



All for dreams



User Guide

M'Ax

Compact, high-performance,
single-axis servo amplifier for
brushless AC servo motors

Part Number: 0453-0015-08

Issue: 8

Original Instructions

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

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Registered Office

Nidec Control Techniques Ltd

The Gro

Newtown

Powys

SY16 3BE

UK

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1 Introduction

1.1 Important information about this User Guide and the Installation Guide



Variable speed drives may be hazardous if misused. Carefully follow the instructions in this User Guide, and especially those in Chapter 1 *Safety Information* in the Installation Guide.

Read this User Guide *before* starting the installation or the setting up process.

This User Guide is arranged on a step-by-step basis to lead you through the following:

- When to refer to the Installation Guide
- Making signal and data connections
- Learning how to operate the drive
- Setting up the drive for the majority of applications

When a motion controller is used for controlling the **M'Ax** (drive), this User Guide does not contain all the information required for setting up the drive. In this case, refer to this User Guide in conjunction with the instruction manual(s) for the motion controller. This is necessary not only for setting up the drive and servo system, but also for ensuring the user is made aware of all the related safety issues.

For advanced programming of the drive, refer to the *M'Ax Advanced User Guide*.

1.2 Models and versions of the drive

The **M'Ax** is a range of high-performance single-axis servo amplifiers for controlling permanent-magnet brushless motors that are installed with a Control Techniques Speed Loop Module (**SLM**).

Each model in the **M'Ax** range can be supplied in either of two versions, each possessing a variation in functionality specific to a particular type of application. The version code is a suffix to the model number. See Table 1.1 and Table 1.2 .

Table 1.1 Model sizes, model numbers and current ratings

Model size	Model	Output current	
		Maximum continuous	Maximum overload (2s max.)
	M'Ax 403	3.5 A	7.0 A
	M'Ax 406	6.5 A	13.0 A
	M'Ax 409	9.5 A	19 A
	M'Ax 412	12.5 A	25 A

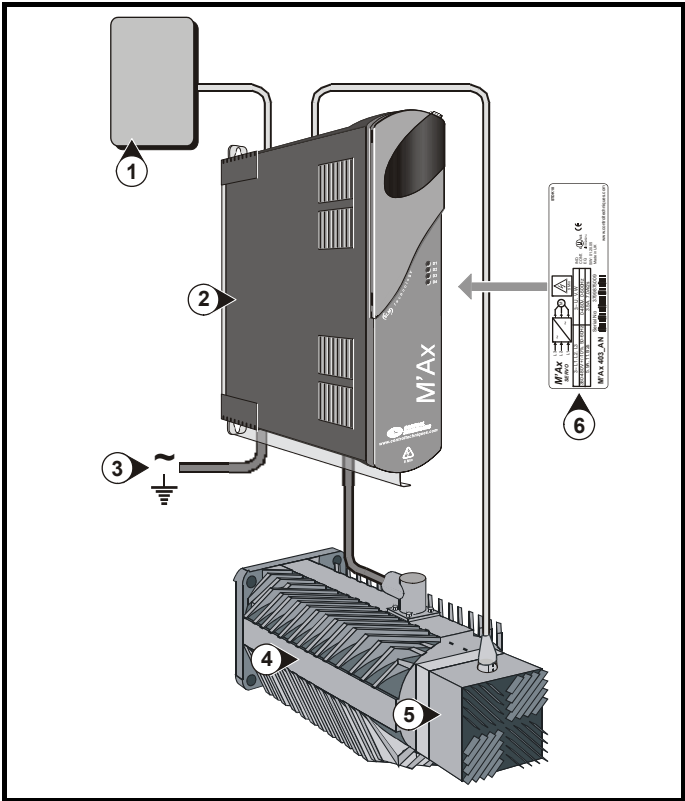
Table 1.2 Versions

Suffix	Functionality
_SL (e.g. M'Ax 403_SL)	Standard-precision analog input No display and keypad (defaulted to operate in external host mode)
_AN (e.g. M'Ax 403_AN)	High-precision analog input Display and keypad (defaulted to operate in standalone mode with high precision analog input)

1.3 Familiarizing yourself with the drive before installing it

If this is your first encounter with the M'Ax, you may wish to try it out in a convenient environment before installing it. From this, you can learn how to set up and control it. Appropriate guidance is given later in this User Guide.

Figure 1-1 The M'Ax in a basic single-axis servo system



1. Controls and monitoring
2. **M'Ax** installed with ground bar
3. AC supply
4. Motor
5. **SLM**
6. Rating label

1.4 Methods of control

Each version can be operated as a standalone unit where all the control functions take place in the drive (host mode); each version is supplied configured for this form of control. Alternatively, a drive (in particular, version _SL) can be configured by the user to be controlled by an external host (motion controller) communicating by **SLM technology**.

1.5 SLM technology

High system-performance is achieved by the use of **SLM technology** which is an EIA-485 two-wire high-speed data communications network specially designed by Control Techniques for linking the elements of servo systems. By this means digital control and synchronisation are maintained between all the elements. Data, which consists of unit addresses, parameter numbers and values, is transferred at 125 μ s intervals and at a rate of 2.5 Mbits/second.

1.6 Programming the drive

The drive is configured and controlled by the adjustment of software parameters. These reside in menus, as follows:

Menu 0

Menu 0 contains a group of parameters that apply to simple applications; these parameters are duplicates of certain advanced parameters (see below).

Advanced menus

The advanced menus are numbered 1 to 13; and contain all the (advanced) parameters, which are grouped according to function.

After adjustment, new parameter-values can be saved for future use.

The drive can be restored to its default state (all parameters returned to their default values). This is normally performed during the initial setting-up of the drive, and can be performed again at any appropriate time. See also *Automatic setting up of the drive for the motor* below.

1.7 Automatic setting up of the drive for the motor

At power-up all the motor characteristics are automatically read from the motor via the **SLM**. This substantially reduces the setting-up time.

The drive has a facility initiated by the user for calculating the PID gains from user-specified compliance angle and load-inertia figures, as well as from the motor characteristics. The calculated values are then automatically entered into the appropriate parameters. If a motor is subsequently replaced by one of a different size or type, this calculation will require repeating.

1.8 Braking resistor

The drive is installed with an internal braking resistor; either this resistor or an external braking resistor can be used for dissipating regenerated energy.

1.9 Thermal protection of the motor

The drive protects the motor from thermal overload without the need for an external thermistor.

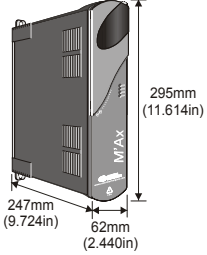
When the motor is running, every 125ms a thermal-modelling function in the **SLM** updates an accumulator whose value represents the temperature of the motor windings. If the value of the accumulator reaches a level that indicates the motor windings are at the specified maximum safe working temperature, the output current is limited to a specified level and a motor thermal-overload alarm is produced. This alarm can be applied to, or read by, the system or motion controller to initiate reduction of demand, otherwise continued demand at this level will cause the drive to trip and cease controlling the motor.

Initial conditions are read by the drive, as follows:

- The thermal characteristics of the motor are obtained by the drive during setting-up (described in Automatic setting up of the drive for the motor).
- Each time the drive is powered-up, the value of the initial motor temperature is obtained from a thermistor embedded in the **SLM**.

Adjustments can be made to the motor-protection function, so that the drive provides an early warning to the host before it starts current limiting. Preventative action can then be taken.

1.10 Features of the M'Ax

General	_AN	_SL
Continuous output current ratings of 3.5A, 6.5A, 9.5A, 12.5A	☐	☐
200% overload for up to 2 seconds	☐	☐
AC supply 380 ~ 480V $\pm 10\%$ category III	☐	☐
Compact IP20 case 	☐	☐
EMC compliance EN50081-2 and EN61800-3 Immunity (generic standard) Emission (only when using recommended input RFI filter)	☐	☐
Parallel connection of DC-buses	☐	☐
Internal 125W braking resistor with fail-safe protection	☐	☐
Operation alternatively with an external braking resistor	☐	☐
i^2t protection for: Drive Motor Internal braking resistor	☐	☐
Controlled stop on loss of AC supply	☐	☐
For use with 2 to 32 pole motors Also CT Unimotors SL75 to SL190	☐	☐
6000 rpm motor-speed capability	☐	☐
Short-circuit protection for all 24V supply outputs	☐	☐
24V SLM-and-user back-up supply input primarily to maintain position information in the SLM	☐	☐
28V 2A Auxiliary back-up supply input for keeping the control circuits powered or for setting up the drive without an AC supply; the external supply can also be used to power the motor at low speed for positioning purposes	☐	☐

Performance	_AN	_SL
High-precision synchronisation of axis-position within 50ns	☐	☐
High-precision synchronisation of the speed-loop within 50ns	☐	☐
SLM technology robust 2-wire serial link to the SLM Sampling rate: 125µs Two additional wires carry a 24V DC supply to the SLM	☐	☐
8kHz switching frequency	☐	☐
8 million counts per revolution (in speed control)	☐	☐
SLM technology high-precision link to a motion controller Resolution: 16 bits per revolution	☐	☐

Reference inputs	_AN	_SL
Pulse input (frequency and direction [F/D] or quadrature square-wave [encoder-following]) Directional pulse input Maximum 1.2MHz Note: Quadrature phase displacement at a maximum $90^\circ \pm 8^\circ$ 400ns input filter	☐	☐
Gearing for pulse inputs Ratio range 0.00015: 1 to 2.0000: 1	☐	☐
Preset speeds	☐	☐
Standard-precision analog input (12-bit)		☐
High-precision analog input (16-bit)	☐	
<150µV zero-crossing error for the high-precision analog input	☐	
Setting up in Keypad mode	☐	
SLM technology high-precision link to a motion controller	☐	☐

Interfaces	_AN	_SL
Encoder-simulation output producing 100 ~ 8192 selectable or 16384 counts per revolution EIA232 or EIA485 serial communications	☐	☐
SLM technology 2-wire EIA485 2-wire serial communications	☐	☐
Two analog outputs Resolution: 10 bit	☐	☐
LED status indicators	☐	☐
Seven-segment display and keypad	☐	
Hardware enable input	☐	☐
Hardware event counter	☐	☐
Pulse measurement with 200ns resolution	☐	☐
Eight isolated, programmable digital inputs, protected	☐	☐
External trip via serial communications	☐	☐
Four isolated, programmable digital outputs, short-circuit protected	☐	☐
Touch-trigger / position-freeze (time stamp) having 200ns resolution	☐	☐
Drive ok relay contact, programmable to other functions	☐	☐
MODBUS RTU to FIELDBUS gateways	☐	☐

Miscellaneous	_AN	_SL
Automatic recognition of the motor (motor data is held in the encoder EPROM)	☐	☐
RFI filter in bookcase and footprint format available	☐	☐
Acceleration and deceleration ramps	☐	☐
Adjustment of PID gains while the motor is running	☐	☐
Position control loop	☐	☐
Internal programmable logic controller	☐	☐
Trip log	☐	☐
Easy setting up of the drive	☐	☐
User-defined parameter values saved in EEPROM in the option module, or flash memory in drive	☐	
Parameter transfer and storage (cloning); see Appendix H	☐	☐

2 Connecting the drive

Follow the instructions in this chapter for product familiarisation as well as permanent installation.



Personnel requirements

The drive must be installed and operated only by personnel having the necessary training or experience.



Motor safety

If this is the first time the drive has been operated, ensure that no damage or safety hazard could arise from the motor starting unexpectedly.

For product familiarisation as well as full installation, the motor must be fixed down and the shaft guarded against inadvertent contact.



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 five minutes before work may continue.



Wait 30 seconds after removing power to the drive before inserting or removing control cables as 'hot plugging' cables can result in damage to the drive or SLM.



Permanent magnet motors

Permanent magnet motors generate electrical power if they are rotated, even when the supply to the drive is disconnected. If that happens then the drive will become energized through its motor terminals.

If the motor load is capable of rotating the motor when the supply is disconnected, then the motor must be isolated from the drive before gaining access to any live parts.

Refer to the remainder of this User Guide for making signal connections.

For product familiarisation...

For operation in Keypad mode (version **_AN**), make temporary power and signal connections (see *Signal connections for operation in Keypad mode* on page 9), then follow Chapter 4 *Programming Instructions* on page 24 and Chapter 5 *Getting Started* on page 26.

For control via serial communications (any version), make temporary power and signal connections (see *Signal connections for serial communications* on page 13), then follow Appendix C *Serial Communications* on page 90 and Chapter 5 *Getting Started* on page 26.

For making the power connections, refer to Chapter 1 *Safety Information* and the following sections in Chapter 2 *Installing the drive* in the Installation Guide:

- AC supply protection
- Power cables
- Signal cables and connectors
- Fitting the mounting brackets to the drive
- Precautions for making power connections
- Terminal sizes and tightening torques
- Method of connecting the power cables
- Circuit diagrams for the power connections

Refer to the remainder of this User Guide for making signal connections.

2.1 Making electrical connections

Setting up the drive without an AC supply...

If required, the drive can be set up for the application without the use of an ac supply. In this case, either an *Auxiliary back-up supply* (see types of back-up supplies on page 18 and Appendix E *Auxiliary Back-up supply* on page 99), or a DC Bus Input is required (contact the local drive centre for information on DC input connections)

Sending a motor-overload alarm to the system or motion controller

A motor-protection trip is indicated by software Pr **10.17** changing to logic state 1. This can be detected by the controller in either of the following ways:

- Reading Pr **10.17** via serial communications; in this case, make the appropriate signal connections shown in *Example signal connections* on page 8 and see Appendix C *Serial Communications* on page 90.
- Assigning a digital output to Pr **10.17** and making a dedicated signal connection from the drive to the controller; in this case, before continuing, see Appendix F *Motor Thermal-Overload Protection* on page 107.

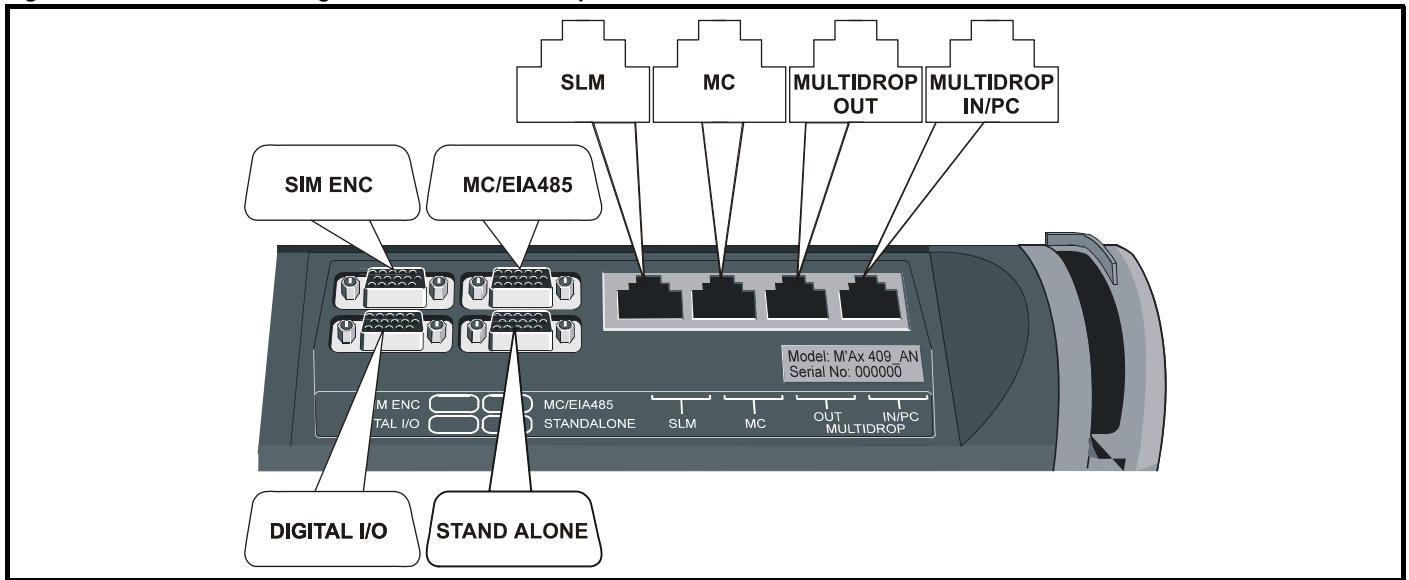
For permanent installation...

Refer to the following in the Installation Guide:

- Chapter 1 *Safety Information*
- Chapter 2 *Installing the drive*

2.2 Locations of the signal connectors

Figure 2-1 Locations of the signal connectors on the top surface of the drive



2.3 Functions of the signal connectors

The following functions are available for versions **_SL** and **_AN**.

D-type connectors

SIM ENC

(15-way high-density female D-type)

- Simulated-encoder quadrature AB plus Z marker-pulse outputs for supplying encoder speed and position to a system controller or PLC or another servo amplifier (**following power-up, Z marker-pulses are produced only after the motor shaft has passed through the zero position of the feedback encoder; it may then be necessary to adapt the homing procedure accordingly; for more information, refer to the supplier of the drive**)
- Two analog outputs
- Standard-precision analog speed or torque reference input (version **_SL** only)

MC/EIA485

(15-way high-density female D-type)

- **SLM technology** I/O to a motion controller
- **Hardware enable** input (electrical enable signal for the drive)
- **Status-relay** contact
- Alternative use as an EIA485 port for control from a system controller, PLC or PC
- **SLM-and-user back-up supply** input for retaining position information when the drive is powered-down (see *Back-up supplies* later in this chapter)
- **24V user supply** output generated in the drive (maintained by an **SLM-and-user back-up supply** when the drive is powered-down)
- Status-relay contact

DIGITAL I/O

(15-way high-density male D-type)

- Eight digital inputs for electrical contacts for local or remote (system controller or plc) control of the drive
- Four digital outputs for local or remote monitoring and/or simple control of other equipment
- **24V user supply** output generated in the drive (maintained by an **SLM-and-user back-up supply** when the drive is powered-down)

STANDALONE

(15-way high-density male D-type)

- Frequency-and-direction, quadrature square-wave inputs and directional pulse inputs
- High-precision analog speed or torque reference input (**_AN** version only)
- **Touch trigger** input
- **SLM-and-user back-up supply** input for retaining position information when the drive is powered-down (see *Back-up supplies* later in this chapter)
- **24V user supply** output generated in the drive (maintained by an **SLM-and-user back-up supply** when the drive is powered-down)
- Single digital output
- **Hardware enable input** (electrical enable signal for the drive)

RJ45 connectors

SLM

- **SLM technology** I/O to the **SLM**
- 24Vdc supply to the **SLM** (maintained by an **SLM-and-user back-up supply** when the drive is powered-down)
- **Hardware enable input** (electrical enable signal for the drive)
- **Drive-status supply**

MC

- **SLM technology** I/O to a motion controller
- **Hardware enable** input (electrical enable signal for the drive)
- Drive-status supply
- **24V user supply** output generated in the drive (maintained by an **SLM-and-user back-up supply** when the drive is powered-down)

MULTIDROP OUT

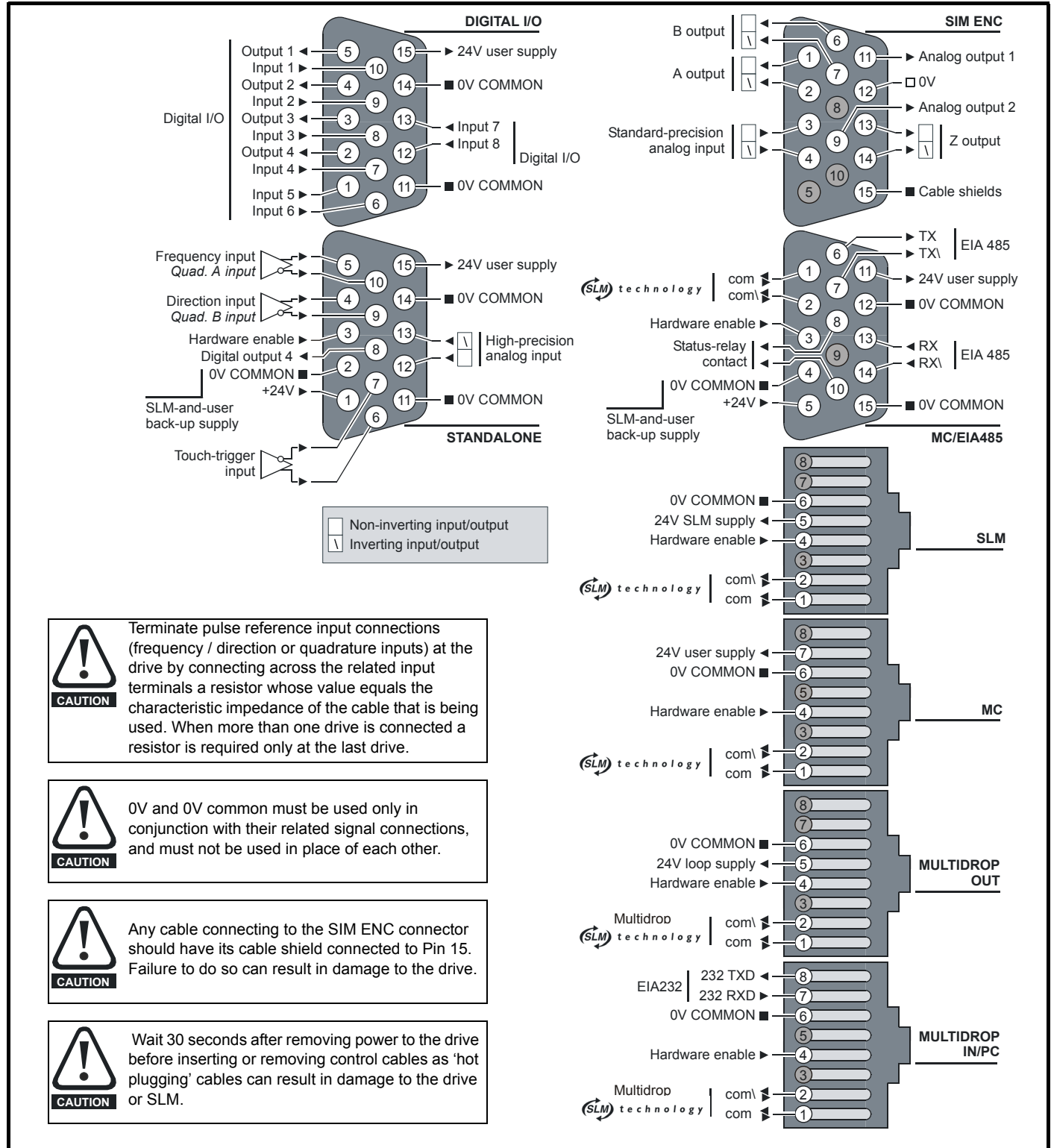
- **Hardware enable** input (electrical enable signal for the drive)
- **Drive-status** output
- **+24V loop output**

MULTIDROP IN/PC

- **Hardware enable** input (electrical enable signal for the drive)
- EIA232 communications to a PC running a dedicated application program (for setting-up purposes only)
- **Drive-status input**
- **+24V loop input**

2.4 Functions of the signal terminals

Figure 2-2 Plan view of top of drive: Functions of the signal terminals (note that some functions are available only in specific version(s) of the drive)



For data on each terminal see Appendix A *Signal Connectors* on page 79.

Parallel and multiple connections

The following functions are available on more than one connector (the related terminals are connected in parallel in the drive):

- 0V COMMON
- Hardware enable
- SLM**-and-user back-up supply input
- 24V user supply

The functions shown in each group below are electrically identical in the drive:

- 24V loop input
- 24V loop output
- **SLM**-and-user back-up supply
- Drive-status input
- Drive-status output
- 24V user supply
- 24V **SLM** supply

Signal-ground connections

The drive has two types of 0V connection named **0V** and **0V COMMON** which are electrically isolated from each other in the drive. A single **0V** connection appears on the **SIM ENC** connector for use with the simulated-encoder and analog outputs; a **0V COMMON** connection appears on each of the remaining connectors for use with all the other signal connections.

0V and **0V COMMON** must be used only in conjunction with their related signal connections and must not be used in place of each other.

If ground-loop currents cause problems under the following conditions...

- The drive is controlled by an analog speed reference
- **0V** and **0V COMMON** are connected direct to ground in external equipment

... indirectly ground the **0V COMMON** connections through a 10nF 2kV ceramic capacitor. Ensure that input signals remain referenced to their related 0V-line (**0V COMMON** or **0V**) (see *Additional ground connections for the signal cables* described in *EMC emission standards - instructions* in Chapter 2 *Installing the drive* of the Installation Guide).

2.5 Example signal connections



Isolation

The signal connections are isolated from the power circuits by basic insulation only. Ensure that all external control circuits are separated from human contact by at least one layer of insulation rated for use at the ac supply voltage.



Incorrect connections

Ensure that a plug carrying a 24Vdc supply intended for the MC connector is not inserted in the MULTIDROP IN/PC connector. (Damage may occur to the EIA232 port on the MULTIDROP IN/PC connector if 24Vdc is applied to terminal 7.)



Analog outputs

The analog outputs (SIM ENC connector pins 9 and 11) are intended for indication purposes, not for use in process control. The signal level on Analog output 2 may become undefined at the following occasions:

- During the process of saving parameter values
- At power-up and power-down

Before continuing, see Appendix A *Signal Connectors* on page 79 for details relating to the signal connections, including those to the **SLM**. For making the required control and **SLM** connections refer to the example circuit diagrams that follow. Make monitoring connections as required (they may be omitted for product familiarisation). Example signal connections are shown for the following:

Application	Version(s)
Keypad mode (setting up and/or product familiarisation)	_AN
High-precision analog speed control in Terminal mode	_AN
Standard-precision analog speed control in Terminal mode	_SL
Remote control by a system controller or plc supplying quadrature AB, F/D signals, or directional pulse inputs	All
Serial communications (remote control and/or setting up)	All
High-precision speed control by motion controller supplying an analog speed reference	_AN
Standard-precision speed control by motion controller supplying an analog speed reference	_SL
Remote control by motion controller communicating by SLM technology	All

If position information is to be retained when the drive is powered-down for any reason, see *Types of back-up supplies* on page 19.

Signal connections for operation in Keypad mode

Suitable for version:

_AN

(If required, refer to the rating label on the right side of the drive to find the version code.)

Keypad mode is normally used only for the following:

- Setting up
- Monitoring purposes

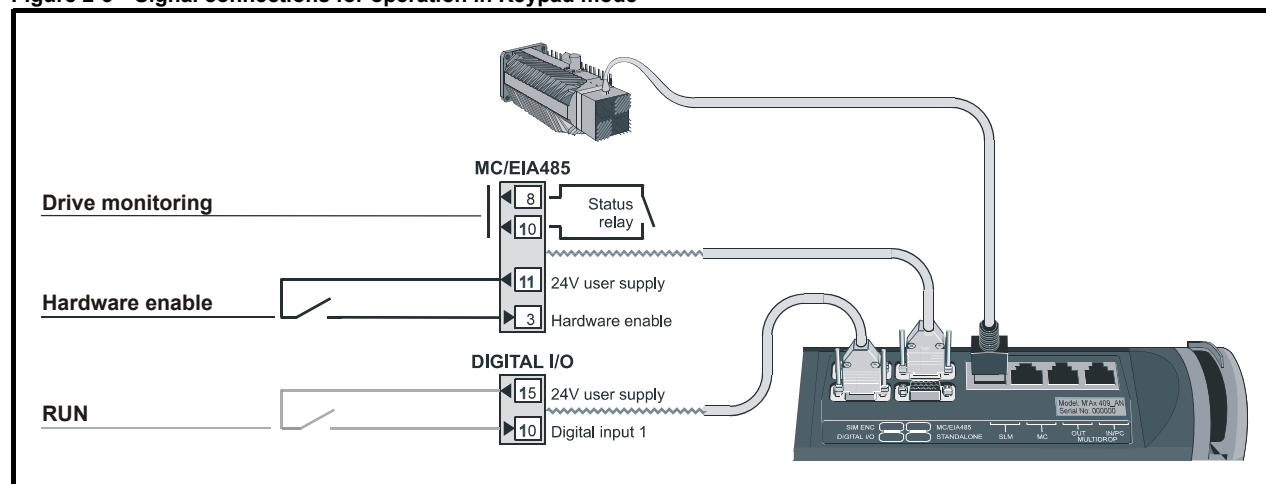
For normal use of keypad mode, the **RUN** contact (shown in grey) should not be connected.

Product familiarisation

The connections for Keypad mode are also used for product familiarisation (Chapter 4 *Programming Instructions* on page 24 and Chapter 5 *Getting Started* on page 26) where the motor is to be started and stopped. In this case, a **RUN** contact should be connected.

Parameter	Setting
1.14 {0.30}	4

Figure 2-3 Signal connections for operation in Keypad mode



Signal connections for high-precision analog speed control in Terminal mode

Suitable for version:
_AN

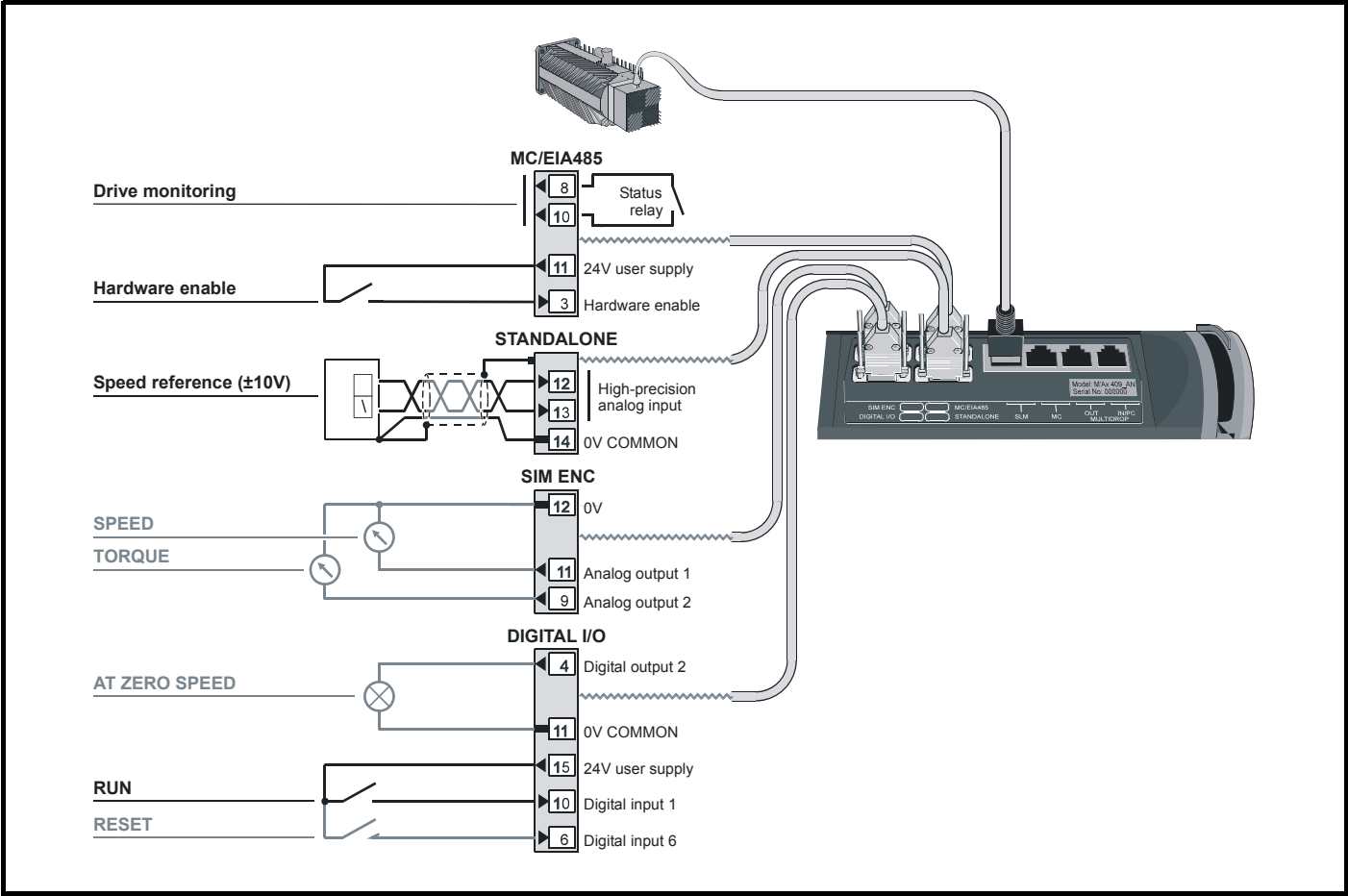
(If required, refer to the rating label on the right side of the drive to find the version code.)

Make these connections to allow the drive to be controlled and monitored locally by simple external controls and indicators.
Connections shown in grey are optional.

The **RESET** contact is required for version _SL, but is optional for version _AN which can also be reset by use of the keypad.

Parameter	Setting
1.14 {0.30}	1

Figure 2-4 Signal connections for high-precision analog speed control in Terminal mode



Signal connections for standard-precision analog speed control in Terminal mode

Suitable for version:

_SL

(If required, refer to the rating label on the right side of the drive to find the version code.)

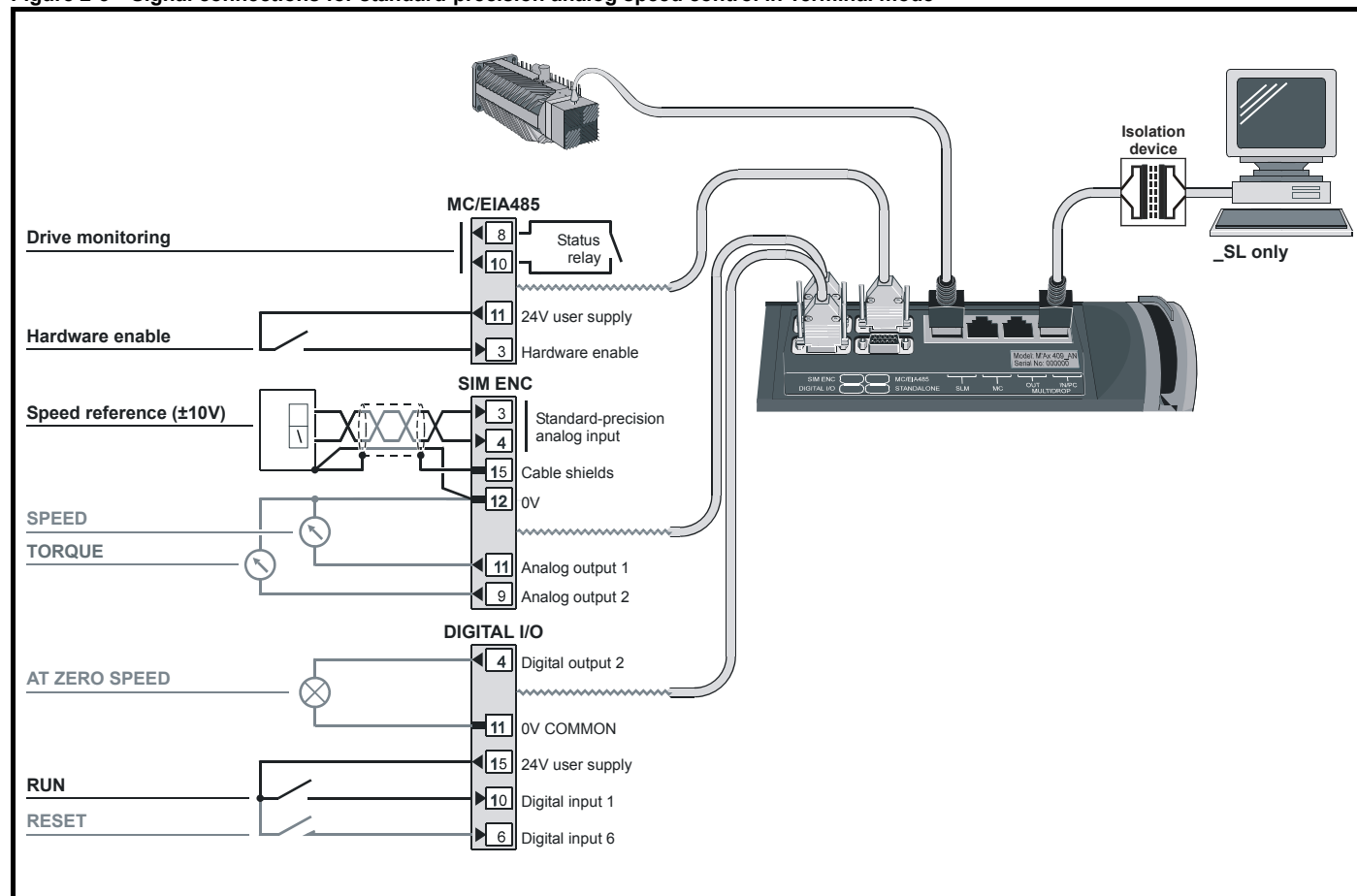
Make these connections to allow the drive to be controlled and monitored locally by simple external controls and indicators.

Connections shown in grey are optional.

Version **_SL**: Since a keypad and display are not installed, a pc must be used for setting up the drive for the application. For connection details, see Figure 2-7 *Signal connections for remote control and setting up by serial communications (PC running a dedicated application program or a PLC)* on page 13; these connections are made in addition to those shown below.

Parameter	Setting
1.14 {0.30}	1

Figure 2-5 Signal connections for standard-precision analog speed control in Terminal mode



Signal connections for remote control by a system controller or PLC supplying quadrature AB, F/D signals or directional pulse inputs

Suitable for versions:

_SL, _AN

When the encoder feedback is to operate at greater than 4096 pulses per revolution, a suitable connecting cable must be used. Each line pair must be terminated at the system controller or PLC by a resistor of an appropriate value and the cable shield must be connected to pin 12, as shown.

Version **_SL**: Since a keypad and display are not installed, a PC must be used for setting up the drive for the application. For connection details, see Figure 2-7 *Signal connections for remote control and setting up by serial communications (PC running a dedicated application program or a PLC)* on page 13; these connections are made in addition

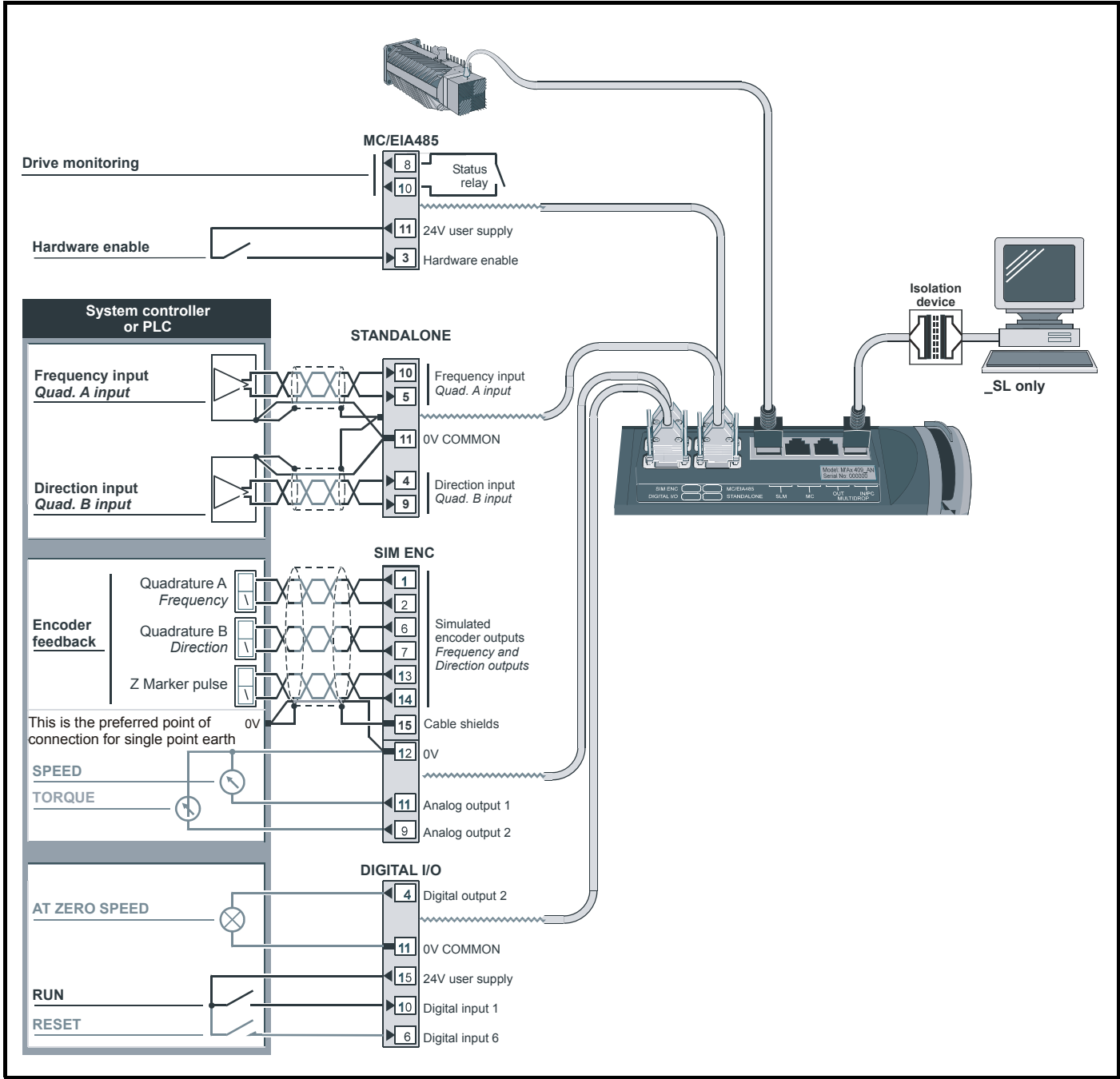
to those shown below.

Connections shown in grey are optional.

The **RESET** contact is required for version **_SL**, but is optional for version **_AN** which can also be reset by use of the keypad.

Parameter	Function	Setting
1.14 {0.30}		5
13.20	F/D	0
	Quadrature	1
	Directional pulse	2

Figure 2-6 Signal connections for remote control by system controller or PLC



Signal connections for serial communications

Suitable for versions:

_SL, _AN (essential for version _SL)

Use either of the following types of serial link, as appropriate:

EIA232

Use with a PC running a dedicated application program only for setting up a single drive

Maximum recommended cable length: 2 metres (6 feet)

EIA485

Use with a PLC for setting up, controlling and monitoring one or more drives and/or other devices.

Maximum cable length: 1200 metres (4000 feet)

For further information, see Appendix C *Serial Communications* on page 90. Then make the connections shown below for either EIA232 or EIA485 (not both).

Connections shown in grey are optional.

The drive can be reset in any of the following ways:

Closing the **RESET** contact

PC or PLC: Setting Pr **10.33** at 1

Version **_AN**: Keypad

Via serial communications: Setting Pr **10.38** at 100

The drive can be started and stopped by a **RUN** contact or by changing the setting of Pr **6.34 Sequencing bit RUN** via serial communications.

Using a **RUN** contact gives faster control.

Parameter	Function	Setting
1.14 {0.30}		Any
8.21	RUN to be controlled by contact	Leave at default (6.34)
	RUN to be controlled by serial comms.	The number of a parameter that is not being used, e.g. 6.32

Figure 2-7 Signal connections for remote control and setting up by serial communications (PC running a dedicated application program or a PLC)

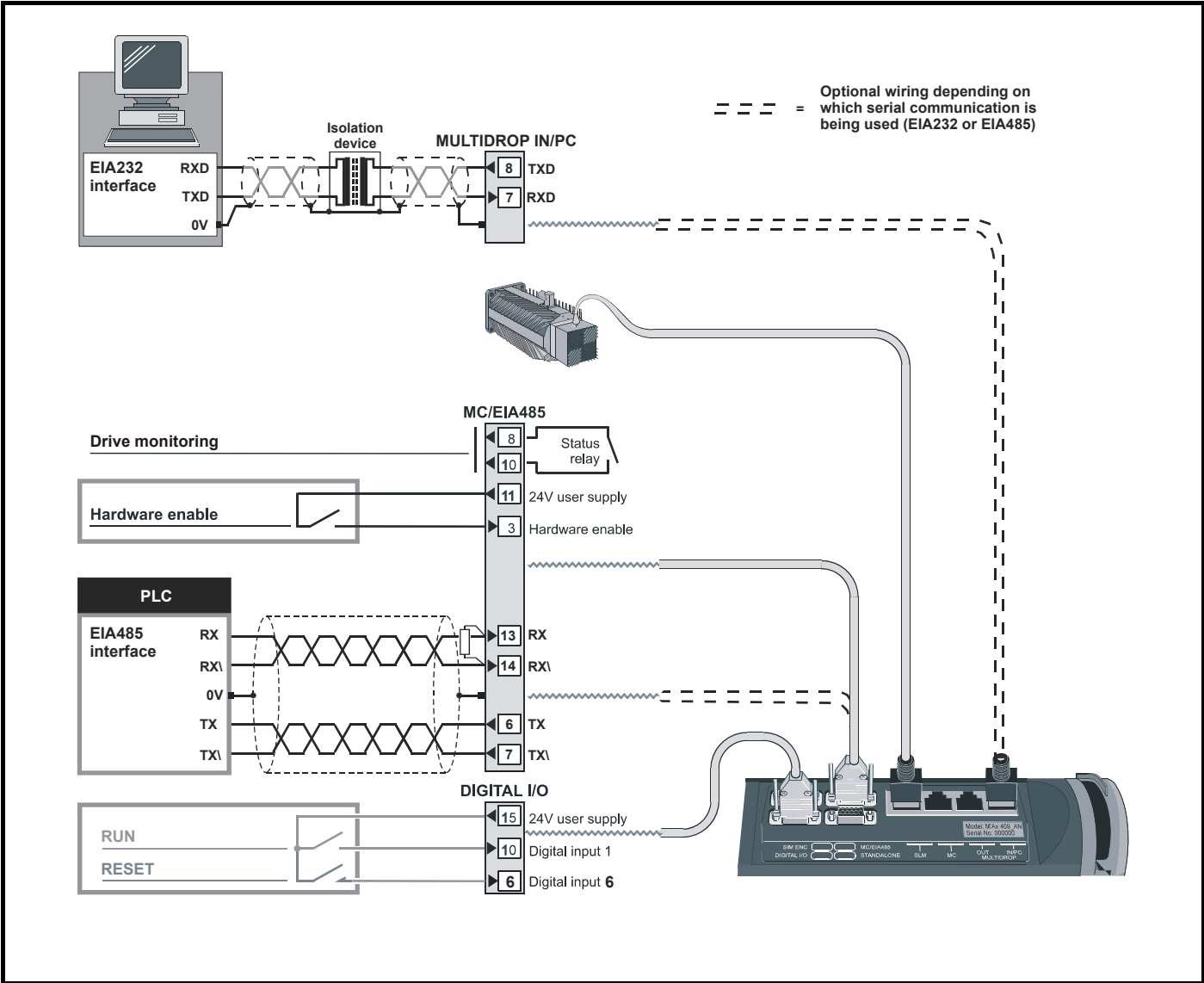
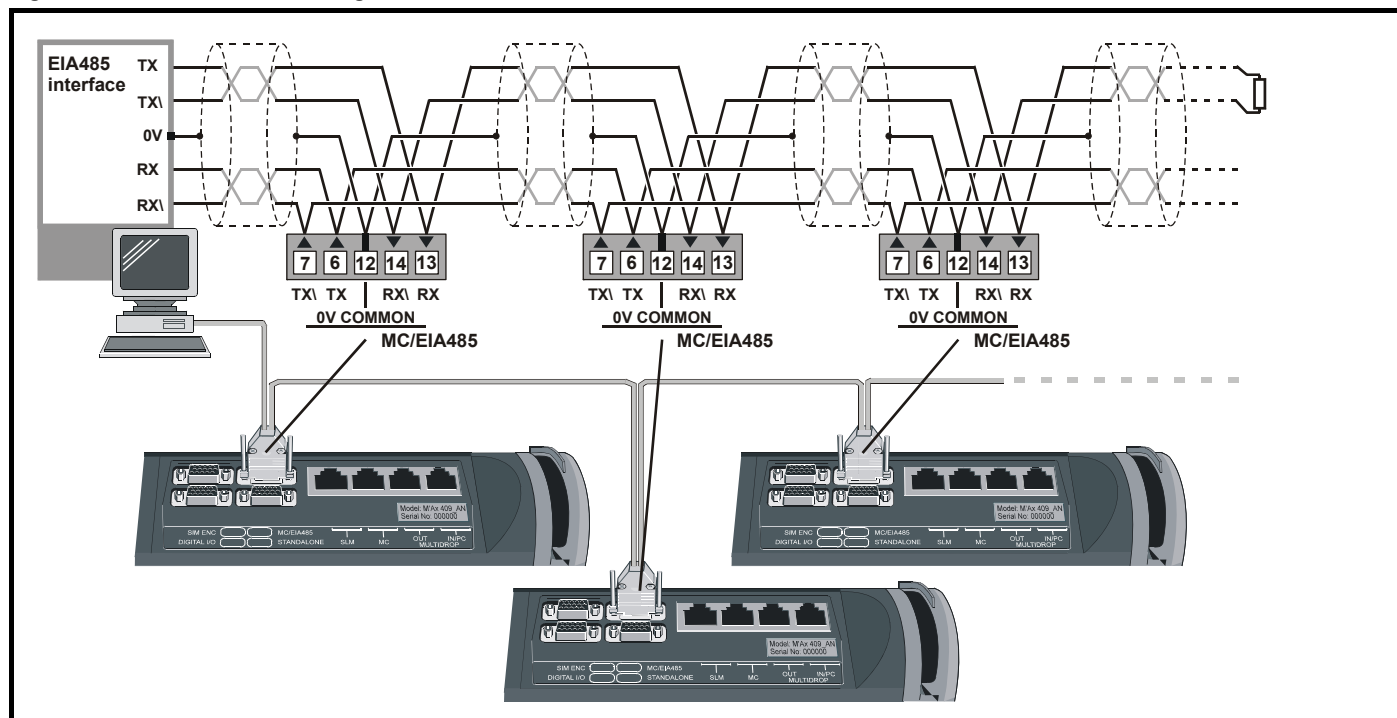


Figure 2-8 EIA485 link connecting a number of devices



Connect a line-termination resistor between the RX and RX\ lines only at the last drive or device on the serial link (i.e. the unit furthest from the host). The value of the resistor must be equal to the characteristic impedance of the cable.

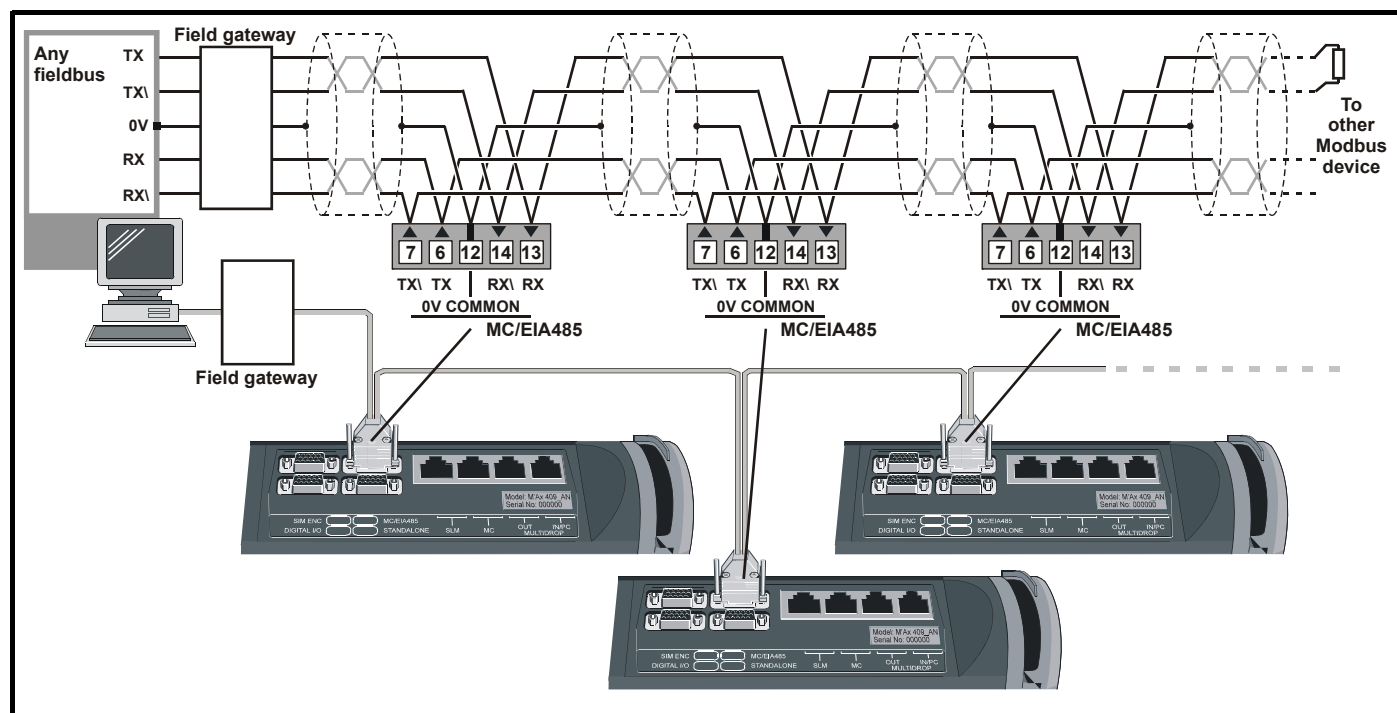
Do not fit resistors to other units in the system, otherwise excessive signal loss will occur.

Fieldbus

For multi-drive systems, the current trend is to use fieldbus communications to connect all the components of the drive system together. This reduces field wiring, and allows comprehensive control and diagnostic information to be transferred from device to device. The **M'Ax** drives have an RS485 port that can be configured to operate using the Modbus RTU protocol. Modbus is a multi-drop protocol so that multiple drives can be connected on the same network. To connect a **M'Ax** drive to a fieldbus system a gateway device can be used to convert from one network system to another, such as Devicenet to Modbus.

Control Techniques Drive Centres can supply a range of gateway options to suit most common fieldbuses.

Figure 2-9 Modbus RTU



Signal connections for high-precision speed control by motion controller supplying an analog speed reference

Suitable for version:

_AN

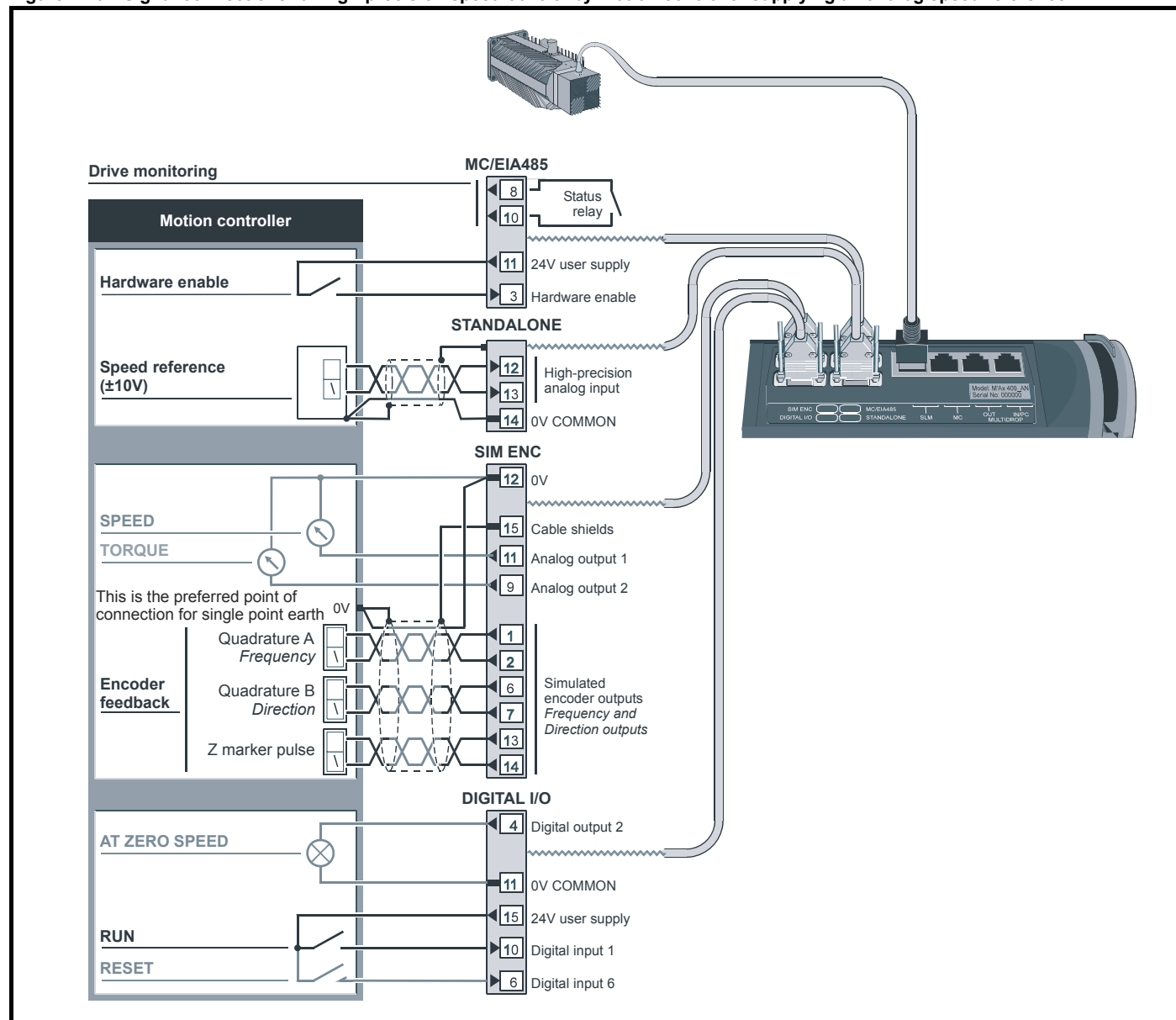
(If required, refer to the rating label on the right side of the drive to find the version code.)

Connections shown in grey are optional.

The **RESET** contact is optional since version **_AN** can also be reset by use of the keypad.

Parameter	Setting
1.14 {0.30}	1

Figure 2-10 Signal connections for high-precision speed control by motion controller supplying an analog speed reference



Signal connections for standard-precision speed control by motion controller supplying an analog speed reference

Suitable for version:

SL

(If required, refer to the rating label on the right side of the drive to find the version code.)

Version SL: The drive must be set up via serial communications. Use a

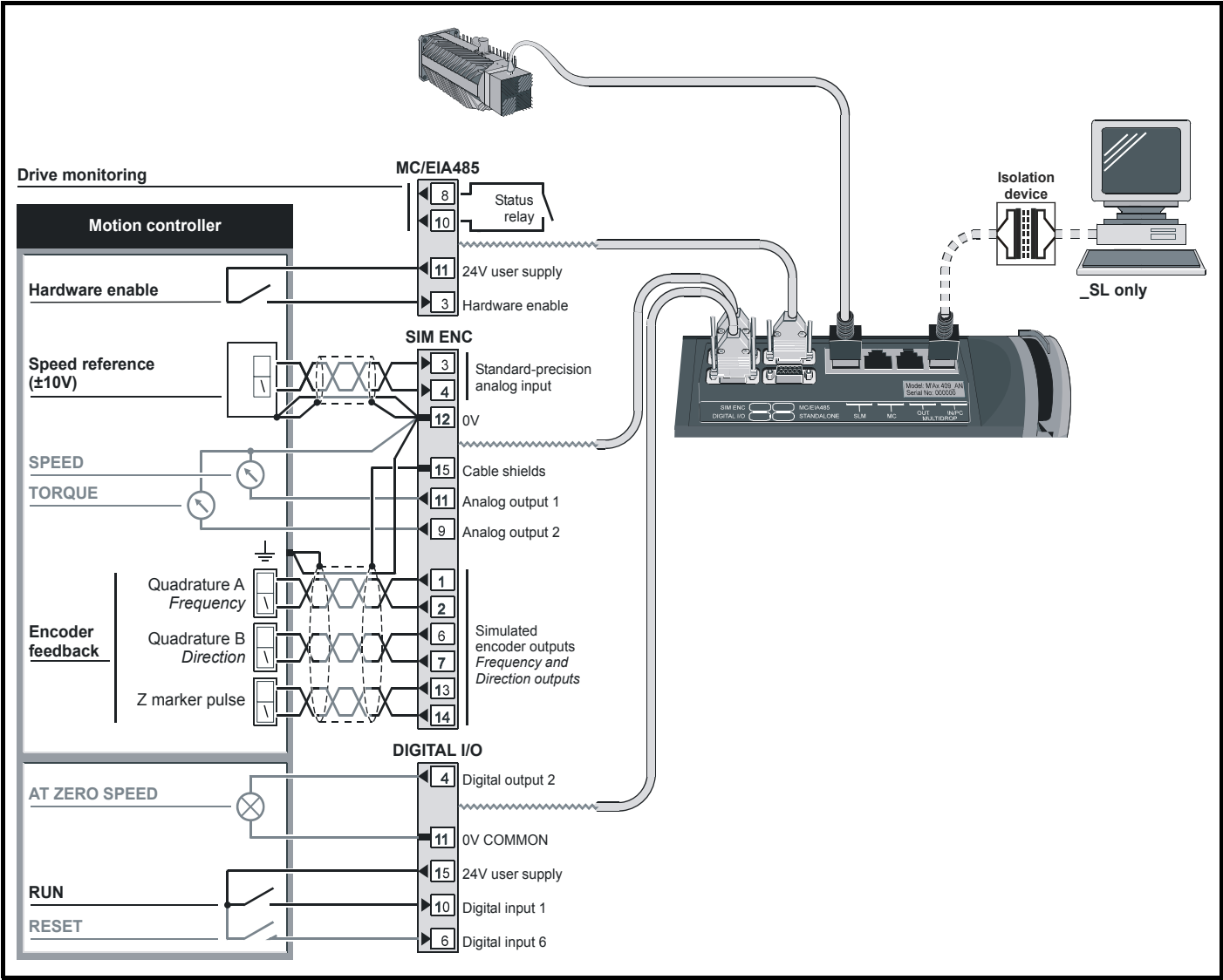
PC, or the motion controller if it has an EIA485 interface.

For connections, see Figure 2-7 *Signal connections for remote control and setting up by serial communications (PC running a dedicated application program or a PLC) on page 13.*

Connections shown in grey are optional.

Parameter	Setting
1.14 {0.30}	1

Figure 2-11 Signal connections for standard-precision speed control by motion controller supplying an analog speed reference



Signal connections for remote control by motion controller communicating by SLM technology

Suitable for versions: **_SL, _AN**

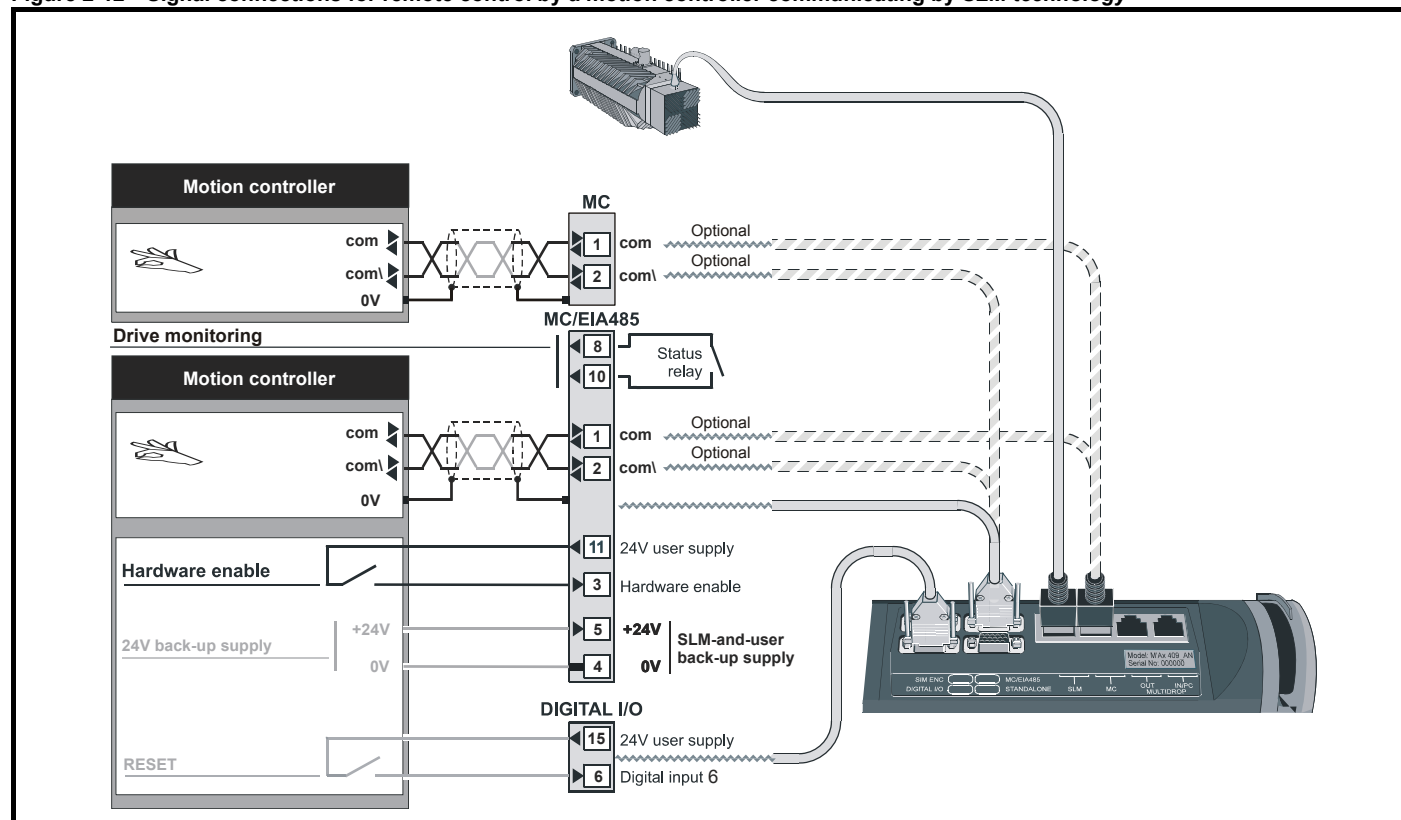
The motion controller is used also for setting up the drive.

Connections shown in grey are optional.

The **RESET** contact is required for version **_SL**, but is optional for version **_AN**.

Parameter	Setting
11.66	0

Figure 2-12 Signal connections for remote control by a motion controller communicating by *SLM technology*



Signal connections for Master and Slave applications

Suitable for versions: **_SL, _AN**

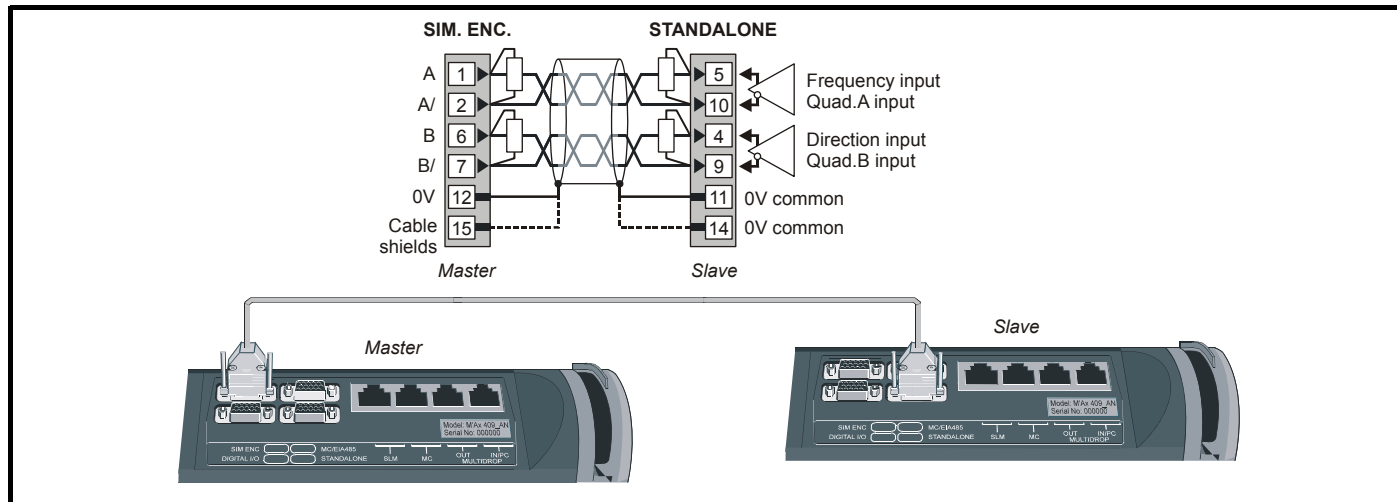
Master

Parameter	Setting
1.14 (0.30)	Optional (0 to 4)

Slave 1, Slave 2

Parameter	Setting
1.14 (0.30)	5

Figure 2-13 Master and slave connections

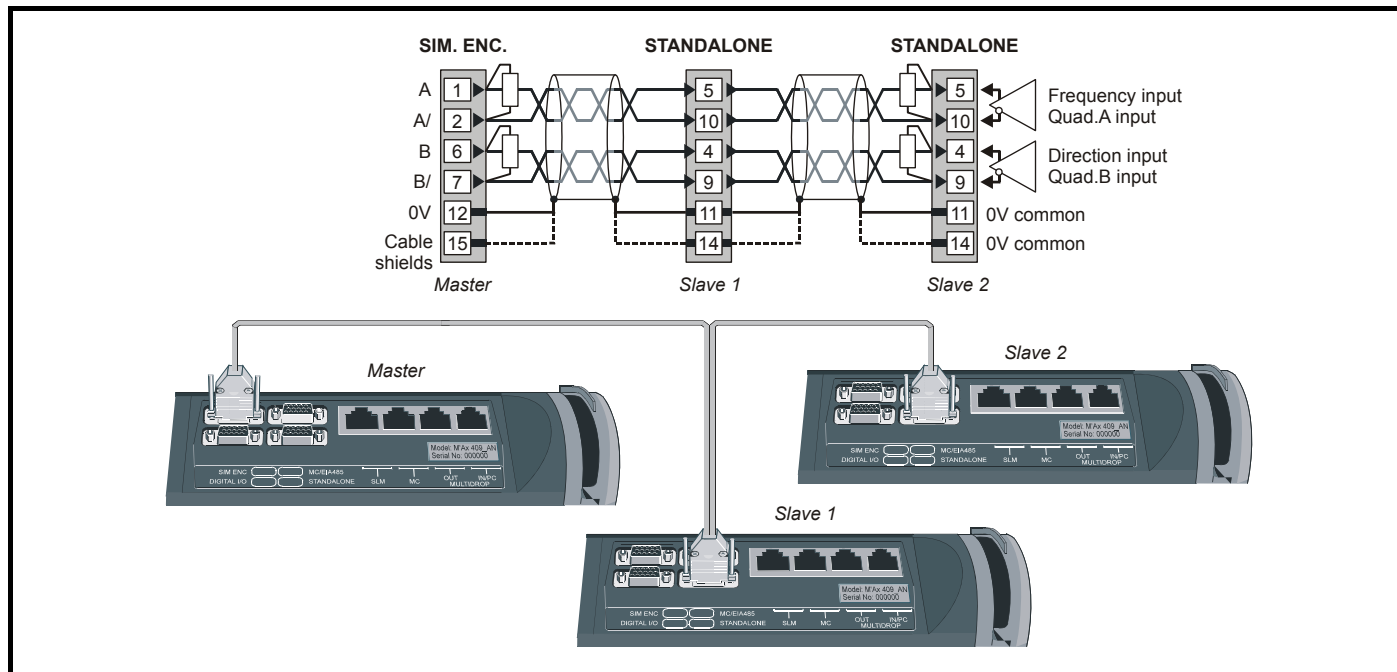


NOTE

Do not connect the cable shield to the shell of the connector.

When running a multiple axis master/slave operation, terminating resistors will be installed to the last drive in the chain only. Refer to Figure 2-14 for multidrop connections.

Figure 2-14 Multidrop master and slave connections



2.6 Planning the signal-current consumption

When the drive is connected to the AC supply, an internal 24VDC supply supplies the internal and external signal circuits. The maximum output current of this supply is 400mA. Refer to Table 2-1 for calculating the total load that the signal circuits will impose on this supply.

Table 2-1 Currents drawn from the internal 24V supply

Circuit	Current drawn
SLM and control circuits	65mA
24V user supply	User-defined circuits Each digital input (when activated): 9mA
Digital outputs	User-defined loads, up to 100mA each

If the total exceeds 400mA, check that the total *at any one time* does not exceed 400mA (not all digital terminals may be drawing current simultaneously). Then, if necessary, reduce the current drawn by the user-defined circuits and from the digital outputs.

2.7 Types of back-up supplies

The following two types of back-up supply can be applied individually or concurrently to the drive. They can continue to be applied when the AC supply is present.

SLM-and-user back-up supply

This back-up supply primarily supplies the **SLM** to ensure position information is not lost in the **SLM** when the drive is powered-down for any reason. A controller communicating by **SLM technology** will then be kept updated by the **SLM**.

The low current demand of an **SLM** (65mA) makes it practical for a battery to be used for this back-up supply.

See *SLM-and-user back-up supply* on the next page.

Auxiliary back-up supply

The auxiliary back-up supply supplies the control circuits in the drive, as well as the **SLM**. A controller receiving simulated-encoder feedback signals will then be kept updated by the **SLM**.

Parameters can be accessed and, when suitable connections are made, the motor can be positioned at low speeds.

This supply can be used also for setting up the drive without an AC supply being connected.

See Appendix E *Auxiliary Back-up Supply* on page 102.

For a recommended auxiliary back-up supply, contact the supplier of the drive.

2.8 SLM-and-user back-up supply

Functions

- Maintains the 24V supply to the **SLM**
- Maintains the **24V user supply** output
- Maintains the **Drive-status supply**
- The 24V supply to the control circuits of the drive is **not** maintained
- Low-current requirement (65mA for an **SLM** and control circuits)
- The **SLM-and-user back-up supply** can be at ground potential
- The **SLM-and-user back-up supply** can supply one or more drives, their **SLMs** and external circuits, on condition the total current entering any one drive does not exceed 500mA

Requirements



The current from the back-up supply to each drive must be limited to 500mA by a fuse or other protection means.

By regulated power supply or battery

Maximum permissible voltage: 28VDC (30VDC including AC ripple peaks)

Minimum permissible voltage: 12VDC (including AC ripple troughs)

Maximum current: 500mA

Maximum fuse I²t-rating: 5A²s

NOTE

A maximum voltage of 22V ensures that when the M'Ax is powered up no current will be drawn from the supply.

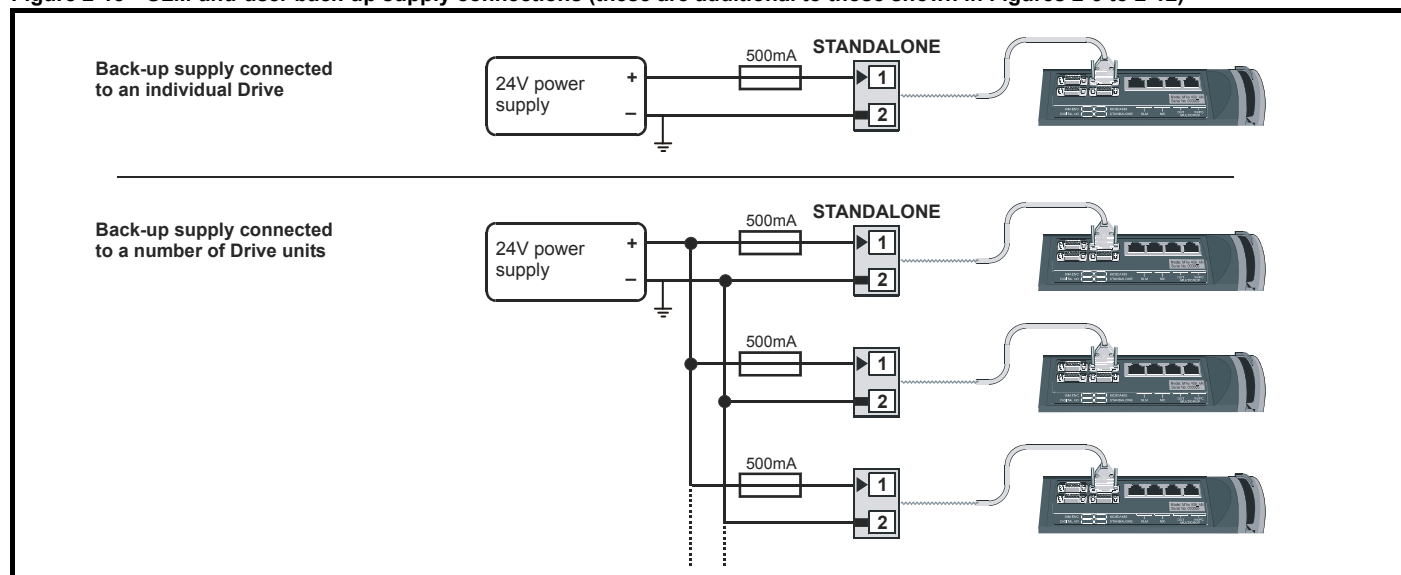
If battery back-up is used, it is recommended that an 18V lead acid battery is used to ensure the battery is not discharged when the M'Ax is energized.

Refer to *Planning the signal-current consumption* (earlier in this chapter) for each drive to be supplied by the **SLM-and-user back-up supply**.

Ensure the supply is able to deliver the total current for the following for all the drives:

- **SLM and control circuits**
- **24V user supply**
- **Drive-status supply**

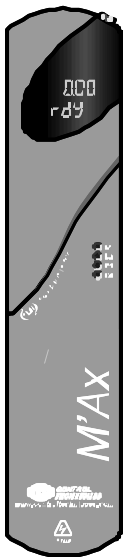
Figure 2-15 SLM-and-user back-up supply connections (these are additional to those shown in Figures 2-3 to 2-12)



3 User Interface

3.1 Displays and keypad

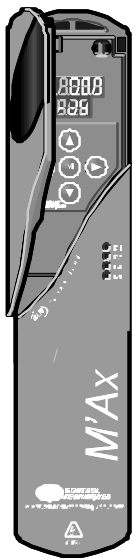
The locations of the displays and keypad are shown below.



A two-line alphanumeric display and a keypad are installed in version **_AN**.

When the drive is powered up, both the upper and lower lines of the alphanumeric display are visible through the tinted window.

On all versions, a column of four leds give additional status information.



To gain access to the keypad, use the finger tab at the top of the drive to open the door.



Upper line of the alphanumeric display

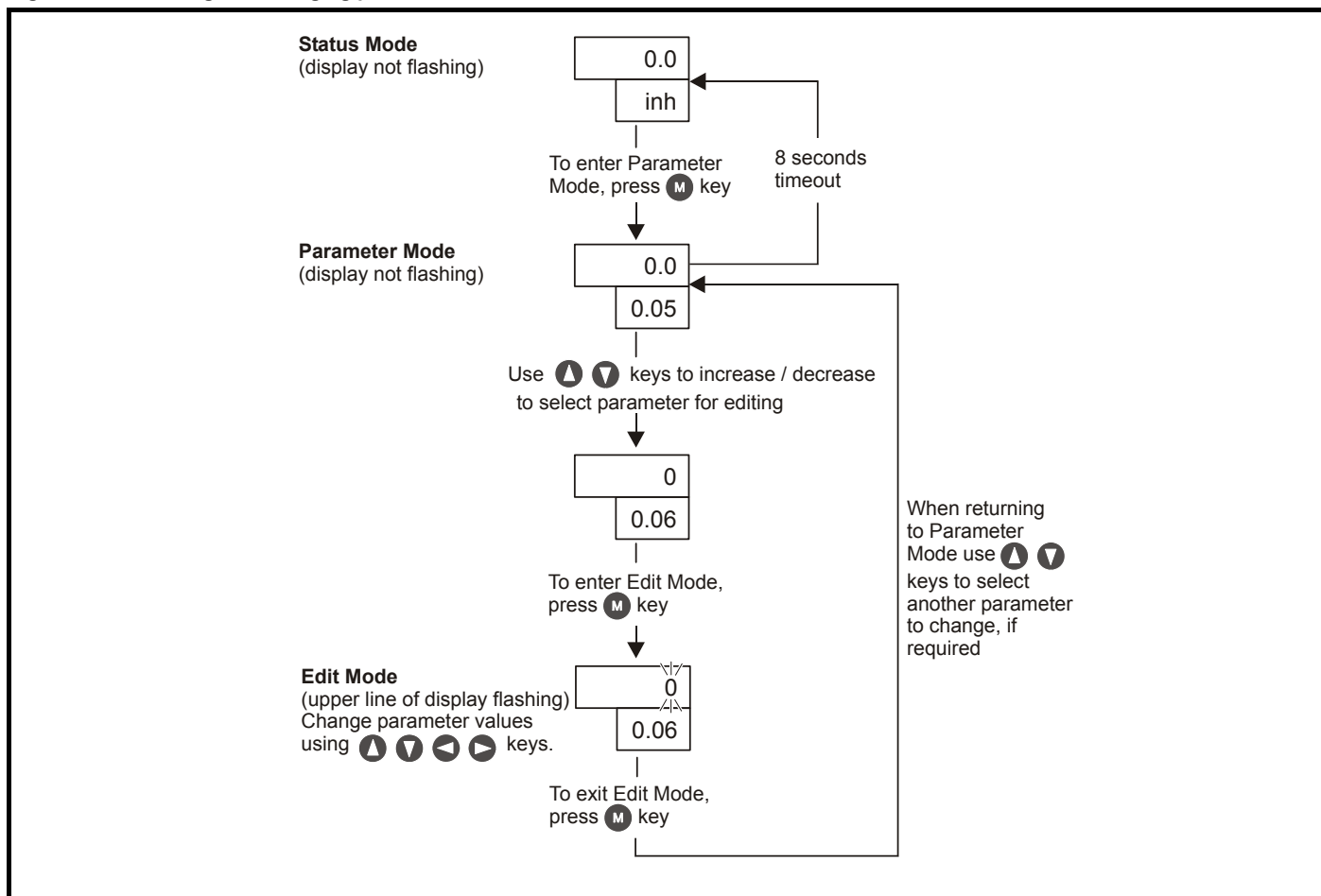
Lower line of the alphanumeric display

Keypad

Status LEDs

- Red - OI trip
- Red - General trip
- Green - Drive ok
- Amber - Drive enabled

Figure 3-1 Selecting and changing parameters



Alphanumeric display

The alphanumeric display is used for the following...

- Reading the values of software parameters that are used to configure, control and monitor the drive
- Displaying the operating status of the drive
- Displaying fault and trip codes

... has three display modes as follows...

- Status mode
Used to indicate the status of the drive
- Parameter mode
Used for selecting a parameter to edit
- Edit mode
Used for editing the selected parameter

... and shows the following:

Display	Display mode		
	Status	Parameter	Edit
Upper line	Value of a selected parameter (initially after power-up, this is normally Pr 0.05 which indicates the motor speed)	Value of a selected parameter; the value cannot be changed	Value of a selected parameter; the value can be changed
Lower line	Status of the drive: Inhibit (inh), Ready (rdY), Trip (trP)	Parameter number; a different parameter can be selected	Parameter number; a different parameter cannot be selected

Keypad

The keypad is used for the following:

- Changing the values of software parameters in order to configure and reset the drive
- Controlling the motor speed when the drive is operating in Keypad mode (the display must be in Status mode indicating run)

When using the keypad to change parameter values, the following steps must be performed:

- Change the mode of operation of the display
- Select a parameter to edit
- Edit (change the value of) the selected parameter
- When required, save new value(s) given to parameter(s)

Status LEDs

When illuminated, these indicate the following:

D1	red	Trip OI has occurred; control of the motor has ceased
D2	red	The drive has tripped due to a cause other than OI ; control of the motor has ceased
D3	green	Drive-status (Drive ok) indication
D4	amber	The drive is enabled, allowing the motor to be driven

3.2 Software parameters

Parameters and menus

All the parameters that need to be accessed for the majority of applications are contained in Menu 0. These parameters are actually duplicates of certain *advanced parameters* that are contained in *advanced menus* (numbered 1 to 13). The parameters in each advanced menu are related by function.

Each parameter is identified by a number that is structured as in these examples:

Menu.Parameter
Pr **0.05**
Pr **3.02**

In addition to this number, each parameter has a name which is stated in **M'AxSoft** as well as in this User Guide where the number and name are represented in the following way:

Pr **0.05** *Speed feedback*

When the *value* of a parameter is referred to in this User Guide, it is indicated as [0.05].

Parameter numbers appear individually on the lower line of the alphanumeric display.

Types of parameter

There are three types of parameter, as follows:

Bit parameters

(digital settings)

Bit parameters are set at 0 or 1 for performing the following:

- Enable and disable functions
- Select from two options

When a bit parameter is selected, the upper line of the alphanumeric display states the value as **bit 0** or **bit 1**.

Variable parameters

(analog settings)

Variable parameters are set at any numeric value within the specified range for performing the following:

- Enter values
- Select from more than two options

Some variable parameters are bipolar (positive and negative values), others are unipolar (positive values only).

When a variable parameter is selected, the upper line of the alphanumeric display states the numeric value.

Text parameters

(text selection)

Text parameters are used for selecting from a range of character strings that indicate the functions of available options.

When a text parameter is selected, the upper line of the alphanumeric display states the selected text.

No distinction is made in the parameter numbering system between the types of parameters.

Read-write and read-only

Parameters can be as follows:

- Read-write (RW)
- Read-only (RO)

Read-write parameters can be edited by use of the keypad (when installed), as well as remotely.

Read-only parameters are intended for monitoring purposes. Some of these indicate a result, such as motor speed. Their values cannot be changed directly by the user.

Others indicate the value of a demand, such as a preset speed reference. Their values can be changed only by the user applying a signal to a related input and/or directly editing the parameter from a remote source (system controller, PLC or motion controller) but not by use of the keypad.

The values of all parameters can be read individually on remote control

equipment and on the display (when installed).

When new values take effect

New values of most parameters take effect immediately; for this reason it is essential that before a parameter is edited its impact on the system is fully understood.

New values given to certain parameters take effect only after the drive has been reset.

Pr XX.00

Pr **XX.00** is a special parameter that can be accessed from every menu (**XX** represents the menu number). In Menu 0, for example, it is referred to as Pr **0.00**.

Pr **XX.00** is used for the following special operations:

- Saving new values given to parameters
- Restoring the drive to a default state
- Controlling security
- Calculating the current-loop PID gains

The operations are initiated by the user entering the values shown in the table below.

Setting	Operation	State
1000	Version _AN Save main-parameter values in the option module EEPROM	Motor stopped or running
1233	Version _AN (The drive is supplied in this default state) Restore all parameters to their default values, and... Enable retrieval of parameter values from the option module eeprom at subsequent power-ups (0.50 Parameter transfer selector set at no) Enable standalone operation (11.66 Host mode enable set at 1) Calculate PID gains using the default values	Drive disabled
1244	Version _SL (primarily) Restore all parameters to their default values, and... Enable restoring of parameter values from flash memory at subsequent power-ups (0.50 Parameter transfer selector set at boot2) Enable standalone operation (11.66 Host mode enable set at 1) Calculate PID gains using the default values	Drive disabled
1255	Version _SL (primarily) (Version _SL is supplied in this default state) Restore all parameters to their default values, and... Enable restoring of parameter values from flash memory at subsequent power-ups (0.50 Parameter transfer selector set at boot2) Enable external-host operation (11.66 Host mode enable is set at 0) Calculate PID gains using the default values	Drive disabled
149	Unlock standard security	Motor stopped or running
0 ~ 255	User security code	Motor stopped or running
2000	Lock security	Motor stopped or running
3000	Calculate the speed-loop PID gains (see 0.13 , 0.14 , 0.15)	Drive disabled
3001	Calculate the speed-loop PID gains and symmetrical current limit (see 0.13 , 0.14 , 0.15)	Drive disabled
4001	Selects SLM software page 1 (see Menu 15)	Drive disabled
4003	Selects SLM software page 3 (see Menu 15)	Drive disabled



To change from external host to host mode, the drive requires defaulting twice, i.e. XX.00 to either 1233, 1244 or 1255. The first default changes the operation of the drive, and the second default identifies the drive and motor default settings.

Instructions for performing these operations are given in...

Chapter 4 *Programming Instructions* on page 24

- *Saving new parameter-values*
- *Making new values take effect*
- *Restoring the drive to the default state*

Chapter 7 *Security and Accessing the Advanced Parameters* on page 40

Appendix C *Serial Communications* on page 90

- Restoring the drive to a default state

Appendix D *Optimising the Dynamic Performance* on page 96

Where to find information on parameters

Instructions are given in *Chapter 6 Setting Up the drive for Basic Applications* on page 29.

Menu 0 parameters are described in Chapter 8 *Menu 0 Parameters* on page 42.

The advanced parameters are listed in Chapter 9 *Advanced Parameters* on page 49 and described fully for advanced applications in the *M'Ax Advanced User Guide*.

4 Programming Instructions

Version: **_AN**

Follow the relevant instructions in this chapter as part of product familiarisation in order to learn how to read and change the values of parameters. The instructions take you step-by-step through learning how to use the display and keypad and alert you to avoiding actions that could cause confusion. It is in your interests to follow these instructions carefully.

The instructions apply to all menus and for operation in Keypad or Terminal mode.

Afterwards follow Chapter 5 *Getting Started* on page 26.

All versions that are to be controlled by serial communications, in particular, version **_SL.**

Refer to Appendix C *Serial Communications* on page 90. Then follow the relevant instructions in Chapter 5 *Getting Started* on page 26.

4.1 Sequence for editing parameters

Use the following sequence when editing parameters by use of the keypad and alphanumeric display:

1. Edit parameter value(s) with the motor running or stopped, as appropriate.
2. Parameters indicated by the letter **R** in Chapter 8 *Menu 0 Parameters* on page 42 and Chapter 9 *Advanced Parameters* on page 49 require the drive to be reset before their new values take effect. If any of these parameters have been adjusted, follow the procedure in *Making new values take effect* on page 25.
3. If required, follow the procedure in *Saving new parameter-values* on page 25 to save new parameter-values for future use (the motor can be running or stopped).

Advanced parameters

When advanced parameter(s) are to be edited by use of the display and keypad, perform the following:

Before editing....

Unlock security to enable the parameter(s) to be edited.

After editing

Lock security.

See Chapter 7 *Security and Accessing the Advanced Parameters* on page 40 and Chapter 9 *Advanced Parameters* on page 49 for information on the advanced parameters.

4.2 Summary of the keypad functions

Version: **_AN**

Key(s)	Status mode	Parameter mode	Edit mode
	<i>When the status is displayed:</i> select Parameter mode <i>When the parameter number is displayed:</i> display the status	Select Edit mode when a read-write parameter is selected Return to Parameter mode when a read-only parameter is selected	Select Parameter mode
	<i>When the drive is operating in Keypad mode and the display indicates run:</i> Increase the motor speed in the forward direction Reduce the motor speed in the reverse direction	Select a parameter	Increase the value of a digit
	<i>When the drive is operating in Keypad mode and the display indicates run:</i> Increase the motor speed in the reverse direction Reduce the motor speed in the forward direction	Select a parameter	Decrease the value of a digit
	Display the parameter number	Select another menu (standard security must first be unlocked)	Select the next display digit to the left
	Display the parameter number	Select another menu (standard security must first be unlocked)	Select the next display digit to the right
	Reset the drive	Quick selection of initial parameter displayed (i.e. Pr 0.05)	Set the value at zero
			Execute an operation that has been selected in Pr XX.00

4.3 Electrical power connections

Before continuing, ensure the drive has been connected in accordance with the instructions in Chapter 2 *Installing the drive*, in the Installation Guide, **including correct use of the ground bracket**.

When following the instructions in this chapter, it is your responsibility to connect and disconnect the ac supply as required.



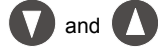
The AC supply must be connected to the drive with appropriate fuses or protection, as described in the Installation Guide.

4.4 Making new values take effect

Parameters that are indicated by the letter **R** in Chapter 8 *Menu 0 Parameters* on page 42 and Chapter 9 *Advanced Parameters* on page 49 require the drive to be reset for the new value(s) to take effect. (New values given to other parameters take effect immediately.)

To reset the drive, perform any one of the following:

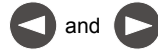
- Momentarily close the **RESET** contact (see Figures 2-3 to 2-12 in Chapter 2 *Connecting the drive* on page 5)
- When the display is in Status mode, press at the same time:



- Set Pr **10.38** at **100** via serial communications.

4.5 Saving new parameter-values

1. Use the following procedures to set Pr **0.00** at **1000** in order to initiate the *save* operation:
 - *Selecting a parameter to access*
 - *Changing the value of a parameter*(These procedures are described earlier in this chapter.)
2. To activate the drive save, perform anyone of the following:
 - While the display is in Edit mode, execute the save operation by pressing at the same time:



- Set Pr **10.38** at 100 via serial communications.
- New values are now saved.

3. So that these values are used after the next power-up, ensure Pr **0.50** *Parameter transfer selector* is set at **no**. If you have to change the setting, immediately afterwards execute the operation, as in step 2.

4.6 Selecting a different option

Bit parameters that are used for selecting between two options are used in the way described in *Changing the setting of a bit parameter*.

The following parameters...

- **Variable parameters** used for selecting among a number of options which are identified as numbers
 - **Text parameters**
- ... are used as follows:

To ascend through the range of options for variable and text parameters, press...



To descend through the range of options, press...



When selecting an option, it is possible only to ascend and descend through the range; there is no shortcut between the first and last option.

4.7 Restoring the drive to the default state

The drive is supplied in the *default state* which is defined as all the parameters being at their *standard factory default values* (for details of alternative default states, see Chapter 8 *Menu 0 Parameters* on page 42).

When the drive is configured for the application and during use, parameters are over-written. If required, these can be returned to their default values by restoring the drive to the *default state*.

Restoring the drive to the default state also causes the drive to calculate the PID-gains, using the default values of Pr **3.19** **{0.09}** *Stiffness angle* and Pr **3.20** **{0.10}** *Load inertia* (see *Specifying shaft stiffness and load inertia* on page 97).

The values of the parameters that are saved at power-down (S-parameters) are unaffected.

Procedure

NOTE

Any settings that have been made will be lost. If any continue to be required, ensure that you have a note of them before following this procedure.

1. Open the **Hardware enable** contact (or set Pr **6.15** *Drive enable* at **0**) to inhibit (disable) the drive.

Use these procedures (described earlier) to set Pr **XX.00** at 1233 in order to initiate the default operation

- *Quick selection of Pr XX.00*
- *Changing the value of a parameter*

2. Execute the operation by performing the following...
 - While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at 100 via serial communications.

3. All parameters are now restored to their default values and saved; PID gains have been calculated.
4. If required, enter and save the noted settings.

5 Getting Started

5.1 Electrical power connections

Before continuing, ensure the drive has been connected in accordance with the instructions in Chapter 2 *Installing the drive* in the Installation Guide, **including correct use of the ground bracket**.

When following the instructions in this chapter, it is your responsibility to connect and disconnect the AC supply as required.



The AC supply must be connected to the drive with appropriate fuses or protection, as described in the Installation Guide.



Adjustment of parameter values must be performed only by suitably trained or experienced personnel. Incorrect values could be hazardous.

For product familiarisation, it is recommended that you make only the adjustments stated in the following procedures. If you do adjust any other parameter(s), first note the original value(s).



Failure to restore the drive to the default state when instructed in this chapter may result in inadequate thermal protection and unstable control of the motor.

5.2 Procedure for Keypad mode

Version: **_AN**

1. Ensure the signal connections for Keypad mode have been made (Figure 2–3).
2. Perform the procedure in *Specifying shaft stiffness and load inertia* on page 97. **Failure to perform this procedure will omit essential steps. It may also result in unstable control of the motor and the drive tripping.**
3. Set Pr **0.30 Reference selector** at **4**.
4. Ensure Pr **0.34 Keypad reference** is set at **0**.
Return to Pr **0.05 Speed feedback** (the default *initially displayed parameter*) is now displayed on the upper line of the display.
5. The display indicates as follows:



6. Close the **Hardware enable** contact.
7. The display indication changes as follows:



8. Close the **RUN** contact. The display indicates as follows:



NOTE

If mechanical resonances occur when the motor is running, see Testing the system in Specifying shaft stiffness and load inertia in Appendix D Optimizing the Dynamic Performance.

9. Press and hold down...



The motor speed increases in the forward direction. The upper line of the display indicates an increasing value of speed in RPM. Release the key when the display indicates a suitable value (e.g. **100.0**). The display now indicates as follows:



10. Press and hold down...



The motor speed decreases to zero then increases in the reverse direction. The upper line of the display indicates the speed with a minus sign.



11. So far, the upper line of the display has been indicating the value of speed feedback, which is the actual motor speed. If changes in speed demand cause the drive to enter current limiting or ramp control occurs (by default ramps are disabled), the new value will be displayed only when the motor has reached the new speed. The following four steps will cause the value of the keypad (speed) reference to be displayed, giving immediate indication of the value of speed demand.
12. Press...



The display is now in Parameter mode, its lower line indicating Pr **0.05**.

13. Press and hold down...



... until Pr **0.34** is displayed on the lower line. The upper line now indicates the value of Pr **0.34 Keypad reference**.



14. Perform either of the following:
 - Wait eight seconds; the display will return to Status mode
 - Press...



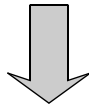
15. The display indicates as follows:



Return to Pr **0.05 Speed feedback** is now displayed on the upper line of the display.

16. Open the **RUN** contact. The following occur:

- The motor decelerates to rest
- The value indicated on the upper line of the display correspondingly reduces to zero
- The lower line of the display shows **dEC**, then **StP**



17. Open the **Hardware enable** contact (or set Pr **6.15 Drive enable** at **0**). The display indicates as follows:



18. Initiate the save operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

19. To use the *saved* values after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 20.

Summary

The procedure has shown the following (for version **_AN**):

- When the drive is inhibited (disabled) (i.e. **Hardware enable** contact is open or Pr **6.15 Drive enable** is set at **0**), the lower line of the display states **inh**.
- When the drive is enabled (i.e. **Hardware enable** contact is closed and Pr **6.15 Drive enable** is set at **1**) but the **RUN** contact is open, the lower line of the display states **StP**.
- When the **RUN** contact is closed and the motor is stationary, accelerating, decelerating or running at a constant speed, the lower line of the display states **run**.
- When the **RUN** contact has been opened and while the motor is decelerating, the lower line of the display indicates **dEC** (when the deceleration time is sufficiently long).
- The upper line of the display indicates the value of a parameter; Pr **0.05 Speed feedback** for indicating actual motor speed and Pr **0.34 Keypad reference** for indicating the speed demand were demonstrated.
- When the motor is running in the reverse direction, a minus sign appears in front of the indicated speed value.

Alarms and trips

Alarms and trips are described in Appendix B *Diagnostics* on page 87.

1. If an alarm message appears on the lower line of the display, the drive continues running, but will trip if the cause of the alarm is not corrected.
2. If the drive trips, the motor will no longer be controlled and will be allowed to coast. The lower line of the display will indicate as shown below and the upper line will indicate a trip code:



3. To clear a trip, correct or remove the cause of the trip, then reset the drive by either of the following means...
 - Momentarily close the **RESET** contact
 - Press:



5.3 Procedure for serial communications

1. Ensure the signal connections for serial communications have been made (Figure 2–7).
2. Perform the procedure in *Specifying shaft stiffness and load inertia* on page 97. **Failure to perform this procedure will omit essential steps. It may also result in unstable control of the motor and the drive tripping.**
3. Send a read-command to check that Pr **1.14 {0.30}** Reference selector is set at **3**. If required, send a write-command to set it at **3**.
4. Send a read-command to check that Pr **1.15 Preset reference selector** is set at **1**. If required, send a write-command to set it at **1**.
5. Send a read-command to check that Pr **1.21 {0.33}** Preset reference 1 is set at **0.0**. If required, send a write-command to set it at **0.0**.
6. Close the **Hardware enable** contact.
7. Send a read-command to check that Pr **8.09 {0.01}** Hardware enable status is set at **1**.
8. Send a read-command to check that Pr **10.03 At zero speed indicator** is set at **1**.
9. The drive is supplied configured for start and stop control by a **RUN** contact. For start and stop control via serial communications, send a write-command to set Pr **8.21 Digital input 1 destination selector** at

00.00. This ensures digital input 1 cannot continue to control the motor. Alternatively, digital input 1 can be assigned to another parameter in order to perform a different function.

10. Send a write-command to set Pr **6.34 Sequencing bit RUN** at **1**.

NOTE

If mechanical resonances occur when the motor is running, see Testing the system on page 98.

11. Send a write-command to set Pr **1.21 Preset reference 1** at a suitable value of speed in RPM (e.g. **100**). The motor then accelerates to the entered value.
12. Send a read-command to check that Pr **10.02 Drive running indicator** is set at **1**.
13. Send a read-command to check that the value of Pr **3.02 {0.05} Speed feedback** (e.g. **100.0**) is the same as the value of Pr **1.21 Preset reference 1** (e.g. **100**).
14. Send a write-command to change Pr **1.21 Preset reference 1** to a negative value (e.g. **-80**). The motor decelerates to rest then accelerates to the speed reference in the reverse direction.
15. Send a read-command to check that the value of Pr **3.02 {0.05} Speed feedback** (e.g. **-80**) is the same as the value of Pr **1.21 Preset reference 1** (e.g. **-80.0**).
16. Send a write-command to set Pr **6.34 Sequencing bit RUN** at **0**. The motor decelerates to rest.
17. When the motor has stopped, send a read-command to check that Pr **10.03 At zero speed indicator** is set at **1**.
18. Open the **Hardware enable** contact or send a write-command to set Pr **6.15 Drive enable** at **0**.
If a **Hardware enable** contact is being used, it can be left continuously closed. In this case, to disable the drive, set **6.15 Drive enable** at **0**. To subsequently re-enable the drive, open then re-close the contact or set Pr **6.15** at **1**.
19. Send a read-command to check that Pr **8.09 {0.01} Hardware enable status** is set at **0**.
20. Perform the following, as appropriate:

Version _AN

Initiate the save operation by setting Pr **XX.00** at **1000**.
Execute the operation by setting Pr **10.38** at **100**.

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the store operation by setting Pr **0.50** at **2 (Prog)**.
Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

21. To use the *stored* values after the next power-up, ensure Pr **0.50** is set at **boot2 (4)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 20.

Summary

The procedure has shown the following (for either version controlled by serial communications):

- When the drive is inhibited (disabled) (i.e. **Hardware enable** contact is open or Pr **6.15 Drive enable** is set at **0**), **8.09 {0.01} Hardware enable status** is set at **0**.
- When the drive is enabled (i.e. **Hardware enable** contact is closed and **6.15 Drive enable** is set at **1**) but not running, **8.09 {0.01} Hardware enable status** is set at **1**.
- To start the motor, set **6.34 Sequencing bit RUN** at **1**.
- When **6.34 Sequencing bit RUN** is set at **1** and the motor is stationary, accelerating, decelerating or running at a constant speed, **10.02 Drive running indicator** is set at **1**.
- When the motor is running in the reverse direction, the speed value is negative.
- To stop the motor, set **6.34 Sequencing bit RUN** at **0**.

Alarms and trips

Alarms and trips are described in Appendix B *Diagnostics* on page 87.

When the drive is running, periodically send read-commands to check the values of the following parameters:

Pr **10.01 Drive ok indicator**

Pr **10.19 Alarm indicator**

If Pr **10.01** becomes set at **0**, this indicates that the drive has tripped (the motor will no longer be controlled and will be allowed to coast). Pr **10.20** is set at the value of the trip code.

If **10.19** becomes set at **1**, this indicates that one of the following alarms has occurred:

Pr **10.12 Braking-resistor overload alarm indicator**

Pr **10.17 Motor overload trip indicator**

Pr **10.18 Heatsink temperature alarm indicator**

To clear a trip, correct or remove the cause of the trip, then reset the drive by sending a write-command to set Pr **10.38** at **100**.

6 Setting Up the drive for Basic Applications

The setting-up instructions are presented in the form of flow diagrams, as follows:

Procedure for version **_AN**

- Power-up routine
- Select speed reference routine
- Ramps routine
- Starting routine

Procedure for version **_SL**

(control via serial communications; also suitable for version **_AN**)

- Power-up routine
- Select speed reference routine
- Ramps routine
- Starting routine

Setting up requires you to adjust parameters; information on these is given in Chapter 8 *Menu 0 Parameters* on page 42 and Chapter 9 *Advanced Parameters* on page 49.

If any of the following apply...

- An external braking resistor is to be used
- The analog input is to be calibrated
- The programmable parameter is to be set up

... before continuing, follow the instructions in Chapter 7 *Security and Accessing the Advanced Parameters* on page 40. When setting up is completed, follow the instructions for locking security.

6.1 Procedure for version _AN

Power-up routine (_AN)

Ensure the Drive is installed correctly.

1

Ensure the motor is connected to the machine and the machine is safe to be driven.

2

Ensure the **Hardware enable** and **RUN** contacts are open

3

Apply AC power to the Drive

4

Is the display lit?

5

NO

See *Status LEDs* in
Appendix B *Diagnostics*

Is the green status LED (D3) lit?

6

NO

YES

A **Hardware enable** signal
is being applied. Open the
Hardware enable contact.

Display indicates **rdY**?

7

YES

NO

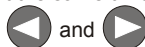
Display indicates **inh**

8

Ensure parameter **0.50 Parameter transfer selector** is set at **no**

9

After changing the setting and
while the display is in Edit mode,
press at the same time:



Perform the procedure in
*Specifying shaft stiffness and load
inertia* in Appendix D *Optimising
the Dynamic Performance*

10



Failure to perform this procedure
will omit essential steps. It may
also result in unstable control of
the motor and in the Drive tripping.

Drive to operate in **SPEED** mode?

11

NO

For operation in **TORQUE**
mode, see the *M'Ax
Advanced User Guide*.

Ensure parameter **0.22 Torque mode select** is set at **0**.

12

Go to *Select speed reference*
routine.

Select speed reference routine (_AN)

Use the high-precision analog input? (Version **_AN**)

1

NO

Use the preset speed reference(s)?

2

NO

Use the keypad reference? (For setting up the Drive only)

3

NO

Use pulse (frequency-and-direction or quadrature) inputs?

4

NO

Control by serial communications?

5

NO

Control by  technology.

6

Is the value of parameter **0.08** *Maximum speed clamp* suitable?

7

YES

Is the value of parameter **0.04** *Final speed reference* suitable?

8

YES

Are acceleration and/or deceleration ramps required?

9

NO

Go to *Starting* routine.

YES

Set parameter **0.30** *Reference selector* at 1. Set the speed reference at the required value. (If required, see *Calibrating the Analog Input* later in this chapter.)

YES

Set parameter **0.30** *Reference selector* at 3. Enter the required speed value in parameter **0.33** *Preset reference*.

YES

Set parameter **0.30** *Reference selector* at 4. Enter the required speed value in parameter **0.34** *Keypad reference*.

YES

Set parameter **0.30** *Reference selector* at 5.

YES

Set parameter **0.30** *Reference selector* at any value.

Set parameter **0.30** *Reference selector* at any value. Set parameter **11.66** *Host mode enable* at 0.

The motion controller now has full control of the Drive.

NO

Adjust as required

NO

YES

Go to *Ramps* routine.

**Ramps routine
(_AN)**

Set parameter **0.24 Ramps enable** at 1.

1

Set parameter **0.25** at the required acceleration rate (in s/1000RPM).

2

Set parameter **0.26** at the required deceleration rate (in s/1000RPM).

3

Is deceleration to be fixed at the user-defined rate?

4

YES

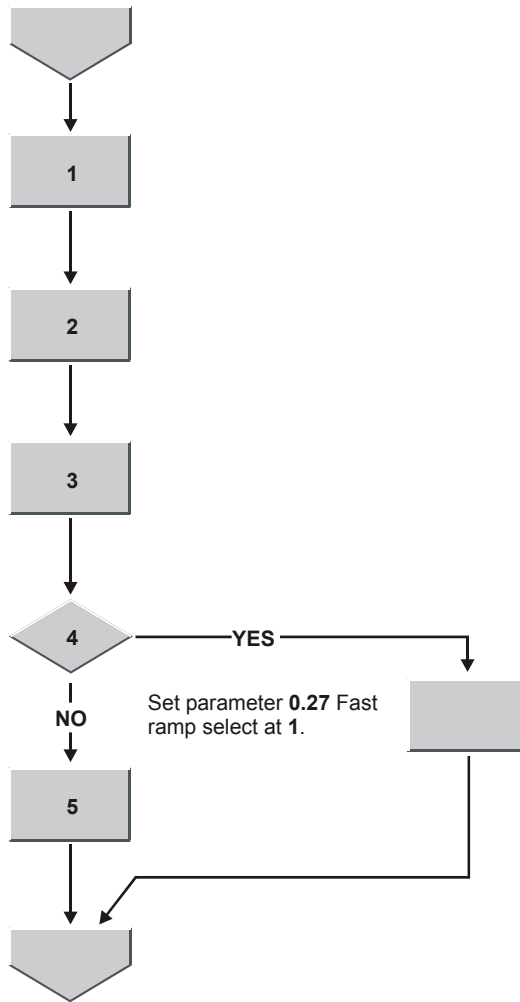
Set parameter **0.27 Fast ramp select** at 1.

NO

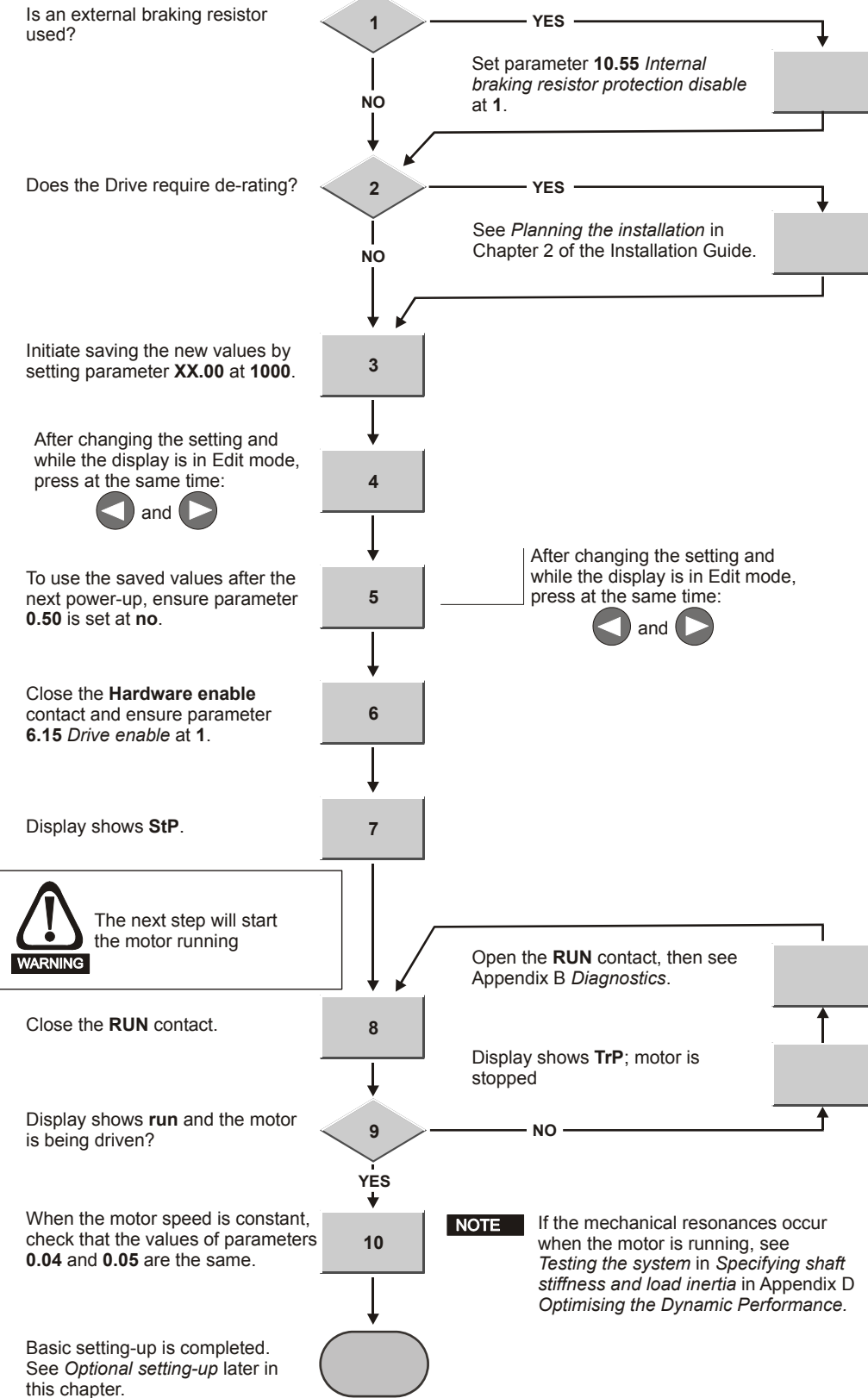
When necessary, deceleration time is automatically extended to prevent over-voltage trips.

5

Go to *Starting* routine



Starting routine (_AN)



6.2 Procedure for version _SL

Power-up routine (_SL)

Ensure the Drive is installed correctly and able to be controlled and monitored via serial communications.

1

Ensure the motor is connected to the machine and the machine is safe to be driven.

2

Ensure the **Hardware enable** contact and, if connected, the **RUN** contacts are open.

3

Apply AC power to the Drive

4

YES

See *Status LEDs* in
Appendix B *Diagnostics*

Is the green status LED (D3) lit?

5

NO

YES

A **Hardware enable** signal
is being applied. Open the
Hardware enable contact.

Is parameter **0.01 Hardware enable indicator** set at 1?

6

NO

YES

Ensure parameter **0.50 Parameter transfer selector** is set at **4 (boot2)**. After changing the setting, set parameter **10.38** at 100.

7

Perform the procedure in *Specifying shaft stiffness and load inertia* in Appendix D *Optimising the Dynamic Performance*

8

Drive to operate in **SPEED** mode?

9

NO

YES

Ensure parameter **0.22 Torque mode select** is set at **0**.

10

Go to *Select speed reference* routine.



WARNING

Failure to perform this procedure will omit essential steps. It may also result in unstable control of the motor and in the Drive tripping.

For operation in **TORQUE** mode, see the *M'Ax Advanced User Guide*.

Select speed reference routine (_SL)

Use the standard-precision analog input?

1

YES

Set parameter **0.30 Reference selector** at 1. Set the speed reference at the required value.
(If required, see *Calibrating the Analog Input* later in this chapter.)

NO

Use the preset speed reference?

2

YES

Set parameter **0.30 Reference selector** at 3.
Enter the required speed value in parameter **0.33 Preset reference**.

NO

Use pulse (frequency-and-direction or quadrature) inputs?

3

YES

Set parameter **0.30 Reference selector** at 5.

NO

Control by serial communications?

4

YES

Set parameter **0.30 Reference selector** at any value.

NO

Control by  technology.

5

Set parameter **0.30 Reference selector** at any value.
Set parameter **11.66 Host mode enable** at 0.

The motion controller now has full control of the Drive (external-host mode).

Is the value of parameter **0.08 Maximum speed clamp** suitable?

6

NO

Adjust as required

YES

Is the value of parameter **0.04 Final speed reference** suitable?

7

NO

YES

Are acceleration and/or deceleration ramps required?

8

YES

NO

Go to *Starting* routine.

Go to *Ramps* routine.

**Ramps routine
(_SL)**

Set parameter **0.24 Ramps enable** at **1**.

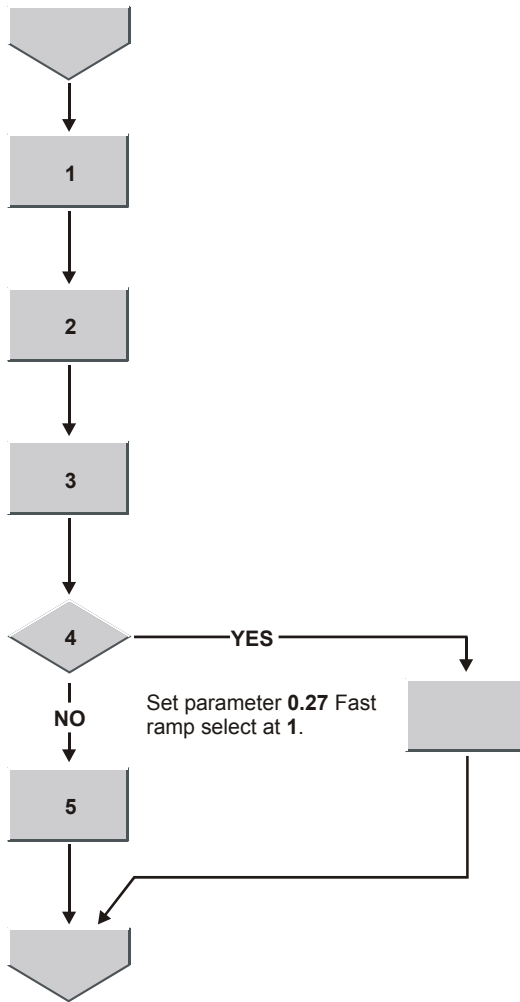
Set parameter **0.25** at the required acceleration rate (in s/1000RPM).

Set parameter **0.26** at the required deceleration rate (in s/1000RPM).

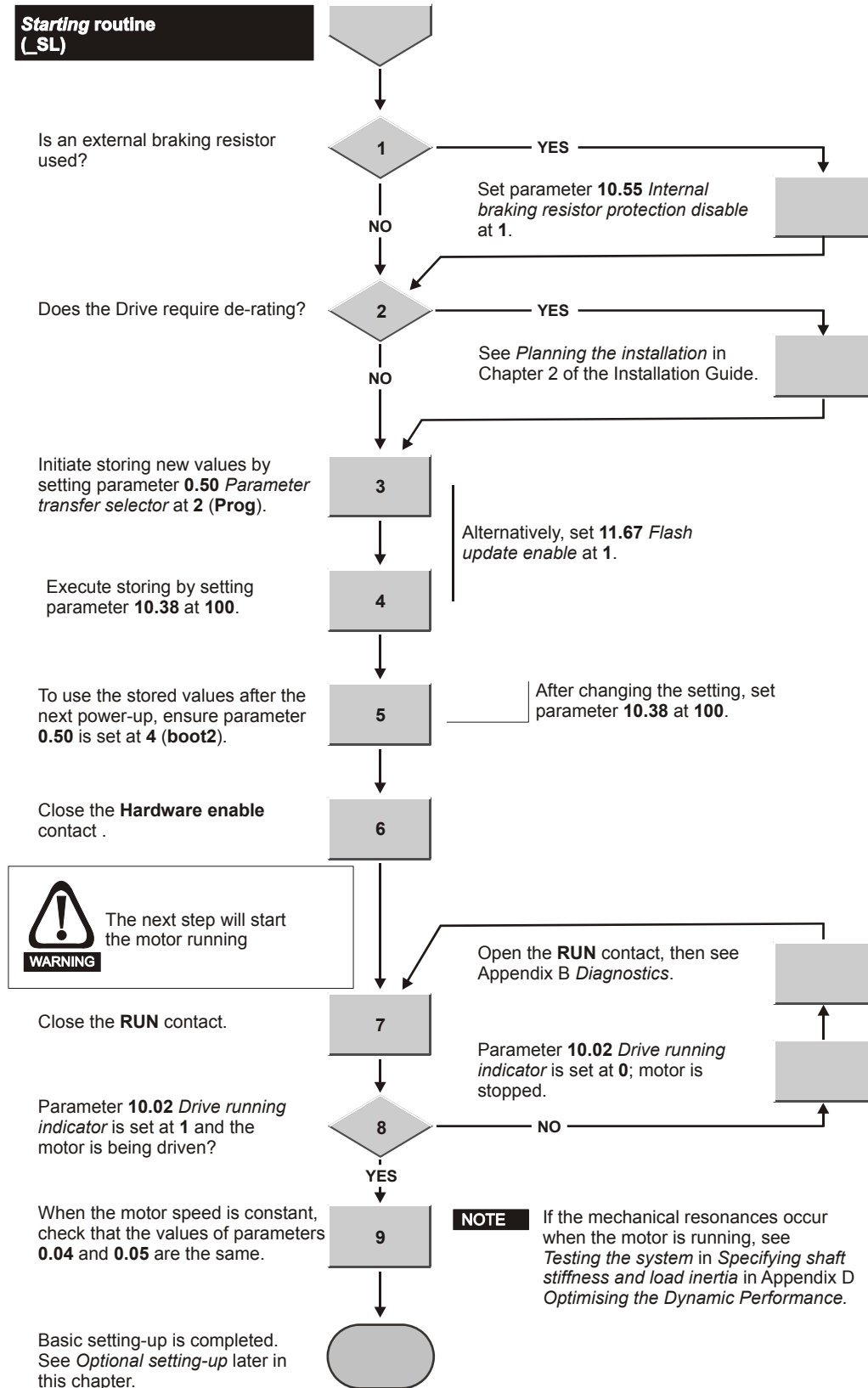
Is deceleration to be fixed at the user-defined rate?

When necessary, deceleration time is automatically extended to prevent over-voltage trips.

Go to *Starting routine*



Starting routine (_SL)



6.3 Additional setting-up

Refer as required to the following sections later in this chapter:

- De-rating the drive
 - Calibrating the analog input
 - Specifying a different initially displayed parameter
 - Using the programmable parameter to indicate rate of flow
- If required, refer also to the following:
- Appendix D *Optimising the Dynamic Performance* on page 96
 - Appendix H *Storage and Transfer of Parameter values* on page 111 (cloning)

6.4 De-rating the drive

Follow this procedure if the output current of the drive is to be de-rated; this should have been established when the Installation Guide was being followed.

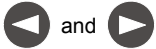
1. Set Pr **4.07 Symmetrical current limit Kc1** at the required percentage of the rated output current of the drive. The value will define the 2-second overload current.
2. If *gain sequencing* is to be used (see Appendix D *Optimising the Dynamic Performance* on page 96), repeat the previous step for the following parameters:
Pr **4.24 Symmetrical current limit Kc2**
Pr **4.28 Symmetrical current limit Kc3**
3. Perform the following, as appropriate:

Version _AN

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.
Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

4. Version **_AN**: So that the *saved* values are used after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.
5. Version **_SL**: So that the *stored* values are used after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.

6.5 Calibrating the analog input

When the speed is being controlled by an analog speed reference, the analog input that is in use (high- or standard-precision, depending on drive version) can be automatically calibrated for the actual voltage range of the speed reference.

Procedure

1. Ensure the **Hardware enable** contact is open.
2. If not already performed, follow the instructions in *Unlocking Standard Security* on page 40.
3. Version **_AN**: Check the lower line of the alphanumeric display states **inh**.
Version **_SL**: Check that the value of Pr **0.01** is **0**.
4. Apply the required speed-reference voltage (not exceeding $\pm 10V$) for maximum speed, as follows:
Version **_AN**: **STANDALONE** connector, pins 13 and 12
Version **_SL**: **SIM EMC** connector, pins 4 and 3
5. Set Pr **7.25 Calibrate analog input 1 full scale** at **1**.

6. The scale factor is automatically entered in Pr **7.53 V/f scale**. Pr **7.25** automatically returns to **0**.
7. Perform the following, as appropriate:

Version _AN

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.
Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

8. Version **_AN**: So that the *saved* values are used after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.
9. Version **_SL**: So that the *stored* values are used after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.

This procedure can be repeated, as required.

6.6 Analog input scaling

To adjust the full scale speed with a higher resolution, a scaling factor needs to be introduced. This is possible by using the following parameters:

Pr **7.55 Analog input scaling numerator**

Pr **7.56 Analog input scaling denominator**

Pr **7.57 Analog input scaling enable**

To increase the resolution, ensure that large numbers are selected for the numerator and denominator.



Ensure the motor shaft is disconnected for the following two procedures. This will allow the motor to run without the limitation of end stop or mechanical limitations.

Procedure

Example:

Full scale analog input = 9.0V

Full scale speed = 3000rpm

1. Enable analog input scaling by setting Pr **7.57** to **1**
2. The scaling factor required to operate the drive from a 9V analog input for 3000rpm:

$$\frac{\text{Pr 7.55 Analog input scaling numerator}}{\text{Pr 7.56 Analog input scaling denominator}} = \frac{1000}{900}$$

3. Enable the drive and set controller to full scale speed. Check the motor makes the required speed. If the speed is not quite reaching the required full scale speed, make minor changes to the scaling factor.
4. Perform the following, as appropriate:

Version _AN

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

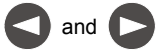
Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.
- Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

6.7 Specifying a different initially displayed parameter

Version _AN

1. If the value of an advanced parameter is to be displayed, set Pr **0.35 User security code** at **0**.
2. Set Pr **0.38 Initial parameter displayed selector** at the number of the required parameter.
3. Initiate the save operation by setting Pr **XX.00** at **1000**.
4. Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)
5. To use the *saved* values used after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 4.
 6. The value of the specified parameter is now displayed and will be displayed every time the drive is subsequently powered-up.

6.8 Setting up the programmable parameter

Versions _AN, _SL

Pr **0.46** can be assigned to any advanced parameter and given a scaling factor. Typical uses are as follows:

- Indicates the rate of flow in a way that is meaningful to the production process (e.g cans per hour)
- Indicates the torque calculated from the motor current.

The default function is as follows:

$$0.1 \times \text{Pr } 0.05 \text{ speed feedback}$$

1. Assigning [Pr 0.46] to another parameter.

Enter the number of the required parameter in [Pr **11.20 Pr 0.46 assigned selector**].

2. Changing the scaling for [Pr 0.46.]

Note the number of decimal places used by the values of the parameter assigned to Pr **0.46**. Obtain the value of the modifier from the following table.

No. of decimal places	Scaling modifier (M)
0	0.1
1	1
2	10
3	100
etc.	etc.

3. Use [11.21] to define the required scaling factor, as follows:

$$[11.21] = [0.46] / [XX.XX] \times M$$

Where:

[XX.XX] is the value of the parameter that is assigned to Pr **0.46** by Pr [11.20].

4. Perform the following, as appropriate:

Version _AN

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.
- Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

5. Version **_AN**: So that the *saved* values are used after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.
6. Version **_SL**: So that the *stored* values are used after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.

This procedure can be repeated, as required.

Examples

Default settings.

Parameter assigned to Pr **[0.46] = [3.02]**

Number of decimal places used in the value of Pr **[3.02] = 1**

Therefore **M = 1**

Default setting of Pr **[11.21] = 0.1**

The value of Pr **[0.46]** is given by:-

$$[0.46] = [3.02] \times [11.21] \times M$$

For example, when **[3.02] = 1500rpm**, **[0.46]** is as follows:-

$$[0.46] = 1500 \times 0.1 \times 1 = 150$$

Approximate indication of torque.

1. Set Pr **[11.20]** at **[4.01]** or **[0.07]** (motor current magnitude).
2. Two decimal places are used in the value, therefore **M = 10**
3. Set Pr **[11.21]** at 0.16 (1.6 / 10 = 0.16) to represent the **K_T** of the motor. (Here **K_T** is divided by 10 due to **M = 10**.)
4. Pr **[0.46]** will indicate as follows:-
 $[0.46] = [4.01] \times 0.16 \times 10$

When **[4.01]** is 2.75A:-

$$[0.46] = 2.75 \times 0.16 \times 10 = 4.4$$

7 Security and Accessing the Advanced Parameters

Version _AN

7.1 Summary of security operations

Condition	Standard Security	User Security
Drive as despatched from the factory	Advanced parameters cannot be read or edited (Menu 0 is fully accessible)	None
Locked	Advanced parameters cannot be read or edited (Menu 0 is fully accessible)	Only Pr 0.00 can be edited; all other parameters can be read
Setting up security	Set Pr 0.35 at 149	Set Pr 0.35 at 0 ~ 255 (but not 149); the display reverts to 149 hiding the true value
Saving the code number		Occurs automatically at power-down
Locking security	Perform either of the following... Remove the AC supply (security is automatically locked at power-down) Set Pr XX.00 at 2000 then press:  and 	
Unlocking security	Set Pr 0.00 at 149 then press:  and 	Set Pr XX.00 (in any menu) at the user security code; the display reverts to 0 , hiding the true value
Changing the code	Not possible	Set Pr 0.35 at the required value
Disabling security	Set Pr 0.35 at 0 and interrupt the AC supply	Set Pr 0.35 at 149 (this value is always displayed; just enter Edit mode and return to Parameter mode)
Restoring a default configuration	No change	

7.2 Security levels

Security operates at the following two levels to prevent unauthorized editing of parameters:

User-defined Security

User-defined Security operates only when it has been set up by the user. When locked, it prevents editing of all parameters in *all the menus* except for Pr **XX.00** (in each menu).

Standard Security

When locked, Standard Security prevents editing of all the parameters in the advanced menus, but allows editing of the parameters in Menu 0. The drive has this level of security when supplied.

The code number used to unlock User-defined Security is defined by the user. This gives protection against unauthorized editing of parameters. The code number can be read and edited only when User Security has been unlocked.

7.3 Setting up User Security

The drive is supplied without User Security having been set up. Consequently, when Standard Security is unlocked, all parameters can be read and all read– write parameters can be edited.

Set up User Security as follows:

1. Select Pr **0.35** *User security code*. The default value **149** is displayed.
2. Change the value to the required User Security number which must be within the range **0** to **255**. Do not use the default value **149**.
3. When the display is returned to Parameter mode, the displayed value reverts to **149**. This hides the new User Security number.
4. Follow the procedure in *Saving new parameter-values* on page 25.

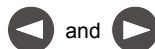
User Security is now set up.

7.4 Unlocking User Security

When User Security has been set up and AC power is re-applied to the drive, User Security is automatically locked. No parameters can be edited except for Pr **XX.00** (in any menu).

Unlock User Security as follows:

1. Select Pr **XX.00** (in any menu).
2. Set the value at the User Security code number.
3. Press:



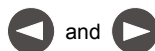
Menu-0 read–write parameters can now be edited. To enable read–write parameters in the advanced menus to be edited, unlock Standard Security.

7.5 Unlocking Standard Security

When AC power is applied to the drive, Standard Security is automatically locked. Only the parameters in Menu 0 can be displayed for reading and editing.

To read and edit parameters in the advanced menus, unlock Standard Security, as follows:

1. Select Pr **0.00**
2. Set the value at **149**.
3. Press:



All the parameters can now be read and edited unless User Security has been set.

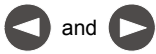
Pr **XX.00** is now accessible in all the menus as **1.00**, **2.00**, etc.

7.6 Locking Standard Security

When AC power is removed and subsequently re-applied, Standard Security and User Security (when set up) are locked.

Lock Standard and User Security without removing AC power, as follows:

1. Select Pr **XX.00** (in any menu).
2. Set the value at **2000**.
3. Press:

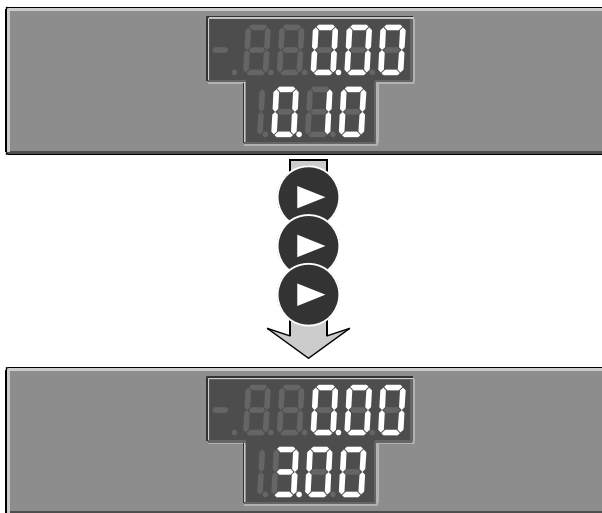


7.7 Selecting an advanced menu

1. Follow the instructions in *Unlocking security* earlier in this chapter.
2. Within eight seconds of unlocking security, press as many times as required...



... in order to select the required menu (Menu 3 shown below).



Note that parameter number **3.00** is displayed; e.g. Pr **XX.00** in the newly selected menu is selected.

3. Select the required parameter.

8 Menu 0 Parameters

NOTE

In some cases, the function and/or range of a parameter are affected by the setting of another parameter; the following descriptions relate to the default condition of such parameters.

Key

FLC	Full-load current (maximum continuous)
n_{MAX}	Maximum speed of the motor (defined by the motor via the SLM)
[SLM]	Value defined by the motor via the SLM
↕	Range of values
⇨	Default value
RW	Read-write parameter
RO	Read-only parameter
{...}	Related advanced parameter
[...]	Value of a parameter
Uni	Unipolar variable parameter <i>Positive values only</i>
Bi	Bipolar variable parameter <i>Positive and negative values</i>
Txt	Text variable parameter <i>Alphanumeric code is displayed</i>
Bit	Bit parameter <i>Two digital states only</i>
R	Parameters must be copied to the EEPROM (saved) or copied to the flash memory (stored) for a new value to take effect
S	A new value is normally copied to the EEPROM (saved) or copied to the flash memory (stored) at power-down (see parameter 0.50 <i>Parameter transfer selector</i>)
P	Protected <i>The parameter cannot be controlled by an external signal (cannot be a destination parameter)</i>

0.00	Parameter XX.00
↕ 0 ~ 3001	
RW	Uni R S P

Parameter **0.00** is used for the following operations:

- Saving new values given to parameters
- Restoring the drive to the default state
- Controlling security
- Calculating the current-loop PID gains

Procedure

1. Initiate an operation by entering one of the following values, as appropriate:

Setting	Operation
1000	Version _AN Save main-parameter values in the option module EEPROM <i>The motor can be stopped or running</i>
1233	Version _AN (The drive is supplied in this default state) Restore all parameters to their default values, and... Enable retrieval of parameter values from the option module EEPROM at subsequent power-ups (0.50 <i>Parameter transfer selector</i> set at no) Enable standalone operation (11.66 <i>Host mode enable</i> set at 1) Calculate PID gains using the default values <i>The drive must be disabled</i>
1244	Version _SL (primarily) Restore all parameters to their default values, and... Enable restoring of parameter values from flash memory at subsequent power-ups (0.50 <i>Parameter transfer selector</i> set at boot2) Enable standalone operation (11.66 <i>Host mode enable</i> set at 1) Calculate PID gains using the default values <i>The drive must be disabled</i>
1255	Version _SL (primarily) (The drive is supplied in this default state) Restore all parameters to their default values, and... Enable restoring of parameter values from flash memory at subsequent power-ups (0.50 <i>Parameter transfer selector</i> set at boot2) Enable slave operation (11.66 <i>Host mode enable</i> is set at 0) Calculate PID gains using the default values <i>The drive must be disabled</i>
149	Unlock standard security <i>The motor can be stopped or running</i>
0 ~ 255	User security code <i>The motor can be stopped or running</i>
2000	Lock security <i>The motor can be stopped or running</i>
3000	Calculate the speed-loop PID gains (see 0.13 , 0.14 , 0.15) <i>The drive must be disabled</i>
3001	Calculate the speed-loop PID gains and symmetrical current limit (see 0.13 , 0.14 , 0.15) <i>The drive must be disabled</i>
4001	Selects SLM software page 1 (see Menu 15)
4003	Selects SLM software page 3 (see Menu 15)



To change from external host to host mode, the drive requires defaulting twice, i.e. XX.00 to either 1233, 1244, 1255 or 3001. The first default changes the operation of the drive, and the second default identifies the drive and motor default settings.

2. Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:



- Set **10.38** at **100** via serial communications.

0.01	Hardware enable indicator
{8.09}	↕ 0 ~ 1
RO	Bit P

0.01 indicates 1 when a **Hardware enable** signal is present on any of the following signal-connector pins:

Connector	Terminal
STANDALONE	3
MC/EIA	3
SLM	4
MC	4
MULTIDROP OUT	4
MULTIDROP IN	4

A **Hardware enable** signal must be applied when the motor is to be driven.

0.02	Reference selected indicator		
{1.49}	⇅ 1 ~ 5		
RO	Uni	P	

Pr 0.02 indicates which speed reference has been selected by Pr 0.30 *Reference selector*, as follows:

0.02	Speed reference selected
1	Analog speed reference
2	Analog speed reference
3	Preset speed reference
4	Keypad speed reference
5	Pulse reference

0.03	Value of selected reference		
{1.01}	⇅ ±[0.08]		
RO	Bi	P	RPM

Pr 0.03 indicates the value of the speed reference that has been selected by Pr 0.30 *Reference selector* (see Pr 0.02 *Reference selected indicator*) and the value of Pr 0.06 {1.04} *Reference offset*.

0.04	Final speed reference		
{3.01}	⇅ ±[0.08]		
RO	Bi	P	RPM

Pr 0.04 indicates the instantaneous value of the sum of the following:
Pr 0.03 {1.01} *Value of selected reference*, and Pr 3.22 *Hard speed reference* only enabled if Pr 3.23 *Hard speed reference selector* set to 1.

During acceleration and deceleration under ramp control (see Pr 0.25, Pr 0.26), [0.04] will differ from the sum of the applied speed reference and reference offset.

0.05	Speed feedback		
{3.02}	⇅ ±[0.08]		
RO	Bi	P	RPM

Pr 0.05 indicates the instantaneous value of the speed feedback. This is supplied to the drive by the CT-Coder via the **SLM**.

When the drive is not in current limit, [0.04] = [0.05].

0.06	Reference offset		
{1.04}	⇅ ±[0.08] ⇒ 0		
RW	Uni		

Set Pr 0.06 at the required value of offset (e.g. amount of trim) to be added to or subtracted from the selected speed reference (see Pr 0.02 *Reference selected indicator*).

0.07	Motor current magnitude		
{4.01}	⇅ 0 ~ I _{OL}		
RO	Uni	P	A

I_{OL} Maximum overload current from the drive (2 x FLC)

Pr 0.07 indicates the average RMS phase current to the motor.

0.08	Maximum reference clamp		
{1.06}	⇅ 0 ~ 7500 ⇒ n _{MAX}		
RW	Uni		rpm

n_{MAX} Maximum speed of the motor (defined by the motor via the **SLM**)

Pr 0.08 is used for defining the maximum speed at which the drive will drive the motor. Excessive speed references are clamped to [0.08]. If the motor speed exceeds [0.08] (e.g. under torque control), the drive will trip allowing the motor to coast. (See trip **OU.SPd** in Appendix B *Diagnostics*.)

0.09	Compliance angle		
{3.19}	⇅ 0.0 ~ 30.0 ⇒ 6.0		
RW	Uni		°

Stiffness angle is defined as the angular displacement of the motor shaft that would cause the drive to deliver a torque-producing current equivalent to the value of FLC (without field weakening).

Enter a suitable value in Pr 0.09 in order to define the dynamic performance of the system.

See Pr 0.10 *Load inertia* and *Specifying shaft stiffness and load inertia* in Appendix D *Optimizing the Dynamic Performance*.

0.10	Load inertia		
{3.20}	⇅ 0.01 ~ 600.00kgcm ² or		
	⇅ 0.00001 ~ 0.06kgm ² ⇒ J _L		
RW	Uni		

J_L Motor load

The measurement units are defined by the motor via the **SLM**.

Use the following procedure for adjusting Pr 0.10:

1. Unlock security.
2. Ensure Pr 0.11 *Inertia units selected* is set as follows:

0.11	Units
0	kgm ²
1	kgcm ²

3. Enter into Pr 0.10 the value of load inertia seen by the motor.

See Pr 0.09 *Compliance angle* and *Specifying shaft stiffness and load inertia* in Appendix D *Optimizing the Dynamic Performance*.

0.11	Inertia units selected		
{5.34}	⇅ 0 ~ 1		
RO	Bit		

See Pr 0.10 *Load inertia* above

0.12	Speed-loop PID gains selector		
{3.16}	⇅ 0 ~ 3	⇒	1
RW	Uni		

Ensure **0.12** is set at **1** before adjusting any of the following parameters:

Pr **0.13** Speed-loop proportional gain Kp1

Pr **0.14** Speed-loop integral gain Ki1

Pr **0.15** Speed-loop derivative gain Kd1

See *Gain sequencing* in Appendix D *Optimising the Dynamic Performance*.

0.13	Speed-loop proportional gain Kp1		
{3.10}	⇅ 0.000 ~ 0.3000	⇒	[SLM]
RW	Uni		

See Appendix D *Optimising the Dynamic Performance*.

0.14	Speed-loop integral gain Ki1		
{3.11}	⇅ 0.000 ~ 20.000	⇒	[SLM]
RW	Uni		

See Appendix D *Optimising the Dynamic Performance*.

0.15	Speed-loop derivative gain Kd1		
{3.12}	⇅ 0.0000 ~ 0.1000	⇒	[SLM]
RW	Uni		

See Appendix D *Optimising the Dynamic Performance*.

0.16	Current-demand filter 1 cut-off frequency		
{4.12}	⇅ 0 ~ 1200	⇒	500
RW	Uni		Hz

Pr **0.16** is used for adjusting the cut-off frequency of a first-order filter in the current demand to the speed loop. See Appendix D *Optimizing the Dynamic Performance*.

0.17	SLM online enable		
{11.64}	⇅ 0 ~ 1	⇒	0
RW	Bit		

Set Pr **0.17** at **1** to copy to the related PID buffer in the SLM new values entered in the following parameters:

Pr **0.13**, Pr **0.14**, Pr **0.15** Speed-loop PID gains

Pr **0.16** Current-demand filter 1 cut-off frequency

Return Pr **0.17** to **0** immediately afterwards. Do not leave Pr **0.17** at **1** since this will prevent the drive from operating correctly.

0.18	Symmetrical current limit		
{4.07}	⇅ 0 ~ 300	⇒	200
RW	Uni		%I _M

I_M Rated continuous motor-current (defined by the motor via the **SLM**)

Use Pr **0.18** for changing the level of overload current from the drive.

The default overload is 200% rated continuous motor-current for up to 2 seconds.

For basic applications, do not set Pr **0.18** at values greater than 200%.

0.19	Motor - rated current		
{5.07}	⇅ 0 ~ FLC	⇒	[SLM]
RO	Uni		A

0.19 indicates the value of the continuous-current rating of the motor. The value is automatically defined by the motor via the **SLM**.

0.20	Drive rated current (FLC)		
{11.32}	⇅ 00.00 ~ 99.99		
RO	Uni	P	A

0.20 indicates the maximum continuous output current of the drive. This is also referred to as the FLC (full-load current).

0.22	Torque mode selector		
{4.11}	⇅ 0 ~ 1	⇒	0
RW	Bit	P	

Set **0.22** as follows:

0.22 set at 0 (default)

The motor speed is controlled by the speed reference selected by **0.30** *Reference selector*, or by jog (see **0.31** *Jog selected indicator* and **0.32** *Jog reference*).

0.22 set at 1

The motor torque is controlled by **0.23** *Torque reference*. The speed may vary in order to maintain the motor torque at the level of the torque demand.

No speed limit is applied; if the motor speed exceeds [0.08] *Maximum reference clamp*, the drive will trip, allowing the motor to coast. (See trip **OU.SPd** in Appendix B *Diagnostics*.)

0.23	Torque reference		
{4.08}	⇅ ±200.00	⇒	0.00
RW	Bi		%I _{LIM}

I_{LIM} Value of the current limit that is obtained from the setting of **0.18** *Symmetrical current limit*

Set at the required percentage of maximum continuous motor current.

The value can be entered in the following ways:

- Use of the display and keypad
- Via serial communications

If the torque is to be controlled by an external torque reference, see the *M'Ax Advanced User Guide*.

0.24	Ramp enable		
{2.02}	⇅ 0 ~ 1	⇒	0
RW	Bit		

Set **0.24** as follows for speed control (ramps are not used with torque control):

0.24 set at 0 (default)

The motor speed responds directly to changes in the speed reference. Excessive acceleration demand will cause current-limiting, resulting in the motor acceleration not meeting the demand. Excessive deceleration demand will cause excessive DC-bus voltage, resulting in the drive tripping (trip **OU**).

0.24 set at 1

Maximum acceleration and deceleration due to the following...

- Starting the motor when a speed reference is already applied to the drive

- Rapid changes in the speed reference
 - Stopping the motor by opening the **RUN** contact.
- ...are limited to the values of the following parameters:

Pr **0.25** Acceleration rate

Pr **0.26** Deceleration rate

0.25	Acceleration rate		
{2.11}	⇅ 0 ~ 32.000	⇒	0.200
RW	Uni		s/1000RPM

Set Pr **0.25** for the required maximum acceleration rate in both directions of rotation under the following conditions:

- Starting the motor when a speed reference is already applied to the drive
 - Rapid increases in the speed reference
- Larger values produce lower acceleration.

See Pr **0.24** Ramp enable.

0.26	Deceleration rate		
{2.21}	⇅ 0 ~ 32.000	⇒	0.200
RW	Uni		s/1000RPM

Set Pr **0.26** for the required maximum deceleration rate in both directions of rotation under the following conditions:

- Rapid decreases in the speed reference
- Larger values produce lower deceleration.

See the following:

Pr **0.24** Ramp enable

Pr **0.27** Ramp mode select

0.27	Fast ramp select		
{2.04}	⇅ 0 ~ 1	⇒	0
RW	Bit		

Set Pr **0.27** as follows:

Pr **0.27 set at 0 (default)**

If regenerated power during deceleration causes the maximum DC-bus voltage (820V) to be reached, the deceleration is automatically reduced to prevent the maximum voltage from being exceeded. This lengthens the deceleration time.

Pr **0.27 set at 1**

The motor is decelerated according to the demand (or deceleration ramp). If regenerated power during deceleration causes the maximum DC-bus voltage (820V) to be exceeded, the drive will trip (trip code **OU**).

0.28	Feedback-encoder revolution counter		
{3.28}	⇅ 0 ~ 65535		
RO	Uni		REVOLUTIONS

Pr **0.28** indicates a number of revolutions performed by the motor shaft. When the count passes through **65535** on clockwise rotation (run forward), it returns to zero, then resumes counting upward.

When the count passes through zero on anti-clockwise rotation (run reverse), it returns to **65535**, then resumes counting downward.

Pr **0.28** is set at zero each time the drive is powered-up.

0.29	Feedback-encoder position		
{3.29}	⇅ 0 ~ 65535		
RO	Uni		1/65536REV

Pr **0.29** initially indicates the angular position of the motor shaft relative to its position at the time the drive was powered-up. After the first Z marker

pulse has been received from the CT-Coder, Pr **0.29** indicates the angular position of the motor shaft relative to the Z marker pulse.

0.30	Reference selector		
{1.14}	⇅ 0 ~ 5	⇒	1
RW	Uni		s/1000RPM

Set Pr **0.30** as follows:

0.30	Speed reference
0	(See the <i>M'Ax Advanced User Guide</i>)
1	Analog speed reference
2	Analog speed reference
3	Preset speed reference (see 0.33)
4	Keypad speed reference (see 0.34)
5	Pulse speed reference

See also Pr **0.31** Jog selected indicator.

0.31	Jog selected indicator		
{1.13}	⇅ 0 ~ 1		
RO	Bit		P

The setting of Pr **0.31** is controlled by digital input 3 (**DIGITAL I/O** pin 8) and indicates as follows:

Pr **0.31 set at 0**

No signal applied to digital input 3. The motor is controlled by the speed reference selected by Pr **0.30** Reference selector.

Pr **0.31 set at 1**

Signal applied to digital input 3. The motor speed is controlled by Pr **0.32** Jog reference.

0.32	Jog reference		
{1.05}	⇅ 0 ~ 500	⇒	50
RW	Uni		RPM

Enter the required value of jog speed in Pr **0.32**.

See Pr **0.31** Jog selected indicator.

0.33	Preset reference		
{1.21}	⇅ +[0.08]	⇒	1
RW	Bi		RPM

Enter the required value of jog speed in Pr **0.33**.

See Pr **0.30** Reference selector.

0.34	Keypad reference		
{1.17}	⇅ +[0.08]		
RO	Bi		RPM

Version **_AN**: **0.34** indicates the value of the speed reference set by use of the keypad.

Version **_SL**: **0.34** is not used.

0.35	User Security code			
{11.30}	↕	0 ~ 255	⇒	149
RW	Uni	S	P	

See Chapter 7 *Security and Accessing the Advanced Parameters*.

0.36	Serial comms. baud rate			
{11.25}	↕	(see below)	⇒	9600
RW	Txt	S	P	BAUD

Baud rate	
300	
600	
1200	
2400	
4800	
9600	Default
19200	

See Appendix C *Serial Communications*.

0.37	Serial comms. address			
{11.23}	↕	0.0 ~ 24.7	⇒	1.1
RW	Uni	P		GROUP.UNIT

See Appendix C *Serial Communications*.

0.38	Initial parameter displayed selector			
{11.22}	↕	00.00 ~ 21.51	⇒	0.05
RW	Uni	P		MENU.PARAMETER

Version _AN

Use Pr **0.38** to specify the parameter whose value is to be displayed on the upper line of the alphanumeric keypad when the drive is powered-up; this is termed the initially displayed parameter. By default, parameter Pr **0.05** *Speed feedback* is the *initially displayed parameter*.

Normally only one of the Menu 0 parameters can be specified as the initially displayed parameter. If Pr **0.35** *User security code* is set at **0**, any parameter can be specified.

Version _SL

Pr **0.38** has no effect.

0.39	Motor [I^2t] overload trip indicator			
{10.17}	↕	0 ~ 1		
RO	Bit	P		

Pr **0.39** indicates **1** when both the following conditions arise:

- Motor current exceeds 110% of the rated motor current
- The value in the overload accumulator in the SLM exceeds 75%

Version _AN: The lower line of the alphanumeric display indicates the alarm **OuL**.

If the motor current is not reduced, the drive will trip due to excessive motor current (trip code: **I2t.AC**).

0.40	Motor I^2t accumulator			
{10.58}	↕	0.0 ~ 100.0		
RO	Uni			%

Pr **0.40** indicates the value of a motor thermal-overload accumulator in the drive that monitors the power delivered to the motor. If the value reaches

100%, the lower line of the alphanumeric display (version _AN) indicates the alarm **OuL** (the drive continues controlling the motor). If the value exceeds 100%, the drive will trip; the display then indicates **I2t.AC**.

0.41	Drive overload accumulator			
{10.56}	↕	0.0 ~ 100.0		
RO	Uni	P		%

Pr **0.41** indicates the value of an I^2t accumulator that monitors the output power of the drive. If the value exceeds 100%, the drive will trip; the lower line of the alphanumeric display (version _AN) then indicates **O.ht1**.

0.42	Internal braking-resistor overload accumulator			
{10.39}	↕	0 ~ 100.0		
RO	Uni	P		%

Pr **0.42** indicates the value of the of an I^2t accumulator that monitors the power dissipated in the internal braking resistor. If the value exceeds 100% (representing 150W), the drive trips; the lower line of the alphanumeric display (version _AN) indicates **It.br**.

0.43	DC-bus voltage			
{5.05}	↕	0 ~ 1000		
RO	Uni	P		V

Pr **0.42** indicates the value of the DC-bus voltage.

0.44	Last trip			
{10.20}				
RO	Txt	S	P	

Pr **0.44** indicates the trip code of the last trip.

0.45	SLM communications integrity			
{11.56}	↕	0 ~ 100		
RO	Uni			

Pr **0.45** indicates **1** when A *technology* data links are operating correctly.

0.46	Programmable parameter			
------	------------------------	--	--	--

Pr **0.46** can be assigned to any advanced parameter and given a scaling factor. A typical use would be indicating the rate of flow in a way that is meaningful to the production process (e.g. cans per hour).

The default function is as follows:

0.01 x [0.05] Speed feedback

See *Optional setting-up* in Chapter 6 *Setting Up the drive for Basic Applications*.

0.47	SLM software version	
{11.39}	↕ 00.99 ~ 99.99	
RO	Uni	P

0.48	Drive software version	
{11.29}	↕ 1.00 ~ 99.99	
RO	Uni	P

0.49	Security status indicator	
	↕ 000 ~ 111	
RO	Uni	

Pr **0.49** indicates the state of security as shown below (the displayed digits are treated as individual digits; they do not create a three-digit number):

Digit 1	
Value	Indicates...
0	Standard security is unlocked
1	Standard security is locked
Digit 2	
Value	Indicates...
0	Standard security is unlocked
1	Standard security is locked
Digit 3	
Value	Indicates...
0	User security is not set up
1	A User security number has been entered into Pr 0.35

See Chapter 7 *Security and Accessing the Advanced Parameters*.

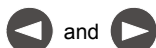
0.50	Parameter transfer selector	
	↕ (see below)	
RW	Txt	

Default settings

Version	Setting
AN	no
SL	boot2

Use Pr **0.50** to initiate the transfer of parameter values between the RAM, EEPROM (when an option module is installed), and the flash memory in the drive (see Appendix H *Storage and Transfer of Parameter Values*). After changing the setting of Pr **0.50**, perform either of the following, as appropriate:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at 100 via serial communications.

Terminology

Save	Copy main-parameter values in the RAM to the EEPROM (when an option module is installed)
Retrieve	Copy all parameter values from the EEPROM to the RAM (when an option module is installed)
Store	Copy parameter values from the RAM to the flash memory in the drive
Restore	Copy parameter values from the flash memory to the RAM
Main parameters	All parameters other than those that are normally saved or stored at power-down
S-parameters	Parameters that are normally saved at power-down (version _AN only)

Notes

At the time of selecting **no**, **boot1** or **boot2**, all parameter values (including the S-parameters) are copied to the flash memory (store).

All parameters can be stored at any time by setting Pr **11.67 Flash update enable** at **1**. The drive must not be powered-down within 15 seconds.

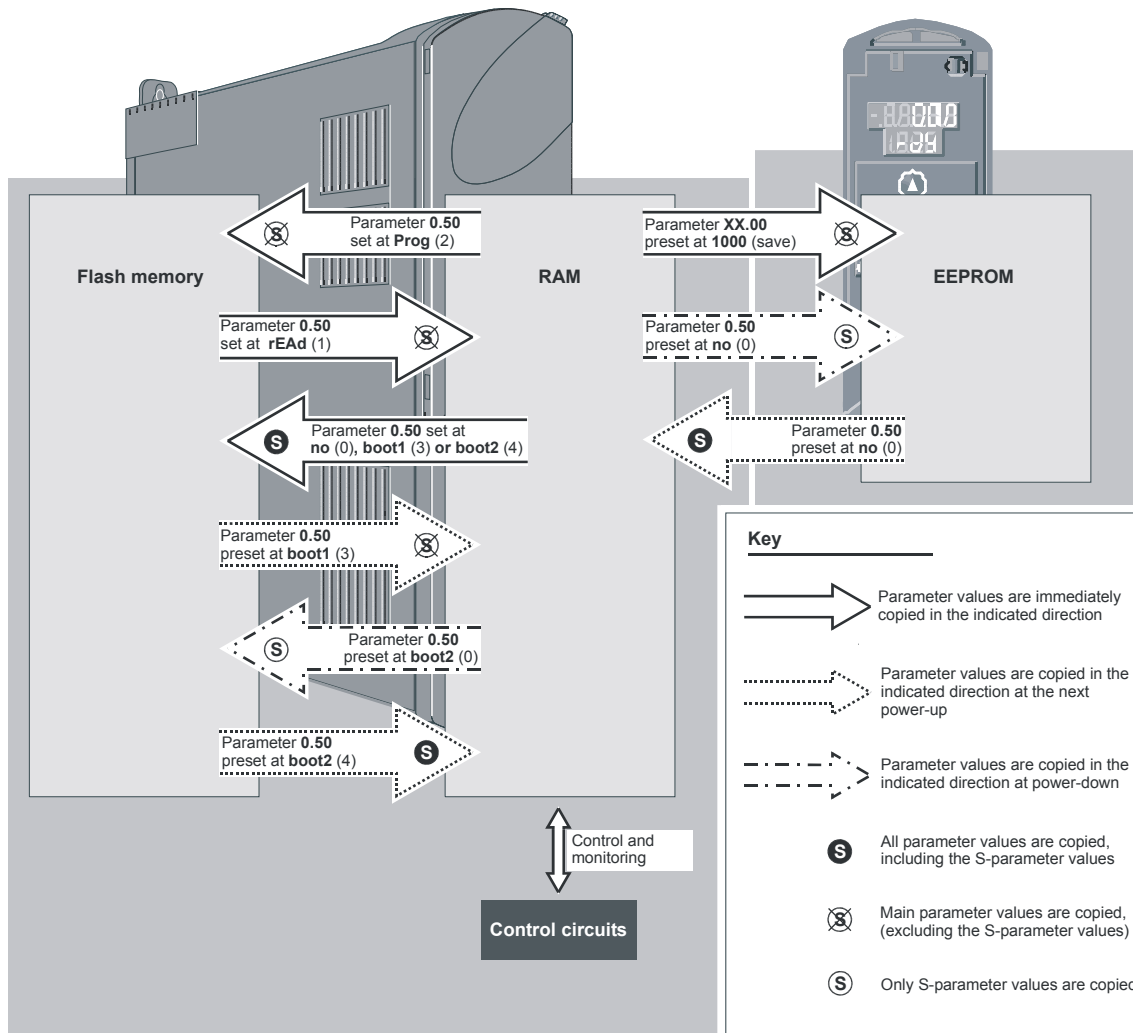
When S-parameters are not copied, the related values at the destination remain unchanged.

Main parameters can be saved irrespective of the setting of Pr **0.50** (i.e. by setting Pr **XX.00** at **1000** and executing the operation).

Setting	Function	Usage
no	0 At power-down: S-parameter values are copied from the RAM to the EEPROM (save). At power up: All parameter values are copied from the EEPROM to the RAM (retrieve).	Used only when an option module is installed (normally, in version _AN)
rEAd	1 The main-parameter values in the flash memory are immediately copied to the RAM (restore).	Normally used in version _SL , but can also be used in version _AN
Prog	2 The main-parameter values in the RAM are immediately copied to the flash memory (store).	
boot1	3 At power-up: The main-parameter values in the flash memory are copied to the RAM (restore). The values of the S-parameters are ignored.	
boot2	4 At power-up: All parameter values (including the S-parameters) in the flash memory are copied to the RAM (restore).	

0.51	SLM page number	
{15.01}	↕ 0 ~ 3	
RO	Uni	P

0.52	SLM page software version	
{15.02}	↕ 00.99 ~ 99.99	
RO	Uni	P



9 Advanced Parameters



These parameters are listed for reference purposes only; the lists do not include sufficient information for adjusting the parameters.

NOTE

In some cases, the function or range of a parameter are affected by the setting of another parameter; the information in these lists relate to the default condition of such parameters.

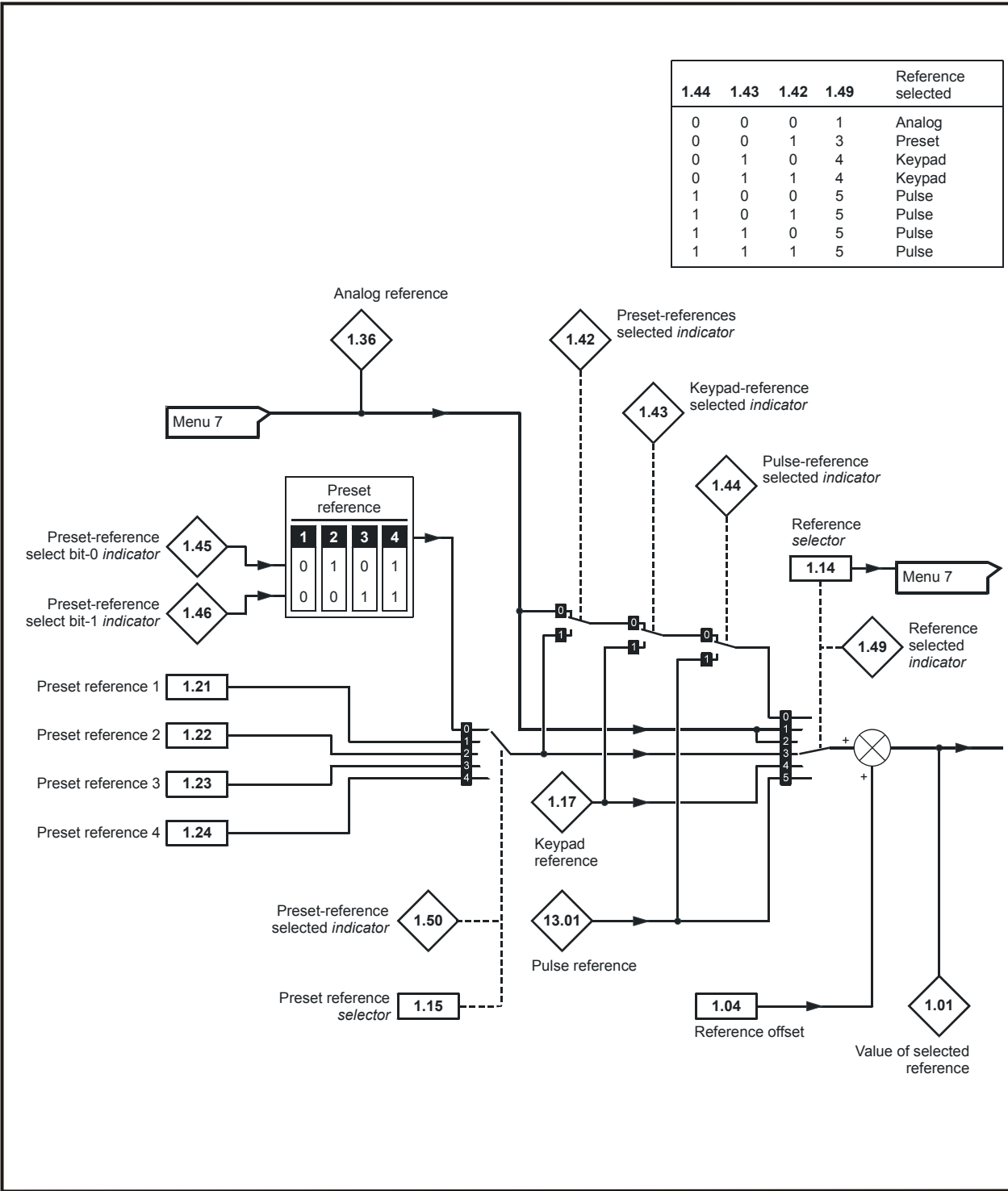
Key

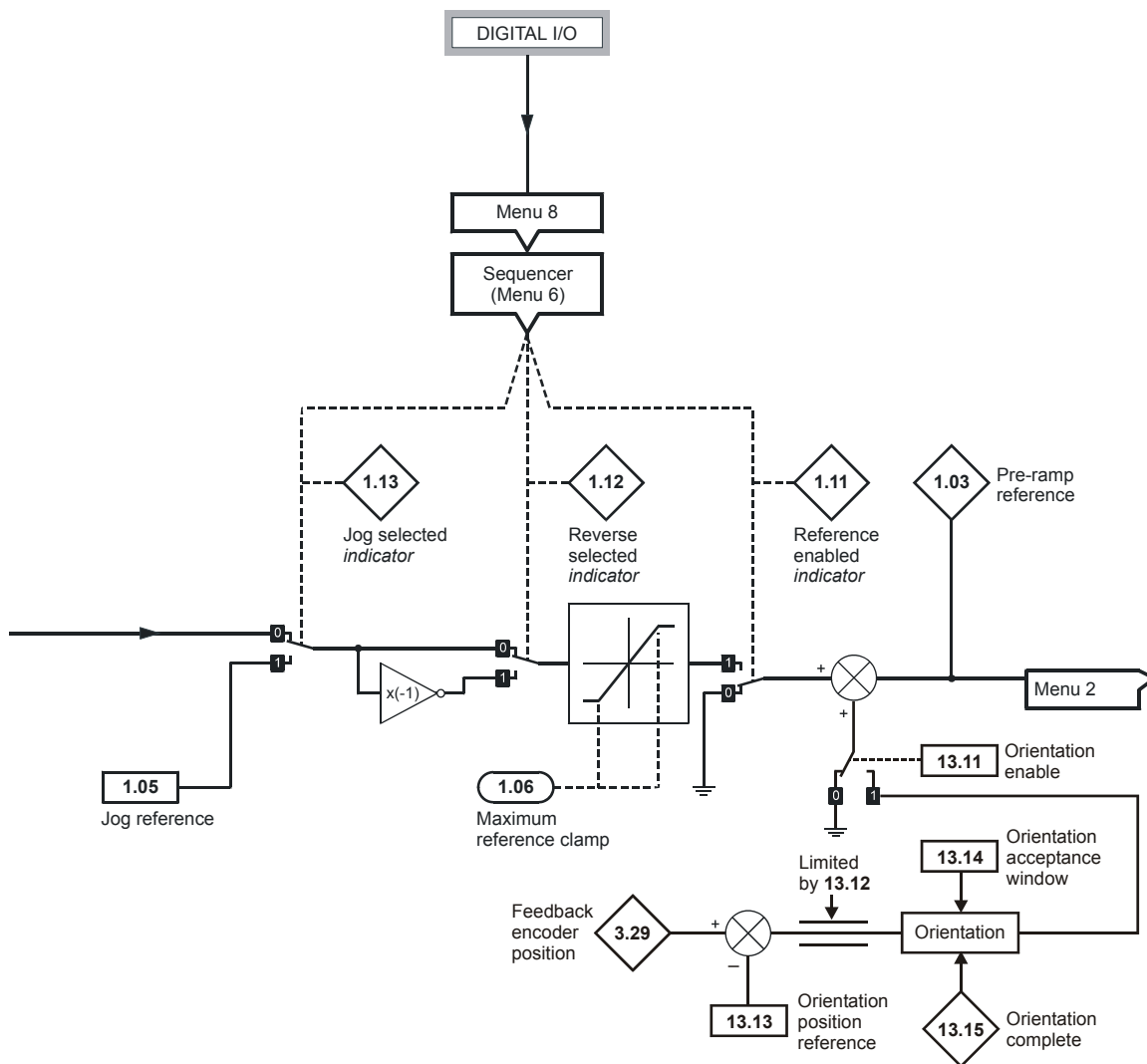
RW	x.xx	Read-write parameter
	x.xx	Read-write (RW) parameter whose default value is defined by the motor via the SLM
RO	x.xx	Read-only parameter
	x.xx	Read-only parameter whose value is defined by the motor via the SLM
{...}	Related Menu 0 parameter	
[...]	Value of a parameter	
Uni	Unipolar variable parameter <i>Positive values only</i>	
Bi	Bipolar variable parameter <i>Positive and negative values</i>	
Txt	Text variable parameter <i>Alphanumeric code is displayed</i>	
Bit	Bit parameter <i>Two digital states only</i>	
R	Parameters must be copied to the EEPROM (saved) or copied to the flash memory (stored) for a new value to take effect	
S	A new value is normally copied to the EEPROM (saved) or copied to the flash memory (stored) at power-down (see parameter 0.50 <i>Parameter transfer function selector</i> in Chapter 8 <i>Menu 0 Parameters</i>)	
P	Protected <i>The parameter cannot be controlled by an external signal (cannot be a destination parameter)</i>	
n _{MAX}	Maximum speed of the motor (defined by the motor via the SLM)	
[SLM]	Value defined by the motor via the SLM	

9.1 Menu 1 parameters

Speed reference selection

Figure 9-1 Software diagram for Menu 1



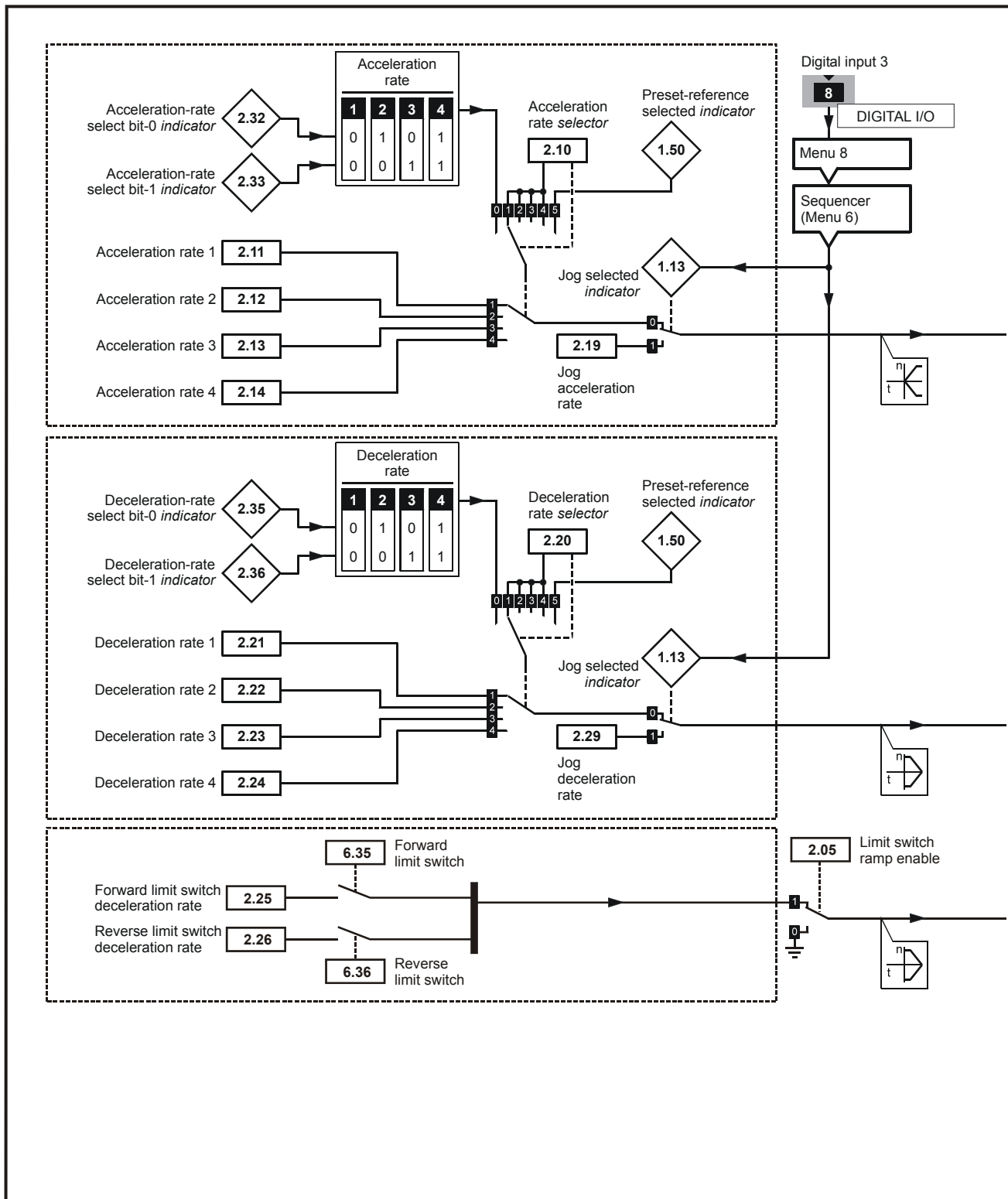


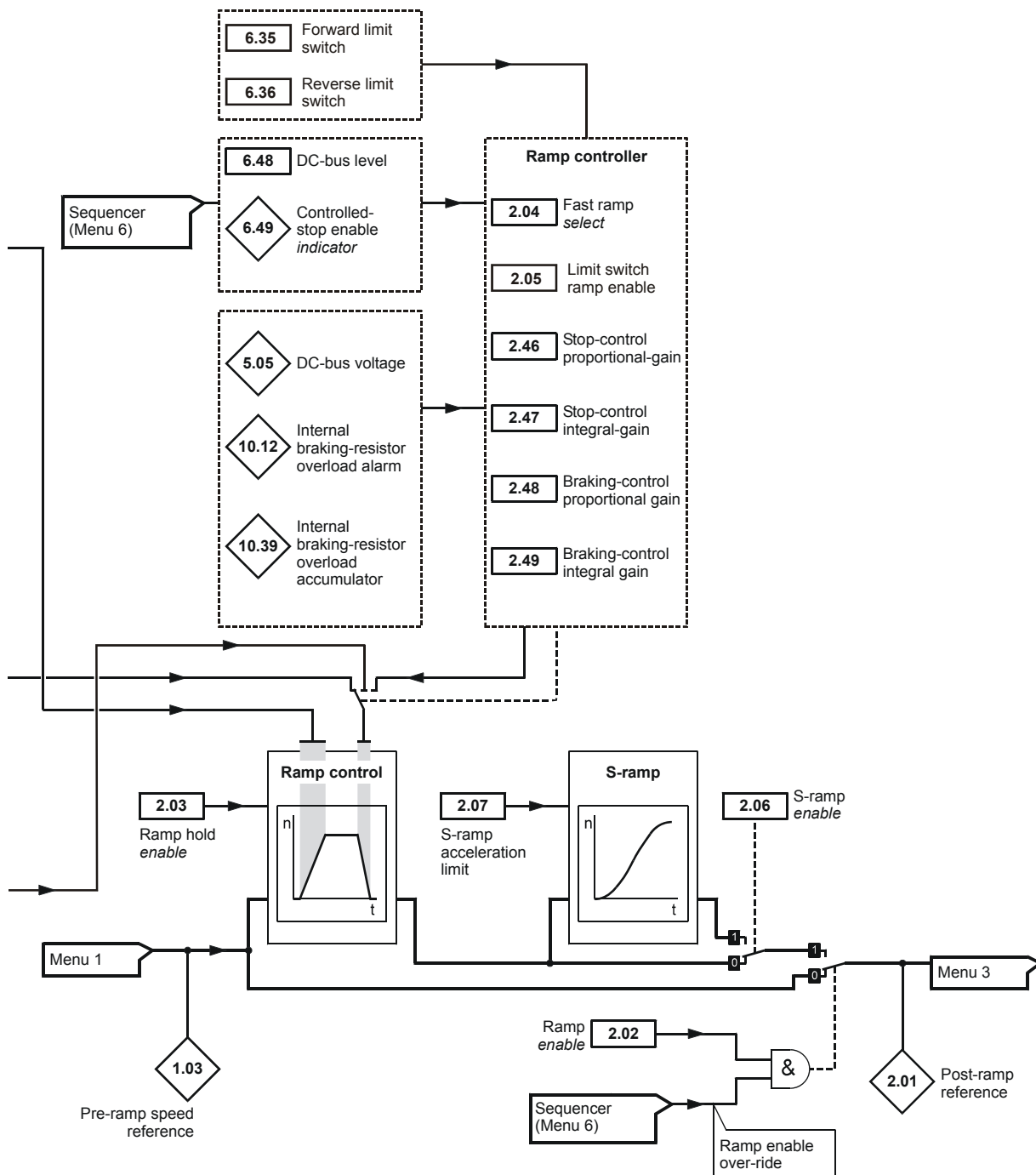
Parameter		Range(⇅)	Default(⇄)	Type			
1.01 {0.03}	Value of selected reference	±[1.06] RPM		RO	Bi		P
1.03	Pre-ramp reference	±[1.06] RPM		RO	Bi		P
1.04 {0.06}	Reference offset	±[1.06] RPM	0	RW	Bi		
1.05 {0.32}	Jog reference	0 ~ 500 RPM	50	RW	Uni		
1.06 {0.08}	Maximum reference clamp	0 ~ n _{MAX} RPM	[SLM]	RW	Uni		
1.11	Reference enabled <i>indicator</i>	0 ~ 1		RO	Bit		P
1.12	Reverse selected <i>indicator</i>	0 ~ 1		RO	Bit		P
1.13 {0.31}	Jog selected <i>indicator</i>	0 ~ 1		RO	Bit		P
1.14 {0.30}	Reference <i>selector</i>	0 ~ 5	1	RW	Uni		P
1.15	Preset reference <i>selector</i>	0 ~ 4	0	RW	Uni		P
1.17 {0.34}	Keypad reference	±[1.06] RPM		RO	Bi	S	P
1.21 {0.33}	Preset reference 1	±[1.06] RPM	1	RW	Bi		
1.22	Preset reference 2	±[1.06] RPM	10	RW	Bi		
1.23	Preset reference 3	±[1.06] RPM	100	RW	Bi		
1.24	Preset reference 4	±[1.06] RPM	1000	RW	Bi		
1.36	Analog reference	±[1.06] RPM		RO	Bi		
1.42	Preset references selected <i>indicator</i>	0 ~ 1		RO	Bit		
1.43	Keypad reference selected <i>indicator</i>	0 ~ 1		RO	Bit		
1.44	Pulse reference selected <i>indicator</i>	0 ~ 1		RO	Bit		
1.45	Preset reference select bit-0 <i>indicator</i>	0 ~ 1		RO	Bit		
1.46	Preset reference select bit-1 <i>indicator</i>	0 ~ 1		RO	Bit		
1.49 {0.02}	Reference selected <i>indicator</i>	1 ~ 5		RO	Uni		P
1.50	Preset reference selected <i>indicator</i>	1 ~ 4		RO	Uni		P

9.2 Menu 2 parameters

Ramp selection

Figure 9-2 Software diagram for Menu 2



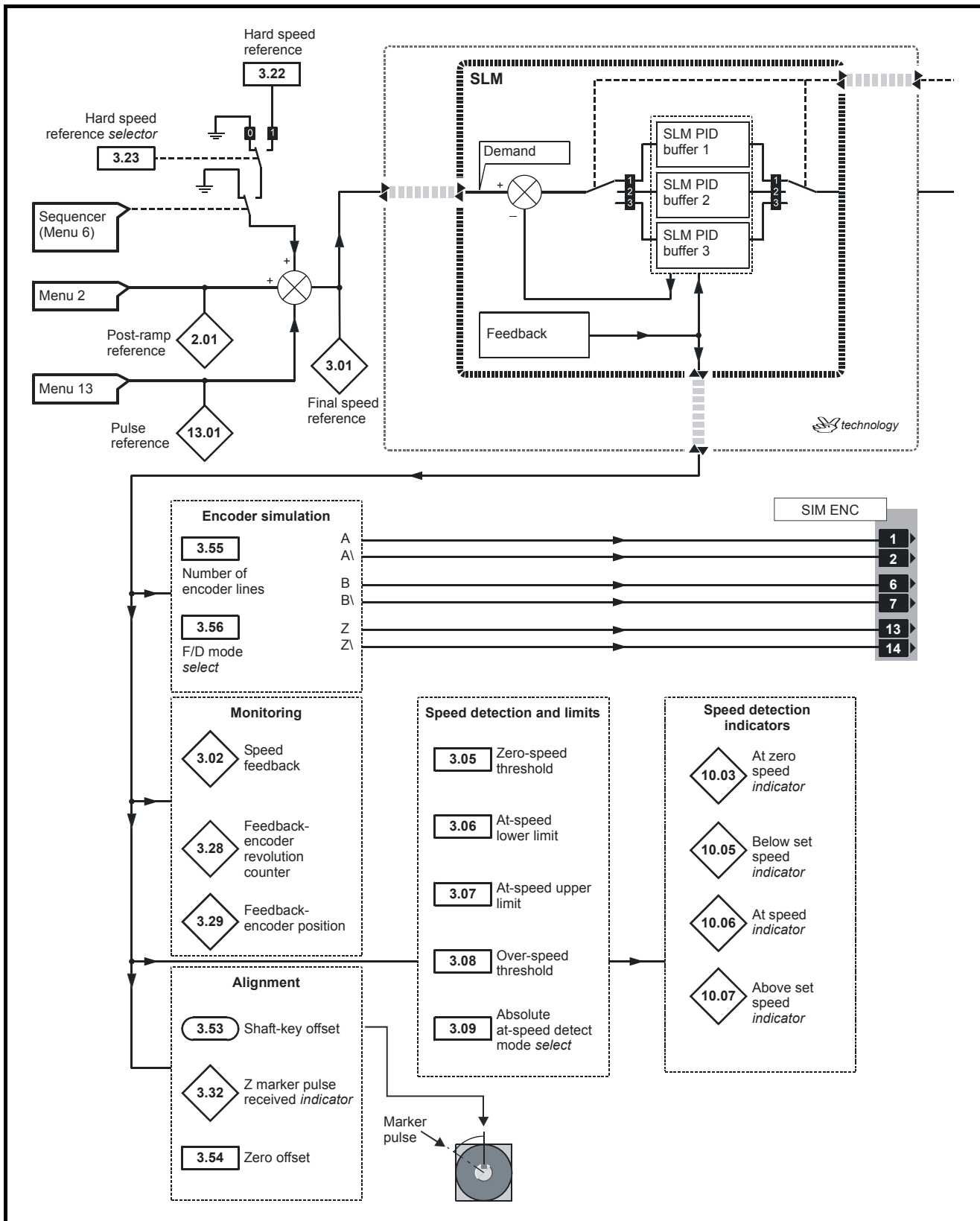


Parameter		Range($\hat{=}$)	Default($\Rightarrow$)	Type			
2.01	Post-ramp reference	$\pm[1.06]$		RO	Bi		P
2.02 {0.24}	Ramp <i>enable</i>	0 ~ 1	0	RW	Bit		
2.03	Ramp hold enable	0 ~ 1	0	RW	Bit		
2.04 {0.27}	Fast ramp <i>select</i>	0 ~ 1	0	RW	Bit		
2.05	Limit switch ramp enable	0 ~ 1	0	RW	Bit		
2.06	S-ramp enable	0 ~ 1	0	RW	Bit		
2.07	S-ramp acceleration limit	0 ~ 300.000 s ² /1000RPM	0.031	RW	Uni		
2.10	Acceleration rate <i>selector</i>	0 ~ 5	0	RW	Uni		
2.11 {0.25}	Acceleration rate 1	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.12	Acceleration rate 2	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.13	Acceleration rate 3	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.14	Acceleration rate 4	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.19	Jog acceleration rate	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.20	Deceleration rate <i>selector</i>	0 ~ 5	0	RW	Uni		
2.21 {0.26}	Deceleration rate 1	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.22	Deceleration rate 2	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.23	Deceleration rate 3	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.24	Deceleration rate 4	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.25	Forward limit switch deceleration rate	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.26	Reverse limit switch deceleration rate	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.29	Jog deceleration rate	0 ~ 32.000 s/1000RPM	0.200	RW	Uni		
2.32	Acceleration-rate select bit-0 <i>indicator</i>	0 ~ 1	0	RO	Bit		
2.33	Acceleration-rate select bit-1 <i>indicator</i>	0 ~ 1	0	RO	Bit		
2.35	Deceleration-rate select bit-0 <i>indicator</i>	0 ~ 1	0	RO	Bit		
2.36	Deceleration-rate select bit-1 <i>indicator</i>	0 ~ 1	0	RO	Bit		
2.46	Stop-control proportional-gain	1 ~ 200	1	RW	Uni		
2.47	Stop-control integral-gain	1 ~ 200	10	RW	Uni		
2.48	Braking-control proportional gain	1 ~ 200	50	RW	Uni		
2.49	Braking-control integral gain	1 ~ 200	10	RW	Uni		

9.3 Menu 3 parameters

Speed-loop PID gains

Figure 9-3 Software diagram for Menu 3



Parameter		Range(⇅)	Default(⇒)	Type			
3.01 {0.04}	Final speed reference	±[1.06] RPM		RO	Bi		P
3.02 {0.05}	Speed feedback	±[1.06] RPM		RO	Bi		P
3.05	Zero-speed threshold	0 ~ 200 RPM	5	RW	Uni		
3.06	At-speed lower limit	0 ~ [1.06] RPM	5	RW	Uni		
3.07	At-speed upper limit	0 ~ [1.06] RPM	5	RW	Uni		
3.08	Over-speed threshold	0 ~ n_{MAX} RPM	0	RW	Uni		
3.09	Absolute at-speed detect mode select	0 ~ 1	0	RW	Bit		
3.10 {0.13}	Speed-loop proportional gain Kp1	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.11 {0.14}	Speed-loop integral gain Ki1	0.000 ~ 30.000	[SLM]	RW	Uni		
3.12 {0.15}	Speed-loop derivative gain Kd1	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.13	Speed-loop proportional gain Kp2	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.14	Speed-loop integral gain Ki2	0.000 ~ 30.000	[SLM]	RW	Uni		
3.15	Speed-loop differential-feedback gain Kd2	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.16 {0.12}	Speed-loop PID gains <i>selector</i>	0 ~ 3	1	RW	Uni		
3.18	Total inertia	0.1 ~ 6000.0 kgcm ² or 0.00001 ~ 0.6 kgm ²	J_t	RO	Uni		
3.19 {0.09}	Compliance angle	0.0 ~ 30.0 °	6.0	RW	Uni		
3.20 {0.10}	Load inertia	0.1 ~ 6000.0 kgcm ² or 0.00001 ~ 0.6 kgm ²	J_L	RW	Uni		
3.22	Hard speed reference	±500.0 RPM	0.0	RW	Bi		
3.23	Hard speed reference <i>selector</i>	0 ~ 1	0	RW	Bit		
3.25	Feedback-encoder phase offset	0 ~ 65535 REV/65536	[SLM]	RO	Uni		
3.28 {0.28}	Feedback-encoder revolution counter	0 ~ 65535 REV		RO	Uni		
3.29 {0.29}	Feedback-encoder position	0 ~ 65535 REV/65536		RO	Uni		
3.32	Z marker pulse received <i>indicator</i>	0 ~ 1		RO	Bit		
3.51	High resolution Marker select	0		RW	Bit		
3.52	Z marker pulse offset	0 ~ 65535 REV/65536		RO	Uni		
3.53	Shaft-key offset	0 ~ 65535 REV/65536	[SLM]	RO	Uni		
3.54	Zero offset	±180 °	0	RW	Uni		
3.55*	Number of encoder lines	0, 100 ~ 8192 and 16384	4096	RW	Uni		
3.56	F/D mode <i>select</i>	0 ~ 1	0	RW	Bit		
3.57	Speed-loop PID buffer 1 <i>select</i>	0 ~ 1	0	RW	Bit		
3.58	Speed-loop PID buffer 2 <i>select</i>	0 ~ 1	0	RW	Bit		
3.59	Speed-loop PID buffer 3 <i>select</i>	0 ~ 1	0	RW	Bit		
3.60	Speed-loop proportional gain Kp3	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.61	Speed-loop integral gain Ki3	0.000 ~ 30.000	[SLM]	RW	Uni		
3.62	Speed-loop derivative gain Kd3	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.63	Speed-loop PID buffer in use <i>indicator</i>	0 ~ 3		RO	Uni		
3.64	Speed feedback (unfiltered)	±2048		RO	Bi		

Notes

The measurement units for Pr 3.18 and Pr 3.20 depend on the setting of Pr 5.34 and Pr 5.54. (Pr 5.34 = Inertia units and Pr 5.54 = Inertia range.)

Pr 3.64: sample time = 250µs

Pr 3.23 can be used for setting a fine analog offset or trim; resolution = 0.1RPM

See Appendix D *Optimising the Dynamic Performance* on page 96.

J_M	Motor inertia (defined by the motor via the SLM , Pr 5.33)
J_L	Load inertia
J_t	Total inertia = $J_M + J_L$

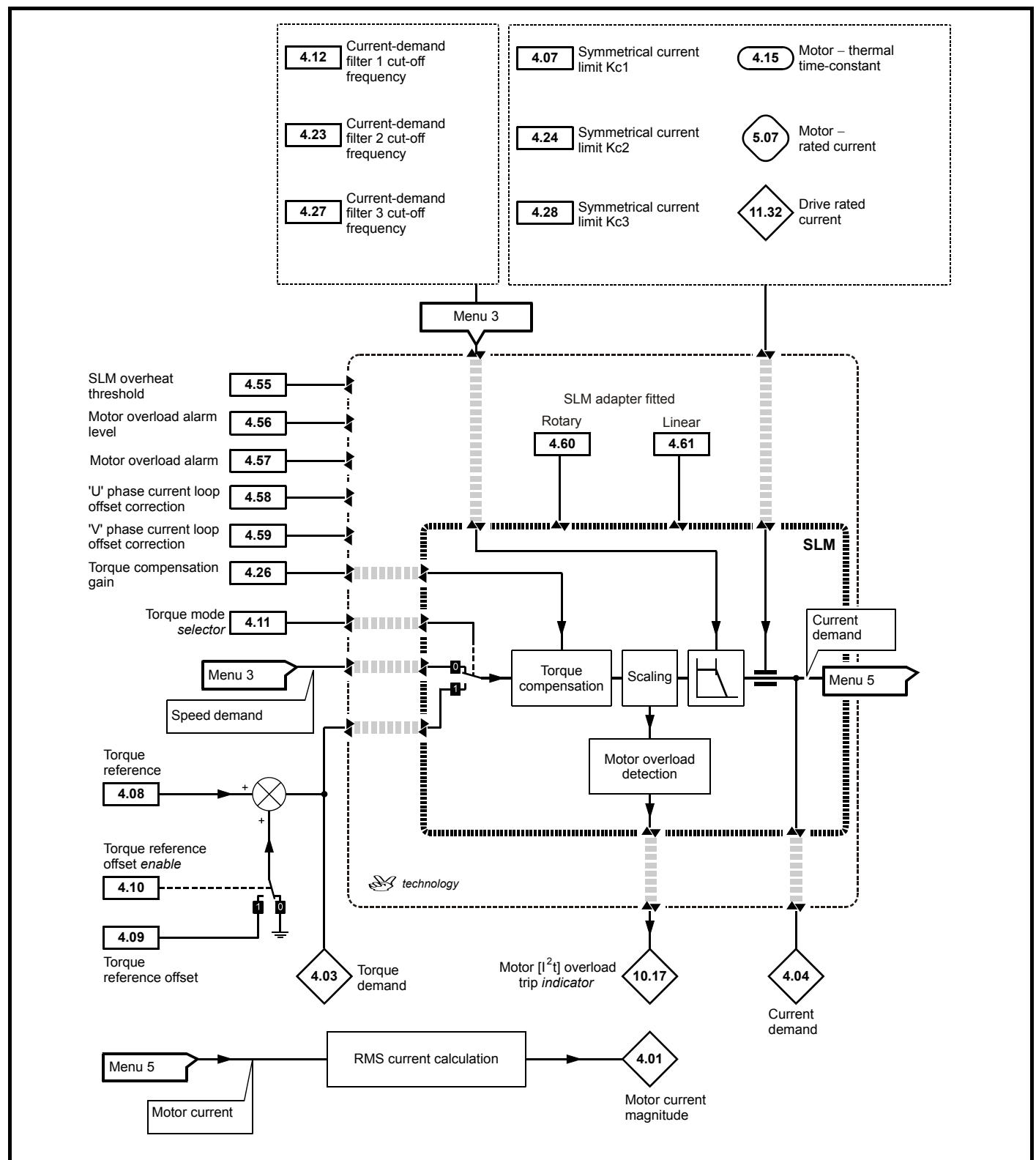
* When Pr 3.55 is set to 0, the number of encoder lines = 16384

A power down and up again is required for new values to take effect.

9.4 Menu 4 parameters

Torque control

Figure 9-4 Software diagram for Menu 4



Parameter		Range(⚡)	Default(⇒)	Type			
4.01 {0.07}	Motor current magnitude	0 ~ I _{OL} A		RO	Uni		P
4.03	Torque demand	±200.0 %I _T A		RO	Bi		P
4.04	Current demand	0 ~ 620		RO	Uni		P
4.07 {0.18}	Symmetrical current limit Kc1	0 ~ 300.0 % I _M	200.0	RW	Uni		
4.08	Torque reference	±200.0 %I _{LIM}	0.0	RW	Bi		
4.09	Torque-reference offset	±200.0 %I _{LIM}	0.0	RW	Bi		
4.10	Torque-reference offset <i>enable</i>	0 ~ 1	0	RW	Bit		
4.11	Torque mode <i>selector</i>	0 ~ 2	0	RW	Uni		
4.12 {0.16}	Current-demand filter 1 cut-off frequency	0 ~ 1200 Hz	500	RW	Uni		
4.15	Motor - thermal time-constant		[SLM]	RO	Uni		
4.23	Current-demand filter 2 cut-off frequency	0 ~ 1200 Hz	500	RW	Uni		
4.24	Symmetrical current limit Kc2	0 ~ 300.0 % I _M	200.0	RW	Uni		
4.26	Torque-compensation gain	0 ~ 1225 rads/s	0	RW	Uni		
4.27	Current-demand filter 3 cut-off frequency	0 ~ 1200 Hz	500	RW	Uni		
4.28	Symmetrical current limit Kc3	0 ~ 300.0 % I _M	200.0	RW	Uni		
4.51	Reserved for internal system purposes						
4.52	Motor thermal-overload trip level	0 ~ 125 %I _M	110	RW	Uni		
4.53	Symmetrical current limit after motor thermal-overload trip	0 ~ 300 %I _M	105	RW	Uni		
4.54	Thermal-overload time to trip	0 ~ 200 s	10	RW	Uni		
4.55	SLM overheat threshold	0 ~ 100 °C	85	RW	Uni		
4.56	Motor overload alarm level	0 ~ 100	70	RW	Uni		
4.57	Motor overload alarm	0 ~ 1		RO	Bit		
4.58	'U' phase current loop offset correction	0 ~ 65535	0	RW	Uni		
4.59	'V' phase current loop offset correction	0 ~ 65535	0	RW	Uni		
4.60	SLM adapter installed rotary	0 ~ 1		RO	Bit		
4.61	SLM adapter installed linear	0 ~ 1		RO	Bit		

Notes

Pr 4.52, Pr 4.53, Pr 4.54: see Appendix F.2 *Adjusting the threshold for the motor thermal-overload alarm* on page 108.

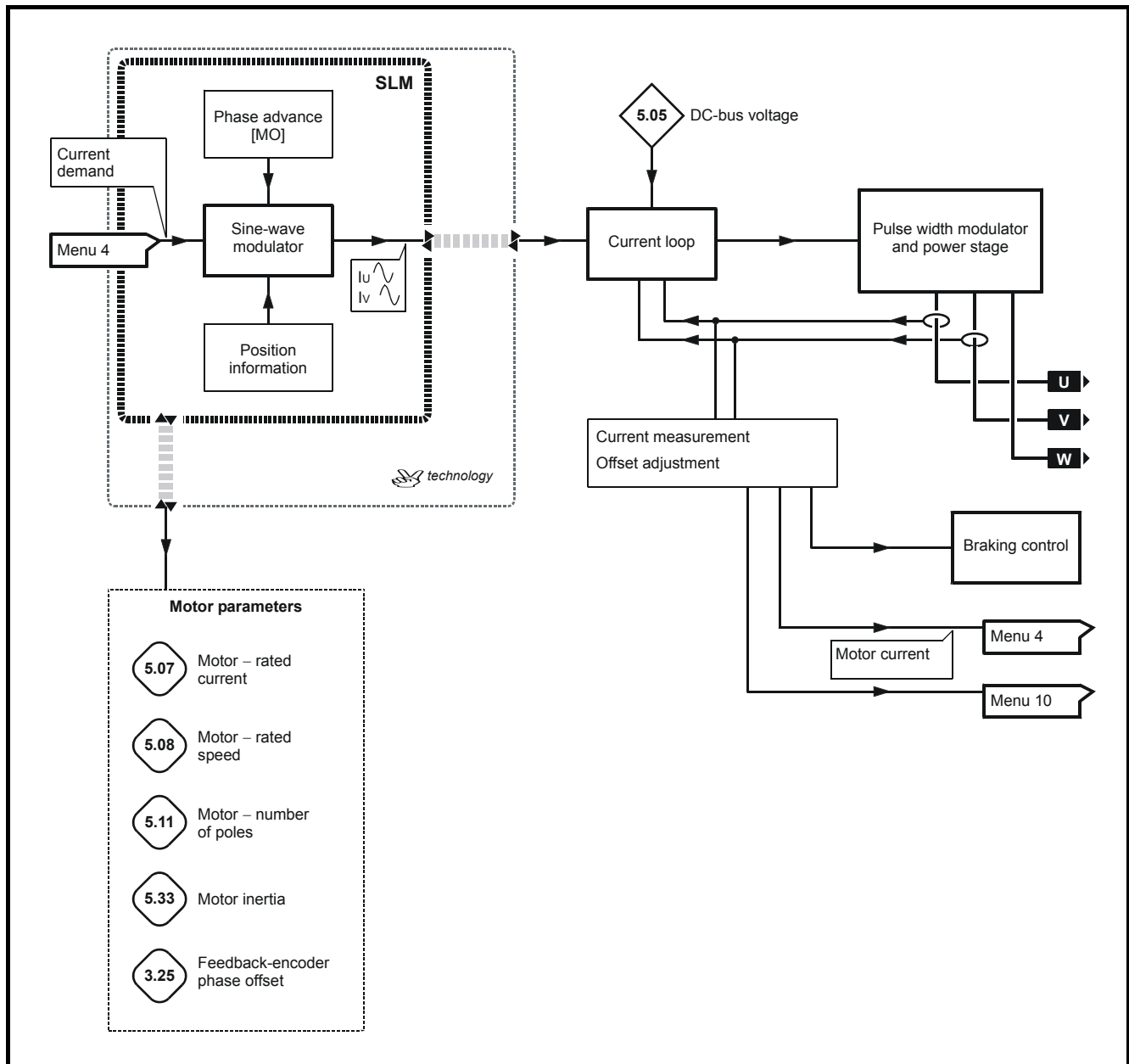
Pr 4.04: the range 0 ~ 620 represents 0 ~ 200% FLC

FLC	Full-load current (continuous-current rating of the drive)
I _{OL}	Maximum overload current from the drive [2 x FLC]
I _M	Rated continuous motor-current (defined by the motor via the SLM)
I _T	Maximum torque-producing current (derived from [FLC x kT])
I _{LIM}	Value of the current limit that is obtained from the setting of Pr 4.07 <i>Symmetrical current limit</i>
LT	Trip level of the drive thermal-overload accumulator
n _{MAX}	Maximum speed of the motor (defined by the motor via the SLM)
J _M	Motor inertia (defined by the motor via the SLM)

9.5 Menu 5 parameters

Motor control

Figure 9-5 Software diagram for Menu 5



Parameter		Range(⇅)	Default(⇒)	Type			
5.05 {0.43}	DC-bus voltage	0 ~ 1000 V		RO	Uni		P
5.07 {0.19}	Motor - rated current	0 ~ FLC A	[SLM]	RO	Uni		
5.08	Motor - rated speed	0 ~ 7500RPM	[SLM]	RO	Uni		
5.09	Motor - rated voltage	0 ~ V _S	[SLM]	RO	Uni		
5.11	Motor - number of poles	0 ~ 255	[SLM]	RO	Uni		
5.12	Flux alignment test <i>enable</i>	0 ~ 1	0	RW	Bit		
5.32	Motor torque-constant	0.00 ~ 500.00 Nm/A	[SLM]	RO	Uni		
5.33	Motor inertia	0.1 ~ 6000.0 kgcm ² or 0.00001 ~ 0.6 kgm ²	[SLM]	RO	Uni		
5.34 {0.11}	Inertia units <i>selected</i>	0 ~ 1	[SLM]	RO	Bit		
5.52	Reserved for internal system purposes						
5.53	Reserved for internal system purposes						
5.54	Inertia range <i>select</i>	0 ~ 1	1	RW	Bit		
5.55	Offset calibration routine enable	0 ~ 1	0	RW	Bit		

Notes

The settings of Pr **5.34** are as follows:

- 0** kgm²
- 1** kgcm²

The settings of Pr **5.54** are as follows:

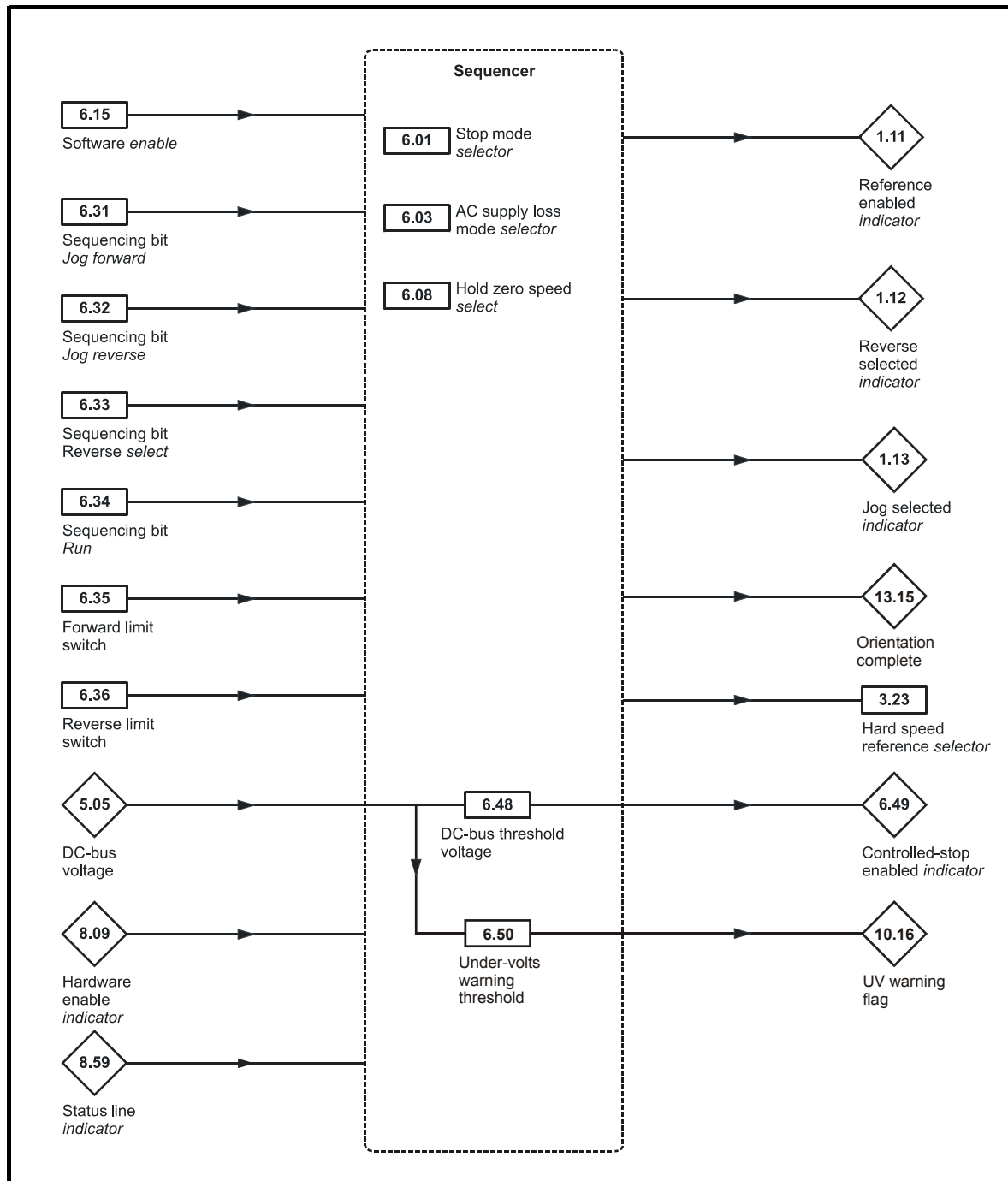
- 0** Ranges are as shown for Pr **3.18** and Pr **3.20**
- 1** Ranges are divided by **10**

FLC	Full-load current (continuous-current rating of the drive)
V _S	AC supply voltage

9.6 Menu 6 parameters

Sequencer functions AC supply loss modes

Figure 9-6 Software diagram for Menu 6



Parameter		Range(⇅)	Default(⇒)	Type			
6.01	Stop mode <i>selector</i>	COASt (0), rP (1), no.rP (2)	2	RW	Txt		P
6.03	AC supply loss mode <i>selector</i>	0 ~ 1	0	RW	Uni		P
6.08	Hold zero speed <i>select</i>	0 ~ 1	1	RW	Bit		
6.15	Drive <i>enable</i>	0 ~ 1	1	RW	Bit		
6.20	Powered-up time (years, days)	00.00 ~ 9.365 y.d		RO	Uni	S	P
6.21	Powered-up time (hours, minutes)	00.00 ~ 23.59 h.m		RO	Uni	S	P
6.31	Sequencing bit JOG FORWARD	0 ~ 1	0	RW	Bit		
6.32	Sequencing bit JOG REVERSE	0 ~ 1	0	RW	Bit		
6.33	Sequencing bit FORWARD/REVERSE	0 ~ 1	0	RW	Bit		
6.34	Sequencing bit RUN	0 ~ 1	0	RW	Bit		
6.35	FORWARD LIMIT switch	0 ~ 1	0	RW	Bit		
6.36	REVERSE LIMIT switch	0 ~ 1	0	RW	Bit		
6.44	Active supply <i>indicator</i>	0 ~ 1		RO	Bit		
6.48	DC-bus threshold voltage	0 ~ 600	400	RW	Uni		
6.49	Controlled-stop enabled <i>indicator</i>	0 ~ 1		RO	Bit		
6.50	Under-volts warning threshold	0 ~ 600	400	RW	Uni		

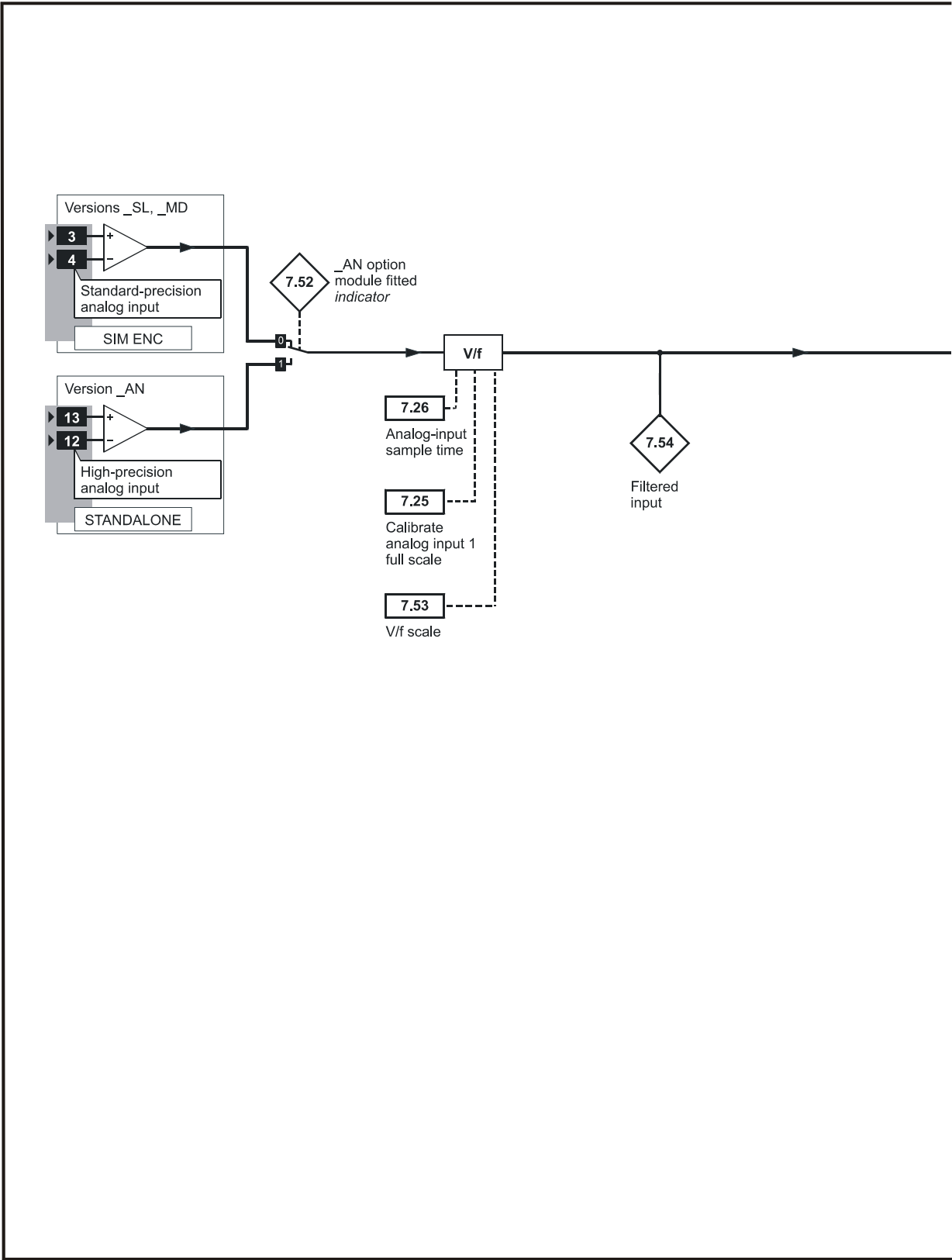
Use this page for notes

9.7 Menu 7 parameters

Analog I/O settings

Temperature monitoring

Figure 9-7 Software diagram for Menu 7



Parameter		Range(⇅)	Default(⇒)	Type			
7.01	Analog input	±100.0 %		RO	Bi		P
7.04	Heatsink temperature	0 ~ 100 °C ±10 °C		RO	Uni		P
7.07	Analog input offset trim	±10.0 %	0.0	RW	Bi		P
7.08	Analog input scaling	0.000 ~ 4.000	1.000	RW	Uni		
7.09	Analog input <i>invert</i>	0 ~ 1	0	RW	Bit		
7.10	Analog input destination <i>selector</i>	00.00 ~ 20.50 menu.parameter	1.36	RW	Uni	R	P
7.19	Analog output 1 source <i>selector</i>	00.00 ~ 20.50 menu.parameter	3.64	RW	Uni		
7.20	Analog output 1 scaling	0.000 ~ 4.000	1.000	RW	Uni		
7.22	Analog output 2 source <i>selector</i>	00.00 ~ 20.50 menu.parameter	4.04	RW	Uni		
7.23	Analog output 2 scaling	0.000 ~ 4.000	1.000	RW	Uni		
7.25	Calibrate analog input 1 full scale	0 ~ 1	0	RW	Bit		
7.26	Analog-input sample time	0.25 ~ 4.0 ms	1.000	RW	Uni		
7.52	_AN option module installed <i>indicator</i>	0 ~ 1		RO	Bit		
7.53	V/f scale	±4096	871	RW	Uni		
7.54	Filtered input	±8192		RO	Uni		
7.55	Analog input scaling numerator	0 ~ 32767	1	RW	Uni		
7.56	Analog input scaling denominator	0 ~ 32767	1	RW	Uni		
7.57	Analog input scaling <i>enable</i>	0 ~ 1	0	RW	Bit		

Notes

Analog-input selection

When Pr 1.14 is set at 0, 1 or 2, Pr 7.10 is automatically set at Pr 1.36 in order to select Pr 1.36 as the destination parameter for the analog input. The setting of Pr 7.10 cannot then be changed.

Other settings of Pr 1.14 allow Pr 7.10 to be set at any value (including Pr 1.36).

When Pr 7.10 is set at any of the following...

Pr 1.36

(irrespective of the setting of Pr 1.14)

Pr 4.08

Pr 3.22

... the parameters listed below are by-passed in order to simplify setting-up and increase speed of response to changes in the input signal:

Pr 7.01 *Analog input*

Pr 7.07 *Analog input offset trim*

Pr 7.08 *Analog input scaling*

Pr 7.09 *Analog input invert*

Pr 7.54: sample time = 250µs

Pulse mode

The analog input destination selection Pr 7.10 cannot be used when a pulse reference is selected (i.e. Pr 1.14 to 5). This is due to the internal characteristics of the drive.

Analog-input scaling

Analog-input scaling operates only when Pr 7.10 Analog input destination selector is set at Pr 1.36 or Pr 3.22 and Pr 7.57 Analog input scaling enable is set at 1.

The appropriate parameter, as follows, indicates the scaled speed demand:

Pr 1.36 *Analog reference*

Pr 3.22 *Hard speed reference*

Analog-output scaling

When Pr 3.64 is selected, and Pr 7.20 is set at 1, 10V at **Analog output**

1 represents 7500RPM.

When Pr 4.04 is selected, and Pr 7.23 is set at 1, 10V at **Analog output 2** represents 200% FLC.

Analog-input destination in torque mode

When the drive is in torque mode (Pr 4.11 set to 1 or 2), and controlled by an analog input Pr 7.10 *Analog input destination selector* must be set to Pr 4.08, Pr 1.14 *Reference selector* must be set to 3 to 5.

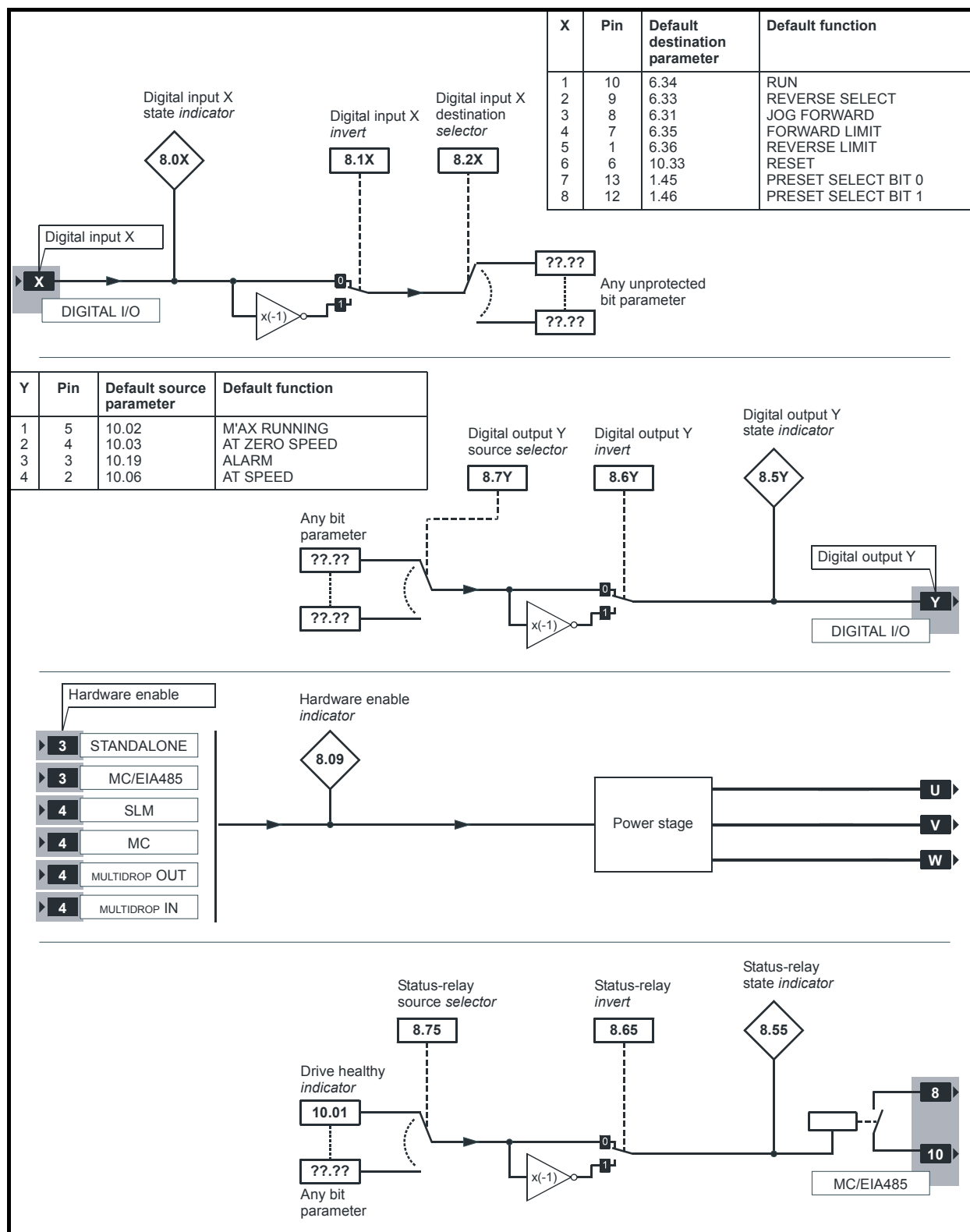
Summary for torque mode with analog reference

1. Set Pr 1.14 to 3
2. Set Pr 4.11 to 1 or 2
3. Set Pr 7.10 to Pr 4.08
4. Set XX.00 to 1000
5. Execute command  and  in Edit mode
6. Power-down
7. Power-up

9.8 Menu 8 parameters

Digital I/O settings and indications

Figure 9-8 Software diagram for Menu 8



Parameter		Range(⇅)	Default(⇒)	Type			
8.01	Digital input 1 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.02	Digital input 2 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.03	Digital input 3 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.04	Digital input 4 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.05	Digital input 5 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.06	Digital input 6 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.07	Digital input 7 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.08	Digital input 8 state <i>indicator</i>	0 ~ 1		RO	Bit		P
8.09 {0.01}	Hardware enable <i>indicator</i>	0 ~ 1		RO	Bit		P
8.11	Digital input 1 invert	0 ~ 1	0	RW	Bit		
8.12	Digital input 2 invert	0 ~ 1	0	RW	Bit		
8.13	Digital input 3 invert	0 ~ 1	0	RW	Uni		
8.14	Digital input 4 invert	0 ~ 1	0	RW	Bit		
8.15	Digital input 5 invert	0 ~ 1	0	RW	Bit		
8.16	Digital input 6 invert	0 ~ 1	0	RW	Uni		
8.17	Digital input 7 invert	0 ~ 1	0	RW	Bit		
8.18	Digital input 8 invert	0 ~ 1	0	RW	Bit		
8.20	Digital-inputs read-word	0 ~ 16384		RO	Uni		P
8.21	Digital input 1 destination selector (RUN)	00.00 ~ 20.50 menu.parameter	6.34	RW	Uni		P
8.22	Digital input 2 destination selector (REVERSE SELECT)	00.00 ~ 20.50 menu.parameter	6.33	RW	Uni		P
8.23	Digital input 3 destination selector (JOG FORWARD)	00.00 ~ 20.50 menu.parameter	6.31	RW	Uni		P
8.24	Digital input 4 destination selector (FORWARD LIMIT)	00.00 ~ 20.50 menu.parameter	6.35	RW	Uni		P
8.25	Digital input 5 destination selector (REVERSE LIMIT)	00.00 ~ 20.50 menu.parameter	6.36	RW	Uni		P
8.26	Digital input 6 destination selector (RESET)	00.00 ~ 20.50 menu.parameter	10.33	RW	Uni		P
8.27	Digital input 7 destination selector (Preset reference select bit-0)	00.00 ~ 20.50 menu.parameter	1.45	RW	Uni		P
8.28	Digital input 8 destination selector (Preset reference select bit-1)	00.00 ~ 20.50 menu.parameter	1.46	RW	Uni		P
8.51	Digital output 1 state indicator	0 ~ 1		RO	Bit		P
8.52	Digital output 2 state indicator	0 ~ 1		RO	Bit		P
8.53	Digital output 3 state indicator	0 ~ 1		RO	Bit		P
8.54	Digital output 4 state indicator	0 ~ 1		RO	Bit		P
8.55	Status-relay state indicator	0 ~ 1		RO	Bit		P
8.61	Digital output 1 invert	0 ~ 1	0	RW	Bit		
8.62	Digital output 2 invert	0 ~ 1	0	RW	Bit		
8.63	Digital output 3 invert	0 ~ 1	0	RW	Bit		
8.64	Digital output 4 invert	0 ~ 1	0	RW	Bit		
8.65	Status-relay invert	0 ~ 1	0	RW	Bit		
8.71	Digital output 1 source selector (DRIVE RUNNING)	00.00 ~ 20.50 menu.parameter	10.02	RW	Uni		P
8.72	Digital output 2 source selector (AT ZERO SPEED)	00.00 ~ 20.50 menu.parameter	10.03	RW	Uni		P
8.73	Digital output 3 source selector (ALARM)	00.00 ~ 20.50 menu.parameter	10.19	RW	Uni		P
8.74	Digital output 4 source selector (AT SPEED)	00.00 ~ 20.50 menu.parameter	10.06	RW	Uni		P
8.75	Status-relay source selector (DRIVE OK)	00.00 ~ 20.50 menu.parameter	10.01	RW	Uni		P

9.9 Menu 10 parameters

Status and diagnostic information

Trip log

Braking control

Parameter		Range(↕)	Default(⇒)	Type			
10.01	Drive ok <i>indicator</i>	0 ~ 1		RO	Bit		P
10.02	Drive running <i>indicator</i>	0 ~ 1		RO	Bit		P
10.03	At zero speed <i>indicator</i>	0 ~ 1		RO	Bit		P
10.05	Below set speed <i>indicator</i>	0 ~ 1		RO	Bit		P
10.06	At speed <i>indicator</i>	0 ~ 1		RO	Bit		P
10.07	Above set speed <i>indicator</i>	0 ~ 1		RO	Bit		P
10.11	Braking active <i>indicator</i>	0 ~ 1		RO	Bit		P
10.12	Braking-resistor overload alarm <i>indicator</i>	0 ~ 1		RO	Bit		P
10.15	AC supply loss <i>indicator</i>	0 ~ 1		RO	Bit		P
10.16	UV warning flag	0 ~ 1		RO	Bit		
10.17 {0.39}	Motor [I^2t] overload trip <i>indicator</i>	0 ~ 1		RO	Bit		P
10.18	Heatsink temperature alarm <i>indicator</i>	0 ~ 1		RO	Bit		P
10.19	Alarm <i>indicator</i>	0 ~ 1		RO	Bit		P
10.20 {0.44}	Last trip			RO	Txt	S	P
10.21	Second last trip			RO	Txt	S	P
10.22	Third last trip			RO	Txt	S	P
10.23	Fourth last trip			RO	Txt	S	P
10.24	Fifth last trip			RO	Txt	S	P
10.25	Sixth last trip			RO	Txt	S	P
10.33	Drive reset	0 ~ 1		RO	Bit		
10.38	User-defined trips	0 ~ 255	0	RW	Uni		
10.39 {0.42}	Internal braking-resistor overload accumulator	0 ~ 100.0 %		RO	Uni		P
10.40	Status word	0 ~ 32767		RO	Uni		P
10.41	Trip-0 time (years, days)	0.000 ~ 9.365 y.d		RO	Uni		P
10.42	Trip-0 time (hours, minutes)	00.00 ~ 23.59 h.m		RO	Uni	S	P
10.43	Trip-1 time (hours, minutes)	00.00 ~ 600.00 h.m		RO	Uni	S	P
10.44	Trip-2 time (hours, minutes)	00.00 ~ 600.00 h.m		RO	Uni	S	P
10.45	Trip-3 time (hours, minutes)	00.00 ~ 600.00 h.m		RO	Uni	S	P
10.46	Trip-4 time (hours, minutes)	00.00 ~ 600.00 h.m		RO	Uni	S	P
10.47	Trip-5 time (hours, minutes)	00.00 ~ 600.00 h.m		RO	Uni	S	P
10.52	SLM <i>technology</i> failure <i>indicator</i>	0 ~ 8192		RO	Uni		P
10.53	Under-voltage protection <i>disable</i>	0 ~ 1		RO	Bit		P
10.54	AC-supply phase failure protection <i>disable</i>	0 ~ 1	0	RW	Bit		
10.55	Internal braking-resistor protection <i>disable</i>	0 ~ 1	0	RW	Bit		
10.56 {0.41}	Drive overload accumulator	0.0 ~ 100.0 %		RO	Uni		P
10.57	Supply interlock	0 ~ 1		RO	Bit		P
10.58 {0.40}	Motor I^2t accumulator	0.0 ~ 100.0 %		RO	Uni		P
10.59	SLM software < V10 pcb temperature SLM software > V10 motor temperature	0 ~ 100 °C		RO	Uni		P
10.60	SLM <i>technology</i> fault warning	0 ~ 1		RO	Bit		

NOTE

The under-voltage protection [Pr 10.53] can only be disabled via a digital input.

9.10 Menu 11 parameters

Scale factor

Initially displayed parameter

Serial communications

Drive information

Parameter		Range(⇅)	Default(⇒)	Type			
11.20	Parameter 0.46 assignment <i>selector</i>	00.00 ~ 19.71	3.02	RW	Uni		
11.21	Parameter 0.46 scaling	0.000 ~ 9.999	0.1	RW	Uni		
11.22	Initially displayed parameter <i>selector</i>	00.00 ~ 13.99 menu.parameter	0.05	RW	Uni		
11.23 {0.37}	Serial comms. address	0.0 ~ 24.7 group.unit	1.1	RW	Uni		
11.24	Serial comms. protocol <i>selector</i>	0 ~ 1	0	RW	Txt		P
11.25 {0.36}	Serial comms. baud rate	0 ~ 6	5 (9600)	RW	Uni		P
11.26	Serial comms. transmit-delay time	0 ~ 255 µs	2	RW	Uni		P
11.29 {0.48}	Drive software version	01.00 ~ 99.99		RO	Uni		P
11.30 {0.35}	User security code	0 ~ 255	149	RW	Uni	S	P
11.32 {0.20}	Drive rated current (FLC)	00.00 ~ 99.99 A		RO	Uni		P
11.33	Drive voltage rating	200 ~ 480 V		RO	Uni		P
11.34 {0.47}	Drive software build number	00 ~ 99		RO	Uni		P
11.39	SLM software version	00.99 ~ 99.99		RO	Uni		P
11.51	Hardware revision	0 ~ 15		RO	Uni		
11.52	SLM update <i>enable</i>	0 ~ 1		RW	Bit		
11.53	SLM address	1 ~ 128		RW	Uni		
11.54	SLM data/command	0 ~65535		RW	Uni		
11.55	SLM instruction	0 ~65535		RW	Uni		
11.56 {0.45}	SLM communications integrity	0 ~ 100 %		RO	Uni		P
11.57	Number of errors on last instruction	0 ~ 255		RO	Uni		P
11.58	SLM update error <i>indicator</i>	0 ~ 1		RO	Bit		P
11.59	SLM busy <i>indicator</i>	0 ~ 1		RO	Bit		P
11.60	SLM background-read <i>enable</i>	0 ~ 1		RW	Bit		P
11.61	SLM test results	0 ~ 1		RO	Bit		P
11.62	SLM power-up delay	0 ~ 5	1 (250)	RW	Uni		P
11.63	SLM buffer update	0 ~ 1	0	RW	Bit		
11.64 {0.17}	SLM on-line <i>enable</i>	0 ~ 1	0	RW	Bit		
11.65	SLM encoder mode <i>select</i>	0 ~ 1	0	RW	Bit		
11.66	Host mode <i>enable</i>	0 ~ 1	1	RW	Bit		P
11.67	Flash update <i>enable</i>	0 ~ 1	0	RW	Bit		P
11.68	Flash device type	FL28 ~ FL29		RO	Txt		P

Notes

Pr 11.25 settings

11.25	0	1	2	3	4	5	6
Baud rate (bits/s)	300	600	1200	2400	4800	9600	19200

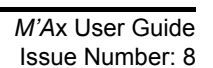
Pr 11.62 settings

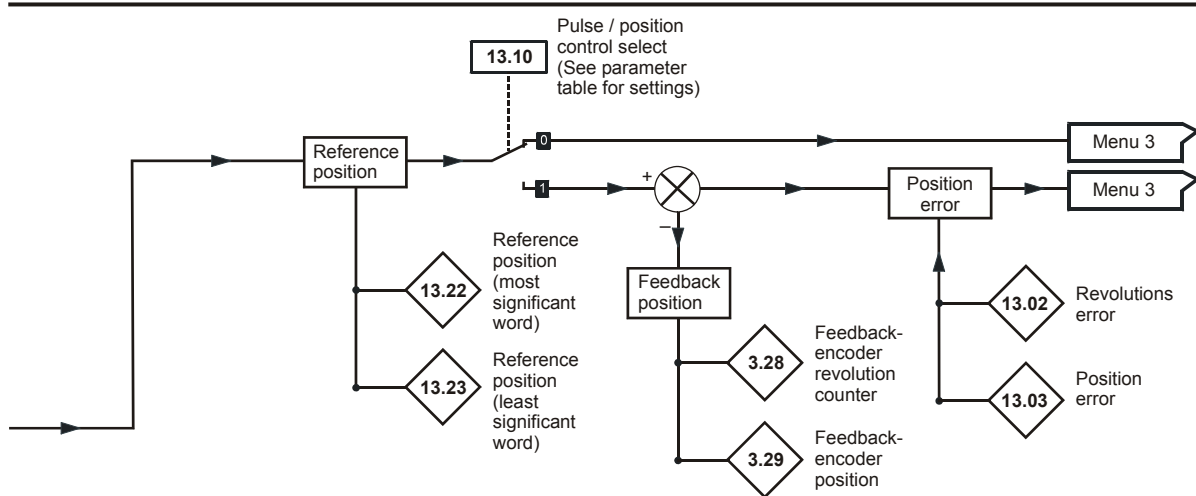
11.62	0	1	2	3	4	5
SLM power-up delay (ms)	0	250	500	750	1000	1250

Pr 11.68 settings

11.68	Description
FL-28 (0)	Intel device installed
FL-29 (1)	AMD compatible device installed

Figure 9-9 Software diagram for Menu 13





Parameter		Range(⚙)	Default(⇌)	Type			
13.01	Pulse reference	±7500 rpm		RO	Bi		P
13.02	Revolutions error	0 ~ 65535		RW	Uni		
13.03	Position error	0 ~ 65535		RW	Uni		
13.10	Pulse / Position control select	0 ~ 2*	0	RW	Uni		
13.11	Orientation enable	0 ~ 1	0	RW	Bit		
13.12	Orientation speed	0 ~ 250 rpm	50	RW	Uni		
13.13	Orientation position reference	0 ~ 65535	0	RW	Uni		
13.14	Orientation acceptance window	0 ~ 2000	200	RW	Uni		
13.15	Orientation complete	0 ~ 1		RO	Bit		
13.20	Pulse reference <i>selector</i>	F&D (0), Quad (1), Pulse Pulse (2)	Quad (1)	RW	Uni		
13.21	Reference encoder - pulses per revolution	0 ~ 32767	4096	RW	Uni		
13.22	Reference position (most significant word)	0 ~ 65536		RO	Uni		
13.23	Reference position (least significant word)	0 ~ 65536		RO	Uni		
13.24	Ratio-0 numerator	0 ~ 32767	1	RW	Uni		
13.25	Ratio-0 denominator	0 ~ 32767	1	RW	Uni		
13.26	Ratio-1 numerator	0 ~ 32767	1	RW	Uni		
13.27	Ratio-1 denominator	0 ~ 32767	1	RW	Uni		
13.28	Ratio <i>select</i>	0 ~ 1	0	RW	Bit		
13.29	Pulse-reference offset	±32767	0	RW	Bi		
13.30	Move to offset <i>enable</i>	0 ~ 1	0	RW	Bit		
13.31	Maximum positioning speed	0 ~ 512	0	RW	Uni		

NOTE

Below 100RPM use the following parameters for display purposes only (Pr 1.01, Pr 3.01 and Pr 13.01). Use the speed feedback Pr 3.02 for control purpose if necessary.

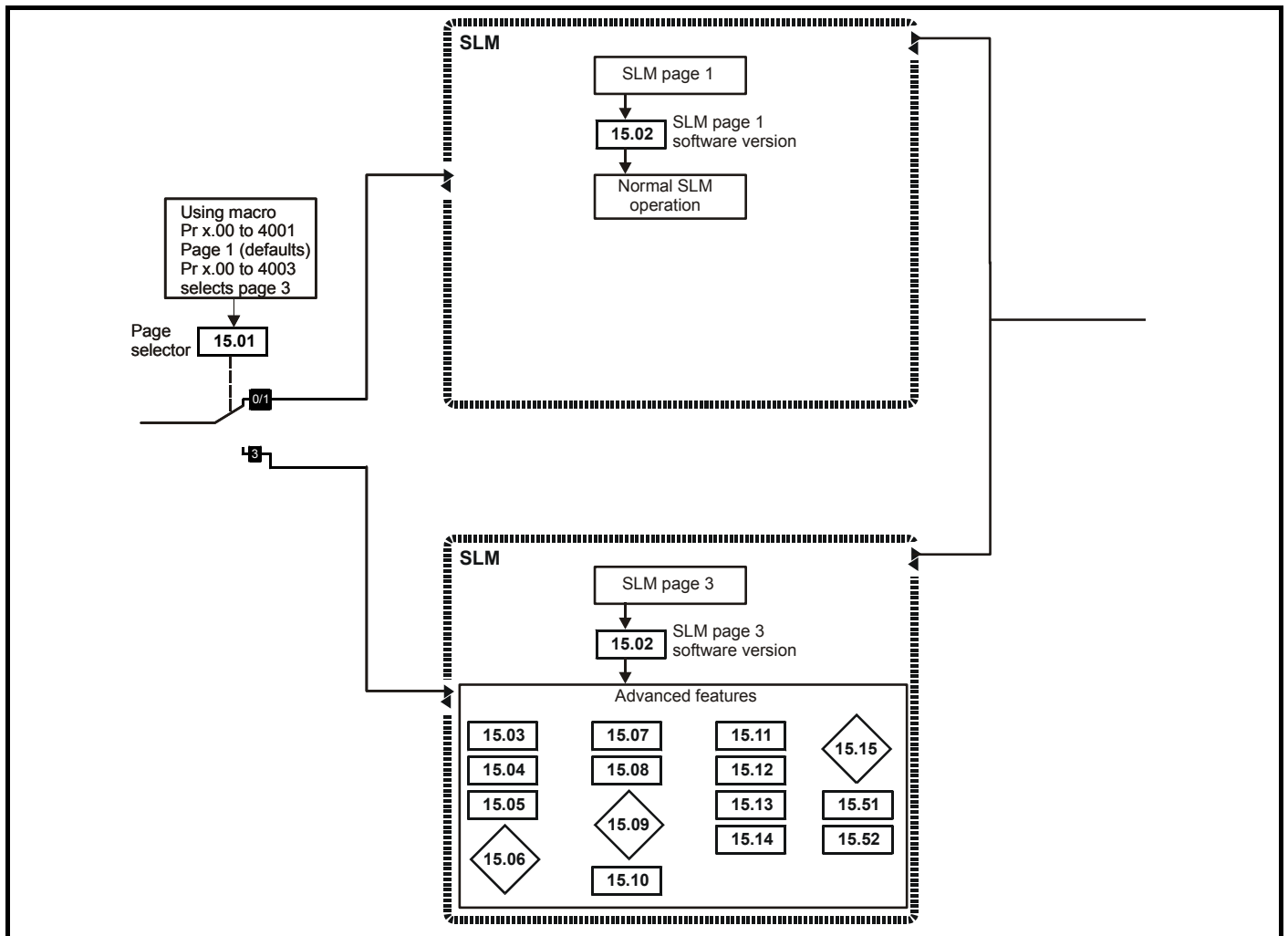
* Pr 13.10 settings:

- 0 = Pulse reference without position control
- 1 = Pulse reference with position control
- 2 = Digital reference control via serial communications

9.12 Menu 15 Parameters

PLM, Notch functions

Figure 9-10 Software diagram for Menu 15



Parameter		Range(°)	Defaults	Type			
15.01(0.51)	SLM Page Number	0 to 3		RO	Uni		P
15.02(0.52)	SLM Page Software Version	0.00 to 9.99		RO	Uni		P
15.03	Position Loop Gain (Kv)	0 to 300	0	RW	Uni		
15.04	Velocity Feed Forward Gain (Kvff)	0.0000 to 2.0000	1.0000	RW	Uni		
15.05	Acceleration Feed Forward Gain (Kaff)	0.0000 to 1.0000	0	RW	Uni		
15.06	Following Error	-32767 to +32767		RO	Bi		
15.07	Following Error Detection Resolution	0 to 8	6	RW	Uni		
15.08	Following Error Set Limit	0 to 32768	32767	RW	Uni		
15.09	Following Error Limit Exceeded Trip Flag	0 to 1	0	RO	Bit		
15.10	Following Error Trip Clear	0 to 1	0	RW	Bit		
15.11	Notch Filter 1 Centre Frequency	0.0 to 1700.0	0	RW	Uni		
15.12	Notch Filter 1 Buffer Update	0 to 1	0	RW	Bit		
15.13	Notch Filter 2 Centre Frequency	0.0 to 1700.0	0	RW	Uni		
15.14	Notch Filter 2 Buffer Update	0 to 1	0	RW	Bit		
15.15	Active Notch Filter Indication	0 to 2	0	RO	Uni		
15.51	T4 Offset Value for DNA	0 to 65535	14567	RW	Uni		
15.52	T3 Offset Value for DNA	0 to 65535	14567	RW	Uni		

SLM provides two Notch filters, which can be switched in between dynamically. Though switching between Notch filter buffers is supported, due to extensive floating point math calculations involved in calculating the Notch filter constants, these constants are calculated during power-up initialisation only and written to respective SLM parameters. Notch filter buffer update bit parameters work in the same way as the Speed Loop PID buffer update bit parameters.

NOTE

Either a save and power cycle or SLM on-line commissioning mode will activate notch filter 1. Only save and power cycle will activate Notch filter 2.



Setting a low value in Notch filter may cause the system to go unstable.

CAUTION

When SLM on-line bit is set for commissioning purposes with SLM page 3 selected, all relevant position loop parameters are updated in such a manner as the speed loop PID parameters are updated in SLM page 1 default mode. Only Notch filter 1 buffer can be used for SLM on-line mode commissioning. (Note: Marker found flag (Pr 3.32) should be set for this function to work.)



The value of Pr 15.52 is written to SLM parameter 59 for DNA output. If encoder simulation is used this value must not be changed from its default value.

CAUTION

NOTE

When SLM page 3 is selected the drive cannot be defaulted. Function Pr x.00 to 1233 is locked out.

NOTE

Menu 15 is available on M'Ax software V01.50.xx and SLM software V04.xx or later.

Appendix A Signal Connectors



Isolation

All the signal connections are isolated from the power circuits by basic insulation only. Ensure that all external control circuits are separated from human contact by at least one layer of insulation rated for use at the AC supply voltage.

A.1 Cables and connectors

RJ45 connectors

For connection to the following connectors on the drive...

- **SLM**
- **MC**
- **MULTIDROP OUT**
- **MULTIDROP IN/PC**

... use the following:

Cables

Up to four twisted-pairs having an overall braided shield (unused wires must not be connected to pins at the other end)

Maximum length: 50m (165ft)

Maximum diameter: 5.7mm ($7/32$ in)

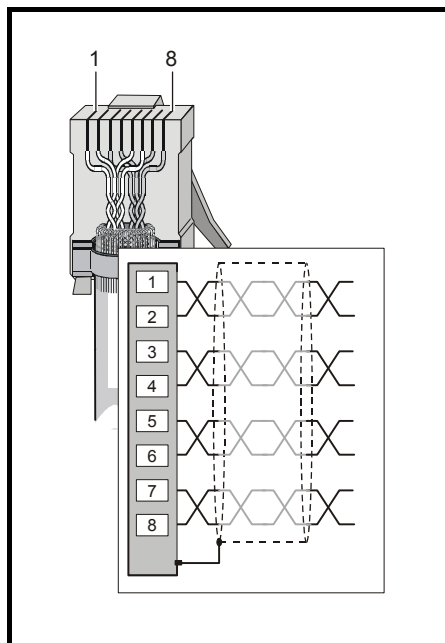
Characteristic impedance (recommended): $100\Omega \pm 15\%$

Static installations: for example, use BICC type **S-FTP patch**, four twisted pairs, 5.33mm diameter

Dynamic installations: for example, use Intercond type **3MBM 26P 02P**, 2 twisted pairs, 5.5mm diameter

Connectors

Shielded 8-way RJ45 plugs (e.g. Stewart Connectors 36 series)



Connect the pins in pairs as shown.

Comb out the braided shield, fold the strands back and trap them under the cable clamp to ensure good electrical contact with the clamp.

Ordering signal cables

Cables of the required lengths and installed with RJ45 connectors as required are supplied by Control Techniques Dynamics Ltd. For ordering, create the required order code (see below) and contact the supplier of the drive.

The order code is constructed as follows:

SL	B	A	?	?	???
1	2	3	4	5	6

Details of the code are shown below.

1	Type of cable
SL	Two twisted pairs in overall shield

2	Type of sheath
B	PUR Use for dynamic applications (motor mounted on a moving structure) - increased oil resistance

3	Options
A	Standard

4	Connection details (drive side)
E	M'Ax RJ45 connector
X	Cut end

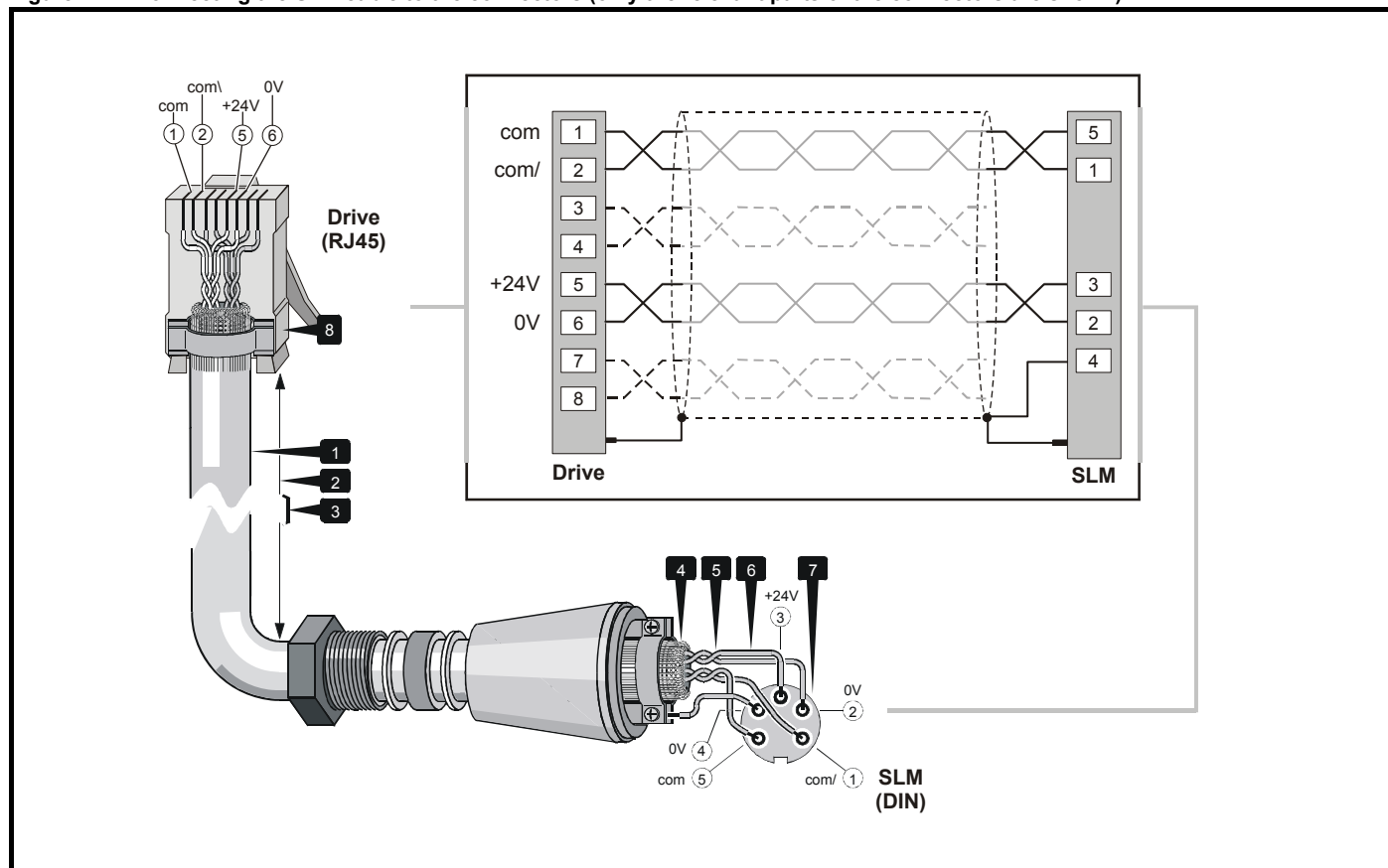
5	Connection details (motor side)
D	SLM 5 way amphenol connector
K	RJ45 connector
X	Cut end

6	Cable length
	Specify length in metres Minimum: 002 (2 metres) Maximum: 050 (50 metres)



Wait 30 seconds after removing power to the drive before inserting or removing control cables as 'hot plugging' cables can result in damage to the drive or SLM.

Figure A.1 Connecting the SLM cable to the connectors (only the relevant parts of the connectors are shown)



CAUTION Incorrect wiring of this cable could result in failure of the M'Ax or SLM

CAUTION When connecting the Amphenol connector to the motor, ensure the Amphenol connector ring is hand tightened only, don't apply any tightening torque to the body of the connector. Excessive torque on the body of the connector or the tightening ring, will result in the internal flexi PCB being strained.

- 8-way shielded cable having an overall diameter not greater than 6.6mm ($\frac{1}{4}$ in)
- Maximum length: 50m (165ft)
- Route the cable by the shortest convenient path and so that it is no closer than 300mm (1ft) from any power cable.
- Overall shield of tinned copper braid. Comb out the braid at both ends, fold the strands back and trap them under the cable clamp to ensure good electrical contact with the connector shell.
- The required twisted pairs connected to the DIN connector, the unwanted twisted pairs should be cut at each end and insulated to prevent inadvertent contact.
- Make the wire ends as short as possible (this affects performance).
- Amphenol C091 31D005 100 2 5-way screw-locking DIN connector meeting IP67.
- Shielded RJ45 8-way plug

D-type connectors

For connection to the following connectors on the drive...

- SIM ENC**
- MC/EIA485**
- DIGITAL I/O**
- STANDALONE**

... use the following:

Cables

Multi-core cables having tinned-copper stranded conductors, overall braided shield and braided outer sheath
Maximum overall diameter: depends on the D-type connector being used

Connectors

SIM ENC

MC/EIA485

15-way high-density male D-type having a metal shell (improved EMC type)

DIGITAL I/O

STANDALONE

15-way high-density female D-type having a metal shell (improved EMC type)

A.2 24V user supply

Output voltage: 24V $\pm 20\%$

Maximum current: 400mA - I_o

Where I_o is the total current being drawn from the following:

Circuit	Current drawn
SLM	65mA
24V user supply	User-defined circuits
Digital outputs	Each digital input (when activated): 9mA
	User-defined loads, up to 100mA each

A.3 Digital inputs

Logic sense: Positive

Voltage range: $-0.3V \sim +30V$

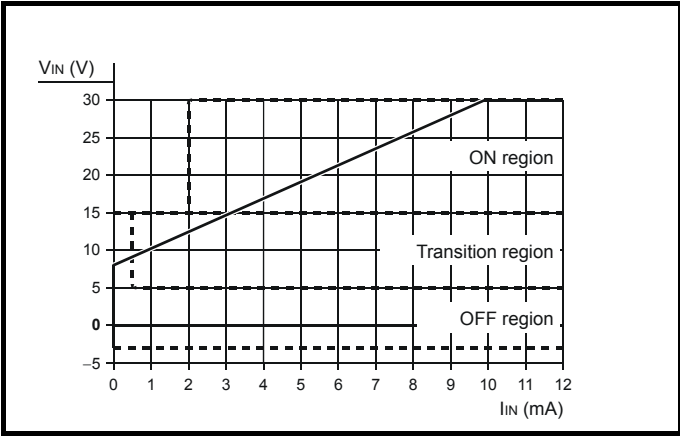
Isolation: optical

Input impedance: 3k Ω (at 24V; see Figure A.1)

Sample time: 500 μs

Filter response time: 100 μs

Figure A.1 Digital-input characteristic for the drive (solid line) and IEC1131-2 standard (broken lines)



Hardware enable

Hardware enable is a positive-logic input having the specification given above. Time delays are as follows:

Enable time: <250 μ s

Disable time: <500 μ s

A.4 Digital outputs

Logic sense: Positive

Output voltage: -0 ~ 24V $\pm$ 10%

Isolation: optical

Maximum output current: 100mA, short-circuit protected at 450mA

Update time: 500 μ s

Capacitive-load tolerance: 0.1 μ F

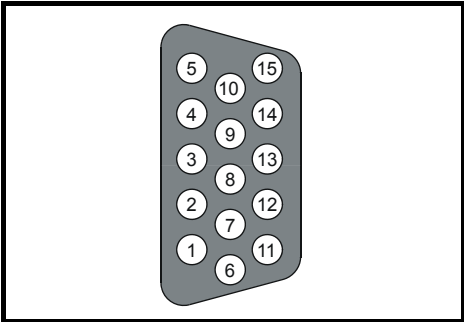
NOTE

For clarity in the following lists, the pins are not all shown in numerical order.

A.5 Functions of the terminals

Name	Pin	I/O	Function	Specification
Digital input 1	10	I	RUN	(See <i>Digital inputs</i> earlier in this Appendix.)
Digital input 2	9	I	REVERSE SELECT	
Digital input 3	8	I	JOG FORWARD	
Digital input 4	7	I	FORWARD LIMIT	
Digital input 5	1	I	REVERSE LIMIT	
Digital input 6	6	I	RESET	
Digital input 7	13	I	PRESET SELECT BIT-0	
Digital input 8	12	I	PRESET SELECT BIT-1	
Digital output 1	5	O	DRIVE RUNNING	(See <i>Digital inputs</i> earlier in this Appendix.)
Digital output 2	4	O	AT ZERO SPEED	
Digital output 3	3	O	ALARM	
Digital output 4	2	O	AT SPEED	
0V COMMON	11 14		For use with all the I/O on this circuits	0V COMMON must not be interchanged with 0V
24V user supply	15	O	24V supply for external control circuits	(See <i>24V user supply</i> earlier in this Appendix.)
Cable shields	Shell		Connect all the cable shields to the connector shell	

Figure A.1 Male D-type connector pin locations (as seen from the top of the drive)



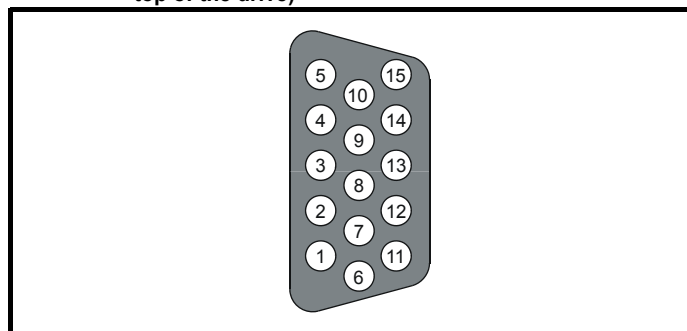
STANDALONE

Name	Pin	I/O	Function	Specification
SLM-and-user back-up supply	1 2	I	+24V input OV	(See <i>Types of back-up supplies</i> on page 19.)
0V COMMON	11 14	I	For use with: Hardware enable Direction input <i>Quadrature B input</i> Frequency input <i>Quadrature A input</i> 24V user supply	OV COMMON must not be interchanged with 0V
Hardware enable	3	I		(See <i>Digital inputs</i> on page 80.)
Direction input <i>Quadrature B input</i> Reverse Frequency	4	I	Tri-function input, used for: Specifying direction when pins 10 and 5 are used for frequency input (default function) Quadrature B input when speed is controlled by quadrature AB signals Reverse frequency input when speed is controlled by a pulse directional signal	2 wire EIA485 Connecting cable: Shielded twisted pair Unit load: 3.5 Line termination resistor: (see below) Line bias resistors: 12K Ω
Direction input \ <i>Quadrature B input</i> \ Reverse Frequency \	9			
Frequency input <i>Quadrature A input</i> Forward Frequency	5	I	Tri-function input, used for: Frequency input (direction applied to pins 4,9) Quadrature A input when speed is controlled by quadrature AB signals Forward frequency input when speed is controlled by a pulse directional signal	2 wire EIA485 Connecting cable: Shielded twisted pair Unit load: 3.5 Line termination resistor: (see below) Line bias resistors: 12K Ω
Frequency input \ <i>Quadrature A input</i> \ Reverse Frequency \	10			
Touch-trigger input	6	I	Touch-trigger function	Positive-logic digital input Voltage range: 0~30V Response time (on and off): 200ns Optically isolated from all other signals
Touch-trigger input \	7			
Digital output 4	8	0	At speed	Refer to digital I/O con
High-precision analog input	12	I	Available only in version _AN	Differential analog input Voltage range: $\pm 10V$ Voltage offset: $\leq 150\mu V$ (equivalent to 17-bit resolution) Resolution: 16-bit (in speed mode) Sample time: 250 μs Maximum common-mode voltage: $\pm 25V$ relative to 0V COMMON Linearity: 400ppm (full-scale) Full-scale accuracy before the analog input is calibrated: 1% Input impedance: 20k Ω
High-precision analog input \	13			
24V user supply	15	O	24V supply for external control circuits	(See <i>24V user supply</i> on page 80.)
Cable shields	Shell		Connect all the cable shields to the connector shell	

Pulse reference inputs

Terminate pulse reference inputs at the drive by connecting across the related input terminals a resistor whose value equals the characteristic impedance of the cable that is being used. When more than one drive is connected to a pulse reference link, a terminating resistor is required only at the last drive on the link.

Figure A.2 Male D-type connector pin locations (as seen from the top of the drive)



SIM ENC

Connecting cable for simulated-encoder signals

When the encoder feedback is to operate at greater than 4096 pulses per revolution, a suitable connecting cable must be used. Each line pair must be terminated at the system controller or PLC by a resistor of an appropriate value.

Name	Pin	I/O	Function	Specification
Simulated encoder quadrature A output <i>Frequency output</i>	1	O	Dual-function output, used for: Simulated encoder A output derived from the CT-Coder on the motor (default function)	EIA 485 differential outputs Connecting cable: Three shielded twisted-pairs inside an overall shield
Simulated encoder quadrature A \ output <i>Frequency output \</i>	2		Frequency output (direction output on pins 6, 7) Use for feedback to a system controller, plc or motion controller, plc or motion controller, or for digital another drive	
Simulated encoder quadrature B output <i>Direction output</i>	6		Dual-function output, used for: Simulated encoder B output derived from the CT-Coder on the motor (default function)	
Simulated encoder quadrature B \ output <i>Direction output \</i>	7		Specifying direction when pins 1 and 2 are used for frequency output	
Simulated encoder Z output	13		Marker pulse output available only when quadrature A B outputs are used	
Simulated encoder Z \ output	14			
Standard-precision analog input	3	I	Speed-reference input available only in version _SL	Differential analog input Voltage range: $\pm 10V$ Voltage offset: $\leq 20mV$ (equivalent to 10-bit resolution) Resolution: 12-bit (in speed mode) Sample time: $250\mu s \sim 32ms$ Maximum common-mode voltage: $\pm 25V$ relative to 0V Linearity: 800ppm (full-scale) Full-scale accuracy before the analog input is calibrated: 8% Input impedance: $16k\Omega$
Standard-precision analog input \	4			
Analog output 2	9	O	TORQUE output signal (default function)	Resolution: 10 bit Voltage range: $\pm 10V$ Maximum output current: 1mA Update time: 1ms
Analog output 1	11		SPEED output signal (default function)	
0V	12		For use only with all the I/O on this connector	0V must not be interchanged with 0V COMMON
Cable shields	15		When the cable is required to be shielded (see above), connect all the cable shields to this pin	



Analog outputs

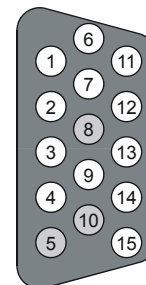
The analog outputs (pins 9 and 11) are intended for indication purposes, not for use in process control. The signal level on Analog output 2 may become inaccurate at the following occasions:

- During the process of saving parameter values
- At power-up and power-down



Any cable connecting to the SIM ENC connector should have its cable shield connected to Pin 15. Failure to do so could result in the drive being damaged.

Figure A.3 Female D-type connector pin-locations (as seen from the top of the drive)



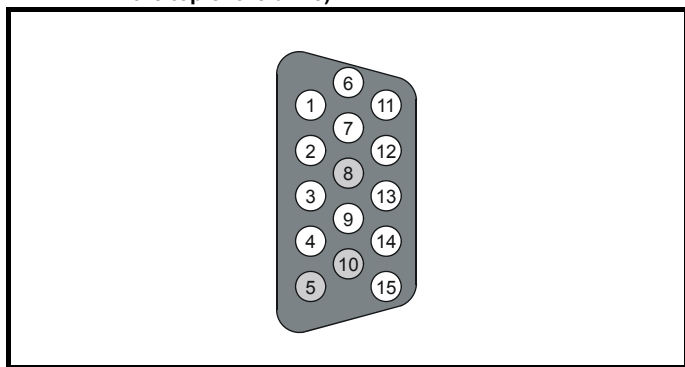
MC/EIA485

Name	Pin	I/O	Function	Specification
com	1	I/O	A <i>technology</i> port for bi-directional communications with a motion controller	2-wire EIA485 Connecting cable: Shielded twisted pair
com\	2			
Hardware enable	3	I		(See <i>Digital inputs</i> on page 80.)
0V COMMON	12 15		For use with: A <i>technology</i> com and com\ Hardware-enable SLM-and-user back-up supply EIA485 ports 24V user supply	0V COMMON must not be interchanged with 0V
SLM-and-user back-up supply	5	I	+24V input	(See <i>24V user supply</i> on page 80.)
	4		0V	0V COMMON must not be interchanged with 0V
EIA 485RX EIA 485RX \	6 7	O	Bi-directional communications port for control by system controller or PLC	4 wire EIA485 Connecting cable: Two shielded twisted pairs inside an overall shield Unit load: 3.5 Line termination: (see below) Line bias resistors: 12 Ω
EIA 485 TX EIA 485 TX \	13 14	I		
Status-relay contact	8 10	O	DRIVE OK Relay contact opens if the drive trips	Voltage rating: 50VAC/DC category 2 Current rating: 1A resistive Update period: 500 μ s Default source parameter: 10.01 <i>Drive ok indicator</i>
(No connection)	9		Do not use	
24V user supply	11	O	24V supply for external control circuits	(See <i>224V user supply</i> on page 80.)
Cable shields	Shell		Connect all the cable shields to the connector shell	

EIA connections

Terminate EIA485 connections at the drive by connecting across the related input terminals a resistor whose value equals the characteristic impedance of the cable that is being used. When more than one drive is connected to an EIA485 link, a terminating resistor is required only at the last drive on the link.

Figure A.4 Female D-type connector pin-locations (as seen from the top of the drive)



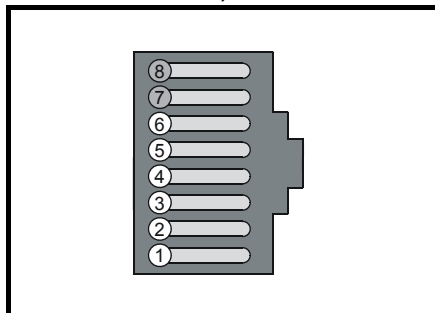
SLM

Name	Pin	I/O	Function	Specification
com	1	I/O	A <i>technology</i> port for communication with the SLM	2-wire EIA485 100Ω twisted-pair inside 8-way shielded cable (see <i>Cables and connectors</i> on page 79)
com\	2			
	3			
Hardware enable	4	I		(See <i>Digital inputs</i> on page 80.)
24V SLM supply	5	O	24V supply to the SLM	
0V COMMON	6		For use with all the I/O on this connector	0V COMMON must not be interchanged with 0V
(No connections)	7 8		Do not use	
Cable shield	Shell		Connect the cable shield to the connector shell	

MC

Name	Pin	I/O	Function	Specification
com	1	I/O	A <i>technology</i> port for communication with a motion controller	2-wire EIA485 100Ω twisted-pair inside 8-way shielded cable (see <i>Cables and connectors</i> on page 79)
com\	2			
	3			
Hardware enable	4	I		(See <i>Digital inputs</i> on page 80.)
(No connections)	5 8		Do not use	
0V COMMON	6		For use with all the I/O on this connector	0V COMMON must not be interchanged with 0V
SLM-and-user back-up supply	7	I		(See <i>Types of back-up supplies</i> on page 19.)
Cable shield	Shell		Connect the cable shield to the connector shell	

Figure A.5 RJ45 connector pin-locations (as seen from the top of the drive)



MULTIDROP OUT

Name	Pin	I/O	Function	Specification
com	1	I/O	Version _MD only: A <i>technology</i> port for communication with the next slave drive in multi-drop systems	2-wire EIA485 100Ω twisted-pair inside 8-way shielded cable (see <i>Cables and connectors</i> earlier in this Appendix)
com\	2			
	3			
Hardware enable	4	I		(See <i>Digital inputs</i> earlier in this Appendix.)
24V loop output	5	0	Version _MD only: In multi-drop systems, connect to the 24V LOOP INPUT of the next drive in order to convey the supply to the SLM	
0V COMMON	6		For use with all the I/O on this connector	0V COMMON must not be interchanged with 0V
(No connections)	7 8		Do not use	
Cable shield	Shell		Connect the cable shield to the connector shell	

MULTIDROP IN/PC

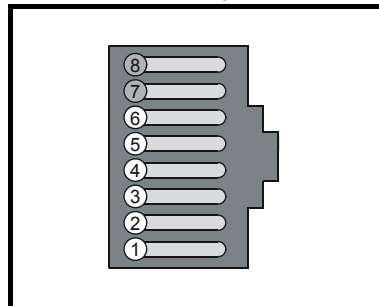


Incorrect connections
Ensure that a plug carrying a 24VDC supply intended for the MC connector is not inserted in the MULTIDROP IN/PC connector. (Damage may occur to the EIA232 port on the MULTIDROP IN/PC connector if 24VDC is applied to terminal 7.)

CAUTION

Name	Pin	I/O	Function	Specification
com	1	I/O	Version _MD only: A <i>technology</i> port for connecting to a motion controller or the previous slave drive in multi-drop systems	2-wire EIA485 100Ω twisted-pair inside 8-way shielded cable (see <i>Cables and connectors</i> on page 79)
com\	2			
	3			
Hardware enable	4	I		(See <i>Digital inputs</i> on page 80.)
24V loop input	5	I	Version _MD only: In multi-drop systems, connect to the 24V LOOP OUTPUT of the previous drive in the system in order to convey the supply to the SLM	
0V COMMON	6		For use with all the I/O on this connector	0V COMMON must not be interchanged with 0V
232 RXD 232 TXD	7 8	I 0	Versions other than _MD : Bi-directional communications port for control by a PC	EIA232 Maximum cable length: 2m (6ft 6in) An external isolating device must be used
Cable shield	Shell		Connect the cable shield to the connector shell	

Figure A.6 RJ45 connector pin-locations (as seen from the top of the drive)



Appendix B Diagnostics



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 Appendix.

Under no circumstances must the casing of the drive be opened when the AC supply is connected.

If a drive is faulty, it must be returned to an authorized Control Techniques distributor for repair.

B.1 Types of indications

Status indications

Version **_AN**: When the drive is in normal operation and the display is in Status mode, its lower line shows a code which indicates the status of the drive.

Both versions, especially version **_SL**: Parameters that are used for indicating status can be read via serial communications.

Alarm indications

Version **_AN**: If a critical condition is detected, the drive continues operating. When the display is in Status mode, its lower line shows an alarm code in place of the status code. If the condition is not rectified, the drive could trip.

The alarm message flashes alternately with the normal display indication.

Both versions, especially version **_SL**: Parameters that are used for indicating alarms can be read via serial communications.

Trip codes

Version **_AN**: If the drive trips, the output is disabled so that the drive stops controlling the motor. When the display is in Status mode, its lower line indicates that a trip has occurred and the upper line shows a trip code.

Both versions, especially version **_SL**: Each trip code has a corresponding numerical value which is entered into parameter **10.20**. This can be read via serial communications.

B.2 Status indications

Lower line of the display

The number given in brackets under each status indication is the number of the parameter that is correspondingly set at **1**. After Standard Security has been unlocked, these parameters can be read via serial communications.

inh	[0.01 set at 0]	Hardware enable signal is not applied. The drive output is disabled.
rdY	[6.15 set at 1]	Hardware enable signal is applied. The drive output is enabled. The drive is ready to be run.
StP	[10.03 set at 1]	Hardware enable signal is applied. RUN contact is open. The drive output is enabled. The motor is stopped (speed reference is zero).
run	[10.02 set at 1]	Hardware enable signal is applied. RUN contact is closed. Motor is accelerating or at a steady speed.
Jo9	[1.13 set at 1]	Hardware enable signal is applied. JOG FORWARD contact is closed.
Ini		Servo initialisation at power-up and when the drive is reset.
CSP	[6.49]	The motor is being subject to controlled deceleration to a stop during failure of the AC supply
Sby	[6.44 set at 1]	The drive and SLM are being supplied from an auxillary back-up supply.
LSP	[6.35 or 6.36 is set to 1]	The drive limit switch stop is activated
dEC		The motor is being decelerated by the drive
trP	[10.01 set at 0]	The drive has tripped and is no longer controlling the motor. The trip code appears on the upper line of the display. See <i>Trip codes</i> on page 88. The drive output is disabled allowing the motor to coast.

B.3 Status LEDs

When illuminated, these indicate the following:

D1	red	Trip OI.AC has occurred; control of the motor has ceased
D2	red	The drive has tripped due to a cause other than OI.AC; control of the motor has ceased
D3	green	The drive is operating normally (Drive ok); when unlit, this indicates the drive has tripped
D4	amber	The drive is enabled, allowing the motor to be driven

When the state of any of these LEDs indicates that the drive has tripped, perform the following:

Version **_AN**: Read the trip code displayed on the upper line of the alphanumeric display and refer to *Trip codes* on page 88.

Both versions, especially version **_SL**: Read the value of parameter **10.20** via serial communications and refer to *Trip codes* on page 88.

B.4 Alarm indications

Version **_AN**

Alarm indications appear on the lower line of the display.

Version **_SL**

The number given in brackets under each alarm indication (in the following list) is the number of the parameter that is correspondingly set at **1**. To identify which alarm has occurred, check the settings of these parameters via serial communications.

Global alarm indication

When an alarm occurs, Pr **10.19** becomes set at **1**.

Ibr	[10.12]	The [I ² t] accumulator for the internal braking resistor in the drive has reached 75% of the value at which the drive will be tripped. The drive output remains enabled.
OuL	[10.17]	The motor thermal-overload accumulator in the drive indicates that the motor windings are at their maximum specified working temperature (see <i>Adjusting the threshold for the motor thermal-overload alarm</i> on page 108). The drive output remains enabled. If the motor current is not reduced, the drive will trip (trip code: I2t.AC).
hot	[10.18]	The drive heatsink and/or internal control circuits have reached 90°C (176°F).
OnL	[11.64 {0.17}]	SLM-online enabled A delay can occur before new parameter values are transferred to the SLM

B.5 Trip codes

Version _AN

Trip codes appear on the upper line of the display.

Version _SL

The number given in brackets under each trip code (in the following list) is the value that appears in Pr **10.20**. This can be read via serial communications.

User defined trips

A user-defined trip can be created by setting Pr **10.38** at **1** to **255** (but not **100**) via serial communications. The value entered in Pr **10.38** then appears in Pr **10.20**; if Pr **10.38** is set at a value that corresponds with an existing trip (e.g. **1**), the cause of the trip will be interpreted accordingly (e.g. if **1** is used, it will be interpreted as **UU Insufficient DC-bus voltage**).

- Setting Pr **10.38** at **100** resets the drive
- Setting Pr **10.38** to **255** resets the trip log

Trip Code	Trip No.	Description
UU	[1]	Insufficient DC-bus voltage ($\leq 350V$). This occurs when the AC supply is removed.
OU	[2]	Excessive DC-bus voltage. Excessive regenerated power caused by the following: - Ramps not being used - Pr 0.26 Deceleration rate value too low - Incorrect value of braking resistor
OI.AC	[3]	Excessive instantaneous output current caused by a hardware fault.
OI.br	[4]	Excessive instantaneous current through the braking transistor caused by the braking-resistor value being too low or a short-circuit.
PS	[5]	Internal power supply fault. <i>Remove and re-connect the AC supply. If the trip persists, contact the supplier of the drive.</i>
Et	[6]	Pr 10.38 has been set at 6 (via serial communications) to indicate an External trip . <i>Correct the cause of the trip and reset the drive.</i>
OU.SPd	[7]	The motor has exceeded the over-speed threshold. This can be caused by the following: - Sudden removal of a large mechanical load - Pr 0.26 Deceleration rate value too low - Inappropriate setting for Pr 0.27 Fast ramp select

Trip Code	Trip No.	Description
tr08 ~ tr10	[8~10]	User-defined trips.
tunE1	[11]	The flux-alignment procedure has not changed the position feedback.
tunE2	[12]	The flux-alignment procedure has not changed the direction feedback.
tr13 ~ tr17	[13~17]	User defined trips.
tunE	[18]	The flux-alignment procedure stopped before completion.
It.br	[19]	Excessive braking duty-ratio. Excessive value of [I ² t] for the braking resistor.
I2t.AC	[20]	The motor current has not been sufficiently reduced within the specified time after a motor thermal-overload alarm (OuL) has been produced by the thermal-overload accumulator in the SLM (see <i>Adjusting the threshold for the motor thermal-overload alarm</i> on page 108). The drive output becomes disabled.
O.ht1	[21]	The thermal model indicates excessive temperature of the power stage of the drive.
O.ht2	[22]	Excessive temperature detected by the drive heatsink thermistor.
O.ht3	[23]	Excessive pcb temperature SLM software < V10 Excessive motor temperature SLM software > V10
O.ht4	[24]	Excessive DC-bus capacitor temperature due to excessive ripple current. To avoid shortening the life of these capacitors, fit line reactors (see <i>AC supply disturbances – use of line reactors</i> in Chapter 2 of the Installation Guide).
tr25	[25]	User defined trip.
OP.OuL	[26]	The total current drawn from the digital outputs has exceeded 400mA.
tr27 ~ tr29	[27~29]	User defined trips.
SCL	[30]	Serial communications link error
EEF	[31]	Fault in the internal EEPROM, causing loss of parameter values. <i>Follow the procedure in Restoring the drive to the default state on page 25, then re-enter the values for the application.</i>
Ph	[32]	Loss of an AC supply phase.
tr33 ~ tr49	[33~49]	User defined trips.
dL.Er	[50]	A <i>technology</i> communications error caused by any of the following: - No 24V supply to the SLM - Faulty cable to the SLM - Damaged SLM
dr.SI	[51]	Excessive mismatch between the current rating of the motor and the drive.
SL.Er	[52]	The value of Pr 10.52 indicates which of the following has caused this trip.

[10.52]	Cause of the trip
0	dL.Er trip has occurred before SL.Er trip
1	<i>ENCODER OBJECT</i> CRC checksum incorrect
2	<i>MOTOR OBJECT</i> CRC checksum incorrect
4	<i>EZE OBJECT</i> CRC checksum incorrect
8	Failure in the CT-coder
16	Invalid entry for address 49 of the <i>MOTOR OBJECT</i>
32	SLM not compatible with the drive software
64	<i>EZE OBJECT</i> not compatible with the drive software
128	A <i>technology</i> background communication error
256	The SLM has become disabled
512	SLM software version 3.01 but number of poles greater than 6
1024	SLM module hardware error
2048	SLM page 3 load failure
4096	Encoder type and gains mismatch in SLM adaptor
8192	EnDat encoder configuration error

Trip Code	Trip No.	Description
CtC.Er	[53]	Ct-Coder error; contact the supplier of the drive.
SL.Inl	[54]	The SLM is being initialised (the trip code is seen momentarily when the drive is being powered-up) Momentary display of the trip code does not cause the drive to trip.
In.An9	[55]	Initial mismatch from the SLM ; contact the supplier of the drive.
tr56 ~ tr99	100	User defined trips.
tr100	[101~254]	Drive reset
tr101~tr254	[101~254]	User defined trips.
tr255	255	Clear trip log information.

B.6 HF hardware fault trip codes

HF trips are internal hardware faults within the drive. Powering the drive down and re-applying power could clear the fault. Resetting the drive will not clear a HF trip.

Below is a full list of hardware faults trip codes on M'Ax:

Trip Code	Description
HF80	Incompatible hardware
HF88	Watchdog failure
HF89	Unused interrupts (nmi as source)
HF90	Stack overflow
HF91	Stack underflow
HF92	Software error (undefined operating code)

If the drive persistently trips on a HF trip, contact the supplier of the drive.

NOTE

If a HF trip occurs, the drive ok relay will open to indicate this. The serial communications will not function during a HF trip and the PVM outputs are disabled.

Appendix C Serial Communications

Refer to this Appendix for either version to be controlled by serial communications, in particular, version **_SL**.

C.1 Sequence for editing parameters

Use the following sequence when editing parameters via serial communications:

1. Send write-command(s) to edit parameter value(s) with the motor running or stopped, as appropriate.
2. Parameters indicated by the letter **R** in Chapter 8 *Menu 0 Parameters* on page 42 and Chapter 9 *Advanced Parameters* on page 49 require the drive to be reset before their new values take effect. If any of these parameters have been adjusted, follow the procedure in *Making new values take effect* on page 95.
3. If required, follow the procedure in *Saving new parameter-values* on page 96 to save new parameter-values for future use (the motor can be running or stopped).

After following this Appendix, refer to Chapter 5 *Getting Started* on page 26.

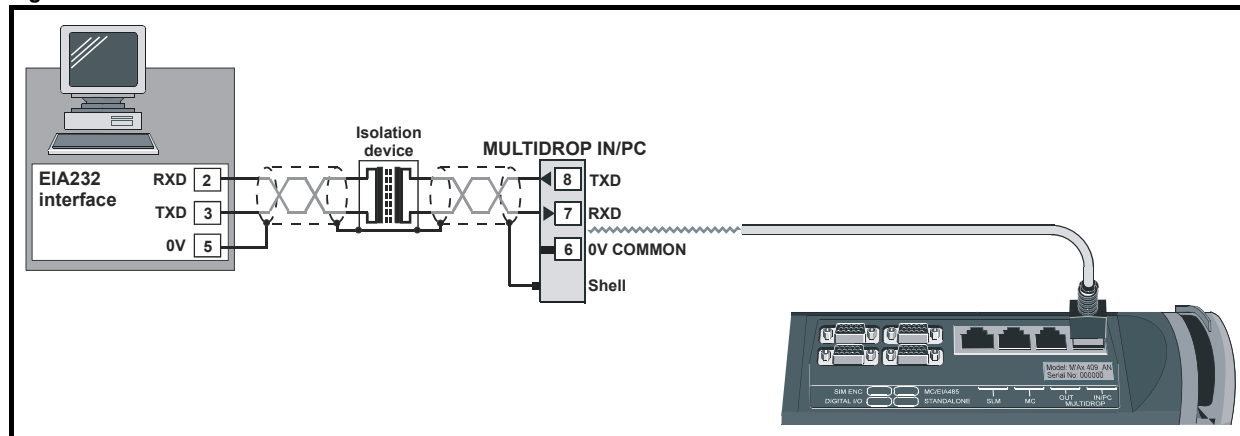
C.2 Serial communications protocols and interfaces

Protocols

Ensure Pr 11.24 *Serial comms. protocol selector* is set for the protocol to be used, as follows:

11.24	Protocol
0	ANSI
1	MODBUS RTU

Figure C.1 Connections for an EIA232 link



C.4 EIA485 interface

An EIA485 serial communications link allows up to 81 devices to be controlled and monitored by a host PLC. The devices can be drives and/or other equipment having a suitable serial communications interface. Alternatively a drive can be designated as the host for controlling and monitoring other drives.

Serial communications connections

Connector: **MC/EIA485**

Interfaces

An EIA232 or EIA485 (4-wire only) interface can be used with either protocol.

Serial communications connections must be made only to one of these interfaces. The drive automatically detects which is used.

(See also *Signal connections for remote control by serial communications* in Chapter 2 *Connecting the drive*.)

C.3 EIA232 interface

An EIA232 serial communications link allows a single drive to be controlled and monitored by a host PC, and can be used only for setting-up purposes.

Serial communications connections

Connector: **MULTIDROP IN/PC**

Terminal	Name	Function
7	RXD	Receive input
8	TXD	Transmit output
6	0V COMMON	
Shell		Cable shield

Connect an isolation device between the drive and PC.

See Figure 2-7 for other signal connections that must be made.

Terminal	Name	Function
4 12 15	0V COMMON	
6	TX	Transmit output (non-inverted)
7	TX\	Transmit output (inverted)
13	RX	Receive input (non-inverted)
14	RX\	Receive input (inverted)
Shell		Cable shield

Connect a line-termination resistor between the RX and RX\ lines only at the last drive or device on the serial link (i.e. the unit furthest from the host). The value of the resistor must be equal to the characteristic impedance of the cable.

Do not fit resistors to other units in the system, otherwise excessive signal loss will occur.

See Figure 2-7 for other signal connections that must be made.

Line loading

The drive loads the EIA485 serial communications lines as follows:

RX	2 unit-loads (EIA485)
TX	2 unit-loads (EIA485)

In accordance with the EIA485 specification, the total load on a line must not exceed 32 unit-loads.

Each transmitter and receiver of the drive loads the line by two unit-loads. This allows up to 16 drives to be linked without the use of line repeaters.

If a line repeater is added, a maximum of 15 drives can be linked direct to the PLC (i.e. before the line repeater).

Routing the serial communications cables

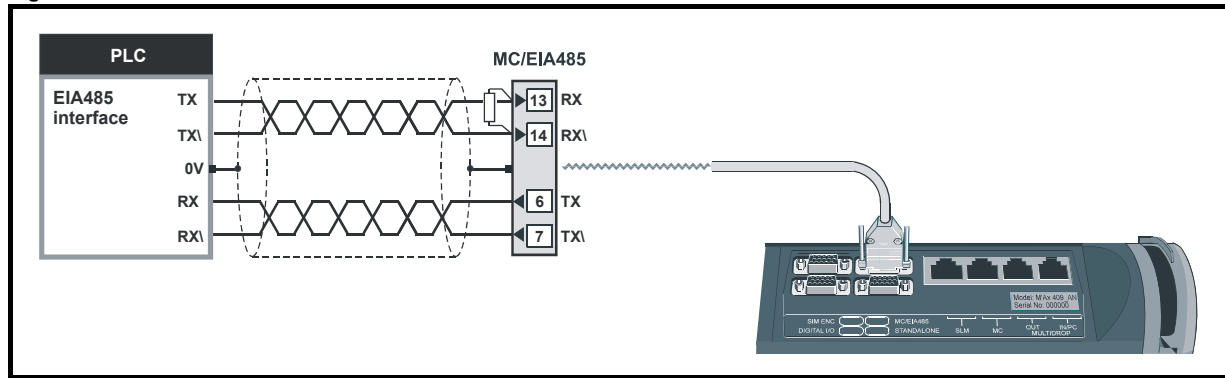
A data communications cable should not run parallel to any power cables, especially any that connect drives to motors. If parallel runs are unavoidable, ensure a minimum spacing of 300mm (12 in) between the communications cable and the power cable.

Where cables are required to cross, they should be at right-angles to each other in order to minimize coupling.

The maximum cable length for an EIA485 link is 1200 metres (4000 feet).

Devices must be chain-connected on an EIA485 communications link.

Figure C.1 Connections for an EIA485 4-wire link



Line biasing

Internal 12kΩ bias resistors ensure that logic 1 is detected when the RX lines are not driven.

Specifying an address

Each device must be programmed by the user to have a two-part address number in the form **G.U**, where **G** is the group number (1 to 9) and **U** is the unit number (1 to 9) in the specified group.

This form of addressing allows the following:

- An individual device to be addressed
- A group of devices to be addressed
- All devices to be addressed

Setting-up procedure

1. Set Pr **0.37** at the required address for the drive. The value entered in this parameter must take the form **G.U**, where **G** is the group number (1 to 9) and **U** is the unit number (1 to 9) in the specified group. The default value is **1.1**. The value **0** must not be used.
2. Set parameter **0.36** as follows for the required baud rate:

300	
600	
1200	
2400	
4800	
9600	Default
19200	

Low-ASCII character-byte									
1st hex character					2nd hex character				
Start bit	Seven data bits							Parity bit	Stop bit
0	lsb	...	...	...	...	...	msb	even	1

This is known as a 10-bit frame, since 10 bits in total are transmitted.

The format of the frame is often described as follows:

1 start bit, 7 data bits, even parity, 1 stop bit

lsb = Least-significant bit (i.e. bit 0)

msb = Most-significant bit (i.e. bit 6)

The parity bit is used by the receiver for checking the integrity of the data.

Typical-message format

A typical message consists of the following:

- Start control-code
- Device address
- Parameter number
- Parameter value (data)
- End-of-data control code (i.e. stop bit)
- Block checksum (BCC)

Message types

Command

Change the value of a parameter

Enquiry

Enquire the value of a parameter

Reply

Contains a parameter value in response to an enquiry

Acknowledge

Message accepted or rejected, or repeat the last command

Acknowledge messages contain only a control code

C.5 Transmitting and receiving data

Fundamentals of data transmission

Data is transmitted at a fixed speed (baud rate) in the form of a character. A character may typically comprise seven or eight bits.

In order for a receiver to recognise valid data, a start bit, an optional parity bit and a stop bit are transmitted along with the character, forming a frame, as shown following.

Message sequence

A typical message sequence is as follows:

1. The host enquires the value of a parameter in a drive.
2. The drive sends the value.
3. The host sends a command to the drive to change the value of the parameter.
4. The drive sends an acknowledgement that the parameter value has been changed.

Control codes

Commands, requests and responses can contain the following codes:

EOT

(Reset)

From the host: Instructs a drive to receive a message

From a drive: Indicates that an addressed parameter does not exist

ASCII code: 04

Keys: Ctrl D

STX

(Start of text)

From the host: Start of a command

From a drive: Start of a reply

ASCII code: 02

Keys: Ctrl B

ETX

(End of text)

From the host: End of a command

From a drive: End of a reply

ASCII code: 03

Keys: Ctrl C

ENQ

(Enquiry)

From the host: Instructs a drive to reply with the value of a specified parameter

ASCII code: 05

Keys: Ctrl E

ACK

(Acknowledge)

From the host: Instructs a drive to reply with the value of the next parameter in the menu

From a drive: Last command from host has been accepted and performed

ASCII code: 06

Keys: Ctrl E

NAK

(Negative acknowledge)

From the host: Instructs a drive to reply again with the value of a parameter

From a drive: Last message from host was rejected because of any of the following:

- Invalid message structure
- Specified parameter does not exist
- Data too long or out of range
- Attempting to edit a read-only parameter
- BCC incorrect (message corrupted)

ASCII code: 21

Keys: Ctrl U

BS

(Backspace)

From the host: Instructs a drive to reply with the value of the previous parameter in the menu

ASCII code: 08

Keys: Ctrl H

Addressing the devices

Addressing device(s) is performed by specifying an address number immediately after the start bit in a message. This address number is the same as the address of the device but modified by repeating each of the address digits.

To address an individual device, for example unit **6** in group **4**, which has the address **4.6**, the address used must be **4466**.

To address a group of devices, for example group **4**, the address used must be **4400**.

To address all devices, the address used must be **0000**. (e.g. to start all the drives in a system at the same time).

When group addressing is used, the drives will not transmit an acknowledgement since simultaneous transmissions will produce meaningless data.

Specifying a parameter

Commands and enquiries require a parameter number to be specified after the address in a message. Four digits must always be used (e.g. **0000**, **1101**, **0103**).

Specifying a value

Values are expressed as decimal numbers. The number of characters used for conveying a value depends on the value itself.

One of the following characters must precede the value:

Space (ASCII 32)

+

–

For example, this allows the value –1 to be transmitted.

Checking for data corruption

Messages that carry data are terminated by a block checksum (BCC) character. This is described in Block checksum later in this chapter.

C.6 Message structure

Key

G	Group number
U	Unit number
m1, m2	Menu number
p1, p2	Parameter number
v1...vn	Parameter value (variable number of bits)

Request the value of a parameter (read-command)

Host to drive

EOT	G	G	U	U	m1	m2	p1	p2	ENQ
------------	----------	----------	----------	----------	-----------	-----------	-----------	-----------	------------

Example

Group 4, Unit 6

Pr 1.17

Host sends: **EOT 4466 0117 ENQ**

Reply to a request for a parameter value

Drive to host

STX	m1	m2	p1	p2	v1	...	vn	ETX	BCC
------------	-----------	-----------	-----------	-----------	-----------	------------	-----------	------------	------------

Example

Value of Pr 1.17 is –4500

Drive sends: **STX 0117 –4500 ETX (**

Repeat the previous request for a parameter value

Host to drive

NAK

A drive will respond to this message only if the previous read-command issued by the host was addressed to and understood by the drive. Otherwise, the host must send a new read-command.

Request the value of the next parameter in the menu

Host to drive

ACK

A drive will respond to this message only if the previous read-command issued by the host was addressed to and understood by the drive. Otherwise, the host must send a new read-command.

Request the value of the previous parameter in the menu

Host to drive

BS

A drive will respond to this message only if the previous read-command issued by the host was addressed to and understood by the drive. Otherwise, the host must send a new read-command.

Change the value of a parameter (write-command)

Host to drive

EOT | G | G | U | U | STX | m1 | m3 | p1 | p2 | ...
... | v1 | ... | vn | ETX | BCC

Example

Group 4, Unit 6

Set Pr 1.17 at +76.4

Host sends:

EOT 4466 STX 0117 +076.4 ETX \$

Acknowledge response to a command

Drive to host

When a write-command has been understood and performed by the drive:

ACK

If a write-command has not been understood (hence not been performed) by the drive:

NAK or EOT (depending on the reason)

Sending a re-write command

Host to drive

The re-write command can be used for changing the value of any parameter in the last drive that was addressed by the host in a write-command. The re-write command eliminates the need to include the address in the message. This function can be used irrespective of whether the drive had understood the write-command.

STX | m1 | m2 | p1 | p2 | v1 | ... | vn | ETX | BCC

Calculating the block checksum

Calculation of the BCC is performed on the binary number for the hex code of each character that follows the STX character in a message. The calculation applies, in turn, an exclusive-OR (XOR) logic function between each binary number and the XOR result from the previous number.

XOR truth table		
A	B	Result
0	0	0
0	1	1
1	0	1
1	1	0

Procedure

To calculate the BCC for a write-command that is to set Pr 1.21 Preset reference 1 at -34.5RPM in a drive whose address is 1.2.

The message to be calculated is as follows:

EOT	1	1	2	2	STX	0	1	2	1	STX	...
Excluded from the calculation											
...	0	1	2	1	-	3	4	.	5	ETX	
Included in the calculation											

The first character of the BCC calculation is 0. The ASCII code for this character (48) is 0011 0000 in binary format. This binary number is then taken as a starting or result value. The next character is 1 (0011 0001 in binary). The exclusive-OR (XOR) operator is now applied to this number in conjunction with the previous result. This yields a new result of 0000 0001. The process is repeated as follows to produce a final result:

Character	Binary value	XOR result
0	0011 0000	(0011 0000)
1	0011 0001	0000 0001
2	0000 0010	0011 0011
1	0011 0001	0000 0010
-	0010 1101	0010 1111
3	0011 0011	0001 1100
4	0011 0100	0010 1000
.	0010 1110	0000 0110
5	0011 0101	0011 0011
ETX	0000 0011	0011 0000

The final binary value is used for the BCC, provided that its decimal equivalent is greater than 31 (ASCII characters from 0 to 31 are used as control codes). If it is less than 32, 32 must be added.

In this example, the decimal equivalent of 0011 0000 is 48 which exceeds 31; 48 is then used for defining the BCC character. ASCII code 48 is the character 0 (zero).

The complete message will be as follows:

EOT	1	1	2	2	STX	0	1	2	1	STX	...
...	0	1	2	1	-	3	4	.	5	ETX	0

C.7 Making new values take effect

Parameters that are indicated by the letter R in Chapters M0 to M13 require the drive to be reset for the new value(s) to take effect. (New values given to other parameters take effect immediately.)

To reset the drive, send a write-command to set Pr 10.38 at 100.



When using Pr 10.38 to 100 to reset the drive after certain function (i.e. Pr XX.00 to either 1233, 1244 or 1255, or setting Pr 0.50 to either boot1, boot2, no or Prog), the drive will not send back an ack signal to the host. It can also take 15 seconds for the flash memory to be updated before the next function can be carried out.

C.8 Storing new parameter-values

Parameter values can be stored in the flash memory in any version of the drive; in the case of version **_SL**, the flash memory is the only non-volatile storage (see Pr **0.50** in Chapter 8 *Menu 0 Parameters* on page 42). Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**.

1. Initiate the store operation by sending a write-command (described in *Change the value of a parameter (write-command)* on page 95) to set Pr **0.50** at **2 (Prog)** (alternatively, see step 3).
2. Execute the *store* operation by sending a write-command to set Pr **10.38** at **100**.
3. Instead of following steps 1 and 2, set **11.67 Flash update enable** at 1.
4. New values are now stored.
5. To use these values after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 2.

C.9 Saving new parameter-values

Parameter values can be saved only when an option module is installed in the drive (normally, in the case of version **_AN**).

1. Initiate the save operation by sending a write-command (described in *Change the value of a parameter (write-command)* on page 95) to set Pr **XX.00** at **1000**.
2. Execute the *save* operation by sending a write-command to set Pr **10.38** at **100**.
3. New values are now saved.
4. To use these values after the next power-up, ensure Pr **0.50** is set at **0 (no)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 2.

C.10 Restoring the drive to the default state

The drive is supplied in the appropriate *default state* for the version. A default state is defined as all the parameters being at their *standard factory default values*. There are three default states which are distinguished by how the drive is to be controlled; this is defined by the settings of two parameters.

Version	XX.00	Functions	Related parameter setting	
_SL (primarily)	1244	Enable restoring of parameter values from the flash memory at power-up	0.50 Parameter transfer selector set at 4 (boot2)	
		Enable standalone operation	11.66 <i>Host mode enable</i> set at 1	
	1255	Enable restoring of parameter values from the flash memory at power-up	0.50 Parameter transfer selector set at 4 (boot2)	This version is supplied with these settings
		Enable external-host operation	11.66 <i>Host mode enable</i> set at 0	
_AN	1233	Enable retrieval of parameter values from the option module EEPROM at power-up	0.50 Parameter transfer selector set at 0 (no)	This version is supplied with these settings
		Enable standalone operation	11.66 <i>Host mode enable</i> set at 1	

C.11 M'Ax-Soft

M'Ax-Soft is an application program that runs on Microsoft Windows 95™ or later and has the following features:

- Every parameter can be monitored and, when appropriate, edited
- Graphical representation in real-time of the values of parameters in a selected menu
- Compare the values of parameters in different drives
- Initiate auto-tune for flux alignment
- Initiate auto-scaling for the analog inputs.
- Help

When the drive is configured for the application and during use, parameters are over-written. If the drive is required to be returned to a default state, set Pr **XX.00** as shown in the table below (see also Appendix H *Storage and Transfer of Parameter values* on page 111). Restoring the drive to a default state also causes the drive to calculate the PID-gains, using the default values of Pr **3.19 {0.09} Stiffness angle** and Pr **3.20 {0.10} Load inertia** (see *Specifying shaft stiffness and load inertia* on page 97).

The values of the parameters that are stored (or saved) at power-down (S-parameters) are unaffected.

Procedure

NOTE

Any settings that have been made will be lost. If any continue to be required, ensure that you have a note of them before following this procedure.

1. Open the **Hardware enable** contact or set Pr **6.15** at **0** to disable the drive.
2. Send a write-command to set Pr **XX.00** at **1233**, **1244** or **1255**, as appropriate (restore default parameter-values).
3. Execute the operation by sending a write-command to set Pr **10.38** at **100** (reset the drive).
All parameters are now restored to their default values and the motor parameters are entered into the drive. The following also occur:
 - When Pr **1244** or Pr **1255** has been used: The default values of all the parameters (i.e. including the S-parameters) are *stored*.
 - When Pr **1233** has been used: The default values of the main parameters only (i.e. excluding the S-parameters) are *saved*.
4. If required, re-enter and store (or save) the noted settings.
5. To use the *stored* values after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.
6. To use the *saved* values (version **_AN** only) after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 3.

C.12 MODBUS RTU protocol

Related parameters

11.23	Serial comms. address		
↕ 0.1 ~ 24.7			⇒ 1.1
RW	Uni	P	GROUP.UNIT

11.24	Serial comms. protocol selector		
↕ 0 ~ 1			
RW	Txt	P	

The text settings are as follows:

11.24	Protocol
0	ANSI
1	MODBUS RTU

11.25	Serial comms. baud rate		
↕ 0 ~ 6			⇒ 5
RW	Uni	P	

The text settings are as follows:

11.25	Baud rate (bits/s)
0	300
1	600
2	1200
3	2400
4	4800
5	9600
6	19200

11.26	Serial comms. transmit-delay time		
↕ 0 ~ 255			⇒ 2
RW	Uni	P	ms

MODBUS frame

1 start bit	8 data bits	2 stop bits
-------------	-------------	-------------

No parity bit is used.

MODBUS commands

Function	MODBUS command code
Read holding registers	0x03 (3)
Read multiple registers	
Preset multiple registers	0x10 (16)
Write multiple registers	
Read and write multiple registers	0x17 (23)

MODBUS registers

Mapping of parameters

Drive parameters are mapped to the 4XXXX-series of MODBUS registers. Menu-parameter numbers are mapped by removal of the decimal point and the addition of a prefix number (e.g. Pr 11.24 is converted to 41124). All parameter values (including the settings of bit

parameters and the serial-communications values of text parameters) are treated as 16-bit values.

Multiple registers

A maximum of 16 consecutively numbered registers can be accessed at a time.

If one or more parameters in a specified series of parameters does not exist, the specified action will not be performed and the drive will respond with an exception code (see *Exception codes* below).

Broadcast messages

When address 0.0 is specified by the controller messages will be sent to all units. These will respond accordingly but will not reply.

Exception codes

Code	Indicates
1	Invalid command code specified
2	Invalid register address specified (out of range or more than 16 parameters specified)

Out-of-range conditions

During write-commands

If the value specified in a write-command (0x10) to a drive exceeds the maximum permissible value for a parameter, the parameter remains unchanged. If this occurs during a multiple write-command, subsequent parameter(s) will also remain unchanged, but the value(s) of the preceding parameter(s) will have been changed.

The drive does not send an exception code in reply; only confirmation of the actual changes is sent to the master.

During a multiple read/write command

If the value specified in a multiple read/write-command (0x17) to a drive exceeds the maximum permissible value for a parameter, the parameter remains unchanged. The values of all preceding and subsequent parameters are changed.

No indication of error(s) is sent to the master.

To connect a **M'Ax** drive to a fieldbus system a gateway device can be used to convert from one network system to another, such as Devicenet to Modbus.

Control Techniques Drive Centres can supply a range of gateway options to suit most common fieldbuses.

Appendix D Optimising the Dynamic Performance

D.1 Speed-loop parameters

The dynamic performance during operation in speed control is controlled by the following parameters which are adjusted during commissioning of the system:

Pr 3.10 {0.13} Speed-loop proportional gain

Pr 3.11 {0.14} Speed-loop integral gain

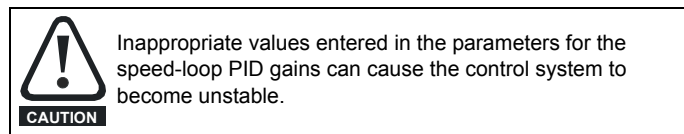
Pr 3.12 {0.15} Speed-loop derivative gain

The default values of these speed-loop PID-gains parameters can be used for most applications.

Parameter	Range
Pr 3.10 {0.13} Speed-loop proportional gain	0 ~ 0.3000
Pr 3.11 {0.14} Speed-loop integral gain	0 ~ 20.00
Pr 3.12 {0.15} Speed-loop derivative gain	0 ~ 0.1000

Table D.1 Ranges of values

The default values depend on the motor being used.



Current-loop bandwidth

If any mechanical resonances lie within the current-loop bandwidth of the drive they can give rise to torque oscillations resulting in the following effects, for example:

- Noisy motor
 - Vibration
 - Instability
 - Over-current trips
- (Inertia mismatch and flexible couplings are prone to introducing such resonances.)

Torque oscillations can be minimised by adjusting the current-loop bandwidth of the drive in addition to the PID gains.

PID-gains buffers

The PID-gains parameters are held in the drive, along with a copy of each held in a buffer in the SLM for use by the speed loop.

Adjustment of the PID gains is made by changing the values of the parameters held in the drive (e.g. 3.10 {0.13}, 3.11 {0.14}, 3.12 {0.15}) and updating the SLM either concurrently or subsequently.

In addition to the set of PID gains already described and which are duplicated in Menu 0, two additional sets of gains are available only in Menu 3. Rapid selection can be made between these three sets while the motor is running (see *Gain sequencing* on page 100).

Methods of adjusting the PID gains

For a practical approach to optimising the dynamic performance, see *Adjusting the speed-loop gains* (which follows).

For a simple approach, see *Specifying shaft stiffness and load inertia* on page 97.

D.2 Adjusting the speed-loop gains

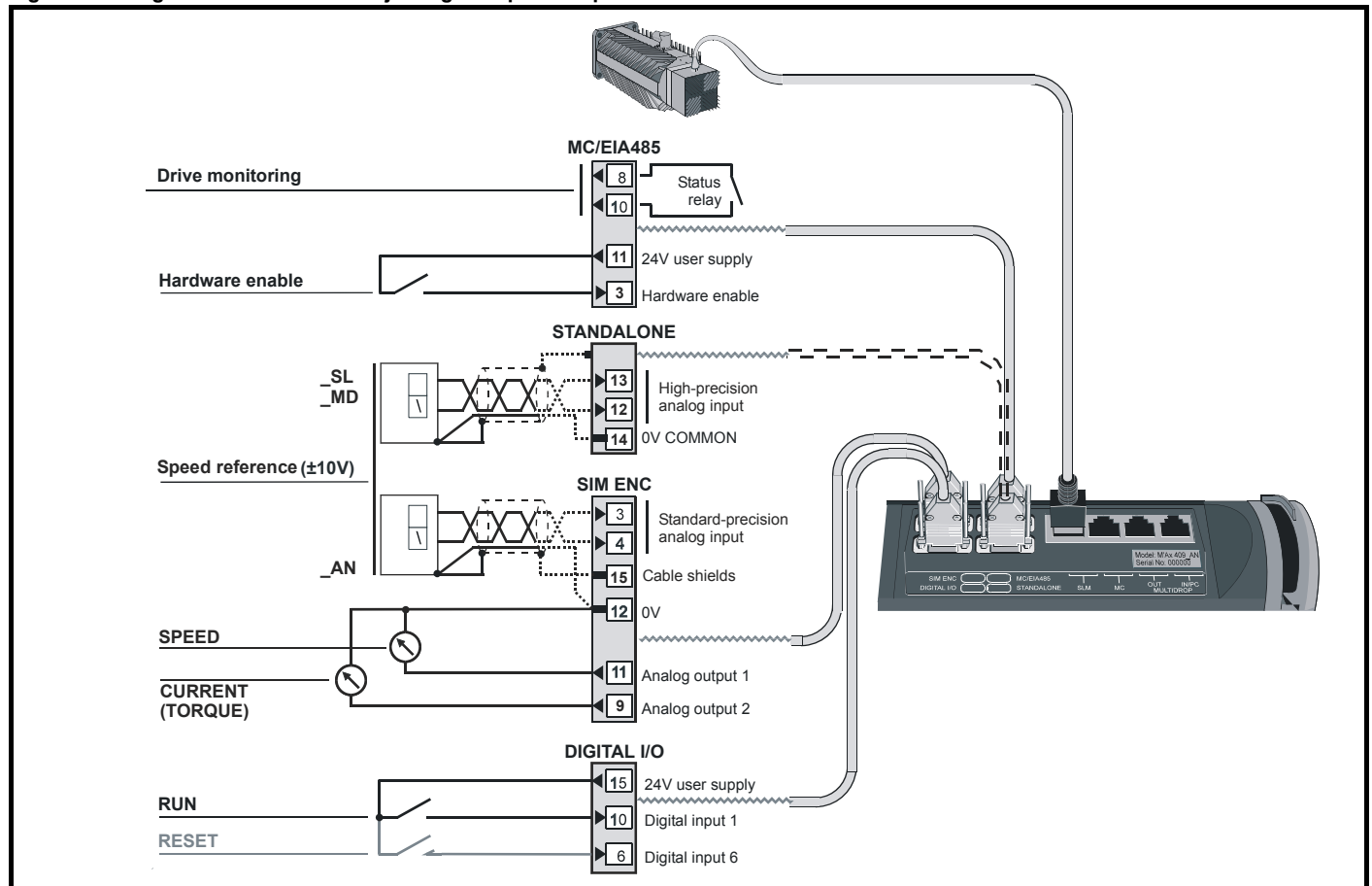
This procedure requires the drive to be operated in speed control during adjustments.

Higher gains result in the following:

- Greater shaft stiffness
- Greater peak currents with increased possibility of the drive tripping on over-current
- Smaller stability margin

If required, see also Appendix D.5 *Gain sequencing* on page 100.

Figure D-1 Signal connections for adjusting the speed loop



Procedure

1. Make the signal connections shown in Figure D-1. Make the **SPEED REFERENCE** connections for either high or standard precision as appropriate, not both. Connect an oscilloscope to terminal 11 (**SPEED**) and terminal 9 (**CURRENT**) of the **SIM ENC** connector.
2. Ensure the **Hardware enable** contact is open or that parameter **6.15 Drive enable** is set at **0**.
3. Connect the AC supply to the drive.
4. Set Pr **2.02 {0.24} Ramp enable** at **0**.
5. Ensure Pr **3.16 {0.12} Speed-loop gains selector** is set at **1** in order to select **PID-gains set 1** in the drive and **PID-buffer 1** in the **SLM**. (If a different PID-gains set is to be adjusted, set Pr **3.16 {0.12}** accordingly; see *Gain sequencing* later in this chapter.)
6. Connect the load to the motor.
7. Set Pr **11.64 {0.17} SLM on-line enable** at **1**. This allows the **SLM** to be updated with new values of the PID-gains parameters.

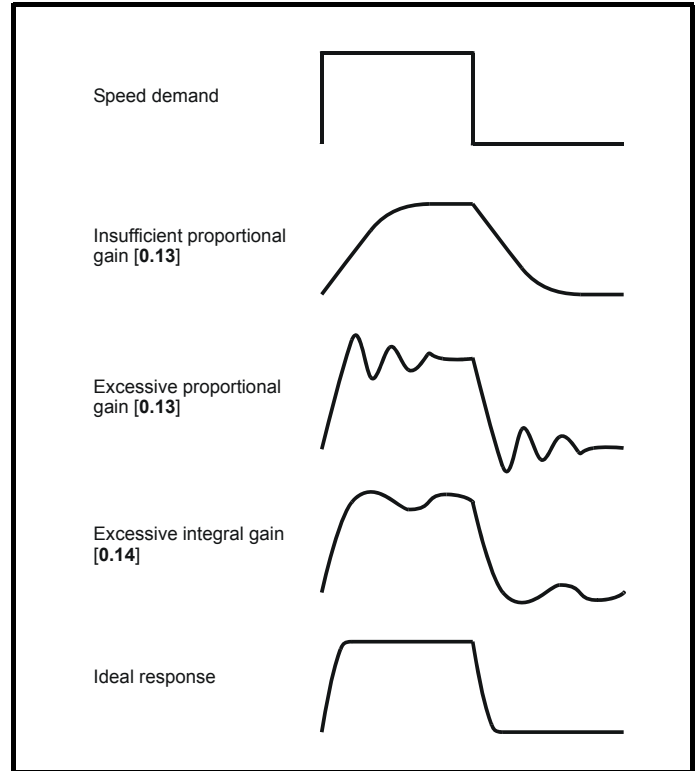


Following power-up, new PID-gain(s) value(s) take effect only after the motor shaft has passed through the zero position of the feedback encoder.

8. Close the **Hardware enable** contact or set Pr **6.15 Drive enable** at **1**.
9. Set the motor running at a suitable speed, then stop and re-start the drive as required.
10. To increase the speed of response to a change in speed demand, or to a change in load, increase Pr **3.10 {0.13} Speed-loop proportional gain**.
Set Pr **3.10 {0.13}** just below the value that causes the motor to vibrate. It is common for the vibration to be worse at zero speed. An excessive proportional gain can result in instability.
11. To improve the ability of the drive to maintain a speed demand under steady-state or slowly-changing conditions, increase Pr **3.11 {0.14} Speed-loop integral gain**.
A high value of Pr **3.11 {0.14}** can cause the motor speed to vary sinusoidally around the speed demand. This effect can be minimized by increasing the value of Pr **3.10 {0.13} Speed-loop proportional gain**.
12. To reduce overshoot when the speed demand or the load on the motor is suddenly changed, increase Pr **3.12 {0.15} Speed-loop derivative gain**. Excessive derivative gain will cause noise in the motor.
13. If mechanical resonances are affecting the performance of the system, reduce the value of Pr **4.12 {0.16} Current-demand filter 1 cut-off frequency**, then repeat steps 10 to 12. Repeat this step as required.
14. Set Pr **11.64 {0.17} SLM on-line enable** at **0** to prevent inadvertent adjustments. Do **not** leave this parameter set at **1**.
15. Perform the following, as appropriate:
Version _AN
Initiate the save operation by setting Pr **XX.00** at **1000**.
Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr **10.38** at 100 (via serial communications)**Version _SL**
Version _AN (if required)
Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:
 - Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**. Execute the operation by setting Pr **10.38** at **100**.
 - Set Pr **11.67 Flash update enable** at **1**.
16. To use the saved values (version **_AN** only) after the next power-up, ensure Pr **0.50** is set at **no (0)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 15.

17. To use the *stored* values after the next power-up, ensure Pr **0.50** is set at **4 (boot2)**. If you have to change the setting, immediately afterwards execute the operation, as described in step 15.
18. Disconnect the AC supply.
19. Re-make the required signal connections for the application.

Figure D-2 Response to a step-change in speed demand when the speed-loop PID gains are adjusted



The waveforms shown in Figure D-2 represent the **SPEED** output signal from terminal 11 of the **SIM ENC** signal connector when the speed demand is a square-wave.

D.3 Specifying shaft stiffness and load inertia

When the following are entered into the appropriate parameters, the drive can calculate the required PID gains:

- Stiffness angle
- Load inertia

Stiffness angle

Stiffness angle is defined as the angular displacement of the motor shaft that would cause the drive to deliver a torque-producing current equivalent to the value of FLC (without field weakening). Smaller stiffness angles result in the following:

- Greater shaft stiffness
 - Greater peak currents with increased possibility of the drive tripping on over-current
 - Smaller stability margin
- Typical values are 6 to 10°.

Load inertia

Load inertia should include the inertia of the following, as appropriate:

- Shaft(s)
- Attachments (e.g. brake)
- Gearing

If gearing is employed, the value of reflected load inertia must be used.

The drive can accept inertia values in either kgm² or kgcm² (indicated by Pr **5.34 Inertia units selected**, which is set by the motor manufacturer).

If required, see also *Gain sequencing* on page 100.

No special signal connections are required.

Procedure

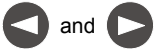
1. Ensure the **Hardware enable** contact is open or that Pr **6.15 Drive enable** is set at **0** to disable the drive.
2. Connect the AC supply to the drive.
3. Version **_AN**: Check the display indicates **inh**.
4. Version **_SL**: Send a read-command to check that Pr **8.09 {0.01} Hardware enable status** is set at **0**.
5. Unlock security (see Chapter 7 *Security and Accessing the Advanced Parameters* on page 40).
6. Check the setting of Pr **5.34 {0.11} Inertia units selected**. The settings indicate as follows:

5.34	Units
0	kgm ²
1	kgcm ²

7. Calculate the load inertia to be experienced by the motor in kgcm² or kgm², as defined in step 6.
8. Ensure Pr **3.16 {0.12} Speed-loop gains selector** is set at **1** in order to select *PID-gains set 1* in the drive and *PID-buffer 1* in the **SLM**. (If a different PID-gains set is to be adjusted, set Pr **3.16 {0.12}** accordingly; see *Gain sequencing* on page 100.)
9. Enter the required value of stiffness angle (in degrees and decimals of a degree) into Pr **3.19 {0.09}**.
10. Version **_AN**: If the display does not indicate the required range, change the setting of Pr **5.54 Inertia range select** as follows:

5.54	kgm ²	kgcm ²	
0	0.1 ~ 6000.0	0.00001 ~ 0.6	
1	0.01 ~ 600.0	0.000001 ~ 0.06	Default

11. Enter the value of load inertia (calculated at step 7) into Pr **3.20 {0.10}**.
12. Set Pr **XX.00** at **3000** to initiate calculation of the PID gains.
13. Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

The PID gains are now calculated by the drive and saved or stored, as appropriate.

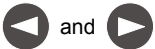
14. To save the new PID-gains values, perform the following as appropriate:

Version **_AN**

Initiate the save operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version **_SL**

Version **_AN** (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.
- Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.



Following power-up, new PID-gain(s) value(s) take effect only after the motor shaft has passed through the zero position of the feedback encoder.

CAUTION

Testing the system

1. Close the **Hardware enable** contact or set Pr **6.15** at **1**, and test the system.
2. If mechanical resonances are affecting the performance of the system, open the **Hardware enable** contact. Reduce the value of Pr **4.12 {0.16} Current-demand filter 1 cut-off frequency**, then repeat steps 10 to 15 of the procedure. Repeat this step as required.
3. Open the **Hardware enable** contact or set Pr **6.15** at **0**.
4. Lock security.

D.4 Methods of updating PID buffers

Updating the SLM while values are being changed

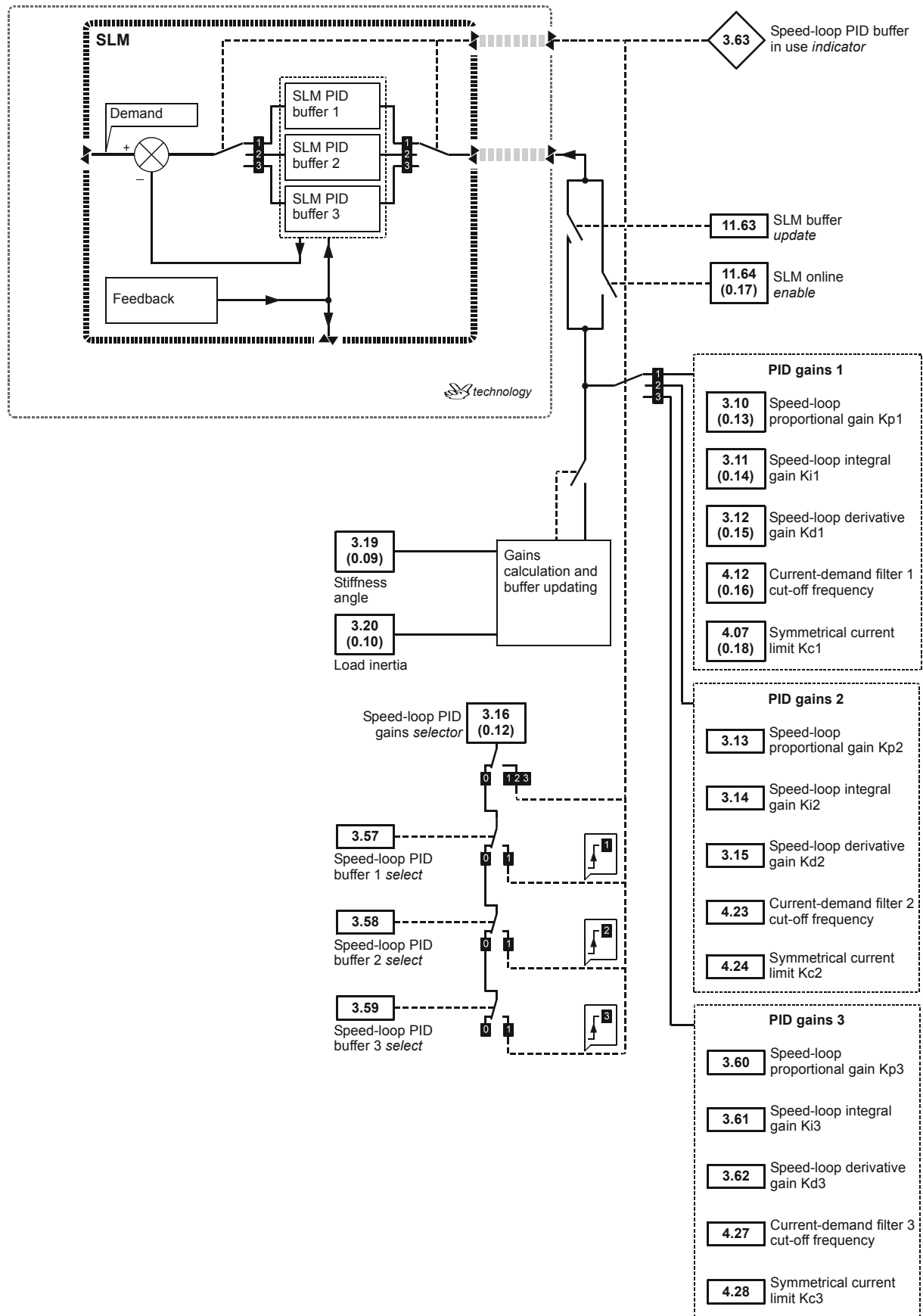
1. Use Pr **3.16 {0.12} Speed-loop gains selector** to select the required PID-gains set in the drive and PID buffer in the **SLM**.
2. Set Pr **11.64 {0.17} SLM on-line enable** at **1**.
3. Change the values of the PID-gains parameter(s), as required.
4. When adjustments are completed, set Pr **11.64 {0.17} SLM on-line enable** at **0**. Do not leave this parameter set at **1**.

Updating all values

All values in all the PID buffers (see *Gain sequencing* on page 100) in the **SLM** are updated when the AC supply is removed and re-connected.

Related parameters

Figure D-3 Software diagram for PID gains and buffers



Parameter		Range(⇅)	Default(⇨)	Type			
3.10 {0.13}	Speed-loop proportional gain Kp1	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.11 {0.14}	Speed-loop integral gain Ki1	0.000 ~ 30.000	[SLM]	RW	Uni		
3.12 {0.15}	Speed-loop derivative gain Kd1	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.13	Speed-loop proportional gain Kp2	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.14	Speed-loop integral gain Ki2	0.000 ~ 30.000	[SLM]	RW	Uni		
3.15	Speed-loop differential-feedback gain Kd2	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.16 {0.12}	Speed-loop PID gains <i>selector</i>	0 ~ 3	1	RW	Uni		
3.18 {0.11}	Total inertia	0.01 ~ 600.00kgcm ²		RO	Uni		
3.19 {0.09}	Stiffness angle	0 ~ 30.0°	6.0	RW	Uni		
3.20 {0.10}	Load inertia	0.01 ~ 600.00kgcm ²	J _{ML}	RW	Uni		
3.57	Speed-loop buffer 1 <i>select</i>	0 ~ 1	0	RW	Bit		
3.58	Speed-loop buffer 2 <i>select</i>	0 ~ 1	0	RW	Bit		
3.59	Speed-loop buffer 3 <i>select</i>	0 ~ 1	0	RW	Bit		
3.60	Speed-loop proportional gain Kp3	0.0000 ~ 0.3000	[SLM]	RW	Uni		
3.61	Speed-loop integral gain Ki3	0.000 ~ 30.000	[SLM]	RW	Uni		
3.62	Speed-loop derivative gain Kd3	0.0000 ~ 0.1000	[SLM]	RW	Uni		
3.63	Speed-loop PID buffer in use <i>indicator</i>	0 ~ 3		RO	Uni		

D.5 Gain sequencing

The drive has three sets of PID gains and the SLM has a corresponding set of PID buffers. Each PID-gains set in the drive can be set up for a different operating condition (e.g. a particular load and/or position). A PID buffer in the **SLM** can be activated within 1ms of a command being received.

For example, lower values of PID gains can be used when a resonance is traversed during acceleration, and the required values for the process used when the range of operating speeds is reached.

The PID-gains parameters in Menu 0 relate to the parameters in *PID gains 1* (see Figure D-3). Selection among the three sets is made by Pr 3.16 {0.12} *Speed-loop gains selector*.

Setting up PID gains for gain sequencing

Each PID-gains set is set up individually by following the procedure in *Adjusting the speed-loop gains* or *Specifying shaft stiffness and load inertia*. To ensure the required PID-gains set is adjusted while following the procedure, set Pr 3.16 {0.12} *Speed-loop gains selector* as follows:

3.16	PID gains
1	1
2	2
3	3

Unlock security before adjusting these gains.

The parameters in each PID-gains set are as follows:

PID-gains set 1

- Pr 3.10 {0.13} *Speed-loop proportional gain Kp1*
- Pr 3.11 {0.14} *Speed-loop integral gain Ki1*
- Pr 3.12 {0.15} *Speed-loop derivative gain Kd1*
- Pr 4.12 {0.16} *Current-demand filter 1 cut-off frequency*
- Pr 4.07 {0.18} *Symmetrical current limit Kc1*

PID-gains set 2

- Pr 3.13 *Speed-loop proportional gain Kp2*
- Pr 3.14 *Speed-loop integral gain Ki2*
- Pr 3.15 *Speed-loop derivative gain Kd2*
- Pr 4.23 *Current-demand filter 2 cut-off frequency*
- Pr 4.24 *Symmetrical current limit Kc2*

PID-gains set 3

- Pr 3.60 *Speed-loop proportional gain Kp3*
- Pr 3.61 *Speed-loop integral gain Ki3*
- Pr 3.62 *Speed-loop derivative gain Kd3*

Pr 4.27 *Current-demand filter 3 cut-off frequency*

Pr 4.28 *Symmetrical current limit Kc3*

Selection of PID-gains sets and PID buffers



Following power-up, new PID-gain(s) value(s) take effect only after the motor shaft has passed through the zero position of the feedback encoder.

When the motor is running or stopped, a PID buffer in the **SLM** (and the related PID-gains set in the drive) can be selected by any of the following means:

Using the keypad or serial communications to adjust the PID-gains selector

1. Change the setting of Pr 3.16 {0.12} *Speed-loop gains selector* as follows:

3.16	Select PID buffer...
1	1
2	2
3	3

2. Set Pr 11.63 *SLM buffer update* at 1.
3. The newly selected PID buffer takes effect immediately.

Using the keypad or serial communications to select by edge-triggering

1. Set Pr 3.16 {0.12} *Speed-loop gains selector* at 0. This allows PID buffers to be selected by edge-triggering.
2. Refer to the following table and ensure the appropriate parameter is first set at 0, then set it at 1 in order to select the required PID buffer; the PID buffer is selected on the rising edge.

To select PID buffer...	Use parameter...
1	3.57
2	3.58
3	3.59

3. The newly selected PID buffer takes effect immediately.

Assigning and using digital inputs to select by edge-triggering

1. Establish which digital inputs are not required for other purposes.
2. Refer to Pr **8.21** to **8.28** in *Menu 8 Parameters* (Chapter 9 *Advanced Parameters* on page 49) to identify the assignment parameters which are related to the digital inputs to be used for selecting PID buffers.
3. Unlock security.
4. Enter the following values in the assignment parameters:

To select PID buffer...	Enter...
1	3.57
2	3.58
3	3.59

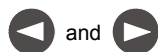
5. Set Pr **3.16** {**0.12**} *Speed-loop gains selector* at **0**. This allows PID buffers to be selected by edge-triggering.
6. Perform the following as appropriate:

Version _AN

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2** (**Prog**).

Execute the operation by setting Pr **10.38** at **100**.

- Set Pr **11.67** *Flash update enable* at **1**.

7. Connect a normally-open momentary contact between each digital input and **+24V user supply** (see Figure D-2).
8. To select a PID buffer, momentarily close the related contact. The newly selected PID buffer takes effect immediately.
9. If more than one contact is closed at one time, priority is given to the lowest numbered PID buffer (e.g. 1).
10. When the AC supply is re-applied to the drive, the last-selected buffer will remain selected.

Appendix E Auxiliary Back-up Supply



Isolation

The auxiliary back-up supply must be isolated from ground since it is referenced to –DC of the DC bus. It must also be isolated from any other auxiliary back-up supply except when the DC-buses of the drives are connected in parallel. Failure to observe these requirements will result in damage to the back-up supplies and drive(s).

When low-speed positioning of the motor shaft is required, the positive output of the back-up supply must be connected to terminal +DC of the drive via a 1000V blocking diode and fuse, as shown in Figure E–1. The auxiliary back-up supply must NOT be connected directly to terminal +DC.

Supply interlock

The supply interlock circuit shown in Figure E-1 MUST be connected.

Failure to observe any of these requirements will result in damage to the drive(s) and auxiliary back-up supply/supplies. For a recommended auxiliary back-up supply, contact the supplier of the drive.

E.1 Functions

- Maintains the DC supply to the control circuits of the drive.
- Maintains the 24V supply to the **SLM**.
- Maintains the **24V user supply**.
- When suitably rated, the auxiliary back-up supply can also supply power to the motor for positioning at low speed

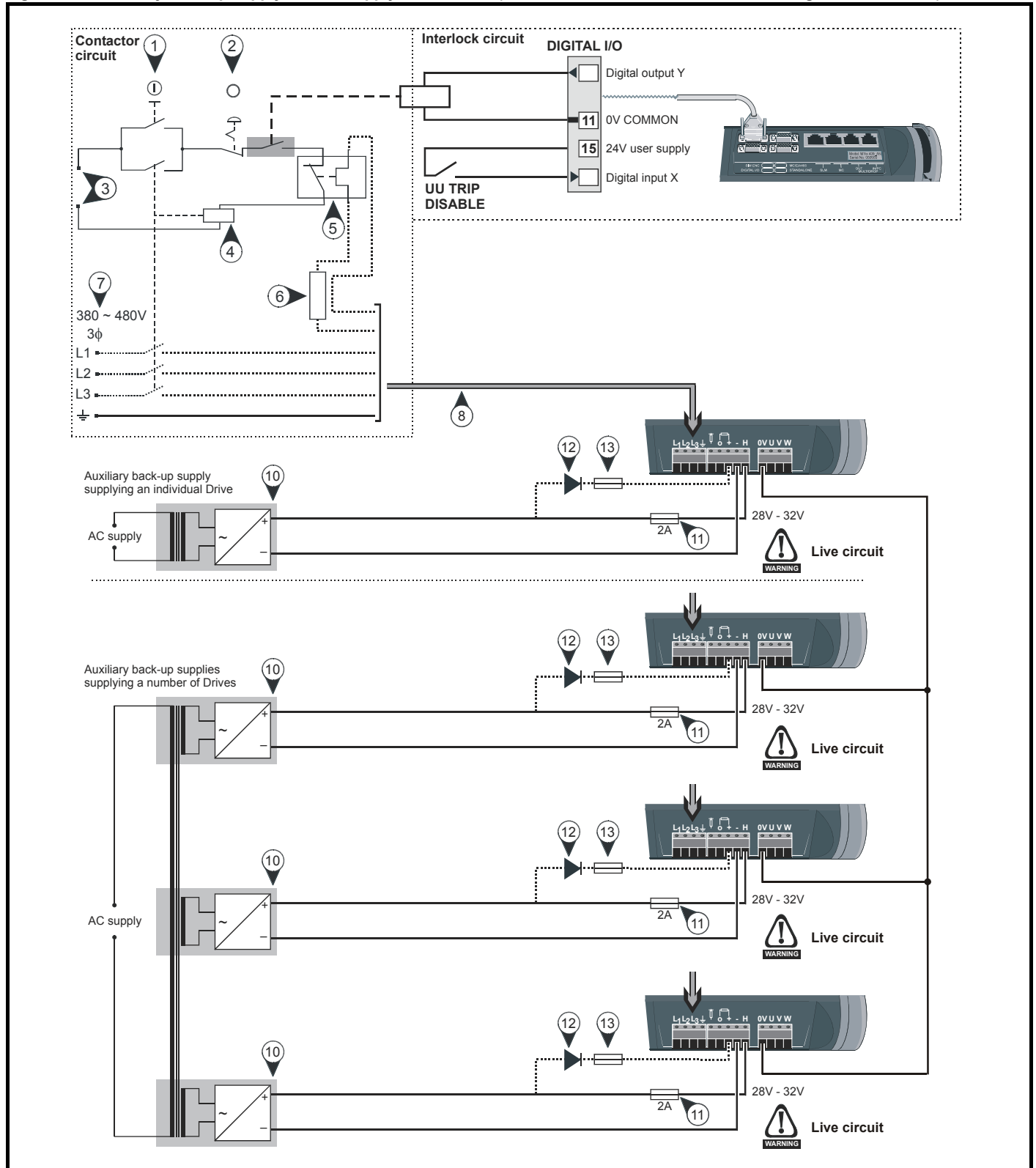
E.2 Auxiliary back-up supply requirements

- Voltage: 28VDC ~ 32VDC (Operation outside these limits will result in damage to the drive)
- Maximum output current to the control circuits (of each drive): 2A
- One digital input and one digital output of the drive are required for the supply interlock circuit.
- When suitably rated, the auxiliary back-up supply can also supply power to the motor for positioning at low speed.
- Specific parameters must be adjusted.

Refer to *Planning the signal-current consumption* on page 19). The maximum current available for the following for each drive is 400mA:

- **SLM**
- **24V user supply**
- Digital outputs
- **Drive-status supply**

Figure E-1 Auxiliary back-up supply and AC supply connections (these are additional to those shown in Figures 2–3 to 2–12)



Key to Figure E-1

1. **START/RESET** switch (momentary)
2. **STOP** switch (latching)
3. Control-circuit supply
4. Contactor coil
5. Thermal-overload protection relay for braking resistor
6. Optional external braking resistor
7. 380 ~ 480VAC supply to the drive
8. Power connectors on the drive
9. Interlock relay in contactor circuit

10. Isolated power supply
11. 2A fuse to protect the control circuits
12. 1000V blocking diode is required only when the auxiliary back-up supply is also to power the motor; the diode to be current-rated according to the model of drive being used
13. Fuse required when the auxiliary back-up supply is also to power the motor; the fuse to be rated according to the model of drive being used

E.3 Setting-up procedure

- Referring to the appropriate circuit diagram in *Example signal connections* on page 8, identify one digital input and one digital output that are not used.
- Make the connections shown in Figure E-1. Use the terminals located at step 1 for Digital input X and Digital output Y. The interlock circuit requires a relay having the following specification:
Isolation: 1000V
Coil voltage: 24V
Coil current: 100mA maximum
- Refer to the following table to identify which *Output selection parameter* is related to the digital output being used. Set this parameter at Pr 10.57.

Digital output	DIGITAL I/O terminal	Output selection parameter
1	5	8.71
2	4	8.72
3	3	8.73
4	2	8.74

- Refer to the following table to identify which *Input selection parameter* is related to the digital input being used. Set this parameter at Pr 10.53

Digital output	DIGITAL I/O terminal	Output selection parameter
1	10	8.21
2	9	8.22
3	8	8.23
4	7	8.24
5	1	8.25
6	6	8.26
7	13	8.27
8	12	8.28

- Perform the following, as appropriate:
Version _AN
Initiate the save operation by setting Pr XX.00 at 1000.
Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr 10.38 at 100 (via serial communications)**Version _SL**
Version _AN (if required)
 Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr 6.15 is set at 0, then perform either of the following:
 - Initiate the store operation by setting Pr 0.50 at 2 (Prog).
Execute the operation by setting Pr 10.38 at 100.
 - Set Pr 11.67 *Flash update enable* at 1.
- To use the *saved* values (version _AN only) after the next power-up, ensure Pr 0.50 is set at **no** (0). If you have to change the setting, immediately afterwards execute the operation, as described in step 5.
- To use the *stored* values after the next power-up, ensure Pr 0.50 is set at 4 (**boot2**). If you have to change the setting, immediately afterwards execute the operation, as described in step 5.
- If the auxiliary back-up supply is to supply power to the motor for low-speed positioning, for commissioning connect a 1000V (blocking) diode and a fuse between the positive output of the back-up supply and terminal +DC of the drive (items 12 and 13 in Figure E-1); this is in addition to the connection to terminal H. The fuse current-rating and the minimum current rating of the diode must be as follows:

:

Model	Current rating	Fuse rating
M'Ax 403	6A	10A
M'Ax 406	9A	10A
M'Ax 409	12A	16A
M'Ax 412	14A	20A

- Make power connections as shown in the Installation Guide (the power connections shown in Figure E-1 are shown as a guide only).

Example

A M'Ax model 412 remotely controlled by a system controller or PLC supplying quadrature AB signals (as shown in Figure 2-6).

The **DIGITAL I/O** terminals in use are shown in Figure E-2 (below).

Digital output

- Refer to Figure E-2 and use the following table to find out which digital outputs are not in use:

Digital output	DIGITAL I/O terminal	
1	5	Unused
2	4	Used
3	3	Unused
4	2	Unused

- Select one of the unused digital outputs, for example **Digital output 3**, for the interlock and make connections to it as shown in Figure E-3.
- Use the following table to find out which *Output selection parameter* to adjust:

Digital output	DIGITAL I/O terminal	Output selection parameter
1	5	8.71
2	4	8.72
3	3	8.73
4	2	8.74

- Set Pr 8.73 at 10.57.

Digital input

- Refer to Figure E-2 and use the following table to find out which digital inputs are not in use:

Digital input	DIGITAL I/O terminal	
1	10	Used
2	9	Unused
3	8	Unused
4	7	Unused
5	1	Unused
6	6	Used
7	13	Unused
8	12	Unused

- Select one of the unused digital inputs, for example Digital input 5, for the interlock and make connections to it as shown in Figure E-3.

Figure E-2 Example DIGITAL I/O terminals in use

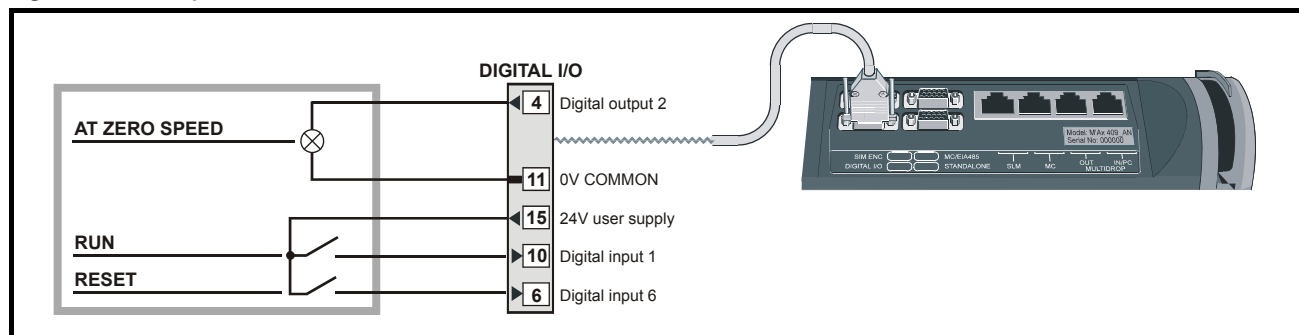
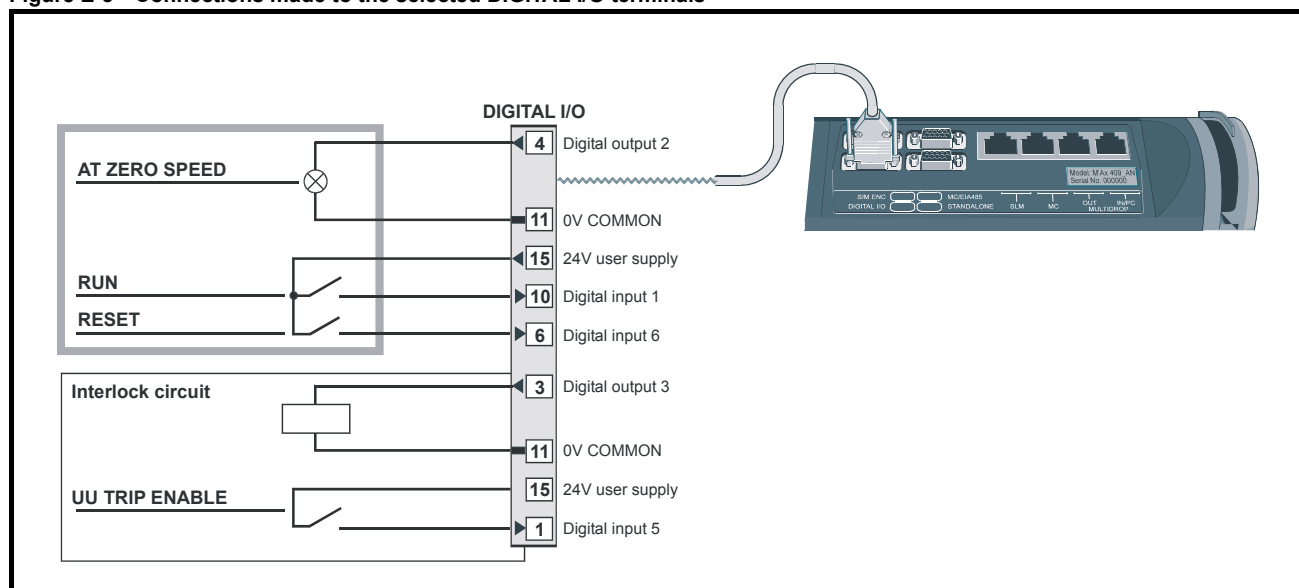


Figure E-3 Connections made to the selected DIGITAL I/O terminals



7. Use the following table to find out which *Input selection* parameter to adjust:

Digital input	DIGITAL I/O terminal	Input selection parameter
1	10	8.21
2	9	8.22
3	8	8.23
4	7	8.24
5	1	8.25
6	6	8.26
7	13	8.27
8	12	8.28

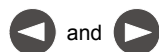
8. Set Pr 8.25 at 10.53.
9. Perform the following, as appropriate:

Version _AN

Initiate the save operation by setting Pr XX.00 at 1000.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr 10.38 at 100 (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr 6.15 is set at 0, then perform either of the following:

- Initiate the *store* operation by setting Pr 0.50 at 2 (**Prog**). Execute the operation by setting Pr 10.38 at 100.
- Set Pr 11.67 *Flash update enable* at 1.

10. To use the *saved* values (version _AN only) after the next power-up, ensure Pr 0.50 is set at **no** (0). If you have to change the setting, immediately afterwards execute the operation, as described in step 9.
11. To use the *stored* values after the next power-up, ensure Pr 0.50 is set at 4 (**boot2**). If you have to change the setting, immediately afterwards execute the operation, as described in step 9.

Blocking diode and fuse

12. If the auxiliary back-up supply is also to supply power to the motor for positioning, refer to the following table to establish the fuse rating and the minimum permissible current-rating for the blocking diode:

Model	Current rating
M'Ax 403	6A
M'Ax 406	9A
M'Ax 409	12A
M'Ax 412	14A

E.4 Using the auxiliary back-up supply

1. Apply the AC supply and the auxiliary back-up supply to the drive (in either order).
2. The drive and motor will run normally while the AC supply is present. If the AC supply fails while the motor is running, the drive will behave according to the setting of Pr **6.03 AC supply loss mode selector** (see Chapter 9 *Advanced Parameters* on page 49).
3. The motor will be decelerated to rest and the display (version **_AN**) will show trip **UU** (under-voltage trip).
4. The control circuits remain active.
5. While the drive is tripped, it will not be possible to edit any parameters, or to position the motor (if the connections for this have been made). To disable the trip, close the **UU TRIP DISABLE** contact. While the contact is closed, the AC supply is prevented from being applied to the drive and the display (version **_AN**) shows **Sby**.
6. To allow the AC supply to be re-connected, stop the motor (if it is running on the auxiliary back-up supply) and open the **UU TRIP DISABLE** contact.

Appendix F Motor Thermal-Overload Protection

If the output current of the drive is to be de-rated, follow the instructions in this Appendix after following *De-rating the drive* on page 38.

Being suitable for most applications, the default motor-protection settings produce the following:

- An alarm is produced by the drive when the motor windings are calculated to be at their maximum safe working temperature (defined by the motor) and the motor current is at least 110% of the rated continuous current of the motor (also defined by the motor).
- When the motor is calculated to be in thermal overload, the **SLM** alters its current-scaling to limit the motor current to 105% of the rated continuous motor current.
- If the calculated value of temperature is not reducing (i.e. demand is not reduced), the drive will trip 10 seconds after the alarm is produced (trip code: **I2t.AC**). (10 seconds is the default value of Pr 4.54 Thermal-overload time to trip.)

If required (after having followed the instructions in Appendix D *Optimising the Dynamic Performance* on page 96), follow the instructions in this Appendix in order to achieve the following:

- Apply a motor thermal-overload alarm signal to the controller.
- Adjust the overload alarm to operate at a lower motor current. This allows the controller sufficient time to reduce the demand before the motor becomes overheated (e.g. to allow for a process cycle to finish)
- Increase the limit-level for the motor current during thermal overload so that the **SLM** does not alter the current scaling
- Adjust the time delay after which the drive will trip (trip code: **I2t.AC**)

A motor thermal-overload alarm is indicated by Pr 10.17 *Motor [I²t] overload trip indicator* becoming set at 1 and the display (version **_AN**) indicated **OuL**.



Before making any adjustments to the motor-protection parameters, ensure that the intended level of protection will be suitable for the motor. Failure to observe this may result in fire.

F.1 Assigning a digital output

1. Identify an unused digital output.
2. Refer to the following table to identify which *selection parameter* to adjust for the digital output to be used:

Digital output	DIGITAL I/O	Selection parameter	Invert parameter
1	5	8.71	8.61
2	4	8.72	8.62
3	3	8.73	8.63
4	2	8.74	8.64

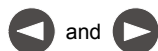
3. Set the related selection parameter at Pr 10.17.
4. By default, the output state will become logic 1 (+24V) when the alarm occurs. If this needs inverting, set the related *invert parameter* at 1.
5. Perform the following, as appropriate:

Version **_AN**

Initiate the *save* operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version **_SL**

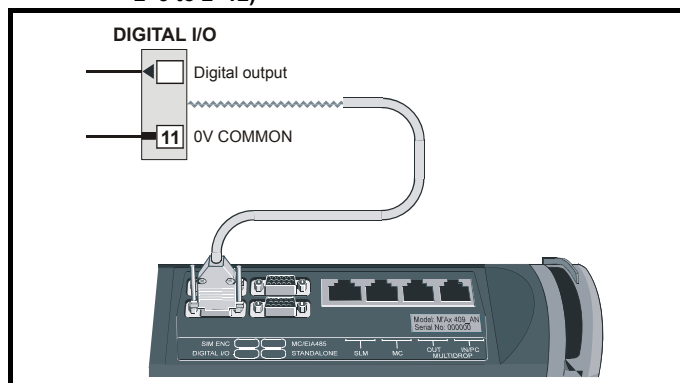
Version **_AN** (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2** (**Prog**). Execute the operation by setting Pr **10.38** at **100**.
- Set Pr **11.67 Flash update enable** at **1**.

6. Version **_AN**: To use the saved values after the next power-up, ensure Pr **0.50** is set at **no (0)**. Do not change the setting while following the remainder of this Appendix.
7. Version **_SL**: To use the stored values after the next power-up, ensure Pr **0.50** is set at **4** (**boot2**). Do not change the setting while following the remainder of this Appendix.

Figure F-1 Signal connections for the motor thermal-overload alarm (these are additional to those shown in Figures 2-3 to 2-12)



Example

A drive is to be remotely controlled by a system controller or PLC supplying quadrature AB signals. A supply interlock is to be used. The motor protection input of the controller requires logic state **0** to initiate the alarm.

1. Refer to Figure F-1 and use the following table to find out which digital outputs are not in use:

Digital output	DIGITAL I/O terminal	
1	5	Unused
2	4	Used
3	3	Used
4	2	Unused

2. Select one of the unused digital outputs, for example **Digital output 4**, and make an appropriate connection to it.
3. Use the following table to find out which *selection parameter* to adjust:

Digital output	DIGITAL I/O terminal	Selection parameter
1	5	8.71
2	4	8.72
3	3	8.73
4	2	8.74

4. Set Pr **8.74** at **10.17**.
5. Use the following table to find out which *invert parameter* to adjust:

Digital output	DIGITAL I/O terminal	Invert parameter
1	5	8.61
2	4	8.62
3	3	8.63
4	2	8.64

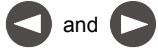
6. Set Pr **8.64** at **1**.
7. Perform the following, as appropriate:

Version _AN

Initiate the save operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

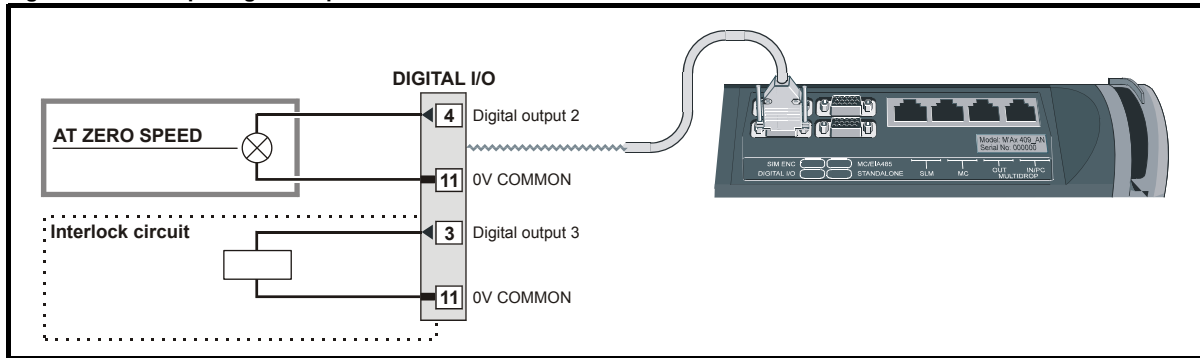
Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the **store** operation by setting Pr **0.50** at **2 (Prog)**.

Execute the operation by setting Pr **10.38** at **100**.

- Set Pr **11.67 Flash update enable** at **1**

Figure F-2 Example digital output terminals in use



F.2 Adjusting the threshold for the motor thermal-overload alarm

NOTE

A number stated in square brackets, e.g. [4.52], represents the value of the parameter whose number is stated.

- Read the value(s) of the appropriate parameter(s) in the following table...

PID gains-set being used	Parameter
1	Pr 4.07 Symmetrical current limit Kc1
2	Pr 4.24 Symmetrical current limit Kc2
3	Pr 4.28 Symmetrical current limit Kc3

... and enter the appropriate value in Pr **4.53 Symmetrical current limit after motor thermal-overload alarm**. If gains sequencing is being used, enter the highest of the values that are in use. Note the value that is entered.

- Determine the time required for the controller to complete a process cycle or reduce the speed demand after a motor thermal-overload alarm has been produced by the drive. Enter the value of time (in seconds) in Pr **4.54 Thermal-overload time to trip**. Note the value that is entered.
- Read and note the value of Pr **4.15 Motor – thermal time-constant**.
- Calculate the time t_c that the motor will take to enter thermal overload when it is operating at the current limit set in Pr **4.53** (after an overload alarm has been produced), as follows:

$$t_c = -[4.15] \times \ln \left(1 - \frac{105^2}{[4.53]^2} \right)$$

- Calculate the following:
 $t_D = t_c - [4.54]$
- Calculate the required value of Pr **4.52 Motor thermal-overload alarm level** as follows:

$$[4.52] = [4.53] \times \sqrt{1 - e^{t_D/[4.15]}}$$

- Enter the calculated value into Pr **4.52**.
- Perform the following, as appropriate:

Version _AN

Initiate the save operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the **store** operation by setting Pr **0.50** at **2 (Prog)**.

Execute the operation by setting Pr **10.38** at **100**.

- Set Pr **11.67 Flash update enable** at **1**

Example

Parameter	Value
Pr 4.15 Motor – thermal time-constant	89
Pr 4.07 Symmetrical current limit Kc1	150
Pr 4.24 Symmetrical current limit Kc2	200
Pr 4.28 Symmetrical current limit Kc3	175
Process cycle time	11.5s
Gain sequencing using all three PID-gains buffers	

1. Set Pr 4.53 Symmetrical current limit after motor thermal-overload alarm at **200** (the largest of the symmetrical current limit values).
2. Set Pr 4.54 Thermal-overload time to trip at **12** (process cycle time, rounded-up to nearest integer).
3. Calculate the following:

$$t_c = -[4.15] \times \ln \left(1 - \frac{105^2}{[4.53]^2} \right)$$

$$t_c = -89 \times \ln \left(1 - \frac{105^2}{200^2} \right) = 28.7(s)$$

4. Calculate the following:

$$t_D = t_c - [4.54] = 28.7 - 12 = 16.7(s)$$

5. Calculate the following:

$$[4.52] = [4.53] \times \sqrt{1 - e^{-t_D/[4.15]}}$$

$$[4.52] = [200] \times \sqrt{1 - e^{(-16.7)/89}} = 82.7(\%)$$

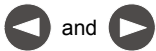
6. Enter the calculated value into Pr 4.52.
7. Perform the following, as appropriate:

Version _AN

Initiate the save operation by setting Pr **XX.00** at **1000**.

Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr **10.38** at **100** (via serial communications)

Version _SL

Version _AN (if required)

Ensure the drive is disabled by checking that the **Hardware enable** contact is open or that Pr **6.15** is set at **0**, then perform either of the following:

- Initiate the *store* operation by setting Pr **0.50** at **2 (Prog)**.

Execute the operation by setting Pr **10.38** at **100**.

Set Pr **11.67 Flash update enable** at **1**.

Appendix G Flux Alignment and Encoder Calibration

Flux Alignment

Use this procedure only in exceptional circumstances; Not Normally required with CTD SL Motors. The motor will rotate during this test and therefore should be clamped in order to avoid unexpected movements.

1. Disconnect the load from the motor.
2. Ensure the **Hardware enable** contact is open.
3. If a **RUN** contact is connected, ensure that it is open.
4. Apply the AC supply to the drive.
5. Ensure Pr **6.08** *Hold zero speed select* is set at **0**.
6. Close the **Hardware enable** contact.
7. Check that the display shows **rdY**, or that Pr **0.01** is set at **1**.
8. Set Pr **5.12** *Flux alignment test enable* at **1**. When the test is completed, Pr **5.12** automatically returns to **0**.
9. Re-enter the required settings into the appropriate parameters.
10. Remove the AC supply or auxiliary back-up supply; the new flux-alignment value is automatically stored in the **SLM**.

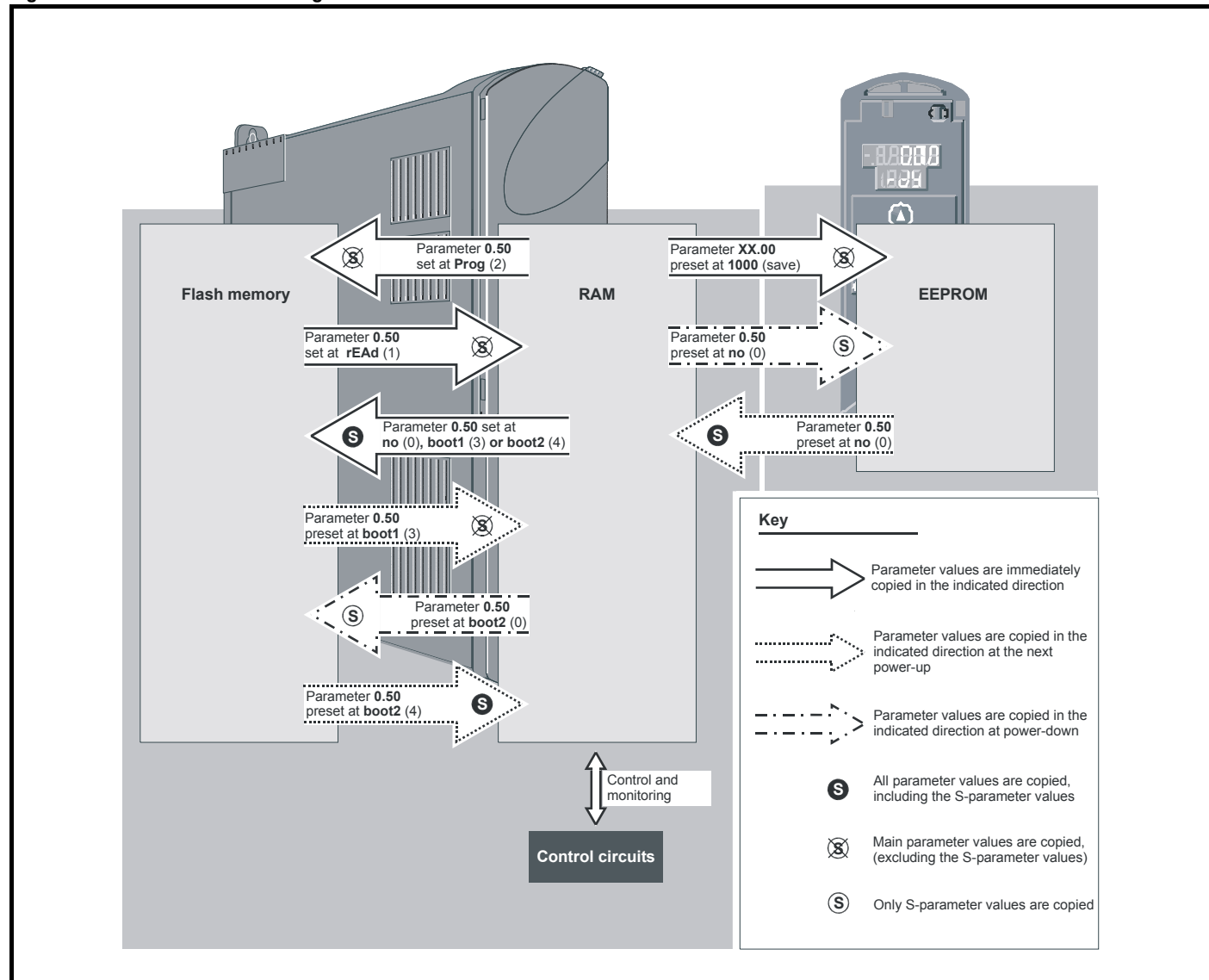
Encoder Calibration

Encoder calibration is required when setting up the SLM adapter with its encoder. This procedure should only be implemented after flux alignment procedure above has been executed. This procedure will only work with SLM adapter (SD262 PCB). Motor will initially rotate very slowly for first half of the test and will rotate much faster on the second part of the test. The motor should be clamped in order to avoid unexpected movements.

1. Disconnect the load from the motor.
2. Ensure the **Hardware enable** contact is open.
3. If a **RUN** contact is connected, ensure that it is open.
4. Apply the AC supply to the drive.
5. Close Hardware Enable.
6. Set Pr **5.55** offset calibration routine enable at **1**. When the test is completed, Pr **5.55** Automatically returns to **0**.
7. Open Hardware Enable.
8. Remove the AC Supply. New values are automatically stored in the **SLM**.

Appendix H Storage and Transfer of Parameter values

Figure H-1 Parameter-value storage locations and transfer directions



H.1 List of S-parameters

In the storage and transfer of parameters, the parameters designated **S** in the parameter lists are treated separately from the remaining (main) parameters. The following parameters are designated **S** and referred to as *S-parameters*:

- Pr 1.17 {0.34} Keypad reference
- Pr 6.20 Powered-up time (years, days)
- Pr 6.21 Powered-up time (hours, minutes)
- Pr 10.20 {0.44} Last trip
- Pr 10.21 Second last trip
- Pr 10.22 Third last trip
- Pr 10.23 Fourth last trip
- Pr 10.24 Fifth last trip
- Pr 10.25 Sixth last trip
- Pr 11.30 User security code
- Pr 10.42 Trip-0 time (hours, minutes)
- Pr 10.43 Trip-1 time (hours, minutes)
- Pr 10.44 Trip-2 time (hours, minutes)
- Pr 10.45 Trip-3 time (hours, minutes)
- Pr 10.46 Trip-4 time (hours, minutes)
- Pr 10.47 Trip-5 time (hours, minutes)

H.2 Transferring parameter values from one drive to another

Source drive

**Version _SL**

If the analog inputs are being used, do not fit an option module until instructed.

When an option module is installed, do not operate the drive (i.e. close the Hardware enable contact).

Failure to observe these requirements will result in unstable control of the motor.



When the display is used for cloning purposes, the drives in question must have the same software version. Cloning between drives with different software versions will cause the drive to trip.

1. Edit parameters as required.
2. Open the Hardware enable contact.
3. Set Pr 0.50 *Parameter transfer selector* at **boot1 (3)**. (If it is already at this setting, go to step 4).
Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr 10.38 at **100** (via serial communications)
4. Perform this step only if instructed to do so in step 3.
 - Set Pr 0.50 at **Prog (2)**
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr 10.38 at **100** (via serial communications)
(Alternatively, set Pr 11.67 *Flash update enable* at 1.)
5. Wait 15 seconds then power-down the drive.
6. Fit the option module that is to be used for transferring parameter values.
7. Power-up the drive.
8. Set Pr **XX.00** at **1000** in order to initiate a save operation (copy the main-parameter values in the RAM to the EEPROM).
9. Execute the operation by performing either of the following:

- While the display is in Edit mode, press at the same time:



- Set Pr 10.38 at **100** (via serial communications)

10. Power-down the drive.
11. Remove the option module.
12. If a number of option modules are to be programmed, repeat steps 6 to 11 for each module.

**Version _AN**

If the analog inputs are being used, do not operate the drive while an option module is not installed in the drive. Failure to observe this requirement will result in unstable control of the motor.

Destination drive

1. Ensure the **Hardware enable** contact is open, or that Pr 6.15 *Drive enable* is set at **0**.
2. Set Pr 0.50 *Parameter transfer selector* at no (0).
Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr 10.38 at **100** (via serial communications)
3. Power-down the drive.
4. Insert the option module containing the values to be transferred.
5. Power-up the drive. The main-parameter values are copied from the EEPROM in the option module to the RAM in the drive.
6. Ensure the **Hardware enable** contact is still open, or that Pr 6.15 *Drive enable* is still set at **0**.

**Version _SL**

If the analog inputs are being used, do not fit an option module until instructed.

Failure to observe this requirement will result in unstable control of the motor.

7. Version _SL (and, if required, version _AN):
To *store* the values in the flash memory and use them after the next power-up, set Pr 0.50 *Parameter transfer selector* at **4 (boot2)**.
Execute the operation by performing either of the following:
 - While the display is in Edit mode, press at the same time:
 and 
 - Set Pr 10.38 at **100** (via serial communications)
8. Version _SL: Power-down the drive and remove the option module.

**Version _AN**

If the analog inputs are being used, do not fit an option module until instructed.

Failure to observe this requirement will result in unstable control of the motor.

Appendix I Position loop and notch filter

I.1 SLM Software Paging

SLM software paging (software reconfiguration) provides code space that allows the user to take advantage of software enhancements such as PLM and notch filters. The default page is page 1. If page 3 is selected, the following features are available:

- PLM - closing the position loop within SLM every 125µs, irrespective of host sampling time.
- Notch filter - for resonance problems.

Page	1	2	3
Function	Normal operation	Not applicable to M'Ax	PLM, Notch functions.

Pr **15.01** & Pr **0.51** show the page number selected. Values 0 & 1 indicate page 1 and 3 indicates page 3. Pr **15.02** & Pr **0.52** show the page software version. Set Pr **x.00** to 4001 to select page 1 and set Pr **x.00** to 4003 to select page 3.

These options are only available with the following software combinations. SLM software V4.xx or later and M'Ax V1.50.xx or later. When SLM page 3 is selected the drive cannot be defaulted. Pr **x.00** to 1233 is locked out.

I.2 Introduction to PLM

The position loop is closed inside the SLM, but is treated as open loop from the motion controller. Irrespective of motion controller sampling time, the position loop is closed with a sample time of 125µs. The advantages are higher bandwidth, reduced following error, and the capability to work with higher values of Kv (Pr **15.03**) which allows higher stiffness and better rejection of torque disturbances.

When parameter Pr **15.03** (position loop gain) is changed, either a save and a power down or select Pr **11.64** (SLM on-line) is required for a new value to take effect on the fly. Marker found flag also needs to be set for this function to work. Pr **3.32** (Z marker pulse received indicator) set to 1. This is achieved by turning the motor shaft up to two revolutions.

I.3 Introduction to Notch Filter

Mechanical resonance can be a problem for almost any motion control system, and usually occurs during installation. Raising loop gains makes the machine perform better i.e. move faster, settle quicker between moves, and better resist outside disturbance; but when the gains go too high, resonance causes instability. The first sign of resonance may be a faint, pure ringing, or an irregular grinding noise. Sometimes the oscillations increase gradually and other times they appear suddenly.

Mechanical resonance in servo systems takes two forms: high and low frequency. High frequency resonance is a problem where the resonant frequency of the driven load is very high compared to the servo-system response rate. It is more common on mechanically stiff machines such as machine tools, and often produces a pure sound. Low frequency resonance is a problem where the resonant frequency is nearer to (but still significantly above) the servo-system response rate. It is more common in industrial applications (with less stiff machines), and produces a rough unpleasant sound.

Mechanical improvements such as machine stiffening, extra damping and reducing load-to-motor inertia ratio help reduce resonance problems. After exhausting mechanical cures, engineers are left with electrical cures. The primary electrical cures for resonance are low-pass and notch filters. Low-pass filters work well for high frequency resonance but not low frequency resonance. The main problem of low-pass filters is that they degrade the servo performance of a loop, especially when the filter bandwidth must be reduced to levels near the servo response rate.

Notch filters offer an alternative, and can often remove resonance without compromising performance. Like low-pass filters, they work well for high frequency resonance, but not for low frequency resonance. Their main limitation is that they work only for a narrow frequency range.

Therefore, the notch filter must be set precisely, and if the resonant frequency changes significantly, the notch filter will not be effective.

Two notch filters are available;

Filter 1 controlled by Pr **15.11** (Notch filter 1 centre frequency), and Pr **15.12** (Notch filter 1 Buffer update),

Filter 2 controlled by Pr **15.13** (Notch filter 2 centre frequency) and Pr **15.14** (Notch filter 2 Buffer update). Pr **15.15** (Active notch filter indication) display selected filter.

Notch filter 1 can be either enabled on power up or be changed while on line (Pr **11.64** set to 1). Set the centre frequency to Pr **15.11** and select filter 1 by setting Pr **15.12** to 1.

Notch filter 2 can only be enabled on power up and can not be used / changed while on line (Pr **11.64** set to 1). Set the centre frequency to Pr **15.13**. The drive must then be power cycled to enable the values. Select filter 2 by setting Pr **15.14** to 1.

If not sure what centre frequency to use, start with 500 in filter 1 (Pr **15.11**), and use SLM online (Pr **11.64** set to 1). Ensure Pr **3.32** (Z marker pulse received indicator) is set to 1 and then increase / decrease centre frequency until resonance has been removed. Caution is required when setting a low frequency value to either filter 1 or 2 (Pr **15.11** or Pr **15.13**) as it may cause the motor to go unstable when selected.

Active notch filter indication (Pr **15.15**) indicates 0, 1 or 2, depending on what parameters Pr **15.12** (filter 1 buffer update) and Pr **15.14** (filter 2 buffer update) are set to. Pr **15.15** gets updated on the rising edge, with the last set value taking priority. i.e. if both filter 1 (Pr **15.12**) and filter 2 (Pr **15.14**) are selected and filter 1 (Pr **15.12**) was the last to be set then Pr **15.15** is set to 1.

Filter 1 buffer update (Pr **15.12**) and filter 2 buffer update (Pr **15.14**) can be controlled with a digital input, which would allow both filters to be used during an application.

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