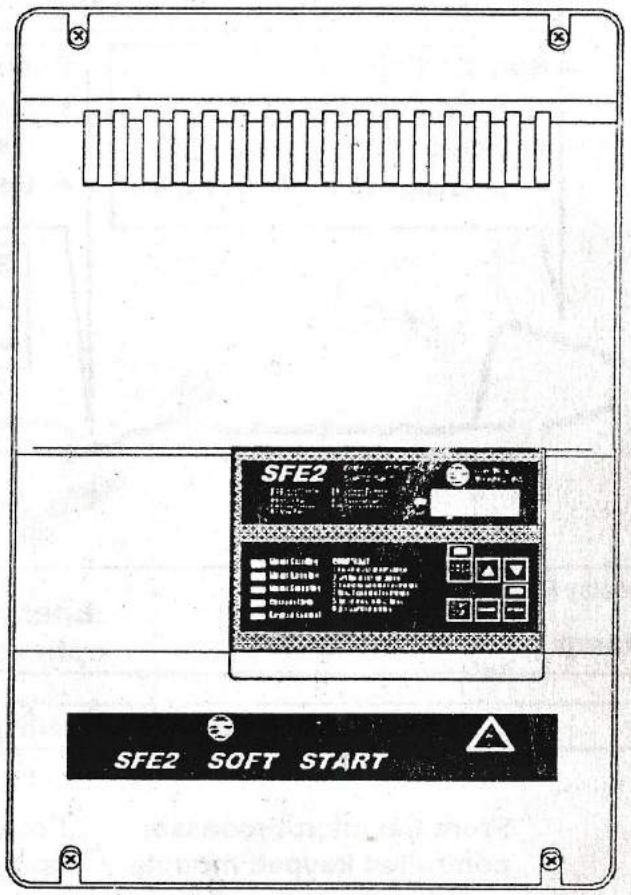
Energy optimising soft-start products for standard AC and squirrel-cage motors

SFE2



Technical Handbook

1. del

INSTALLATION

instructions for qualified electricians and maintenance engineers

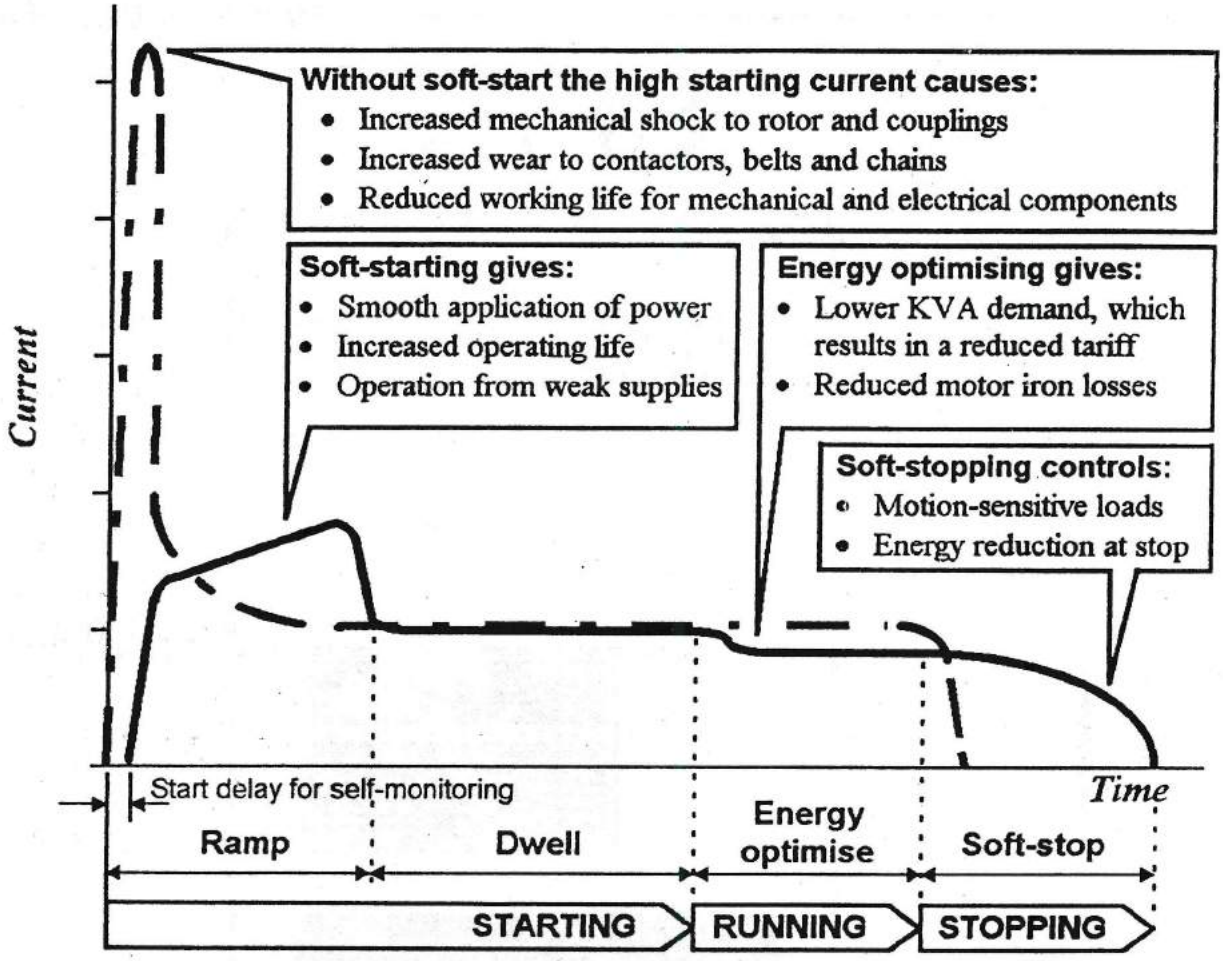
APPLICATIONS

information for system designers and consulting engineers

CONCEPTS str. 1-52

underlying principles for energy optimising and soft-start

The Reasons for Motor Soft-Start and Optimised Running



SFE2 lets you control:	From the microprocessor-controlled keypad module:	From external circuitry (supplied by the user):
Starting voltage to the motor (Pedestal voltage)	✓	✓ Signal initiates soft-start
Start-up Ramp time	✓	✓ Selects setting
Dwell time	✓	✓
Overcurrent protection	✓	✓
Soft-stop or Coast to stop	✓	✓ Signal initiates soft-stop

1 INSTALLATION

2 APPLICATIONS

3 CONCEPTS

WARNING

THIS UNIT OPERATES FROM A SUPPLY VOLTAGE WHICH IS DANGEROUS. IF YOU TOUCH THE LIVE SUPPLY OR LOAD TERMINALS IT MAY CAUSE DEATH OR SERIOUS INJURY. TO PREVENT ACCIDENTAL CONTACT, INSTALL THE UNIT IN A SUITABLE ENCLOSURE. ALWAYS ISOLATE THE UNIT FROM THE SUPPLY BEFORE YOU GAIN ACCESS TO, ALTER OR DISCONNECT ANY ELECTRICAL WIRING.

CE

MANUFACTURERS DECLARATION OF CONFORMITY

THIS IS TO CERTIFY THAT THE PRODUCTS DESCRIBED HEREIN CONFORM TO THE REQUIREMENTS OF THE FOLLOWING PRODUCT STANDARD IN RESPECT OF THE LOW VOLTAGE DIRECTIVE, 73/23/EEC:

EN 60947 - 1

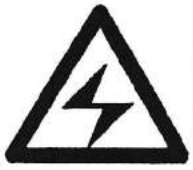
THE PRODUCTS COMPLY IN OTHER RESPECTS WITH THE FOLLOWING STANDARDS :

IEC 947 - 4 - 2 (1995):	AC SEMICONDUCTOR MOTOR CONTROLLERS AND STARTERS
EN 60947 - 4 - 2:	AC SEMICONDUCTOR MOTOR CONTROLLERS AND STARTERS [EMC DIRECTIVE 89/336]

Signed, R E Bristow, July, 1996.

Fairford Electronics Limited, Derby Road, Kingsbridge, Devon TQ7 1JL. England

IMPORTANT INFORMATION BEFORE YOU BEGIN



SAFETY AT WORK

The owner, installer and user of this SFE2 unit are responsible for its correct installation and use, and must ensure that:

(a) Only qualified persons install the unit

(b) The installation complies with the information contained in this publication

(c) The operation and maintenance of the unit complies with the relevant Codes of Practice, Regulations and Statutory Requirements.

The Manufacturer or his agents do not assume any liability, expressed or implied, for any consequences resulting from inappropriate, negligent or incorrect installation, application, use or adjustment of the product or circuit design, or from the mismatch of the unit to a motor.

The unit is not designed for use in hazardous areas. Its use in such an area may invalidate the hazardous area certification.

IN THE EVENT OF A MALFUNCTION

If you follow the installation instructions carefully the unit will perform motor control in accordance with its settings. If a malfunction occurs in your application, then a fault code (E - - -) will appear in the display area of the keypad. If you need help from the supplier, then the following information is useful when identifying problems and tracing faults:

- The fault code that appears on the display
- The manufacturer and rating of the motor
- The voltage level of the AC supply to the motor
- The wiring diagram for the installation

1.1 INSTALLATION - PRELIMINARY GUIDELINES

1.1.1 The SFE2 unit regulates the motor torque by controlling the voltage and current applied to the motor during three stages of operation: Start-up, Dwell and Run.

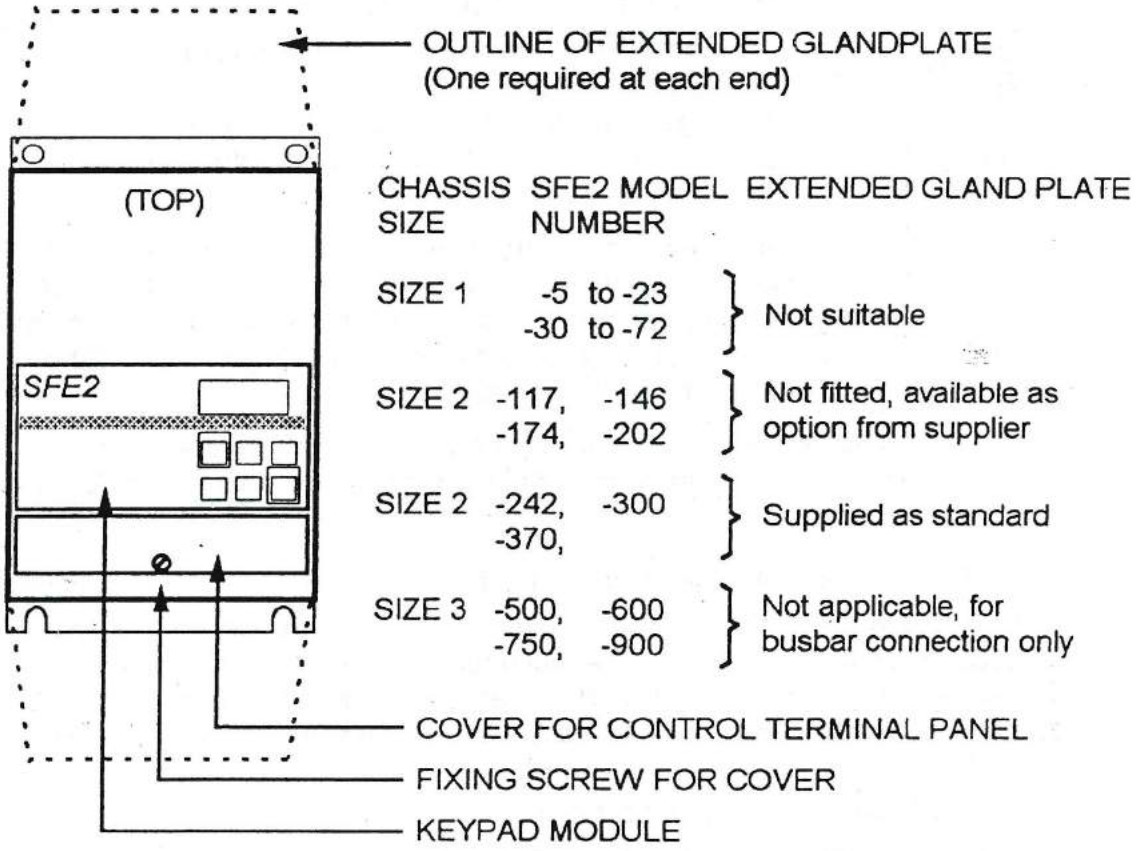
At Start-up, the voltage applied to the motor increases from an initial pre-set level towards the mains supply level. Throughout start-up (termed soft-starting), the unit adjusts the motor voltage or current to provide smooth motor acceleration to full speed.

The Dwell period commences when the motor voltage achieves its maximum level and continues for approximately 15 seconds; this stage allows time for the motor and its load to stabilise.

The final stage, motor running, can occur with or without the optimising mode, a feature that reduces energy consumption.

Through the keypad, the operator can monitor and/or change the range of parameters associated with the motor control function.

1.1.2 Remove the unit from its packaging and identify the parts supplied using the chassis sizes and model numbers given below.



Notes:
1. The diagram above is for illustration purposes only. The various models of SFE2 have different mechanical outlines. (Refer to individual chassis diagrams in sections 1.5.1 to 1.5.3.)
2. Removal of the cover will reveal the electrical connections for the control functions.

1.1.3 **A Basic Installation** of the SFE2 unit involves:

(a) Mounting the unit to a flat, vertical surface, within an enclosure or cubicle, which allows operation at a satisfactory temperature and humidity level and protection from accidental contact with live parts.

(b) Wiring the unit to the mains supply, to isolating devices (e.g. contactors), to the motor, and to a suitable electrical earth (ground).

(c) Entering settings into the unit from its keypad

(d) Starting and running the motor, and checking the motor performance with its permanently-coupled load

Sections 1.2, 1.3 and 1.4 describe a basic installation.

1.1.4 **An Advanced Installation** of the SFE2 unit could involve the use of:

(a) Additional contactors, relays etc. to provide more complex motor control systems (e.g. motor reversing, multi-motor starting)

(b) A ventilated or forced-air cooled enclosure

(c) An external circuit, with one or more SFE2 units, to provide an integrated system (e.g. multiple stages of a process).

Section 2 introduces application guidelines for an advanced installation.

1.1.5 Before commencing the installation, ensure that:

- There are no loose objects within the controller
- The keypad module is securely connected
- You can identify the electrical connections and their cable entry positions (refer to section 1.5)
- Sufficient space exists for the electrical cables that will connect to the unit, particularly when using the extended gland plates.

1.1.6 Read the installation sections 1.1 to 1.5, and if appropriate, the application sections (2.1 to 2.6) that apply to your use of the unit. Follow the instructions carefully.

IF IN DOUBT, CONSULT THE SUPPLIER

1.2 MECHANICAL INSTALLATION

1.2.1 Mounting

Fix the unit to a flat, vertical surface using the mounting holes (or slots) on its baseplate. The mechanical outline diagrams, shown in section 1.5, give the dimensions and mounting hole positions for each model of SFE2. Ensure that:

- The orientation of the unit has the 'TOP' uppermost (see the illustration in section 1.1.3)
- The location allows adequate front access to the control connections and the keypad push-button switches
- You can view the 4-digit display and indicators of the keypad

1.2.2 Requirements for an Enclosure

For a typical industrial environment, an enclosure would provide the following:

- A single location for the unit and its protection/isolation switchgear
- The safe termination of cabling and/or busbars
- Means to effect proper air flow through the enclosure in order to prevent heat build-up.

1.2.3 Ventilation

To maintain adequate ventilation, the unit requires a minimum clearance from each face to adjacent equipment and partitions (except for the mounting surface). Refer to section 1.5.4: Specifications and Data; Ventilation for these clearances.

While the unit is working it generates heat due to the passage of current through the semiconductors in the main circuit, therefore an unventilated enclosure may cause the ambient temperature to rise to unacceptable levels. The installer must ensure the enclosure is able to maintain the ambient temperature below 40 deg. C (without derating) or 60 deg. C (with derating.) whenever the controller is operating.

The four low-power models of SFE2 (-5, -9, -16 and -23) with chassis size 1 rely on natural convection to dissipate the heat that they generate. The remaining models of SFE2 are forced-air cooling by the built-in fan. An enclosure may need additional fans to ***assist*** the flow of air through a unit mounted within it. (For further detail, refer to section 2.4.)

To ensure that the unit operates within a suitable temperature range, make periodic measurements of the temperature internal to the enclosure. (This is particularly important for operation in warm climates.)

Note: **If you situate the unit above equipment that generates a significant amount of heat, it will reduce the unit full-load rating.**

Use the following formula when calculating the cooling air requirements for all models of SFE2. For the value of 'W', refer to section 1.5.15: Heat Output.

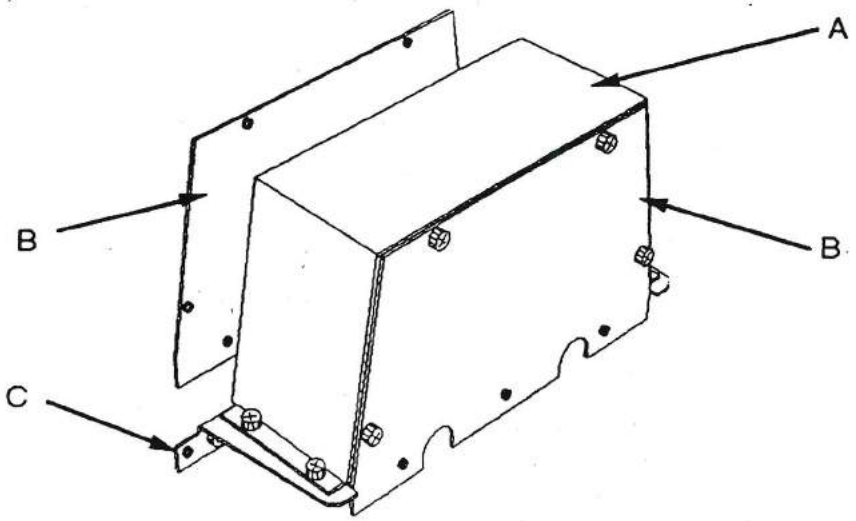
$$Q = \frac{W}{(t_{max} - t_{amb})}$$

- Q = required volume of air (Cubic metres per hour)
- W = power produced by the unit and other heat sources in the enclosure (Watts)
- t_{max} = maximum permissible temperature within the enclosure (deg. C)
- t_{amb} = temperature of the air entering the enclosure (deg. C)

1.2.4 Extended Gland Plates (for Chassis size 2 models only)

Lower power chassis size 2 models of SFE2 are fitted with flat gland plates which can be drilled to allow for insulated cable or busbar connections. For higher power chassis size 2 models, two extended gland plates are provided to accommodate larger size connections. These are available as an option for lower power size 2 modules. The diagram below illustrates the three parts of the extended gland plate, the gland frame (A), a side panel (B) (2 for each assembly) and a bracket (C) (2 for each assembly).

1.2.4 continued



To use the extended gland plates, follow Step 1 to Step 9 below.

STEP 1	Determine the cable entry positions of the power and control wiring. (Refer to section 1.3 for this wiring.)
STEP 2	Fit the cable glands to the extended gland plate.
STEP 3	Assemble one panel (B) to the gland frame (A) using the four M5 x 12mm screws supplied.
STEP 4	Assemble the two brackets (C) to the gland frame (A) using the four M5 x 12mm sems screws supplied.
STEP 5	Slide this assembly into the gland locating slots at the bottom of the unit chassis moulding and secure using the five M5 x 12mm sems screws supplied.
STEP 6	Remove the four nylon pillars from the standard gland plate and refit on to the extended gland plate.
STEP 7	Reconnect the internal earth wires (Green/Yellow insulation) to the captive stud internal to the extended gland plate.
STEP 8	Assemble the second (identical) extended gland plate using Step 3 and Step 4 above.
STEP 9	Slide the second extended gland plate assembly into the gland locating slots at the top of the unit chassis moulding and secure using the five M5 x 12mm sems screws supplied.

Using the remaining M5 x 12mm sems screws supplied, fit the second (cover) panel to each extended gland plate when the mounting and wiring of the unit is complete.

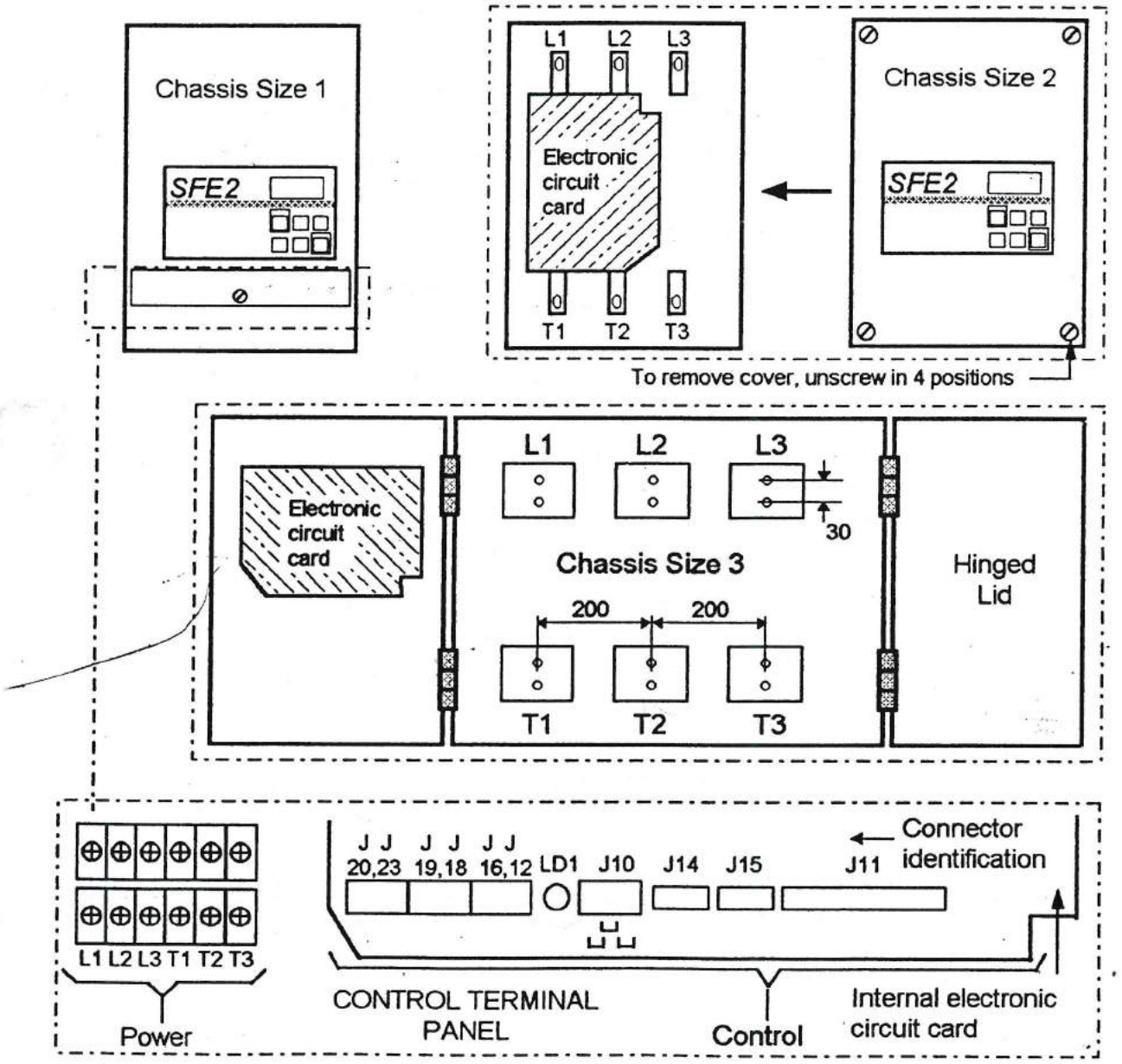
1.3 ELECTRICAL INSTALLATION

1.3.1 Electrical Connections of the Unit

All electrical connections to the SFE2 controllers are made to power input and output terminals, control terminals and a single earth stud. Removal of the cover panel will reveal the power and control terminals. For chassis size 1 models, the earth stud is near the power terminals. For chassis sizes 2 and 3, the earth stud is on the baseplate. (Refer to the mechanical outline diagrams in section 1.5.2 and 1.5.3.)

Note: Sections 1.5.17 and 1.5.18 specify the SFE 2 control inputs and outputs. Section 2 describes advanced applications that use these control signals.

Caution: **Always replace the cover panel on the unit after gaining access to the electrical connections.**



1.3.1 continued

Description of the Electrical Connections

(Section 1.5 specifies the characteristics of these connections.)

Power Terminals:	**Connection for:**
L1, L2, L3 (Input)	Isolatable 3-phase supply (via contactor, disconnect etc.). Any phase can connect to any terminal.
T1, T2, T3 (Output)	Induction motor. For correct motor rotation, these connections must correspond with the supply connections at L1, L2, L3.
Earth Stud	Electrical ground (earth). A single metric threaded stud for connection to a proper earth.
Control Terminals:	**Connection for:**
J10	Control voltage selector links. Four-way terminal block for the user to select one of two voltage levels for the control supply at terminals J14/X1, X2. LD1 will illuminate when control voltage is present.
J11/11, 12, 14 (Output)	Alarm relay contacts, change-over. J11/11: Pole J11/12: Normally-closed J11/14: Normally-open
J11/23, 24 (Output)	Run relay contacts, normally-open.
J11/31, 32, 34 (Output)	Programmable relay contacts, change-over. J11/31: Pole J11/32: Normally-closed J11/34: Normally-open
J12/+t (Input)	External motor thermistor (two terminals). Fit a shorting link to these terminals if the motor does not have a thermistor.
J14/X1, X2 (Input)	Control Supply. The internal control circuitry requires power from a 110V/230V supply. The voltage level applied must correspond with the position of the voltage selector links at J10.
J15/S1, 00 (Input)	Programmable Input. A voltage present across these terminals will CLEAR the Bit Parameter - Read/Write pointed to by parameter P21; removal will SET the bit parameter.
J15/S2, 00 (Input)	Start/Stop Input. A voltage present across these terminals will cause the unit to initiate a START; removal will cause the unit to initiate a STOP.

1.3.1 continued

Control Terminals:	Connection for:
J16/0V(COMM), J16/4-20mA (Input)	External electronic device that provides a current of 4 to 20 mA which the unit can monitor (e.g. temperature sensor). May also be used for parameter mapping.
J18/0V(COMM), J19/0-21V (input) J19/0-120V (Input)	Input for monitoring (e.g. set point potentiometer). May also be used for parameter mapping. Note: Only use the 0 -21V input or the 0 - 120V input ***but not both.*** A trimming pot Is located between J20 and J23 to adjust for voltages in the range15V to 45V or 90V to 180V.
J23/0V(COMM), J23/AN1 (Output)	Analogue output. A voltage (in the range 0 -10V) represents the analogue value of the parameter pointed to by parameter P25.
J20/0V(COMM), J20/AN2 (Output)	Analogue output. A voltage (in the range 0 -10V) represents the analogue value of the parameter pointed to by parameter P26.

1.3.2 Cabling Requirements

The electrical wiring for a basic installation involves connecting the unit to:

(1) The Mains Supply, usually through isolation and protection switchgear
(2) The Motor, in a star (wye) or delta configuration
(3) A Control Supply
(4) A low impedance electrical earth (ground).

Power Terminals

When connecting to the power terminals, use cables with an equivalent rating to the feeder cable and provide a suitable termination for each conductor. A power terminal is one of the following:

- a clamping terminal (chassis size 1). Refer to section 1.5.16 for the size of conductor that these terminals can accommodate.
- a metric, threaded stud (chassis size 2).
- a busbar with insulating panels (chassis size 3).

Control Supply

Use cable suitable for 110V or 230V AC, 50Hz/60Hz (user selected). Refer to section 1.5.16 for the size of conductor that these terminals can accommodate.

Earth

Connect the earth stud on the unit to a proper earth as required by the statutory regulations covering electrical equipment installation. (Note: The unit operates from a 3-phase balanced supply without a neutral connection.)

An advanced installation requires additional wiring for the control input and control output signals. Refer to sections 1.5.17 and 1.5.18, which specifies the voltage and current ratings of these signals.

1.3.3 Electrical Supplies

The unit requires two AC supplies:

(1) A 3-phase balanced Mains Supply to provide the source of power for the controlled motor.

(2) A single phase supply, 110V/230V, 50Hz/60Hz, for the internal control circuitry.

The unit will not operate until the control supply voltage is within its specified limits. The sequence of application of these two supplies is not important. (Note: The overload will reset after control supply removal. It is recommended that the control supply is maintained between starts to ensure overload integrity.)

1.3.4 Isolation and Protection Equipment

Caution:	**The SFE2 uses semiconductor devices in the main circuit and is not designed to provide isolation. For this reason isolation means (e.g. circuit breaker, contactor, isolator) must be installed elsewhere in the circuit in accordance with the appropriate wiring and safety regulations.**

The Mains Supply and the Control Supply each require fuse protection, although all units have electronic overload protection for the motor load. (Section 1.4.2 describes how the user can change the overload level (parameter P18) using the keypad module.) The installer should always place fuse protection ***between*** the unit and the Mains Supply, ***not between*** the unit and the motor. (Refer to the standard configurations shown in section 1.3.5.)

Semiconductor fuses, are supplied as an option for short-circuit protection of the semiconductors. These fuses cannot be fitted within SFE2 chassis size 1 models, and must be mounted externally by the user. For chassis sizes 2 and 3, fuses can be fitted internally by replacing the fuse links which are fitted as standard in the power circuit.

1.3.5 Standard Wiring Configurations

There are two standard wiring configurations for the interconnection of the motor, the unit and the mains supply:

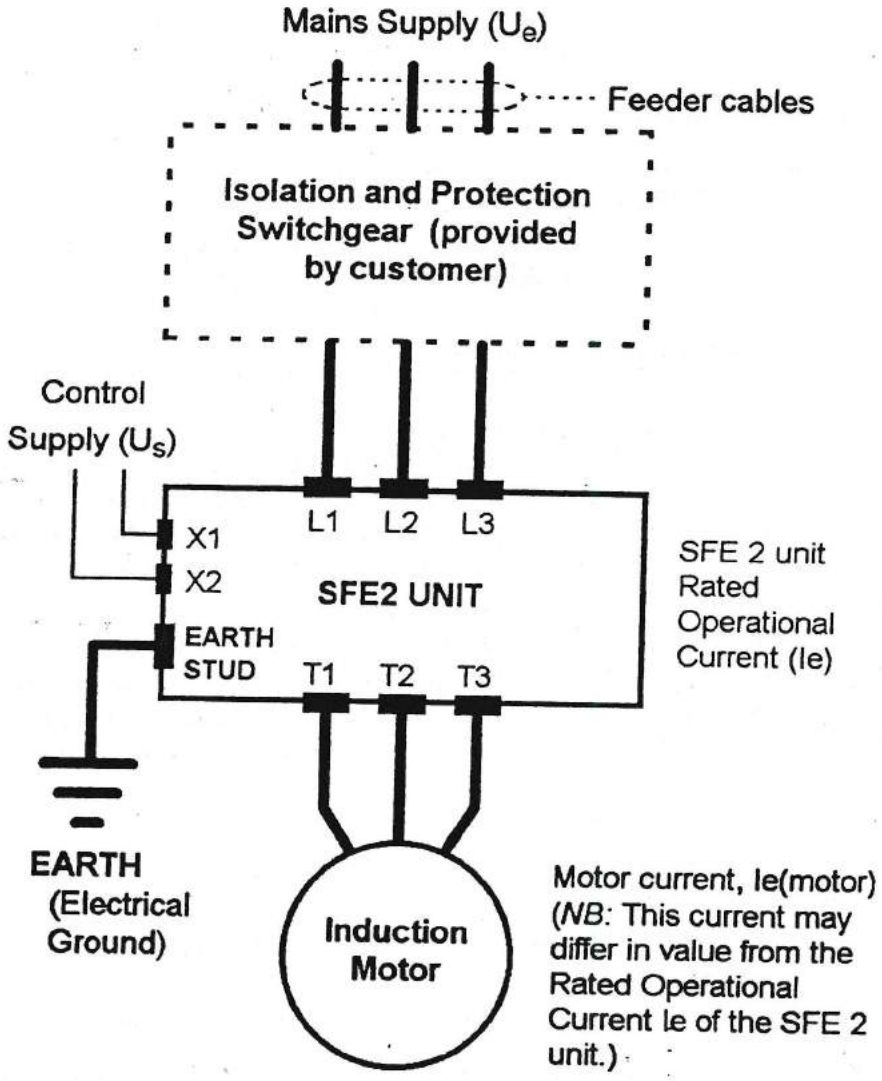
Configuration 1: In-Line connection for Delta and Star (Wye) Connected Induction Motors

Configuration 2: In-Delta connection for Delta Connected Induction Motors.

Schematic diagrams for each configuration are shown on the following pages. (Refer to section 2 which describes configurations that require other features such as motor bypassing and motor reversing.)

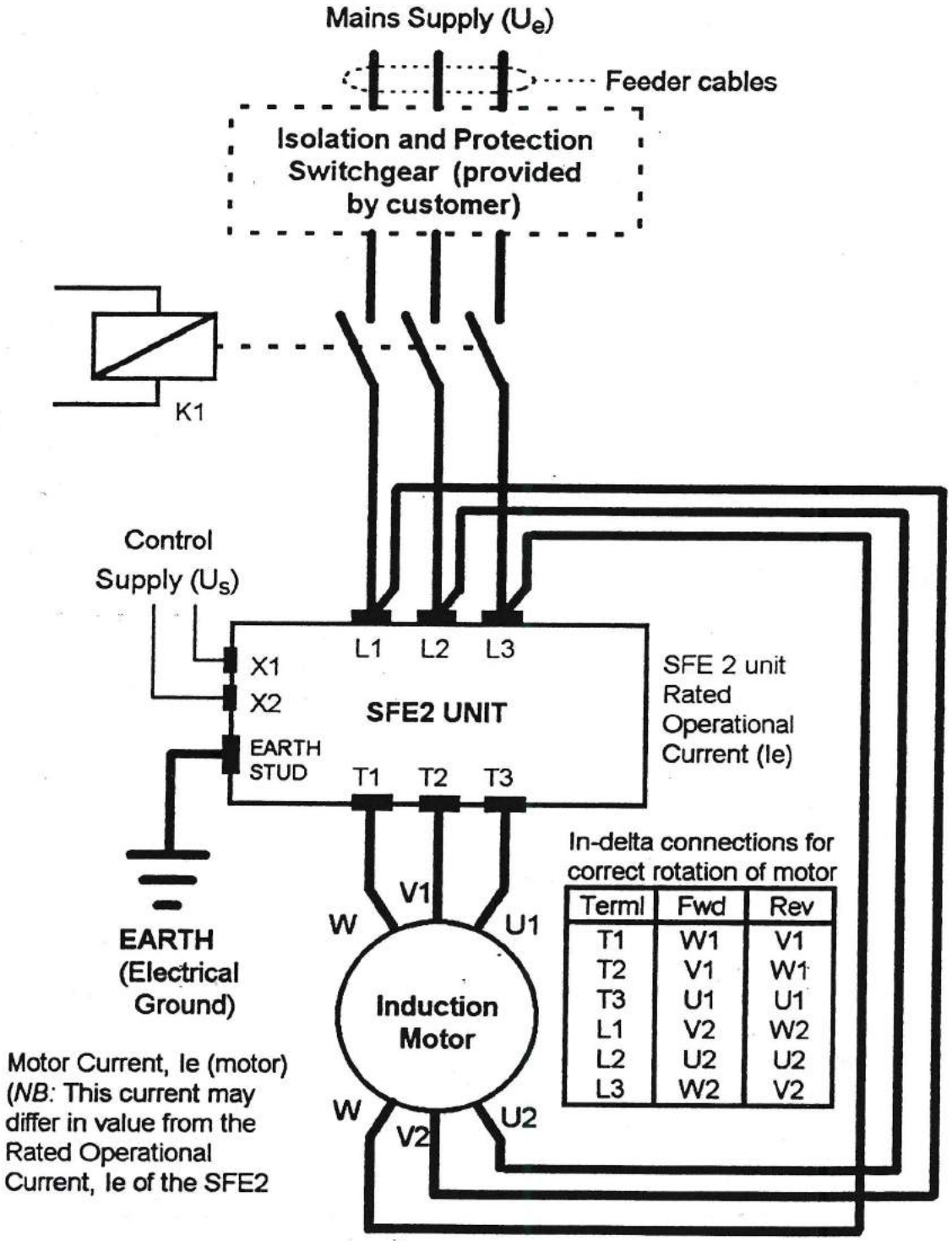
1.3.5 continued

Standard Wiring Configuration (1):
In-line Connection for Delta and Star (Wye) Connected Induction Motors



1.3.5 continued

Standard Wiring Configuration (2):
In-Delta connection for Delta connected induction motors



Terml	Fwd	Rev
T1	W1	V1
T2	V1	W1
T3	U1	U1
L1	V2	W2
L2	U2	U2
L3	W2	V2

1.3.6 Electro-Magnetic Compatibility (EMC)

Installations within Europe using the SFE2 unit must comply with the EC Directive 89/336/EEC. The European Commission document 'Guidelines on the Applications of Council Directive 93/336/EC' describes the following three important criteria:

(1) Classification of the SFE2 soft-starter unit as a component when used by 'Professional Assemblers' or within an 'Installation'. For these applications the 'CE Mark' (see Page 2) is not required, but see (3) below.

(2) Classification of the SFE2 soft-starter unit within a 'single commercial unit' when it forms part of a system that has an intrinsic function for the end-user. For these applications, the whole system requires CE marking certification to signify compliance with the generic standard or the appropriate product standard.

(3) Obligation by the manufacturer of the soft-starter to provide technical information to support the installation and use of the product. Section 2.3 of this Technical User Manual fulfils this obligation.

Meeting the required standards may involve special wiring arrangements, fitting filters, etc.

If you are unclear concerning the implementation of the EMC guidelines, then consult your supplier.

Caution:	**Although the SFE 2 will operate in an environment that meets European EMC standards, it may malfunction if a powerful radio frequency transmitter (e.g. mobile telephone) is operated in very close proximity to the controller with the enclosure door open. Make sure that under normal circumstances the unit only operates with the enclosure door kept shut.**

1.4 PREPARING AND USING THE UNIT

Before you begin to follow the instructions in sections 1.4.1 to 1.4.3, ensure that:

(1) The mechanical installation complies with the instructions given in section 1.2.

(2) The electrical installation complies with the instructions given in section 1.3.

(3) It is safe to apply power to the unit and start the motor.

(4) A second person will not operate the controls or switches of an external circuit connected to the unit.

To achieve the best performance from a motor with a permanently-coupled load, the SFE2 unit needs to control various parameters. (Such parameters include the start-up voltage, and, the time it takes for this start-up voltage to equal the input supply voltage.) The keypad module gives the operator access to these parameters.

Section 1.4.1 introduces the keypad module, and allows the operator to:

- Select and view any parameter. The parameter settings indicate the limits within which the unit will effect motor control.

- Select and identify the Code Table. The Code Table contains six separate instructions, which collectively define how the unit should operate. (The unit ***only*** responds to an instruction that the operator selects ***and*** enters.)
- Start, run, optimise and stop the motor using parameter settings chosen by the manufacturer. (These settings are called the 'Manufacturer's Default Settings'.)

Section 1.4.2 directs the operator to:

- Change and store parameter settings appropriate to the application.
- Start, run, optimise and stop the motor using parameter settings chosen by the operator.

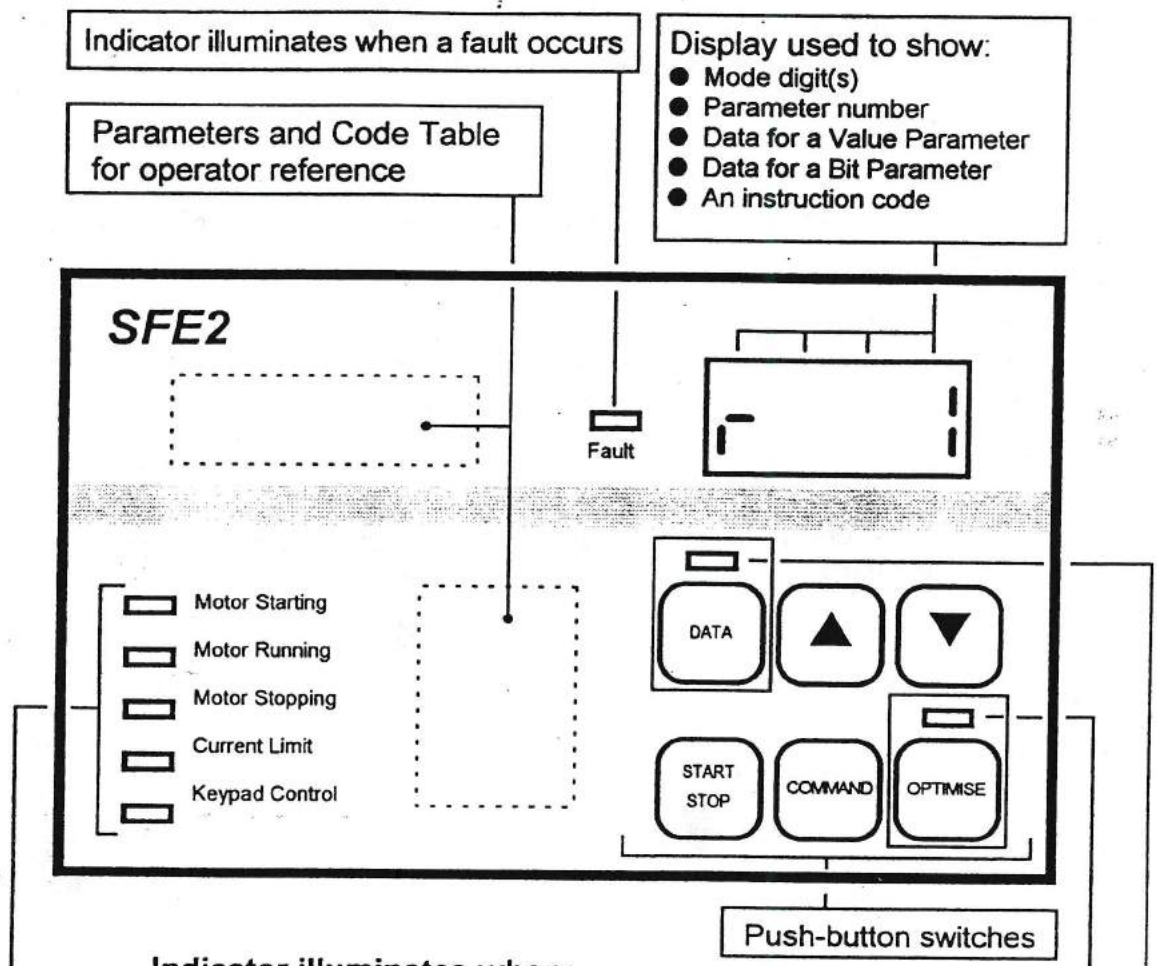
NOTE TO ALL USERS

Section 2 recommends parameter settings for various typical applications. You may use these settings as a guideline for your application.

Section 1.4.3 describes further features of the keypad module.

Section 1.4.4 is an index of the tables, parameters and fault codes that can appear on the display.

1.4.1(a) Unit Familiarisation - Identifying the Keypad Controls and Indicators



Indicator illuminates when:

- The unit is in optimising mode
- The display shows data for a Value Parameter or a Bit Parameter
- The motor is starting (pedestal voltage applied)
- The motor is running (full supply voltage applied)
- The motor is stopping
- The unit is operating in current limit
- The keypad controls motor soft-start

DATA	Switches the display between a parameter number and its data	COMMAND	Selects a parameter table or executes an instruction from the code table
▲	Increments the number shown on the 4-digit display	START STOP	Initiates either SOFT-START or SOFT-STOP
▼	Decrements the number shown on the 4-digit display	OPTIMISE	Switches the motor control between OPTIMISE ON and OPTIMISE OFF

1.4.1(b) Unit Familiarisation - Identifying the Parameters

The parameter settings on the keypad module determine how the unit performs motor control. These parameters, each identified by a Mode digit and a number, are put into 4 tables as shown below. Two tables contain parameters that the operator can change and store, whilst the other two tables contain parameters that the operator can view but not change.

Parameters that the operator can change and store. [Section 1.4.4 describes these parameters and sections 1.4.2(a)-(c) describes how to change them.]

VALUE PARAMETERS - READ/WRITE
(/P indicates a pointer to a read-only value)

P1	Default offset /P	P17	Current limit
P2	Start pedestal	P18	Overload level
P3	Start time	P19	Soft-stop smoothing
P4	Stop pedestal	P20	Programmable relay
P5	Stop time	P21	Programmable input
P6	Optimise rate	P22	Heatsink temperature trip level
P7	Overload delay		
P8	Current rating hundreds	P23	Set level for 4-20mA input
P9	Current rating units	P24	Set level for DC input
P10	Kickstart time	P25	Analogue output channel 1
P11	Kickstart volts	P26	Analogue output channel 2
P12	Under-current timeout	P27	Firing mode
P13	Shearpin timeout	P28	Dwell time
P14	Password	P29	Read/Write pointer for DC input
P15	Under-current level		
P16	Shearpin level	P30	Read/Write pointer for 4 - 20mA input

BIT PARAMETERS - READ/WRITE

b1	Current limit and overload trip selector
b2	Energy saving input
b3	Kickstart input
b4	Local start/stop input
b5	Shearpin trip selector
b6	Under-current trip selector
b7	Low voltage soft-stop selector
b8	Programmable relay table selector
b9	Ramp hold input
b10	Table to use
b11	Thermistor selector
b12	Go to full speed

Parameters that the operator can view, but not change. [Section 1.4.4 describes these parameters.]

VALUE PARAMETERS - READ-ONLY

r1	Default display	r12	Software version number
r2	Present power factor	r13	Last detected trip
r3	Reference power factor	r14	Last trip before r13
r4	Delay angle	r15	Last trip before r14
r5	Normalised current	r16	Last trip before r15
r6	Motor current	r17	Last trip before r16
r7	Frequency of supply	r18	Last trip before r17
r8	Maximum optimise delay angle	r19	4-20mA input
		r20	DC voltage input
r9	Percentage of overload	r21	Thermistor input
r10	Peak current detector	r22	Heatsink temperature
r11	Software product number	r23	Thermister count trip

BIT PARAMETERS - READ-ONLY

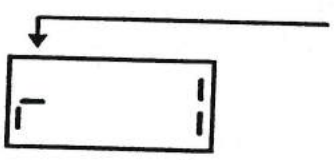
br1	Programmable input state
br2	Run relay
br3	Top of Ramp indicator
br4	Alarm indicator
br5	Dwell indicator
br6	Current limit indicator
br7	Remote start/stop input
br8	Voltage/current mode indicator
br9	Noise indicator
br10	Integrating indicator
br11	milliamp bit
br12	inverse of br11
br13	dc input bit
br14	inverse of br13

1.4.1(b) continued

Displaying Parameters from a Table:

As supplied, the keypad the display is set to show motor phase current. (You can change this default, refer to section 1.4.3(c).) (Note: Motor current is always shown as phase current, irrespective of the circuit configuration.) The only indicator illuminated is above the DATA push-button switch. Press this switch once and its indicator will extinguish. The display will then show:

- the Mode digit, which indicates the selected parameter table
- the Parameter number, which indicates the parameter selected from that table.



Mode digit for the selected table:
Value Parameter - Read-only

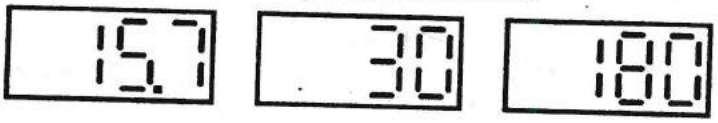
Parameter number

Displaying the Data for a Value or Bit Parameter:

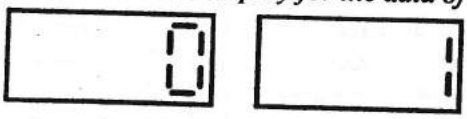
Each parameter has data associated with it. This data appears on the display when the operator presses the DATA push-button switch once. The data is shown in one of four ways:

Data	Represents	Range	Example
VALUE	Analogue quantity	0 to 8191	Voltage, Seconds
VALUE	Multiple of an absolute quantity	0 to x 1, or x 1 to x 5	Undercurrent level, multiple of full-load current (x FLC) Current limit, multiple of full-load current (x FLC)
VALUE	Percentage of an absolute quantity	0 to 100%	Start Pedestal voltage as a percentage of input supply voltage
BIT	Logical selection	0 or 1	0 means Off, Disable, Not selected 1 means On, Enable, Selected Energy Saving Input Current Limit Indicator

Examples of the display for the data of Value Parameters:



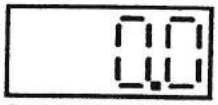
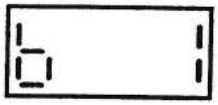
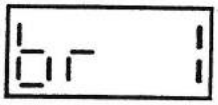
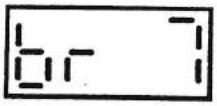
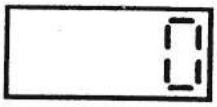
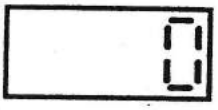
The only digits shown on the display for the data of Bit Parameters:



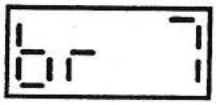
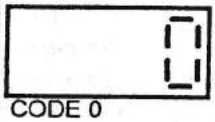
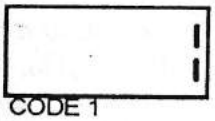
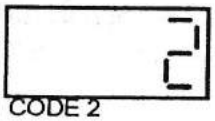
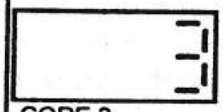
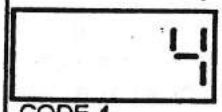
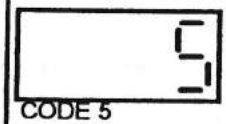
1.4.1(c) Unit Familiarisation - Using the Keypad Controls and Indicators

DO NOT PRESS THE KEYPAD START/STOP PUSH-BUTTON SWITCH BECAUSE THIS SECTION DOES NOT REQUIRE THAT YOU OPERATE THE MOTOR.

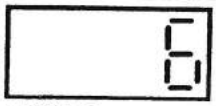
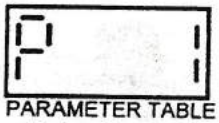
This section lets you use the keypad push-button switches and view the display and indicators. (Note: Section 1.4.1(d), 'Entering the Default Settings and Selecting Keypad Control', nullifies any changes in parameter settings made from the keypad. This means that you can make mistakes when following the instructions in this section without affecting the default values.)

DISPLAY	PUSH-BUTTON SWITCHES TO OPERATE	
 PARAMETER TABLE: Value Parameter - Read-only		At power-up, the display shows the motor current. Press the DATA push-button switch once and the display will show the parameter number r1.
 PARAMETER TABLE: Bit Parameter - Read/Write		Press COMMAND once. The display will advance to the next parameter table. Again, the parameter number is 1 and all indicators remain extinguished.
 PARAMETER TABLE: Bit Parameter - Read-only		Press COMMAND once. The display will advance to the next parameter table. (Note: This is a Read-only table.)
 PARAMETER TABLE: Bit Parameter - Read-only		As necessary, Press UP (increment) and DOWN (decrement) to select a valid parameter number. (br7, the parameter shown, is the Remote Start/Stop Input.)
 DISPLAYS EITHER BIT = 0, OR BIT = 1		Press DATA and the green indicator above it will illuminate. The display shows the data for the parameter number selected.
		Press UP (increment) and DOWN (decrement) to change the data. It does not change because the table is read-only. (You can only view this data, but not change it.)

1.4.1(c) continued

DISPLAY	PUSH-BUTTON SWITCHES TO OPERATE	
		Press DATA and the green indicator above it will extinguish. The display again shows the parameter number selected.
 CODE TABLE:		Press COMMAND once. The display will advance to the Code Table.
 CODE 0		Press DATA once. The display shows a 0, which indicates no instruction selected. CODE 0: Indicates no selection
 CODE 1		Press UP (increment) once. Instruction CODE 1: Read data from store. *Takes the parameter settings from storage memory and puts them into temporary memory.*
 CODE 2		Press UP (increment) once. Instruction CODE 2: Write data to store. *Puts the operator's changes to the parameter settings into storage memory.*
 CODE 3		Press UP (increment) once. Instruction CODE 3: Remote control of motor. *Enables control of the soft-start from an external circuit.*
 CODE 4		Press UP (increment) once. Instruction CODE 4: Local control of motor. *Enables control of the soft-start from the keypad.*
 CODE 5		Press UP (increment) once. Instruction CODE 5: Load default values. *Puts the manufacturer's default parameter settings into temporary memory.*

1.4.1(c) continued

DISPLAY	PUSH-BUTTON SWITCHES TO OPERATE	
 CODE 6		Press UP (increment) once. Instruction CODE 6: Password entry. *Used in the sequence of steps to enable:* • *Security with the password in parameter P14* • *Password entry, which then allows manipulation of Read/Write parameters* (Refer to section 1.4.3 (h).)
 CODE TABLE		Press DATA once and the display will again show CodE to indicate selection of the Code Table.
 PARAMETER TABLE Value Parameter - Read/Write		Press COMMAND once. The display will advance to the last of the four parameter tables.

Notes: 1. The unit has two types of memory as follows:
- **Storage memory.** The unit puts the parameter settings that it uses at power-up into storage memory. These settings are either the User-defined tables or the default settings.
- **Temporary memory.** In order to use the parameter settings and make them available for change, the unit automatically puts them into temporary memory at power-up.

2. If you change parameter settings, and then want to recall the original settings at the last power-up, use instruction CODE 1 in the Code Table. If you want to put changes to parameter settings into storage memory, use instruction CODE 2 in the Code Table. (Refer to section 1.4.2 (d).)
3. The UP (increment) and DOWN (decrement) push-button switches do not operate when you select the data for a Value or Bit Parameter Table - Read-only.
4. Should the operator make a mistake in setting a Value or Bit Parameter - Read/Write, then the Manufacturer's default settings are always available through instruction CODE 5 in the Code Table.

1.4.1(d) Unit Familiarisation - Entering the Default Settings and Selecting Keypad Control

To help the user, default settings for all Value and Bit Parameters are pre-loaded at the factory. These settings, called the 'Manufacturer's Default Settings', are made available to the operator when either of the following two events occur,

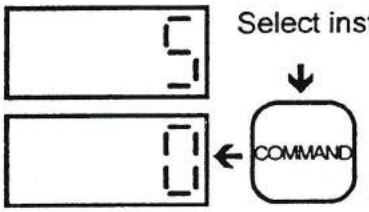
(1) Power is first applied to a new unit.

(2) You follow the steps described in this section.

Steps 1 to 3 below describe how to:

- Put the manufacturer's default settings into the unit storage memory. (Note: These steps nullify any parameter settings made in section 1.4.1(d).)
- Control the unit from the keypad. This also prevents control of the unit from an external circuit.

STEP 1

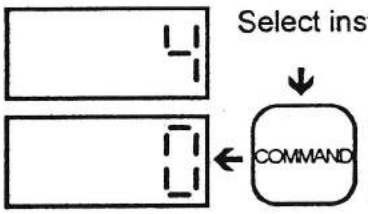


Select instruction CODE 5: Load default values.

Press the COMMAND push-button switch once, which enters instruction CODE 5.

The display will then show a 0 to indicate completion of the instruction.

STEP 2

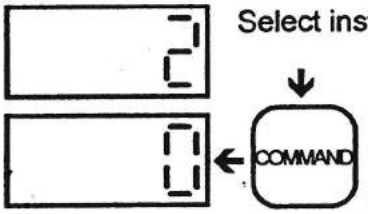


Select instruction CODE 4: Local control of motor.

Press the COMMAND push-button switch once, which enters instruction CODE 4.

The display will then show a 0 to indicate completion of the instruction.

STEP 3



Select instruction CODE 2: Write data to store.

Press the COMMAND push-button switch once, which enters instruction CODE 2.

The display will then show a 0 to indicate completion of the instruction.

Note:

1. If you want storage memory to keep the changes made, then use instruction CODE 2.
2. You only need to select and enter instruction CODE 2 once ***after*** entering the other instructions.

1.4.1(e) Unit Familiarisation - Starting and Running the Motor (with the Manufacturer's default settings)

The unit is now ready to start a motor from the keypad START/STOP push-button switch and will use the manufacturer's default settings. This section directs the operator to start and run the motor using these settings.

Caution:

Some components may become hot during normal operation. You should ensure that the system is only re-started after allowing sufficient time for cooling. Refer to sections 1.5.13 and 1.5.14, Overload Current Profile.

For most applications, the default settings will start and run a motor satisfactorily. Motors which have a high-inertia load may need a longer time to achieve full speed. To accommodate the additional thermal stress that such loads cause, a higher rated unit may need to be used. (Refer to section 2.)

If a motor stalls during the initial start-up, or if excessive current flows, the input supply circuit breaker may trip. If this happens:

(1) Isolate, and check the wiring to the unit and the motor.

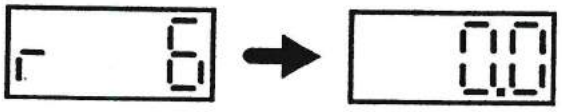
(2) Ascertain that the circuit protection is not sensitive to non-sinusoidal waveforms. (Any electronic protection systems must be capable of working with these waveforms)

(3) Check, and if possible, reduce the load on the motor.

(3) Re-apply the input supply and store a longer start-up time by changing parameter P3. (Refer to sections 1.4.2 (a) and 1.4.2 (d).)

(4) Continue with step 1 to step 3 described in this section.

STEP 1 Select the table VALUE PARAMETERS - READ-ONLY and the parameter r6. Press the DATA push-button switch once and ensure that the green indicator above it illuminates. The display will show the motor current as 0.0, that is, zero amperes.



1.4.1(e) continued

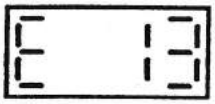
STEP 2 To start the motor, press the keypad START/STOP push-button switch once and observe that:

- the Motor Starting indicator illuminates
- the display shows the motor current increasing

STEP 3 When the motor reaches its run condition, observe that:

- the Motor Starting indicator extinguishes
- the Motor Running indicator illuminates
- the motor current stabilises. (It is usual for the value displayed to change fractionally.)

Points to note during motor starting and running:

1 

If an error occurs, then the unit will remove the input supply to the motor and show a Fault Code (E- - -) on the keypad display.

(The example above shows E13, the fault code for an Overload trip. Refer to section 1.4.4 for the list of all the fault codes.)
To clear a fault code that appears during motor starting, press the START/STOP push-button switch once. To restart the motor, press the switch once more.
To clear a fault code that appears during motor stopping, and to restart the motor, press the START/STOP push-button switch once. (Note: Always investigate a fault before restarting a motor.)

2 To achieve smooth motor acceleration for the load applied, the unit allows the operator to change the start-up characteristics through the following Value Parameters -Read/Write:

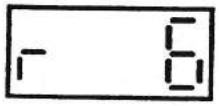
- Start pedestal (P2)
- Start time (P3)
- Current limit (P17)
- Kickstart volts (P11)
- Kickstart time (P10)

3 The instructions in section 1.4.1(d) enabled the control of the unit to occur from the keypad push-button switches, not from an external circuit connected between the START input (terminal S2) and COMMON (terminal 00).
To activate the controls and switches of an external circuit, the operator must select and enter instruction CODE 3: Remote Control of Motor. (Refer to section 1.4.3(d).)

1.4.1(f) Unit Familiarisation - Running the Motor in Optimising Mode

When the SFE controller is in optimise mode, depending on load conditions, the motor current reduces and the power factor increases. To view these performance changes, follow steps 1 to 4 below.

STEP 1



Select the table VALUE PARAMETER - READ-ONLY and the parameter r6 (motor current).

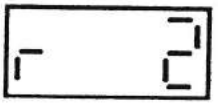
Press the keypad DATA push-button switch and ensure that the green indicator above it illuminates. The display will show the motor current (in amperes).

STEP 2

Press the keypad OPTIMISE push-button switch and ensure that the red indicator above it illuminates. Observe that the display shows a reduced motor current. (Under certain load conditions this reduction is fractional.)

Press the OPTIMISE push-button switch again and ensure that the red indicator above it extinguishes.

STEP 3



Select the table VALUE PARAMETER - READ-ONLY and the parameter r2 (present power factor).

Press the DATA push-button switch and ensure that the green indicator above it illuminates. The display will show the value of the present power factor.

STEP 4

Press the OPTIMISE push-button switch and ensure that the red indicator above it illuminates. Observe that the display shows an increase in power factor. (Under certain conditions this increase is fractional.)

Press the OPTIMISE push-button switch again and ensure that the red indicator above it extinguishes.

Points to note during motor optimising:

1 For some applications optimising gives a fractional change to the motor current and power factor. The greatest effect is seen when the motor is most lightly loaded.

2 The selection of OPTIMISE may cause instability on low inertia applications with motors which have small slip speeds. To counteract this effect, and to restore stability, the unit allows the operator to select an Optimise Rate (parameter P6).

1.4.1(g) Unit Familiarisation - Stopping the Motor

To stop the motor the operator must press the START/STOP push-button switch once. If the operator wants to view the motor current as the motor stops, then follow Step 1 and Step 2 below.

STEP 1

Select the table VALUE PARAMETER - READ-ONLY and the parameter r6 (motor current).

Press the DATA push-button switch and ensure that the green indicator above it illuminates. The display will show the motor current (in amperes).

STEP 2 To stop the motor press the START/STOP push-button switch once and observe that:

- the Motor Running indicator extinguishes
- the Motor Stopping indicator illuminates
- the display shows the motor current

When the motor current stops, the Motor Stopping indicator will extinguish.

Points to note during motor stopping:

1 When the operator stops the motor, the Manufacturer's default settings cause the motor supply voltage to decrease over 10 seconds. The operator may change this setting through the parameter Stop Time (P5).

2 The unit allows the operator to apply a soft-stop, which is the reverse operation to soft-start. When enabled through the Low Voltage Soft-stop bit (b7), Soft-stop causes the motor supply voltage to reduce rapidly to a level determined by the parameter Stop Pedestal (P4). It then continues to decrease according to the ramp characteristics.

3 If the Low Voltage Soft-stop bit (b7) is 0 (not enabled), and the motor is fully optimising at minimum delay, then initiating a STOP will cause the motor to coast to a stop immediately.

4 The parameter Soft-stop Smoothing (P19) provides smooth deceleration for motor loads that benefit from controlled stopping.

To use the installed unit with a motor and its permanently-coupled load, the operator could select the default settings. In many applications these settings will give satisfactory motor operation, but they may not offer the best performance. To improve motor operation, sections 1.4.2(a) to 1.4.2(c) guide the operator through the changing and storing of selected Value and Bit Parameters - Read/Write. These sections, with the parameters that they affect, are as follows:

1.4.2(a) Changing the settings for the Start-up Ramp
- Value Parameters - Read/Write: P2-P5, P10, P11, P17, P19
- Bit Parameters - Read/Write: b3, b7, b9

1.4.2(b) Changing the settings for the Optimising Mode
- Value Parameters - Read/Write: P6
- Bit Parameters - Read/Write: b2

1.4.2(c) Changing the settings for the Protection Parameters
- Value Parameters - Read/Write: P7, P12, P13, P15, P16, P18, P22
- Bit Parameters - Read/Write: b1, b5, b6, b11

Section 1.4.2(d) describes how to put, in one procedure, all the parameter settings into the unit storage memory. Section 1.4.2(e) to 1.4.2(h) takes the operator through the motor start, run, optimise and stop sequence.

Notes:
1. If necessary, use the security password first.
2. The parameter settings that the operator will make form a 'User-defined Table'. The unit can keep two user-defined tables in storage memory. (Notes 1 and 2; refer to section 1.4.3, Further Keypad Features.)
3. The complete index of parameters is shown in section 1.4.4.
4. Section 2.5 recommends parameter settings for various applications.

To change a Value or Bit Parameter - Read/Write

STEP 1 Use the COMMAND push-button switch to select the required parameter table.

STEP 2 Use the UP (increment) or DOWN (decrement) push-button switches to select a parameter number. (You can press and hold these switches to scroll through the available numbers.)

STEP 3 Press the DATA push-button switch once; the display will show the data of that parameter.

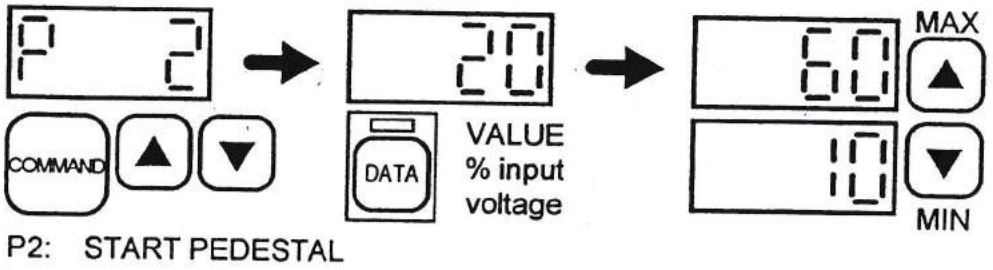
STEP 4 Use the UP (increment) or DOWN (decrement) push-button switches to change the data of the required parameter number. (Note: You cannot enter or view values outside the parameter's range. For a Bit Parameter - Read/Write this is only 0 or 1.)

STEP 5 Press the DATA push-button switch once to display the existing parameter number.

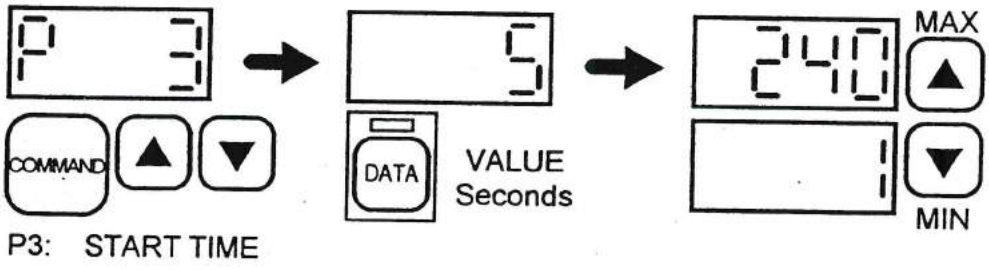
To help the operator follow these steps using the switches and indicators described, sections 1.4.2(a) to 1.4.2(c) represents them pictorially.

1.4.2(a) Unit Implementation - Changing the Settings for Starting and Stopping

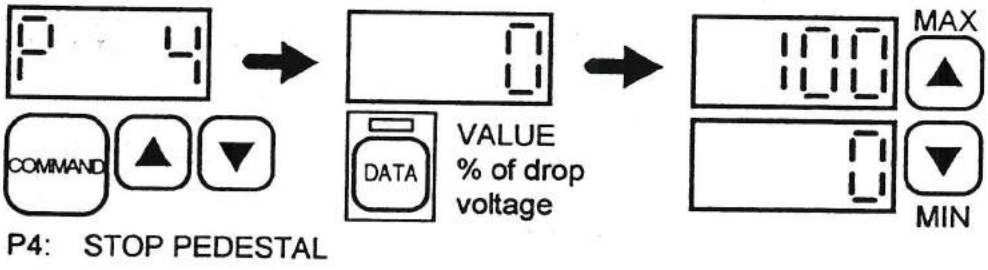
PARAMETER TABLE AND PARAMETER NUMBER	DISPLAY OF DATA (Default settings shown)	CHANGE DATA



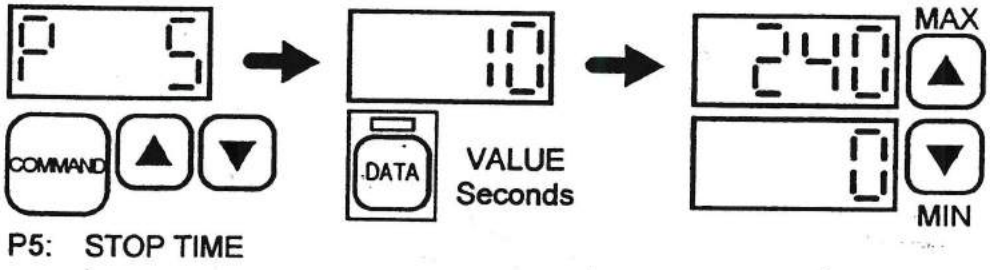
P2: START PEDESTAL



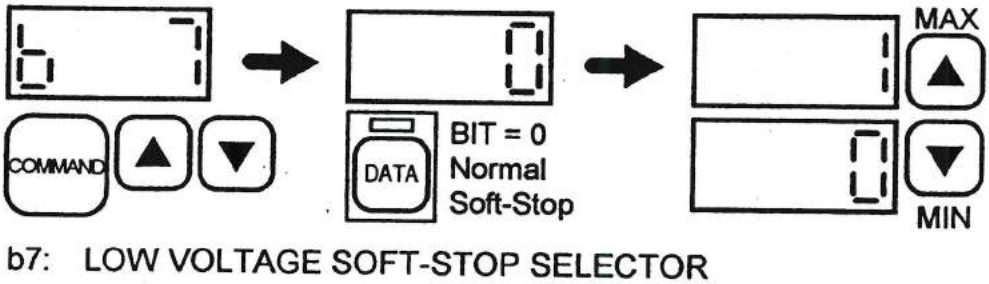
P3: START TIME



P4: STOP PEDESTAL



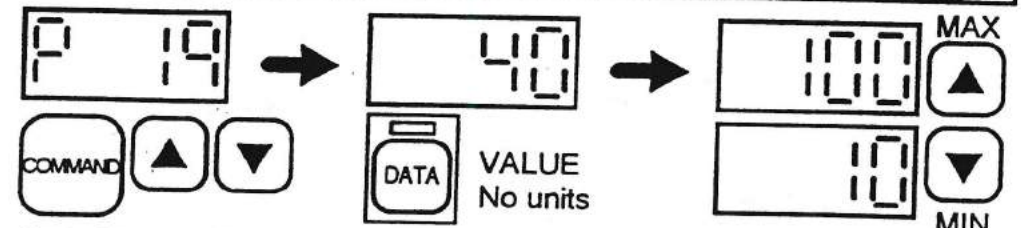
P5: STOP TIME



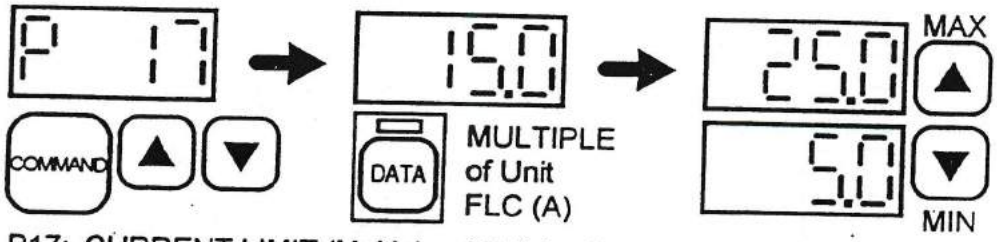
b7: LOW VOLTAGE SOFT-STOP SELECTOR

1.4.2(a) continued

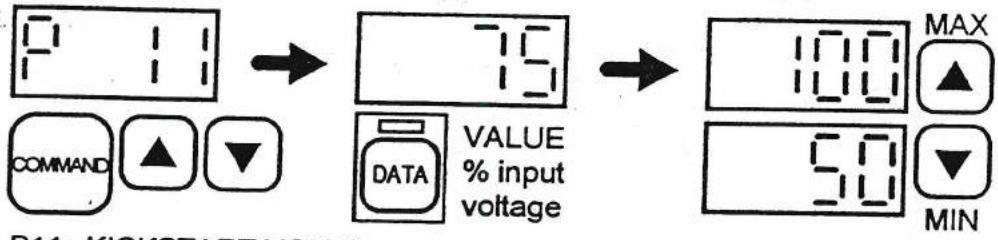
PARAMETER TABLE AND PARAMETER NUMBER	DISPLAY OF DATA (Default settings shown)	CHANGE DATA



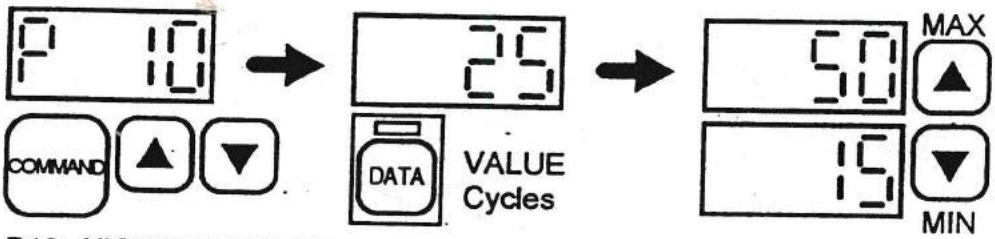
P19: SOFT-STOP SMOOTHING (100 gives the greatest smoothing effect)



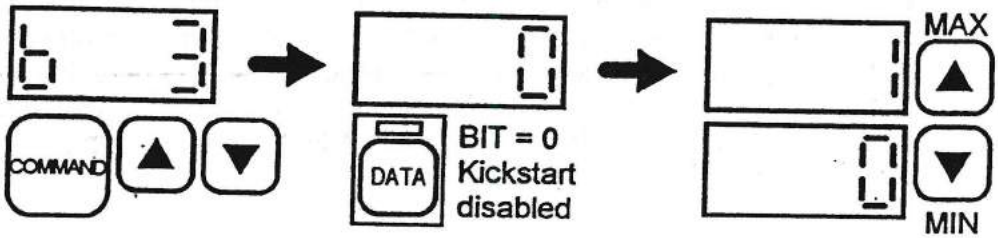
P17: CURRENT LIMIT (Multiple of Full-load current (FLC) in amperes)
[The example displays shown are for a 5A unit.]



P11: KICKSTART VOLTS

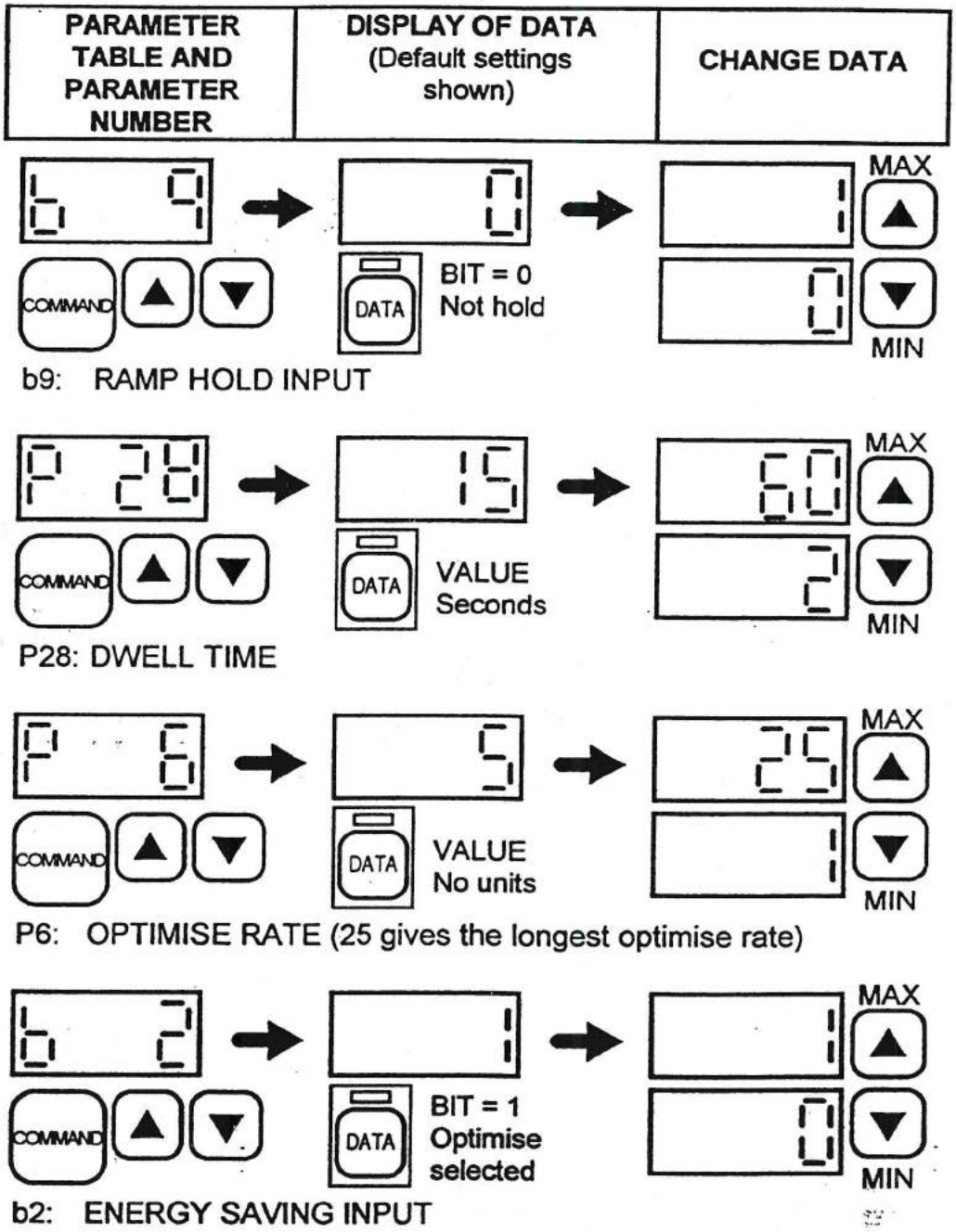


P10: KICKSTART TIME



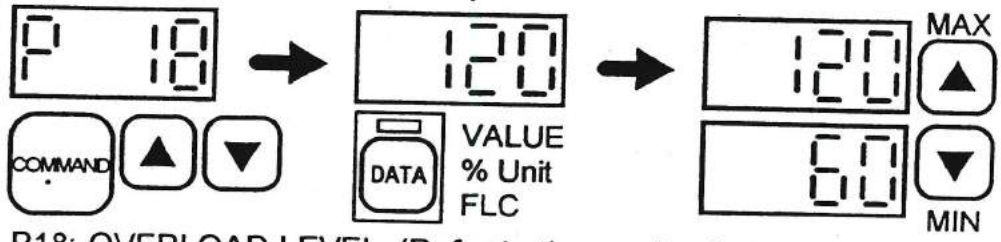
b3: KICKSTART INPUT

1.4.2(b) Unit Implementation - Changing the Settings for the Optimising Mode

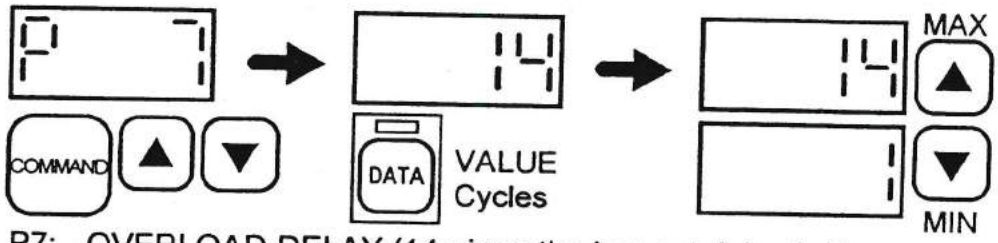


Note: If the parameter b2 is BIT = 1, then after the dwell period, the unit will automatically put the control into optimising mode. If the parameter is BIT = 0, use the keypad OPTIMISE push-button switch to select the optimising mode. (A common alternative is to use the Programming Input (P21), which allows remote selection of this mode. Refer to section 1.4.3(d): Further Keypad Features - Using an External Circuit.)

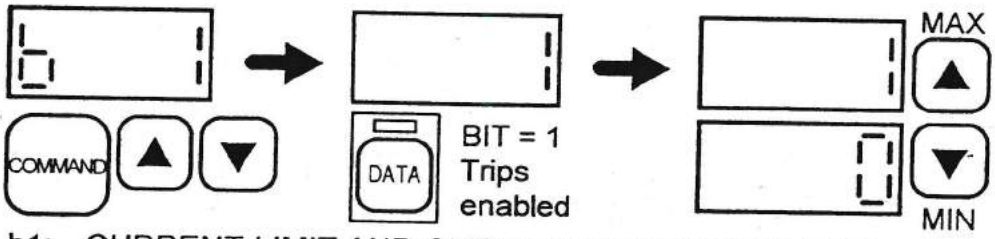
1.4.2(c) Unit Implementation - Changing the Settings for the Protection Parameters



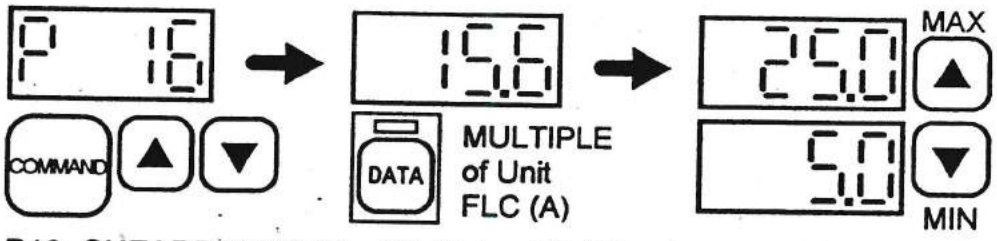
P18: OVERLOAD LEVEL (Refer to the overload trip curves shown in the specification section 1.5.22.)



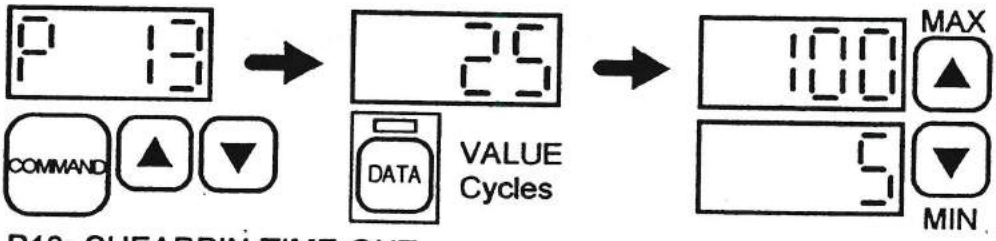
P7: OVERLOAD DELAY (14 gives the longest delay before an overload. Refer to the overload trip curves shown in the specification section 1.5.22.)



b1: CURRENT LIMIT AND OVERLOAD TRIP SELECTOR



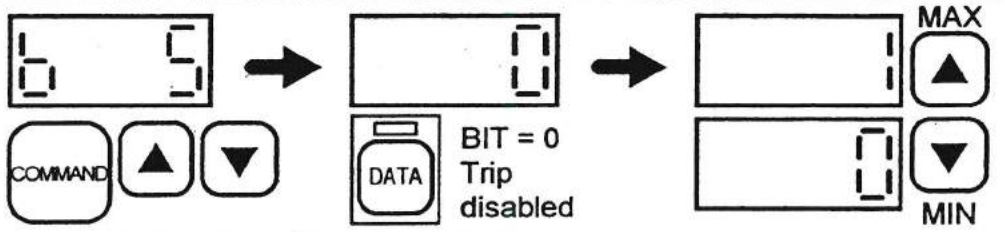
P16: SHEARPIN LEVEL (Multiple of Full-load current (FLC) in amperes) The example displays shown above are for a 5A unit.



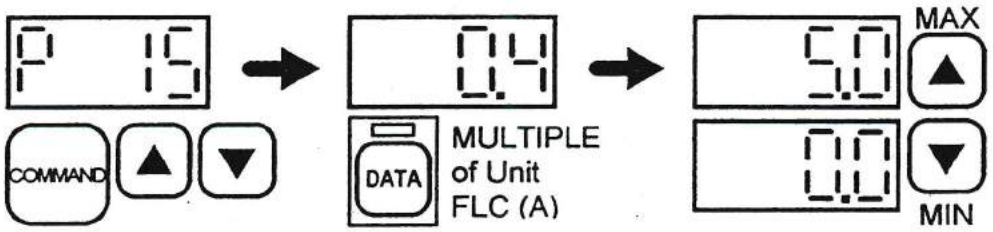
P13: SHEARPIN TIME-OUT

1.4.2(c) continued

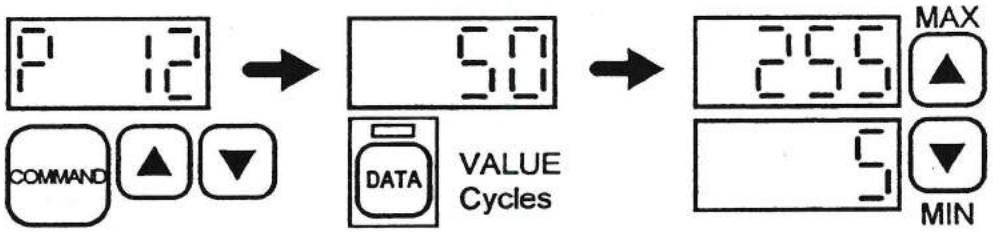
PARAMETER TABLE AND PARAMETER NUMBER	DISPLAY OF DATA (Default settings shown)	CHANGE DATA



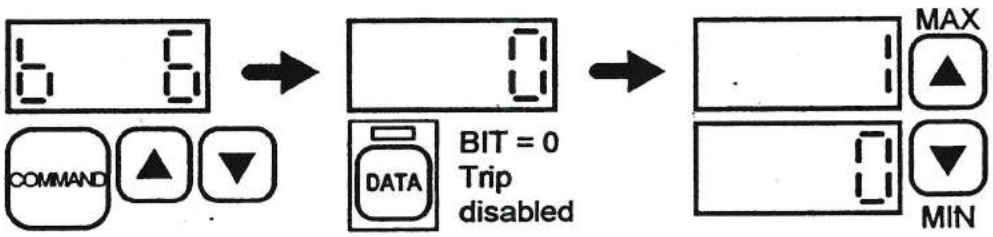
b5: SHEARPIN TRIP SELECTOR



P15: UNDER-CURRENT LEVEL (Multiple of Full-load current (FLC) in amperes.) The example displays shown above are for a 5A unit.



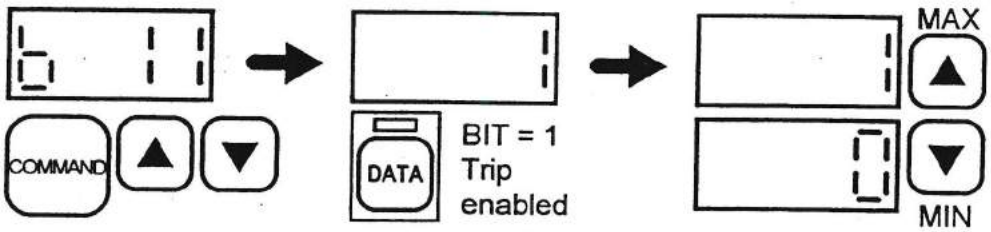
P12: UNDER-CURRENT TIME-OUT



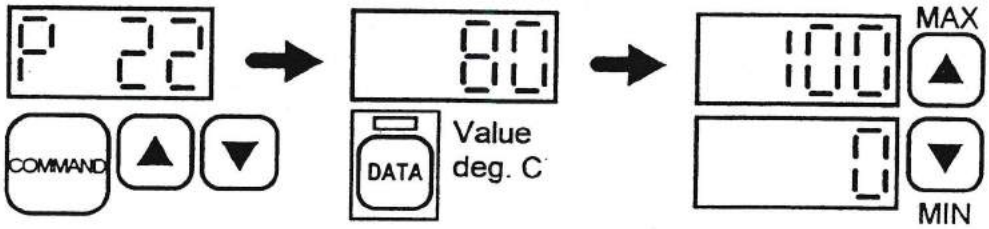
b6: UNDER-CURRENT TRIP SELECTOR

1.4.2(c) continued

PARAMETER TABLE AND PARAMETER NUMBER	DISPLAY OF DATA (Default settings shown)	CHANGE DATA

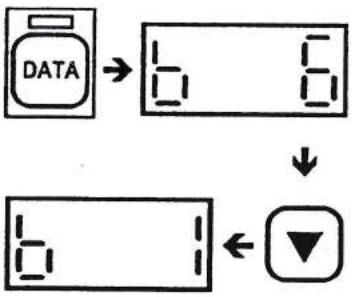


b11: THERMISTOR SELECTOR



P22: HEATSINK TEMPERATURE TRIP LEVEL

This completes the parameters that change for sections 1.4.2(a) to 1.4.2(c).



Before continuing with section 1.4.2(d), press the DATA push-button switch once and ensure that the indicator above it extinguishes. The display will show the Parameter Table and Parameter Number of the last selection.

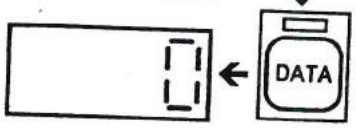
Use the DOWN (decrement) push-button switch to select Parameter Number 1.

1.4.2(d) Unit Implementation - Putting the Value and Bit Parameters - Read/Write into Unit Storage Memory

This section describes how the operator can put the parameter settings made in sections 1.4.2(a) to 1.4.2(c) into unit storage memory. If other parameters need changing, or if you want to make more changes, repeat the following steps.

STEP 1

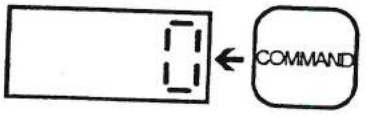
Use the COMMAND push-button switch to select the Code Table.



Press the DATA push-button switch once. The display shows a 0, which indicates an instruction is not selected.

STEP 2

Select instruction CODE 2: Write data to store.



Press the COMMAND push-button switch once, which enters instruction CODE 2.

The display will then show a 0 to indicate completion of the instruction.

1.4.2(e) Unit Implementation - Starting and Running the Motor (with the settings made by the operator)

To start and run the motor, follow the procedure described in section 1.4.1(e). In addition:

- Observe, and if necessary record, the motor current during starting and running.
- Ensure that the overload level (P18) is at a suitable setting compared with the observed motor current.

If the performance of the motor concerns you during its starting or running, then press the keypad START/STOP push-button switch to stop the motor. Check the parameter settings made in sections 1.4.2(a) to 1.4.2(c), and if necessary, change the settings.

1.4.2(f) Unit Implementation - Running the Motor in Optimising Mode

To run the motor in the optimising mode, follow the procedures described in section 1.4.1(f).

1.4.2(g) Unit Implementation - Stopping the Motor

To stop the motor, follow the procedures described in section 1.4.1(g).

1.4.3 Further Keypad Features

Sections 1.4.3(a) to 1.4.3(h) describe more features available from the keypad; to use them, follow the procedures given in sections 1.4.1 and 1.4.2. (Note: To help the user, sections 1.4.3(a)-(h) identify the parameters in a separate column adjacent to the text.) Section 2 describes some of these features in the context of specific applications, and as such, gives further detail. Please refer to that section where indicated.

1.4.3(a) Further Keypad Features - Using Another User-defined Table

b10 A User-defined Table is a group of parameter settings in storage memory which the unit uses to perform motor control. The unit storage memory can keep two user-defined tables and allows the operator to select different settings for different motors.

To make the parameter settings for the first User-defined Table, then designate the table and put it into storage memory, follow Step 1 to Step 4 below.

STEP 1 Make the required settings to the Value and Bit Parameters - Read/Write by following Step 1 to Step 5 shown at the start of section 1.4.2: Unit Implementation.

STEP 2 Select parameter b10 and press the DATA push-button switch once.

STEP 3 Select either BIT = 0 (for TABLE 0) or BIT = 1 (for TABLE 1). To show the parameter number again, press the DATA push-button switch once.

STEP 4 Use instruction CODE 2 from the Code Table to put this first user-defined table into storage memory. (Follow Step 1 and Step 2 in section 1.4.2(d).

(Optional)

To make the parameter settings for a second user-defined table, repeat Step 1 and Step 2 above. At Step 3, select the unused bit for this second user-defined table, and to put it into the unit storage memory, follow Step 4 above.

Notes:

1. If you remove and then re-apply power to the unit, it will operate using the last user-defined table put into storage memory.
2. If you want to change the parameter settings of a user-defined table, repeat Step 1 to Step 4 above using the correct bit setting for b10.

1.4.3(b) Further Keypad Features - Viewing Details about the Unit

r11
r12

The software within the unit provides the control for its internal electronic circuitry. Periodically, the manufacturer upgrades this software to add new attributes and where appropriate, improved control and monitoring. To identify the installed software, the parameter r11 shows its Product Number and r12 its Version Number.

P8
P9

The supplied unit is one model from a range of SFE2 units, and in order to identify its current rating, parameters P8 and P9 show the digits of the rating.

P8 indicates the third (hundreds) digit and fourth (thousands) digit.

P9 indicates the first (units) digit and second (tens) digit.

The unit current rating is useful when determining the Overload Level (P18) and the Overload Delay (P7) from the overload trip graph. (Refer to section 2.5)

1.4.3(c) Further Keypad Features - Changing the Default Display

P1
r1

At power-up, the default display shows the data of a Value Parameter - Read-only. The parameter number is the number that P1 (Default Offset) contains. Parameter r1 indicates the parameter number of the selected Value Parameter - Read-only.

Changing the Default Display

STEP 1 Select parameter P1, and to show its data, press the DATA push-button switch once.

STEP 2 From the Value Parameter - Read-only Table, select the parameter (r2 to End of Table) that you want to be displayed at power-up.

STEP 3 Change the display to show the number which corresponds to the selected parameter (2 to End of Table). To show the parameter number again, press the DATA push-button switch once.

STEP 4 Put the changed parameter setting for P1 into the unit storage memory by following Step 1 and Step 2 in section 1.4.2(d).

The removal and re-application of power causes the display to show the data for the selected parameter.

1.4.3(d) Further Keypad Features - Control from an External Circuit

The Control Terminal Panel provides terminals for the connection of external circuitry and allows control of the unit from a remote location. (Refer to section 1.3 which identifies these terminals.)

Programmable Input (Terminals S1 and Common)

P21
br1

An external circuit can SET or CLEAR any one of the Bit Parameters - Read/Write, (b1 to b12), from the terminal S1 (PROG I/P) on the Control Terminal Panel by means of the programmable input. This changes between the current state (of the bit parameter) and an alternative state dependent on the presence of a voltage between S1 and 00. When a voltage is present, the assigned bit is cleared. When the voltage is absent, the assigned bit is set. An operator can view the state of the programmable input through parameter br1. To select which read/write bit parameter this terminal will control, follow Step 1 to Step 4 below.

STEP 1 — Select parameter P21, and to show its data, press the DATA push-button switch once.

STEP 2 — From the Bit Parameter - Read/Write table, select the parameter (b1 to End of Table) which you want an external circuit to change.

STEP 3 — Change the display to show the number that corresponds to the selected parameter (1 to End of Table). To show the parameter number again, press the DATA push-button switch once.

STEP 4 — Put the changed parameter setting for P21 into the unit storage memory. (Follow Step 1 and Step 2 in section 1.4.2(d).

Notes:

1. The default setting puts the data for parameter P21 to 0, which corresponds to OFF (no selection).
2. When the data for parameter P21 is 0, it indicates no bit selection. Parameter br1 will still show the programmable input state even though the programmable input does not affect any bit parameter.

Remote Start and Stop (Terminals S2 and Common)

CODE 3
CODE 2
br7

The START terminal (S2) allows remote starting and stopping. To enable the start input, the operator must select and enter instruction CODE 3: Remote Control of Motor. To put this instruction into the unit storage memory, select and enter instruction CODE 2: Write Data to Store. An operator can view the state of the input at the START terminal through parameter br7, Remote START/STOP input.

1.4.3(d) continued

Programmable Relay (Terminals 31, 32 and 34)

P20
b8

The programmable relay K2 provides normally open and normally closed contacts for an external circuit. The relay can operate from any bit in either the Bit Parameter - Read/Write or Bit Parameter - Read-only table. The bit parameter b8 selects the table and P20 selects the bit parameter number. To select which bit parameter controls the relay, follow Step 1 to Step 5 below.

STEP 1 — From either the Bit Parameter - Read/Write or Bit Parameter - Read-only table, select the parameter which you want to operate the programmable relay.

STEP 2 — Select parameter b8, and to show its data, press the DATA push-button switch once. Select the bit parameter table; BIT = 1 (Bit Parameter - Read/Write) or BIT = 0 (Bit Parameter - Read-only).

STEP 3 — Select parameter P20, and to show its data, press the DATA push-button switch once.

STEP 4 — Change the display to show the number which corresponds to the selected parameter. To show the parameter number again, press the DATA push-button switch once.

STEP 5 — Put the changed parameter setting for P20 into the unit storage memory. (Follow Step 1 and Step 2 in section 1.4.2(d).

Motor Temperature Monitoring (Terminals: Thermistor Input)

r21
b11

The thermistor input on the Control Terminal Panel allows remote temperature monitoring. The parameter r21 shows the analogue level of this input as a value between 0 and 255. To make the unit trip from the monitored temperature, change the bit parameter b11 to BIT = 1.

Notes:
1. Parameter r21 still shows the analogue level of the thermistor input even when parameter b11 is at BIT = 0 (trip disabled).
2. The user cannot alter the trip level because the unit determines this level.

1.4.3(d) continued

Analogue Output Channel 1 and Channel 2 (Terminals AN1, AN2 and 0V)

P25
P26

The terminals AN1 and AN2 can each provide an output voltage, between 0V and 10V, to represent the analogue value of a selected Value Parameter - Read-only. Parameter P25 determines which parameter (r1 to End of Table) appears at the terminal AN1; similarly, P26 determines the parameter that appears at terminal AN2. To select which Value Parameter - Read-only appears at AN1, follow Step 1 to Step 4 below.

STEP 1 Select parameter P25, and to show its data, press the DATA push-button switch once.

STEP 2 From the Value Parameter - Read-only table, select the parameter (r1 to End of Table) which you want to appear at terminal AN1.

STEP 3 Change the display to show the number which corresponds to the selected parameter. To show the parameter number again, press the DATA push-button switch once.

STEP 4 Put the changed parameter setting for P25 into the unit storage memory. (Follow Step 1 and Step 2 in section 1.4.2(d).

To select which Value Parameter - Read-only appears at AN2, follow Step 1 to Step 4 above, but use parameter P26 instead of P25.

1.4.3(e) Further Keypad Features - Viewing the Operating Status of the Unit

r22
P22

The unit continuously monitors the heatsink temperature. Parameter r22 displays the temperature in deg. C. Parameter P22 is the unit trip temperature, with a default setting of 80°C. To change the trip temperature, change the setting of P22.

Notes:

1. Some units do not have temperature monitoring fitted.
2. You cannot disable the heatsink temperature trip (P20).
3. The reasons for an abnormal operating temperature could include: inadequate cooling, excessive use, or a malfunctioning or overloaded motor.

1.4.3(e) continued

r4 The unit is provided with semi-conductor switches (thyristors) to control the AC voltage to the motor. The delay angle shows the period (in degrees) in each half-cycle during which the thyristors are turned off.

b4 Parameter b4 (Local START/STOP input) indicates the operating mode of the motor when the unit controls it from the keypad.

BIT = 1 indicates that the motor is running

BIT = 0 indicates that the motor is stopping or has already stopped

b9 During the start-up ramp, the voltage applied to the motor increases towards the level of the input supply. When the Ramp Hold Bit (b9) changes from BIT = 0 to BIT = 1, the applied voltage stops increasing. If you keep b9 at BIT = 1, then the applied voltage will remain at this level until time out. (The manufacturer of the unit determines this time-out, which is approximately 4 minutes.)

br6 Parameter br6 indicates whether the unit is operating in current limit (BIT = 1), or is not operating in current limit (BIT = 0)

br8 Parameter br8 indicates whether the unit is operating in Voltage Mode (BIT = 1) or Current Mode (BIT = 0).

1.4.3(f) Further Keypad Features - Viewing the Operating Status of the Motor

r2
r3 During start-up the unit monitors power-factor. This data is used to derive a reference power factor for the motor. When the controller is in optimising mode, the unit aims to align the present power factor (parameter r2) with the reference power factor (parameter r3).

r8 Parameter r8 shows the limiting delay angle (in degrees) of the off period of the thyristors. (Thyristors are internal electrical components).

r5
r6 Parameter r6 shows the motor running current in amperes. Alternatively, parameter r5 (normalised current) shows the same current as a percentage of the unit full-load current.

r7 Parameter r7 shows the frequency of the input supply as 50Hz or 60Hz.

r10 Parameter r10 shows the peak current provided by the unit to the motor during start-up.

P7
P18
r9 Section 1.4.2(c) introduced the protection parameters P18 (overload level) and P7 (overload delay). The parameter r9 shows the percentage of the overload level, which helps the operator to view the margin between its overload level and a trip.

Note:
1. From start-up, the unit continuously monitors the motor current against the overload level. If the value of parameter r9 reaches 100%, the unit will trip immediately.
2. You should always select the settings of the overload level (P18) and overload delay (P7) to give protection to the motor. (The setting for P18 and P7 comes from the graph shown in section 1.5.22)

br2
br3
br5
br10 Four Bit Parameters - Read-only indicate the operating status of the motor as follows: (the data of the bit is shown in brackets):

br2: Motor should be running (1)
Motor should not be running (0)

br3: Start-up ramp complete, motor is running (1)
Motor is starting, stopping or stopped (0)

br5: Motor is operating in the dwell period (1)
Motor is not operating in the dwell period (0)

br10: Motor current is above the overload setting (1)
Motor current is below the overload setting (0)

1.4.3(g) Further Keypad Features - Viewing a Fault Condition

E1 to E16

When the unit detects a fault condition, it becomes inactive and the display will show a fault code (E - - -). There are two types of fault that cause this inactive state:

1. Motor operation caused one of the fault protection features to trip the unit. For example, if the motor current reaches the overload level, the overload trip will operate. This causes the unit to shut-down and the display to show E13.
2. A malfunction in the unit. For example, if a thyristor within the unit goes short-circuit, then the unit will trip and the display will show E10.

Refer to section 1.4.4 which describes the fault codes E1 to E16.

Caution:

If a unit malfunction causes the fault condition, it may not remove the power to the motor. When a fault occurs, always isolate the supply before you attempt a repair.

r13 to r18

The unit uses parameters r13 to r18 to make a record of the last six detected faults, where r13 ***always*** contains the number of the last detected fault. When a fault occurs, the unit puts the fault code number into storage memory as parameter r13. If parameter r13 already contains a fault code, which is the number of the previous detected fault, then that fault number is put into parameter r14. This sequence continues for each subsequent fault using parameters r15 to r18.

br4

Parameter br4 (Alarm Flag) indicates either a correctly functioning unit (BIT = 0) or the occurrence of a fault (BIT = 1).

br9

The unit continuously monitors the input supply for electrical noise since severe disturbance on the input supply may cause intermittent faults. Parameter br9 (Noise Flag) indicates that the level of this electrical noise is either acceptable (BIT = 0) or high (BIT = 1).

1.4.3(h) Further Keypad Features - Entering and Using a Security Password

P14
CODE 6
CODE 2

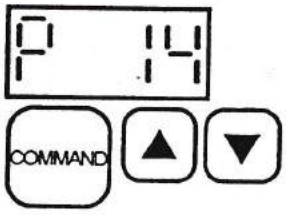
As supplied, a new unit does not have a password, therefore, any person may change the parameter settings. After a security password has been entered, only those persons who use the password can change the parameter settings. Once a password has been put into memory, it cannot be changed without assistance from the manufacturer,

Note:
1. If you install more than one unit in a single location, it is recommended that you make a record of the passwords entered for each unit.
2. In case of difficulty, contact the supplier of the unit. It is possible to remove the security setting.

Selecting and Entering a Security Password

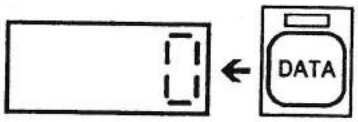
To select a password and put it into the unit storage memory, follow Step 1 to Step 7 below.

STEP 1



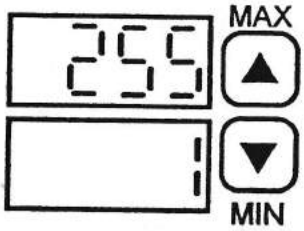
Use the COMMAND push-button switch to select the Value Parameter - Read/Write table. Use the UP (increment) and DOWN (decrement) push-button switches to select parameter P14.

STEP 2



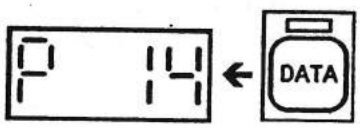
Press the DATA push-button switch once. The display will show a 0, the default setting for a password.

STEP 3



Use the UP (increment) and DOWN (decrement) push-button switches to select a password number. A valid password number is between 1 and 255.

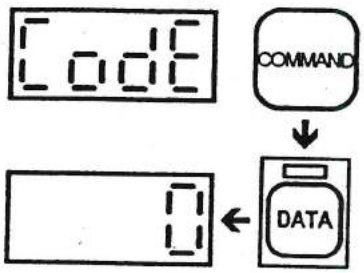
STEP 4



To show the parameter number again, press the DATA push-button switch once.

1.4.3(h) continued

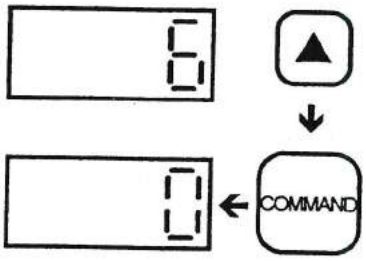
STEP 5



Use the COMMAND push-button switch to select the Code Table.

Press the DATA push-button switch once. The display will show a 0, which indicates an instruction is not selected.

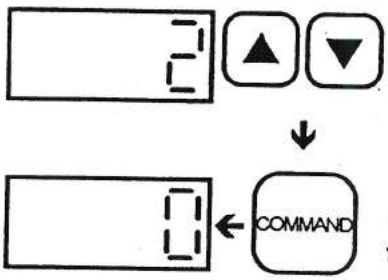
STEP 6



Use the UP (increment) push-button switch to select instruction CODE 6: Password Entry.

Press the COMMAND push-button switch once. This enters instruction CODE 6.

STEP 7



Use the UP (increment) and DOWN (decrement) push-button switches to instruction CODE 2: Write data to store.

Press the COMMAND push-button switch once. This enters the instruction CODE 2 into the unit storage memory.

The display will show a 0 to indicate completion of the instruction.

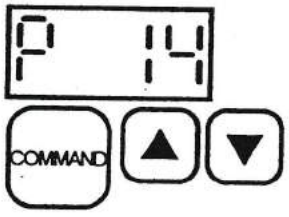
SERIAL NUMBER OF UNIT:	PASSWORD:

Using a Security Password

P14
CODE 6

Once a security password (step 1 to step 7 above) has been entered, parameter settings can only be changed after the password has been re-entered and accepted. To enter a known password follow Step 1 to Step 6 below.

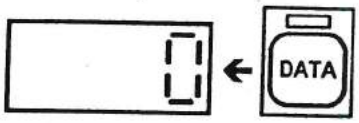
STEP 1



Use the COMMAND push-button switch to select the Value Parameter - Read/Write table. Use the UP (increment) and DOWN (decrement) push-button switches to select parameter P14.

1.4.3(h) continued

STEP 2

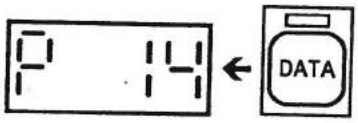


Press the DATA push-button switch once. The display will show a 0.

STEP 3

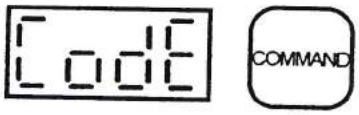
Use the UP (increment) and DOWN (decrement) push-button switches to select the known password number.

STEP 4



To show the parameter number again, press the DATA push-button switch once.

STEP 5



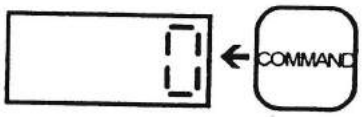
Use the COMMAND push-button switch to select the Code Table.

Press the DATA push-button switch once. The display will show a 0, which indicates an instruction is not selected.

STEP 6

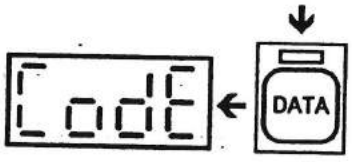
Use the UP (increment) push-button switch to select instruction CODE 6: Password Entry.

STEP 7



Press the COMMAND push-button switch once.

The unit then checks the password entered at Step 3 against the known password, and if they are the same, the display will show a 0. This indicates completion of the instruction and acceptance of the password.



Press the DATA push-button switch once. The display will show CodE to confirm entry of the correct password.

Incorrect password entry causes the keypad display to show the default display. To confirm this, press the DATA push-button switch once; the display will then show the parameter number r1.

1.4.3(i) Further Keypad Features - Selecting the Firing Mode, and Attaching Parameters to the DC or 4-20mA Inputs.

P27

There are 2 firing modes, MODE 0 and MODE 1, which provide the following:

MODE 0 The default mode for both star and delta connected motors; the thyristors connect between the motor and the supply.

MODE 1 Delta connected motors only; the thyristors connect ***within*** the delta. This mode is phase rotation sensitive and optimising motor running is disabled. The display will show parameter r6 (motor current) as phase current.

P29

This parameter allows the user to attach the DC input to any other parameter from P1 to P28. For example, to change the start time in proportion to the voltage present at the DC input, connect the voltage source to the DC input on the SFE2 board. Set P29 to3; The start time will now vary according to the voltage at the DC input. The default value is 0

P30

This parameter allows the user to attach the 4-20 mA input to any other parameter from P1 to P28. For example, to change the start time in proportion to the current present at the 4-20 mA input, connect the current source to the 4-20 mA input on the SFE2 board. Set P29 to3, The start time will now vary according to the current flowing in the 4-20 mA input. The default value is 0

1.4.3(j) Further Keypad Features - Setting up Two Tables Controlled by the Programmable Input.

The following procedure can be used to set up the programmable input to select between two tables. This will allow the SFE2 to use two different start times for say, a two-speed motor application, which are selected depending on the state of the programmable input at start up.

STEP1 Set the Tables to Default Values

(a) Execute instruction 5 in the CodE table. This will load the default values into the starter.
(b) Execute instruction 2 in the CodE table. This will save the default values to the first table.
(c) Change Parameter Read/Write bit 'b10' to '1'. This will point to the second table.
(d) Execute instruction 2 in the CodE table. This will save the default values to the second table.
(e) Apply voltage to the programmable input. This will select the first table.
(f) Set the programmable input 'P21' to '10'. This reads the first table from the store.

STEP 2 Set Up and Save the First Table

(a) Set up the SFE2 parameter table and bit table to the required values.
(b) Set the programmable input 'P21' to '10'. This points to the first table number, table0.
(c) Execute instruction 2 in the CodE table. This will save the changed parameters to the first table.

STEP 3 Set Up and Save the Second Table

(a) Remove the voltage from the programmable input. This selects the second table.
(b) Set the programmable input 'P21' to '10'. This points to the second table number, table1.
(c) Set up the SFE2 parameter table and bit table to the required values for the second table.
(d) Execute instruction 2 in the CodE table. This will save the changed parameters to the second table.

1.4.4 Index of Tables, Parameters and Fault Codes

NOTES TO ALL USERS

This section describes the information which can appear on the keypad display. Its purpose is to inform the operator about the operating condition of the motor and the unit. Details on changing settings are given in sections 1.4.1 to 1.4.3. If a malfunction occurs in your application, this information is useful when identifying problems and tracing faults. If you need help from the supplier of the unit, then:

- Make a note of the fault code which appears on the display
- Identify the manufacturer and rating of the motor
- Identify the voltage level of the AC supply to the motor
- Make available the wiring diagram of the installation

TABLES	MODE DIGIT(S)
Value Parameter - Read/Write	P
Value Parameter - Read-only	r
Bit Parameter - Read/Write	b
Bit Parameter - Read-only	br
Code Table	CodE
Fault Codes	E

PARAMETERS Value Parameter - Read/Write			
PARAMETER NUMBER AND NAME			
MINIMUM	**MAXIMUM**	**DEFAULT**	**UNITS**
Description and Notes			

P1: DEFAULT OFFSET /P			
2	23	6	—
Determines which Parameter - Read-only is displayed at unit power-up. The default is r6, the motor current, so the display will show a value in Amps.			

P2: START PEDESTAL			
10	60	20	% of input supply
Determines the percentage of input supply voltage applied to the motor at the 'Start of Voltage Ramp'. The setting must give the motor sufficient voltage to generate a breakaway torque.			

P3: START TIME			
1	240	5	Seconds
Determines the time taken for motor voltage to reach 100%.			

P4: STOP PEDESTAL			
0	100	0	% of drop voltage
Determines the drop in the voltage applied to the motor at the start of the 'Stop Voltage Ramp'. The display shows the percentage of this drop voltage.			

1.4.4 continued

PARAMETERS Value Parameter - Read/Write			
PARAMETER NUMBER AND NAME			
MINIMUM	**MAXIMUM**	**DEFAULT**	**UNITS**
Description and Notes			

P5: STOP TIME				
0	240	10	Seconds	1
Determines the ramp - down time during motor stopping.				

P6: OPTIMISE RATE				
1	25	5	Cycles	5
Determines the response rate of the optimising. (This setting helps to maintain stability for small slip speed motors with low inertia loads.) (1 = fastest optimise rate; 25 = slowest optimise rate.)				

P7: OVERLOAD DELAY				
1	14	14	Cycles	14
Determines the delay before an overload trip occurs.				

P8: CURRENT RATING HUNDREDS				
0	13	—	—	
Indicates the third (hundreds) digit and fourth (thousands) digit of the unit current rating. This setting cannot be changed.				1

P9: CURRENT RATING UNITS				
0	99	—	—	46
Indicates the first (units) digit and second (tens) digit of the unit current rating. This setting cannot be changed.				

P10: KICKSTART TIME				
15	50	25	Cycles	25
Determines the time that the Kickstart Voltage (P11) is applied.				

P11: KICKSTART VOLTS				
50	100	75	% of input supply	75
Determines the voltage level of the kickstart function.				

P12: UNDER CURRENT TIME-OUT				
5	255	50	Cycles	50
The time taken for the unit to trip when the motor current is less than the setting of the Under-Current Level (P15).				

P13: SHEARPIN TIME-OUT				
5	100	25	Cycles	50
Determines the time taken for a Shearpin trip.				

1.4.4 continued

PARAMETERS Value Parameter - Read/Write			
PARAMETER NUMBER AND NAME			
MINIMUM	**MAXIMUM**	**DEFAULT**	**UNITS**
Description and Notes			
P14: PASSWORD			
0	255	0	—
Determines the password number. The number cannot be changed after it has been stored. Note that selecting and entering the password occurs only once for each unit. In case of difficulty, contact the supplier of the unit.			
P15: UNDERCURRENT LEVEL			
0 x FLC	1 x FLC	0.125 x FLC	Amps
Determines the level of the under current trip in amps.			
P16: SHEARPIN LEVEL			
1 x FLC	5 x FLC	3.125 x FLC	Amps
Determines the level of an over current trip in amps. Operates when the motor current exceeds the shearpin level and start-up is complete			
P17: CURRENT LIMIT			
1 x FLC	5 x FLC	3 x FLC	Amps
Sets the current level for motor starting in amps. (Note: current limit starting is only permitted for a fixed period fixed by the manufacturer.)			
P18: OVERLOAD LEVEL			
60	120	120	% of Unit FLC
Sets the overload current level as a percentage of the unit full-load current.. The overload is always active, but the Current Limit (P17) is only active for motor starting.			
P19: SOFT STOP SMOOTHING			
10	100	40	Value
Determines the profile of motor stopping for loads susceptible to instability. (100 = greatest smoothing effect.)			
P20: PROGRAMMABLE RELAY			
1	End of Table	3	—
Determines which Bit Parameter, (Read/Write or Read-only), operates the relay K2. (The contacts for relay K2 (identified 31, 32 and 34) are available on the control terminal panel.) The selection of the Bit Parameter Table is made through the setting of b8, Programmable Relay Table.) The default setting makes br3, the 'Top of Ramp' bit, operate the relay.			

1.4.4 continued

PARAMETERS Value Parameter - Read/Write			
PARAMETER NUMBER AND NAME			
MINIMUM	**MAXIMUM**	**DEFAULT**	**UNITS**
Description and Notes			
P21: PROGRAMMABLE INPUT			
0	End of Table	0	—
Selects the Bit Parameter - Read/Write to be changed by an external circuit. (The default setting is 0, no selection.)(see 1.3.1)			
P22: HEATSINK TEMPERATURE TRIP LEVEL			
0	100	80	Temperature, deg. C
Sets the level of heatsink overheating trip. (Not fitted on some units. Refer to section 1.5: Specifications and Data.)			
P23: SET LEVEL FOR 4-20mA INPUT			
0	25.8	12.8	milliamps
Determines the level over which the milliamp bit Br11 will be set			
P24: SET LEVEL FOR DC INPUT			
0	100	50	percent
Determines the level above which the DC bit Br13 will be set. This expressed as a percentage because there are two possible scales			
P25: ANALOGUE OUTPUT CHANNEL 1			
0	23	0	—
Selects the Value Parameter - Read-only whose value is output as 0 -10V			
P26: ANALOGUE OUTPUT CHANNEL 2			
0	23	0	—
Selects the Value Parameter - Read-only whose value is output as 0 -10V			
P27: FIRING MODE			
0	**1**	**0**	**—**
Selects the firing mode. 0 = Normal, 1 = In-Delta			
P28: DWELL TIME			
2	60	15	SECONDS
Allows the user to vary the dwell time following top-of-ramp.			
P29: READ/WRITE POINTER FOR DC INPUT			
0	28	0	—
Attaches the DC input to the parameter indicated in P29			
P30: READ/WRITE POINTER FOR 4-20mA INPUT			
0	28	0	—
Attaches the 4-20 mA input to the parameter indicated in P30			

1.4.4 continued

PARAMETERS Value Parameter - Read-only			
PARAMETER NUMBER AND NAME			
MINIMUM	**MAXIMUM**	**DEFAULT**	**UNITS**
Description and Notes			
r1: DEFAULT DISPLAY			
—	—	Data for r6	—
Shows the data of the Value Parameter - Read-only contained in P1 (Default offset /P). The default puts 6 into P1, and r1 shows the data for r6. (motor current)			
r2: PRESENT POWER FACTOR			
0	180	—	Angle, degrees
Shows the present power factor of the motor.			
r3: REFERENCE POWER FACTOR			
0	180	—	Angle, degrees
Shows the reference power factor of the motor.			
r4: DELAY ANGLE			
0	180	—	Angle, degrees
Shows the period (in degrees) during which the thyristors are in the off-state.			
r5: NORMALISED CURRENT			
0	8 x Unit FLC	—	% of Unit FLC
Shows the motor current as a percentage of the unit full-load current.			
r6: MOTOR CURRENT			
0	8 x Unit FLC	—	Amps
Shows the motor current as a value in amperes. (Note: The motor current is always shown as phase current, irrespective of the circuit configuration.)			
r7: FREQUENCY OF SUPPLY			
[50]	[60]	—	Hertz
Shows the frequency of the supply voltage as either 50 or 60. (Note: The display does not show the absolute value of frequency.)			
r8: MAXIMUM OPTIMISE DELAY ANGLE			
0	180	—	Angle, degrees
Shows the maximum delay angle used during the optimising mode.			
r9: PERCENTAGE OF OVERLOAD			
0	100	—	%
Shows percentage of overload. The unit will trip at100%.			