



## *User Guide*

# **Mentor II**

DC Drives  
25A to 1850A  
output

Part Number: 0410-0013-13  
Issue Number: 13

## **Safety Information**

Persons supervising and performing the electrical installation or maintenance of a drive and/or an external Option Unit must be suitably qualified and competent in these duties. They should be given the opportunity to study and if necessary to discuss this User Guide before work is started.

The voltages present in the drive and external option units are capable of inflicting a severe electric shock and may be lethal. The Stop function of the drive does not remove dangerous voltages from the terminals of the drive and external Option Unit. Mains supplies should be removed and left removed for a minimum of 2 minutes before any servicing work is performed.

The installation instructions should be adhered to. Any questions or doubt should be referred to the supplier of the equipment. It is the responsibility of the owner or user to ensure that the installation of the drive and external Option Unit, and the way in which they are operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

The Stop and Start inputs of the drive should not be relied upon to ensure safety of personnel. If a safety hazard could exist from unexpected starting of the drive, an interlock should be installed to prevent the motor being inadvertently started.

## **General information**

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

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

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## **Important! Drive software version**

This product is supplied with the latest version of user-interface and machine-control software.

If this product is to be used with other Control Techniques variable speed drives in an existing system, there may be some differences between their software and the software in this product. These differences may cause a difference in functions. This may also apply to variable speed drives returned from a Control Techniques Service Centre.

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

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# Declaration of Conformity

## Control Techniques

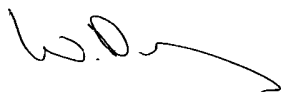
The Gro  
Newtown  
Powys  
UK  
SY16 3BE

The DC variable speed drive product Mentor II current range 25A to 1850A, single quadrant and four quadrant versions, has been designed and manufactured in accordance with the following European harmonised, national and international standards:

EN60249	Base materials for printed circuits
IEC326-1	Printed boards: general information for the specification writer
IEC326-5	Printed boards: specification for single- and double-sided printed boards with plated-through holes
IEC326-6	Printed boards: specification for multilayer printed boards
IEC664-1	Insulation co-ordination for equipment within low-voltage systems: principles, requirements and tests
EN60529	Degrees of protection provided by enclosures (IP code)
UL94	Flammability rating of plastic materials
*CSA C22.2 0-M1982	General Requirements, Canadian Electrical Code, Part II
*CSA C22.2 0.4-M1982	Bonding & Grounding of Electrical Equipment (Protective Grounding)
*CSA C22.2 14-M1987	Industrial Control Equipment
UL508	Standard for power conversion equipment

\* Applies to Mentor II current range 900A - 1850A only

These products comply with the Low Voltage Directive 73/23/EEC and the CE Marking Directive 93/68/EEC.



**W. Drury**  
**Executive VP Technology**  
**Newtown**

Date: 30 April 1998.

This electronic drive product is intended to be used with an appropriate motor, controller, electrical protection components and other equipment to form a complete end product or system. It must only be installed by a professional assembler who is familiar with requirements for safety and electromagnetic compatibility ("EMC"). The assembler is responsible for ensuring that the end product or system complies with all the relevant laws in the country where it is to be used. Refer to the product manual or EMC data sheet for further information on EMC standards complied with by the product, and guidelines for installation.

# 1 Features of Mentor II

## 1.1 Mentor II parameters

Mentor II is equipped with a range of parameters designed to give the utmost flexibility of application to industrial requirements. The parameters are arranged in menus, as being the most convenient way of making access easy and quick for the user.

Within each menu, those parameters which are needed only for customization of the drive for the more complex applications have been made invisible - that is, they are normally inaccessible except through high level security access. With low level security access, invisible parameters do not appear in the digital display.

This arrangement has the effect of reducing the apparent size of the menus for greater convenience in normal use, and ensuring the maximum protection for the parameters which are specially set up for a particular application or process.

## 1.2 Supply phase-sequence

Loss of one or more phases of input is automatically detected. Drive will run irrespective of input phase rotation.

## 1.3 Output

- 6-pulse firing of output thyristors (SCRs). Optionally configurable to (series or parallel) 12-pulse operation.

## 1.4 Speed feedback

- Motor armature voltage, or
- Tachogenerator (tachometer), or
- Encoder (pulse tachometer).
- PID speed loop algorithm.

## 1.5 Speed reference

- -10V to +10V
- 0 to 10V
- 4 to 20mA
- 20 to 4mA
- 0 to 20mA
- 20 to 0mA
- Encoder digital input
- Internally-generated digital reference.

## 1.6 Serial communications interface

- RS485 serial communications port, optically-isolated.

## 1.7 Current feedback

- Resolution 0.1%.
- Current loop linearity 2%, bandwidth 80Hz.
- Uniform response at all current values.

## 1.8 Control

- All analog and most digital inputs configurable by the user for specific applications.
- PID speed loop algorithm.
- Provision for encoder inputs for position control.
- On-board provision for tachogenerator (tachometer) calibration.
- Programmable control of field-weakening.
- Phase sequence and phase-loss detection.
- Software includes current loop self-tuning algorithm.
- Menu-driven parameter structure.
- Drive returns to last parameter adjusted in each menu.
- User-defined menu for quick access to most-used parameters.

## 1.9 Speed resolution

Reference		Feedback		Combined resolution
Analog	0.025%	Armature volts	0.83V	0.83V
Analog	0.025%	Tachogenerator (tachometer)	0.1%	0.125%
Digital	0.1%	Tachogenerator (tachometer)	0.1%	0.2%
Analog	0.025%	Encoder	0.01%	0.035%
Digital	0.1%	Encoder	0.01%	0.11%
Encoder		Encoder		Absolute

## 2 Safety Information

### 2.1 Warnings, Cautions and Notes



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



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

#### NOTE

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

### 2.2 Electrical safety - general warning

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

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

### 2.3 System design and safety of personnel

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

The drive uses high voltages and currents, and is used to control equipment which can cause injury.

Close attention is required to the electrical installation and the system design to avoid hazards either in normal operation or in the event of equipment malfunction. System design, installation, commissioning and maintenance must be carried out by personnel who have the necessary training and experience. They must read this safety information and this User Guide carefully.

The STOP and ENABLE functions of the drive do not isolate dangerous voltages from the output of the drive or from any external option unit. The supply must be disconnected by an approved electrical isolation device before gaining access to the electrical connections.

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

### 2.4 Environmental limits

Instructions in this User Guide regarding transport, storage, installation and use of the drive must be complied with, including the specified environmental limits. Drives must not be subjected to excessive physical force.

### 2.5 Compliance with regulations

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

This User Guide contains instruction for achieving compliance with specific EMC standards.

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

98/37/EC: Safety of machinery.

89/336/EEC: Electromagnetic Compatibility.

### 2.6 Motor

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

Do not exceed the motor maximum speed rating.

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

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

### 2.7 Adjusting parameters

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

## 3 Introduction

Mentor II is the latest family of advanced, fully microprocessor-controlled DC variable speed industrial drives. The range of output current is from 25A to 1850A. All sizes share control, monitoring, protection and serial communications features.

All units are available alternatively in either single-ended or four-quadrant configuration. Single-ended drives provide forward run operation only. Four-quadrant drives are fully-reversible. Both types offer comprehensive control of motor speed and/or torque, the four-quadrant drives providing full control in both directions of rotation.

Operating parameters are selected and changed either at the keypad or through the serial communications link (interface). Access for writing or changing parameter values can be protected by the three-level security code system.

### 3.1 DC motor control

The functions of a DC motor which must be controllable for practical use are the speed, the torque delivered, and the direction of rotation. Speed is proportional to armature back-emf and inversely proportional to field flux. Torque is proportional to armature current and field flux. Direction of rotation is simply a matter of the relative polarities of the armature and field voltages. It follows that it is necessary to control:

1. The armature voltage; back-emf is a component of armature voltage. Thus, assuming the field to be constant, control of armature voltage provides complete control of speed up to the point where the voltage reaches the maximum value for which the armature is designed. Armature current is also a function of armature voltage, so that within the speed range up to maximum voltage, torque is controlled by voltage also. Provided that the field is fully-excited, the availability of maximum torque is normally maintained from zero speed up to armature voltage maximum (base speed).
2. The field voltage; this determines the field current and, in consequence, field flux. If field voltage can be varied independently of the armature voltage, speed can be increased at full power (full armature voltage) beyond the point where the applied armature voltage and current are at maximum. Since torque is directly proportional to field flux, maximum torque is reduced if speed is increased by weakening the field.

Basically, therefore, a variable speed DC drive is a means of controlling the voltage applied to the armature of the motor, and thus the current delivered to the motor. The drive may be equipped with means for control of the field if speeds higher than base speed are required. Separate control of the field within the operating range up to base speed can be exploited also, to obtain extended control of speed and torque for more-complex motor applications. If a suitable feedback is available, position control becomes possible.

### 3.2 Principles of the variable speed drive

A single phase voltage applied to a fully-controlled thyristor (SCR) bridge and a resistive load produces an intermittent flow of current which is started by the firing of the thyristor (SCR), and stopped as a result of the supply voltage passing through zero at the end of each half cycle.

Maximum voltage is delivered when the firing angle is fully advanced, that is, when  $f$  in Figure 3-1 becomes zero. Retarding the firing angle reduces the current output. When the load is inductive, such as a motor, or the firing angle is sufficiently advanced, current becomes continuous. The fundamental of the current characteristically lags behind the voltage due partly to the inductive nature of the load and partly due to firing angle delay.

Figure 3-1 Behavior of a single-phase fully-controlled thyristor rectifier (SCR) supplying a highly-inductive load

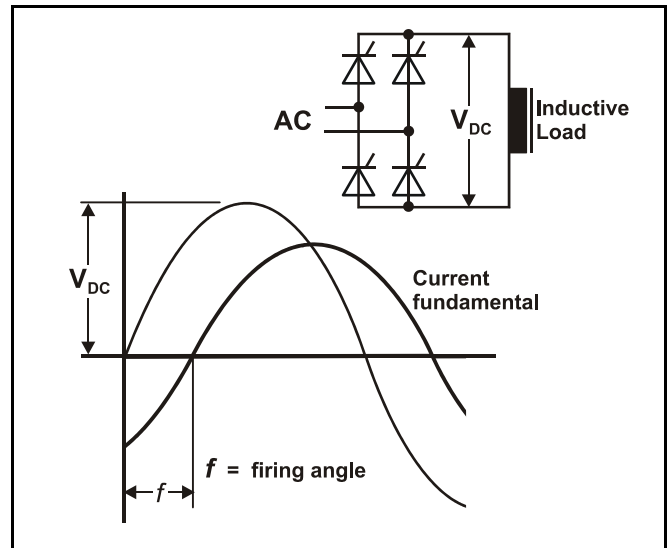
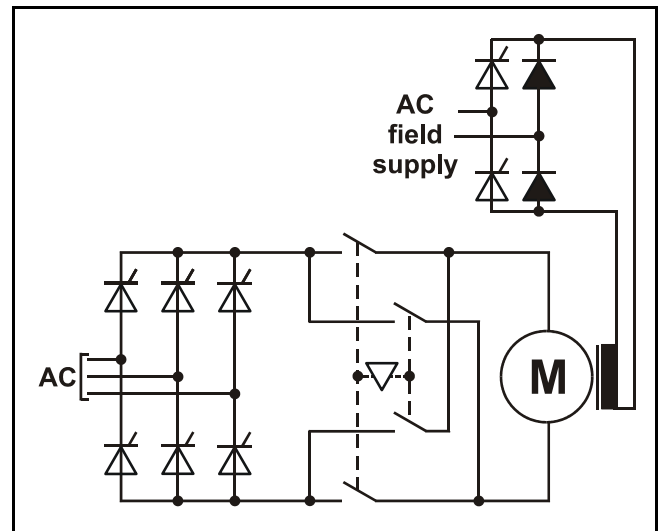


Figure 3-2 Typical arrangement for reversing a “single-ended” DC drive using an interlocked pair of contactors in the armature circuit



### 3.3 Reversing

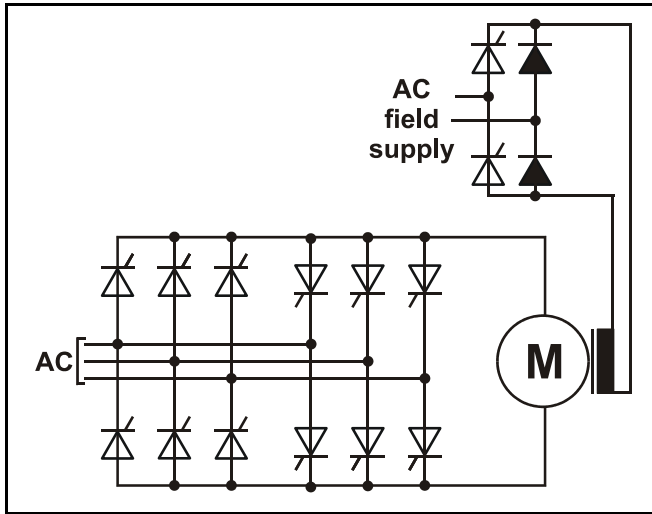
Reversal of rotation is done in one of two ways, dependent on the type of drive bridge configuration. The simplest fully-controllable arrangement of thyristor (SCR) bridge configuration to operate from a 3-phase AC supply is a full-wave bridge but this is not capable of reversing the output polarity. This type, which is called single-quadrant or single-ended, requires a means of switching the motor terminals externally as shown in Figure 3-2 if reversing is required. For some applications this simple system is an adequate practical solution.

If, however, the motor application is such that it demands complete control of motor operation in both directions, with the ability to reverse motor torque rapidly and frequently, two anti-parallel bridges must be used, Figure 3-3. This configuration provides full control of forward and reverse drive and forward and reverse braking without the need for reversing contactors, and is called four-quadrant, Figure 3-4.

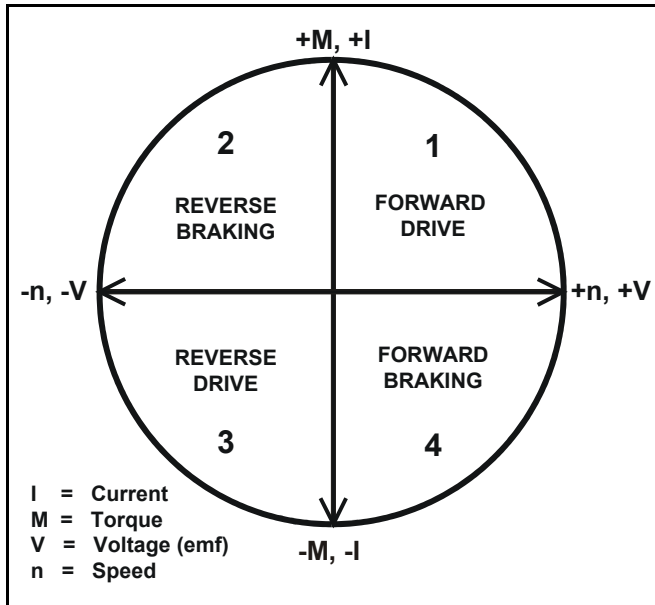
If braking is required with a single-ended drive, an external circuit has to be provided, Figure 3-5 (dynamic braking). In this case, deceleration is neither controlled nor linear.



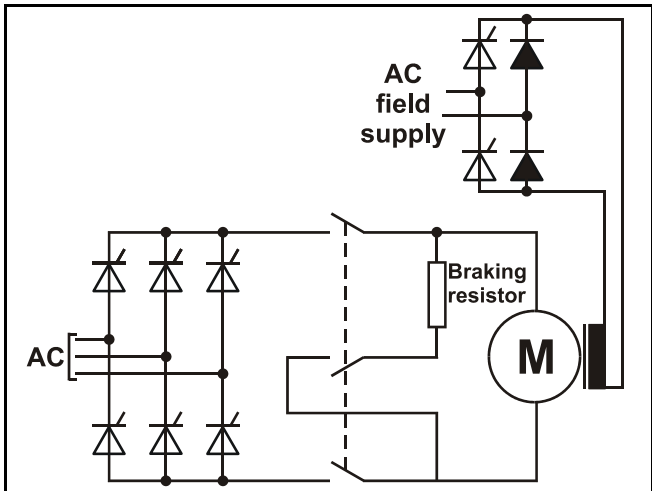
**Figure 3-3 Dual bridge or parallel-pair 3-phase thyristor (SCR) arrangement for a 4-quadrant DC motor drive**



**Figure 3-4 The four quadrants of the DC motor torque-speed diagram**



**Figure 3-5 Typical arrangement for dynamic (resistive) braking of a "single-ended" DC drive**



### 3.4 Control

Regardless of whether a drive is single- or four-quadrant, motor response is fundamentally a function of voltage output, which is a function of the firing angle of the thyristor (SCR) bridge, and this can be controlled precisely.

The quality of the response obtained from the motor is, therefore, dependent on the ability of the drive logic to receive, interpret and process a complete range of data concerning the state of the motor, and the desired state. Some of this data may be from external sources, such as the speed reference (demand), torque reference, motor speed feedback, and so on; some are derived internally by the drive logic itself, for example, output voltage and current, and the demand condition of the logic system at various stages.

The logic system requires a set of instructions to allow it to undertake the process of interrogation, processing and signal-generation to control thyristor (SCR) firing. The instructions are provided in the form of data broken down into individual values or parameters for the user to provide in accordance with the particular operations required for the motor application. The behavior of the drive in terms of any given industrial application is a function of the information it receives for processing from user-written and internally-monitored parameter values.

For this reason, the Mentor II drive is equipped with a dedicated microprocessor, and with software which is configured by the parameters written to it by the user. The parameters cover every significant factor related to motor performance, so that the user can set the drive up to meet the application requirements exactly. Further parameters are provided for communications, security and other operational functions.

### 3.5 Menus

The number of parameters is large, but understanding of them and access to them have been greatly facilitated by arranging them in menus, each menu covering a particular logical or functional grouping. An overview of the control logic system of the drive and a graphical representation of each individual menu will be found in the set of logic diagrams at the end of Chapter 8 *Parameter Set*.

### 3.6 Serial communications

The serial communications link (interface) with which the Mentor II drive is equipped is a significant feature in relation to operation within an industrial process application. For example, external programmable process logic controllers (PLCs) can be set up with access to the whole or part of the drive logic, enabling the setting of parameters to be changed, virtually instantaneously, to suit different stages of a duty cycle or different operating conditions in the process.

The serial communications facility also provides for the operation of the drive to be continuously monitored for control or analytical purposes.

## 4 Data

### 4.1 Specifications

#### 4.1.1 Maximum input voltage to drive (L1, L2 and L3, i.e. main power to thyristor bridge)

480V +10%	standard
525V +10%	optional
660V +10%	special order

#### 4.1.2 Maximum recommended motor voltage

$$V_{arm} = 1.15 \times V_{supply}$$

#### 4.1.3 Input power supply voltage (E1, E2 and E3, i.e. auxiliary power supply)

Balanced 3-phase 3-wire, 45Hz to 62Hz, maximum 480V +10%.

With the higher voltage (525V, 660V) versions the maximum power supply voltage is also 480V +10%.

The input to the control (electronic) circuits is:

Standard -2-wire, 220V - 10% to 480V +10%

With North American field bridge - 3-wire, 220V - 10% to 480V +10%

#### NOTE

E1 & E3 must be connected to the same phases as L1 & L3

#### 4.1.4 Output supplies and references (Short-circuit proof)

10V reference  $\pm 5\%$  10mA drive capability.

Encoder supply 300mA drive capability at 5V, 12V or 15V selectable.

+24V supply 200mA drive capability for relays.

All outputs are wire-proof - unaffected by accidental short circuiting.

#### 4.1.5 Ambient temperature & humidity

Rated ambient temperature 40°C (104°F)

Rated maximum altitude 1000m (3200ft).

Storage temperature range -40°C to +55°C (-40°F to 131°F)

Humidity requirement non-condensing.

#### 4.1.6 Derating

Nominal ratings are affected by:

1. The altitude of the installation.

Where the site is above 1000m (3200ft), reduce the normal full load current by 1.0% for each additional 100m (320ft), up to a maximum of 4000m.

2. The ambient temperature.

Where the local ambient temperature is above 40°C (104°F), derate by 1.5% per °C up to 55°C (0.75% per °F up to 131°F).

#### 4.1.7 Enclosure Ingress Protection

Mentor II drives are constructed in accordance with European IP00 specification. Mentor II drives are suitable for mounting in NEMA ingress-protected enclosures.

The drive must be protected against moisture and conductive contamination. The drive is intended for use in pollution degree 2 environments.

## 4.2 Ratings

### 4.2.1 Current, input and output



Mentor is suitable in a circuit capable of delivering no more than 10000 RMS symmetrical amperes for M25-M210 and M25R-M210R and 18000 RMS symmetrical amperes for M350-M825 and M350R-M825R short circuit current, 480V +10% maximum.

Drive type & model		Typical* ratings				Maximum continuous current rating	
Single Quadrant	Four Quadrant	at 400V (armature)		at 500V (armature)		input	output
		kW	HP	kW	HP	Aac	Adc
M25	M25R	7.5	10	9	12	21	25
M45	M45R	15	20	19	25	38	45
M75	M75R	30	40	38	50	60	75
M105	M105R	37.5	50	47	63	88	105
M155	M155R	56	75	70	94	130	155
M210	M210R	75	100	94	126	175	210
M350	M350R	125	168	156	209	292	350
M420	M420R	150	201	188	252	350	420
M550	M550R	200	268	250	335	460	550
M700	M700R	250	335	313	420	585	700
M825	M825R	300	402	375	503	690	825
M900	M900R	340	456	425	570	750	900
M1200	M1200R	450	603	563	755	1000	1200
M1850	M1850R	750	1005	938	1258	1540	1850

\* Motor rating may be increased at higher armature voltages

Refer to *Maximum recommended motor voltage* in section 4.1 *Specifications*.

## 4.2.2 Fuses and cabling



The AC supply to the drive must be fitted with suitable protection against overload and short-circuits. The following table shows recommended fuse ratings. Failure to observe this recommendation will cause a risk of fire.

Drive type & model		HRC	Recommended fuse ratings		Typical cable size		
Single Quadrant	Four Quadrant		Semiconductor(1)			AC input and DC output	
			Rated Input AC	Rated Input AC	Rated Output DC		
		A	A	A	mm <sup>2</sup> (2)	AWG(3)	
M25		32	35	NR	4	10	
	M25R	32	35	40(4)	4	10	
M45		50	60	NR	6	6	
	M45R	50	60	70(4)	6	6	
M75		100	100	NR	25	2	
	M75R	100	100	125(4)	25	2	
M105		100	125	NR	35	1/0	
	M105R	100	125	175(4)	35	1/0	
M155		160	175	NR	50	3/0	
	M155R	160	175	250(4)	50	3/0	
M210		200	250	NR	95	300MCM	
	M210R	200	250	300(4)	95	300MCM	
M350		355	400	NR	150	(5)	
	M350R	355	400	550(4)	150	(5)	
M420		450	500	NR	185	(5)	
	M420R	450	500	700(4)	185	(5)	
M550		560	700	NR	300	(5)	
	M550R	560	700	900(4)	300	(5)	
M700		630	900	NR	2 x 185	(5)	
	M700R	630	900	1000(4)	2 x 185	(5)	
M825		800	1000	NR	2 x 240	(5)	
	M825R	800	1000	1200(4)	2 x 240	(5)	
M900		1000	1200	NR	2 x 240	(5)	
	M900R	1000	1200	2 x 700(4)	2 x 240	(5)	
M1200		1250	2 x 700	NR	2 x 400	(5)	
	M1200R	1250	2 x 700	2 x 900(4)	2 x 400	(5)	
M1850		2000	2 x 1200	NR	3 x 400	(5)	
	M1850R	2000	2 x 1200	2 x 1000(4)	3 x 400	(5)	

- DC fuses must be fast semiconductor type.  
Rated voltage -  
for 380V supply - 500V DC  
for 480V supply - 700V DC  
for 525V supply - 700V DC  
for 660V supply - 1000V DC
- The cable sizes are for 3-core (3-wire) and 4-core (4-wire) pvc-insulated armoured (conduited) cable with copper conductors, and laid in accordance with defined conditions.
- Typical wire gauge sizes based on 30°C (86°F) ambient, 1.25 x rated current, 75°C (167°F) copper wire with no more than 3 conductors in a conduit or raceway.  
Branch circuit protection must be provided by the user.  
All wiring must conform to NEC Art. 310 and applicable electrical codes.
- In applications where load inertia is low and regeneration infrequent, DC fuses may not be needed.
- Refer to NEC Table 310-16 for wire sizes.

NR Not required

## Mentor thyristors I<sup>2</sup>t values for fusing

Drive Model	480V Part no	I <sup>2</sup> t (kA <sup>2</sup> s)	525V Part no	I <sup>2</sup> t (kA <sup>2</sup> s)	660V Part no	I <sup>2</sup> t (kA <sup>2</sup> s)
M25/M25R	2435-0026	1.03	2435-2616	0.73		
M45/M45R	2435-0049	4.75	2435-9116	14.52		
M75/M75R	2435-0116	19.1	2435-9116	14.52		
M105/M105R	2435-0130	108	2435-1326	47		
M155/M155R	2435-0130	108	2435-1326	47		
M210/M210R	2435-0130	108	2435-1326	47		
M350/M350R	2436-7310	149	2436-7161	370	2436-7162	370
M420/M420R	2436-7310	149	2436-7161	370	2436-7162	370
M550/M550R	2436-7141	370	2436-7161	370	2438-3123	370
M700/M700R	2438-3223	370	2438-3117	370	2438-3123	370
M825/M825R	2438-3223	370	2438-3117	370	2438-3123	370
M900/M900R	2438-3234	5126	2438-3236	4250	2438-3236	4250
M1200/M1200R	2438-3234	5126	2438-3236	4250	2438-3236	4250
M1850/M1850R	2438-3234	5126	2438-3236	4250	2438-3236	4250

## 4.2.3 Ventilation and weight

Drive type & model		Ventilation			Approx. weight	
Single Quadrant	Four Quadrant	Type	Flow			
			m <sup>3</sup> min <sup>-1</sup>	ft <sup>3</sup> min <sup>-1</sup>	kg	lb
M25, M45, M75		1	-	-	10	22
	M25R, M45R, M75R	1	-	-	11	24
M105		1	-	-	14	31
	M105R	1	-	-	15	33
M155, M210	M155R, M210R	2	2	70	21	46
M350		3	7.6	270	22	48
	M350R	3	7.6	270	23	51
M420, M550		3	17	600	22	48
	M420R, M550R	3	17	600	23	51
M700, M825		3	17	600	27	59
	M700R, M825R	3	17	600	30	66
M900, M1200, M1850		4	20	700	70	154
	M900R, M1200R, M1850R	4	20	700	120	264

### NOTE

Supply voltages for ventilation fans are as follows:

### Type of Ventilation

- Natural convection
- Forced ventilation M155 - M210 24V internally supplied
- Forced ventilation M350 - M825 110V / 220V dual voltage single phase
- Forced ventilation M900 - M1850 415V AC three phase

#### 4.2.4 Losses

Losses are equivalent to 0.5% of drive rated output across the range. The following table lists the losses in kW and HP for all models, at 400 V armature voltage.

Drive type & model		Typical motor ratings		Losses	
Single Quadrant	Four Quadrant				
		kW	HP	kW	HP
M25	M25R	7.5	10	0.038	0.05
M45	M45R	15	20	0.075	0.1
M75	M75R	30	40	0.15	0.2
M105	M105R	37.5	50	0.19	0.25
M155	M155R	56	75	0.28	0.37
M210	M210R	75	100	0.38	0.5
M350	M350R	125	168	0.63	0.83
M420	M420R	150	201	0.75	1
M550	M550R	200	268	1.0	1.3
M700	M700R	250	335	1.3	1.7
M825	M825R	300	402	1.5	2
M900	M900R	340	456	1.7	2.3
M1200	M1200R	450	603	2.3	3
M1850	M1850R	750	1005	3.8	5

The field rectifier is protected by fuses FS1, FS2, FS3 on the power boards.



Before attempting to replace fuses FS1, FS2, FS3 the supply voltages must be removed from the drive and left removed for at least 2 minutes.

#### 4.2.6 Field current rating

Drive type & model	Field Current Rating (A)	Fuse FS1, FS2, FS3
M25, M25R	8 regulated	CT Part number 3535-0010
M45, M45R	8 regulated	
M75, M75R	8 regulated	
M105, M105R	8 regulated	
M155, M155R	8 regulated	
M210, M210R	8 regulated	
M350, M350R	10	CT Part number 3535-0020
M420, M420R	10	
M550, M550R	10	
M700, M700R	10	
M825, M825R	10	
M900, M900R	20	
M1200, M1200R	20	
M1850, M1850R	20	

#### 4.2.5 Recommended line reactors



To avoid electrical interference and di/dt stress, do not operate without line reactors. The following table gives typical values to achieve a notch depth of 50%. Where a specific notch depth is required, values must be calculated. Refer to IEC 61800-3 for details of calculation of notching depth.

Drive type & model	Line reactors La, Lb, Lc (μH)
M25, M25R	200
M45, M45R	200
M75, M75R	100
M105, M105R	100
M155, M155R	75
M210, M210R	75
M350, M350R	35
M420, M420R	27
M550, M550R	25
M700, M700R	23
M825, M825R	19
M900, M900R	17
M1200, M1200R	13
M1850, M1850R	8.6

## 5 Mechanical Installation

### 5.1 Dimensions

Principal dimensions are shown in Figure 5-3, Figure 5-4 and Figure 5-5. Cut-out and drilling dimensions for mounting a drive with the heatsink projecting through a panel into the space behind are shown in Figure 5-3 and Figure 5-4.

### 5.2 Mounting

The drive enclosure conforms to international enclosure specification IP00 and is suitable for mounting in NEMA-rated enclosures.

#### 5.2.1 Location

The drive should be installed in a place free from dust, corrosive vapors and gases, and all liquids. Care must also be taken to avoid condensation of vaporized liquids, including atmospheric moisture.

#### 5.2.2 Ventilation

If the drive is to be located where condensation is likely to occur when it is not in use, a suitable anti-condensation heater must be installed. The heater must be switched OFF when the drive is turned on. An automatic changeover switching arrangement is recommended.

Mentor II drives are not to be installed in classified Hazardous Areas unless correctly mounted in an approved enclosure and certified. (Refer also to section 6.1.4 *Hazardous areas* on page 18.)

#### 5.2.3 Cooling

There are certain variations across the Mentor II range of drives, in respect of mounting and cooling arrangements. With most models there is the option of surface or through-panel mounting. The higher-rated drives require forced ventilation and can optionally be supplied complete with ducted cooling fans.

Alternatively, the installer may arrange to use separately-provided ducted cooling air. Air flow requirements are shown in the table in section 4.2.3 *Ventilation and weight* on page 11. The variants are summarized in the following table.

Drive model	Mounting		Ventilation	Heat Sink
	Surface	Through-panel		
M25 to M75	Yes	Yes	Natural	Isolated*
M25R to M75R	Yes	Yes	Natural	Isolated*
M105 and M105R	Yes	Yes	Natural	Isolated*
M155 and M155R	Yes	Yes	Forced (fan built in)	Isolated*
M210 and M210R	Yes	Yes	Forced (fan built in)	Isolated*
M350 to M550	Yes (1)	Yes (2)	Forced	LIVE
M350R to M550R	Yes (1)	Yes (2)	Forced	LIVE
M700 and M825	Yes (1)	Yes (2)	Forced	LIVE
M700R and M825R	Yes (1)	Yes (2)	Forced	LIVE
M900 to M1850	Only		Forced (3)	LIVE (4)
M900R to M1850R	Only		Forced (3)	LIVE (4)

\* Isolated heat sinks must be earthed (grounded) for safety. A terminal is provided.

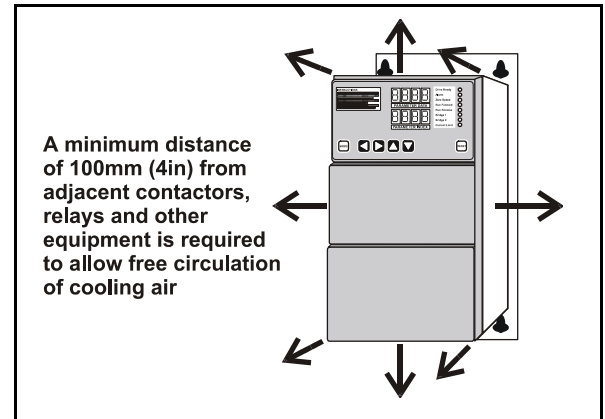
1. Surface-mounting requires the optional fan ducting, with integral fans, mounting flanges and earthing (grounding) stud.
2. Adequate forced ventilation must be provided.
3. A suitable fan can be supplied as an optional extra.
4. Enclosed.

### 5.3 Cooling and ventilation

#### 5.3.1 Enclosure minimum dimensions

Care must be taken that the enclosure in which the drive is installed is of adequate size to dissipate the heat generated by the drive. A minimum clearance of 100mm (4in) all around the drive is essential, Figure 5-1. All equipment in the enclosure must be taken into account in calculating the internal temperature.

Figure 5-1



#### 5.3.2 Effective heat-conducting area

The required surface area  $A_e$  for an enclosure containing equipment which generates heat is calculated from the following equation:

$$A_e = \frac{P}{k(T_i - T_{amb})}$$

where

- $A_e$  Effective heat-conducting area, in  $m^2$ , equal to the sum of the areas of the surfaces which are not in contact with any other surface.
- $P$  Power loss of all heat-producing equipment in Watts.
- $T_i$  Max. permissible operating temperature of the drive in  $^{\circ}C$ .
- $T_{amb}$  Maximum external ambient temperature in  $^{\circ}C$ .
- $k$  Heat transmission coefficient of the material from which the enclosure is made in  $W/m^2/^{\circ}C$ .

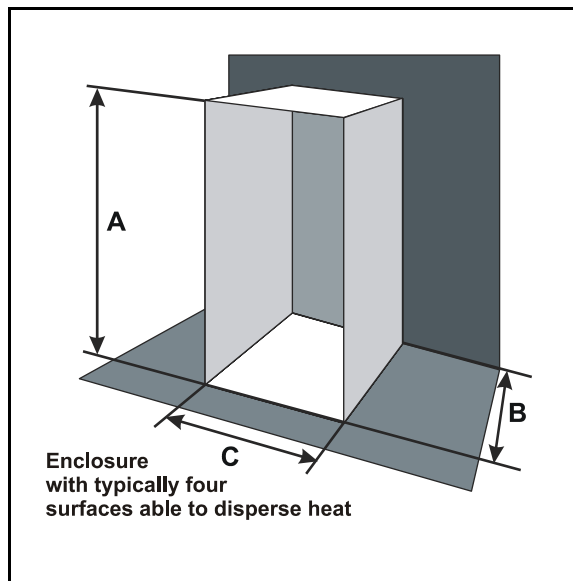
#### Example:

##### Calculation of the size of an IP54 (NEMA 12) enclosure for a drive size M210

The worst case is taken as the basis of the example, for which the following conditions are assumed:

- The installation is to conform to IP54 (NEMA 12), which means that the drive and its heatsink are to be mounted wholly within the enclosure, and that the enclosure is virtually sealed and without any ventilation of the air inside. Heat can escape only by conduction through the skin of the enclosure, which is cooled by conduction, convection and radiation to the external air.
- The enclosure is to stand on the floor and against a wall, so that its base and back surfaces cannot be considered to play any part in the cooling process. The effective heat-conducting area  $A_e$  is provided by the top, front, and two sides only, Figure 5-2.
- The enclosure is to be made of 2mm (0.1in) sheet steel, painted.
- The maximum ambient temperature is  $25^{\circ}C$ .

Figure 5-2



#### To find the effective heat-conducting area

The values of the variables appropriate to the above specification are:

$$P_i \quad 400\text{W (losses)}$$

#### NOTE

It is essential to include any other heat-generating equipment in the value for  $P_i$ .

$$T_i \quad 40^\circ\text{C (for all Mentor II drives)}$$

$$T_{amb} \quad 25^\circ\text{C}$$

$$k \quad 5.5 \text{ (typical value for 2mm (0.1in) sheet steel, painted)}$$

$$A_e = \frac{400}{5.5(40 - 25)} = 4.85\text{m}^2 (52\text{ft}^2)$$

#### To find the dimensions of the enclosure

If an enclosure is to be fabricated to suit the installation, there is a free choice of dimensions. Alternatively, it may be decided to choose an enclosure from a range of standard products. Either way, it is important to take into account the dimensions of the drive, and the minimum clearance of 100mm (4in) round it (Figure 5-1).

The procedure is to estimate two of the dimensions - the height and depth, for example - then calculate the third, and finally check that it allows adequate internal clearance.

The effective heat-conducting area of an enclosure as illustrated in Figure 5-2, located on the floor and against one wall is:

$$A_e = 2AB + AC + BC$$

Where:

- A** is the enclosure height
- B** is the depth, front to back
- C** is the width.

Suppose the enclosure height **A** is 2.2m (7ft 3in), and the depth **B** is 0.6m (2ft), as a first estimate. The actual figures chosen in practice will be guided by available space, perhaps, or standard enclosure sizes.

Since  $A_e$ , **A**, and **B** are known, the dimension to be calculated is **C**. The equation needs to be rearranged to allow **C** to be found, thus:

$$A_e - 2AB = C(A + B)$$

$$\text{or, } C = \frac{A_e - 2AB}{A + B}$$

$$C = \frac{4.85 - (2 \times 2.2 \times 0.6)}{2.2 + 0.6} = 0.8\text{m (2ft 7in) approx}$$

Clearance on either side of the drive must be checked. The width of the drive is 250mm (10in). Clearance of 100mm (4in) is required on either side. So the minimum internal width of the enclosure must be 450mm, or 0.45m (18in). This is within the calculated width, and therefore acceptable. However, it allows limited space for any equipment to either side of the drive, and this may be a factor in deciding the proportions of a suitable enclosure. If so, modify the calculated value of **C** to allow for other equipment, and re-calculate either of the other two dimensions by the same method.

If an enclosure is to be selected from a stock catalogue, the corresponding surface area should be not less than the figure calculated above for  $A_e$ .

As a general rule, it is better to locate heat-generating equipment low in an enclosure to encourage internal convection and distribute the heat. If it is unavoidable to place such equipment near the top, consideration should be given to increasing the dimensions of the top at the expense of the height, or to installing internal circulation fans with drives which are not equipped with a built-in fan to ensure air circulation.

#### Enclosure ventilation

If a high Ingress Protection rating is not a critical factor, the enclosure can be smaller if a ventilating fan is used to exchange air between the inside and the outside of the enclosure.

To calculate the volume of ventilating air, **V**, the following formula is used:

$$V = \frac{3.1P_i}{T_i - T_{amb}}$$

Where:

**V** is the required air flow in  $\text{m}^3 \text{h}^{-1}$ .

#### To find the ventilation required for an M210 drive

$$P_i \quad 400\text{W}$$

$$T_i \quad 40^\circ\text{C (for Mentor II drives)}$$

$$T_{amb} \quad 25^\circ\text{C (for example)}$$

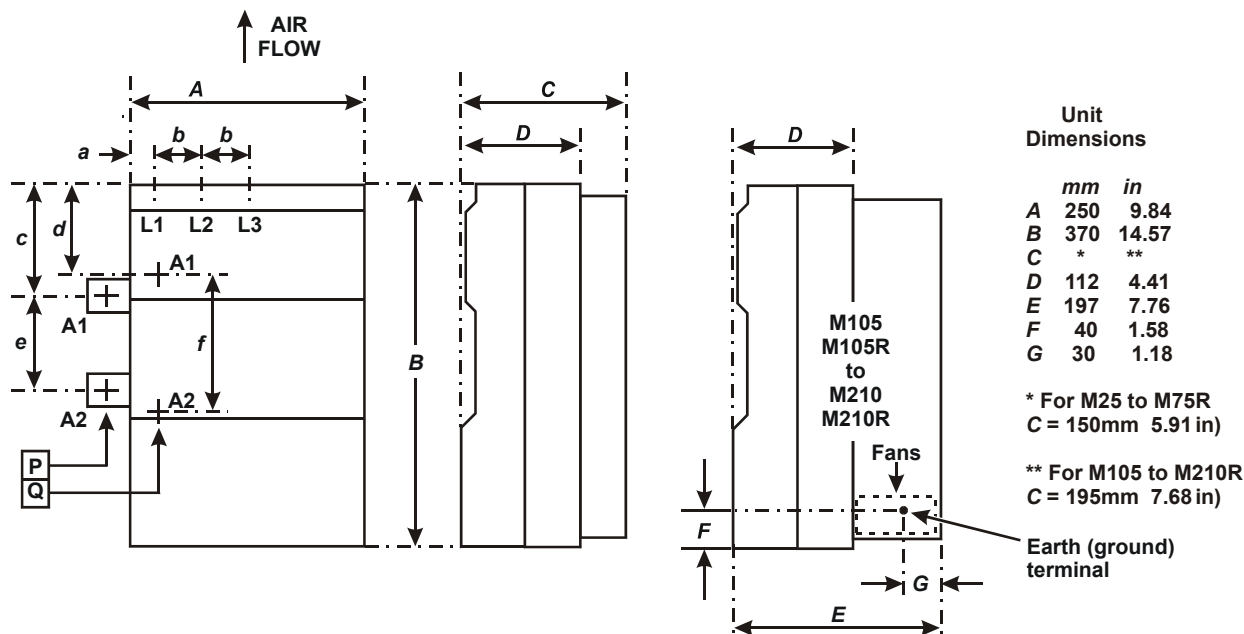
Then:

$$V = \frac{3.1 \times 400}{40 - 25} = 83\text{m}^3 \text{h}^{-1} (2930\text{ft}^3 \text{h}^{-1})$$

Figure 5-3 M25(R) to M210(R) drive dimensions

**NOTE**

The diagram shows terminals A1 and A2 for FOUR-QUADRANT drives only.  
For SINGLE-QUADRANT drives, the locations of A1 and A2 are REVERSED.



UNIT	TERMINALS A1, A2
M25	Q
M25R	Q
M45	Q
M45R	Q
M75	Q
M75R	Q
M105	Q
M105R	P
M155	Q
M155R	P
M210	Q
M210R	P

**Terminal Dimensions**

	mm	in
a	30	1.18
b	60	2.36
c	110	4.33
d	100	3.94
e	115	4.53
f	140	5.51
g	54	2.13

**TERMINALS L1, L2, L3**

- M8 stud

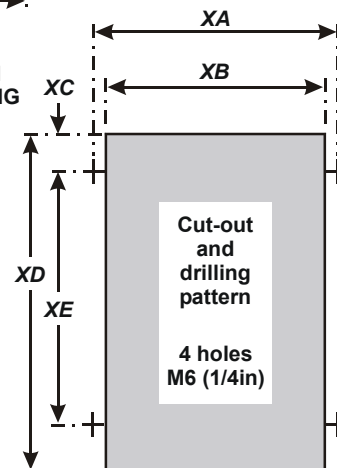
**TERMINALS A1, A2**

and Earth (ground)  
- drilled for M8  
(0.32 in) bolt

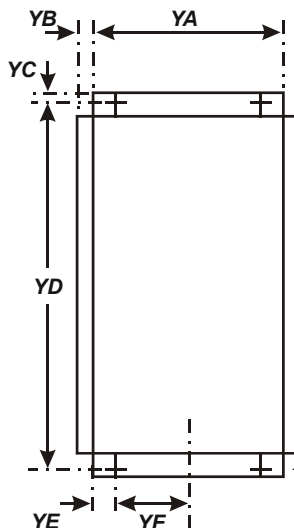
**CUT-OUT & DRILLING PATTERN  
FOR THROUGH\_PANEL MOUNTING**

**Through-Panel  
Mounting  
Dimensions**

	mm	in
XA	220	8.66
XB	200	7.87
XC	42.5	1.67
XD	360	14.17
XE	245	9.65



**DRILLING PATTERNS  
FOR SURFACE MOUNTING**



**Surface Mounting  
Dimensions**

	mm	in
YA	186	7.32
YB	32	1.26
YC	10	0.39
YD	352	13.86
YE	42	1.65
YF	50	1.97

Not to Scale  
Metric dimensions are exact  
Inch dimensions are calculated

Units M25 and M25R to M210 and  
M210R (incl) are suitable for both  
Surface Mounting and Through-  
Panel Mounting



Figure 5-4 M350(R) to M825(R) drive dimensions

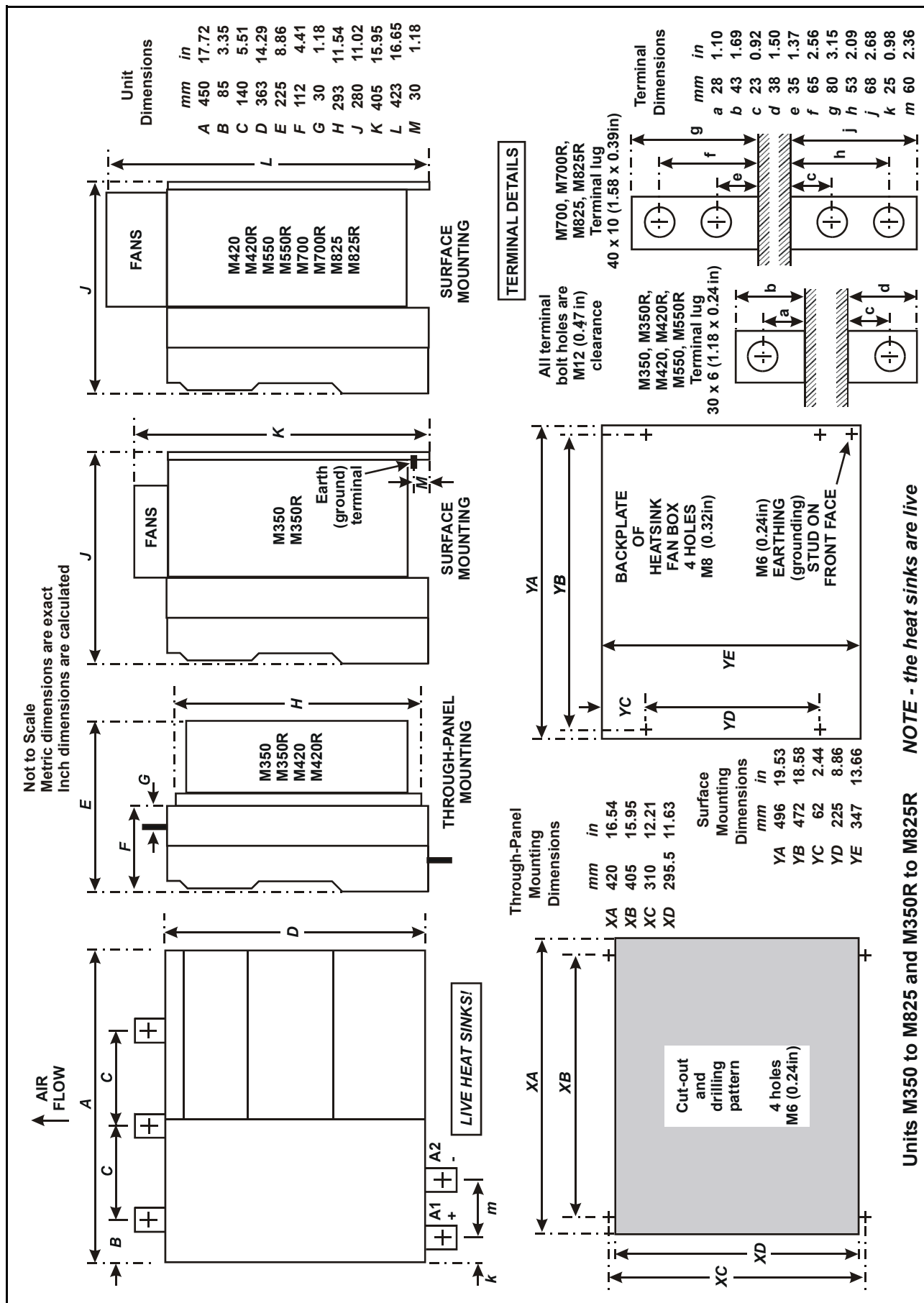
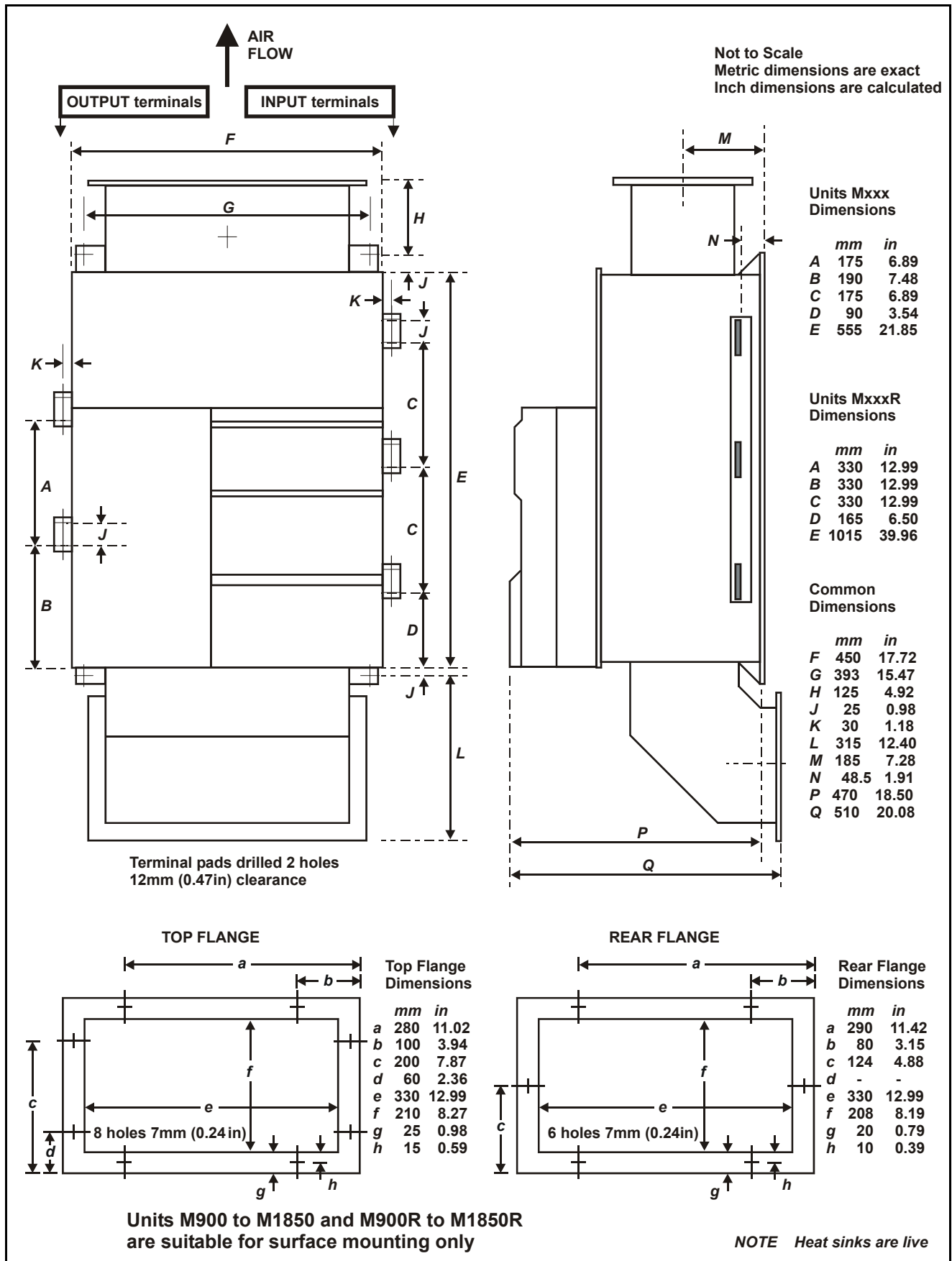





Figure 5-5 M900(R) to 1850(R) drive dimensions



## 6 Electrical Installation

### 6.1 Installation criteria


#### 6.1.1 Safety



**WARNING**

The voltages present in the supply cables, the output cables and terminals, the control power supply wiring and in certain internal parts of the drive are capable of causing severe electric shock and may be lethal.

#### 6.1.2 Electric Shock Risk!




**WARNING**

Whenever the drive has been connected to the main AC supply system it must be **DISCONNECTED** and **ISOLATED** before any work is done that requires the removal of a cover. A period of 2 minutes **MUST** elapse after isolation to allow the internal capacitors to discharge fully. Until the discharge period has passed, dangerous voltages may be present within the module.

Persons supervising and performing electrical installation or maintenance must be suitably-qualified and competent in these duties, and should be given the opportunity to study, and to discuss if necessary, this Users Guide before work is started.


#### 6.1.3 Ingress Protection



**CAUTION**

The drive enclosure conforms to international enclosure specification IP00 and is suitable for mounting in NEMA-rated enclosures. It is necessary to consider the location of and access to the drive unit itself in the light of local safety regulations applicable to the type of installation.


#### 6.1.4 Hazardous areas



**WARNING**

The application of variable speed drives of all types may invalidate the hazardous area certification (Apparatus Group and/or Temperature Class) of Ex-protected (externally-protected) motors. Approval and certification should be obtained for the complete installation of motor and drive. (Refer also to *section 5.2.1 Location* on page 13)

#### 6.1.5 Earthing (Grounding)



**WARNING**

Drives with isolated heat sinks require that the heat sink is earthed (grounded) for safety. (Refer also to *section 5.2 Mounting* on page 13)

It is recommended that any metal components which could accidentally become live are solidly earthed (grounded). Earth (ground) impedance must conform to the requirements of local industrial safety regulations and should be inspected and tested at appropriate and regular intervals.

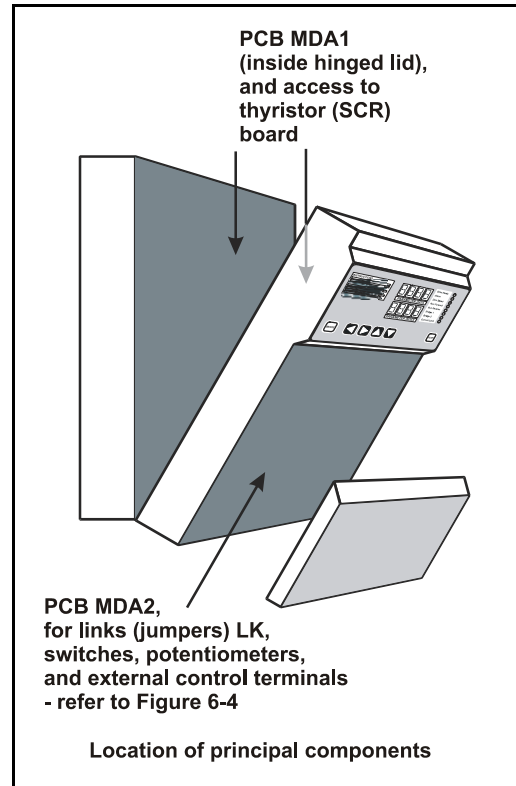
#### 6.1.6 Control system earthing (grounding)

External AC control circuits, for example, contactors, should be supplied (from any two phases of the supply) through an isolating transformer equipped with an earthing (grounding) shield (screen) between the primary and secondary as shown in Figure 6-2 and Figure 6-3. The control wiring should be connected to the same earthing (grounding) point if possible, or arrangements made to ensure that the earth (ground) loop impedance complies with an authorized code of practice.

#### 6.1.7 Location

The location of principal components is shown in Figure 6-1.

Figure 6-1



Refer to Figure 6-2 and Figure 6-3.

### Single Quadrant

\* Fuses for wiring protection only  
 + Only need to connect E2 with North American field bridge and for field supply on M350(R) to M1850(R)

**Terminals**

Terminal	Function
31	Enable
21	Run permit
25	Run forward

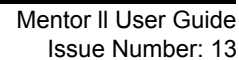
**Components**

- LR Line reactor
- LC Line contactor
- LF Line fuses
- LK Link (Jumper)
- MBS Motor blower starter
- MT Motor thermal switch
- RR Run relay
- T Tachometer

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Check that the direction of rotation is as required as soon as the drive is first turned on. If not, exchange the connections to the armature or the field (but not both). If an encoder or tachogenerator (tachometer) feedback is installed, the sense of the signals to the drive must be reversed to correspond.

**Figure 6-3 Four quadrant power connections**



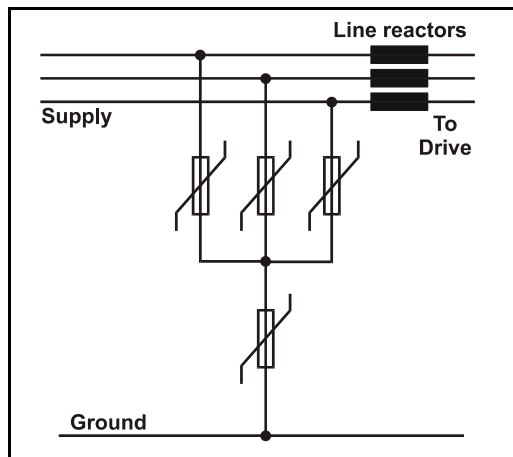
### 6.2.2 Overvoltage suppression

The Mentor II drive contains overvoltage suppression components to protect the thyristors from high voltage pulses (transients or spikes) appearing between the phases because of lightning strikes etc. It is also designed to withstand pulses of over 4kV between the phases and ground.

In regions of high lightning activity, especially where grounded delta supplies are in use, it is recommended that additional protection should be fitted externally between the phases and ground. This would typically be by using MOVs (varistors).

One possible arrangement is shown in Figure 6-4.

Figure 6-4 Overvoltage suppression



The AC voltage rating of the MOVs can be up to 550V. This is suitable for all supply voltages up to 660V +10%.

Ensure that the MOVs are rated for surge currents of at least 3kA for the standard surge (1.2/50µs voltage or 8/20µs current). The wires to the MOVs should be short (e.g. less than 6in/15cm) to avoid additional over-voltage caused by wiring inductance with the fast-rising current.

MOVs approved by a safety agency such as UL are recommended, and in some regions this is essential for legal or insurance reasons.

### 6.2.3 Overvoltage category and voltage surge suppression

The Mentor II drive contains comprehensive voltage surge suppression and co-ordinated electrical spacings. It is resistant to surges of 4kV between lines and from lines to ground.

The 480V version of the drive may be connected to a supply system of overvoltage category III (as specified in IEC664-1). This means that it is suitable for permanent connection to any power system other than an outdoor installation. For outdoor installation it is recommended that additional overvoltage protection be provided.

The 525V and 660V versions may be connected to a supply system of overvoltage category II. For permanent connection directly to industrial supply systems it is necessary to provide additional surge suppression between lines and ground. Suitable suppression devices using metal oxide varistors (MOVs) are widely available. This is not required where the drive is provided with an isolation transformer.

The status relay contacts are designed for overvoltage category II at 240V.

Overvoltage categories are as follows:

I	Protected circuits with overvoltage surge suppression
II	General building power supplies for use by electrical appliances
III	Fixed installations with permanent supply connection
IV	Building power incomer (eg utility meter etc.)

### 6.3 Current feedback burden resistors

To allow the use of a motor which has a lower rating than the drive, the current feedback has to be re-scaled by changing the burden resistors R234 and R235 (or in the case of drive size M350 and above, the three resistors R234, R235 and R236) mounted on the power board. The following equations provide the value of the appropriate resistance. Resistors are in *parallel*.

Where  $I_{max}$  is 150% of the rated full load current of the motor:

For drives M25 up to M210R (up to 210A DC output) and PCBs MDA75, MDA75R, MDA 210, and MDA210R:

$$R_{total} = \frac{400}{I_{max}}$$

For drives M350 and above, and PCB MDA6, three burden resistors, R234, R235 and R236 are used in parallel:

$$R_{total} = \frac{1600}{I_{max}}$$

#### Worked example of current feedback burden resistor values

For an M350 drive and a 200A motor:

Full load current output (Table 1) is 350A

Maximum current is 350 x 1.5amps

Total burden resistance:

$$R_{total} = \frac{1600}{200 \times 1.5} = 5.33\Omega$$

$$\frac{1}{R_{total}} = \frac{1}{R_{234}} + \frac{1}{R_{235}} + \frac{1}{R_{236}}$$

From data tables of standard resistor values, find three which give the closest approximation.

For example, if :

R234 = 12Ω

R235 = 12Ω

R236 = 47Ω

The power rating of each burden resistor in turn is calculated from :

$$\text{Power(W)} = \frac{V^2}{R}$$

and where the voltage across the three resistors in parallel is 1.6V, power absorbed is :

$$\text{R234 and R235: } \frac{1.6^2}{12} = 0.213W$$

a 0.5W or 0.6W rating is adequate

$$\text{R236: } \frac{1.6^2}{47} = 0.055W$$

a 0.25W rating is adequate


#### NOTE

If the current ripple measured at terminal 11 is less than 0.6V p-p, it is possible to increase the burden resistors (provided that version V5.1.0 (or later) software is used) by a factor of 1.6. If the burden resistors are increased parameter 05.29 must be set to 1.

The burden resistor values should not be increased by the factor of 1.6 if the current ripple measured at terminal 11 is greater than 0.6V as the drive will operate better with the standard values.

## 6.4 Control connections

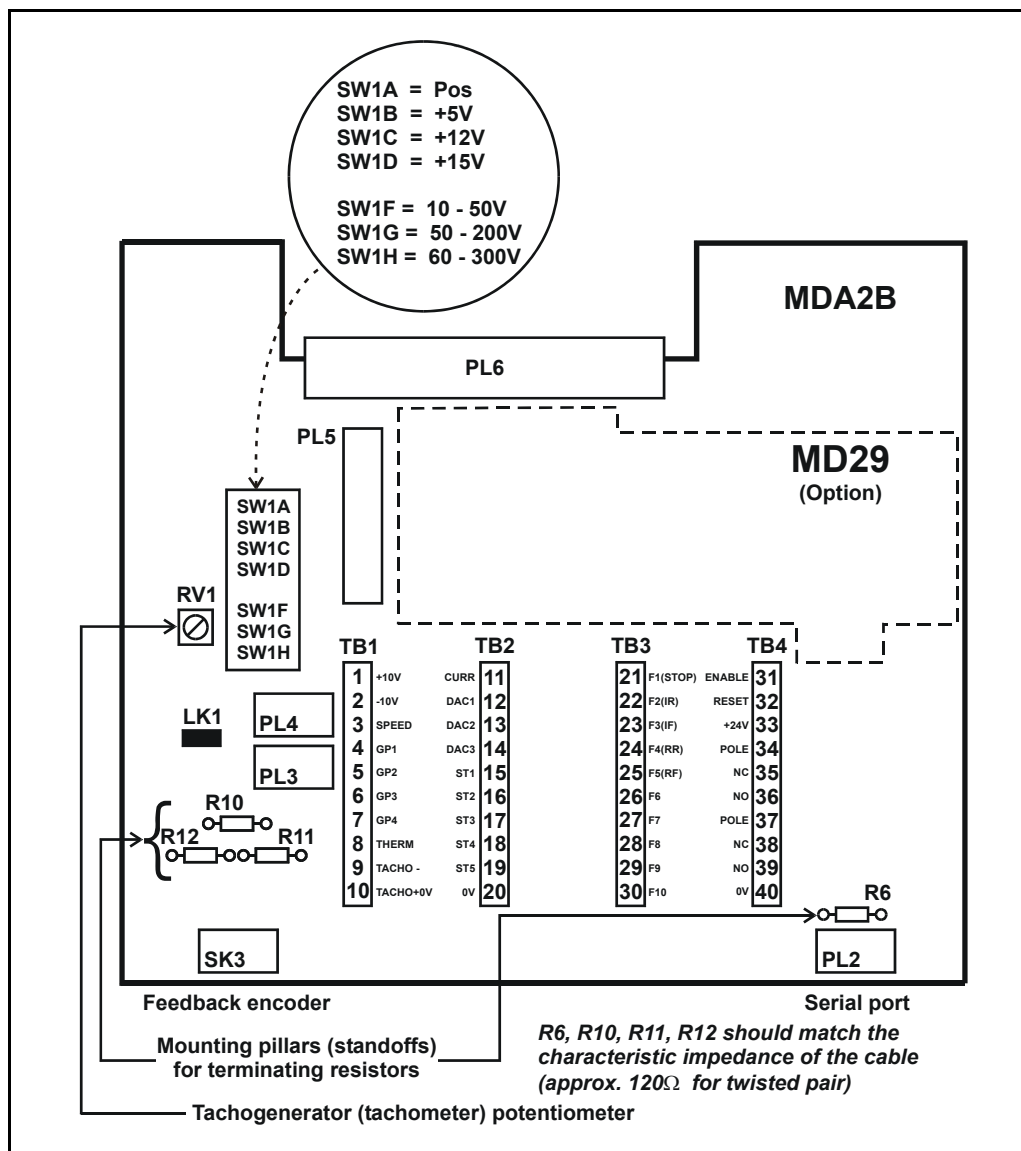
Refer to Figure 6-2, Figure 6-3, Figure 6-5, and Figure 6-6. Also section 6.5 *Terminals index* on page 23 and section 6.6 *Terminals classified* on page 24.



**Isolation**  
The control circuits and terminals are isolated from the power circuits only by basic insulation to IEC664-1. The installer must 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.

**WARNING**

Figure 6-5 Location of principal components on PCB MDA2B issue (revision) 2



## 6.5 Terminals index

Terminals are located on PCB MDA2B, Figure 6-1 and Figure 6-5.

Terminal		Description	Type	Programmable
Block	Number			
TB1	1	+10V	Reference supply	
	2	-10V	Reference supply	
	3	Speed reference	Analog input	Yes
	4, 5, 6, 7	General purpose GP1, GP2, GP3, GP4	Analog inputs	Yes
	8	Motor thermistor (thermal)	Analog input	
	9	Tachogenerator (tachometer) negative	Analog input	
	10	Tachogenerator (tachometer) positive (0V)	Analog input	
TB2	11	Current	Analog output	
	12	DAC1	Analog output	Yes
	13	DAC2	Analog output	Yes
	14	DAC3	Analog output	Yes
	15, 16, 17, 18, 19	ST1, 2, 3, 4, 5	Open collector outputs	Yes
	20	0V		
TB3	21	F1 Run permit	Digital input	
	22	F2 Inch reverse	Digital input	Yes
	23	F3 Inch forward	Digital input	Yes
	24	F4 RUN reverse (latched)	Digital input	Yes
	25	F5 RUN forward (latched)	Digital input	Yes
	26, 27, 28, 29, 30	F6, 7, 8, 9, 10	Digital inputs	Yes
TB4	31	ENABLE	Digital input	
	32	RESET	Digital input	
	33	+24V relay supply		
	34	Pole	Relay output (ST6)	Yes
	35	Normally closed contact	Relay output (ST6)	Yes
	36	Normally open contact	Relay output (ST6)	Yes
	37	Pole	Drive ready relay	
	38	Normally closed contact	Drive ready relay	
	39	Normally open contact	Drive ready relay	
	40	0V		

### PL5

Number	Function	Number	Function	Number	Function
1	+10V	11	Current	21	F1
2	-10V	12	DAC1	22	F2
3	Speed ref	13	DAC2	23	F3
4	GP1	14	DAC3	24	F4
5	GP2	15	ST1	25	F5
6	GP3	16	ST2	26	F6
7	GP4	17	ST3	27	F7
8	Thermistor (thermal switch)	18	ST4	28	F8
9	NC	19	ST5	29	F9
10	0V	20	0V	30	F10
				31	ENABLE
				32	RESET
				33	External 24V
				34	0V

## 6.6 Terminals classified

### 6.6.1 Analog outputs

Terminal block TB2, terminals 11 to 14 inclusive.

Armature current indication, 5mA drive capability.

Three undedicated outputs, 5mA drive capability. Output voltage range -10V to +10V.

### 6.6.2 Analog inputs

Terminal block TB1, terminals 3 to 10 inclusive.

Five undedicated inputs, impedance 100kΩ. Input voltage range -10V to +10V.

Dedicated inputs for motor thermistor (thermal) or thermostat (trip level 3kΩ, reset 1.8kΩ approx.) and tachogenerator (tachometer) feedback.

### 6.6.3 Digital outputs

Terminal block TB2, terminals 15 to 19 inclusive.

Terminal block TB4, terminals 34 to 39 inclusive.

Five undedicated open-collector outputs.

Maximum current-sinking capability 100mA.

One undedicated relay output.

Dedicated drive ready relay output.

Maximum relay current at:

250V AC 2.2A

110V AC 5A

5V DC 5A

When using digital outputs with an external 24V supply and an external load, such as a relay coil, a fly wheel diode should be connected across the load.

It is recommended that the external power supply is not energized when the Mentor II is not powered up.

### 6.6.4 Digital inputs

Terminal block TB3, terminals 21 to 30 inclusive.

Terminal block TB4, terminals 31, 32.

Nine undedicated inputs, impedance 10kΩ.

Drive enable signal - operates directly on the output gate-pulse circuits for safety. Delay 30ms between removal of enable signal and inhibit firing. Drive enable control is internally interlocked with fault detection signals for maximum safety.

Run Permit

Drive reset input for external control.

Input logic selectable - active high or active low. Circuit voltage +24V.

Provision for inputs from two encoders.

Run Forward and Run Reverse, latched.

### 6.6.5 Programmable outputs

Terminal block TB2

Terminals 12 to 14 inclusive Analog

Terminals 15 to 19 inclusive Open collector (digital)

Terminal block TB4

Terminals 34 to 36 inclusive Relay

### 6.6.6 Programmable inputs

Terminal block TB1

Terminals 3 to 7 inclusive Analog

Terminal block TB3

Terminals 22 to 30 inclusive Digital

## 6.6.7 Encoder (pulse tachometer) - Reference & Feedback

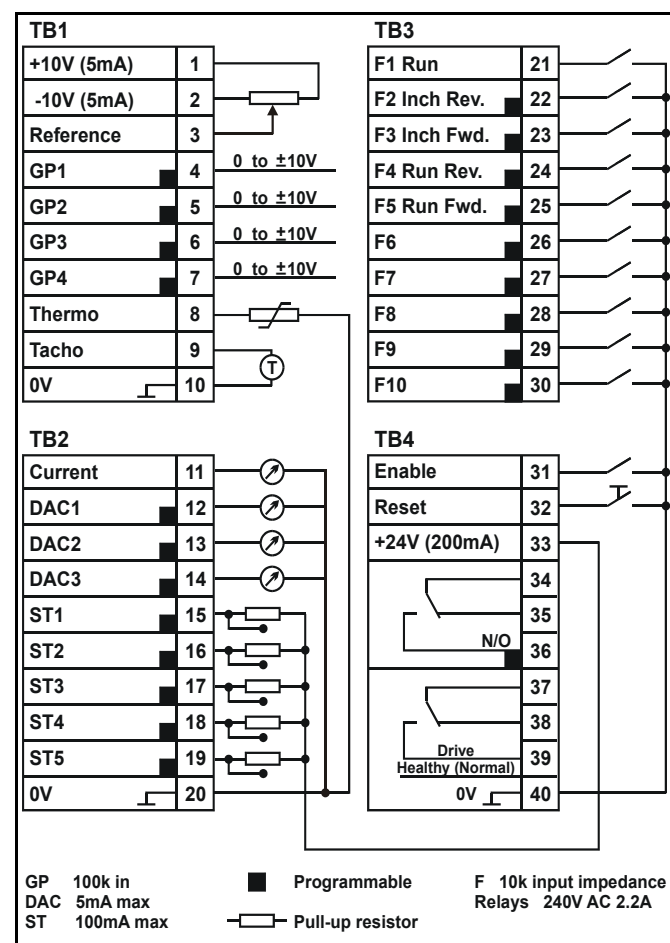
Channel A must lead channel B for forward rotation.

Connections for:

Pin	Encoder		Serial Comms.
	Reference PL4	Feedback SK3/PL3*	PL2
1	0V	0V	0V isolated
2	NC	Supply	/TX
3	A	A	/RX
4	/A	/A	NC
5	B	B	NC
6	/B	/B	TX
7	NC	NC	RX
8	C	C	NC
9	/C	/C	NC
10	0V	0V (NOT SK3)	

- PL3 is connected in parallel with SK3
- PL4 is a 10-way header for the Reference Encoder
- SK3 is a 9-way D-type female socket for the Feedback Encoder

Figure 6-6 Control connections



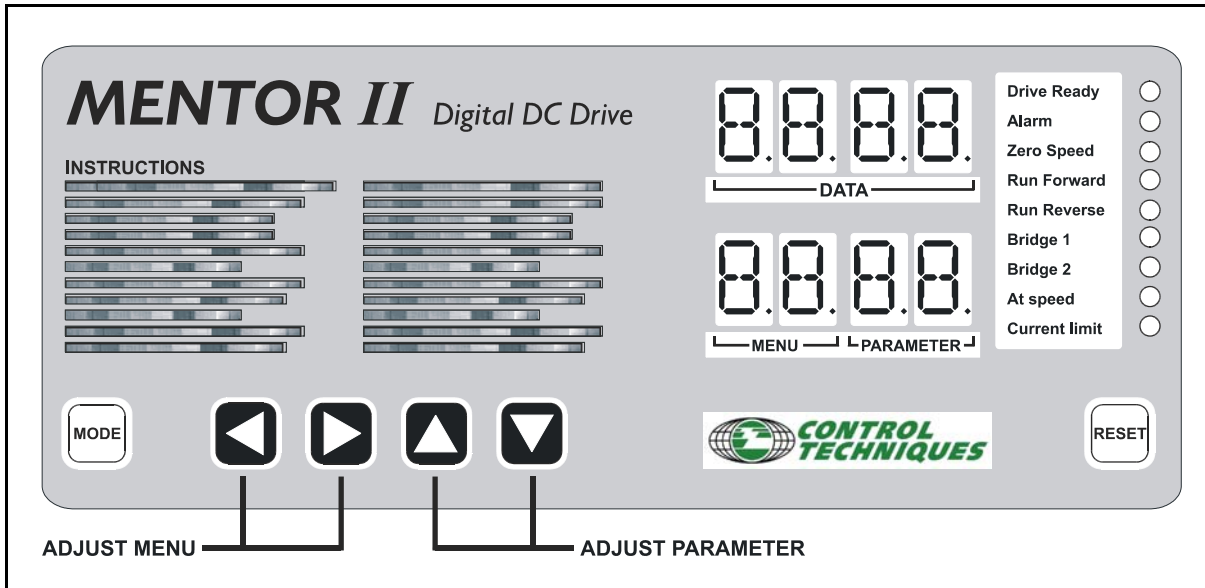


## 7 Operating procedures

### 7.1 Keypad and displays

#### 7.1.1 Keypad

Figure 7-1 Keypad



The keypad serves two purposes:

1. It allows the operator to configure the drive to match particular applications and to change its behavior in a variety of ways, for example by altering the times of acceleration and deceleration, presetting levels of protection, and so on.  
  
Subject to safety considerations, adjustments may be made with the drive running or stopped. If running, the drive will respond immediately to the new setting.
2. It provides full information about the settings and the operational status of the drive, and extensive diagnostic information if the drive trips.

For parameter adjustment, the keypad has five keys, Figure 8-1. Use the *LEFT* or *RIGHT* keys to select a Menu (functional group of parameters). The menu number appears to the left of the decimal point in the Index window.

Use the *UP* or *DOWN* keys to select a Parameter from the chosen menu. The parameter number appears to the right of the decimal point in the Index window, and the value of the chosen parameter appears in the Data window.

Press the *MODE* key once to access the displayed parameter value for adjustment. The value flashes if access is permitted.

Use the *UP* or *DOWN* keys to adjust the value. To adjust rapidly, press and hold a key.

Press the *MODE* key again to exit from the adjustment mode.

Store (make permanently effective) parameter values after changes, otherwise the new values will be lost when the drive is powered-off. To store, set Parameter 00 = 1 and press *RESET*.

#### 7.1.2 Displays

##### 1. Index

The lower four-digit display indicates menu number to the left of the (permanent) decimal point, and parameter number to the right.

##### 2. Data

The upper four-digit display indicates the value of a selected parameter. The present value of each parameter in turn appears in the data display as parameter numbers are changed.

Numerical parameters have values in ranges of 000 to 255, 000 to +1999, or 000 to 1000. Refer to Chapter 6 for parameter unit values, e.g. volts, rpm, etc.

Bit parameter values are displayed as 0 or 1, preceded by a b. The first digit for integer parameters (0 to 255) is a ☐.

##### 3. Status Indicators

Nine LED's to the right of the parameter data and index panels present information, continuously updated, about the running condition of the drive and enable basic information to be seen at a glance.

LED Illuminated	Information
Drive ready	The drive is switched on and is not tripped
Drive ready flashing	The drive is tripped
Alarm flashing	The drive is in an overload trip condition or is integrating in the $I \times t$ region
Zero speed	Motor speed < zero speed threshold (programmable)
Run forward	Motor running forward
Run reverse	Motor running in reverse
Bridge 1	Output bridge 1 is enabled
Bridge 2	Output bridge 2 is enabled (Inactive in 1-quadrant drives)
At speed	Motor running at the speed demanded by the speed reference
Current limit	Drive running and delivering maximum permitted current

## 7.2 Setting up to run

Install the drive and make electrical power and control connections in accordance with Chapter 8 *Parameter Set*, and Figure 6-2, Figure 6-3 and Figure 6-5. Before attempting to run the drive, there are further connections and settings - some optional - to make or to be considered.

These are summarized below:

Action	Reference
Preset the link (jumper)LK1 and switches	section 7.2.1
Preset the adjustable potentiometer if tachogenerator (tachometer) feedback selected	section 7.2.2
Adjust operating parameters as appropriate to the application	section 8.1 <i>Adjustment of parameters</i> on page 29
Autotune current loop	parameter <b>05.09</b>
Adjust field feedback scaling	parameter <b>06.11</b>
Allocate security code optional	section 8.2 <i>Security</i> on page 31

### 7.2.1 Link LK1 (jumper) and switches

The link LK1 (jumper) and switch block are located on PCB MDA2B (Figure 6-5), accessible when the lower, snap-on front cover is removed (Figure 6-1).

Control	Purpose	
SW1A	Logic input polarity. MDA2B is marked POS. and NEG. to indicate the positions of SW1A. Pos. = 24V Neg. = 0V.	POWER-OFF BEFORE CHANGING
SW1H	60V to 300V	Tachogenerator (tachometer) feedback range*
SW1G	50V to 200V	Tachogenerator (tachometer) feedback range*
SW1F	10V to 50V	Tachogenerator (tachometer) feedback range*
LK1	Tachogenerator (tachometer) potentiometer calibration adjustable link (jumper)	
SW1D	+15V	Encoder supply voltage selector*
SW1C	+12V	Encoder supply voltage selector*
SW1B	+5V	Encoder supply voltage selector*

\* ONE ONLY to be selected

### 7.2.2 Potentiometer RV1

Refer to Figure 6-5.

**Pot. Purpose**  
RV1 Tachogenerator (tachometer) feedback adjustment

#### Procedure for Adjustment

1. Select the appropriate tachogenerator range using SW1.
2. Set LK1 in the ADJUST position.
3. Adjust RV1 until the value of parameter **03.02** (Speed Feedback) is:

$$03.02 = \frac{10,000}{V_{\max}}$$

where  $V_{\max}$  = Tach. voltage at full speed.

4. Set LK1 in the FEEDBACK position and fine tune RV1 with the motor running at between half to three-quarter speed.

## 7.3 Getting started

### Essential data

Before attempting to tune a Mentor II to operate a particular load, collect the following information from the nameplate of the motor, manufacturers data, and other sources.

Data values are given here for the sake of the worked examples which follow.

- Armature full load amps 67A
- Armature voltage 500V DC
- Field current 1.85A
- Field voltage 300VDC
- Base speed 1750rpm
- Maximum permissible speed with weakening field 2500rpm
- The method of delivering speed feedback data to the drive - various examples are considered below

### Worked examples

#### 7.3.1 Armature current

##### Current limit

Current limit is set in parameter **04.05** only if the drive is not regenerative, and in *both* **04.05** and **04.06** if it is regenerative.

An M75 drive is rated at 75A full load current.

The default value (1000) of parameter **04.05** (and **04.06**) allows a maximum current limit of 150% of full load current, which would be  $1.5 \times 75 = 112.5A$ .

Full load current for the selected motor is 67A, and if its maximum current limit is 150%, which is normal, the maximum current that it may experience is 100.5A.

Accordingly, the drive must be adjusted to correspond, or the motor will be damaged. Calculate the ratio from:

$$\frac{\text{Motor full load current}}{\text{Drive rating}} = \frac{67}{75} = 0.89$$

The full-scale value of the Current Limit parameters, corresponding to 150% of full load current of the motor, is 1000. The actual setting of the Current Limit parameters is, therefore :

$$1000 \times 0.89 = 890$$

$$\text{Set } 04.05 = 890.$$

If the drive system is regenerative,

$$\text{set } 04.06 = 890 \text{ also.}$$

#### NOTE

##### Current resolution

The rating of the selected drive is typically higher than the rating of the motor, but it should not be very much higher. It would not be prudent to select a drive-to-motor ratio less than 2/3 (current limit parameter setting 600). Current feedback resolution at any lower ratio would be unable to give good current loop control.



Although full scale resolution can be achieved by changing the burden resistors of the drive current transformer, this would create a non-standard drive that is not a stock item. The risk is that the drive might be replaced by a standard drive of the same nominal rating; the motor could be permanently damaged. Special modifications of this nature should always be supported by thorough documentation, and the non-standard drive should itself be indelibly tagged in some way.

### Current overload I x t

The threshold at which I x t integration begins in parameter **05.06** is typically 105%.

The parameter full-scale value is 1000, corresponding to 150%, so that :

$$\text{05.06 threshold} = \frac{105 \times 1000}{150} = 700$$

This value, as with the Current Limit, must be adjusted to take account of the actual motor full load amps by applying the factor already calculated for Current Limit, namely, 0.89. The actual value required for this motor and drive combination is therefore :

$$700 \times 0.89 = 623$$

$$\text{Set 05.06} = 623$$

### Access to these parameters

To gain access to these parameters and set the values select parameter 00 and enter 200.

This permits access to all required parameters.

## 7.3.2 Speed feedback

### Armature voltage feedback

For armature voltage feedback, set parameter **03.13** = 1.

For practical applications a small tolerance of 2% or 3% above the nameplate voltage should be allowed. For an armature voltage of 500V, set parameter **03.15** = 510 or 520.

### Analog speed feedback

For analog tachogenerator (tachometer) feedback, set parameter **03.13** = 0 (default setting).

The default values of the speed loop proportional and integral gains are usually satisfactory for analog feedback.

Depending on the application the characteristic behavior of the load adjustment of the speed loop gains may be needed to obtain the optimum dynamic performance and speed-holding.

### Encoder (pulse tachometer) speed feedback

For encoder (pulse tachometer) feedback, set parameter **03.12** = 1.

The scaling parameter, **03.14**, must be adjusted to correspond with the encoder PPR (pulses per revolution) and the intended maximum speed of the motor in rpm :

$$\text{03.14} = \frac{750 \times 10^6}{\text{PPR} \times (\text{Max. rpm})}$$

For example:

Encoder (pulse tach.)	240PPR
Motor rated max. speed	1750rpm
Motor max. speed required	1710rpm

$$\text{03.14} = \frac{750 \times 10^6}{240 \times 1710} = 1827$$

#### NOTE

When this type of feedback is applied there are several additional factors to consider. The instrument should be a dual-channel quadrature type with line driver outputs (using RS485 line drivers). The Mentor II on-board power supply for the encoder (pulse tachometer) is selectable to 5V, 12V or 15V by means of the red DIP switch on PCB MDA2B. (Refer to Figure 6-5) This supply can deliver 300mA. It is not isolated from the drive.

Transmission line terminating resistors should be installed on the mounting pillars (stand-offs) provided at the lower left-hand corner of the PCB, Figure 6-5. These resistors help to prevent line reflections and to reduce noise pick-up into the differential receiver on the drive.

When an encoder (pulse tachometer) is employed, the P and I gains should be adjusted to the following suggested values as a starting point

$$\text{03.09} = 15$$

$$\text{03.10} = 5$$

Connection of the marker pulses is only necessary if the drive is being used in an application which requires position control such as digital lock or spindle orientation. If marker pulses are used then the encoder must have 1024 pulses per revolution.

## 7.3.3 Field current

First enable the Field Controller.

Set parameter **06.13** = 1.

### Current range

The Mentor II M75 provides for a field current range of either 2A maximum or 8A please refer to the table in the description of parameter **06.11**. In the example chosen, the maximum field current is 1.85A. This is >1.5A and <2A.

Set **06.11** = 204 to select the correct range.

### Maximum field current

The full-scale value of the Max. Field Current parameter **06.08** is 1000. The maximum field current of the chosen example is 1.85A. The setting for parameter **06.08** is:

$$\frac{\text{Motor max field current}}{\text{Field range}} = \frac{1.85}{2.00} \times 1000 = 925$$

### Field weakening

Since field weakening is not employed in this particular example, set **06.07** = 1000 (default).

For details of settings and calculations for field weakening, please refer to section 7.3.4 *Field weakening*.

### Field economy

For applications which involve the drive being at zero speed no-load (i.e. motor stopped but on stand-by) for periods in the duty cycle, provision is made to economise on the field current. The user can set the value of the reduced field current (parameter **06.09**) and the period of time before field current is reduced (parameter **06.12**).

To employ field economy, the following settings are required:

**Field Economy Time-out Enable - set 06.15 = 1**

### Field economy current

Suppose the chosen value of the reduced field current is 0.5A:

$$\frac{\text{Motor reduced field current}}{\text{Motor max field current}} = \frac{0.5}{1.85} \times 1000 = 270$$

Set **06.09** = 270

Test the effect by temporarily setting the Field Economy Time-out, **06.12**, to 2 seconds (**06.12** = 2). Disable the drive and monitor the current value at parameter **06.03**. Two seconds after the drive is disabled, **06.03** will be seen to reduce to the selected value of **06.09**.

#### NOTE

### Internal field regulator

If Mentor II is supplied with the Internal Field Regulator, field economy is under automatic control of the software and an external field ON-OFF control switch (Figure 6-2 and Figure 6-3) is not required. Link out (jumper across) terminals L11 and L12 with wire which is capable of carrying the field current.

### 7.3.4 Field weakening

In the example, the maximum armature voltage is 500V DC. If field weakening is required, a typical practical setting for the back-emf cross-over point **06.07** would be 15 to 20 volts below the maximum armature voltage.

For example, set **06.07** = 480.

At the reduced voltage, the field would begin to weaken progressively down to the value set by parameter **06.10**. Since the field current feedback setting **06.11** in this example is 204 - 2A range - the minimum is a selected percentage of it. Suppose 90% is selected. Then:

$$\frac{\text{Selected value}}{\text{Feedback setting}} = \frac{0.9}{2.0} = 0.45$$

The setting for minimum field current is :

$$\mathbf{06.10} = 0.45 \times 1000 = 450$$

For correct operation, field weakening requires speed feedback. (Armature voltage feedback would not be adequate to ensure control.) Therefore, **03.13** would be set to 0 for AC or DC tach. feedback, and speed scaling **03.16** would be set to 250, corresponding to 2500rpm maximum permissible motor speed. Parameter **03.03** will then correctly read out the actual motor rpm.

If an encoder (pulse tach.) were to be employed, parameter **03.12** would be set to 1 and the encoder scaling **03.14** would need to be set accordingly. The value of **03.14** is dependent on :

- The maximum motor speed required, and
- The number of encoder (pulse tach.) pulses per revolution.

### 7.3.5 Current loop self-tuning

#### NOTE

The following procedure is optional, and for most general applications is not required. However, if optimum dynamic response is desirable, the current loop, which is the innermost control loop, must be set up to enable the outer control loop (such as the speed loop) to function correctly. The dynamics of the current loop are principally a function of the electrical characteristics of any particular motor.

The Mentor II has a built-in self-tuning procedure.

First, the motor rotor must be locked or the field disconnected to allow the drive to inject armature current and determine the electrical characteristics of the armature. The rotor must not be allowed to rotate during the self-tuning procedure. (Normally, if the field is disconnected, the rotor of a shunt wound motor will not move.)

Mentor II units from M25 through to M210 contain an internal field regulator and do not require the field to be disconnected.

#### Self-tuning procedure

1. Power-up the drive.
2. Set parameter **00** = 200 to satisfy security.
3. Set **05.09** = 1
4. Enable the drive connect terminal TB4-31 to 0V
5. Perform a Save parameter values procedure before disconnecting the drive. The parameters affected by the self-tuning procedure are **05.12** to **05.15**. (For the save procedure, refer to section *To Save the value(s) written* on page 30.
6. The drive also has the facility to carry out a continuous autotune by setting parameter **05.27** which will adjust the current loop gains to keep the current loop performance optimised in the case of varying load conditions.

### 7.3.6 User-defined parameters

Although the following parameter settings are optional it is desirable to set them because doing so allows the user to view various critical drive values without having to run through several menu sets to find them. All are collected together in Menu 00

Parameter	Drive quantity	Setting	Accessed at
<b>11.01</b>	Armature voltage	<b>03.04</b>	00.01
<b>11.02</b>	Armature current	<b>05.02*</b>	00.02
<b>11.03</b>	Motor rpm	<b>03.03</b>	00.03
<b>11.04</b>	Speed reference	<b>01.02</b>	00.04
<b>11.05</b>	AC line voltage	<b>07.06</b>	00.05

\* A direct armature current reading can be read on parameter **05.02** if 05.05 is set with the appropriate scale factor. Using the same figures as before, for an M75 drive, in this instance the setting would be 150% of 75A, **05.05** = 113.

As for the motor and drive configuration parameters, perform a "Save parameter values" procedure before disconnecting the drive; refer to section *To Save the value(s) written* on page 30.

# 8 Parameter Set

## Index to sections

### 8.1 Adjustment of parameters

### 8.2 Security

### 8.3 Index of parameters

### 8.4 Descriptions of parameters

Menu 01	Speed Reference
Menu 02	Ramps
Menu 03	Feedback Selection & Speed Loop
Menu 04	Current Selection & Limits
Menu 05	Current Loop
Menu 06	Field Control
Menu 07	Analogue I/O
Menu 08	Digital Inputs
Menu 09	Status Outputs
Menu 10	Status Logic & Diagnostic Information
Menu 11	Miscellaneous
Menu 12	Programmable Thresholds
Menu 13	Digital Lock

### 8.5 Menu Logic Diagrams

#### NOTE

The available range and units for the values of real parameters is given in the index, section 8-3, and with the descriptions, section 8-4. Those parameters for which no range is shown are bit-parameters. Comment or explanation of parameters is given in the descriptions where necessary.

## 8.1 Adjustment of parameters

### 8.1.1 The parameter set

Parameters are of two principal kinds: numerical-value (real) parameters such as speed and acceleration, and digital or bit parameters. The numerical values are comparable to the adjustable potentiometers used in purely analog drives. They are much more precise, and not subject to drift from the set value. Bit values are comparable to links (jumpers) or switches, having an either-or function.

All parameters, of either kind, are either Read Only (RO) or Read-Write (RW).

The parameter set with which Mentor II drives are equipped is divided into two further groups for operational convenience.

Those which are ordinarily needed for setting the drive up at the installation and start-up stage can be called up whenever the drive is powered on, and are called the visible parameters.

The second group contains the invisible parameters, so called because at Level 1 security they do not appear in the Index display, even if called

up. These are the parameters required for fine-tuning a drive to operate, for example, in a process system, usually in conjunction with one or more other drives of the same or different type.

### 8.1.2 Visible and invisible parameters

Visible parameters, both RO and RW, are always available to read when the drive is powered on. Visible RW parameters are normally protected by one or more levels of security and cannot be changed until the correct codes have been entered. This is Level 1 security, unless and until a higher level code is set.

Invisible parameters always require Level 2 security code, and will require Level 3 (if set). With the correct code(s), invisible RO parameters are accessible to read, and invisible RW parameters are accessible to write.

Visible and invisible parameters are distinguished in the text and in the control logic diagrams for Menus 1 to 9 and 12. Visible parameter numbers are in plain typeface, e.g. 01.01, and invisible parameters in italics, e.g. *01.01*.

### 8.1.3 Organization

Parameters are organized into functionally-related sets - menus - so that access to any individual parameter is logical and quick. The menus are listed at the beginning of Section 8.2.

### 8.1.4 Adjustment

Any menu, and any *visible* parameter can be selected and will display its value to read without need for a Security Code. The procedure is the same if a parameter value is to be changed, except that entering a Security Code will normally have to be the first action.

Any menu, and any *invisible* parameter can be selected and its value displayed to read and to write when the correct security code has been entered.

Whenever the user returns to a menu (between power-on and power-off) the software immediately goes to the last parameter to have been selected in that menu. This is convenient when making a series of adjustments to a particular group of parameters.

### 8.1.5 Access to parameters

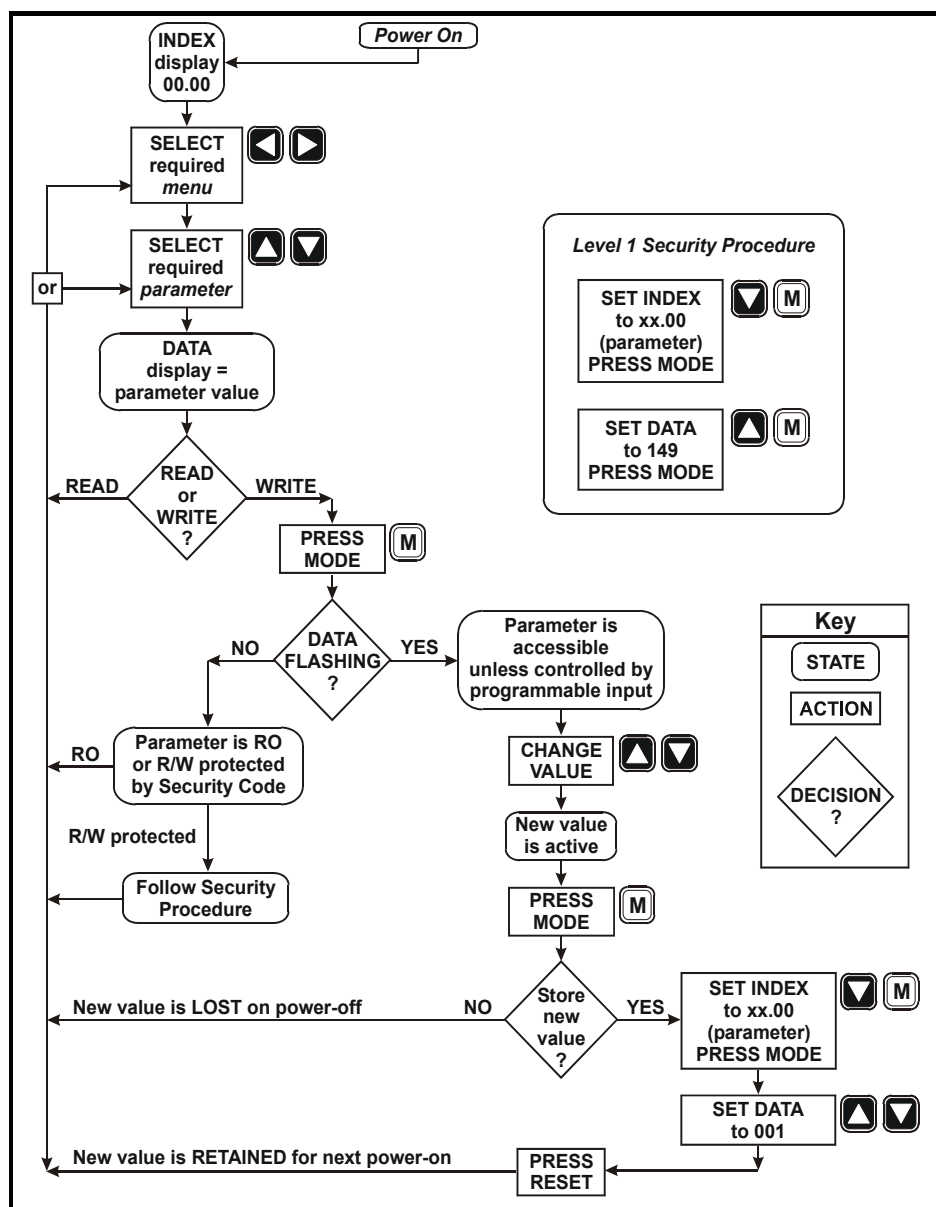
Initially, when the drive is first powered on, and if Level 3 security is not set, access to write is immediately available to a small group of the visible parameters - refer to section 8.2 *Security*, and the Overview Control Logic Diagram A.

If Level 3 security is set, all parameters are protected at all times.

## 8.1.6 Procedure

The procedure for selecting and changing a parameter is shown in Figure 8-1, described in the following section, and also on the keypad itself.

Figure 8-1 Adjustment of parameters and level 1 security



Procedures for selecting and changing parameters

Action	Keys	Display
Select menu	LEFT or RIGHT	Index, left of decimal point
Select parameter	UP or DOWN	Index, right of decimal point
Read only		Data
Change value only if display is flashing - refer to 8.2	MODE, then UP or DOWN	Data
Enter new value	MODE	Data

For most parameters, the drive accepts and uses the value entered, and the motor will respond to the new value immediately. The exception is a change of Baud Rate (11.12), Serial Mode (11.13), Threshold 1 Destination (12.07) and Threshold 2 Destination (12.12). To allow the drive to act on the change in these cases it is necessary to press RESET after writing the new value.

Any new value is not saved however, and will be lost at power-off.

The keypad is ready to select another menu or parameter.

The procedure below SAVES the values of all parameters changed since the previous save.

### To Save the value(s) written

Action	Keys	Display
Press DOWN	DOWN	until Index (par.) xx.00
	MODE, then UP or DOWN	Data, set value = 001
Press RESET		

### Value(s) saved

### 8.1.7 Default settings

To return the drive parameter settings to the factory default setting, set parameter X.00 to:

233 for 4 quadrant drive  
255 for 1 quadrant drive  
and press reset

## 8.2 Security

After selecting a parameter number and pressing MODE -

- If the parameter data flashes, the user can change the value UNLESS the parameter has already been configured to be controlled by a programmable input.
- If the data does not flash, either the parameter is RO or, if RW, it is protected by security. The procedure for gaining access to parameters protected by Level 1 security is given below.

If the Level 1 security code does not afford access when applied, the parameter is protected by Level 3 security.

Visible parameters are always accessible to the user to read only. Unless the Level 1 security code is entered, most RW parameters are not accessible to write.

Exceptionally - and provided that Level 3 security is not set - a group of 24 parameters in Menus 1 to 6 plus parameters **11.01** to **11.10**, are immediately accessible to write.

### 8.2.1 Power on

The following visible parameters are immediately accessible, NOT protected by security level 1 and 2

<b>01.05</b>	Inch reference
<b>01.06</b>	Maximum speed forward
<b>01.09</b>	Maximum speed reverse
<b>01.11</b>	Reference ON
<b>01.12</b>	REVERSE selector
<b>01.13</b>	INCH selector
<b>02.04</b>	Forward acceleration 1
<b>02.05</b>	Forward deceleration 1
<b>02.06</b>	Reverse deceleration 1
<b>02.07</b>	Reverse acceleration 1
<b>03.09</b>	Speed loop P gain (proportional)
<b>03.10</b>	Speed loop I gain (integral)
<b>03.11</b>	Speed loop D gain (differential)
<b>03.14</b>	Feedback encoder scaling
<b>03.15</b>	Maximum armature voltage
<b>03.16</b>	Maximum speed (scaling rpm)
<b>03.17</b>	IR compensation
<b>04.05</b>	I limit Bridge 1
<b>04.06</b>	I limit Bridge 2
<b>05.05</b>	Maximum current ( scaled )
<b>06.06</b>	IR. compensation 2
<b>06.07</b>	Back-emf set point
<b>06.08</b>	Maximum field current 1
<b>06.10</b>	Minimum field current

and **11.01** to **11.10** - User Menu 00

Of the rest of the parameters:

- RO parameters are accessible to read.
- RW parameters are read-only until a Level 1 security code is entered.

### 8.2.2 Level 1 security to access the visible RW parameters (Figure 8-1)

- UP or DOWN to set index to zero
- Press MODE
- UP or DOWN to write 149 in data (Level 1 security code)
- Press MODE

Visible RW parameters are now accessible to write new values.

### 8.2.3 Level 2 security to access the invisible RW parameters

- UP or DOWN to set index to zero
- Press MODE
- UP or DOWN to write 200 in data (Level 2 security code)
- Press MODE

All RW parameters are now accessible to write new values.

RO parameters can be read.

### 8.2.4 To enable and inhibit free access to ALL parameters

To **cancel** security:

- Power on
- UP or DOWN to set index to zero
- Press MODE
- UP or DOWN to write 200 in data (Level 2 security code)
- Press MODE
- LEFT or RIGHT plus UP or DOWN to set index to **11.17**
- Press MODE
- DOWN to write 0

If the parameters are now *Saved* (refer to section *To Save the value(s) written* on page 30) there is **no protection** for ANY parameter.

To **reinstate** security:

Repeat the procedure in section 8.2.4 but make parameter **11.17** = 149, and *Save* (refer to section *To Save the value(s) written* on page 30).

### 8.2.5 Level 3 security

An additional, private, security code, Level 3, is available to the user. The code is user-programmable from 1 to 255 EXCEPT 149 (the Level 1 code). If applied, the effect is to prevent access to all parameters until the Level 3 code has been entered prior to entering the Level 1 or Level 2 code.

To **assign** a Level 3 security code number:

- Power up
- UP or DOWN to set index to zero
- Press MODE
- UP or DOWN to write 200 in data (Level 2 security code)
- Press MODE
- LEFT or RIGHT plus UP or DOWN to set index to **11.17**. Data display shows 149
- Press MODE
- UP or DOWN to write any 3-digit number from 1 to 255 in data (excluding 149 - the Level 1 security code)
- Press MODE
- *Save* (refer to section *To Save the value(s) written* on page 30)

There is now no access to any parameter, not even to read only, until the assigned Level 3 code has been entered.

Level 3 Security **access**:

- \* *LEFT* or *RIGHT* plus *UP* or *DOWN* to set index to zero
- \*Press *MODE*
- \**UP* or *DOWN* to write the assigned code number in data (Level 3 security code)
- \*Press *MODE*

The user now has access through Level 1 and Level 2 Security, one or other of which has to be entered next.

## 8.3 Index of parameters

The Index of Parameters lists the sixteen Menus, followed by the basic data for each parameter of the Mentor II Parameter Set listed menu by menu. For detailed descriptions of parameters please refer to section 8.6 *Advanced parameter descriptions* on page 46.

### 8.3.1 Menus list

Menu	Description
00	User Menu - to give fast access to the most-used parameters
01	Speed Reference - selection of source and limits
02	Acceleration and Deceleration Ramps
03	Speed Feedback Selection and Speed Loop
04	Current - selection and limits
05	Current Loop
06	Field Control
07	Analog Inputs and Outputs
08	Logic Inputs
09	Status Outputs
10	Status Logic & Fault Information
11	Miscellaneous
12	Programmable Thresholds
13	Digital Lock
14	MD29 System Set-up
15	Applications Menu 1
16	Applications Menu 2

### 8.3.2 Parameters - names, range & default values

References in brackets (xx.xx) in the Default column indicate parameters which default to other parameters.

Parameters shown in **bold** type are those which are freely accessible ONLY immediately after power-on.

Parameters at the end of each menu list in *italic* type are invisible. Refer to section 8.1 *Adjustment of parameters* and section 8.2 *Security*.

## 8.4 Mentor parameters that cannot be controlled by analog input

ALL read only parameters

ALL bit parameters

ALL parameters which have a range of 0-255

In addition,

2.02 to 2.12

3.15, 3.16

5.05

6.21

7.08 to 7.23

8.12 to 8.20

9.07, 9.09, 9.13, 9.15, 9.19, 9.21, 9.23, 9.25

11.01 to 11.10, 11.18, 11.19, 11.20

12.03, 12.07, 12.08, 12.12

13.14

15.01 to 15.05

15.60, 15.61, 15.62, 15.63

16.01 to 16.05

## 8.5 Parameter descriptions

Abbreviations used in the following parameter descriptions are as follows:

RW	Read/Write
RO	Read Only
Bit	Two state only parameter, 0 or 1
Bi	Bipolar - can have positive and negative values
Uni	Unipolar - can have positive values only
Int	Integer

Symbols used in the parameter descriptions are as follows:

⇒	default value
⇄	range of values

Units are shown in the bottom right cell



### 8.5.1 Menu 00: User library - refer to Menu 11

Contains ten parameters (00.01 to 00.10). The user sets parameters 11.01 to 11.10 to any parameter numbers most often required or used. These can then be accessed directly through the corresponding numbers 00.01 to 00.10, avoiding the need to call up different menus.

### 8.5.2 Menu 01: Speed reference - selection of source and limits

Number	Description	Range	Type	Default
01.01	Pre-offset speed reference	±1000	RO	
01.02	Post-offset speed reference	±1000	RO	
01.03	Pre-ramp reference	±1000	RO	
01.04	Offset	±1000	RW	+ 000
<b>01.05</b>	<b>Inch reference</b>	<b>±1000</b>	<b>RW</b>	<b>+ 050</b>
<b>01.06</b>	<b>Maximum speed forward</b>	<b>0 to +1000</b>	<b>RW</b>	<b>+1000</b>
01.07	Minimum speed forward	0 to +1000	RW	+ 000
01.08	Minimum speed reverse	-1000 to 0	RW	+ 000
<b>01.09</b>	<b>Maximum speed reverse (4Q)</b>	<b>-1000 to 0</b>	<b>RW</b>	<b>- 1000</b>
	(1Q)	-1000 to 0	RW	000
01.10	Bipolar reference selector (4Q)	0 or 1	RW	1
	(1Q)	0 or 1	RW	0
<b>01.11</b>	<b>Reference "ON"</b>	<b>0 or 1</b>	<b>RW</b>	<b>0</b>
<b>01.12</b>	<b>Reverse selector</b>	<b>0 or 1</b>	<b>RW</b>	<b>0</b>
<b>01.13</b>	<b>Inch selector</b>	<b>0 or 1</b>	<b>RW</b>	<b>0</b>
01.14	Reference selector 1	0 or 1	RW	0
01.15	Reference selector 2	0 or 1	RW	0
01.16	Zero reference interlock	0 or 1	RW	0
01.17	Reference 1	±1000	RW	(07.15)
01.18	Reference 2	±1000	RW	+ 300
01.19	Reference 3	±1000	RW	(07.13)
01.20	Reference 4	±1000	RW	(07.14)

### 8.5.3 Menu 02: Acceleration and deceleration ramps

Number	Description	Range	Type	Default
02.01	Post-ramp reference	±1000	RO	
02.02	Ramp enable	0 or 1	RW	1
02.03	Ramp hold	0 or 1	RW	0
<b>02.04</b>	<b>Forward acceleration 1</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+ 050</b>
<b>02.05</b>	<b>Forward deceleration 1</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+ 050</b>
<b>02.06</b>	<b>Reverse deceleration 1 (4Q)</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+ 050</b>
	(1Q)	0 to 1999	RW	000
<b>02.07</b>	<b>Reverse acceleration 1 (4Q)</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+ 050</b>
	(1Q)	0 to 1999	RW	000
02.08	Forward acceleration 2	0 to 1999	RW	+ 100
02.09	Forward deceleration 2	0 to 1999	RW	+ 100
02.10	Reverse deceleration 2 (4Q)	0 to 1999	RW	+ 100
	(1Q)	0 to 1999	RW	000
02.11	Reverse acceleration 2 (4Q)	0 to 1999	RW	+ 100
	(1Q)	0 to 1999	RW	000
02.12	Inch ramp rate	0 to 1999	RW	+ 100
02.13	Enable inch ramp	0 or 1	RW	0
02.14	Forward acceleration selector	0 or 1	RW	0
02.15	Forward deceleration selector	0 or 1	RW	0
02.16	Reverse deceleration selector	0 or 1	RW	0
02.17	Reverse acceleration selector	0 or 1	RW	0
02.18	Common ramp selector	0 or 1	RW	0
02.19	Ramp scaling (x 10)	0 or 1	RW	0

### 8.5.4 Menu 03: Speed feedback - selection and speed loop

Number	Description	Range	Type	Default
03.01	Final speed demand	$\pm 1000$	RO	
03.02	Speed feedback	$\pm 1000$	RO	
03.03	Speed feedback (rpm)	$\pm 1999$	RO	
03.04	Armature voltage	$\pm 1000$	RO	
03.05	IR Compensation output	$\pm 1000$	RO	
03.06	Speed error	$\pm 1000$	RO	
03.07	Speed loop output	$\pm 1000$	RO	
03.08	Speed error integral	$\pm 1000$	RO	
<b>03.09</b>	<b>Speed loop Proportional gain</b>	<b>0 to 255</b>	<b>RW</b>	<b>080</b>
<b>03.10</b>	<b>Speed loop Integral gain</b>	<b>0 to 255</b>	<b>RW</b>	<b>040</b>
<b>03.11</b>	<b>Speed loop Derivative gain</b>	<b>0 to 255</b>	<b>RW</b>	<b>0</b>
03.12	Digital feedback selector	0 or 1	RW	0
03.13	AV analog feedback selector	0 or 1	RW	0
<b>03.14</b>	<b>Encoder feedback scaling</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+ 419</b>
<b>03.15</b>	<b>Maximum armature voltage</b>	<b>0 to 1000</b>	<b>RW</b>	<b>+ 600</b>
<b>03.16</b>	<b>Maximum speed (scaling rpm)</b>	<b>0 to 1999</b>	<b>RW</b>	<b>+1750</b>
<b>03.17</b>	<b>IR Compensation</b>	<b>0 to 255</b>	<b>RW</b>	<b>000</b>
03.18	Hard speed reference	$\pm 1000$	RW	(07.11)
03.19	Hard speed reference selector	0 or 1	RW	0
03.20	IR droop selector	0 or 1	RW	0
03.21	Ramp output selector	0 or 1	RW	1
03.22	Speed offset fine	0 to 255	RW	128
03.23	Zero speed threshold	0 to 255	RW	16
03.24	Derivative-term source	1 to 3	RW	1
03.25	Speed error filter	0 to 255	RW	128
03.26	Tachogenerator Input	$\pm 1000$	RO	
03.27	Reserved			
03.28	Proportional gain x4	0 or 1	RW	0
03.29	Speed loop gains / 8	0 or 1	RW	0

### 8.5.5 Menu 04: Current - selection and limits

Number	Description	Range	Type	Default
04.01	Current demand	±1000	RO	
04.02	Final current demand	±1000	RO	
04.03	Over-riding current limit	±1000	RO	
04.04	Current limit (taper start point)	0 to 1000	RW	+1000
<b>04.05</b>	<b>Current limit Bridge 1</b>	<b>0 to 1000</b>	<b>RW</b>	<b>+1000</b>
<b>04.06</b>	<b>Current limit Bridge 2</b>	<b>0 to 1000</b>	<b>RW</b>	<b>+1000</b>
04.07	Current limit 2	0 to 1000	RW	+1000
04.08	Torque reference	±1000	RW	+ 000
04.09	Current offset	±1000	RW	+ 000
04.10	Current limit bridge 2 selector	0 or 1	RW	0
04.11	Current offset selector	0 or 1	RW	0
04.12	Mode bit 0	0 or 1	RW	0
04.13	Mode bit 1	0 or 1	RW	0
04.14	Quadrant 1 enable	0 or 1	RW	1
04.15	Quadrant 2 enable (4Q)	0 or 1	RW	1
	(1Q)	0 or 1	RW	0
04.16	Quadrant 3 enable (4Q)	0 or 1	RW	1
	(1Q)	0 or 1	RW	0
04.17	Quadrant 4 enable (4Q)	0 or 1	RW	1
	(1Q)	0 or 1	RW	0
04.18	Enable automatic current limit bridge2 change	0 or 1	RW	0
04.19	Current limit timer	0 to 255	RW	000
04.20	Current taper 1 threshold	0 to 1000	RW	+1000
04.21	Current taper 2 threshold	0 to 1000	RW	+1000
04.22	Current taper 1 slope	0 to 255	RW	000
04.23	Current taper 2 slope	0 to 255	RW	000
04.24	Taper 1 threshold exceeded	0 or 1	RO	
04.25	Taper 2 threshold exceeded	0 or 1	RO	

### 8.5.6 Menu 05: Current loop

Number	Description	Range	Type	Default
05.01	Current feedback	±1000	RO	
05.02	Current feedback (amps)	±1999	RO	
05.03	Firing angle	277 to 1023	RO	
05.04	Slew rate limit	0 to 255	RW	040
<b>05.05</b>	<b>Maximum current (scaling)</b>	<b>0 to 1999</b>	<b>RW</b>	<b>(rating)</b>
05.06	Overload threshold	0 to 1000	RW	+ 700
05.07	Overload integrating time (heating)	0 to 255	RW	030
05.08	Overload integrating time (cooling)	0 to 255	RW	050
05.09	Enable start-up autotune	0 or 1	RW	0
05.10	<i>Reduced endstop</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.11	<i>Actual overload</i>	<i>0 to 1999</i>	<i>RO</i>	
05.12	<i>Discontinuous Integral gain</i>	<i>0 to 255</i>	<i>RW</i>	<i>16</i>
05.13	<i>Continuous Proportional gain</i>	<i>0 to 255</i>	<i>RW</i>	<i>16</i>
05.14	<i>Continuous Integral gain</i>	<i>0 to 255</i>	<i>RW</i>	<i>16</i>
05.15	<i>Motor constant</i>	<i>0 to 255</i>	<i>RW</i>	<i>25</i>
05.16	Reserved		RW	
05.17	<i>Inhibit firing</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.18	<i>Enable standstill logic</i>	<i>0 or 1</i>	<i>RW</i>	<i>1</i>
05.19	<i>Standstill mode</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.20	<i>Enable direct firing angle control</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.21	<i>Enable bridge 2 lockout</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.22	<i>Disable adaptive control</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.23	<i>Enable 1 quadrant series 12-pulse</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.24	<i>Series 12-pulse operation</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.25	<i>Parallel 12-pulse operation</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.26	<i>Extra-safe bridge change</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.27	<i>Continuous autotune</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.28	<i>Reduced hysteresis for bridge changeover</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
05.29	<i>Increased current feedback</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>

### 8.5.7 Menu 06: Field control

Number	Description	Range	Type	Default
06.01	Back emf	0 to 1000	RO	
06.02	Field current demand	0 to 1000	RO	
06.03	Field current feedback	0 to 1000	RO	
06.04	Firing angle	261 to 1000	RO	
06.05	IR compensation 2 output	±1000	RO	
<b>06.06</b>	<b>IR compensation 2</b>	<b>0 to 255</b>	<b>RW</b>	<b>000</b>
<b>06.07</b>	<b>Back emf set point</b>	<b>0 to 1000</b>	<b>RW</b>	<b>+ 1000</b>
<b>06.08</b>	<b>Maximum field current 1</b>	<b>0 to 1000</b>	<b>RW</b>	<b>+ 1000</b>
06.09	Maximum field current 2	0 to 1000	RW	+ 500
06.10	Minimum field current	0 to 1000	RW	+ 500
06.11	Field current feedback scaling*	201 to 216	RW	+204
06.12	Field economy timeout	0 to 255	RW	030
06.13	Enable field control	0 or 1	RW	0
06.14	Maximum field 2 selector	0 or 1	RW	0
06.15	Enable field economy timeout	0 or 1	RW	0
06.16	Field current loop integral gain	0 or 1	RW	1
06.17	Voltage loop integral gain	0 or 1	RW	0
06.18	Enable speed gain adjustment	0 or 1	RW	0
06.19	Direct firing angle control	0 or 1	RW	0
06.20	Alternative IR Comp. 2 selector	0 or 1	RW	0
06.21	Firing angle front endstop	0 to 1000	RW	+1000
06.22	Full or half control selector**	0 or 1	RW	0
06.23	Reduce gains by factor of 2	0 or 1	RW	0
06.24	Reduce gains by factor of 4	0 or 1	RW	0

\* Dependent on MDA3 card issue (revision) number

\*\* FXM5 Field Controller only

### 8.5.8 Menu 07: Analog inputs and outputs

Number	Description	Range	Type	Default
07.01	General purpose input 1	±1000	RO	
07.02	General purpose input 2	±1000	RO	
07.03	General purpose input 3	±1000	RO	
07.04	General purpose input 4	±1000	RO	
07.05	Speed reference input	±1000	RO	
07.06	RMS input voltage	0 to 1000	RO	
07.07	Heatsink temperature	0 to 1000	RO	
07.08	DAC 1 source	0 to 1999	RW	+ 201
07.09	DAC 2 source	0 to 1999	RW	+ 302
07.10	DAC 3 source	0 to 1999	RW	+ 304
07.11	GP1 destination	0 to 1999	RW	+ 318
07.12	GP2 destination	0 to 1999	RW	+ 408
07.13	GP3 destination	0 to 1999	RW	+ 119
07.14	GP4 destination	0 to 1999	RW	+ 120
07.15	Speed reference destination	0 to 1999	RW	+ 117
07.16	GP1 scaling	0 to 1999	RW	+1000
07.17	GP2 scaling	0 to 1999	RW	+1000
07.18	GP3 scaling	0 to 1999	RW	+1000
07.19	GP4 scaling	0 to 1999	RW	+1000
07.20	Speed reference scaling	0 to 1999	RW	+1000
07.21	DAC1 scaling	0 to 1999	RW	+1000
07.22	DAC2 scaling	0 to 1999	RW	+1000
07.23	DAC3 scaling	0 to 1999	RW	+1000
07.24	Reference encoder scaling	0 to 1999	RW	+419
07.25	Encoder reference selector	0 or 1	RW	0
07.26	Current input selector	0 or 1	RW	0
07.27	Current input mode selector	0 or 1	RW	0
07.28	Current input mode selector	0 or 1	RW	1
07.29	Invert GP3 and GP4 analog inputs	0 or 1	RW	0

### 8.5.9 Menu 08: Logic inputs

Number	Description	Range	Type	Default
08.01	F1 input run permit	0 or 1	RO	
08.02	F2 input inch reverse	0 or 1	RO	
08.03	F3 input inch forward	0 or 1	RO	
08.04	F4 input run reverse	0 or 1	RO	
08.05	F5 input run forward	0 or 1	RO	
08.06	F6 input	0 or 1	RO	
08.07	F7 input	0 or 1	RO	
08.08	F8 input	0 or 1	RO	
08.09	F9 input	0 or 1	RO	
08.10	F10 input	0 or 1	RO	
08.11	Enable input	0 or 1	RO	
08.12	F2 destination	0 to 1999	RW	+ 000
08.13	F3 destination	0 to 1999	RW	+ 000
08.14	F4 destination	0 to 1999	RW	+ 000
08.15	F5 destination	0 to 1999	RW	+ 000
08.16	F6 destination	0 to 1999	RW	+ 000
08.17	F7 destination	0 to 1999	RW	+ 000
08.18	F8 destination	0 to 1999	RW	+ 000
08.19	F9 destination	0 to 1999	RW	+ 000
08.20	F10 destination	0 to 1999	RW	+ 000
08.21	Disable normal logic functions	0 or 1	RW	0
08.22	Invert F2 input	0 or 1	RW	0
08.23	Invert F3 input	0 or 1	RW	0
08.24	Invert F4 input	0 or 1	RW	0
08.25	Invert F5 input	0 or 1	RW	0
08.26	Invert F6 input	0 or 1	RW	0
08.27	Invert F7 input	0 or 1	RW	0
08.28	Invert F8 input	0 or 1	RW	0
08.29	Invert F9 input	0 or 1	RW	0
08.30	Invert F10 input	0 or 1	RW	0
08.31	Enable Inch Reverse	0 or 1	RW	0
08.32	Enable Inch Forward	0 or 1	RW	0
08.33	Enable Run Reverse	0 or 1	RW	0
08.34	Enable Run Forward	0 or 1	RW	0

### 8.5.10 Menu 09: Status outputs

Number	Description	Range	Type	Default
09.01	Status 1 output	0 or 1	RO	
09.02	Status 2 output	0 or 1	RO	
09.03	Status 3 output	0 or 1	RO	
09.04	Status 4 output	0 or 1	RO	
09.05	Status 5 output	0 or 1	RO	
09.06	Status 6 output (relay)	0 or 1	RO	
09.07	Status 1 source 1	0 to 1999	RW	+ 111
09.08	Invert status 1 source 1	0 or 1	RW	0
09.09	Status 1 source 2	0 to 1999	RW	000
09.10	Invert status 1 source 2	0 or 1	RW	0
09.11	Invert status 1 output	0 or 1	RW	0
09.12	Status 1 delay	0 to 255 sec	RW	00
09.13	Status 2 source 1	0 to 1999	RW	+ 1007
09.14	Invert status 2 source 1	0 or 1	RW	0
09.15	Status 2 source 2	0 to 1999	RW	000
09.16	Invert status 2 source 2	0 or 1	RW	0
09.17	Invert status 2 output	0 or 1	RW	0
09.18	Status 2 delay	0 to 255 sec	RW	0
09.19	Status 3 source	0 to 1999	RW	+1013
09.20	Invert status 3 output	0 or 1	RW	0
09.21	Status 4 source	0 to 1999	RW	+1003
09.22	Invert status 4 output	0 or 1	RW	0
09.23	Status 5 source	0 to 1999	RW	+1006
09.24	Invert status 5 output	0 or 1	RW	0
09.25	Status 6 source (relay)	0 to 1999	RW	+1009
09.26	Invert status 6 output	0 or 1	RW	0



### 8.5.11 Menu 10: Status logic & diagnostic information

Number	Description	Range	Type	Default
10.01	Forward velocity	0 or 1	RO	
10.02	Reverse velocity	0 or 1	RO	
10.03	Current limit	0 or 1	RO	
10.04	Bridge 1 enabled	0 or 1	RO	
10.05	Bridge 2 enabled	0 or 1	RO	
10.06	Electrical phase-back	0 or 1	RO	
10.07	At speed	0 or 1	RO	
10.08	Overspeed	0 or 1	RO	
10.09	Zero speed	0 or 1	RO	
10.10	Armature voltage clamp active	0 or 1	RO	
10.11	Phase rotation	0 or 1	RO	
10.12	Drive healthy (normal)	0 or 1	RO	
10.13	Alarm (l x t)	0 or 1	RO	
10.14	Field loss	0 or 1	RO	
10.15	Feedback loss	0 or 1	RO	
10.16	Supply or phase loss	0 or 1	RO	
10.17	Instantaneous trip	0 or 1	RO	
10.18	Sustained overload	0 or 1	RO	
10.19	Processor 1 watchdog	0 or 1	RO	
10.20	Processor 2 watchdog	0 or 1	RO	
10.21	Motor overtemperature	0 or 1	RO	
10.22	Heatsink overtemperature	0 or 1	RO	
10.23	Speed loop saturated	0 or 1	RO	
10.24	Zero current demand	0 or 1	RO	
10.25	Last trip	0 to 255	RO	
10.26	The trip before last trip (10.25)	0 to 255	RO	
10.27	The trip before 10.26	0 to 255	RO	
10.28	The trip before 10.27	0 to 255	RO	
10.29	<i>Disable field loss trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.30	<i>Disable feedback loss trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.31	<i>Disable supply or phase loss trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.32	<i>Disable motor overtemperature trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>1</i>
10.33	<i>Disable heatsink overtemperature trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.34	<i>External trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.35	<i>Processor 2 trip</i>	<i>0 to 255</i>	<i>RW</i>	<i>0</i>
10.36	<i>Disable current loop loss trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>
10.37	<i>Disable armature open circuit trip</i>	<i>0 or 1</i>	<i>RW</i>	<i>0</i>

### 8.5.12 Menu 11: Miscellaneous

#### NOTE

Parameters 11.07 through to 11.10 have functions associated with the MD29 PCB. Refer to the MD29 Users Guide.

Number	Description	Range	Type	Default
11.01	Parameter 00.01	0 to 1999	RW	0
11.02	Parameter 00.02	0 to 1999	RW	0
11.03	Parameter 00.03	0 to 1999	RW	0
11.04	Parameter 00.04	0 to 1999	RW	0
11.05	Parameter 00.05	0 to 1999	RW	0
11.06	Parameter 00.06	0 to 1999	RW	0
11.07	Parameter 00.07	0 to 1999	RW	0
11.08	Parameter 00.08	0 to 1999	RW	0
11.09	Parameter 00.09	0 to 1999	RW	0
11.10	Parameter 00.10	0 to 1999	RW	0
11.11	Serial address	0 to 99	RW	001
11.12	Baud rate	0 or 1	RW	0
11.13	Serial Mode	1 to 4	RW	001
11.14	Reserved			
11.15	Processor 1 software version	0 to 1000	RO	
11.16	Processor 2 software version	0 to 1000	RO	
11.17	Level 3 security code	0 to 255	RW	149
11.18	Boot-up parameter	0 to 1999	RW	+ 000
11.19	Serial programmable source	0 to 1999	RW	+ 000
11.20	Serial scaling	0 to 1999	RW	+1000
11.21	LEDs byte	0 to 255	RW	
11.22	Disable normal LED functions	0 or 1	RW	0
11.23	High voltage MDA6	0 or 1	RW	0
11.24	Mains (AC power) dip ride-through	0 or 1	RW	0

### 8.5.13 Menu 12: Programmable thresholds

Number	Description	Range	Type	Default
12.01	Threshold 1 exceeded	0 or 1	RO	
12.02	Threshold 2 exceeded	0 or 1	RO	
12.03	Threshold 1 source	0 to 1999	RW	+ 302
12.04	Threshold 1 level	0 to 1000	RW	+ 000
12.05	Threshold 1 hysteresis	0 to 255	RW	002
12.06	Invert threshold 1 output	0 or 1	RW	0
12.07	Threshold 1 destination	0 to 1999	RW	+ 000
12.08	Threshold 2 source	0 to 1999	RW	+ 501
12.09	Threshold 2 level	0 to 1000	RW	+ 000
12.10	Threshold 2 hysteresis	0 to 255	RW	002
12.11	Invert threshold 2 output	0 or 1	RW	0
12.12	Threshold 2 destination	0 to 1999	RW	+ 000

### 8.5.14 Menu 13: Digital lock

Number	Description	Range	Type	Default
13.01	Master encoder counter	0 to 1023	RO	
13.02	Slave encoder counter	0 to 1023	RO	
13.03	Master counter increment	±1000	RO	
13.04	Slave counter increment	±1000	RO	
13.05	Position error	±1000	RO	
13.06	Precision reference (lsb)	0 to 255	RW	000
13.07	Precision reference (msb)	0 to 255	RW	000
13.08	Position loop gain	0 to 255	RW	025
13.09	Position loop correction limit	0 to 1000	RW	+ 010
13.10	Enable digital lock	0 or 1	RW	0
13.11	Rigid lock selector	0 or 1	RW	1
13.12	Precision reference selector	0 or 1	RW	0
13.13	Precision reference latch	0 or 1	RW	1
13.14	Precision speed reference (16-bit)	000 to 65535	RW	0

### 8.5.15 Menu 14 plus MD29 system set-up

For further information on Menu 14 parameters, please refer to the *MD29 User Guide*.

Number	Description	Range	Type	Default
14.01	ANSI serial address	0 to 99	RW	1
14.02	RS485 mode	1 to 16	RW	1
14.03	RS485 baud rate	3 to 192	RW	48
14.04	CLOCK task time-base (ms)	1 to 200	RW	10
14.05	CTNet Node Address (MD29AN only)	0 to 255	RW	0
14.06	Autorun enable	0 or 1	RW	1
14.07	Global run-time trip enable	0 or 1	RW	1
14.08	I/O link trip enable	0 or 1	RW	0
14.09	Enable watchdog (WDOG)	0 or 1	RW	0
14.10	Trip if a parameter write over-ranges	0 or 1	RW	1
14.11	Disable monitor port protocol	0 or 1	RW	0
14.12	Position controller enable	0 or 1	RW	0
14.13	I/O link synchronisation source	0 or 1	RW	0
14.14	Encoder time-base select	0 or 1	RW	0
14.15	Reserved	0 or 1	RW	0
14.16	Flash store request	0 or 1	RW	0
14.17	RS232 drive-drive comms enable	0 or 1	RW	0
11.09	RS485 parameter pointer	0 to 1999	RW	0
11.10	RS485 parameter pointer #2 (mode 4)	0 to 1999	RW	0
11.10	RS485 mode 3 scaling	0 to 1999	RW	0
16.62	CT Net messages per second	0 to 1999	RO	
16.63	Line number of error	0 to 1999	RO	

### 8.5.16 Menu 15: Applications menu 1

Number	Description	Range	Type	Default
15.01	RO variable 1	±1999	RO	
15.02	RO variable 2	±1999	RO	
15.03	RO variable 3	±1999	RO	
15.04	RO variable 4	±1999	RO	
15.05	RO variable 5	±1999	RO	
15.06	Real RW variable 1	±1999	RW	+ 000
15.07	Real RW variable 2	±1999	RW	+ 000
15.08	Real RW variable 3	±1999	RW	+ 000
15.09	Real RW variable 4	±1999	RW	+ 000
15.10	Real RW variable 5	±1999	RW	+ 000
15.11	Integer RW variable 1	0 to 255	RW	000
15.12	Integer RW variable 2	0 to 255	RW	000
15.13	Integer RW variable 3	0 to 255	RW	000
15.14	Integer RW variable 4	0 to 255	RW	000
15.15	Integer RW variable 5	0 to 255	RW	000
15.16	Integer RW variable 6	0 to 255	RW	000
15.17	Integer RW variable 7	0 to 255	RW	000
15.18	Integer RW variable 8	0 to 255	RW	000
15.19	Integer RW variable 9	0 to 255	RW	000
15.20	Integer RW variable 10	0 to 255	RW	000
15.21	Bit variable 1	0 or 1	RW	0
15.22	Bit variable 2	0 or 1	RW	0
15.23	Bit variable 3	0 or 1	RW	0
15.24	Bit variable 4	0 or 1	RW	0
15.25	Bit variable 5	0 or 1	RW	0
15.26	Bit variable 6	0 or 1	RW	0
15.27	Bit variable 7	0 or 1	RW	0
15.28	Bit variable 8	0 or 1	RW	0
15.29	Bit variable 9	0 or 1	RW	0
15.30	Bit variable 10	0 or 1	RW	0
15.31	Bit variable 11	0 or 1	RW	0
15.32	Bit variable 12	0 or 1	RW	0
15.33	Bit variable 13	0 or 1	RW	0
15.34	Bit variable 14	0 or 1	RW	0
15.35	Bit variable 15	0 or 1	RW	0
15.36	Bit variable 16	0 or 1	RW	0
15.37 to 15.59	Real RW(not saved in NVRAM)	0 to 1999	RW	0
15.60	Ratio 1 wide integer = 15.16 & 15.17	0 to 65535	RW	000
15.61	Ratio 2 wide integer = 15.18 & 15.19	0 to 65535	RW	000
15.62	Serial Mode 4 input data	0 to 65535	RO	
15.63	Serial Mode 4 output data	0 to 65535	RO	

## 8.5.17 Menu 16: Applications menu 2

Number	Description	Range	Type	Default
16.01	RO variable 1	±1999	RO	
16.02	RO variable 2	±1999	RO	
16.03	RO variable 3	±1999	RO	
16.04	RO variable 4	±1999	RO	
16.05	RO variable 5	±1999	RO	
16.06	Real RW variable 1	±1999	RW	+ 000
16.07	Real RW variable 2	±1999	RW	+ 000
16.08	Real RW variable 3	±1999	RW	+ 000
16.09	Real RW variable 4	±1999	RW	+ 000
16.10	Real RW variable 5	±1999	RW	+ 000
16.11	Integer RW variable 1	0 to 255	RW	000
16.12	Integer RW variable 2	0 to 255	RW	000
16.13	Integer RW variable 3	0 to 255	RW	000
16.14	Integer RW variable 4	0 to 255	RW	000
16.15	Integer RW variable 5	0 to 255	RW	000
16.16	Integer RW variable 6	0 to 255	RW	000
16.17	Integer RW variable 7	0 to 255	RW	000
16.18	Integer RW variable 8	0 to 255	RW	000
16.19	Integer RW variable 9	0 to 255	RW	000
16.20	Integer RW variable 10	0 to 255	RW	000
16.21	Bit variable 1	0 or 1	RW	0
16.22	Bit variable 2	0 or 1	RW	0
16.23	Bit variable 3	0 or 1	RW	0
16.24	Bit variable 4	0 or 1	RW	0
16.25	Bit variable 5	0 or 1	RW	0
16.26	Bit variable 6	0 or 1	RW	0
16.27	Bit variable 7	0 or 1	RW	0
16.28	Bit variable 8	0 or 1	RW	0
16.29	Bit variable 9	0 or 1	RW	0
16.30	Bit variable 10	0 or 1	RW	0
16.31	Bit variable 11	0 or 1	RW	0
16.32	Bit variable 12	0 or 1	RW	0
16.33	Bit variable 13	0 or 1	RW	0
16.34	Bit variable 14	0 or 1	RW	0
16.35	Bit variable 15	0 or 1	RW	0
16.36	Bit variable 16	0 or 1	RW	0
16.37 to 16.61	Real RW (not saved in NVRAM)	0 to 1999	RW	0
16.62	CT Net messages	0 to 1999	RO	
16.63	DPL error line number	0 to 1999	RO	

## 8.6 Advanced parameter descriptions

### 8.6.1 Menu 1: Speed reference

There are four speed references, **01.17**, **01.18**, **01.19** and **01.20**. Each of the four can be given any single value in the range 1000 forward to 1000 in reverse (the value 1000 representing full speed), and can be rewritten through the keypad, the programmable inputs or the serial link (interface) at any time. The default destination for external speed reference (terminal TB1-3) is reference 1 (**01.17**), meaning that the external reference is present in reference 1 unless a different selection is made, from the other three references. The availability of four selectable speed reference parameters gives great flexibility in the use of references from other equipment. Such additional external references would be handled by general purpose analog inputs, Menu 07, or digital logic inputs, Menu 08.

Two selectors, **01.14** and **01.15**, control the application of the four internal references as the source speed reference.

Modifying factors applied to the source speed reference are, in sequence, an added offset, selection of bipolar or unipolar input, inversion of polarity (reverse), and the maximum and minimum values of forward and reverse speed, Menu 02.

Control selectors -

**01.11** Reference ON (if **01.11** = 0 then pre-ramp reference = 0),

**01.12** Reverse (by reference inversion)

**01.13** Inch speed reference (**01.05**).

The speed reference at source, **01.01** is the input to the zero reference interlock **01.16**, which (when selected, **01.16** = 1) prevents the drive starting until the speed reference is close to zero.

#### 01.01 Pre-offset speed reference

	RO	Bi			
↕	±1000	⇒			

Monitors the value of the speed reference continuously. Parameter **01.01** is also used to initiate the zero speed reference interlock, **01.16**.

#### 01.02 Post-offset speed reference

	RO	Bi			
↕	±1000	⇒			

Monitors the value of the speed reference after the offset, **01.04**, has been added.

#### 01.03 Pre-ramp reference

	RO	Bi			
↕	±1000	⇒			

The final speed reference before any ramp rates are applied (refer to Menu 02).

#### 01.04 Offset

	RW	Bi			
↕	±1000	⇒	+000		

The analog reference offset (range -1000 to +1000) is a programmable speed demand term added to the speed reference value **01.01**. It is a practical speed trim input, as for example from a dancer arm in tension control, or can be used to set a creep or minimum speed.

#### 01.05 Inch reference

	RW	Bi			
↕	±1000	⇒	+050		

Becomes the source of speed reference when selected by **01.13** (controlled in default by terminals TB3-22 and TB3-23). It provides the convenient facility to set a speed demand different from (and usually less than) the ordinary speed reference. Must be less than the maximum speed set by **01.06** and **01.09**.

#### 01.06 Max. speed forward

	RW	Uni			
↕	0 to +1000	⇒	+1000		

Sets the upper limit of speed in the forward direction of rotation.

#### 01.07 Min. speed forward

	RW	Uni			
↕	0 to +1000	⇒	+000		

Sets the lower limit of speed in the forward direction of rotation. The speed minimum value is disabled if bipolar selector **01.10** = 1 to prevent oscillation between the forward and reverse minimum speeds when the input speed reference is zero.

#### 01.08 Min. speed reverse

	RW	Uni			
↕	-1000 to 0	⇒	+000		

Sets the lower limit of speed in the reverse direction of rotation. The speed minimum value is disabled if bipolar selector **01.10** = 1 to prevent oscillation between the forward and reverse minimum speeds when the input speed reference is zero.

#### 01.09 Max. speed reverse

4 Quadrant

	RW	Uni			
↕	-1000 to 0	⇒	-1000		

1 Quadrant

	RW	Uni			
↕	0	⇒	000		

Sets the upper limit of speed in the reverse direction of rotation.

### 01.10 Bipolar reference selector

4 Quadrant

	RW	Bit			
⇅		⇒	1		

1 Quadrant

	RW	Bit			
⇅		⇒	0		

When set to 1, allows the drive to respond to a bipolar analog speed reference (01.02) in which case the direction of rotation is determined by the bipolar signal. Positive polarity causes forward rotation; negative polarity, reverse. When 01.10 = 0 the drive responds in a unipolar mode, negative-polarity signals being treated as a zero speed demand.

### 01.11 Reference 'ON'

	RW	Bit			
⇅		⇒	0, no speed reference		

Applies the speed reference to 01.03, pre-ramp reference. Defaults to zero if terminal TB3-21 (Run permit) is de-activated. Cannot be set to 1 unless terminal TB3-21 is activated. Is also subject to the status of the normal logic functions refer to Menu 08. Controlled in default by terminals TB3-22, TB3-23, TB3-24, TB3-25

When normal logic functions are disabled a programmable input can be used to control parameter 01.11 only if a RUN PERMIT signal is present.

### 01.12 Reverse selector

	RW	Bit			
⇅		⇒	0, reverse not selected		

Reverse select inverts the polarity of the speed reference signal. It has the effect (in a four-quadrant drive) of reversing the sense of the speed signal without regard to the nominal direction of motor rotation. Default value 01.12 = 0, inversion not applied. Controlled in default by terminals TB3-22, TB3-23, TB3-24, and TB3-25.

### 01.13 Inch selector

	RW	Bit			
⇅		⇒	0, inch not selected		

Inch select replaces all other speed demand references by the inch reference 01.05. Default value 01.13 = 0, normal speed reference applied. Controlled in default by terminals TB3-22, TB3-23.

### 01.14 Reference selector 1

	RW	Bit			
⇅		⇒	0		

The two reference selectors 01.14 and 01.15 in combination allow any one of the four speed references 01.17 to 01.20 to be selected.

1.14	1.15	Reference Selected
0	0	1.17
1	0	1.18
0	1	1.19
1	1	1.20

### 01.15 Reference selector 2

	RW	Bit			
⇅		⇒	0		

The two reference selectors 01.14 and 01.15 in combination allow any one of the four internal speed reference 01.17 to 01.20 to be selected. See table above.

### 01.16 Zero reference interlock

	RW	Bit			
⇅		⇒	0, inhibit not applied		

Prevents the starting of the drive until the analog speed reference, external or internal, is near to zero:

$$-8 < 01.01 < +8 \text{ (values in 0.1\% of full speed)}$$

This facility is convenient in applications where for safety or process reasons the operator determines speed by observations of the process, for example extrusion, or traction drives.

### 01.17 Reference 1

### 01.18 Reference 2

### 01.19 Reference 3

### 01.20 Reference 4

	RW	Bi			
⇅		⇒	As stated below		

Reference 1, parameter 01.17 is the default destination of the external speed reference (terminal TB1-3) through the programmable input 07.15.

Reference 2, parameter 01.18, default +300.

References 3 and 4, parameters 01.19 and 01.20, default to programmable inputs GP3 (TB1-6) and GP4 (TB1-7) respectively.

### 8.6.2 Menu 02: Ramps

The principal alternatives available for setting ramps are as follows -

1. No ramps at all, bypassing the ramp functions.
2. A selection of forward and reverse ramps for normal run conditions and an optional separate ramp for inching.

The arrangement for selecting running ramps affords the maximum flexibility. There are two possible ramp values available for each mode of operation, eg forward accelerations 1 and 2, forward decelerations 1 and 2, and so on. A common ramp selector allows switching between the two groups (all the 1s or all the 2s). In addition it is possible to change ramps 1 and 2 of any quadrant within the common selection. Ramp selectors may be controlled by any of the programmable digital inputs.

To activate the inch ramp, a select signal is required from **01.13** in addition to the enable function **02.13**.

The ramp operation can be interrupted by the ramp hold parameter, which holds the ramp output at its present value when set to 1. Ramp disable over-rides this feature.

The value of the speed reference signal after the ramp is monitored by the post-ramp reference.

#### 02.01 Post-ramp reference

	R0	Bi			
↕	±1000	⇒			

Monitors the value of the speed reference after it has bypassed or been modified by the ramp selected.

#### 02.02 Ramp enable

	RW	Bit			
↕	1	⇒	enabled		

If set to disable, makes the post-ramp speed reference **02.01** equal to the pre-ramp speed reference **01.03**, effectively bypassing the ramp functions.

#### 02.03 Ramp hold

	RW	Bit			
↕		⇒	0		

Holds the ramp output at its present value when set to 1. By using a programmable input to control this parameter, the speed of the drive may be controlled from 'increase' and 'decrease' pushbuttons instead of a potentiometer or other continuously-variable reference source. Ramp disable over-rides this feature.

#### 02.04 Forward acceleration 1

#### 02.05 Forward deceleration 1

#### 02.06 Reverse deceleration 1

#### 02.07 Reverse acceleration 1

	RW	Uni			
↕	0 to 1999	⇒	+050 = 5s	0.1s	

Defines the time taken to accelerate from rest to maximum full-speed (**01.03** = 1000), or to decelerate from this speed to rest, as appropriate.

#### 02.08 Forward acceleration 2

#### 02.09 Forward deceleration 2

#### 02.10 Reverse deceleration 2

#### 02.11 Reverse acceleration 2

	RW	Uni			
↕	0 to 1999	⇒	+100 = 10s	0.1s	

Alternative acceleration and deceleration ramp rates.

#### 02.12 Inch ramp rate

	RW	Uni			
↕	0 to 1999	⇒	+100 = 10s	0.1s	

Defines the rate of acceleration and deceleration when the Inch Reference is selected (**01.13** = 1).

To select, **02.13** = 1.

#### 02.13 Enable inch ramp

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Selects a dedicated ramp rate (defined by **02.12**) when inching. If not selected, the normal ramps **02.04** through to **02.11** are used for inching as well as running.

#### 02.14 Forward acceleration selector

#### 02.15 Forward deceleration selector

#### 02.16 Reverse deceleration selector

#### 02.17 Reverse acceleration selector

	RW	Bit			
↕	0 or 1	⇒	0, Ramp 1		

Select from Group 1 or 2

These selectors allow ramps to be chosen from either of the two groups at will, permitting individual acceleration and/or deceleration rates to be changed on receipt of an appropriate command.

#### 02.18 Common ramp selector

	RW	Bit			
↕	0 or 1	⇒	0, Group 1		

Enables selection between all ramps of Group 1 if **02.14** to **02.17** = 0, or all of Group 2.

#### 02.19 Ramp scaling (x10)

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

When **02.19** = 1, acceleration & deceleration ramp time multiplies by 10.



### 8.6.3 Menu 03: Feedback selection and speed loop

The principal inputs are the post-ramp reference **02.01** and the hard speed reference **03.18**. The post-ramp reference can be summed with or replaced by the hard speed reference. The speed reference can, alternatively, be the hard speed reference alone. The selected input can be modified by the addition of an offset. The result of this summation is the final speed demand (**03.01**) which is added algebraically to the speed feedback to become the speed error (**03.06**). The speed error is finally processed by the PID function to become the speed loop output.

Speed feedback is derived from one of three possible sources, encoder (pulse tach.), tachogenerator (tachometer) or armature voltage. Whichever source is selected becomes the speed feedback (**03.02**). If the armature voltage is selected it is first summed with the IR compensation (**03.05**), which is derived from the integral function of the speed error and the IR compensation factor is then either added to or subtracted from the scaled armature voltage feedback according to whether IR compensation or IR droop is selected.

The armature voltage feedback is passed to a comparator to provide a voltage clamp, used internally to prevent armature overvoltage. Parameter **03.15** becomes the clamp level.

The speed feedback value is used for two further purposes to supply a speed indication in rpm, and to indicate zero speed.

#### 03.01 Final speed demand

	RO	Bi			
⇅	±1000	⇒			

Monitors the value of the speed reference after it has bypassed or been modified by the ramps and/or by the hard speed reference (**03.18**) and speed offset fine (**03.22**). It is the speed reference which is presented to the speed control loop of the drive via the speed summation point.

#### 03.02 Speed feedback

	RO	Bi			
⇅	±1000	⇒			

Monitors the value of the speed feedback, derived from one of the following three sources encoder (pulse tach.), tachogenerator (tachometer), or armature voltage. The selection is controlled by **03.12** and **03.13**. The value is used for the closed-loop speed control of the motor. Scaling of the encoder (pulse tach.) signal is set by **03.14**, and of the armature voltage feedback is controlled by the setting of maximum armature voltage **03.15**. A potentiometer is provided for scaling the tachogenerator (tachometer) feedback signal. The speed feedback **03.02** is summed with the final speed demand **03.01** at the speed loop summation point.

#### 03.03 Speed feedback (rpm)

	RO	Bi			
⇅	±1999	⇒			rpm

Scaled value of motor speed feedback for external information.

#### 03.04 Armature voltage

	RO	Bi			
⇅	±1000	⇒			V

#### 03.05 IR Compensation output

	RO	Bi			
⇅	±1000	⇒			

The result of selected value of IR compensation **03.17** acting on the speed loop integral output.

#### 03.06 Speed error

	RO	Bi			
⇅	±1000	⇒			

The result of the summation of the final speed demand and the speed feedback, after filtering.

#### 03.07 Speed loop output

	RO	Bi			
⇅	±1000	⇒			

Output of the PID speed loop which becomes current demand (menu 04).

#### 03.08 Speed error integral

	RO	Bi			
⇅	±1000	⇒			

The integrated value of the speed error **03.06**, used as input to the IR compensation calculation when using armature voltage feedback (AVF).

#### 03.09 Speed loop proportional gain

	RW	Uni			
⇅	0 to 255	⇒	080		

The factor by which the speed error is multiplied to produce the correction term.

$$\text{Factor} = \frac{\text{ValueOf03.09}}{8}$$

Increasing this value increases both the system damping and the transient speed response, and if made too high for a given load the system will become unstable. The optimum setting is the highest value possible before instability starts to occur. Optimum speed loop performance is achieved by judicious combination of all three gains of the PID algorithm. See **03.28** to increase the speed loop proportional gain by a factor of 4.

### 03.10 Speed loop integral gain

	RW	Uni			
↕	0 to 255	⇒	040		

The factor by which the speed error is multiplied to produce the correction term.

$$\text{Factor} = \frac{6f \times (03.10)}{256}$$

where f = supply frequency

This term ensures zero speed error during steady state load conditions, increasing the value increases the rate of recovery after a disturbance. If the term is made too high, speed tends to oscillate instead of settling quickly. The optimum setting is the highest value possible before oscillation starts to occur. Optimum speed loop performance is achieved by judicious combination of all three gains of the PID algorithm.

The integral term will be clamped if torque mode is selected or if the drive is in current limit.

### 03.11 Speed loop derivative gain

	RW	Uni			
↕	0 to 255	⇒	0		

The factor by which the speed error is multiplied to produce the correction term. There are three possible sources of input to this term either final speed demand **03.01**, speed feedback **03.02**, or speed error **03.06**. The selector is **03.24**. The derivative term is a function of the rate of change of value of the input.

If the input is the speed error **03.06**, output is negative if speed error is increasing. This has a damping effect.

If the input is the final speed demand **03.01**, output is positive when the final speed demand is increasing. This is called velocity feed forward.

If the input is the speed feedback **03.02**, output is negative if speed feedback is increasing. This also has a damping effect, but dependent on the changing value of the speed feedback only, not the speed reference.

### 03.12 Digital feedback selector

	RW	Bit			
↕	0 or 1	⇒	0 (analog feedback)		

Set to 1 to select encoder (pulse tach.) feedback. Set to 0 to select analog feedback.

### 03.13 Armature voltage / external analog feedback selector

	RW	Bit			
↕	0 or 1	⇒	0 (analog feedback)		

Determines the type of analog speed feedback when **03.12** is set to 0. Set to 1 to select armature voltage feedback. Default setting selects analog feedback from a tachogenerator (tachometer) or equivalent external source connected to terminal TB1-09.

### 03.14 Encoder feedback scaling

	RW	Uni			
↕	0 to 1999	⇒	+419		

The value should be set to correspond with the maximum speed of the motor and with the number of lines-per-revolution of the encoder (pulse tach.). To calculate the scale factor:

$$\text{ScaleFactor} = \frac{750 \times 10^6}{N \times n}$$

where:

N = PPR for the encoder (pulse tachometer)

n = max speed of motor in rpm.

Default value is determined on the basis of a 1024-line encoder (pulse tach.), and a maximum speed of 1750rpm. Maximum frequency for the encoder is 105kHz.

### 03.15 Maximum armature voltage

	RW	Uni			
↕	0 to 1000	⇒	+600	V	

Defines the maximum voltage permitted to be applied to the armature. When armature voltage is the selected feedback (**03.12** = 0 and **03.13** = 1), the max. armature voltage value is used for scaling the armature voltage measurement so that speed feedback is full scale at maximum voltage.

If the speed feedback is derived from an encoder (pulse tach.) or tachogenerator (tachometer), the armature voltage is continuously monitored, and the clamp is applied when the voltage exceeds that set in **03.15**. This can be used to prevent the voltage rising above a set level.

An automatic scale factor of 1.2 is applied to clamp the armature voltage feedback to 20% above maximum, to allow for overshoot.

### 03.16 Maximum speed (scaling rpm)

	RW	Uni			
↕	0 to 1999	⇒	+1750	rpm	

Used only to scale the speed feedback so that the value displayed in **03.03** is actual speed in rpm. The value applied to **03.16** should be the max. speed in rpm (divided by ten if the maximum speed is >1999rpm; speed displayed in **03.03** is then rpm / 10.)

### 03.17 IR Compensation

	RW	Uni			
↕	0 to 255	⇒	000		

$$\text{ValueOf03.05} = \frac{(03.08) \times (03.17)}{2048}$$

This value is used to calculate the compensation for the resistive voltage-drop of the armature to improve speed control with varying loads when the selected speed feedback is the armature voltage.

IR compensation is a positive feedback, and may give rise to instability if set too high. Furthermore, modern laminated-frame motors have typically a rising load-speed characteristic which is unsuited to armature voltage feedback with IR compensation. IR compensation is more suited to compound-wound motors with a flat (not rising) load-speed characteristic.

The integral of the speed error is used as the input to IR compensation rather than current feedback because it is the most smooth of the variables; in speed control, the value of the speed error integral is the steady-state value of current demand.

**03.18 Hard speed reference**

	RW	Bi			
↕	±1000	⇒	(07.11)		

Speed reference fed into the speed loop without passing through the ramps.

**03.19 Hard speed reference selector**

	RW	Bit			
↕	0 or 1	⇒	0		

If **03.19** is set to 1, and Ref ON (01.11) = 1, the Hard Speed reference (3.18) is added at the speed loop summation point.

**03.20 IR droop selector**

	RW	Bit			
↕	0 or 1	⇒	0		

If **03.20** = 1 when using armature voltage as the speed feedback, speed will decrease as load increases.

A typical application, for example, is a mechanical blanking press fitted with a heavy flywheel. Applying IR droop prevents the drive from delivering a sudden increase of current at the moment of impact (sudden increase of torque demand). It is better that the drive should deliver energy to the flywheel during the whole operating cycle rather than mostly at the moment of impact.

**03.21 Ramp output selector**

	RW	Bit			
↕	0 or 1	⇒	1		

When **03.21** = 1, Ramp output is added at the speed loop summation point.

**03.22 Speed offset fine**

	RW	Uni			
↕	0 to 255	⇒	128		

Used as a fine trim on the speed reference signal to correct, or introduce, a small offset.

A value of 0 gives an offset of -8 units, the default value gives zero offset and a value of 255 gives an offset of +8 units.

**03.23 Zero speed threshold**

	RW	Uni			
↕	0 to 255	⇒	16		

The threshold may be adjusted to any value up to 25.5% of maximum speed. Refer also to **10.09**.

**03.24 Derivative term source**

	RW	Uni			
↕	1, 2 or 3	⇒	1		

The derivative term of the PID in the speed loop may use one of three sources

- 1 = Speed error **03.06**  
Damping changes in speed demand and feedback
- 2 = Speed reference **03.01**  
Velocity feed-forward
- 3 = Speed feedback **03.02**  
Damping on feedback only (feedback forcing).

**03.25 Speed error filter**

	RW	Uni			
↕	0 to 255	⇒	128		

$$\text{Filter time} - \text{Constant} = \frac{256}{6f \times (03.05)}$$

where  $f$  = supply frequency

A low-pass filter to reduce the effect on the speed error signal (**03.04**) of interference from a noisy tachogenerator (tachometer), for example.

**03.26 Tachogenerator input**

	RO	Bi			
↕	±1000	⇒			

Monitors the tacho input measurement. The tacho potentiometer is used to scale the feedback signal such that at full motor speed, **03.26** = 1000. Units displayed = 0.1% of full speed per increment.

**03.27 Reserved**

	RO	Bi			
↕	±1000	⇒			

**03.28 Proportional gain x 4**

	RW	Bit			
↕	0 or 1	⇒	0		

Setting this parameter at 1 will increase the speed loop proportional gain by a factor of 4.

**03.29 Speed loop gains / 8**

	RW	Bit			
↕	0 or 1	⇒	0		

When set the speed loop gains are reduced by a factor of 8 so that:

$$\text{PGAIN} = \frac{03.09}{64}$$

$$\text{IGAIN} = \frac{03.10 \times 6 \times f}{2048}$$

### 8.6.4 Menu 04: Current selection and limits

The principal input is the speed loop output **03.07** in combination, for torque- or current-control modes, with the torque reference **04.08**. These inputs become the current demand to which an offset or trim option may be applied. The result is then subject to an over-riding limitation derived from several sources including the speed feedback. Six bit-parameters determine the mode of control speed control, current control, number of quadrants, etc.

A feature in this menu is the facility to apply a second current limit (**04.07**) automatically refer to **04.10**, **04.18** and **04.19** which allow current limit 2 to be applied after a chosen time delay. This is appropriate to applications where the initial load torque on start-up is high, but after some period becomes less, as with some mechanical mixing processes, for example.

#### 04.01 Current demand

	RO	Bi			
↕	±1000	⇒			

The current demand signal is the controlling input to the current loop when the drive is being operated in speed-control mode. The signal is subject to limitation by **04.04**, **04.05** and **04.06** before being passed to the current loop.

#### 04.02 Final current demand

	RO	Bi			
↕	±1000	⇒			

Current demand final output, to the current loop (Menu 05) after limits have been applied.

#### 04.03 Over-riding current limit

	RO	Bi			
↕	±1000	⇒			

This is the limiting value of current demand and is the result of the speed-dependent current taper calculation or I-limit 2 (if selected), whichever is the lower.

#### 04.04 Current limit (taper start point)

	RW	Uni			
↕	0 to 1000	⇒	+1000		

This parameter provides symmetrical current-limitation for bridges 1 and 2 and is the datum level from which the current taper functions operate refer to **04.20** and **04.21**. I-limit 1 can be used in application where the motor kW rating is somewhat less than that of the drive, as an alternative to changing the fixed current-burden resistors.

#### 04.05 Current limit bridge 1

	RW	Uni			
↕	0 to 1000	⇒	+1000		

Determines the maximum limit of current demand when bridge 1, the positive bridge, is conducting. It causes any demand for current in excess of the limit set point to be ignored.

#### 04.06 Current limit bridge 2

	RW	Uni			
↕	0 to 1000	⇒	+1000		

Determines the maximum limit of current demand when bridge 2, the negative bridge, is conducting. It causes any demand for current in excess of the limit set point to be ignored.

#### 04.07 Current limit 2

	RW	Uni			
↕	0 to 1000	⇒	+1000		

Available as an additional current limit. Applies to both bridges. The drive can be programmed, if desired, to select **04.07** automatically at a programmed time interval after a RUN signal. Refer to **04.10**, **04.18** and **04.19**.

#### 04.08 Torque reference

	RW	Bi			
↕	±1000	⇒	+000		

This value is an input to the current loop and can be selected for use in applications requiring direct control of current (motor torque).

#### 04.09 Current offset

	RW	Bi			
↕	±1000	⇒	+000		

Current offset is used to apply a trim to the current demand **04.01**.

#### 04.10 Current limit 2 selector

	RW	Bit			
↕	0 or 1	⇒	0		

Set **04.10** = 1 to select current limit 2. Can be caused to change automatically refer to **04.18** and **04.19**.

#### 04.11 Current offset selector

	RW	Bit			
↕	0 or 1	⇒	0		

Set **04.11** = 1 to select current offset.

#### 04.12 Mode bit 0

	RW	Bit			
↕	0 or 1	⇒	0 (not selected)		

Set **04.12** = 1 to select. Operates in conjunction with **04.13** to configure the drive for speed control or any of three modes of torque control. Refer to **04.13**.

## 04.13 Mode bit 1

	RW	Bit			
↕	0 or 1	⇒	0 (not selected)		

Set **04.13** = 1 to select. Operates in conjunction with **04.12** to configure the drive for speed control or any of three modes of torque control, as follows:

- 04.12** = 0 and **04.13** = 0  
Speed control mode (default configuration).
- 04.12** = 1 and **04.13** = 0  
Basic current- or torque-control.
- 04.12** = 0 and **04.13** = 1  
Torque-control mode with speed override.
- 04.12** = 1 and **04.13** = 1  
Coiler/uncoiler control mode.

### Speed mode control

The output of the speed loop becomes the current demand input into the current loop.

### Basic current - or torque - control mode

In this mode, the torque reference **04.08** is the input to the current loop and is subject to the limitations of the over-riding current limit **04.03**, the Bridge 1 and Bridge 2 limits **04.05** and **04.06**, and to the current slew rate **05.04**.

Standstill logic (**05.18**) will need to be disabled if the torque control is being used.

### Torque-control mode with speed override

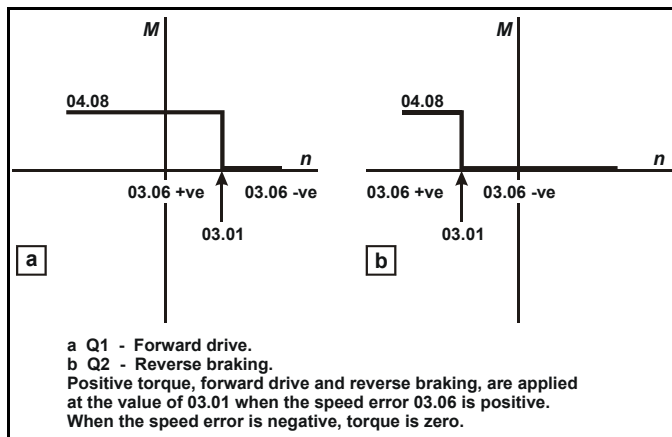
Refer to Figure 8-3 and Figure 8-3

In this mode, the output of the speed loop is clamped either to the value of the torque reference **04.08**, or to zero according to whether the speed error **03.06** is positive or negative, and depending on whether the torque reference is positive or negative, ie dependent on relative polarities.

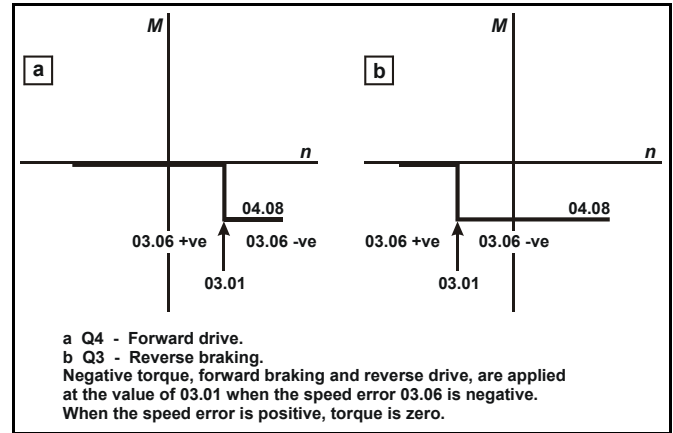
In the two motoring quadrants, speed is limited to the value of the final speed demand **03.01**, preventing uncontrolled increase of speed when load is removed. The drive should be adjusted to run at a slight overspeed when off load, in order to ensure adequate current demand at all speeds.

In the two regenerative quadrants, the current demand set by torque reference **04.08** is disabled when speed is less than that set by the final speed demand **03.01**. This prevents the reducing load torque resulting in reversal of rotation. The value of **03.01** should be zero.

**Figure 8-2 Torque control with speed over-ride. Positive torque reference**



**Figure 8-3 Torque control with speed over-ride. Negative torque reference**



A disadvantage of this mode is that it cannot provide torque at a particular speed both accelerating and decelerating. Parameter **04.08** behaves as a controllable current limit in this mode.

### Coiler/uncoiler control mode

Refer to Figure 8-4 and Figure 8-5.

This mode allows torque to be applied in either sense, for acceleration or deceleration, while preventing uncontrolled increase in speed or reversal if the load becomes zero. When the torque demand is in the sense opposite to that of speed feedback, this mode automatically selects zero speed reference.

For a coiler, the offset **01.04** should be set just slightly positive so that **03.01** is greater than the line speed reference. When a full reel (of a coiler) is decelerating, the torque demand may be negative. Since the speed feedback is positive, the speed reference is automatically made zero so that the speed error becomes negative. Both torque demand and speed error being negative, decelerating torque is applied.

For an uncoiler, the offset **01.04** should be set just slightly negative so that there is a negative speed error at zero speed. (Negative speed error is necessary to produce a negative torque to maintain tension at zero speed.) As the line speed reference increases, **03.01** becomes positive. A suitable scaling of the input should be applied such that **03.01** is always greater than the speed feedback, thus maintaining a positive speed error **03.06**. Since the speed feedback is positive, zero speed is automatically selected whenever the torque demand is negative normal operation but if the torque demand becomes positive then the value of **03.01** becomes the speed demand, and accelerating torque is allowed, provided that the reel speed is not greater than **03.01**.

For coiler/uncoiler applications, line speed reference corresponds to reel speed at minimum diameter.

**Figure 8-4**

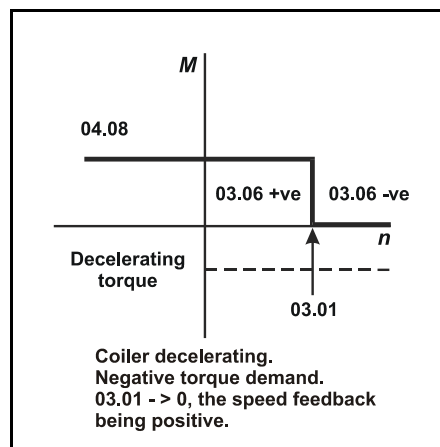
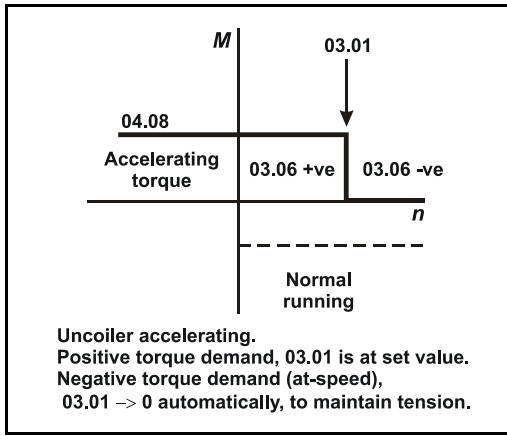


Figure 8-5



#### 04.14 Quadrant 1 enable

	RW	Bit			
⇅	0 or 1	⇒	1 (enabled)		

Quadrant 1 operation is defined as motoring in the forward direction, speed and torque both having positive values.

#### 04.15 Quadrant 2 enable

	RW	Bit			
⇅	0 or 1	⇒	1Q drive: 0 (disabled) 4Q drive: 1 (enabled)		

Quadrant 2 operation is defined as regenerating in the reverse direction, speed being negative and torque positive.

#### 04.16 Quadrant 3 enable

	RW	Bit			
⇅	0 or 1	⇒	1Q drive: 0 (disabled) 4Q drive: 1 (enabled)		

Quadrant 3 operation is defined as motoring in the reverse direction, speed and torque both having negative values.

#### 04.17 Quadrant 4 enable

	RW	Bit			
⇅	0 or 1	⇒	1Q drive: 0 (disabled) 4Q drive: 1 (enabled)		

Quadrant 4 operation is defined as regenerating in the forward direction, speed being positive and torque negative.

#### 04.18 Enable automatic current limit 2 change

	RW	Bit			
⇅	0 or 1	⇒	0 (disabled)		

When this bit is enabled, the current limit 2 selector is automatically changed to 1 after a time interval set by 04.19. The drive can be programmed to select 04.07 automatically at a programmed time-interval (04.19) after a RUN signal.

#### 04.19 Current limit timer

	RW	Uni			
⇅	0 to 255	⇒	000		

A time interval up to 255 seconds can be programmed. If 04.18 = 1, current limit 2 is automatically selected when the set time elapses after a RUN command. This feature is appropriate to applications where the motor is short-time rated, such as mixing machinery, where the starting load is high and falls to a lower, constant value only after the machine has run for some time.

#### 04.20 Current taper 1 threshold

	RW	Uni			
⇅	0 to 1000	⇒	+1000		

Sets a threshold value of speed feedback, beyond which 04.24 changes to 1 to indicate that the threshold has been exceeded, and is the starting point for taper 1 (if implemented). Armature current reduces, as a function of speed, at a rate defined by 04.22. This parameter can also be used as a general-purpose speed threshold.

If only one taper is used, it must be Taper 1. If both are used, Taper 1 must be the first.

#### 04.21 Current taper 2 threshold

	RW	Uni			
⇅	0 to 1000	⇒	+1000		

Sets a threshold value of speed feedback, beyond which 04.25 changes to 1 to indicate that the threshold has been exceeded, and is the starting point for taper 2 (if implemented). Armature current reduces, as a function of speed, at a rate defined by 04.23. This parameter can also be used as a general-purpose speed threshold.

#### 04.22 Current taper 1 slope

	RW	Uni			
⇅	0 to 255	⇒	000		

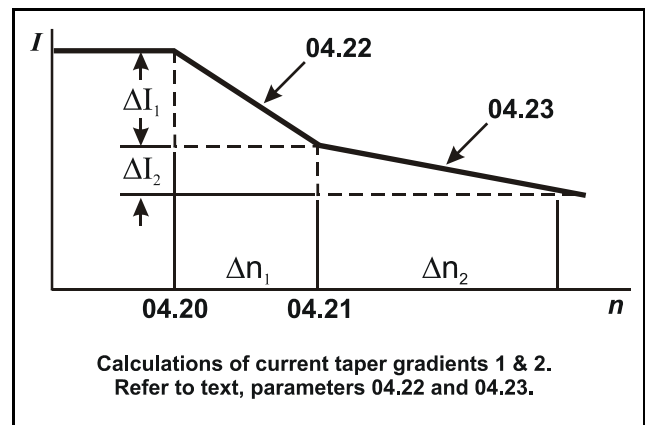
Sets the rate of change of armature current limit with respect to speed in either direction of rotation, above the threshold set by 04.20.

#### Scaling factor

Refer to Figure 8-6

$$04.22 = 128 \times \frac{\Delta I_1}{\Delta n_1}$$

Figure 8-6



<b>04.23</b>	<b>Current taper 2 slope</b>
--------------	------------------------------

	RW	Uni			
↕	0 to 255	⇒	000		

Sets the rate of change of armature I-limit with respect to speed in either direction of rotation, above the threshold set by **04.21**.

**Scaling factor**

Refer to Figure 8-6

$$04.23 = 128 \times \frac{\Delta I_2}{\Delta n_2}$$

<b>04.24</b>	<b>Taper threshold 1 exceeded</b>
--------------	-----------------------------------

	RO	Bit			
↕	0 or 1	⇒	0		

Set to 1 when the threshold set point of **04.20** is exceeded.

<b>04.25</b>	<b>Taper threshold 2 exceeded</b>
--------------	-----------------------------------

	RO	Bit			
↕	0 or 1	⇒	0		

Set to 1 when the threshold set point of **04.21** is exceeded.

### 8.6.5 Menu 05: Current loop

This is the final stage in the processing of the speed and torque references and feedbacks to determine the final firing angle signal. The normal principal input is the final current demand, which is subject to the slew rate limit, summed algebraically with the current feedback and further modified by whatever settings may have been applied to the group of Current Loop parameters.

Current feedback, after scaling, delivers a readable signal to display actual current in amps. Current feedback also is an important function in the protection of the drive. The feedback signal is monitored in relation to the selected overload threshold, modified according to preprogrammed values for overload time. The provision of two parameters for overload timing allows settings to be applied so as to take account of the fact that the cooling time of a motor can be longer than its heating time.

For the drive to operate the current ripple measured at terminal 11 which is a voltage signal indicating current feedback, must be a minimum of 0.6V when there is no back emf i.e at zero speed. The current level measured at the point of continuous conduction with this level of ripple is 9.2% of the drive rating. With software version V5 (or later), software parameter **05.29** allows the user to increase the current feedback burden by a factor of 1.6. The software scales the current feedback differently to compensate for the change in burden value. When **05.29** is set and the burdens have been changed, the minimum value of ripple occurs at 5.7% of the drive rating. The burdens should not be changed if the ripple at terminal is greater than 0.6V.

#### 05.01 Current feedback

	R0	Bi			
↕	±1000	⇒			

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

#### 05.02 Current feedback (amps)

	R0	Bi			
↕	±1999	⇒			A

The current feedback signal, modified by the scaling factor, becomes available as an indication in amps. Refer also to **05.05**.

#### 05.03 Firing angle

	R0	Uni			
↕	277 to 1023	⇒			

This is the output of the current loop algorithm, and the input reference to the ASIC, which generates the firing pulses. **05.03** = 1023 indicates fully phased forward.

#### 05.04 Slew rate limit

	RW	Uni			
↕	0 to 255	⇒	040		

This parameter limits the maximum rate of change of current demand. Older types of motor, especially if of non-laminated construction, may have a tendency to flash over if the rate of change of current is too high for the inherent lag of the interpole windings.

$$\text{Defined as: } S = \frac{I_{\max} \times 6f \times 05.04}{256}$$

Where:

**S** = slew rate in amps s<sup>-1</sup>

**f** = frequency of the power supply in Hz

**I<sub>max</sub>** = max. current (A)

To restrict the rate of change of current, parameter **05.04** should be reduced.

#### 05.05 Maximum current (scaling)

	RW	Uni			
↕	0 to 1999	⇒	Drive current rating		

The maximum output current, in amps, is scaled by this parameter. This does not have any effect on the motor protection. The setting for **05.05** is calculated as follows:

$$05.05 = \frac{I_{\max}}{10} \text{ if } I_{\max} > 1999A$$

$$05.05 = I_{\max} \text{ if } 200A < I_{\max} < 1999A$$

$$05.05 = I_{\max} \times 10 \text{ if } I_{\max} < 200A$$

#### 05.06 Overload threshold

	RW	Uni			
↕	0 to 1000	⇒	+700		

Sets the threshold of armature current feedback beyond which the current-time overload protection begins to integrate.

#### NOTE

To disable the overload trip, parameter **05.07** and **05.08** should be set to 0.

#### 05.07 Overload integrating time (heating)

	RW	Uni			
↕	0 to 255	⇒	030	S	

Integrating time for **05.06**. For use in conjunction with **05.08**, such that **05.07** < **05.08**.

$$\text{Time } t \text{ to trip is: } t = (05.07) \times \frac{1000 - (05.06)}{(05.01) - (05.06)}$$

Refer also to Menu 10, parameter **10.18**.

#### NOTE

To disable the overload trip, parameter **05.07** and **05.08** should be set to 0.



## 05.08 Overload integrating time (cooling)

	RW	Uni			
↕	0 to 255	⇒	050	S	

Integrating time for **05.06**. For use in conjunction with **05.07**, such that **05.07 < 05.08**.

Time  $t$  to reset is:  $t = (05.08) \times \frac{1000 - (05.06)}{(05.06) - (05.01)}$

Refer also to Menu 10, parameter **10.18**.

### NOTE

To disable the overload trip parameter **05.07** and **05.08** should be set to 0.

## 05.09 Enable start-up autotune

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

To autotune the current loop during start up:

- Disconnect the field of the motor if a fixed field is being used. (Open terminals L11 and L12 in the European version of the drive).
- **Observe approved safety procedures!**
- Enable autotune set **05.09** = 1.
- Enable the drive by the input TB4-31.

When the autotune process is complete, the drive ready relay will open for 50ms after which the autotune parameter will be automatically set to disable (**05.09** = 0). The purpose of this process is to allow the autotune sequence to be started when a run permit is present but to return the drive to a safe condition when the autotune is complete. It may be necessary to clamp the motor shaft if it tends to rotate during this procedure.

### NOTE

1. The foregoing assumes that the drive ready relay is interlocked with any run permit that is present.
2. If the motor is being operated with field control (Menu 06), the field will be turned off automatically.
3. Alters parameters **05.12** to **05.15**.

## 05.10 Reduced endstop

	RW	Bit			
↕	0 or 1	⇒	0		

The endstop allows the armature voltage to rise, during regeneration, to  $1.16 \times$  supply voltage. On very soft supplies the endstop may be too close to the crossover point. Setting **05.10** = 1 increases the safety margin but reduces the maximum regenerated armature voltage to  $1.05 \times$  supply voltage.

Setting this parameter may be necessary in series 12 pulse systems.

## 05.11 Actual overload

	RO	Uni			
↕	0 to 1999	⇒			

Monitors the value of the integrating current-time overload. When the value reaches the trip point determined by **05.06**, **05.07** and **05.08**, an overload trip occurs. The overload trip will operate when **05.11** reaches the value given by:

$$(1000 - (05.06)) \times \frac{10}{16}$$

The rate at which **05.11** increases or decreases is controlled by the values of **05.07** and **05.08** respectively.

### NOTE

To disable the overload trip parameter **05.07** and **05.08** should be set to 0.

## 05.12 Discontinuous integral gain

	RW	Uni			
↕	0 to 255	⇒	16		

Set by the Start-up Autotune parameter **05.09**.

This parameter is set to correct any errors in the prediction of firing angle in the discontinuous current region. If **05.15** is set correctly, **05.12** has little effect, but if set too high, instability can occur.

$$\text{Gain applied} = \frac{\text{Value of } 05.12}{128}$$

## 05.13 Continuous proportional gain

	RW	Uni			
↕	0 to 255	⇒	16		

Set by the Start-up Autotune parameter **05.09**.

This parameter allows the current loop to follow very closely a step-change in current. If set too high, there will be an overshoot. If set too low, the new current value will be achieved unduly slowly.

$$\text{Gain applied} = \frac{\text{Value of } 05.13}{256}$$

## 05.14 Continuous integral gain

	RW	Uni			
↕	0 to 255	⇒	16		

Set by the Start-up Autotune parameter **05.09**. Its value will depend on the motor time-constant. Increasing the value of **05.14** will improve the response of the current loop but at the risk of instability. If this parameter is set too low an error between the value of the 'Current Demand' and the 'Current Feedback' can result.

$$\text{Gain applied} = \frac{\text{Value of } 05.14}{512}$$

### NOTE

This parameter is not set by the continuous autotune routine.

### 05.15 Motor constant

	RW	Uni			
↕	0 to 255	⇒	25		

This parameter is used to scale the current demand such that the control loop correctly predicts the firing angle in the discontinuous current region. It is set automatically by the Start-up Autotune parameter **05.09**.

### 05.16 Reserved

	RW				
↕		⇒			

This parameter is reserved.

### 05.17 Inhibit firing

	RW	Bit			
↕	0 or 1	⇒	0, enabled		

If set to 1, disables thyristor (SCR) firing (both bridges), and resets acceleration and deceleration ramps.

### 05.18 Enable standstill logic

	RW	Bit			
↕	0 or 1	⇒	1, enabled		

When enabled, causes the firing angle to be fully phased back when the drive has received a STOP command and when the speed falls below 0.8% of maximum speed. After a short time delay, the thyristor (SCR) firing is stopped also. This prevents creep and is used in applications in which there is no requirement to maintain motor torque at standstill. Refer also to **05.19**.

This parameter will need to be disabled if torque control is selected.

### 05.19 Standstill mode

	RW	Bit			
↕	0 or 1	⇒	0		

**05.19 = 0** Standstill logic is enabled after STOP command or zero reference.

**05.19 = 1** Standstill logic enabled after STOP command only.

Setting **05.19 = 1** has the effect of not enabling the standstill logic when the stopping signal is given by the reference alone. This condition therefore allows creep speeds, shaft orientation, and other functions which take place close to zero speed, while preventing any creep after a STOP command.

### 05.20 Enable direct firing angle control

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

When enabled, the firing angle **05.03** is controlled by the value of the post-ramp reference **02.01**. This mode is valuable for system diagnosis, particularly where instability is present, since it allows the drive to operate without the influence of either the speed loop or the current loop, thereby eliminating their effect upon the system.

#### NOTE

This facility must be used with caution. When the reference is **02.01**, there is no protection against excessive acceleration, output voltage or current other than the instantaneous overcurrent trip. Also take care to reset **05.20 = 0** after completion of tests.

### 05.21 Enable bridge 2 lockout

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Requires to be set only for parallel 12-pulse 4Q system installations comprising two drives which are to share load, to prevent one drive changing bridges while the other is still conducting.

### 05.22 Disable adaptive control

	RW	Bit			
↕	0 or 1	⇒	0, enabled		

Setting **05.22 = 1** disables adaptive control.

When adaptive control is enabled (default status) the current loop employs two different algorithms, one of which applies high gain in the discontinuous-current region. This is unsuitable for some applications, such as non-motor loads, for which adaptive control should be disabled.

### 05.23 Enable 1 - quadrant series 12 - pulse

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Enabling this function configures the drive to deliver normal and delayed firing pulses to two thyristor bridges from one power board. The gate pulses for the delayed thyristor bridge are directed to gate drives numbered 7 to 12 on connector PL1 of the control board (MDA1). The function cannot be enabled if either of the Bridge 2 quadrants **04.16** and **04.17** are enabled.

If two power boards are to be used then **05.23** must not be set and a special MDA1 (part number 9201-0784) must be used.

#### 05.24 Series 12 - pulse operation

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

This parameter should be set for operation in either single- or four-quadrant 12-pulse mode. Parameter **05.23** (see above) is read by the software only at power-on and during a cyclic reset (a reset when the drive is disabled). If either of the Bridge 2 quadrants is enabled when **05.23** is read, the outputs are not diverted within the ASIC and **05.23** is set to 0.

##### NOTE

Series 12-pulse mode is phase-sensitive. The rotation on the stacks must be in the sequence L1, L2, L3 (**10.11** = 1).

#### 05.25 Parallel 12 - pulse operation

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

This parameter instructs the drive to operate in parallel 12-pulse mode and should be set for operation in either single- or four-quadrant mode. For 4-quadrant operation, parameter **05.21** (see above) must be set to 1 and the F10 input of each drive must be connected to the ST5 output of the other. Also, the control 0V terminals of both drives must be connected.

#### 05.26 Extra-safe bridge change

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

When enabled (=1) parameter **05.26** applies an additional safety margin of 1 supply cycle to the bridge changeover logic. This may be required for highly inductive loads, such as a motor field winding.

#### 05.27 Continuous autotune

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

When set, enables the continuous auto-tune which continuously monitors the motor current ripple and adjusts the current loop gains for optimum performance. The commissioning autotune should still be carried out because parameter **05.14** is not set by the continuous autotune.

Calculation of the gains is suspended when the voltage spill-over loop becomes active so that the gains are not increased when the field is weakened.

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

#### 05.28 Reduced hysteresis for bridge changeover

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

There is hysteresis on a bridge changeover to prevent oscillation between the two bridges under lightly loaded conditions. In applications which require fine control of the current the bridge change-over hysteresis can be reduced from 1.6% to 0.2% of drive maximum current by setting this parameter.

#### 05.29 Increased current feedback

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

If the drive is being used with a motor with a high inductance armature such as elevator motors the current feedback burden resistors can be increased (by a factor of 1.6 times) to increase the current feedback signal. This improves the current control at low levels of current. It is necessary to set this bit parameter if the burdens have been increased so that the software allow the current limits to remain unchanged.

Setting this parameter affects **05.15** so that it does not have to be set close to its maximum value of 255 when continuous conduction occurs at very low currents. The autotune routines have been modified to take this into account.

### 8.6.6 Menu 06: Field control

The Mentor II is equipped with field control as part of the on-board software. If a motor is being used with an uncontrolled (fixed) field supply, this menu does not apply.

Provision is made for programming two selectable values of maximum field current. Further, the lower value of maximum field current can be controlled by a programmable timer so that, when the drive is not running, the field can be switched automatically to economy mode.

The resulting field current demand is summed algebraically with the field current feedback to produce a current error which is the input to the field current loop. The output of the field current loop is the firing angle, subject to the front endstop limit.

The field current can alternatively be controlled directly by either of the maximum field parameters **06.08** and **06.09** via a programmable input or by application software, and there is a facility for direct control of the firing angle, useful for diagnosis.

Field current demand is the output of the back-emf voltage loop, subject to programmed maximum and minimum field current values. The voltage loop compares the calculated back-emf value with a programmed set point which is used as factor in determining field current demand.

The voltage loop output, and consequently the field current demand, is maximum when the calculated back-emf is less than the setpoint value. When the calculated value exceeds the set point value (at base speed) the voltage loop reduces the field current demand to regulate the calculated back-emf to the set point value.

Alternatively, the user may wish not to use the voltage loop, but to enter a current demand directly. The user can set two maximum field current parameter values. In this mode, the value of the back-emf set point should be set to maximum, such that the voltage loop always demands maximum field current. The current demand is then the selected maximum field current parameter.

<b>06.01 Back emf</b>					
	RO	Uni			
↕	0 to 1000		⇒		

The calculated motor back emf based on armature voltage minus IR compensation value 2, **06.05**. Feedback to the emf loop in spillover mode.

<b>06.02 Field current demand</b>					
	RO	Uni			
↕	0 to 1000		⇒		

The current demand from the emf loop, subject to the limits of **06.08**, **06.09** and **06.10**.

<b>06.03 Field current feedback</b>					
	RO	Uni			
↕	0 to 1000		⇒		

Feedback to the field current loop

<b>06.04 Firing angle</b>					
	RO	Uni			
↕	261 to 1000		⇒		

Scaling **06.04** = 1000 corresponds to fully phased forward

<b>06.05 IR compensation 2 output</b>					
	RO	Bi			
↕	±1000		⇒		

The value resulting from the application of **06.06** to the speed error integral input.

<b>06.06 IR compensation 2</b>					
	RW	Uni			
↕	0 to 255		⇒	000	

A programmable factor used for calculation of the armature IR-drop as correction to measured armature voltage, to allow the back emf to be computed.

$$\text{If } 06.20 = 0: \quad 06.05 = \frac{(03.08) \times (06.06)}{2048}$$

$$\text{If } 06.20 = 1: \quad 06.05 = \frac{(04.02) \times (06.06)}{2048}$$

Example of setting of **06.06**

Armature voltage = 400V  
 Armature current = 200A  
 Armature resistance = 0.1Ω

$$I \times R = 20V$$

For a M210 with 200A armature current

$$03.08 = 635 \text{ units}$$

$$\text{so, } 06.06 = \frac{20 \times 2048}{635} = 64 \text{ units}$$

$$06.07 = 380V$$

<b>06.07 Back emf set point</b>					
	RW	Uni			
↕	0 to 1000		⇒	+1000	V

The programmable value of the armature back emf in volts, at which the field begins to weaken. Defined as the voltage at which base speed is reached.

<b>06.08 Maximum field current 1</b>					
	RW	Uni			
↕	0 to 1000		⇒	+1000	

Programmable value of the maximum current demand of the emf loop. If the field control is to be used in current mode, this parameter would become the current reference of the field control loop, and the back emf set point should normally be set to maximum to prevent spillover occurring; alternatively, if motor overvoltage protection by spillover is required, the back emf set point should be set to maximum armature voltage.

<b>06.09 Maximum field current 2</b>					
	RW	Uni			
↕	0 to 1000		⇒	+500	

Alternative to **06.08**, for use as an economy setting. Refer to **06.12**, **06.14** and **06.15**.

## 06.10 Minimum field current

	RW	Uni			
↕	0 to 1000	⇒	+500		

The minimum value of current demand, to prevent excessive field weakening, for example with overhauling loads.

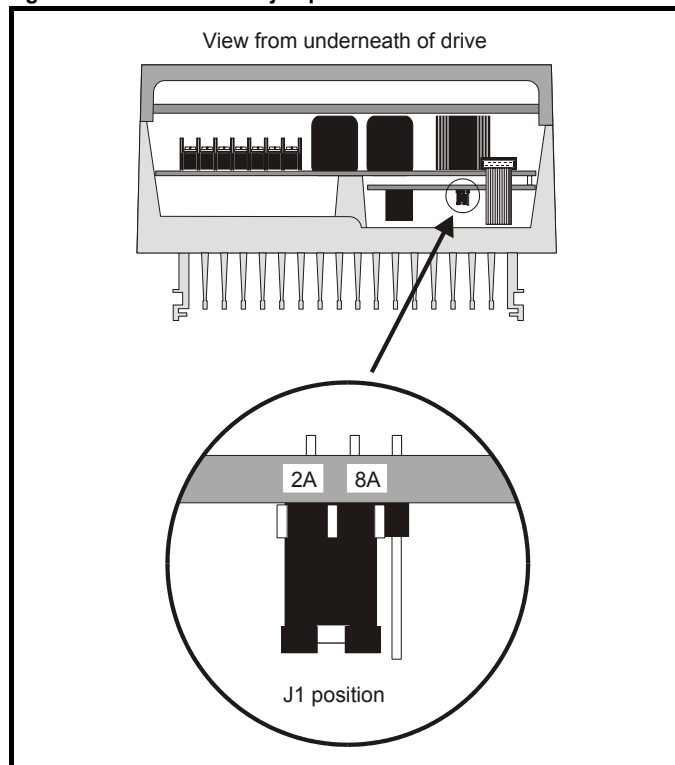
## 06.11 Field current feedback scaling

	RW	Uni			
↕	201 to 216	⇒	204		

Parameter **06.11** permits the user to apply a scaling factor to the current feedback. Output is the value **06.03**. The max. current rating is 2A or 8A according to the position of link (jumper) J1.

J1 position	06.11 setting	MDA3 amps max.
2A	201	0.5
2A	202	1.0
2A	203	1.5
2A	204	2.0
8A	205	2.5
8A	206	3.0
8A	207	3.5
8A	208	4.0
8A	209	4.5
8A	210	5.0
8A	211	5.5
8A	212	6.0
8A	213	6.5
8A	214	7.0
8A	215	7.5
8A	216	8.0

Figure 8-7 Location of J1 jumper



## NOTE

Mentor II can be used with an Issue (rev) 1 MDA3 card, maximum current 5A. Parameter **06.11** then has the range 101 to 110 and a field current range from 0.5A to 5A in steps of 0.5A.

Field control can alternatively be implemented by the FXM5 Field Control Unit (see section 11.7 *Field control unit FXM5* on page 103) for a maximum field current of 20A.

## 06.12 Field economy timeout

	RW	Uni			
↕	0 to 255	⇒	030	S	

Permits the drive to be configured to select maximum field 2 (a reduced setting) automatically after the drive has been disabled for a period (in seconds) defined by the value chosen for this parameter. Provided so that the windings do not overheat if the drive is stopped and the motor ventilation is switched off, or to maintain a reduced level of field current to prevent condensation when the motor is not in use.

## 06.13 Enable field control

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

## 06.14 Maximum field 2 selector

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Set to 1 to engage maximum field 2. Controlled automatically by field economy timeout function if **06.15** is set to 1. Maximum field 2 is selected after a time delay (refer to **06.12**) when a drive disable signal is given.

## 06.15 Enable field economy timeout

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

When enabled (=1), parameter **06.14** is automatically controlled by the field economy timeout function when a drive enable signal is removed. When the timeout is disabled, parameter **06.14** becomes user RW.

## 06.16 Field current loop integral gain

	RW	Bit			
↕	0 or 1	⇒	1, normal gain		

When set to = 0, the field current loop integral gain is increased to allow the loop to track the current demand more closely. However, this may result in instability and so should only be used if a fast change in flux is required and the field time-constant is low.

## 06.17 Voltage loop integral gain

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Set **06.17** = 1 to double the integral gain if less overshoot is desired.

**06.18 Enable speed gain adjustment**

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

This parameter adjusts the speed loop gains (menu 03) to compensate for the weakening of the field flux in field control mode so that the torque response remains substantially constant throughout the whole speed range.

Defined as:  $G = \frac{06.08}{06.02}$

Where:

$G$  = Speed loop gain adjustment factor

**06.19 Direct firing angle control**

	RW	Bit			
↕	0 or 1	⇒	0, disabled		

Enables **06.09** to control the firing angle directly, subject only to the front endstop. Permits operation without the voltage or the current loop, for the purpose of diagnosis.

**NOTE**

In this mode there is no protection against excessive field voltage and current.

**06.20 Alternative IR comp. 2 selector**

	RW	Bit			
↕	0 or 1	⇒	0 (= 03.08)		

Determines the source of the IR Compensation 2. The source selection may be either the Speed Error Integral **03.08** (set to 0) or the final current demand **04.02** (set to 1).

**06.21 Firing angle front endstop**

	RW	Uni			
↕	0 to 1000	⇒	+1000		

Restricts the advance of the firing angle in cases where 180° advance would result in overvoltage being applied to the field windings.

This can be used when the supply voltage is much higher than the required field voltage to prevent an overvoltage condition.

$$06.21 = 1023 - \frac{768}{180} \cos^{-1} \left[ \frac{V_{dc}\pi}{\sqrt{2}V_s} - 1 \right]$$

Where:

$V_{DC}$  = Required field voltage

$V_s$  = Supply voltage

**06.22 Full or half control selector**

	RW	Bit			
↕	0 or 1	⇒	0, half control		

Provides the option of full or half control. Available only with the FXM5 Field Controller. To use FXM5 in Full Control mode, set **06.22** = 1 and LK3 to Full Control position.

**06.23 Reduce gains by factor of 2**

	RW	Bit			
↕	0 or 1	⇒	0		

Setting this parameter to 1 reduces the field current gains by a factor of 2.

**06.24 Reduce gains by factor of 4**

	RW	Bit			
↕	0 or 1	⇒	0		

Setting this parameter to 1 reduces the field current gains by a factor of 4. Setting both **06.23** and **06.24** to 1 will result in the gains being reduced by 8.

### 8.6.7 Menu 07: Analog inputs & outputs

Scaling parameters have a multiplying range from 0.001 to 1.999 (a multiplier of zero would give the parameter a null value).

Source and Destination parameters define a parameter to be used as either input or output, thereby defining the function of the programmable input and output terminals.

Menu 07 contains three analog-input/output groupings. There are two separate groups of analog input. The first is a 12-bit analog input which is normally used as the speed reference input (refer to Menu 01, Diagram B), but can alternatively be programmed to any real RW (but not integer) destination.

High accuracy is achieved by voltage-to-frequency conversion. The terminal can be programmed as a voltage input or as a current loop input, with options 0-20mA, 20-0mA, 4-20mA or 20-4mA.

The second group provides a flexible means for scaling and assigning destinations to the four general purpose inputs GP1, GP2, GP3 and GP4, all of which are 10-bit resolution.

Finally, three analog outputs, via digital-to-analog (DAC) converters, feature programmable-source parameters and scaling.

#### 07.01 General purpose input 1

	RO	Bi			
⇅	±1000	⇒			

Displays the value of the analog signal applied to terminal TB1-04. Can be used as a general-purpose input for monitoring, or for Processor 2 special applications.

#### 07.02 General purpose input 2

	RO	Bi			
⇅	±1000	⇒			

Displays the value of the analog signal applied to terminal TB1-05. Can be used as a general-purpose input for monitoring, or for Processor 2 special applications.

#### 07.03 General purpose input 3

	RO	Bi			
⇅	±1000	⇒			

Displays the value of the analog signal applied to terminal TB1-06. Can be used as a general-purpose input for monitoring, or for Processor 2 special applications.

#### 07.04 General purpose input 4

	RO	Bi			
⇅	±1000	⇒			

Displays the value of the analog signal applied to terminal TB1-07. Can be used as a general-purpose input for monitoring, or for Processor 2 special applications.

#### 07.05 Speed reference input

	RO	Bi			
⇅	±1000	⇒			

Displays the value of the analog speed demand at terminal TB1-03, or master encoder (pulse tach.) reference via PL4, and after scaling by **07.24**; dependent on reference mode being selected by **07.25**.

#### 07.06 RMS input voltage

	RO	Uni			
⇅	0 to 1000	⇒			V

Monitors the value of the voltage applied to line input terminals L1, L2, L3 (the thyristor (SCR) stack supply).

#### 07.07 Heatsink temperature

	RO	Uni			
⇅	0 to 1000	⇒			°C

Monitors the temperature of the thyristor (SCR) stack on those drives provided with thermistors.

#### 07.08 DAC 1 source

	RW	Uni			
⇅	0 to 1999	⇒	+201, ramp output		

Selects the source of analog output 1 via terminal TB2-12.

#### 07.09 DAC 2 source

	RW	Uni			
⇅	0 to 1999	⇒	+302, speed feedback		

Selects the source of analog output 2 via terminal TB2-13.

#### 07.10 DAC 3 source

	RW	Uni			
⇅	0 to 1999	⇒	+304, armature voltage		

Selects the source of analog output 3 via terminal TB2-14.

#### NOTE

Of the following invisible parameters, Scaling parameters have a multiplying range from 0.000 to 1.999

Source and Destination parameters define a parameter to be used as either input or output, thereby defining the function of the programmable input and output terminals.

**07.11 GP1 destination**

	RW	Uni			
↕	0 to 1999	⇒	+318, hard speed ref.		

Selects the destination of analog input 1 via terminal TB1-04.  
A changed value becomes effective only when the RESET pushbutton is pressed.

**07.12 GP2 destination**

	RW	Uni			
↕	0 to 1999	⇒	+408, torque ref.		

Selects the destination of analog input 2 via terminal TB1-05.  
A changed value becomes effective only when the RESET pushbutton is pressed.

**07.13 GP3 destination**

	RW	Uni			
↕	0 to 1999	⇒	+119, speed ref. 3		

Selects the destination of analog input 3 via terminal TB1-06.  
A changed value becomes effective only when the RESET pushbutton is pressed.

**07.14 GP4 destination**

	RW	Uni			
↕	0 to 1999	⇒	+120, speed ref. 4		

Selects the destination of analog input 4 via terminal TB1-07.  
A changed value becomes effective only when the RESET pushbutton is pressed.

**07.15 Speed reference destination**

	RW	Uni			
↕	0 to 1999	⇒	+117, speed ref. 1		

Selects the destination of speed reference **07.05**.  
A changed value becomes effective only when the RESET pushbutton is pressed.

**07.16 GP1 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for the signal from source GP1 via terminal TB1-04.

$$\text{Scaling factor} = \frac{07.16}{1000}$$

**07.17 GP2 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for the signal from source GP2 via terminal TB1-05.

$$\text{Scaling factor} = \frac{07.17}{1000}$$

**07.18 GP3 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for the signal from source GP3 via terminal TB1-06.

$$\text{Scaling factor} = \frac{07.18}{1000}$$

**07.19 GP4 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for the signal from source GP4 via terminal TB1-07.

$$\text{Scaling factor} = \frac{07.19}{1000}$$

**07.20 Speed reference scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

The factor by which **07.05** is multiplied to produce the speed reference.

$$\text{Scaling factor} = \frac{07.20}{1000}$$

**07.21 DAC 1 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for signals output from DAC1 TB2-12.

$$\text{Scaling factor} = \frac{07.21}{1000}$$

**07.22 DAC 2 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for signals output from DAC2 TB2-13.

$$\text{Scaling factor} = \frac{07.22}{1000}$$

**07.23 DAC 3 scaling**

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Sets the scaling for signals output from DAC3 TB2-14.

$$\text{Scaling factor} = \frac{07.23}{1000}$$



## 07.24 Reference encoder scaling

	RW	Uni			
↕	0 to 1999	⇒	+419		

Sets the scaling for signals from the reference encoder (pulse tach.) connected to terminal socket PL4. The value should be set to correspond with the maximum speed of the motor and with the number of pulses-per-revolution of the encoder.

To calculate the scale factor:

$$\text{Scale factor} = \frac{750 \times (10^6)}{N \times n}$$

Where:

**N = number of pulses per revolution**

**n = max speed of motor in rpm.**

Default value is determined on the basis of a 1024-line encoder (pulse tach.), and a maximum speed of 1750rpm. Maximum frequency for the encoder is 105kHz.

## 07.25 Encoder reference selector

	RW	Bit			
↕	0 or 1	⇒	0, analog ref.selected		

0 = analog reference selected.

1 = encoder (pulse tach.) selected.

Selects either the analog signal at terminal TB1-03 or the encoder (pulse tach.) input via PL4 as the source of speed reference signal.

## 07.26 Current input selector

	RW	Bit			
↕	0 or 1	⇒	0, voltage input selected		

Configures the speed input terminal (TB1-03) to accept either a voltage or a 20mA input signal.

## 07.27 Current mode input selector

	RW	Bit			
↕	0 or 1	⇒	0		

In conjunction with **07.28**, configures 20mA current loop input.

Input	07.27	07.28
0-20mA	0	0
20-0mA	1	0
4-20mA	0	1
20-4mA	1	1

## 07.28 Current mode input selector

	RW	Bit			
↕	0 or 1	⇒	1		

In conjunction with **07.27**, configures 20mA current loop input.

When a 4mA offset is being used, the drive will trip if it senses that the current is <3.5mA indicating loop open.

## 07.29 Invert GP3 and GP4 analog inputs

	RW	Bit			
↕	0 or 1	⇒	0		

When set to 1 the polarity of GP3 and GP4 analog inputs will be inverted.

The value of **07.03** and **07.04** are not affected and will indicate the polarity of the voltage applied to terminals TB6 and TB7.

### 8.6.8 Menu 08: Digital inputs

#### 08.01 F1 input run permit

	RO	Bit			
⇅	0 or 1	⇒			

0 = stop drive  
1 = start enabled

Monitors the drive start-permit control input from terminal TB3-21 and indicates status. This input performs an over-riding drive stop function in speed control mode as follows

The input must be active in order that the drive can start.

If the input becomes inactive, **08.01** causes the pre-ramp reference **01.03** to be set to zero.

The drive will stop unless **02.03**, ramp hold, is active.

#### 08.02 F2 input inch reverse

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-22 and indicates status. The drive will respond to this input as inch reverse command only if the external logic controls are enabled (**08.21** = 0). Also its function is freely programmable.

#### 08.03 F3 input inch forward

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-23 and indicates status. The drive will respond to this input as inch forward command only if the external logic controls are enabled (**08.21** = 0). Also its function is freely programmable.

#### 08.04 F4 input run reverse

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-24 and indicates status. The drive will respond to this input as run reverse command only if the external logic controls are enabled (**08.21** = 0). Also its function is freely programmable.

This is a latched input parameter **01.11** will not revert to 0 if the input is removed, provided that **08.21** = 0.

#### 08.05 F5 input run forward

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-25 and indicates status. The drive will respond to this input as run forward command only if the external logic controls are enabled (**08.21** = 0). Also its function is freely programmable.

This is a latched input parameter **01.11** will not revert to 0 if the input is removed, provided that **08.21** = 0.

#### 08.06 F6 input

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-26 and indicates status.

#### 08.07 F7 input

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-27 and indicates status.

#### 08.08 F8 input

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-28 and indicates status.

#### 08.09 F9 input

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-29 and indicates status.

#### 08.10 F10 input

	RO	Bit			
⇅	0 or 1	⇒			

0 = input not active  
1 = input active

Monitors the control input from terminal TB3-30 and indicates status.

### 08.11 Enable input

	RO	Bit			
↕	0 or 1	⇒			

0 = disable  
1 = enable

Monitors the drive enable input from terminal TB4-31 and indicates status. Input must be active for the drive to operate. When the drive is disabled by disconnecting the input, all firing pulses are switched off after a 30ms delay. If the drive is running when this occurs, the result is a coast-stop and ramps reset.

### 08.12 F2 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-22. Effective only after RESET.

### 08.13 F3 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-23. Effective only after RESET.

### 08.14 F4 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-24. Effective only after RESET.

### 08.15 F5 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-25. Effective only after RESET.

### 08.16 F6 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-26. Effective only after RESET.

### 08.17 F7 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-27. Effective only after RESET.

### 08.18 F8 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-28. Effective only after RESET.

### 08.19 F9 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-29. Effective only after RESET.

### 08.20 F10 destination

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines the destination of external logic input at terminal TB3-30. Effective only after RESET.

### 08.21 Disable normal logic functions

	RW	Bit			
↕	0 or 1	⇒	0		

0 = enable normal logic function  
1 = disable normal logic function

Default 0

If set to enable (= 0), this parameter configures logic inputs in the following manner:

F2	TB3-22Inch Reverse
F3	TB3-23Inch Forward
F4	TB3-24Run Reverse
F5	TB3-25Run Forward

If set to disable (=1), the logic inputs must be programmed by the user. A programmable input can be used to control parameter 1.11(Reference ON) only if a RUN PERMIT signal is present.

See also parameters 08.31 to 08.34.

Serial communications can be used to control the drive when normal logic functions are disabled by writing to parameters 1.11, 1.12 and 1.13.

**08.22 Invert input F2****08.23 Invert input F3****08.24 Invert input F4****08.25 Invert input F5****08.26 Invert input F6****08.27 Invert input F7****08.28 Invert input F8****08.29 Invert input F9****08.30 Invert input F10**

	RW	Bit			
↕	0 or 1	⇒	0		

0 = not invert  
1 = invert logic function

**08.31 Enable inch reverse**

	RW	Bit			
↕	0 or 1	⇒	0		

0 = not enable  
1 = enable Inch Reverse

When **08.21** = 1, normal logic functions disabled, **08.31** can enable Inch Rev.

**08.32 Enable inch forward**

	RW	Bit			
↕	0 or 1	⇒	0		

0 = not enable  
1 = enable Inch Forward

When **08.21** = 1, normal logic functions disabled, **08.32** can enable Inch Fwd.

**08.33 Enable run reverse**

	RW	Bit			
↕	0 or 1	⇒	0		

0 = not enable  
1 = enable Run Reverse

When **08.21** = 1, normal logic functions disabled, **08.33** can enable Run Rev.

**08.34 Enable run forward**

	RW	Bit			
↕	0 or 1	⇒	0		

0 = not enable  
1 = enable Run Forward

When **08.21** = 1, normal logic functions disabled, **08.34** can enable Run Fwd.

### 8.6.9 Menu 09: Status outputs

Status Output parameters define a parameter to be used as a source, thereby defining the function of programmable output terminals.

Menu 09 contains three status source groupings, each of which can be inverted. The two sources ST1 and ST2 can be combined in any convenient configuration for output to terminals TB2-15 and TB2-16. The second group selects from sources ST3, ST4, ST5 for output to TB2-17, TB2-18, TB2-19 respectively, or source ST6 (relay output).

Delays **09.12** and **09.18** apply to status outputs ST1 and ST2 in 0 -> 1 transitions.

In 1 -> 0 transitions the effect is immediate, without delay.

<b>09.01</b>	<b>Status 1 output</b>				
<b>09.02</b>	<b>Status 2 output</b>				
<b>09.03</b>	<b>Status 3 output</b>				
<b>09.04</b>	<b>Status 4 output</b>				
<b>09.05</b>	<b>Status 5 output</b>				
<b>09.06</b>	<b>Status 6 output (relay)</b>				
	RO	Bit			
⇅	0 or 1	⇒			
<b>09.07</b>	<b>Status 1 source 1</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+111		
<b>09.08</b>	<b>Invert status 1 source 1</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		
<b>09.09</b>	<b>Status 1 source 2</b>				
	RW	Uni			
⇅	0 to 1999	⇒	000		
<b>09.10</b>	<b>Invert status 1 source 2</b>				
	RW	Bit			
⇅	0 or 1	⇒	+000		
<b>09.11</b>	<b>Invert status 1 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	+000		

<b>09.12</b>	<b>Status 1 delay</b>				
	RW	Uni			
⇅	0 to 255	⇒	0	Sec	
<b>09.13</b>	<b>Status 2 source 1</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+1007		
<b>09.14</b>	<b>Invert status 2 source 1</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		
<b>09.15</b>	<b>Status 2 source 2</b>				
	RW	Uni			
⇅	0 to 1999	⇒	000		
<b>09.16</b>	<b>Invert status 2 source 2</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		
<b>09.17</b>	<b>Invert status 2 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		
<b>09.18</b>	<b>Status 2 delay</b>				
	RW	Uni			
⇅	0 to 255	⇒	0	Sec	
<b>09.19</b>	<b>Status 3 source</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+1013		
<b>09.20</b>	<b>Invert status 3 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		
<b>09.21</b>	<b>Status 4 source</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+1003		

<b>09.22</b>	<b>Invert status 4 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		

<b>09.23</b>	<b>Status 5 source</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+1006		

<b>09.24</b>	<b>Invert status 5 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		

<b>09.25</b>	<b>Status 6 source (relay)</b>				
	RW	Uni			
⇅	0 to 1999	⇒	+1009		

<b>09.26</b>	<b>Invert status 6 output</b>				
	RW	Bit			
⇅	0 or 1	⇒	0		

## 8.6.10 Menu 10: Status logic & diagnostic information

All real (not bit) RO parameters are frozen at the instant of tripping as an aid to diagnosis of the fault. They remain in this condition until the drive is reset.

### 10.01 Forward velocity

	RO	Bit			
↕	0 or 1	⇒			

- 0 = Drive stationary or running in reverse  
1 = Drive running forward at >zero speed threshold

Forward direction defined as follows:

When tachometer feedback selected, terminal TB1-09 negative with respect to terminal TB1-10.

When armature voltage feedback selected, terminal A1 positive with respect to terminal A2.

When encoder (pulse tach.) feedback selected, A-channel leads B-channel.

### 10.02 Reverse velocity

	RO	Bit			
↕	0 or 1	⇒			

- 0 = Drive stationary or running forward  
1 = Drive running in reverse at >zero speed threshold

Reverse direction defined as follows:

When tachometer feedback selected, terminal TB1-09 positive with respect to terminal TB1-10.

When armature voltage feedback selected, terminal A1 negative with respect to terminal A2.

When encoder (pulse tach.) feedback selected, A-channel lags B-channel.

#### NOTE

If **10.01** = **10.02** = 0, the motor is either stationary or running at <zero speed threshold. In this condition, **10.09** = 1 and the Zero Speed LED illuminates on the keypad (and RL2 is turned on, if programmed to indicate zero speed).

### 10.03 Current limit

	RO	Bit			
↕	0 or 1	⇒			

- 0 = Drive not in current limit  
1 = Drive in current limit

Indicates that the sum of the current demand **04.01** and the offset **04.09** is being limited by the current limit over-ride **04.03** or by one of the bridge limits.

### 10.04 Bridge 1 enabled

	RO	Bit			
↕	0 or 1	⇒			

- 0 = disabled  
1 = enabled

Indicates that thyristor (SCR) bridge 1 (the forward or positive bridge) is being fired. Does not necessarily indicate that the bridge is conducting, since conduction depends on firing angle and operating conditions.

### 10.05 Bridge 2 enabled

	RO	Bit			
↕	0 or 1	⇒			

- 0 = disabled  
1 = enabled

Indicates that thyristor (SCR) bridge 2 (the reverse or negative bridge) is being fired. Does not necessarily indicate that the bridge is conducting, since conduction depends on firing angle and operating conditions.

### 10.06 Electrical phase-back

	RO	Bit			
↕	0 or 1	⇒			

- 0 = firing pulses not phased back  
1 = firing pulses phased back (at standstill)

Indicates that the firing pulses are being phased back by the action of the standstill function. Refer to **05.18** and **05.19**.

### 10.07 At speed

	RO	Bit			
↕	0 or 1	⇒			

- 0 = Drive not at speed  
1 = Drive at speed

Indicates that the drive has attained set speed, post-ramp reference **02.01** = pre-ramp reference **01.03**, and also that comparison of final speed demand **03.01** with speed feedback **03.02** results in a speed error of <1.5% of maximum speed. External signal also provided through open collector output ST2 to terminal TB2-16 if source parameter **09.13** is at default setting.

### 10.08 Overspeed

	RO	Bit			
↕	0 or 1	⇒			

- 0 = motor not overspeeding  
1 = motor over speed

Indicates that the speed feedback **03.02** > 1000, that is, the speed is out of range, suggesting that the motor is being mechanically driven faster than the maximum speed of the drive. This function is a monitor only, and does not initiate a trip signal.

## 10.09 Zero speed

	RO	Bit			
⇅	0 or 1	⇒			

0 = speed not zero  
1 = zero speed

Set if speed feedback **03.02** < zero speed threshold **03.23**. Refer to **10.01** and **10.02**

## 10.10 Armature voltage clamp active

	RO	Bit			
⇅	0 or 1	⇒			

0 = clamp not active  
1 = clamp active

Set when the armature voltage clamp is activated. Prevents the voltage from increasing further. Refer to **03.15**.

## 10.11 Phase rotation

	RO	Bit			
⇅	0 or 1	⇒			

0 = L1 L3 L2  
1 = L1 L2 L3

Rotation is detected from L1, L2, L3.

### NOTE

Connection to E1 and E3 must also be correct - refer to Figure 6-2 and Figure 6-3.

## 10.12 Drive healthy (normal)

	RO	Bit			
⇅	0 or 1	⇒			

1 = Drive is powered-up and has not tripped.

## 10.13 Alarm (I x t)

	RO	Bit			
⇅	0 or 1	⇒			

0 = no alarm condition present  
1 = alarm condition present, impending sustained-overload trip

Indicates that the drive is in an overload condition and will eventually trip on sustained overload **10.18** if the overload condition is not removed.

The time taken to trip is dependent on the settings of **05.06** and **05.07** and on the magnitude of overload.

Visual indication that the alarm has been actuated is given by the Alarm LED (flashing). External signal also provided through status logic output ST3 to terminal TB2-17 provided that source parameter 09.19 is at its default value.

## 10.14 Field loss

	RO	Bit			
⇅	0 or 1	⇒			

0 = field healthy (normal)  
1 = field failed

Indicates that no current is being drawn from the internal field supply (or the FXM5 optional external field control unit if installed).

The field loss trip does not operate when the direct firing angle control is selected (**6.19**).

## 10.15 Feedback loss

	RO	Bit			
⇅	0 or 1	⇒			

0 = speed feedback present  
1 = speed feedback absent or polarity reversed

Indicates no feedback signal, or reversed polarity. Applies equally to tachogenerator (tachometer) and encoder (pulse tach.) feedback, whichever is selected. Loss of feedback is not detected until the firing angle has advanced to the point where the value of **05.03** (firing angle) >767. This condition can be prevented from tripping the drive by disabling feedback loss detection **10.30**.

## 10.16 Supply or phase loss

	RO	Bit			
⇅	0 or 1	⇒			

0 = healthy (normal)  
1 = supply/phase loss

Indicates loss of one or more input phases connected to L1, L2, L3. Can be disabled by means of **10.31**.

## 10.17 Instantaneous trip

	RO	Bit			
⇅	0 or 1	⇒			

0 = no overcurrent peak detected  
1 = overcurrent peak detected

Indicates that a current peak >2 x (max. current according to the burden resistor installed) has occurred. The result is that firing pulses are immediately suppressed, shutting the drive down.



### 10.18 Sustained overload

	RO	Bit			
⇅	0 or 1	⇒			

0 = sustained overload not detected  
1 = sustained overload detected

Indicates that current feedback **05.01** has exceeded the overload threshold **05.06** for a length of time determined by the overload time values **05.07** and **05.08** integrated with the magnitude of the overload (the conventional  $I \times t$  function).

When the current exceeds the overload threshold, the excess integrates with time causing the value of the actual overload **05.11** to increase.

Conversely, if the current falls below the threshold during integration, the value of **05.11** falls towards zero. The rate of integration is set by **05.07** when the current is > threshold, and by **05.08** when the current is < threshold. The rate of integration is the trip time with full scale overload (**05.01** = 1000). This function imitates the behavior of a thermal relay and simulates the thermal characteristic of a motor.

### 10.19 Processor 1 watchdog

	RO	Bit			
⇅	0 or 1	⇒			

0 = healthy (normal)  
1 = trip

In normal operation of the drive the watchdog timer is reset periodically by Processor 1 as a check that the processor and drive program are functioning normally. If a reset does not occur before the timer has timed out the conclusion is either that the processor has failed or that the drive program has crashed. The result is immediate controlled shutdown of the drive, accompanied by a watchdog fault trip signal.

### 10.20 Processor 2 watchdog

	RO	Bit			
⇅	0 or 1	⇒			

0 = healthy (normal)  
1 = trip

### 10.21 Motor overtemperature

	RO	Bit			
⇅	0 or 1	⇒			

0 = healthy (normal)  
1 = trip

**10.21** = 1 indicates trip detected at the motor thermistor input terminal.  
trip level 3k $\Omega$   
detector reset level 1.8k $\Omega$

### 10.22 Heatsink overtemperature

	RO	Bit			
⇅	0 or 1	⇒			

0 = healthy (normal)  
1 = trip

**10.22** = 1 indicates thyristor (SCR) stack overtemperature, >100°C (on drives fitted with a thyristor (SCR) stack heatsink thermistor).

### 10.23 Speed loop saturated

	RO	Bit			
⇅	0 or 1	⇒			

0 = speed loop not saturated  
1 = speed loop saturated

Indicates that the output of the speed loop algorithm, from which the current demand **04.01** is derived, is at a limit. This may be due to the application of a current limit or a zero-current clamp, and may occur if the motor is mechanically stalled.

### 10.24 Zero current demand

	RO	Bit			
⇅	0 or 1	⇒			

0 = current demand > 0  
1 = current demand = 0

Indicates that the current demand signal is being limited to zero. This could occur, for example, as a result of a sudden loss of load, the drive being in torque control mode with speed over-ride. The speed could reach the set speed threshold as a consequence, causing the speed loop to reduce the current demand to zero.

### 10.25 Last trip

	RO	Uni			
⇅	0 to 255	⇒			

Record of the last-trip code, forming the basis of a trip history.

### 10.26 The trip before the last trip (10.25)

	RO	Uni			
⇅	0 to 255	⇒			

Record of the trip before that which is saved in **10.25**.

### 10.27 The trip before 10.26

	RO	Uni			
⇅	0 to 255	⇒			

Record of the trip before that which is saved in **10.26**.

### 10.28 The trip before 10.27

	RO	Uni			
↕	0 to 255	⇒			

Record of the trip before that which is saved in **10.27**.

The four parameters **10.25** to **10.28** provide a permanent memory of the last four trips. They are updated only by a new trip occurring.

### 10.29 Disable field loss trip

	RW	Bit			
↕	0 or 1	⇒	0		

0 = field loss trip enabled

Prevents the drive from tripping when field loss is detected, for example, in applications where the internal field supply is not used or is switched off when the drive is not running.

### 10.30 Disable feedback loss trip

	RW	Bit			
↕	0 or 1	⇒	0		

0 = feedback loss enabled

Prevents the drive from tripping when speed feedback loss is detected, for example in certain load-sharing applications and in applications which do not involve motors, such as battery charging and other electrolytic processes.

### 10.31 Disable supply or phase loss trip

	RW	Bit			
↕	0 or 1	⇒	0		

0 = supply/phase loss enabled

Prevents the drive from tripping when supply or supply phase loss is detected, allowing the drive to ride through brief supply interruptions.

### 10.32 Disable motor overtemperature trip

	RW	Bit			
↕	0 or 1	⇒	1		

1 = motor overtemperature trip disabled

Prevents the drive from tripping when motor temperature sensor input changes to high resistance, for example when motor overtemperature protection is used in the alarm mode, or to achieve a line normal stop.

### 10.33 Disable heatsink overtemperature trip

	RW	Bit			
↕	0 or 1	⇒	0		

0 = heatsink overtemperature trip enabled

Prevents the drive from tripping when heatsink temperature sensor detects a temperature greater than 100°C for example when the thyristor (SCR) heatsink overtemperature protection is used in the alarm mode, or to achieve a system normal stop.

#### NOTE

This parameter defaulted to 1 on drives with software before V5. Factory set to 1 on drives from M25-M105.

### 10.34 External trip

	RW	Bit			
↕	0 or 1	⇒	0		

If **10.34** = 1, the drive will trip. If an external trip is required, the user can program any logic input to control this bit (refer to Menu 08). Alternatively it can be controlled by application software or through the serial interface.

### 10.35 Processor 2 trip

	RW	Uni			
↕	0 to 255	⇒	0		

If the drive is healthy (normal), the data display for **10.35** is 0. The value of **10.35** is continuously monitored by the processor. The drive trips immediately if a non-zero value (other than 255) appears via the serial communications interface, or Processor 2 software.

If **10.35** = 255, this is the equivalent of a RESET.

### 10.36 Disable current loop loss trip

	RW	Bit			
↕	0 or 1	⇒	0		

When **10.36** = 1 the trip which normally would follow loss of the current loop is disabled.

### 10.37 Disable armature open circuit trip

	RW	Bit			
↕	0 or 1	⇒	0		

When set, the armature open circuit trip (AOP) is disabled.

## 8.6.11 Menu 11: Miscellaneous

### NOTE

Some menu 11 parameters change dependant on what option module is fitted. For details refer to:

- section 8.6.16 *MD24-PROFIBUS-DP set-up* on page 84
- section 8.6.17 *MD25-DeviceNet set-up* on page 85
- section 8.6.18 *MD-IBS (INTERBUS) set-up* on page 86

### User defined menu

Parameters **11.01** through to **11.10** define the parameters in the user-defined Menu 00. For example, if the user wishes parameter **00.01** to display speed in rpm (**03.03**), parameter **11.01** (corresponding to **00.01**) should be set to 303.

Parameters **11.09** through to **11.10** are shared and have functions associated with the MD29 PCB. Refer to the *MD29 User Guide*.

### 11.11 Serial address

	RW	Uni			
↕	0 to 99	⇒	001		

Defines the unique address of a drive when several are connected to common serial bus in a multidrop application. If set to 100, the value is taken as 99.

### 11.12 Baud rate

	RW	Bit			
↕	0 or 1	⇒	0		

Two Baud rates are available for the communications interface with the standard drives. Enter the setting number appropriate to the required Baud rate as shown:

Baud	Setting
4800	0
9600	1

A drive reset is required before the setting takes effect.

### 11.13 Serial mode

	RW	Uni			
↕	1 to 4	⇒	001		

Defines the mode of operation of the serial port.

There are four modes. Enter the setting number appropriate to the required mode as shown:

Mode	Setting
ANSI protocol	1
Output variable defined by <b>11.19</b>	2
Input variable into parameter defined by <b>11.19</b>	3
Wide integer (16-bit) driver	4

**Mode 1** is for communication between the drive and another serial device (terminal, PLC, computer).

**Mode settings 2 and 3** are for rapid transfer of information between two drives, avoiding the need for analog signals to pass between them. For example, mode settings 2 and 3 could be used in a load-sharing application to output the current demand from one drive in Mode 2 and input a current demand to another in Mode 3.

In **Mode 4** the drive will output the wide integer **15.63** to the transmit lines, and put any received data into **15.62**. This permits a digital reference to be transmitted down a line of drives, and offers the

possibility of setting ratios at each stage. Data must be transferred from **15.62** to **15.63** by an MD29 program. If a Wide Integer is read from the serial comms link (interface), the data will be sent as five ASCII characters with no sign. (The full range of parameters can be written by five ASCII characters so long as no sign is included). Data is transferred by mode 4 at the rate of 3 x AC mains power frequency.

A drive reset is required before the value takes effect.

### 11.14 Reserved

	RW				
↕		⇒			

This parameter is reserved.

### 11.15 Processor 1 software version

	RO	Uni			
↕	0 to 1000	⇒			

Displays the revision number of the software installed in Processor 1. For example, version 4.10.0 is displayed as 410 (data window).

### 11.16 Processor 2 software version

	RO	Uni			
↕	0 to 1000	⇒			

Reserved for processor 2 special application software (MD29 option PCB).

### 11.17 Level 3 security code

	RW	Uni			
↕	0 to 255	⇒	149		

If this parameter is changed (to any value other than 0 or 149) and stored, the value set must be entered into parameter 0 to return the drive to its as-delivered state. Level 1 or Level 2 security must then be used in the normal way. If **11.17** is set = 0, all parameters are freely read-write accessible without the need to enter a security code. To store, set parameter 00 = 1 and press RESET.

### 11.18 Boot-up parameter

	RW	Uni			
↕	0 to 1999	⇒	+000		

Used for setting the parameter displayed at the keypad at power-on.

### 11.19 Serial programmable source

	RW	Uni			
↕	0 to 1999	⇒	+000		

Defines an output or input parameter when serial mode 2 or 3 is selected. Refer to **11.13**.

### 11.20 Serial scaling

	RW	Uni			
↕	0 to 1999	⇒	+1000		

Scales the input data in serial mode 3. Refer to **11.13**.

## 11.21 LEDs byte

	RW	Uni			
↕	0 to 255	⇒			

Designations:

Bit 7	Alarm
Bit 6	Zero speed
Bit 5	Run forward
Bit 4	Run reverse
Bit 3	Bridge 1
Bit 2	Bridge 2
Bit 1	At speed
Bit 0	Current limit

The displayed value is the decimal equivalent of the bit-pattern.

## 11.22 Disable normal LED functions

	RW	Bit			
↕	0 or 1	⇒	0, enabled		

Disables the normal functions of the keypad LED indicators (with the exception of Drive Ready) and renders them programmable. By setting **11.22** = 1, normal LED functions (with the exception of Drive Ready ) can be controlled via the serial interface or processor 2 special application software. The LEDs display the binary equivalent of the value in **11.21**.

## 11.23 High voltage MDA6

	RW	Bit			
↕	0 or 1	⇒	0		

Setting of 1 = MDA6 High voltage (660V)

If the High voltage (660V) MDA6 power board is to be used for a high voltage Mentor II, this parameter must be set = 1.

## 11.24 Mains (AC power) dip ride-through

	RW	Bit			
↕	0 or 1	⇒	0		

Default 1 = Enable ride-through

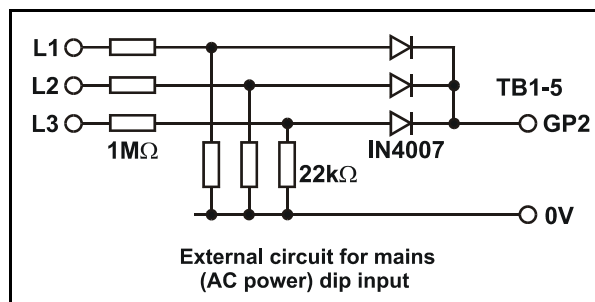
### NOTE

In order to maximize the mains dip ride-through capability of the Mentor II it is necessary to connect the circuit shown in Figure 8-8.

Software version V3.1.0, or later, must be installed.

Analog input GP2 (refer to Menu 07) is set up as a mains healthy (AC power normal) input when parameter 11.24 = 1. When set up in this way, if the voltage on terminal TB1-5 (GP2) falls below the 1 V threshold, the drive disables firing immediately and shuts the display off to reduce power consumption. When the drive detects that the supply has been established for 40mS, it will reset and restart provided that the appropriate RUN and ENABLE commands are still present. The drive will typically take 340ms to restart after a mains dip.

Figure 8-8



### NOTE

With software version V4.2.0 and earlier the drive healthy relay would change state to indicate a fault if the drive detected a mains dip.

## 8.6.12 Menu 12: Programmable thresholds

### 12.01 Threshold 1 exceeded

	RO	Bit			
--	----	-----	--	--	--

⇅	0 or 1	⇒		
---	--------	---	--	--

0 = healthy (normal)  
1 = threshold exceeded

### 12.02 Threshold 2 exceeded

	RO	Bit			
--	----	-----	--	--	--

⇅	0 or 1	⇒		
---	--------	---	--	--

0 = healthy (normal)  
1 = threshold exceeded

### 12.03 Threshold 1 source

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1999	⇒	+302	
---	-----------	---	------	--

### 12.04 Threshold 1 level

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1000	⇒	+000	
---	-----------	---	------	--

### 12.05 Threshold 1 hysteresis

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 255	⇒	002	
---	----------	---	-----	--

### 12.06 Invert threshold 1 output

	RW	Bit			
--	----	-----	--	--	--

⇅	0 or 1	⇒	0	
---	--------	---	---	--

0 = default  
1 = signal inverted

### 12.07 Threshold 1 destination

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1999	⇒	+000	
---	-----------	---	------	--

### 12.08 Threshold 2 source

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1999	⇒	+501	
---	-----------	---	------	--

### 12.09 Threshold 2 level

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1000	⇒	+000	
---	-----------	---	------	--

### 12.10 Threshold 2 hysteresis

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 255	⇒	002	
---	----------	---	-----	--

### 12.11 Invert threshold 2 output

	RW	Bit			
--	----	-----	--	--	--

⇅	0 or 1	⇒	0	
---	--------	---	---	--

0 = default  
1 = signal inverted

### 12.12 Threshold 2 destination

	RW	Uni			
--	----	-----	--	--	--

⇅	0 to 1999	⇒	+000	
---	-----------	---	------	--

## 8.6.13 Menu 13: Digital lock

### 13.01 Master encoder counter

	RO	Uni			
↕	0 to 1023	⇒			

### 13.02 Slave encoder counter

	RO	Uni			
↕	0 to 1023	⇒			

### 13.03 Master counter increment

	RO	Bi			
↕	±1000	⇒			

### 13.04 Slave counter increment

	RO	Bi			
↕	±1000	⇒			

### 13.05 Position error

	RO	Bi			
↕	±1000	⇒			

Indicates the difference between the positions of the master shaft and the slave shaft.

### 13.06 Precision reference (lsb)

	RW	Uni			
↕	0 to 255	⇒	000		

See also **13.07**, **13.12** and **13.13**

### 13.07 Precision reference (msb)

	RW	Uni			
↕	0 to 255	⇒	000		

See also **13.06**, **13.12** and **13.13**

Parameters **13.06** and **13.07** are used, in conjunction with each other, to define a 16-bit velocity reference when parameter **13.12** = 0.

Parameter **13.06** is the least-significant component.

Parameter **13.07** is the most-significant component.

Each unit of **13.07** represents 256 increments of **13.06**.

### 13.08 Position loop gain

	RW	Uni			
↕	0 to 255	⇒	025		

Determines the amount of velocity correction per unit of position error. The setting thus determines how quickly the loop responds to a disturbance, and thus affects the motor output shaft position.

$$\text{The gain applied} = \frac{\mathbf{13.08}}{\mathbf{256}}$$

This parameter must be adjusted in conjunction with the Speed Loop PID Gains **03.09**, **03.10** and **03.11** to attain the best balance between stability and quick response.

### 13.09 Position loop correction limit

	RW	Uni			
↕	0 to 1000	⇒	+010		

Limits the amount of the velocity-correction resulting from a position error.

### 13.10 Enable digital lock

	RW	Bit			
↕	0 or 1	⇒	0		

0 = disabled

1 = enabled

Enables the Position Loop software.

### 13.11 Rigid lock selector

	RW	Bit			
↕	0 or 1	⇒	0		

0 = disabled

1 = enabled

When **13.11** = 1, the position error, relative to the time the position loop is closed, is always absolute. This means that if the slave output shaft is slowed down by an overload, position will be regained by an automatic speed increase when the load reduces to or below maximum.

When **13.11** = 0 (default), the Position Loop is closed only when the At Speed condition is reached. This allows the accelerating Ramps to be used without overspeeding the slave output shaft.

### 13.12 Precision reference source

	RW	Bit			
↕	0 or 1	⇒	0		

1 = master encoder (pulse tach.)

0 = precision reference

Determines the source of the digital loop reference, as between the master encoder (pulse tach.) (**13.01**) or the precision references (**13.06** and **13.07**).

### 13.13 Precision reference latch

	RW	Bit			
↕	0 or 1	⇒	1		

0 = use last values  
1 = use updated values

The two Precision Reference values, **13.06** and **13.07**, cannot be changed simultaneously. To prevent the Position Loop reading inconsistent values during the change, parameter **13.13** = 0 (default) enables the Position Loop to continue to use the last values while the change is taking place. When a change of both **13.06** and **13.07** has been completed, setting **13.13** = 0 causes the updated values to be applied. **13.13** should then be reset to 0, ready for the next update.

### 13.14 Precision speed reference (16-bit)

	RW	Uni			
↕	000 to 65535	⇒	0		

This parameter is a wide integer equivalent to the Precision Reference **13.06** and **13.07**, and allows the precision reference to be written as a single statement, removing the need for the latch, parameter **13.13**. Parameter **13.14** is intended primarily for use through serial communications.

## 8.6.14 Menu 14: MD29 system set-up

### NOTE

Some menu 14 parameters change dependant on what option module is fitted. For details refer to:

- section 8.6.16 *MD24-PROFIBUS-DP set-up* on page 84
- section 8.6.17 *MD25-DeviceNet set-up* on page 85
- section 8.6.18 *MD-IBS (INTERBUS) set-up* on page 86

### NOTE

The set-up parameters take effect only after the MD29 or drive has been reset, or when a RENIT instruction in a DPL program has been executed.

#### 14.01 ANSI serial address

	RW	Int			
⇅	0 to 99	⇒	1		

This parameter defines the addresses for serial communications.

#### 14.02 RS485 mode

	RW	Int			
⇅	1 to 16	⇒	1		

This parameter sets the Mode for serial communications.  
All modes except Modes 7 and 8 are fixed in the format:  
1 start bit, 7 data bits, even parity, 1 stop bit.

#### 14.03 RS485 Baud rate (Mode 1, 5, 6 and 7)

	RW	Int			
⇅	3 to 192	⇒	48		

This parameter sets the Baud rate:  
24 = 2400, 48 = 4800, etc.

#### 14.04 Clock task timebase (ms)

	RW	Int			
⇅	1 to 200	⇒	10		

Defines the clock-tick time in milliseconds for executing the CLOCK Task of a DPL program.  
Maximum: 100ms.

#### 14.05 CTNet Node address

	RW	Int			
⇅	0 to 255	⇒	0		

Specifies the CTNet Node address.  
Available with MD29AN only.

#### 14.06 Auto-run mode

	RW	Bit			
⇅	0 or 1	⇒	1		

When set at 1, this parameter enables a DPL program to be automatically started when the MD29 is reset or powered-up.  
When set at zero, a command must be issued from the MD29 Toolkit software before the DPL program will start.

#### 14.07 Global run time trip enable

	RW	Bit			
⇅	0 or 1	⇒	1		

When set at 1, this parameter causes the MD29 to trip and stop if a Task over-runs.

There is no controlled stop.

The display will show A29.

#### 14.08 I/O link trip enable

	RW	Bit			
⇅	0 or 1	⇒	0		

When set at 1, this parameter causes the MD29 to trip if there is a communication link failure between the MD29 and the CT I/O box.

#### 14.09 Enable watchdog (WDOG)

	RW	Bit			
⇅	0 or 1	⇒	0		

When this parameter is set at 1, the drive will trip if a fault occurs in the MD29 hardware or software.

A user's DPL program cannot cause this trip.

#### 14.10 Trip if a parameter write over-ranges

	RW	Bit			
⇅	0 or 1	⇒	1		

Each drive parameter has a finite range of values which can be accepted. Any value which is outside the parameter limits could signify a program failure.

When this parameter is set at 1, the drive will trip if a parameter is outside the limits. When it is set at 0, the MD29 places a limit-on the value written.

#### 14.11 Disable monitor port protocol

	RW	Bit			
⇅	0 or 1	⇒	0		

Setting this parameter at 1 puts the RS232 serial port into plain ASCII mode, and disables all the communications protocols for debugging and using the MD29 Toolkit.

#### 14.12 Position controller enable

	RW	Bit			
⇅	0 or 1	⇒	0		

When this parameter is set at 1, the MD29 indicates if the Clock Task over-runs.

#### 14.13 I/O link synchronisation source

	RW	Bit			
⇅	0 or 1	⇒	0		

When this parameter is set at 1, the MD29 indicates if the Encoder Task over-runs.



#### 14.14 Encoder time base select

	RW	Bit			
↕	0 or 1	⇒	0		

This parameter sets the timebase for the ENCODER Task.

0 = 5ms

1 = 2.5ms

#### 14.15 Reserved

	RW	Bit			
↕	0 or 1	⇒	0		

#### 14.16 Flash store request

	RW	Bit			
↕	0 or 1	⇒	0		

Set to 1 to save the PLC parameter registers (.PX% and -QX%) into the non volatile memory of the MD29. The parameter value automatically returns to 0.

See the *MD29 User Guide* for more details.

#### 14.17 RS232 drive - drive comms enable

	RW	Bit			
↕	0 or 1	⇒	0		

When set to 1, and the DPL Toolkit communications are disabled, drive to drive RS232 communications are enabled.

See *MD29 User Guide* for more details.

### 8.6.15 Menus 15 and 16: Applications menus

These menus are free for use by any application program within a MD29.

<b>15.01 to 15.05</b>	<b>RO variable 1 to 5</b>				
-------------------------------	---------------------------	--	--	--	--

	RO	Bi			
⇅	±1999	⇒			

<b>15.06 to 15.10</b>	<b>Real RW variable 1 to 5</b>				
-------------------------------	--------------------------------	--	--	--	--

	RW	Bi			
⇅	±1999	⇒	+000		

<b>15.11 to 15.20</b>	<b>Integer RW variable 1 to 10</b>				
-------------------------------	------------------------------------	--	--	--	--

	RW	Uni			
⇅	0 to 255	⇒	000		

<b>15.21 to 15.36</b>	<b>Bit variable 1 to 16</b>				
-------------------------------	-----------------------------	--	--	--	--

	RW	Bit			
⇅	0 or 1	⇒	0		

<b>15.37 to 15.59</b>	<b>Real RW (not saved in NVRAM)</b>				
-------------------------------	-------------------------------------	--	--	--	--

	RW	Bit			
⇅	0 to 1999	⇒	0		

Cannot be set by keypad.

<b>16.01 to 16.05</b>	<b>RO variable 1 to 5</b>				
-------------------------------	---------------------------	--	--	--	--

	RW	Bi			
⇅	±1999	⇒			

<b>16.06 to 16.10</b>	<b>Real RW variable 1 to 5</b>				
-------------------------------	--------------------------------	--	--	--	--

	RW	Bi			
⇅	±1999	⇒	+000		

<b>16.11 to 16.20</b>	<b>Integer RW variable 1 to 10</b>				
-------------------------------	------------------------------------	--	--	--	--

	RW	Uni			
⇅	0 to 255	⇒	000		

<b>16.21 to 16.36</b>	<b>Bit variable 1 to 16</b>				
-------------------------------	-----------------------------	--	--	--	--

	RW	Bit			
⇅	0 or 1	⇒	0		

<b>16.37 to 16.61</b>	<b>Real RW (not saved in NVRAM)</b>				
-------------------------------	-------------------------------------	--	--	--	--

	RW	Bit			
⇅	0 to 1999	⇒	0		

Cannot be set by keypad

## Special parameters in menu 15

<b>15.60</b>	<b>Ratio 1 wide integer</b>
	RW Uni
0 to 65535	000

This parameter is the equivalent of parameters **15.16** and **15.17**, such that Ratio 1 in the Digital Lock software can be written simultaneously, removing the need for the latch, **15.31**.

<b>15.61</b>	<b>Ratio 2 wide integer</b>
	RW Uni
0 to 65535	000

This parameter is the equivalent of parameters **15.18** and **15.19**, such that Ratio 2 in the Digital Lock software can be written simultaneously, removing the need for the latch, **15.31**.

<b>15.62</b>	<b>Serial Mode 4 input data</b>
	RO
0 to 65535	

When serial (interface) Mode 4 is selected, this parameter is loaded with a variable input from the serial (interface) port.  
Refer also to parameter **11.13**.

<b>15.63</b>	<b>Serial Mode 4 output data</b>
	RO
0 to 65535	

When serial (interface) Mode 4 is selected, this parameter is transmitted to the next drive down the line.

## Special parameters in menu 16

<b>16.62</b>	<b>CTNet diagnostic parameter</b>
	RO
0 to 1999	

This parameter indicates the state of the CTNet network.

A value greater than 0 indicates a healthy network, with the value representing the number of messages per second received by the node.

A value of 0 indicates a healthy network, but no data is being transmitted. This usually indicates that there is no node configured to generate cyclic synchronisation messages.

A value of -1 indicates an unhealthy network caused by cabling error, no termination resistors, no other nodes on network, etc.

A value of -2 indicates initialisation failure, such as baud rate mismatch or illegal address. Often this will be accompanied with a trip on power-up.

<b>16.63</b>	<b>DPL line number where trip occurred</b>
	RO
0 to 1999	

This parameter is only used when the DPL program has been compiled with the debugging information switched on. The value it gives indicates the approximate line number within the DPL program where a run-time error occurred. If no run-time error has occurred, the value will be meaningless.

## 8.6.16 MD24-PROFIBUS-DP set-up

### NOTE

The set-up parameters take effect only after the MD24-PROFIBUS-DP or drive has been reset.

#### 14.01 PROFIBUS-DP node address

	RW	Int			
↕	1 to 124	⇒	1		

This parameter defines the node address to be used by the MD24-PROFIBUS-DP.

#### 11.01 IN channel 1 mapping

	RW	Int			
↕	101 to 1941	⇒	1941		

This parameter specifies the source parameter for IN cyclic channel 1. A mapping value of 1941 selects the MD24-PROFIBUS-DP status word as the source parameter.

#### 11.02 IN channel 2 mapping

	RW	Int			
↕	101 to 1941	⇒	302		

This parameter specifies the source parameter for IN cyclic channel 2.

#### 11.03 IN channel 3 mapping

	RW	Int			
↕	101 to 1941	⇒	501		

This parameter specifies the source parameter for IN cyclic channel 3.

#### 11.04 OUT channel 1 mapping

	RW	Int			
↕	101 to 1940	⇒	1940		

This parameter specifies the destination parameter for the OUT cyclic channel 1. A mapping value of 1940 selects the MD24-PROFIBUS-DP control word as the destination parameter.

#### 11.05 OUT channel 2 mapping

	RW	Bit			
↕	101 or 1941	⇒	118		

This parameter specifies the destination parameter for OUT cyclic channel 2.

#### 11.06 OUT channel 3 mapping

	RW	Bit			
↕	101 or 1941	⇒	118		

This parameter specifies the destination parameter for OUT cyclic channel 3.

## 8.6.17 MD25-DeviceNet set-up

### NOTE

The set-up parameters take effect only after the MD25-DeviceNet or drive has been reset.

#### 14.01 DeviceNet node address

	RW	Int			
⇅	0 to 63	⇒	63		

This parameter defines the node address to be used by the MD25-DeviceNet.

#### 14.02 DeviceNet data rate

	RW	Int			
⇅	0 to 2	⇒	0		

This parameter specifies the data rate of the DeviceNet network.

#### 14.03 Node status

	RO	Int			
⇅	1 to 10	⇒	N/A		

Indicates the current operating status of the MD25-DeviceNet.

#### 14.04 Network status

	RW	Int			
⇅	1 to 10	⇒	N/A		

Indicates the current operating status of the DeviceNet network.

#### 14.06 Network loss trip enable

	RW	Int			
⇅	0 to 2	⇒	0		

Set to 1 to enable the DeviceNet network loss trip.

#### 11.01 IN channel 1 mapping

	RW	Int			
⇅	101 to 1941	⇒	1941		

This parameter specifies the source parameter for IN polled channel 1. A mapping value of 1941 selects the MD25-DeviceNet status word as the destination parameter.

#### 11.02 IN channel 2 mapping

	RW	Int			
⇅	101 to 1941	⇒	302		

This parameter specifies the source parameter for IN polled channel 2.

#### 11.03 IN channel 3 mapping

	RW	Int			
⇅	101 to 1940	⇒	501		

This parameter specifies the source parameter for IN polled channel 2.

#### 11.04 OUT channel 1 mapping

	RW	Bit			
⇅	101 or 1941	⇒	1940		

This parameter specifies the destination parameter for OUT polled channel 1. A mapping value of 1940 selects the MD25-DeviceNet control word as the destination parameter.

#### 11.05 OUT channel 2 mapping

	RW	Bit			
⇅	101 or 1941	⇒	118		

This parameter specifies the destination parameter for OUT cyclic channel 2.

#### 11.06 OUT channel 3 mapping

	RW	Bit			
⇅	101 or 1941	⇒	408		

This parameter specifies the destination parameter for OUT cyclic channel 3.

## 8.6.18 MD-IBS (INTERBUS) set-up

### NOTE

The set-up parameters take effect only after the MD-IBS or drive has been reset.

#### 14.01 Parameter map source data

	RW	Int			
↕	0 or 1	⇒	1		

Specifies which data mapping information to use.  
0 = EEPROM mode.  
1 = manual parameter mapping mode

#### 14.02 INTERBUS network loss trip

	RW	Int			
↕	0 to 100	⇒	1		

Specifies the network loss trip time-delay in intervals of 20ms. A value of 5 gives a trip time of 100ms.

#### 14.03 OUT process data disable

	RW	Int			
↕	0 to 48	⇒	48		

Enables and disables data transfer from the INTERBUS master controller to the MD-IBS.  
0 - enabled  
>= 1 - disabled.

#### 11.01 IN channel 1 mapping

	RW	Int			
↕	101 to 1941	⇒	1941		

This parameter specifies the source parameter for IN cyclic channel 1. A mapping value of 1941 selects the MD-IBS status word as the source parameter.

#### 11.02 IN channel 2 mapping

	RW	Int			
↕	101 to 1941	⇒	302		

This parameter specifies the source parameter for IN cyclic channel 2.

#### 11.03 IN channel 3 mapping

	RW	Int			
↕	101 to 1941	⇒	501		

This parameter specifies the source parameter for IN cyclic channel 3.

#### 11.04 OUT channel 1 mapping

	RW	Int			
↕	101to 1940	⇒	1940		

This parameter specifies the destination parameter for the OUT cyclic channel 1. A mapping value of 1940 selects the MD-IBS control word as

the destination parameter.

#### 11.05 OUT channel 2 mapping

	RW	Bit			
↕	101 or 1941	⇒	118		

This parameter specifies the destination parameter for OUT cyclic channel 2.

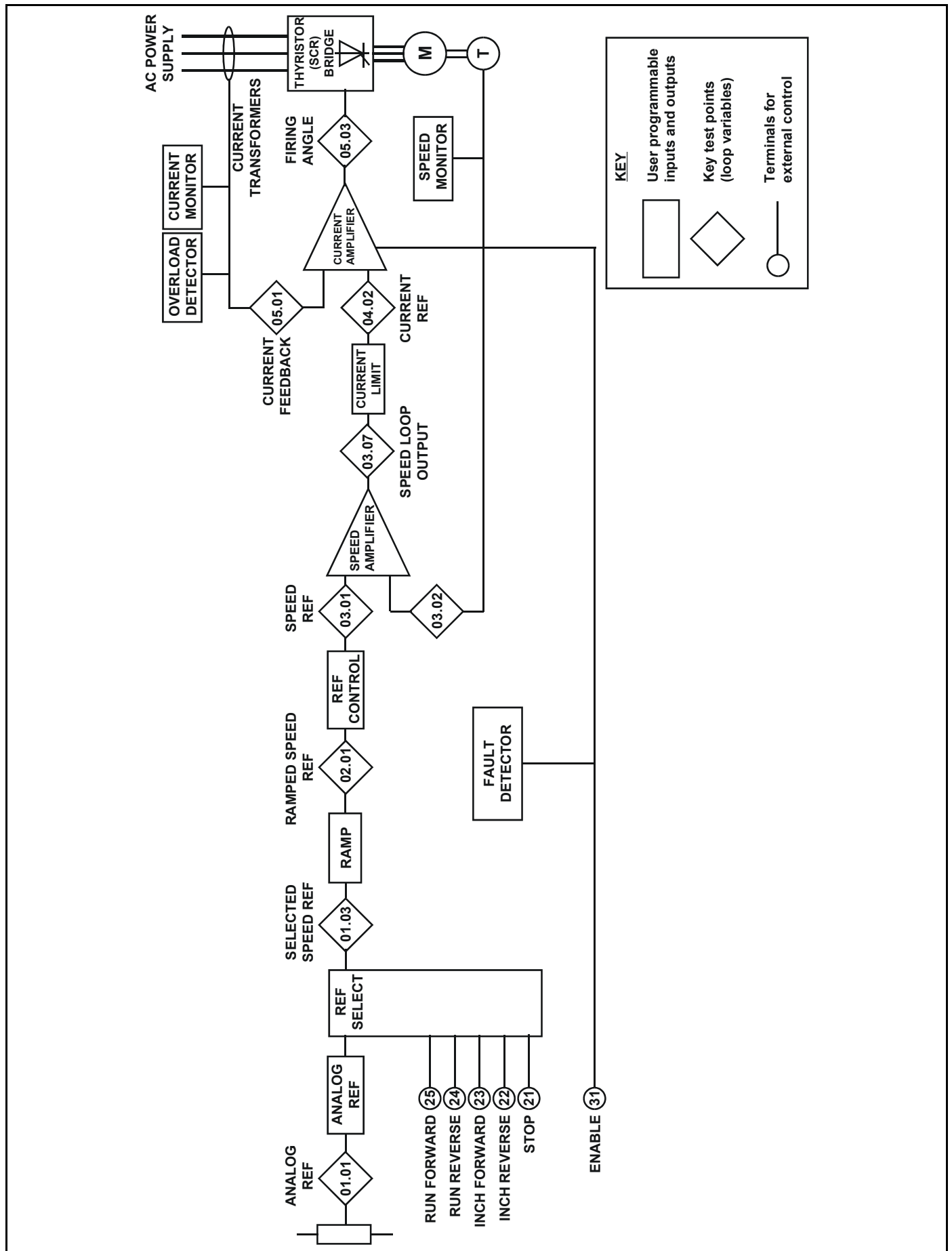
#### 11.06 OUT channel 3 mapping

	RW	Bit			
↕	101 or 1941	⇒	118		

This parameter specifies the destination parameter for OUT cyclic channel 3.

## 8.7 Menu logic diagrams

Figure 8-9 Control logic overview



**Functional Block Diagram of the Speed Reference Control System**

**KEY:**

- R/W logic
- R/O logic
- Internal logic

**Diagram Components and Flow:**

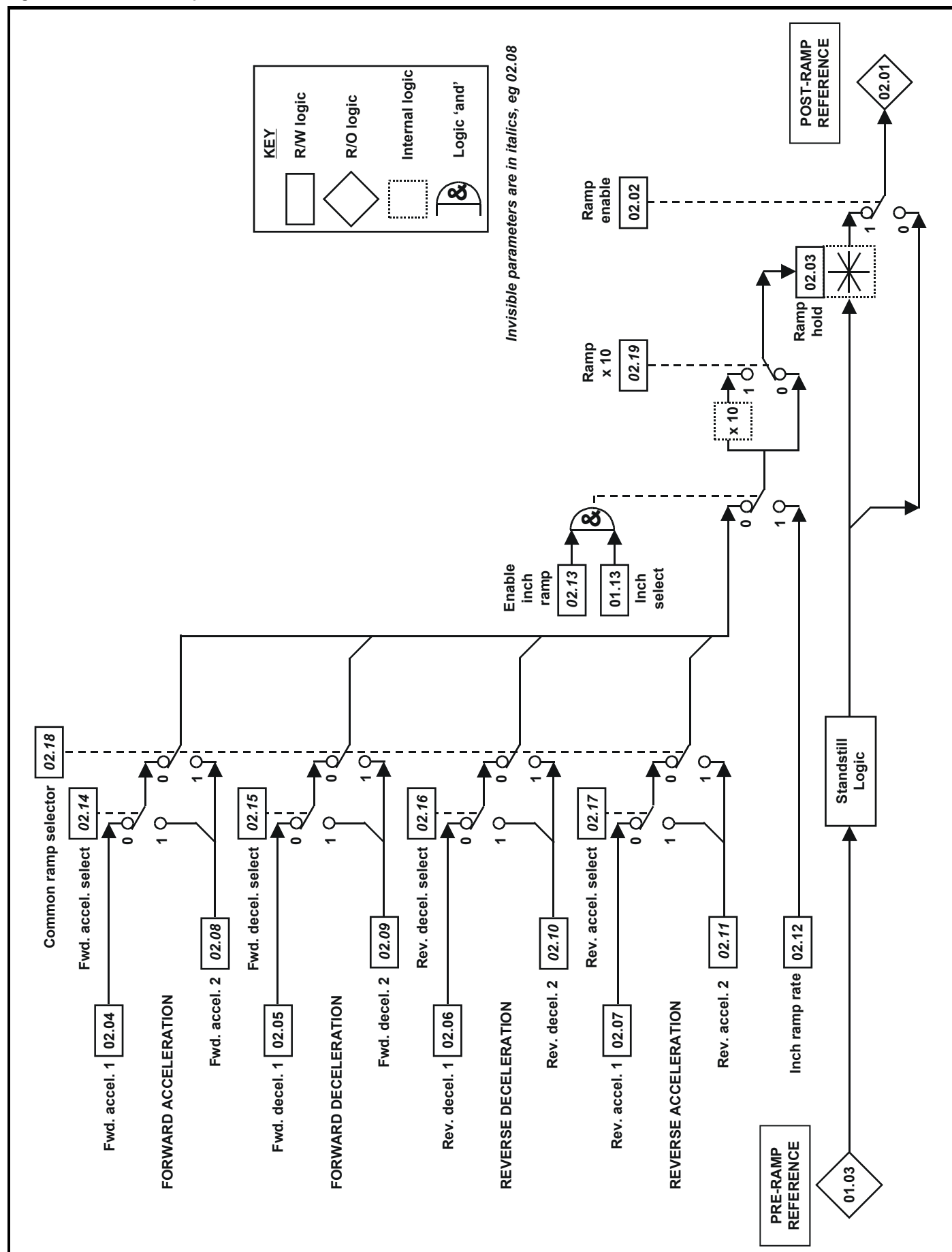
- Inputs:** RUN PERMIT (08.01), Ref. select 1 (01.14), Ref. select 2 (01.15), Ref. 'ON' (01.11), Zero ref. interlock (01.16), Bipolar select (01.10), Rev. (01.12), Inch (01.13), Max. fwd. (01.06), Min. fwd. (01.07), Min. rev. (01.08), Max. rev. (01.09), Offset (01.04), Pre-offset speed reference (01.01), Post-offset speed reference (01.02), REF 1 (01.17), REF 2 (01.18), REF 3 (01.19), REF 4 (01.20), Inch ref. (01.05).
- Logic Blocks:**
  - 01.01:** Pre-offset speed reference logic, receiving REF 1-4 and Ref. select 1.
  - 01.02:** Post-offset speed reference logic, receiving Ref. select 2 and 01.01 output.
  - 01.03:** PRE-RAMP REFERENCE logic, receiving 01.02 output and Ref. 'ON'.
  - 01.04:** Offset logic, receiving 01.03 output and Offset (01.04).
  - 01.05:** Inch ref. logic, receiving Inch (01.13) and 01.04 output.
  - 01.06-01.09:** Max/Fwd and Min/Rev logic, receiving 01.05 output and 01.12.
  - 01.10:** Bipolar select logic, receiving 01.06-01.09 outputs and 01.10.
  - 01.11:** Ref. 'ON' logic, receiving 01.10 output and Ref. 'ON'.
  - 01.12:** Rev. logic, receiving 01.11 output and 01.12.
  - 01.13:** Inch logic, receiving 01.12 output and 01.13.
  - 01.14-01.15:** Ref. select logic, receiving 01.13 output and Ref. select 1/2.
  - 01.16:** Zero ref. interlock logic, receiving 01.14-01.15 outputs and Zero ref. interlock.
  - 01.17-01.20:** REF 1-4 logic, receiving 01.16 output and REF 1-4 inputs.
- Outputs:** The final output is the result of the logic flow, which can be 0 or 1, indicating the speed reference signal.

**Notes:**

- Invisible parameters are in italics, eg 01.14
- TB3-21



Figure 8-11 Menu 02 Ramp selection



**Figure 8-12 Menu 03 Feedback selection and speed loop**

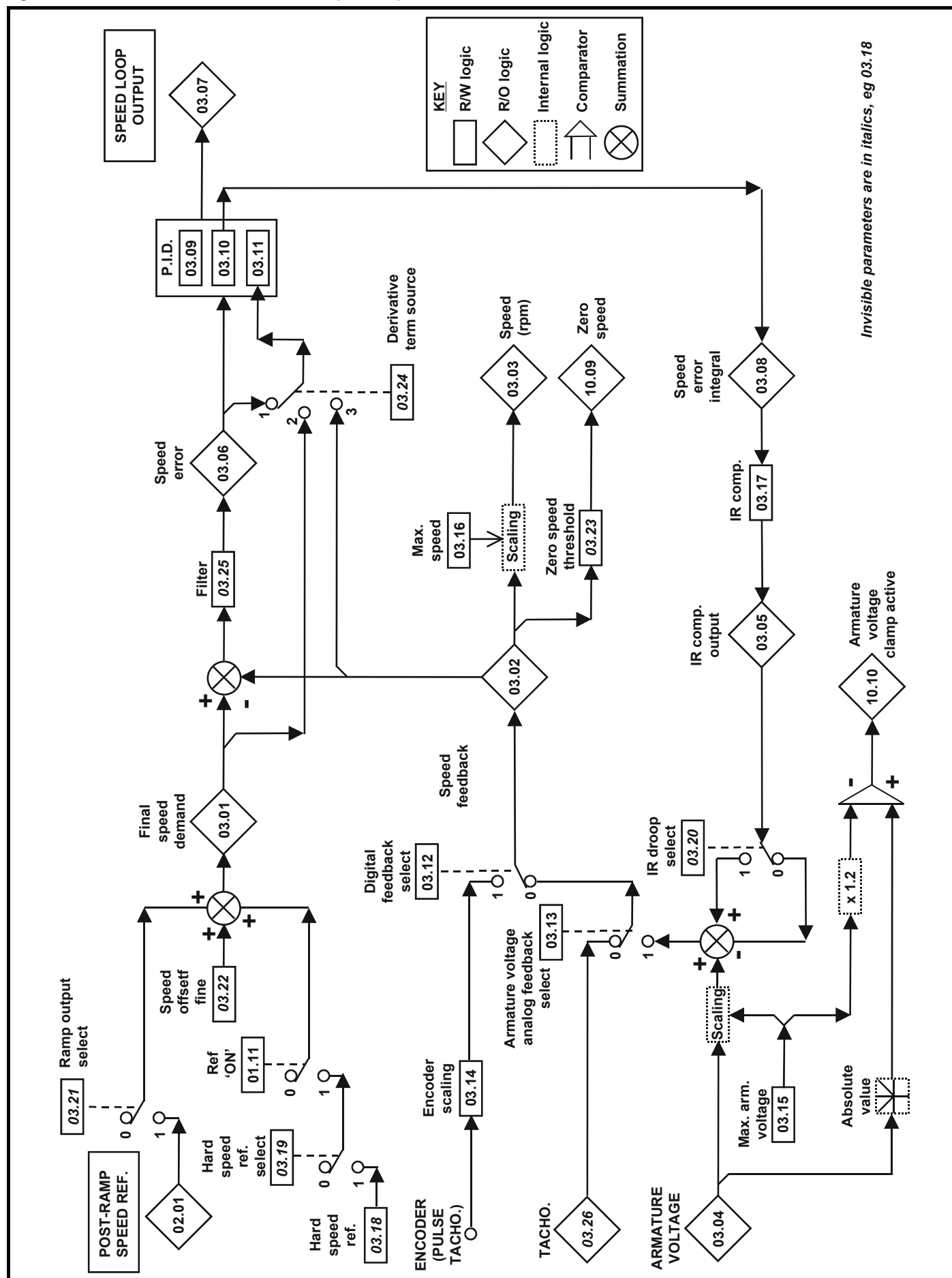
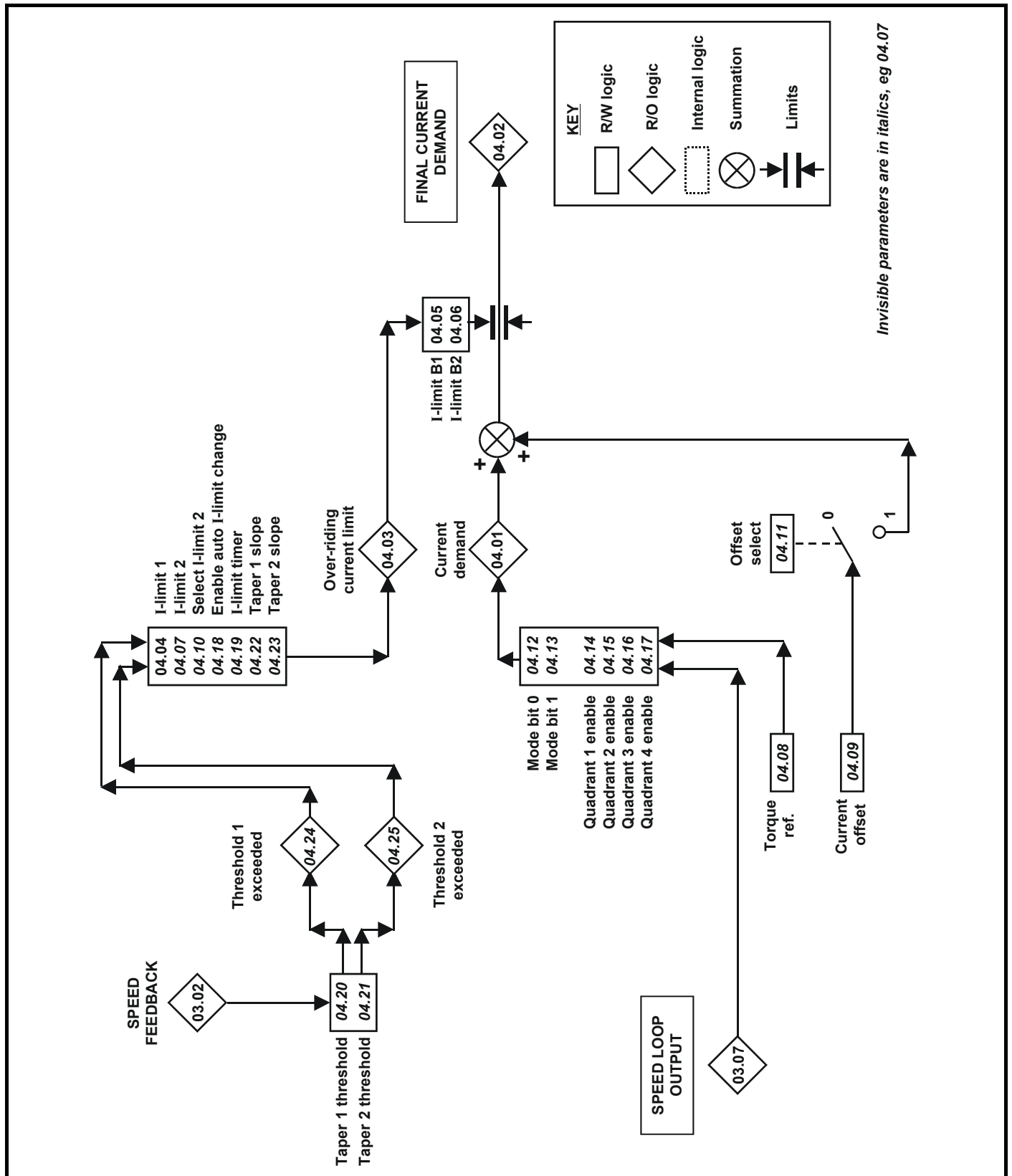


Figure 8-13 Menu 04 Current selection and limits



**Figure 8-14 Menu 05 Current loop**

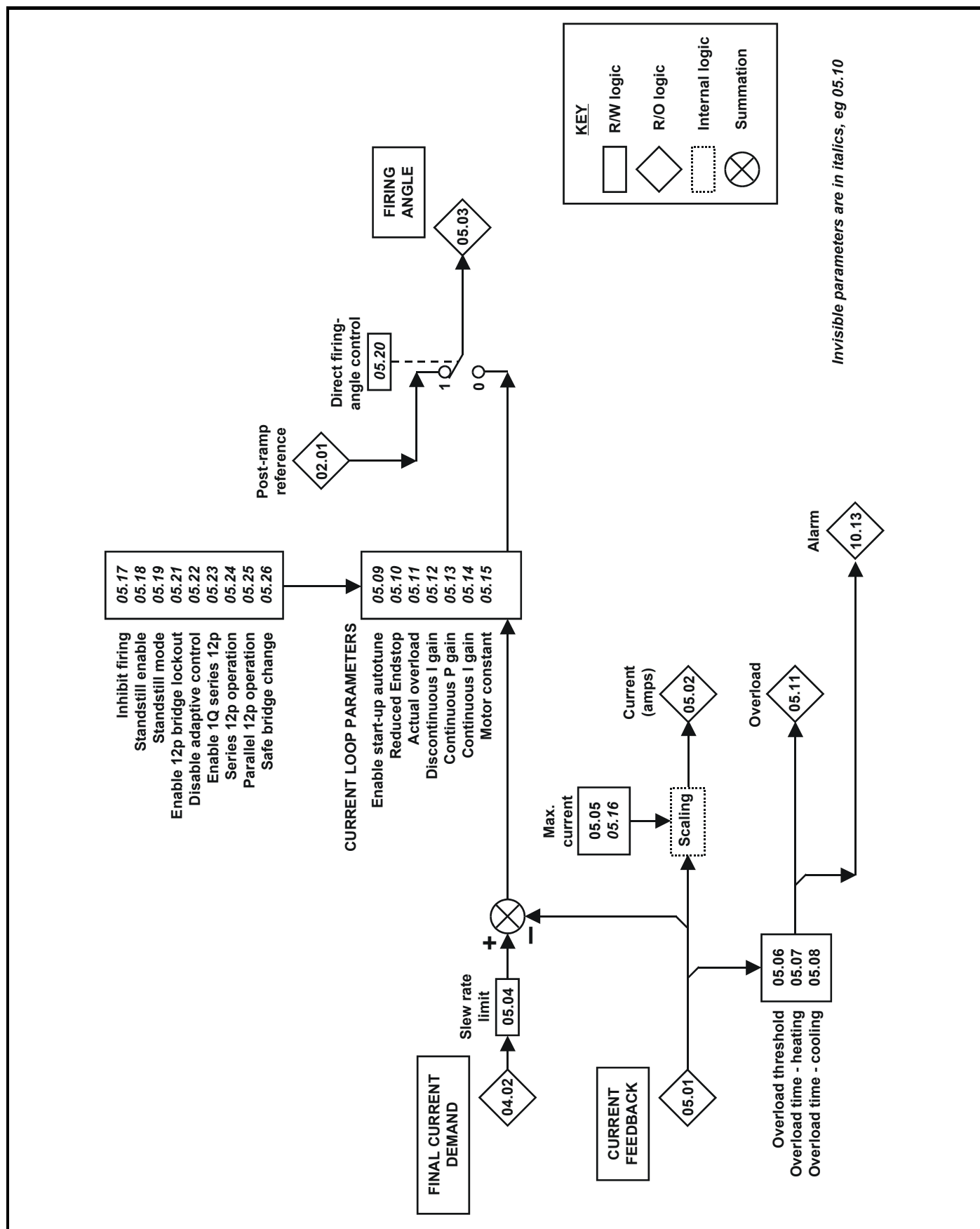




Figure 8-16 Menu 07 Analog inputs and outputs

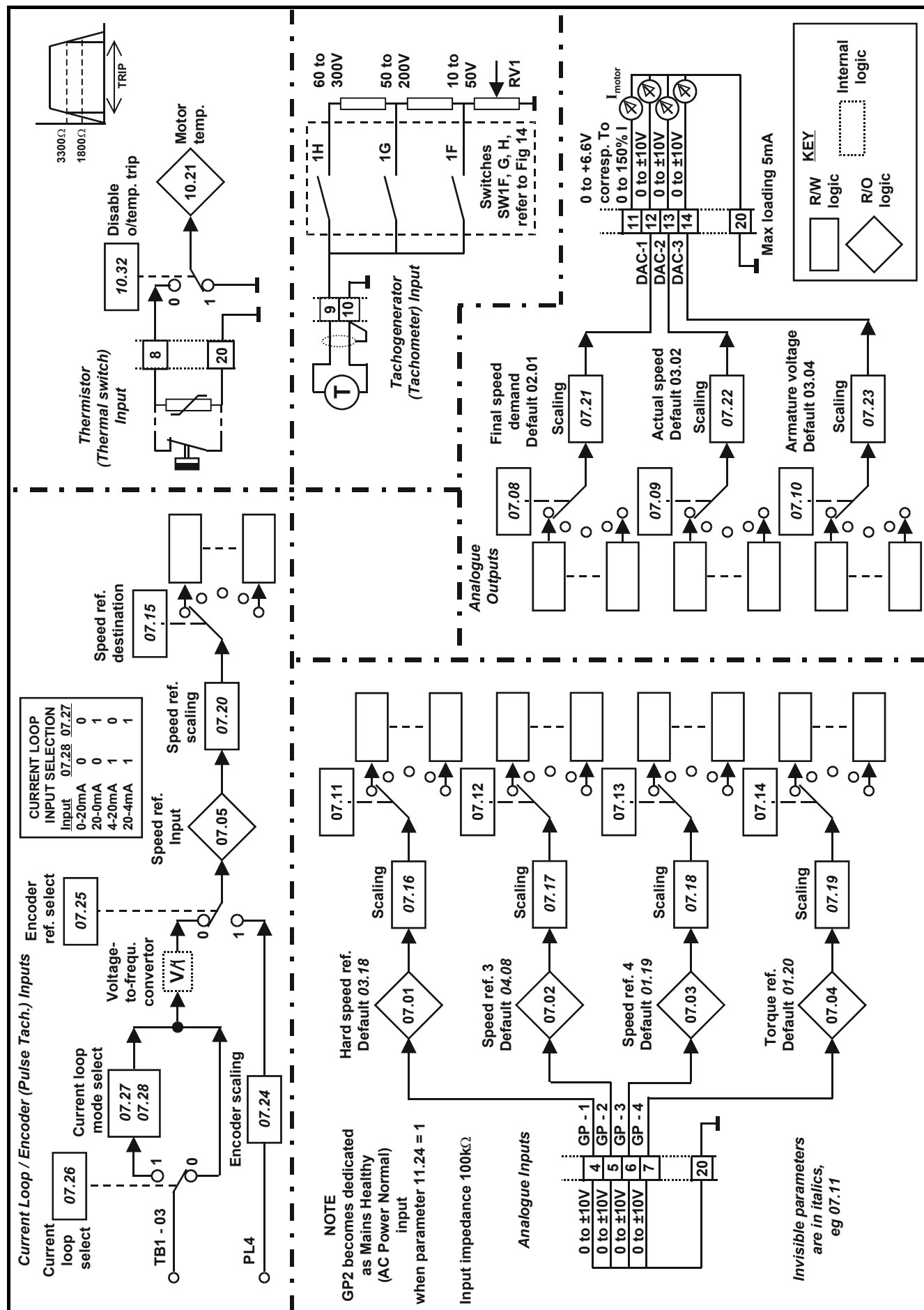




Figure 8-18 Menu 09 Status outputs

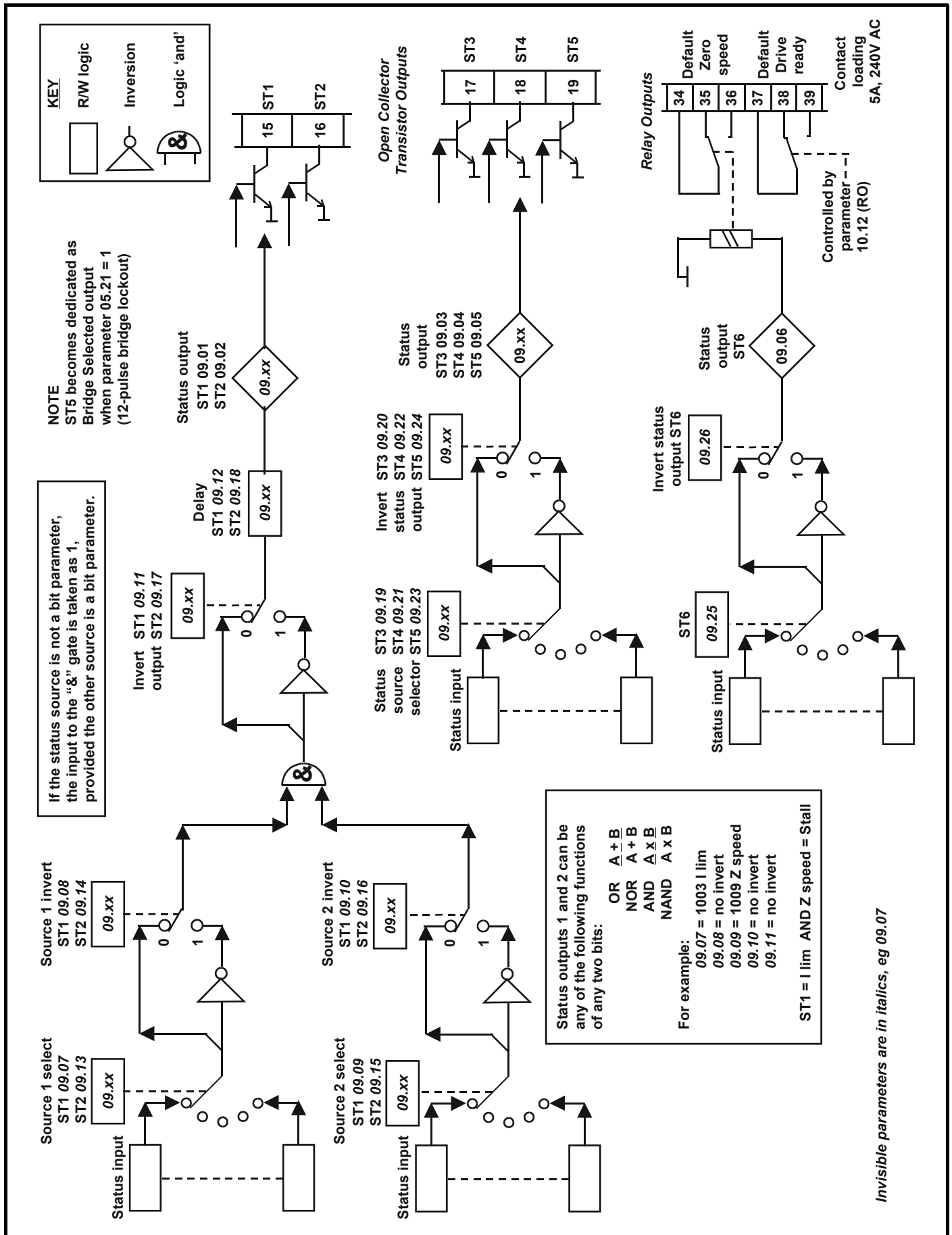
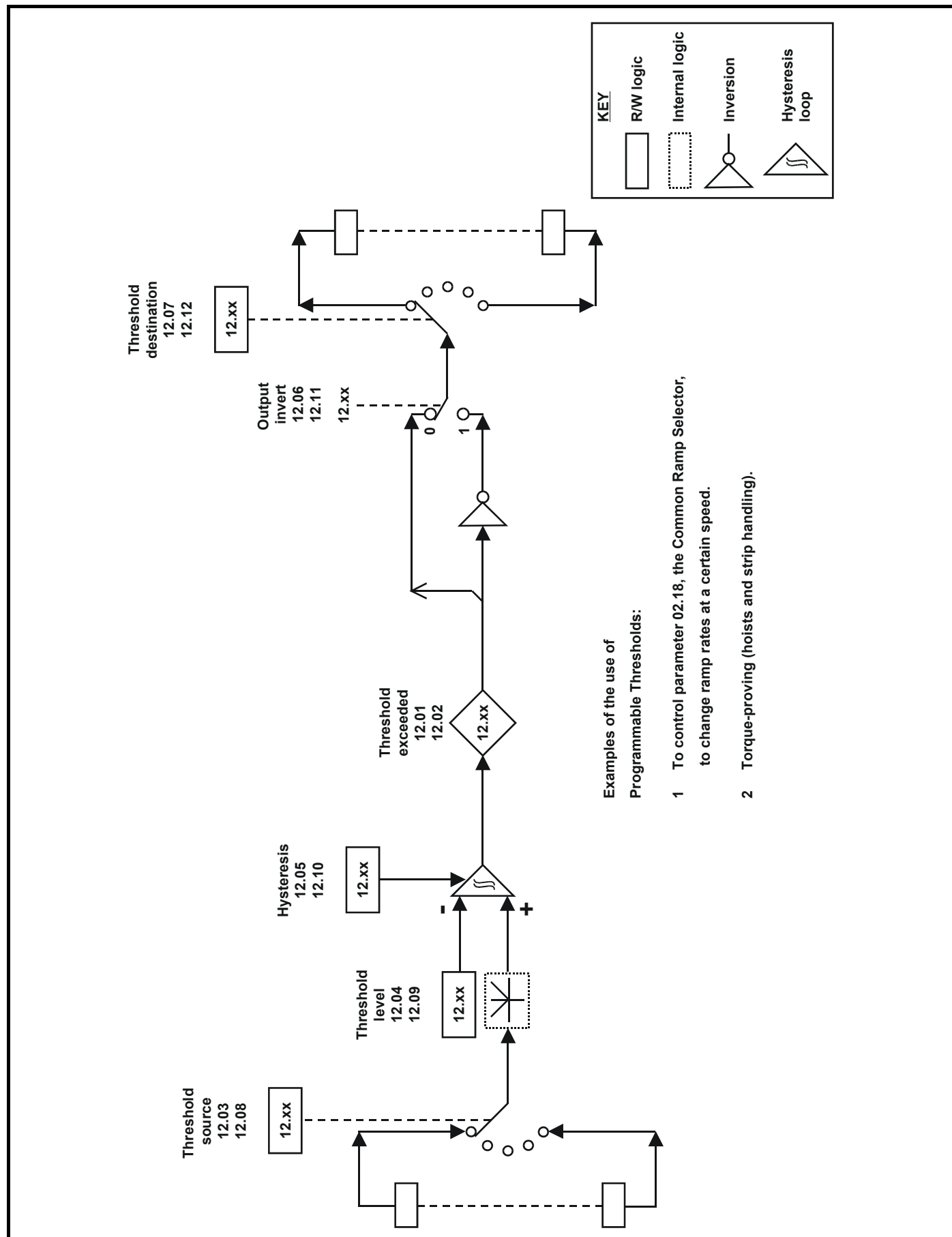
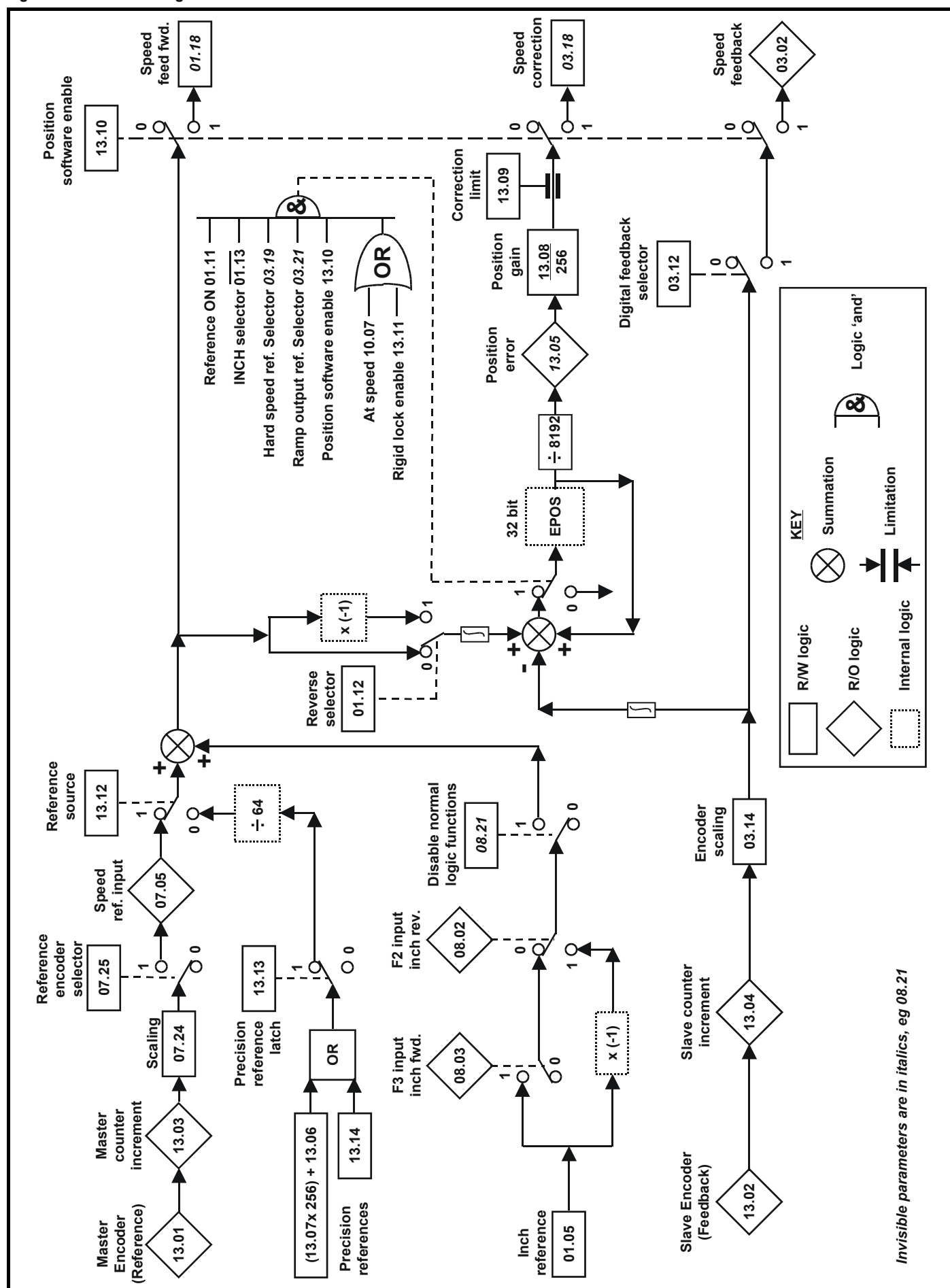




Figure 8-19 Menu 12 Programmable thresholds



**Figure 8-20 Menu 13 Digital lock**



## 9 Diagnostic procedures

### 9.1 Trip codes

Mnem.	Code	Reason for the trip	
<b>AOC</b>	121	Armature overcurrent	An instantaneous protection trip has been activated due to excess current in the armature circuit
<b>AOP</b>	126	Armature open circuit	Drive has detected that the firing angle has advanced but no current feedback has been detected
<b>cL</b>	104	Current (control) loop open circuit	If the input reference is either 4-20mA or 20-4mA, this trip indicates that input current is <3.0mA
<b>EEF</b>	132	EEPROM failure	Indicates that an error has been detected in the parameter set read from the EEPROM at power-up
<b>EPS</b>	103	External power supply	Overcurrent trip at the 24V supply output terminal (TB4-33) has operated, indicating an overload in the external circuit connected to this supply. Maximum current available is 200mA
<b>Et</b>	102	External trip	Parameter <b>10.34</b> = 1. The external trip set up by the user has operated
<b>FbL</b>	119	Feedback loss	No signal from tachogenerator (tachometer) or encoder (pulse tachometer)
<b>Fbr</b>	109	Feedback reversal	The polarity of the feedback tacho or encoder polarity is incorrect. This trip does not operate on 1Q drives
<b>FdL</b>	118	Field loss	No current in field supply circuit
<b>FdO</b>	108	Field on	The user has initiated self-tuning ( <b>05.09</b> ) and field current has been detected
<b>FOC</b>	106	Field overcurrent	Excess current detected in field current feedback. If current feedback is present and firing angle is phased back, then trip
<b>hF</b>	100	Hardware fault	A hardware fault has been detected during the self-diagnosis routine performed after power-up. Users are recommended to consult the supplier of the drive
<b>It</b>	122	I x t trip	The integrating overload protection has reached trip level
<b>Oh</b>	107	Overheat	Thyristor (SCR) heatsink overtemperature. Only on drives equipped with heatsink thermistors (thermal switches)
<b>Pc1</b>	124	Processor 1 watchdog	Indicates a fault in the MDA1 hardware has been detected by malfunctioning of Processor 1 software
<b>Pc2</b>	131	Processor 2 watchdog	Indicates a Processor 2 malfunction, or a software bug (MD29 option)
<b>PhS</b>	101	Phase sequence	Connections to E1 and E3 are not the same phases as are connected to L1 and L3. Investigate and correct
<b>PS</b>	125	Power supply	One or more of the internal power supplies is out of tolerance
<b>ScL</b>	105	Serial communications link (interface) loss	(Only in serial comms mode 3) No input data detected
<b>SL</b>	120	Supply loss.	One or more of the power (input) supply phases is open-circuit
<b>th</b>	123	Thermistor (thermal switch)	Motor protection thermistor (thermal switch) has initiated a trip indicating windings overheating. Trip threshold 3kΩ±5%. Reset 1.8kΩ
<b>A29</b>	40 - 69	Indicates an MD29 fault	Refer to the MD29 Users Guide

If the drive trips, the index display shows **triP**, and the data message will flash. The data display shows a mnemonic to indicate the reason for the trip.

The last four trip codes are stored in parameters **10.25** through to **10.28**, and are available for interrogation unaffected by power down/up cycles. The data stored in these parameters is updated only by the next trip event.

#### NOTE

In the event of any trip, all RO parameter values are frozen and remain so for interrogation while the cause of the fault is investigated. To enter parameter adjustment mode from the trip mode, press any of the five adjustment keys. To re-enter trip mode, go to Menu 00 and press LEFT key.

#### NOTE

If the trip persists, contact your supplier. Attempts to repair the drive may invalidate the warranty.

#### Trip codes in numerical order

<b>A29</b>	40 - 69	MD29 fault
<b>hF</b>	100	Hardware fault
<b>PhS</b>	101	Phase sequence
<b>Et</b>	102	External trip
<b>EPS</b>	103	External power supply
<b>cL</b>	104	Current (control) loop open circuit
<b>ScL</b>	105	Serial communications link (interface) loss
<b>FOC</b>	106	Field overcurrent
<b>Oh</b>	107	Overheat
<b>FdO</b>	108	Field on
<b>Fbr</b>	109	Feedback reversal
<b>FdL</b>	118	Field loss
<b>FbL</b>	119	Feedback loss
<b>SL</b>	120	Supply loss
<b>AOC</b>	121	Armature overcurrent
<b>It</b>	122	I x t trip
<b>th</b>	123	Thermistor (thermal switch)
<b>Pc1</b>	124	Processor 1 watchdog
<b>PS</b>	125	Power supply
<b>AOP</b>	126	Armature open circuit
<b>Pc2</b>	131	Processor 2 watchdog
<b>EEF</b>	132	EEPROM failure.

# 10 Serial communications



The control circuits are isolated from the power circuits in the drive by basic insulation only. The installer must ensure that the external control circuits are insulated from human contact by at least one layer of insulation rated for use at the AC supply voltage.



If the control circuits are to be connected to other circuits classified as Safety Extra Low Voltage (SELV) (e.g. to a personal computer), an additional isolating barrier must be included in order to maintain the SELV classification.

A communications interface is standard in all Mentor II drives. It is a machine-machine interface, enabling one or more drives to be used in systems controlled by a host such as a process logic controller (PLC) or computer.

Mentor II drives can be directly controlled, their operating configuration can be altered, and their status can be interrogated by such a host, and continuously monitored by data logging equipment.

The communication port of the drive unit is the connector PL2 (Figure 6-5 on page 22). The standard connection is the RS422.

Protocol is ANSI x 3.28 - 2.5 - A4, as standard for industrial interfaces.

## Connections

The serial communications interface is made available on the 9-Way D-Type connector labelled PL2 on the MDA2B card. This connector provides standard RS422 interfacing.

The Mentor drive is equivalent to two-unit loads, therefore up to 15 drives may be connected to a host controller before the use of repeaters is necessary. When repeaters are used, up to 99 drives may be connected.

### NOTE

RS422 is practically the same as RS485, the main difference being RS485 allows more than one master controller.



An RS232 connection may be made to the RS422 port, but is not recommended for any purpose other than commissioning due to its inferior specification (low noise rejection, limited cable length, etc). Note that RS232 is not the same as 2-wire RS422/485.

## 10.1 Connecting to the drive

### 485 serial communications port

MentorSoft connects to the RS485 Mentor II port by using either a standard 4-wire RS232 to RS485 converter, or by fabricating the following lead:

PC 25-way	PC 9-way	PL2 9-way
3	2	2
2	3	3
7	5	1 + 6 + 7 (link all three terminals)

### If you have problems...

Cannot go on-line:

Check connections to drive.

Perform an auto-baud detection.

Make sure that the correct "COM" port is selected.

Ensure that the Mentor II is in 4-wire ANSI mode (11.13 = 1).

The components of all messages between the host and a Mentor II drive are formed of ASCII characters. The format of a message, i.e. the sequence in which the characters appear, is standardized for messages of each different kind, and is explained under Structure of Messages, below.

## 10.2 Preliminary adjustments to the drive

Each drive requires a unique identity number, or serial address, set by parameter 11.11. The Baud rate 11.12 is required to be set to match the host. Data, drive status and the parameter set-up can be read from the drive in any mode, provided only that the drive is powered up, and that the serial address and Baud rate are correctly set.

The following tables gives the terminal designations for the connector PL2 for both RS422 and RS232 communications links

Pin no.	RS232	RS422
1	NC	0V
2	TXD	TXD
3	RXD	RXD
4		
5		
6	0V	TXD
7	0V	RXD
8		
9		

## 10.3 Routing the serial communications cable

A data communications cable should not run parallel to any power cables, especially ones that connect drives to motors. If parallel runs are unavoidable, ensure a minimum spacing of 300mm (1 foot) between the communications cable and the power cable.

Cables crossing one another at right-angles are unlikely to give trouble. The maximum cable length of a RS422 link is approximately 1,000 meters (4,000 feet)

## 10.4 Termination

When a multi-drop RS422 network is used, it is necessary to connect a 120Ω resistor between the two receive lines of the last unit on the bus (i.e. the unit farthest away from the host). Care must be taken to ensure that other units in the network do not have the resistor already fitted - excessive signal loss will occur otherwise. The termination resistor can be fitted between the two posts labelled R6 to the right of the 9-way D-Type connector.

## 10.5 Components of messages

### 10.5.1 Control characters

To conform to the standard structure of a message, the stages of a message are signalled by control characters. Each character has a specific meaning, a standard abbreviation, and is transmitted and received in ASCII code. If a message is initiated from a keyboard, the control characters are keyed by holding the Control key down while making a single-letter keystroke. Of the 32 control characters in the ASCII set, the seven in the following table are used in Mentor II serial communications.

**Table 10.1 Control characters in Mentor II drives**

Character	Meaning	ASCII code HEX	Keyed as Control..
EOT	Reset, or "Now hear this", or End of Transmission	04	D
ENQ	Enquiry, interrogating the drive	05	E
STX	Start of text	02	B
ETX	End of text	03	C
ACK	Acknowledge (message accepted)	06	F
BS	Backspace (go to previous parameter)	08	H
NAK	Negative acknowledge (message not understood)	15	U

### 10.5.2 Serial address

Each drive is given an identity or address (parameter 11.11) so that only the drive that is concerned will respond. For security, the format is that each digit of the two-digit drive address is repeated, thus the address of drive number 23 is sent as four characters:

2 2 3 3

The serial address follows immediately after the first control character of the message.

### 10.5.3 Parameter identification

For transmission by serial link (interface), parameters are identified by the four digits representing the menu and the parameter number, but without the decimal point, which is used in the text of this Guide for clarity. For example, to send menu 04, parameter 26, write 0 4 2 6.

### 10.5.4 Data field

Data to be sent or requested occupies the next five characters after the parameter number. All of the operating parameters of the drive are **numerical** values, such as load, current, etc. The field for data is variable in length up to five characters maximum (but see reference to increased resolution on the previous page). No decimal point is used.

The state of **bit-parameters** is transmitted and received as real-value data, of value 0 or 1. Again, the format is flexible so long as no more than five characters are comprised, for example:

1  
0 1

- and so on.

### 10.5.5 Block checksum (BCC)

To permit the drive and the host to ensure that messages from one to the other have not become corrupted in transmission, all commands and data responses must be terminated by a block checksum character (**BCC**, next section).

## 10.6 Structure of messages

### 10.6.1 Host to drive

Messages from the host to the drive are of two kinds:

- a request for information,
- or a command.

Both kinds must start with the control character EOT (Control-D) to initiate the drive to receive a new message. This is followed by the serial address of the drive receiving the message. The format of the data and the choice of control character to terminate the message is different for the two kinds.

For an **information request**, sending the parameter number followed by ENQ instructs the particular drive addressed to supply data relating to that parameter.

For a **command**, a control character after the serial address tells the drive that the message is to be an instruction concerning its operational

parameters, and that the next part of the message will be a parameter number and the instruction data. The instruction data occupies five to nine characters, or ten for high resolution. An instruction message is terminated by control character ETX followed by a block checksum (**BCC**, next section).

### 10.6.2 Drive to host

Messages from the drive to the host are of two kinds:

- a reply to a data request,
- or acknowledgement of a message.

In **reply** to a data request, the start control character is STX, and is followed by the parameter number to confirm the request from the host, and then the five characters of data. The message is terminated by the control character ETX and a block checksum (BCC).

A message is **acknowledged** by the control character ACK if understood, or NAK if invalid, wrongly formatted or corrupt.

## 10.7 Multiple drives

A message can be sent to two or more addresses simultaneously. If all drives are to respond to the same request or instruction, the message is transmitted to address 0 (zero).

## 10.8 Wide integers - serial mode 4

### 10.8.1 Resolution

Some parameters can be set to a higher resolution than that displayed or read by the serial interface. These are the real parameters with a range of 65535.

If the user wishes to set variable to a higher resolution, six digits must be written in the data field. Mentor II then recognizes the request for higher resolution. For example, to set the speed demand to 47.65% of maximum speed, transmit:

+ 0 4 7 6 5

The wide integer (16-bit) parameters are **13.14**, **15.60**, **15.61**, **15.62** and **15.63**. If a wide integer is sent through the comms link (interface), the data is formatted as five ASCII characters, *without a "sign"* in the data field. All parameters can be written via the serial interface by means of five ASCII characters if no sign is included. Refer to parameter **11.13**, Chapter 6 or 7, for further information.

## 10.9 Sending data

Host command:

- reset -
- address -
- start of text -
- menu and parameter -
- 1 to 5 data characters -
- end -
- BCC

For example, the message to the drive:

"change speed reference 1 of drive number 14 to 47.6% in reverse"

would be sent as:

CONTROL	ADDRESS	CONTROL	PARAM	DATA	CONTROL	BCC
EOT	1 1 4 4	STX	0 1 1 7	- 0 4 7 6	ETX	,
Control -D		Control -B			Control -C	

The drive will respond with an acknowledgement, either:

- ACK if the message is understood and implemented,
- or
- NAK if the message is invalid, the data is too long, or the BCC is incorrect.

If a value sent is outside the limits for a parameter, the drive will respond with NAK.

## 10.10 Reading data

The drive will send any data to the host, provided that the request is valid. The format of a data request message is:

Host request:

reset -  
address -  
parameter -  
end

For example, to find the speed set point **01.17** of drive number 12, send:

CONTROL	ADDRESS				PARAM				CONTROL
EOT	1	1	2	2	0	1	1	7	ENQ
Control -D									Control -E

The drive replies in the following form:

start -  
parameter -  
5 characters of data -  
end -  
BCC

CONTROL	PARAM				DATA					CONTROL	BCC
STX	0	1	1	7	-	0	4	7	6	ETX	,
Control -B									Control -C		

The reply first confirms that the data sent is the speed reference 1 (**01.17**); the five characters immediately following give the present setting as a percentage of full speed. The first character is either + or -, to indicate direction of rotation; the remainder is the numerical value. The message reads, reverse at 47.6% of full speed in this example.

### 10.10.1 Repeat enquiry

The negative acknowledgement NAK (Control-U) can be used at a keyboard to cause the drive to send data repeatedly for the same parameter. It saves time when monitoring the value of a parameter over a period of time.

### 10.10.2 Next parameter

To obtain data from the same drive for the next parameter in numerical order, send the positive acknowledgement ACK (Control-F). The drive will respond by transmitting the data relating to the next parameter in sequence.

### 10.10.3 Previous parameter

To obtain data from the same drive for the previous parameter in numerical order, send backspace BS (Control-H).

### 10.10.4 Invalid parameter number

If the host sends a parameter number which the drive does not recognize, e.g. 1723, the drive will respond with EOT.

### 10.10.5 Block checksum (BCC)

To ensure that data received can be verified, a block checksum is attached to the end of each command or data response. The BCC is automatically calculated by the sending logic and is derived in the following manner.

First, a binary exclusive-OR is performed on all characters of the message after the start-of-text command parameter.

For example, if the message to be sent to drive number 14 is:

"set speed reference 1 to 47.6% of full speed in reverse"

It is sent as:

Reset	EOT (Control-D)
Serial address	1 1 4 4
Start of text	STX (Control-B)
	Not included in BCC calculation
	BCC calculation starts here
Parameter	0 1 1 7 (Menu no. and parameter no.)
Reverse	- (a minus sign)
476	0 4 7 6
End of message	ETX (Control-C)
finally,	BCC, calculated as shown

Each of the separate digits

0 1 1 7 - 0 4 7 6 and Control-C

is represented by a hexadecimal character and calculated in binary as shown in the table. The XOR is shown progressively for each character.

Character		ASCII Character		XOR	
menu	0	011	0000		
	1	011	0001	000	0001
parameter	1	011	0001	011	0000
	7	011	0111	000	0111
- (minus)		010	1101	010	1010
0		011	0000	001	1010
4		011	0100	010	1110
7		011	0111	001	1001
6		011	0110	010	1111
ETX		000	0011	<u>010</u>	<u>1100</u>

The final XOR, underlined, is the BCC provided that its equivalent decimal value exceeds 31.

As the ASCII characters from hex 00 to 1F are used only for control codes, the BCC has to exceed the value of 31 decimal. Whenever the XOR produces a (decimal equivalent) number less than 32, 32 is added. Thus, in the previous XOR example,

010 1100 = 44 decimal, so that the BCC is the character 44

for which the ASCII character is =,

Thus the complete message to set the speed of drive number 14, say, to 47.6% in reverse is as shown in the example message on the previous page.

## 10.11 Using Mentor on a network with other CT drives

Unlike some other Control Techniques products such as the Unidrive or the MD29 card, the Mentor does not support the *group addressing* feature. It is important therefore that when a Mentor is on the same network as drives that *do* support group addressing, the drive address defined in parameter **11.11** must not have a zero in it - in other words, choose an address of 11 or greater, and exclude the numbers 20, 30, 40 etc. This will ensure that messages sent to the Mentor are not accidentally recognised by other drives as being group commands.

## 10.12 Global addressing

The Mentor II drive also supports the use of *global addressing*. This is where a message can be broadcast to all drives on the network - to use this, the controller will send its message to address 00. Note that when global addressing is used, the drives will not respond to any command messages.

# 11 Options

The following options are available for the Mentor II drive:

## 11.1 MD29

Programmable applications board that offers user programmability via a basic-like language known as DPL (Drive Programming Language), using a Windows™ based Toolkit. To implement distributed control systems and "Soft Logic Control" to IEC61131-3, use the SYPT (SYstem Programming Tool) Workbench. This supports programming in ladder and function blocks, as well as DPL. This allows the user to highly customise the drive by implementation of additional control loops or functions.

The MD29 offers as standard a single-axis position controller, an RS485 port that offers additional modes such as ANSI master, Modbus-RTU and Modbus-ASCII. The following software options are also available:

### **Single-Axis Position Controller**

(built-in as standard)

Offers slave positioning or speed control using linear or S-ramp control for the velocity profile; digital lock with rigid and non-rigid modes with a slave ratio of 8-decimal places accuracy; incremental cam table providing automatic control of the slave position, relative to the master position; PID control loop.

### **S-Ramp**

S-Ramp is designed for stepless acceleration. It achieves fast, smooth transitions to and from acceleration and deceleration ramps.

### **PID**

PID is an extra control loop for addition to the Mentor II Drive. Proportional, integral and derivative terms can be selected to act upon an error between a reference and its feedback signal such as a dancer arm. Each term is variable to allow the package to be adapted to any application.

### **Centre-Wind**

Centre-Wind allows Mentor II to be tuned to the characteristics of both machine and process in coiling and uncoiling applications.

### **Spindle Orientation**

This is a control loop to hold the motor shaft in a selected, fixed position for automatic tool changing on computer-controlled machine tools.

### **Digital Speed & Position Loop**

Provides precise control of speed, and the ability to synchronise two shafts.

## 11.2 CNet (MD29AN)

This card offers all the features of MD29, but with the addition of the CNet distributed control network. CNet is a high performance network running at 5Mbits/sec. It requires no master controller, and it offers full, easy to configure cyclic data transfer and non-cyclic peer-peer data transfer of drive parameters and any other data.

## 11.3 Interbus-S (MDIBS)

Dedicated Interbus-S communications bus interface. The MDIBS card does not offer MD29 programmability.

## 11.4 Profibus-DP (MD24)

Dedicated Profibus-DP communications bus interface with a maximum speed of 1.5Mbits/sec. The MD24 card does not offer MD29 programmability.

## 11.5 DeviceNet (MD25)

Dedicated DeviceNet interface. The MD25 card does not offer MD29 programmability.

## 11.6 IO box

Remote unit that can be connected to the MD29 card via a RS485 link. The I/O Box offers 8 digital inputs, 8 digital outputs, 5 analogue inputs and 3 analogue outputs. An additional 24 TTL digital I/O ports are also available for connection of thumbwheel switches, etc.

### **Additional hardware and software for the Mentor II range of DC drives**

1. FXM5 Field Control Module
2. Software

## 11.7 Field control unit FXM5

### **Summary**

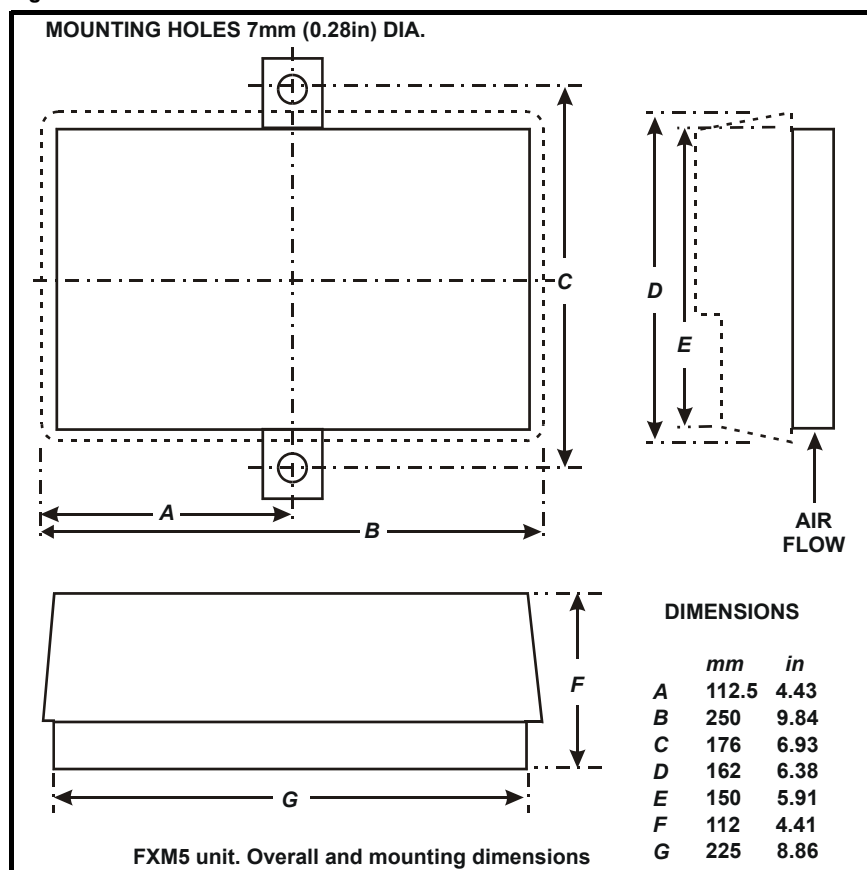
The FXM5 unit enables a Mentor II drive to operate a motor with a variable motor field under digital control. Parameters in Menu 06 (Field Control) are provided as standard for use in conjunction with the FXM5 controller. Parameter 06.11 scales the current, as shown in the table on the next page.

The FXM5 is suitable for motors with field current up to 20 amps, and is installed externally to the drive unit. It is suitable for retrofitting by the user on site if desired.

### **NOTE**

It is essential that links (jumpers) LK1 and LK2 on the Power Board MDA75, MDA75R, MDA210, MDA210R or link LK1 on the MDA6 are cut before using the drive with FXM5 Field Control.

Figure 11-1 FXM5 dimensions



### 11.7.1 FXM5 start-up data

The maximum field current delivered by the FXM5 is determined by the number of primary turns of the DCCT (specified for and supplied with the FXM5 unit), and by the setting of link (jumper) LK1 on the FXM5.

LK1 can be placed in one of two positions, such that:

$$\text{Maximum } I_F = \frac{20}{N_p} \text{ or } \frac{15}{N_p}$$

where  $N_p$  is the number of DCCT primary turns.

In conjunction with the setting of parameter **6.11**, the resulting field current can be adjusted to one of 20 different values from 1A to 20A in one-ampere steps. (See **06.11 Field Current Feedback Scaling**.)

#### NOTE

If the FXM5 is being controlled by the Mentor via a ribbon cable then this cable should be routed to keep it away from the AC busbars or sleeving should be used to prevent contact with the busbar.

### 11.7.2 Protective fuses

Note that the field output circuit is protected by 20A fuses as standard (FS3 and FS4). If a field current in excess of 9A is required the fuses must be replaced by HRC fuses of appropriate rating.

### 11.7.3 Maximum field current, digital control Mentor II software version V4.3.0 onwards

#### NOTE

Issue (rev) 2 FXM5 must not be used with earlier versions of Mentor II software.

Maximum current	Primary turns	LK1 position		Parameter 06.11 setting
		20	15	
A	Np	Np	Np	
1	10		✓	1
2	10	✓		2
3	5		✓	3
4	5	✓		4
5	4	✓		5
6	3	✓		6
7	2	✓		7
8	2	✓		8
9	2	✓		9
10	2	✓		10
11	1		✓	11
12	1		✓	12
13	1		✓	13
14	1		✓	14
15	1		✓	15
16	1	✓		16
17	1	✓		17
18	1	✓		18
19	1	✓		19
20	1	✓		20

#### NOTE

The Field Controller will weaken the field even though the armature voltage clamp may be active.



# 12 Electromagnetic compatibility

## 12.1 General note on EMC data

The information given in this User Guide is derived from tests and calculations on sample products. It is provided to assist in the correct application of the product, and is believed to correctly reflect the behaviour of the product when operated in accordance with the instructions. The provision of this data does not form part of any contract or undertaking. Where a statement of conformity is made with a specific standard, the company takes all reasonable measures to ensure that its products are in conformance. Where specific values are given these are subject to normal engineering variations between samples of the same product. They may also be affected by the operating environment and details of the installation arrangement.

## 12.2 Immunity

Provided that the instructions in this User Guide are correctly implemented, Mentor II drives exhibit excellent immunity to interference from sources outside the drive unit.

For more detailed information, refer to the Mentor II EMC datasheet.

The drive complies with the following international and European harmonised standards for immunity.


The immunity is achieved without any additional measures such as filters or suppressors. To ensure correct operation the wiring guidelines specified in the product manual must be carefully adhered to.

All inductive components such as relays, contactors, electromagnetic brakes, etc., associated with the drive, must be fitted with appropriate suppression, otherwise the immunity of the drive may be exceeded.

Standard	Type of immunity	Test specification	Application	Level
EN 61000-4-2*	Electrostatic discharge	6kV contact discharge 8kV air discharge	Module enclosure	Level 3 (industrial)
IEC 801-3	Radio frequency radiated field	10V/m prior to modulation 27 - 1000MHz 80% AM (1kHz) modulation (reduce to 3V/m for 87-108MHz)	Module enclosure	Level 3 (industrial)
ENV 50140*	Radio frequency radiated field	10V/m prior to modulation 80 - 1000MHz 80% AM (1kHz) modulation (reduce to 3V/m for 87-108MHz)	Module enclosure	Level 3 (industrial)
ENV 50141*	Conducted radio frequency	10V prior to modulation 0.15 - 80MHz 80% AM (1kHz) modulation	Control and power lines	Level 3 (industrial)
EN 61000-4-4*	Fast transient burst	5/50ns 2kV transient at 5kHz repetition frequency via coupling clamp	Control lines	Level 4 (industrial harsh)
		5/50ns 2kV transient at 5kHz repetition frequency by direct injection	Power lines	Level 3 (industrial)
EN50082-1	Generic immunity standard for the residential, commercial and light - industrial environment			Complies
EN50082-2	Generic immunity standard for the industrial environment Calls up basic standards marked *			Complies
EN61800-3 IEC61800-3	Product standard for adjustable speed power drive systems (immunity requirements)		Meets immunity requirements for first and second environment	

## 12.3 Emission

For installation in the "second environment", ie, where the low voltage supply network does not supply domestic premises, no filter is required in order to meet IEC61800-3 (EN61800-3).



Operation without a filter is a practical cost-effective possibility in an industrial installation where existing levels of electrical noise are likely to be high, and any electronic equipment in operation has been designed for such an environment. There is some risk of disturbance to other equipment, and in this case the user and supplier of the drive system must jointly take responsibility for correcting any problem which occurs.

Figure 12-1 shows wiring guidelines to achieve minimum emission in a typical installation. When used with the recommended filter the drive will meet the conducted emission limits required by the generic emission standard EN50081-2.

Motor cable length should not exceed 300m to ensure that the industrial limit is met with adequate margin.

The limits for conducted emissions required by the generic standards are summarized in the following table:

Standard	Description	Frequency range	Limits	Application
EN50081-2	Generic emission standard for the industrial environment	0.15-0.5MHz	79dB $\mu$ V quasi peak 66dB $\mu$ V average	AC supply lines
		0.5-5MHz	73dB $\mu$ V quasi peak 60dB $\mu$ V average	
		5-30MHz	73dB $\mu$ V quasi peak 60dB $\mu$ V average	

## 12.4 Recommended filters

Two methods are shown in Figure 12-1 for suppressing the conducted emission into the power supply line for the main thyristor converter.

### 12.4.1 Method 1

A low cost technique using high value capacitors between power lines and earth which makes use of the suppression provided by the standard line reactors. Component values are given in the following table:

Drive	Line reactors La, Lb, Lc ( $\mu$ H)	Line to earth capacitors Ca, Cb, Cc ( $\mu$ F)	Discharge resistors Ra, Rb, Rc (k $\Omega$ )	Discharge resistor power rating (W)
M25, M25R	200	4.7	470	0.5
M45, M45R	200	4.7	470	0.5
M75, M75R	100	10	220	0.5
M105, M105R	100	10	220	0.5
M155, M155R	75	13	150	1
M210, M210R	75	13	150	1
M350, M350R	35	29	68	3
M420, M420R	27	37	56	3
M550, M550R	25	40	56	3
M700, M700R	23	44	47	3
M825, M825R	19	53	39	4
M900, M900R	17	59	33	4
M1200, M1200R	13	77	27	6
M1850, M1850R	8.6	116	18	9

The capacitors must be wired in as close as possible approximation to a 'Kelvin' connection, minimising the length of the wiring between the capacitors and the power circuit.

An assembly of low-inductance capacitors, designed for direct mounting to a bus-bar, is available from Steatite Ltd with the part number CON9020250. The capacitance value in this box is 10 $\mu$ F per phase. A number of these assemblies can be used together to give the required capacitance. Because of their low inductance, the next higher multiple of 10 $\mu$ F above the required value can be used.

The total capacitance line to earth must be within +/-10% of the value given in the table. If lower value line reactors are used then the capacitors must be increased in proportion. It is important that the capacitors are rated at 440V AC and are suitable for connection to normal industrial supplies. They should also be designed to have a low series inductance.

Suitably rated resistors should be used to discharge the capacitors when the supply is disconnected from the installation. The resistors given in the table are calculated to discharge the network to less than 60V within 5s, based on a 440V supply.

The capacitor network will cause a high leakage current to flow to earth. The leakage current may be calculated using the following expression, assuming the three phase supply is balanced with respect to earth and line to line:

$$I_E = V \times 2\pi \times f \times C \times a$$

Where:

**V** is line to earth voltage  
**f** is supply frequency  
**C** is line to earth capacitance  
**a** is capacitor tolerance.

#### Example: M210 drive operating on a 400V 50Hz supply

Use 10 $\mu$ F + 4.7 $\mu$ F in parallel = 14.7 $\mu$ F between each line and earth (13 $\mu$ F is required).

Select capacitor tolerance to be 10%.

$$I_E = 400 \times 2\pi \times 50 \times 14.7 \times 10^{-6} \times 0.1$$


$$= 185\text{mA}$$

In the event of a phase loss the leakage current will be higher. It can be calculated from the following expression:

$$I_{EPL} = V_{LE} \times 2\pi \times f \times C$$

$$= (400/\sqrt{3}) \times 2\pi \times 50 \times 14.7 \times 10^{-6}$$

$$= 1.07\text{A}$$



The capacitors cause a high earth leakage current. A permanent fixed earth connection must be provided, and subjected to regular testing.

If high earth leakage currents are unacceptable then an RFI filter must be used instead of capacitors. The filter uses lower values of capacitance, achieving the necessary attenuation by inductance.

## 12.4.2 Method 2

RFI filter with low leakage current to earth

Recommended filters are shown in the following table:

Drive	Line reactors La, Lb, Lc (μH)	RFI filter for main convertor		
		Control Techniques part no. 4200 -	Voltage rating (V <sub>rms</sub> ) 50/60Hz	Current rating (A <sub>rms</sub> ) at 50°C
M25, M25R	200	1051 or 6116	440	50
M45, M45R	200	1051 or 6116	440	50
M75, M75R	100	1071 or 6117	440	70 or 63
M105, M105R	100	1111 or 6106	440	110 or 100
M155, M155R	75	1171 or 6107	440	170 or 150
M210, M210R	75	1171 or 6111	440	170 or 180
M350, M350R	35	1301 or 6115	440	300
		<b>Schaffner part no.</b>		
M420, M420R	27	FN3359-400-99	500*	400
M550, M550R	25	FN3359-600-99	500*	600
M700, M700R	23	FN3359-600-99	500*	600
M825, M825R	19	FN3359-1000-99	500*	1000
M900, M900R	17	FN3359-1000-99	500*	1000
M1200, M1200R	13	FN3359-1000-99	500*	1000
M1850, M1850R	8.6	FN3359-1600-99	500*	1600

- 690V version also available - add the code **HV** after 3359 in the part number.

## 12.4.3 Recommended filter for the field regulator

There are several possibilities depending on the main suppression and how the drive is connected to the system.

1) Using method 1 for the main circuit, if the capacitor network remains in circuit at all times when the field regulator is energised, then some low cost radio frequency chokes (L<sub>F1</sub> and L<sub>F2</sub>) can be used - refer to Figure 12-1

2) Using methods 1 or 2, if the field regulator is operated when the main suppression is not connected (not illustrated in Figure 12-1), then a separate RFI filter is required. The filter can be used as an alternative to RF chokes even if the main filter remains in circuit at all times.

### NOTE

Mentor drives rated above 210A are normally supplied with a bridge rectifier to provide a fixed field. The field supply will still require filtering using either RF chokes or separate filter listed in the table. The FXM5 external field controller, rated at 20A, may be filtered in a similar way using the appropriate rated components. Refer to the Mentor II EMC datasheet.

## 12.5 Radiated emissions

When installed in a standard steel enclosure according to *EMC Installation Guidelines*, Figure 12-1 the drive will meet the radiated emission limits required by the generic industrial emission standard EN50081-2.

### NOTE

Compliance was achieved in tests using representative enclosures and following the guidelines given. Every effort was made to ensure that the arrangements were robust enough to be effective despite the normal variations which will occur in practical installations. However no warranty is given that installations built according to these guidelines will necessarily meet the same emission limits.

## 12.6 Enclosure construction

For most installations, the Mentor drive will be mounted in a protective metal enclosure which may have an internal back-plate for mounting VSD modules, RFI filters and ancillary equipment. There may be a requirement to shield the motor cable; if this is the case, electrically bond the shield to the back plate of the enclosure as shown in Figure 12-1. Alternatively, the shield may be bonded to the enclosure wall at the point of cable entry using the normal gland fixings.

In some designs the enclosure wall used for cable entry may consist of separate panels. Bonding the motor cable shield to these surfaces is acceptable provided they make good electrical contact with the remaining structure.

## 12.7 Motor cable selection

When testing the drive module alone, it is necessary to specify the use of a shielded cable for the motor. This is because the output of the drive contains radio frequency energy caused by the switching of the thyristors. In order to meet the standards specified, if the cable were not shielded then an output filter would have to be used in order to reduce the radio frequency voltage in the motor circuit to the level required by the standards. This situation is the same for all DC drives from all manufacturers.



It is the responsibility of the owner or user to ensure that the installation of the drive and the way it is operated and maintained complies with the requirements of the Health and Safety at Work Act in the United Kingdom and applicable legislation and regulations and codes of practice in the UK or elsewhere.

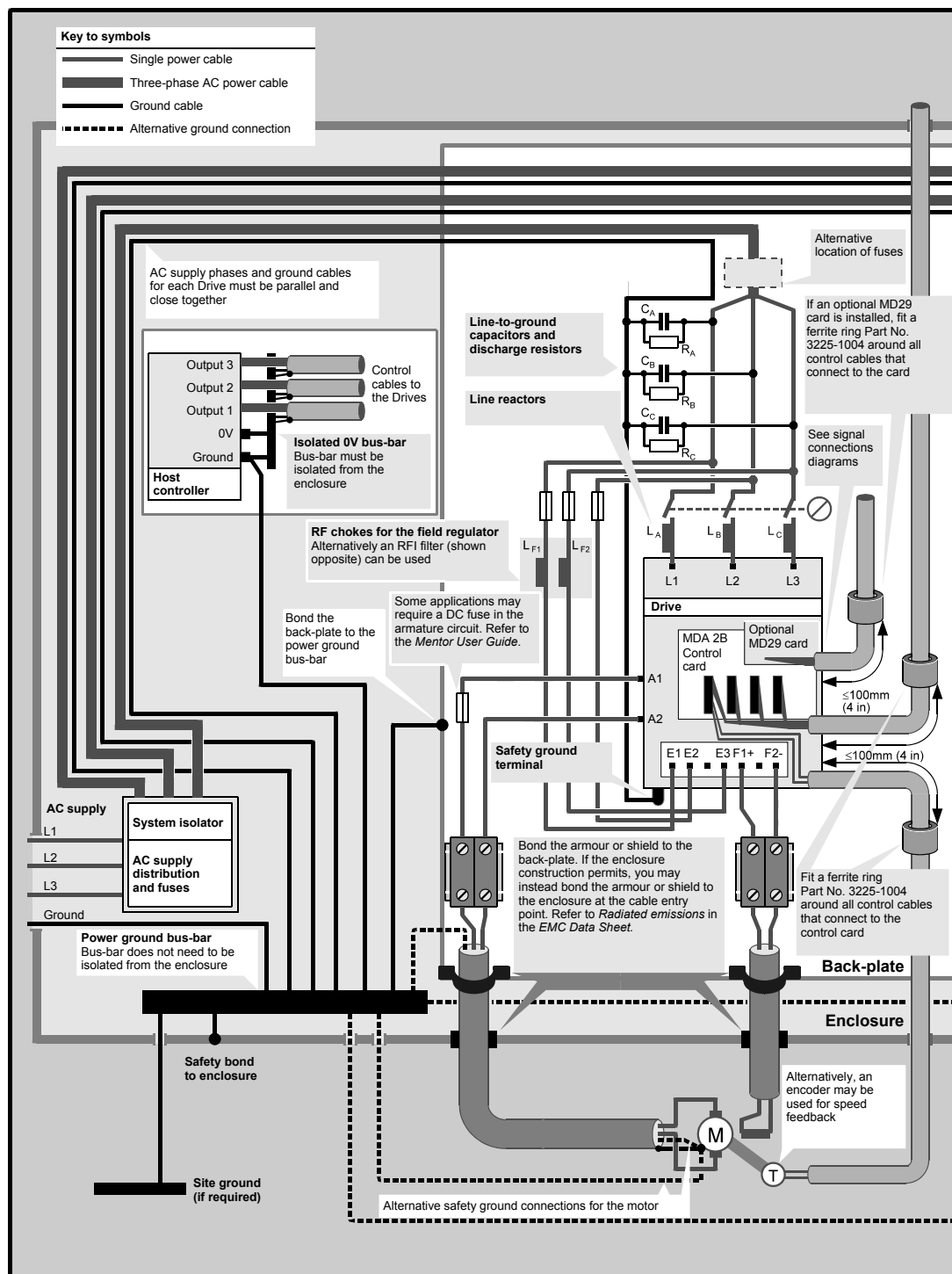


Special consideration is needed if the filter is to be used in movable equipment where the ground is connected through a flexible cable and plug/socket. Additional measures such as a supplementary ground connection or ground continuity monitoring will be required.



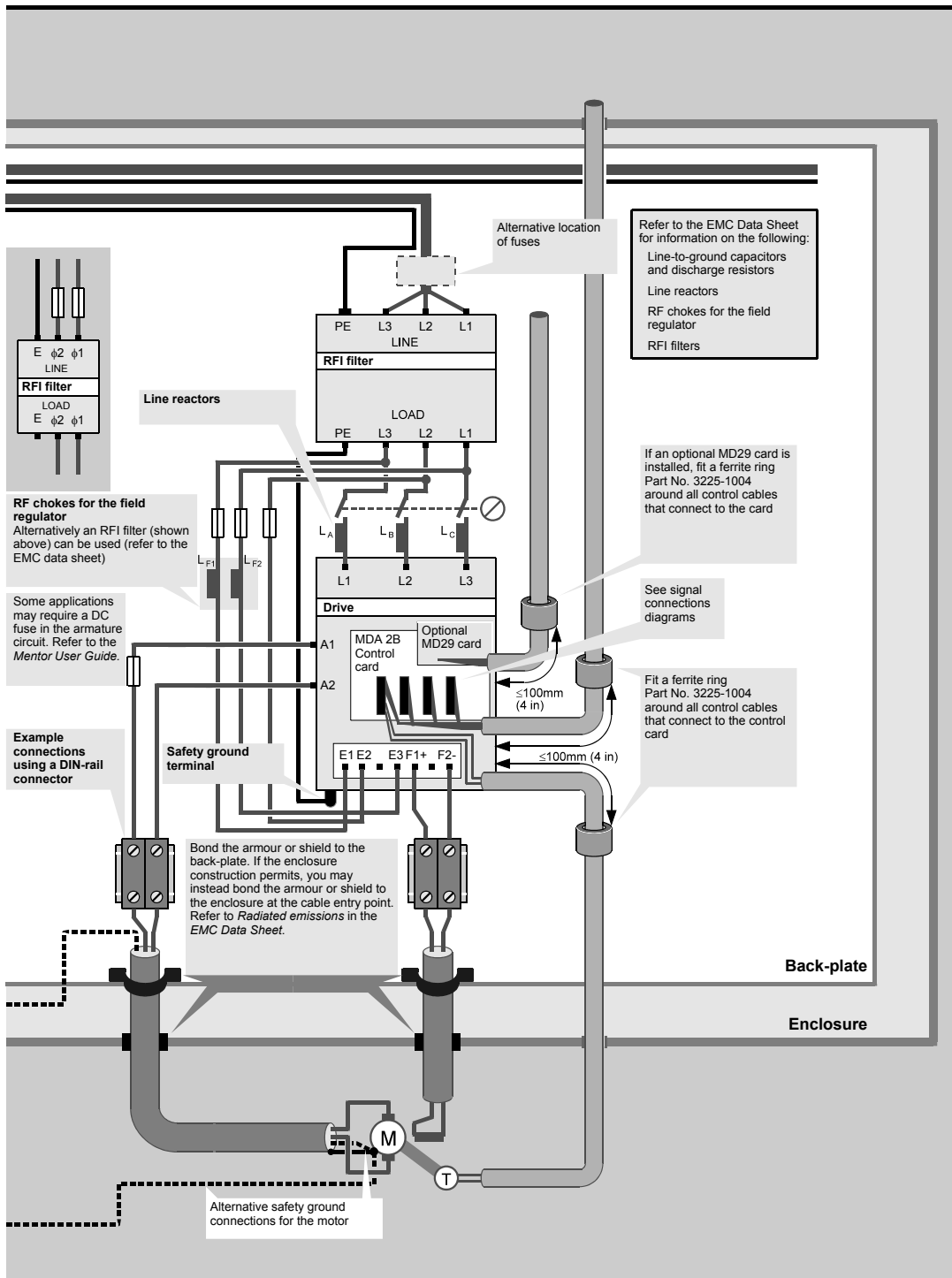
Safety grounding (earthing) and cabling should conform to local codes of practice and regulations. Safety grounding must always take precedence over the requirements of EMC grounding.

**Figure 12-1 EMC installation guidelines for Mentor II drive**  
(field connections are shown for M25 to M210)



Conducted emissions from the main thyristor convertor suppressed by line to earth capacitors and standard line reactors.

For more detailed information, refer to the Mentor II EMC datasheet.



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