5 | NH 00 knife blade | 690Vac | 63 | NH 00 gG 690Vac 63A | 20 209 13.63 |
| MP75A4 | MP75A5 | | | 100 | NH 00 gG 690Vac 100A | 20 209 13.100 |
| MP25A4(R) | MP25A5(R) | NH 000 knife blade | 690Vac | 35 | NH 000 gG 690Vac 35A | 20 477 13.35 |
| MP45A4(R) | MP45A5(R) | NH 00 knife blade | | 63 | NH 00 gG 690Vac 63A | 20 209 13.63 |
| MP75A4(R) | MP75A5(R) | | NH 00 knife blade | 100 | NH 00 gG 690Vac 100A | 20 209 13.100 |
| MP105A4 | MP105A5 | NH 1 knife blade | 690Vac | 160 | NH1 gG 690Vac 160A | 20 211 13.160 |
| MP155A4 | MP155A5 | | | 200 | NH1 gG 690Vac 200A | 20 211 13.200 |
| MP210A4 | MP210A5 | NH 2 knife blade | 690Vac | 315 | NH2 gG 690Vac 315A | 20 212 13.315 |
| MP105A4(R) | MP105A5(R) | NH 1 knife blade | | 160 | NH1 gG 690Vac 160A | 20 211 13.160 |
| MP155A4(R) | MP155A5(R) | | NH 1 knife blade | 200 | NH1 gG 690Vac 200A | 20 211 13.200 |
| MP210A4(R) | MP210A5(R) | NH 2 knife blade | 690Vac | 315 | NH2 gG 690Vac 315A | 20 212 13.315 |

Table 12-33 Siba DC protection fusing for 480V and 575V size 1 drives

| Model | | Fuse type | Rating V | Rating A | Description | Ref number | Configuration |
|----------|----------|------------------------|----------|----------|-------------------------|---------------|---------------|
| MP25A4R | MP25A5R | 20 x 127mm cylindrical | 1000Vdc | 32 | 20 x 127 1000Vdc 32A gR | 90 080 10.32 | single fuse |
| MP45A4R | MP45A5R | | | 50 | 20 x 127 1000Vdc 50A gR | 90 080 10.50 | single fuse |
| MP75A4R | MP75A5R | 36 x 190mm cylindrical | 1500Vdc | 80 | 36 x 190 1500Vdc 80A gR | 90 094 10.80 | single fuse |
| MP105A4R | MP105A5R | SQB-DC2 square body | 900Vdc | 125 | SQB-DC2 1200V 125A | 90 203 25.125 | single fuse |
| MP155A4R | MP155A5R | | | 160 | SQB-DC2 1200V 160A | 90 203 25.160 | single fuse |
| MP210A4R | MP210A5R | | | 250 | SQB-DC2 1200V 250A | 90 203 25.250 | single fuse |

NOTE

DC protection fusing is only required for 4 quadrant drives.

Table 12-34 Siba Semiconductor fusing for size 2 drives

| Model | International | | | USA |
|------------------------|--------------------------------------|-----------------------|----------------|----------------|
| | Description | Part number | | |
| | | Metric thread contact | Blade contact | Blade contact |
| Auxiliary | 10 x 38mm Ferrule Fuse | 50 179 06.20 | | |
| MP350A4 | 690V SQB1 500A | 20 660 31.500 | 20 610 31.500 | 20 617 31.500 |
| MP420A4 | 690V SQB1 550A | 20 660 31.550 | 20 610 31.550 | 20 617 31.550 |
| MP550A4 | 2 x 690V SQB1 400A in parallel. | 20 660 31.400 | 20 610 31.400 | 20 617 31.400 |
| MP350A4R | 690V SQB1 500A | 20 660 31.500 | 20 610 31.500 | 20 617 31.500 |
| MP420A4R | 690V SQB1 550A | 20 660 31.550 | 20 610 31.550 | 20 617 31.550 |
| MP550A4R | 2 x 690V SQB1 400A in parallel. | 20 660 31.400 | 20 610 31.400 | 20 617 31.400 |
| MP350A5 MP350A6 | 1250V SQB1 450A | 20 760 31.450 | 20 713 31.450 | 20 719 31.450 |
| MP470A5 MP470A6 | 2 x 1250V SQB3 350A in parallel. | 20 780 31.350 | 20 733 31.350 | 20 739 31.350 |
| MP350A5R MP350A6R | 1250V SQB1 450A | 20 760 31.450 | 20 713 31.450 | 20 719 31.450 |
| MP470A5R MP470A6R | 2 x 1250V SQB3 350A in parallel. | 20 780 31.350 | 20 733 31.350 | 20 739 31.350 |
| MP700A4 | 690V SQB1 900A | 20 660 31.900 | 20 610 31.900 | 20 617 31.900 |
| MP825A4 | 2 x 690V SQB2 630A in parallel. | 20 670 31.630 | 20 620 31.630 | 20 627 31.630 |
| MP900A4 | 690V SQB2-2 1250A | 20 678 32.1250 | | |
| MP700A4R | 690V SQB1 900A | 20 660 31.900 | 20 610 31.900 | 20 617 31.900 |
| MP825A4R | 2 x 690V SQB2 630A in parallel. | 20 670 31.630 | 20 620 31.630 | 20 627 31.630 |
| MP900A4R | 690V SQB2-2 1250A | 20 678 32.1250 | | |
| MP700A5 MP700A6 | *1250V SQB3 900A | 20 780 31.900 | 20 733 31.900 | 20 739 31.900 |
| MP825A5 MP825A6 | 1250V SQB2 800A | *20 770 31.800 | *20 723 31.800 | *20 729 31.800 |
| MP700A5R MP700A6R | 1250V SQB3 900A | 20 780 31.900 | 20 733 31.900 | 20 739 31.900 |
| MP825A5R MP825A6R | *1250V SQB2 800A | *20 770 31.800 | *20 723 31.800 | *20 729 31.800 |
| MP1200A4 | 690V SQB2-2 1600A | 20 678 32.1600 | | |
| MP1850A4 | *690V SQB3-2 1800A | *20 688 32.1800 | | |
| MP1200A5 MP1200A6 | 2 x 1250V SQB3-2 900A in parallel. | 20 788 32.900 | | |
| MP1850A5 MP1850A6 | **2 x 1250V SQB3-2 900A in parallel. | **20 788 32.900 | | |
| MP1200A4R | 690V SQB2-2 1600A | 20 678 32.1600 | | |
| MP1850A4R | *690V SQB3-2 1800A | *20 688 32.1800 | | |
| MP1200A5R MP1200A6R | 2 x 1250V SQB3-2 900A in parallel. | 20 788 32.900 | | |
| MP1850A5R MP1850A6R | **2 x 1250V SQB3-2 900A in parallel. | **20 788 32.900 | | |

NOTE

*Applications limited to 100% current ripple content and no cyclic overloads to avoid fuse wear-out.

**Applications limited to 30% current ripple content and no cyclic overloads to avoid fuse wear-out.

Table 12-35 Siba branch circuit fusing for size 2 drives

| Model | International | |
|--|----------------------------------|----------------|
| | Description | Part number |
| Aux | *500Vac, 20A gG NH-Knife Blade | 20 000 13.20 |
| | 690Vac, 20A gG NH-Knife Blade | 20 477 13.20 |
| MP350A4(R) | *500Vac, 355A gG NH-knife blade | 20 004 13.355 |
| | 690Vac, 355A gG NH-knife blade | 20 212 13.355 |
| MP350A5(R) MP350A6(R) | 690Vac, 355A gG NH-knife blade | 20 212 13.355 |
| MP420A4(R) | *500Vac, 400A gG NH-knife blade | 20 004 13.400 |
| | 690Vac, 400A gG NH-knife blade | 20 212 13.400 |
| MP470A5(R) MP470A6(R) | 690Vac, 630A gG NH-knife blade | 20 225 13.630 |
| MP550A4(R) | 690Vac, 630A gG NH-knife blade | 20 225 13.630 |
| MP700A4(R) | *500Vac, 800A gG NH-knife blade | 20 006 13.800 |
| | 690Vac, 800A gG NH-knife blade | 20 225 13.800 |
| MP700A5(R) MP700A6(R) | 690Vac, 800A gG NH-knife blade | 20 225 13.800 |
| MP825A4(R) MP825A5(R) MP825A6(R) | 690Vac, 800A gG NH-knife blade | 20 225 13.800 |
| MP900A4(R) | *500Vac, 1250A gG NH-knife blade | 20 006 13.1250 |
| MP1200A4(R) | *500Vac, 1250A gG NH-knife blade | 20 006 13.1250 |

NOTE

Fuses are only rated up to 500Vac.

Table 12-36 Siba DC protection fusing for size 2 drives

| Model | Description | International | | USA | |
|----------------------------------|----------------------------------|----------------|---------------|---------------|---------------|
| | | Part number | | | |
| | | Metric thread | Blade contact | UNC thread | Blade contact |
| MP350A4R | 2 x SQB3 1250V 315A in parallel. | 2078132.315A. | 2073532.315A | 2078432.315A | 2073932.315A |
| MP350A5R MP350A6R | SQB3 1250V 400A | *2078132.400A. | *2073532.400A | *2078432.400A | *2073932.400A |
| MP420A4R | SQB3 1250V 500A | *2078132.500A | *2073532.500A | *2078432.500A | *2073932.500A |
| MP470A5R MP470A6R | 2 x SQB3 1250V 315A in parallel. | *2078132.315A. | *2073532.315A | *2078432.315A | *2073932.315A |
| MP550A4R | 2 x SQB3 1250V 315A in parallel. | *2078132.315A. | *2073532.315A | *2078432.315A | *2073932.315A |
| MP700A4R | 2 x SQB3 1250V 500A in parallel. | 2078132.500A | 2073532.500A | 2078432.500A | 2073932.500A |
| MP700A5R MP700A6R | 2 x SQB3 1250V 450A in parallel. | *2078132.450A | *2073532.450A | *2078432.450A | *2073932.450A |
| MP825A4R MP825A5R MP825A6R | 2 x SQB3 1250V 500A in parallel. | *2078132.500A | *2073532.500A | *2078432.500A | *2073932.500A |
| MP900A4R | 2 x SQB3 1250V 500A in parallel. | *2078132.500A | *2073532.500A | *2078432.500A | *2073932.500A |

NOTE

DC fusing is only required on four quadrant (R) drives.

* Applications limited to 100% current ripple content and no cyclic overloads to avoid fuse wear-out

Table 12-37 Mentor MP size 1 drive thyristor I²t ratings for semiconductor fusing

| Model | | Thyristor I ² t (A ² s) |
|------------|------------|---|
| Auxiliary | | 400 |
| MP25A4 | MP25A5 | 1030 |
| MP45A4 | MP45A5 | 3600 |
| MP75A4 | MP75A5 | 15000 |
| MP25A4(R) | MP25A5(R) | 1030 |
| MP45A4(R) | MP45A5(R) | 3600 |
| MP75A4(R) | MP75A5(R) | 15000 |
| MP105A4 | MP105A5 | 80000 |
| MP155A4 | MP155A5 | |
| MP210A4 | MP210A5 | |
| MP105A4(R) | MP105A5(R) | |
| MP155A4(R) | MP155A5(R) | |
| MP210A4(R) | MP210A5(R) | |

Table 12-38 Mentor MP size 2 drive thyristor I²t ratings for semiconductor fusing

| Model | | | Thyristor I ² t (A ² s) |
|-------------|-------------|-------------|---|
| Auxiliary | | | 400 |
| MP350A4(R) | MP420A4(R) | MP550A4(R) | 320000 |
| MP350A6(R) | MP470A5(R) | MP470A6(R) | 281000 |
| MP700A4(R) | MP825A4(R) | MP900A4(R) | 1050000 |
| MP700A6(R) | MP825A5(R) | MP825A6(R) | 1200000 |
| MP1200A4(R) | MP1200A5(R) | MP1200A6(R) | 2720000 |
| MP1850A4(R) | MP1850A5(R) | MP1850A6(R) | |

12.2.3 Torque settings

Table 12-39 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 12-40 Drive auxiliary and machine armature terminal data

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

Table 12-41 Drive power stage terminals

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

Table 12-42 Drive power stage terminals on size 2 drives

| Model | Connection type | Torque setting |
|---------|-----------------|---------------------|
| Size 2A | M10 stud | 15 Nm (11.06 lb ft) |
| Size 2B | M12 stud | 30 Nm (22.12 lb ft) |
| Size 2C | | |
| Size 2D | | |

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 12-43 Immunity compliance

| Standard | Type of immunity | Test specification | Application | Level |
|------------------------------------|--|---|---|----------------------------|
| IEC 61000-4-2 EN 61000-4-2 | Electrostatic discharge | 6kV contact discharge 8kV air discharge | Module enclosure | Level 3 (industrial) |
| IEC 61000-4-3 EN 61000-4-3 | Radio frequency radiated field | 10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation | Module enclosure | Level 3 (industrial) |
| IEC 61000-4-4 EN 61000-4-4 | 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) |
| IEC 61000-4-5 EN 61000-4-5 | 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 ¹ | Level 2 |
| IEC 61000-4-6 EN 61000-4-6 | Conducted radio frequency | 10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation | Control and power lines | Level 3 (industrial) |
| IEC 61000-4-11 EN 61000-4-11 | Voltage dips and interruptions | -30% 10ms +60% 100ms -60% 1s <-95% 5s | AC power ports | |
| EN 61000-6-1:2007 IEC 61000-6-1 | Generic immunity standard for the residential, commercial and light - industrial environment | | | Complies |
| IEC 61000-6-2 EN 61000-6-2:2005 | Generic immunity standard for the industrial environment | | | Complies |
| IEC 61800-3 EN 61800-3:2004 | Product standard for adjustable speed power drive systems (immunity requirements) | | Meets immunity requirements for first and second environments | |

¹ See section 4.9.4 *Surge immunity of control circuits - long cables and connections outside a building* on page 47 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 12-44 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) | | | |
| MP350A4(R) | | | |
| MP420A4(R) | | | |
| MP550A4(R) | | | |
| MP700A4(R) | | | |
| MP825A4(R) | | | |
| MP900A4(R) | | | |
| MP1200A4(R) | | | |
| MP1850A4(R) | | | |

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

- C4 EN 61800-3:2004 second environment, restricted distribution (Additional measures may be required to prevent interference)
- C3 EN 61800-3:2004 second environment, unrestricted distribution
- C2 Industrial generic standard EN 61000-6-4:2007
EN 61800-3:2004 first environment restricted distribution (The following caution is required by EN 61800-3:2004)

| | |
|---|--|
|  | <p>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.</p> |
|---|--|

- C1 Residential generic standard EN 61000-6-3:2007
EN 61800-3:2004 first environment unrestricted distribution

EN 61800-3:2004 defines the following:

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

12.3 Optional external EMC filters

EMC filters can be sourced directly from Schaffner and Epcos. See Table 12-45 for details.


| | |
|--|---|
|  CAUTION | <p>It is essential that line reactors be connected between the filter terminals and the power input terminals, as shown in Figure 4-1. Failure to observe this requirement could result in destruction of the thyristors.</p> |
|--|---|

Table 12-45 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-T1262D004 |
| MP45A4(R) | | | *B84143-A90-R105 | | |
| MP75A4(R) | | | | | |
| MP105A4(R) | FN3270H-200-99 | FN3258H-180-40 | B84143BO250S080 | FN3280H-25-33 | |
| MP155A4(R) | | | | | |
| MP210A4(R) | | | | | |
| MP350A4 (R) | | | | | |
| MP420A4 (R) | | | | | |
| MP550A4 (R) | | | | | |
| MP700A4 (R) | FN3359-800-99 | | | | |
| MP825A4(R) | | | | | |
| MP900A4 (R) | | | | | |
| MP1200A4 (R) | | | | | |
| MP1850A4 (R) | | FN3359-1600-99 | | | |

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

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 LEROY-SOMER.

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.

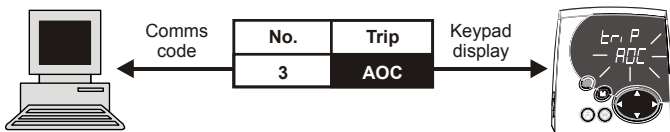
Trips are listed alphabetically in Table 13-1 based on the trip indication shown on the drive display. Refer to Figure 13-1.

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*.

Figure 13-1 Keypad status modes

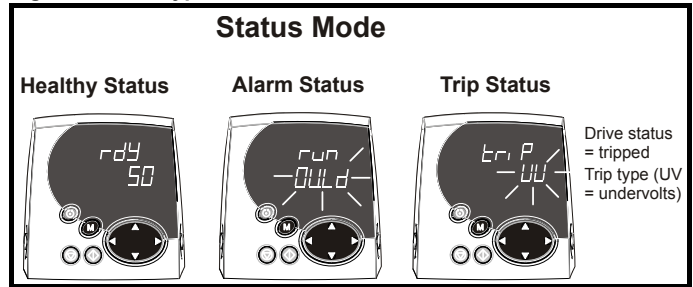


Figure 13-2 Location of the status LED

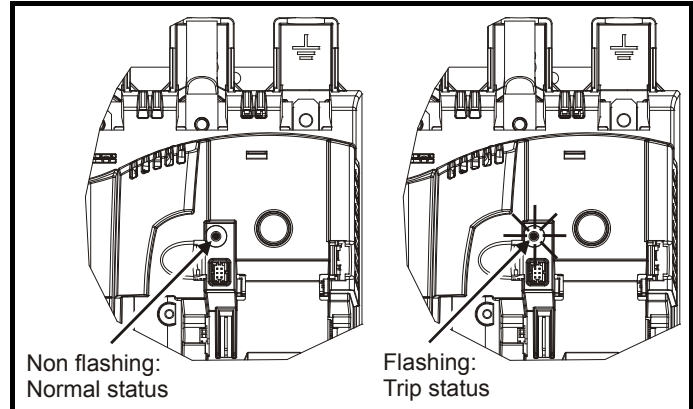



Table 13-1 Trip indications

| Trip | Diagnosis |
|---------------|--|
| AOC | Instantaneous output over current detected: Peak current greater than 225% |
| 3 | Check for short circuit on armature cabling Check integrity of motor insulation Check current loop stability |
| AOP | Voltage has been applied to the armature but no current feedback has been detected |
| 158 | Check the armature circuit |
| C.Acc | SMARTCARD trip: SMARTCARD Read / Write fail |
| 185 | Check SMARTCARD is installed / located correctly Ensure SMARTCARD is not writing data to data location 500 to 999 Replace SMARTCARD |
| C.boot | SMARTCARD trip: The menu 0 parameter modification cannot be saved to the SMARTCARD because the necessary file has not been created on the SMARTCARD |
| 177 | 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 |
| C.bUSY | SMARTCARD trip: SMARTCARD can not perform the required function as it is being accessed by a Solutions Module |
| 178 | Wait for the Solutions Module to finish accessing the SMARTCARD and then re-attempt the required function |
| C.Chg | SMARTCARD trip: Data location already contains data |
| 179 | Erase data in data location Write data to an alternative data location |
| C.cPr | SMARTCARD trip: The values stored in the drive and the values in the data block on the SMARTCARD are different |
| 188 | Press the red reset button |

| Trip | Diagnosis |
|---------------|---|
| C.dAt | SMARTCARD trip: Data location specified does not contain any data |
| 183 | Ensure data block number is correct |
| C.Err | SMARTCARD trip: SMARTCARD data is corrupted |
| 182 | Ensure the card is located correctly Erase data and retry Replace SMARTCARD |
| C.Full | SMARTCARD trip: SMARTCARD full |
| 184 | Delete a data block or use different SMARTCARD |
| cL2 | Analog input 2 current loss (current mode) |
| 28 | Check analog input 2 (terminal 7) current signal is present (4-20mA, 20-4mA) |
| cL3 | Analog input 3 current loss (current mode) |
| 29 | Check analog input 3 (terminal 8) current signal is present (4-20mA, 20-4mA) |
| CL.bit | Trip initiated from the control word (Pr 6.42) |
| 35 | Disable the control word by setting Pr 6.43 to 0 or check setting of Pr 6.42 |
| C.OPtn | SMARTCARD trip: Solutions Modules installed are different between source drive and destination drive |
| 180 | Ensure correct Solutions Modules are installed Ensure Solutions Modules are in the same Solutions Module slot Press the red  reset button |
| C.Prod | SMARTCARD trip: The data blocks on the SMARTCARD are not compatible with this product |
| 175 | Erase all data on the SMARTCARD by setting Pr xx.00 to 9999 and pressing the red  reset button Replace SMARTCARD |
| C.rdo | SMARTCARD trip: SMARTCARD has the Read Only bit set |
| 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 |
| C.rtg | SMARTCARD trip: The voltage and/or current rating of the source and destination drives are different |
| 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 Solution 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. |
| C.TyP | SMARTCARD trip: SMARTCARD parameter set not compatible with drive |
| 187 | Press the reset button Ensure destination drive type is the same as the source parameter file drive type |
| dESt | Two or more parameters are writing to the same destination parameter |
| 199 | Set Pr xx.00 = 2001 check all visible parameters in the menus for duplication |
| EEF | EEPROM data corrupted - Drive mode becomes open loop and serial comms will timeout with remote keypad on the drive RS485 comms port. |
| 31 | This trip can only be cleared by loading default parameters and saving parameters |
| EnC1 | Drive encoder trip: Encoder power supply overload |
| 189 | Check encoder power supply wiring and encoder current requirement Maximum current = 200mA @ 15V, or 300mA @ 8V and 5V |
| EnC2 | Drive encoder trip: Wire break |
| 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 |
| EnC3 | Drive encoder trip: Overload |
| 191 | Overload |
| EnC9 | Drive encoder trip: Position feedback is selected from a Solutions Module slot which does not have a speed / position feedback Solutions Module installed |
| 197 | Check setting of Pr 3.26 (Fb01, 0.71) (or Pr 21.21 if the second motor parameters have been enabled) |
| EnC10 | Drive encoder trip: Termination overload |

| Trip | Diagnosis |
|--------------|--|
| 198 | If the voltage from the encoder is >5V, then the termination resistors must be disabled (Pr 3.39 to 0) |
| Et | External trip |
| 6 | Check terminal 31 signal Check value of Pr 10.32 Enter 12001 in Pr xx.00 and check for parameter controlling Pr 10.32 Ensure Pr 10.32 or Pr 10.38 (=6) are not being controlled by serial comms |
| FbL | No feedback from the tachogenerator or encoder |
| 159 | If the difference between the estimated speed (Pr 5.04) and the actual speed feedback (Pr 3.02 (di05, 0.40)) exceeds the value set in the speed feedback loss window (Pr 3.56) the drive will trip Feedback loss. With fast acceleration rates in applications with low load inertia estimated speed (Pr 5.04) may not track the actual speed feedback (Pr 3.02 (di05, 0.40)) fast enough and the speed feedback loss window (Pr 3.56) may need to be increased. 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 |
| Fbr | The polarity of the feedback tachogenerator or encoder is incorrect |
| 160 | Check that the feedback devices are connected correctly |
| FdL | No current in the field supply circuit |
| 168 | Check that the field controller (Pr 5.77 (SE12, 0.33)) is enabled. For the internal field controller check terminals L11, L12 are closed Check internal auxiliary fuses, refer to section 4.6.3 <i>Internal field fuses</i> on page 44. |
| FOC | Excess current detected in field current feedback |
| 169 | Maximum current feedback is present Check Field rated current (Pr 5.70 (SE10, 0.31)) and Field rated voltage (Pr 5.73 (SE11, 0.32)) are set correct to motor nameplate Check for short circuit on field circuit cabling Check integrity of motor insulation |
| F.OVL | Field I²t overload |
| 157 | See Pr 5.81 and Pr 5.82 |
| HF01 | Data processing error: CPU address error |
| | Hardware fault - return drive to supplier |
| HF02 | Data processing error: DMAC address error |
| | Hardware fault - return drive to supplier |
| HF03 | Data processing error: Illegal instruction |
| | Hardware fault - return drive to supplier |
| HF04 | Data processing error: Illegal slot instruction |
| | Hardware fault - return drive to supplier |
| HF05 | Data processing error: Undefined exception |
| | Hardware fault - return drive to supplier |
| HF06 | Data processing error: Reserved exception |
| | Hardware fault - return drive to supplier |
| HF07 | Data processing error: Watchdog failure |
| | Hardware fault - return drive to supplier |
| HF08 | Data processing error: Level 4 crash |
| | Hardware fault - return drive to supplier |
| HF09 | Data processing error: Heap overflow |
| | Hardware fault - return drive to supplier |
| HF10 | Data processing error: Router error |
| | Hardware fault - return drive to supplier |
| HF11 | Data processing error: Access to EEPROM failed |
| | Hardware fault - return drive to supplier |
| HF12 | Data processing error: Main program stack overflow |
| | Hardware fault - return drive to supplier |

| Trip | Diagnosis |
|----------------|---|
| HF17 | Data processing error: No Comms from power processor |
| 217 | Hardware fault - return drive to supplier |
| HF18 | Bucket suppressor capacitor failure |
| 218 | Hardware fault - return drive to supplier |
| HF19 | Overheat on bucket suppressor or snubber circuits |
| 219 | Check internal fan operation |
| HF20 | Power stage recognition: identification code error |
| 220 | Hardware fault - return drive to supplier |
| HF21 | Power processor: Watchdog failure |
| 221 | Hardware fault - return drive to supplier |
| HF22 | Power processor: Undefined exception |
| 222 | Hardware fault - return drive to supplier |
| HF23 | Power processor: Level overrun |
| 223 | Hardware fault - return drive to supplier |
| HF27 | Power circuit: Thermistor 1 fault |
| 227 | Hardware fault - return drive to supplier |
| HF28 | Power software not compatible with user software |
| 228 | Hardware fault - return drive to supplier |
| HF29 | User processor: Armature timing error |
| 229 | Hardware fault - return drive to supplier |
| It.AC | I^2t on drive output current (Refer to Pr 4.16) |
| 20 | Ensure the load is not jammed / sticking Check the load on the motor has not changed |
| O.ht1 | Drive overheat (thyristor junction) based on thermal model |
| 21 | Reduce ambient temperature Reduce overload cycle |
| O.ht2 | Heatsink over temperature |
| 22 | 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 |
| O.ht3 | External discharge resistor over temperature |
| 27 | 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 |
| O.Ld1 | Digital output overload: total current drawn from 24V supply and digital outputs exceeds 200mA |
| 26 | Check total load on digital outputs (terminals 24,25,26)and +24V rail (terminal 22) |
| O.SPd | Motor speed has exceeded the over speed threshold |
| 7 | The drive will trip O.SPd if the armature is open circuit when the drive is in estimated speed mode. Check armature circuit 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. |
| PAAd | Keypad has been removed when the drive is receiving the speed reference from the keypad |
| 34 | Install keypad and reset Change speed reference selector to select speed reference from another source |
| PLL Err | Phase Lock Loop cannot lock to the auxiliary supply |
| 174 | Check auxiliary supply is stable |

| Trip | Diagnosis |
|--------------------|---|
| PS | Internal power supply fault |
| 5 | Remove any Solutions Modules and reset Hardware fault - return drive to supplier |
| PS.10V | 10V user power supply current greater than 10mA |
| 8 | Check wiring to terminal 4 Reduce load on terminal 4 |
| PS.24V | 24V internal power supply overload |
| 9 | 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"> Reduce load and reset Provide an external 24V >50W power supply Remove any Solutions Modules and reset |
| PSAVE.Er | Power down save parameters in the EEPROM are corrupt |
| 37 | 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 xx.00 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. |
| SAVE.Er | User save parameters in the EEPROM are corrupt |
| 36 | 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 xx.00 to SAVE and reset the drive) to ensure this trip does or occur the next time the drive is powered up. |
| SCL | Drive RS485 serial comms loss to remote keypad |
| 30 | Reinstall the cable between the drive and keypad Check cable for damage Replace cable Replace keypad |
| SL | AC input phase loss |
| 170 | Ensure all three thyristor bridge supply phases are present Check input voltage levels are correct (at full load) |
| SLX.dF | Solutions Module slot X trip: Solutions Module type installed in slot X changed |
| 204,209,214 | Save parameters and reset |
| SLX.Er | Solutions Module slot X trip: Solutions Module in slot X has detected a fault |
| 202,207,212 | Feedback module category See the <i>Diagnostics</i> section in the relevant Solutions Module User Guide for more information. |
| SLX.HF | Solutions Module slot X trip: Solutions Module X hardware fault |
| 200,205,210 | Ensure Solutions Module is installed correctly Return Solutions Module to supplier |
| SLX.nF | Solutions Module slot X trip: Solutions Module has been removed |
| 203,208,213 | Ensure Solutions Module is installed correctly Reinstall Solutions Module Save parameters and reset drive |
| SL.rtd | Solutions Module trip: Drive mode has changed and Solutions Module parameter routing is now incorrect |
| 215 | Press reset. If the trip persists, contact the supplier of the drive. |
| SLX.tO | Solutions Module slot X trip: Solutions Module watchdog timeout |
| 201,206,211 | Press reset. If the trip persists, contact the supplier of the drive. |
| S.Old | The maximum power the over voltage suppressor can handle has been exceeded |
| 171 | Check the recommended line reactors are installed Check the recommended external suppressor resistor is installed |
| S.OV | Excessive suppressor voltage |
| 172 | Operation of the drive requires the installation of the external suppressor resistance, see section 4.7 <i>External suppressor resistor</i> on page 44. |

| Trip | Diagnosis |
|---------------------|---|
| t002 | Reserved |
| 2 | A value of 2 is being written to user trip (Pr 10.38). 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. |
| t004 | Reserved |
| 4 | See diagnosis for t002 |
| t010 | Reserved |
| 10 | See diagnosis for t002 |
| t019 | Reserved |
| 19 | See diagnosis for t002 |
| t023 | User trip |
| 23 | 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 10.38) |
| t032 | Reserved |
| 32 | See diagnosis for t002 |
| t032 to t033 | Reserved |
| 32 to 33 | See diagnosis for t002 |
| t038 to t039 | Reserved |
| 38 to 39 | See diagnosis for t002 |
| t040 to t089 | User trip |
| 40 to 89 | See diagnosis for t023 |
| t099 | User trip defined in 2nd processor Solutions Module code |
| 99 | 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 10.38) |
| t101 | User trip |
| 101 | See diagnosis for t023 |
| t102 to t111 | Reserved |
| 102 to 111 | See diagnosis for t002 |
| t112 to t156 | User trip |
| 112 to 156 | See diagnosis for t023 |
| t161 to t167 | Reserved |
| 161 to 167 | See diagnosis for t002 |
| t176 | Reserved |
| 176 | See diagnosis for t002 |
| t192 to t196 | Reserved |
| 192 to 196 | See diagnosis for t002 |
| t216 | User trip |
| 216 | See diagnosis for t023 |
| th | Motor thermistor trip |
| 24 | Check motor temperature Check thermistor continuity Set Pr 7.15 (in01, 0.81) = VOLT and reset the drive to disable this function |
| th.Err | Missing thyristor |
| 173 | Hardware fault - return drive to supplier |
| thS | Motor thermistor short circuit |
| 25 | Check motor thermistor wiring Replace motor / motor thermistor Set Pr 7.15 (in01, 0.81) = VOLT and reset the drive to disable this function |
| tunE | Autotune stopped before completion |
| 18 | The drive has tripped out during the autotune The red stop key has been pressed during the autotune |
| tunE1* | The position feedback did not change or required speed could not be reached during the inertia test (see Pr 5.12 (SE13, 0.34)) |

| Trip | Diagnosis |
|----------------|--|
| 11 | 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 |
| tunE2* | Position feedback direction incorrect or motor could not be stopped during the inertia test (See Pr 5.12 (SE13, 0.34)) |
| 12 | Check motor cable wiring is correct Check feedback device wiring is correct |
| tunE3* | Field flux has not decayed to zero during autotune |
| 13 | Contact the supplier of the drive |
| tunE4* | Back emf detected during autotune |
| 14 | Check that the motor is not spinning when a static autotune is carried out |
| tunE5* | No field current detected during autotune |
| 15 | Reset Pr 5.70 (SE10, 0.31) to nameplate value and re-autotune motor |
| tunE6* | Cannot achieve ¼ rated back emf during autotune |
| 16 | Reset Pr 5.70 (SE10, 0.31) to nameplate value and re-autotune motor |
| tunE7* | Rotating autotune initiated with Estimated speed selected |
| 17 | Connect a feedback device to carry out a rotating autotune |
| UP ACC | Onboard PLC program: cannot access Onboard PLC program file on drive |
| 98 | 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 |
| UP div0 | Onboard PLC program attempted divide by zero |
| 90 | Check program |
| UP OFL | Onboard PLC program variables and function block calls using more than the allowed RAM space (stack overflow) |
| 95 | Check program |
| UP ovr | Onboard PLC program attempted out of range parameter write |
| 94 | Check program |
| UP PAr | Onboard PLC program attempted access to a non-existent parameter |
| 91 | Check program |
| UP ro | Onboard PLC program attempted write to a read-only parameter |
| 92 | Check program |
| UP So | Onboard PLC program attempted read of a write-only parameter |
| 93 | Check program |
| UP udF | Onboard PLC program un-defined trip |
| 97 | Check program |
| UP uSEr | Onboard PLC program requested a trip |
| 96 | Check program |
| UV | The drive is running from the external 24V supply |
| 1 | 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 | UV | 91 | UP Par | 189 | Enc1 |
| 2 | t002 | 92 | UP ro | 190 | Enc2 |
| 3 | AOC | 93 | UP So | 191 | Enc3 |
| 4 | t004 | 94 | UP ovr | 192-196 | t192 - t196 |
| 5 | PS | 95 | UP OFL | 197 | Enc9 |
| 6 | Et | 96 | UP uSEr | 198 | Enc10 |
| 7 | O.SPd | 97 | UP udf | 199 | dESt |
| 8 | PS.10V | 98 | UP ACC | 200 | SL1.HF |
| 9 | PS.24V | 99 | t099 | 201 | SL1.tO |
| 10 | t010 | 100 | | 202 | SL1.Er |
| 11 | tunE1 | 101 | t101 | 203 | SL1.nF |
| 12 | tunE2 | 102-111 | t102 - t111 | 204 | SL1.dF |
| 13 | tunE3 | 112-156 | t112 - t156 | 205 | SL2.HF |
| 14 | tunE4 | 157 | F.OVL | 206 | SL2.tO |
| 15 | tunE5 | 158 | AOP | 207 | SL2.Er |
| 16 | tunE6 | 159 | FbL | 208 | SL2.nF |
| 17 | tunE7 | 160 | Fbr | 209 | SL2.dF |
| 18 | tunE | 161-167 | t161 - t167 | 210 | SL3.HF |
| 19 | t019 | 168 | FdL | 211 | SL3.tO |
| 20 | It.AC | 169 | FOC | 212 | SL3.Er |
| 21 | O.ht1 | 170 | SL | 213 | SL3.nF |
| 22 | O.ht2 | 171 | S.Old | 214 | SL3.dF |
| 23 | t023 | 172 | S.OV | 215 | SL.rtd |
| 24 | th | 173 | th.Err | 216 | t216 |
| 25 | thS | 174 | PLL Err | 217-229 | HF17 – HF29 |
| 26 | O.Ld1 | 175 | C.Prod | | |
| 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 | | |
| 90 | UP div0 | 188 | C.cpr | | |

13.2 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 HF29, 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 | Enc1, Enc2 | These trips can only override the following priority 5 trips: Enc2, Enc9 or Enc10 |
| 5 | Normal trips | All other trips not included in this table | Can be reset after 1.0s |
| 6 | Self resetting trips | UV | 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.

13.3 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 |
|-----------------|--|
| Hot | Heatsink alarm is active |
| | The temperature displayed in Pr 7.04 has exceeded the alarm level (see Pr 7.04). |
| OVLd | Motor overload |
| | The motor I ² 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)). |
| Autotune | Autotune in progress |
| | The autotune procedure has been initialised. 'Auto' and 'tunE' will flash alternatively on the display. |
| CLt | Current limit is active |
| | Indicates that current limits are active. |
| PLC | Onboard PLC program is running |
| | An Onboard PLC program is installed and running. The lower display will flash 'PLC' once every 10s. |
| S.OV | Indicated suppressor over voltage |
| | Indicates that the over voltage suppressor voltage is within 30V of the trip level |
| S.rS | Suppressor resistor overload |
| | Indicates that the external voltage suppressor resistor is in an overload condition |
| Est SPd | Estimated speed selected |
| | The drive has lost speed feedback and automatically selected Estimated speed mode. See Pr 3.55 (Select estimated speed on feedback loss). |

13.4 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 | Inh bited | 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. | |

13.5 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 |

13.6 Behavior 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 UV) 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 |
| | 1.02 | Pre-skip filter reference | |
| 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 |
| | 3.03 | Speed error | |
| 0.41 | 3.04 | Speed controller output | di06 |
| 0.43 | 4.01 | Current magnitude | di08 |
| | 5.01 | Armature firing angle | |
| 0.45 | 5.02 | Armature voltage | di10 |
| | 5.03 | Output power | |
| | 5.04 | Estimated speed | |
| | 5.05 | Line voltage | |
| | 5.58 | Field firing angle | |
| 0.82 | 7.01 | Analog input 1 | in02 |
| 0.83 | 7.02 | Analog input 2 | in03 |
| 0.84 | 7.03 | Analog input 3 | in04 |
| | 10.77 | Input frequency | |

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.

13.7 Trip masking

Drive trips can be masked by setting the appropriate trip code in Pr 10.52 to Pr 10.61. Refer to Pr 10.52 to Pr 10.72 (Advanced parameter descriptions chapter - Menu 10) in the *Mentor MP Advanced User Guide* for further information.

14 UL information

Mentor MP frame size 1 drives have been assessed to comply with both ULus and cUL requirements.

14.1 Common UL Information

Conformity: The drive conforms to UL listing requirements only when the following are observed:

1. The drive is installed in a type 1 enclosure, or better as defined in UL 50.
2. The ambient temperature does not exceed 40°C when the drive is operating.
3. The terminal torques specified in section 3.9.3 *Torque settings* on page 30 are to be used.
4. The power terminal lug used to crimp the, I/P & O/P cables are to be UL listed.
5. The drive is to be installed in to a pollution degree 2 environment.
6. If the drive control stage is supplied by an external power supply, (+24V), the external power supply must be a UL class 2 power supply.
7. Fuses sized as specified in the various tables in Chapter 4 *Electrical installation* on page 32 are to be used. Fusing is to incorporate a Class J fuse in line with a semiconductor fuse as specified.
8. Field wiring is to be class 1 75°C (167°F) copper wire only.

Motor overload protection

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

The protection level is adjustable, and the method of adjustment is provided with the instructions for the product.

Maximum current overload is dependant on the values entered into the current limit parameters (motoring current limit, regen current limit and symmetrical current limit entered as percentage) and the motor rated current parameter (entered in amperes).

The duration of the overload is dependant on motor thermal time constant (variable up to a maximum of 3000 seconds). The default overload protection is set such that the product is capable of 150% of the current value entered into the motor rated current parameter (Pr **5.07 (SE07, 0.28)**) for 30 seconds (20 seconds for MP470A4(R), MP470A5(R), MP825A5(R) and MP825A6(R)). The product also provides user terminal default functionality such that the product can be connected to a motor thermistor to protect the motor in terms of temperature, in the event of a motor cooling fan failure.

Over speed protection

The drive provides overspeed protection. However it does not provide the level of protection afforded by an independent high integrity overspeed protection device.

14.2 AC supply specification

The maximum UL supply voltage is 600Vac.

The drive is suitable for use in a circuit capable of delivering not more than 100,000rms symmetrical Amperes at 575V (size 1A and 1B).

14.3 Maximum continuous output current

The drive models are listed as having the maximum continuous output currents (FLC) shown in section 2.1 *Ratings* on page 6.

14.4 Safety label

The safety label supplied with connectors and mounting brackets must be placed on a fixed part of the drive enclosure where it can be seen clearly by maintenance personnel for UL compliance.

The label clearly states "CAUTION risk of electric shock power down at least 10 minutes before removing cover".

14.5 UL Listed accessories

- SM-Keypad
- SM-DeviceNet
- SM-INTERBUS
- SM-Ethernet
- SM-Register
- SM-Applications Plus
- SM-Encoder Plus
- SM-I/O Plus
- SM-I/O Lite
- SM-I/O PELV
- SM-I/O 24V Protected
- Single ended encoder interface
- MP-Keypad
- SM-PROFIBUS-DP-V1
- SM-CANopen
- SM-EtherCAT
- SM-Applications Lite-V2
- SM-Universal Encoder Plus
- SM-Encoder Output Plus
- SM-I/O 32
- SM-I/O Timer
- SM-I/O 120V
- 15-way D-type converter

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MOTEURS LEROY-SOMER 16015 ANGOULÊME CEDEX - FRANCE

338 567 258 RCS Angoulême
Simplified Joint Stock Company with capital of 62,779,000 €

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