XFE Manual

INNOVATION IN SOFT STARTER TECHNOLOGY

Sections (click on the title to go to the page)

Guide to contents - applicable to

5MC software V67

1 Mechanical Outlines

Referring to the appropriate size of XFE, mount the XFE ensuring that correct clearances are maintained for adequate ventilation and operation of the XFE.

2 Wiring Diagrams

Referring to the appropriate **Wiring Diagram**, install the XFE electrical connections ensuring that the correct control supply voltage is used and is within its specified operating limits as described on the product specification

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

The unit requires two AC supplies:

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

A single phase supply: 115V/230V, 50Hz/60Hz, for the internal control circuitry.

XFE 300 series need a separate 115V or 230V supply to power the fans.

Voltage must be specified prior to supply of the XFE.

IMPORTANT   **Ensure that the voltage selector switch position corresponds to the control supply before you apply the control supply voltage.**
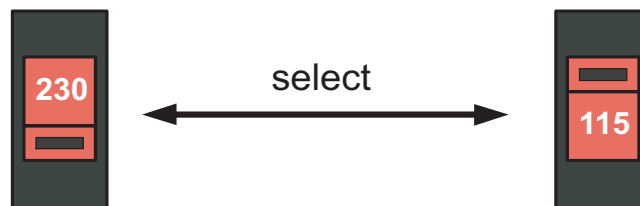
230   select   **115**

> **ISOLATION**
>
> **Caution: The XFE uses semiconductor devices in the main circuit and is not designed to provide isolation. For this reason isolation means must be installed in the supply circuit in accordance with the appropriate wiring and safety regulations.**

The Mains Supply and the Control Supply each require protection. Although all units have electronic overload protection, the installer should always place fuse protection **between** the unit and the Mains Supply, **not between** the unit and the motor. Semiconductor fuses can be supplied for short circuit protection of the semiconductors.

3 Keypad operation and basic set-up

Refer to this, for familiarisation with the keypad controls of the XFE. Use the illustration of the Basic Menu structure to find XFE menu items on the display.

4 Set-up examples

Set-up basic XFE operating parameters, if necessary, by following one or all of the examples described here.

5 Product information

Refer to product information for details of Design Standards and Approvals, operating and storage limits and other installation instructions.
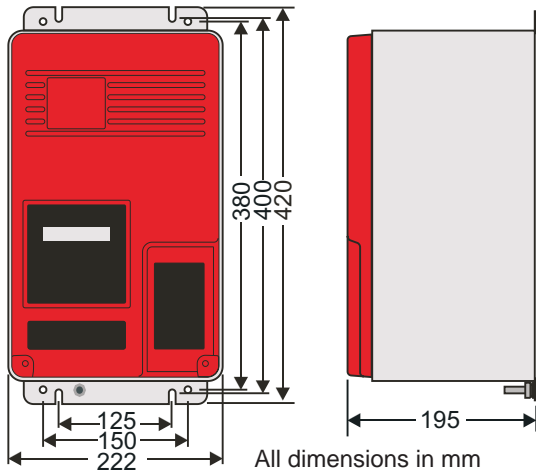
Further Information

Further information about the XFE soft start motor controller, detailed manuals and application notes are available on the Fairford website or from Fairford direct (see back page for contact details).
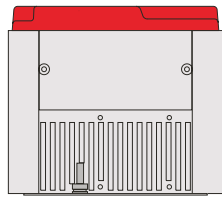
1 Mechanical Outlines

XFE100 Series   IP20

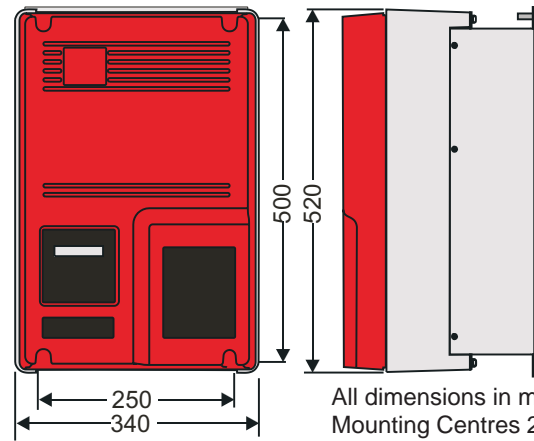

380
400
420

125
150
222

195

All dimensions in mm
Mounting holes suitable for M6 fixings
Unit weights:-
XFE102 to XFE124 7.3Kg
XFE126 to XFE140 8.3Kg
Allow clearance of:-
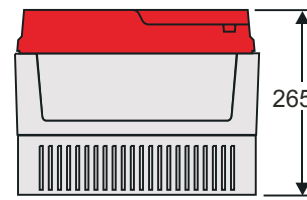15mm each side
75mm top & bottom
25mm front

XFE200 Series   IP20
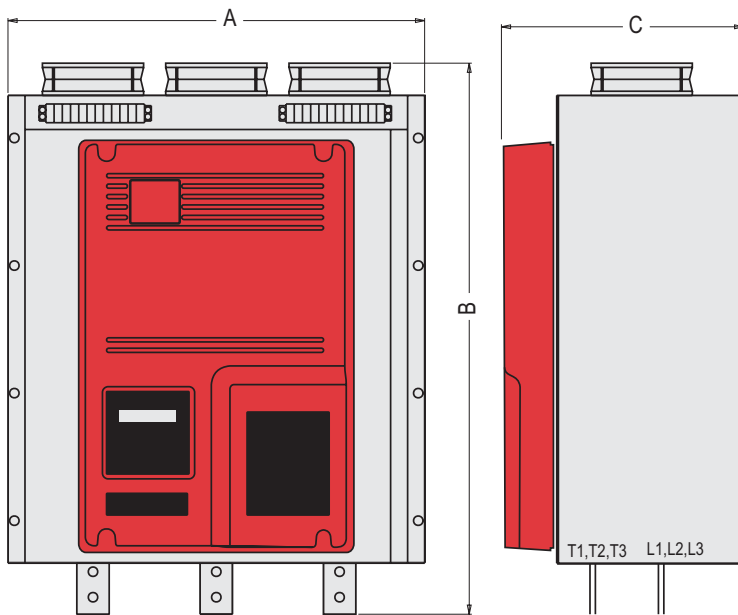

500
520

250
340

265

All dimensions in mm
Mounting Centres 250 x 500
suitable for M6 fixings
2 "keyholes" at top 2 open slots at the bottom.
unit weights
XFE202 to XFE204 - 16Kg
XFE206 to XFE212 - 22Kg
Allow clearance of:-
15mm each side
75mm top & bottom
25mm front

XFE300 Series   IP00

A

C

B

T1,T2,T3   L1,L2,L3

Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

Dimensions (mm)	A	B	C	Weight
XFE302 to XFE308	490	648	285	65Kg
XFE310	508	738	282	72Kg
XFE312 to XFE319	635	746	322	72Kg
XFE320	635	782	322	77Kg
XFE322 to XFE328	775	775	475	82Kg

Enclosure Ventilation

When fitting the XFE into a cabinet, ventilation must be provided if the heat output of the unit is greater than the cabinet will dissipate.Use the following formula to determine the fan requirement. An allowance has been incorporated into the formula so that the figure for "Q" is the air delivery quoted in the fan suppliers data.

An approximation of the heat produced (Watts) by the XFE, when in circuit, can be made by multiplying the line current by three.

When the XFE is bypassed the heat output can be approximated with the formula:-

Watts (soft starter) = Start current x start time in seconds x number of starts per Hour / 800

Exact figures for unit full load current are in the XFE manual.

Q = volume of air (cubic metres per hour - m^3/h)

Wt = heat produced by the unit and all other heat sources within the enclosure (Watts)

t_{max} = maximum permissible temperature within the enclosure (40ºC for a fully rated XFE)

t_{amb} = temperature of the air entering the enclosure (ºC)

If you prefer to work in CFM, substitute ºF for ºC. Q is now in CFM.

$$Q = \frac{4 \times Wt}{(t_{max} - t_{amb})}$$

Current Transformers

XFE100 and **XFE200** series Starters have a CT fitted internally. Due to the Current ratings of the **XFE300** Series units an "Interposing CT" is required. A small CT is fitted internally to these units and an additional CT, rated for the size of the Starter, is provided separately. This MUST be fitted onto the conductors in the L3-T3 phase and be connected to the marked terminal block under the front cover.

2 Wiring Diagrams

The **Electronic control card** is located underneath the cover in the all units.

Connections shown in the control circuit wiring diagram are made to the electronic control card terminals as shown in fig.2.2 below.

Fig 2.1 Control circuit wiring

Control Supply

Note
Contactor K3 is required for the 'Operation in Bypass Power Circuit' and is controlled by the programmable relay set as a 'Top of Ramp' relay.

Emergency Stop

STOP

K2.2

START

K2.1

X1 Control supply card X2

11 / 14   21 / 24   S1 Electronic control card   S0, 00

K2

K1   K3

Note: Extra X1-X2 on 300 Series for fan supply

Fig 2.2

Micro-controller

Relay   Relay

D5

J8   J9   J10

D5 (Green) indicates the presence of the control supply.

22 24 21   12 14 11   S0 S1

Programmable output, Changeover contacts Default: Ramp Complete

Programmable output, Changeover contacts Default: - Run Relay

Programmable Input, Control Input 1. Default: Start/Stop

Use the control circuit with one of these power circuits

Fig 2.3 Power circuit for In-Line connection of motors (see note 3).

L1
L2
L3
Mains Supply Busbar

Feeder cables

K1 Circuit Contactor

Isolation and Protection Switch-gear (provided by the customer)

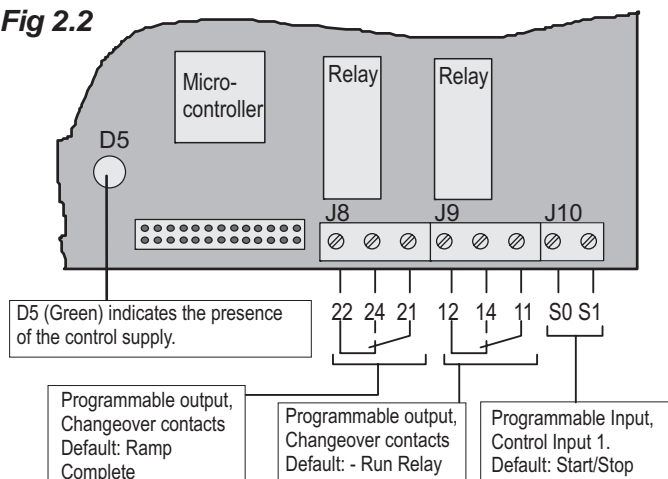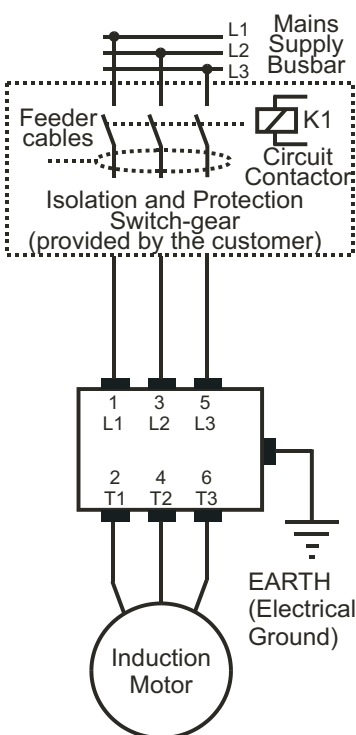1 / L1   3 / L2   5 / L3
2 / T1   4 / T2   6 / T3

EARTH (Electrical Ground)

Induction Motor

Fig 2.4 Power circuit for In-Delta connection of motors (see note 4).

L1
L2
L3
Mains Supply Busbar

K1 Circuit Contactor

Feeder cables

Isolation and Protection Switch-gear (provided by the customer)

For this configuration, applying the equation,

$$Ie(XFE) \geq \frac{Ie(motor)}{\sqrt{3}}$$

allows lower current rating XFE than the motor.

1 / L1   3 / L2   5 / L3
2 / T1   4 / T2   6 / T3

EARTH (Electrical Ground)

V1
W1   U1

Induction Motor

W2   U2
V2

In-delta connections for correct rotation of motor

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

Fig 2.5 Power circuit for bypass operation (see note 5).

L1
L2
L3
Mains Supply Busbar

K1 Circuit Contactor

Feeder cables

Isolation and Protection Switch-gear (provided by the customer)

K3 Bypass Contactor

1 / L1   3 / L2   5 / L3
2 / T1   4 / T2   6 / T3

Induction Motor

EARTH (Electrical Ground)
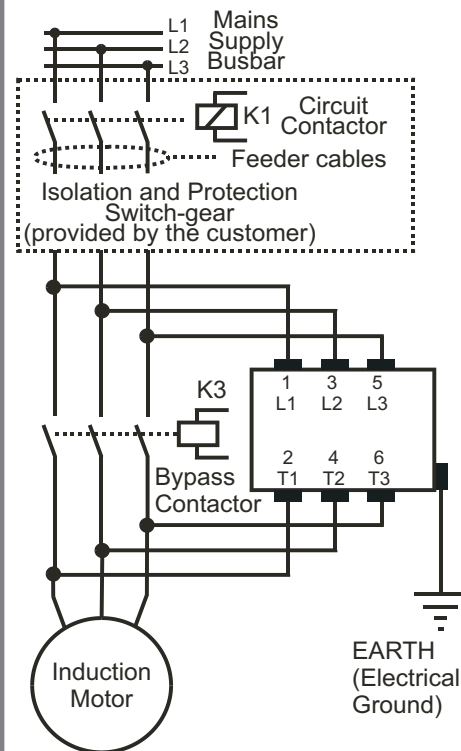
Important

Note 1: Correction capacitors:
Power factor correction capacitors must **NOT** be positioned on the output of the power circuit.

Note 2: Fuse Selection:
Where semiconductor type fuses are required, they should be selected from the table in Section 5.

Note 3: The in-line configuration shown in Fig 2.3 requires that the firing mode be set to '0'.

Note 4: The **In-Delta configuration** as in Fig 2.4 requires that the Firing Mode be set to **'1'.**
An in-line contactor controlled by the XFE **MUST** be used with the In-Delta firing mode.

Note 5: The **bypass configuration** as in Fig 2.5 is automatically detected as "Auto bypass" is set as default.
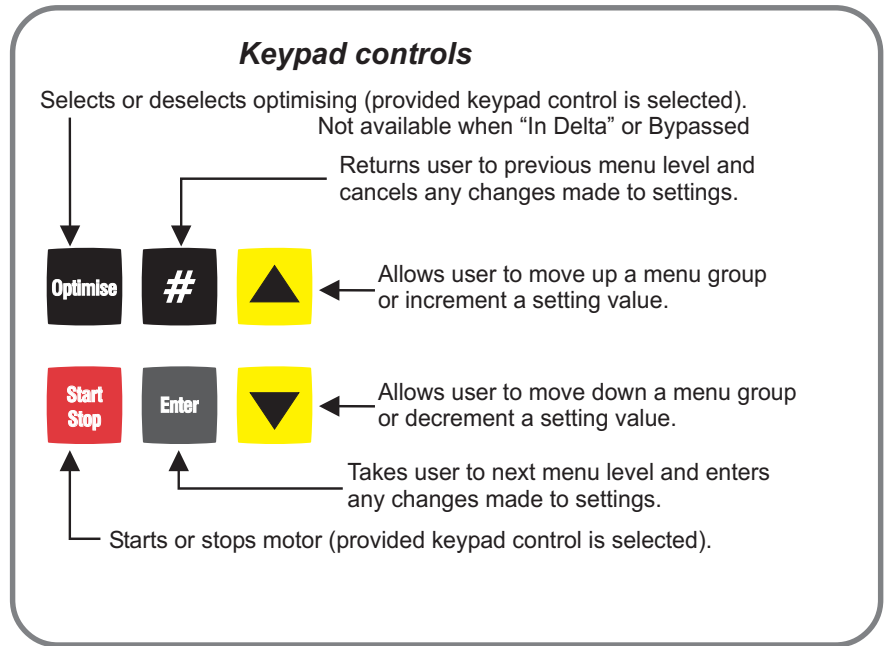
3 Keypad operation and basic set-up

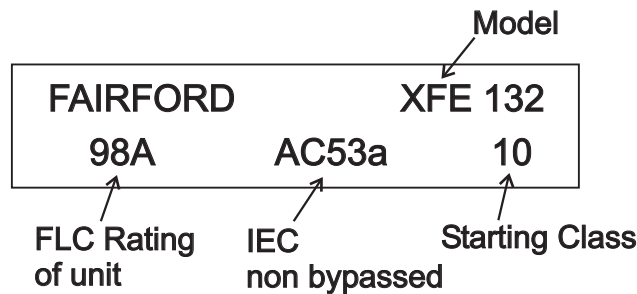ALWAYS ENSURE THAT THE KEYPAD CABLE IS PLUGGED IN BEFORE APPLYING POWER TO THE UNIT

When wired as Fig 2.1,page 3, the XFE display will indicate start up messages followed by 'Stopped and ready'. At this point:

- the XFE will start the motor when the keypad 'START/STOP' key is pressed but not when the START switch as shown in Fig.2.1 is closed.
- the XFE parameters are set to factory default which may not be ideal for the required application.

The examples in section 4 show how to set up some of the essential XFE operating parameters using the keypad. Once these are understood, other XFE settings, as indicated in the programming Menu Structure, can be set in a similar manner (The corresponding default settings are shown in brackets). For the full menu structure see page 6 .

Keypad controls

Selects or deselects optimising (provided keypad control is selected). Not available when "In Delta" or Bypassed

Returns user to previous menu level and cancels any changes made to settings.

Allows user to move up a menu group or increment a setting value.

Allows user to move down a menu group or decrement a setting value.

Takes user to next menu level and enters any changes made to settings.

Starts or stops motor (provided keypad control is selected).

Keypad start-up message

Model

FAIRFORD   XFE 132

98A   AC53a   10

FLC Rating of unit   IEC non bypassed   Starting Class

XFE Soft Starts are either supplied pre-set to a Start Class or ready to set. An appliction selector chart is available from FE to aid in the selection of the correct XFE. If the unit is supplied ready to set then it will force the selection of a starting Class when first powered up.

It is always possible to change the starting Class through menu item >Advanced > current > P106 start class

When the motor is running the XFE can display **current** (default) or **Estimated Power.** Pressing the # key at the top of the menu structure allows the user to toggle between these 2 options.

Cooling

The XFE is designed so that the rated start current/time is close to the maximum allowed. If the start duty is exceeded the unit will trip. All XFE Soft Starts have a forced off cooling time between starts.

In line with the stated IEC starting duties, all XFE 100 series have an enforced off period of 2 minutes, likewise all XFE 200 and XFE 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates **"Stopped.Cooling"** and the XFE will not respond to a start signal.

AC53a ratings are for Optimising or use without a bypass contactor.

AC53b rating is only for use with a bypass contactor and will trip if one is not used

Starter Enable/Disable

An additional safety feature has been added so that following certain actions the XFE will be disabled. It is strongly recommended that before any changes to parameter values are made, that the XFE is **disabled** via the **Basic Menu**. Once disabled, the XFE remains unable to drive the load, until it has been **enabled** via the **Basic Menu**, or the control supply is removed and reapplied, or the ▼ key is pressed when prompted.
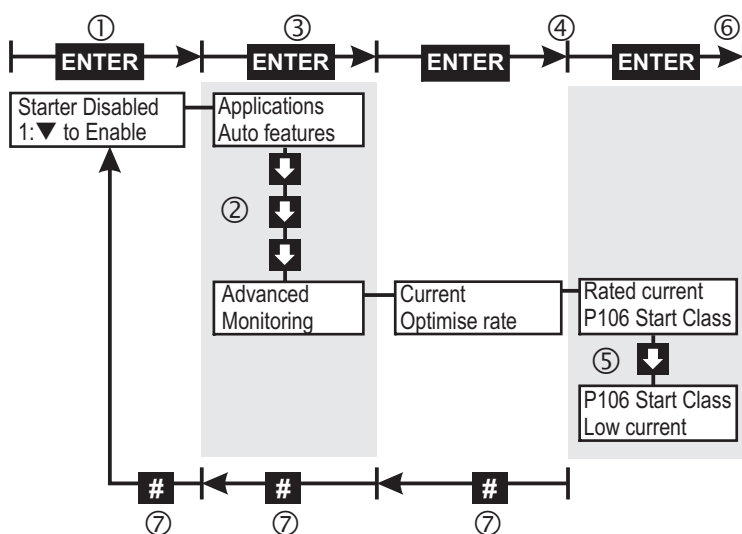
XFE Soft Starters may be set up to 1 of 8 overload start duty settings. The applicable motor current and duty ratings for all the range are shown in the table on the back page of the main manual.
The following tables give the full operating data for 2 sample Soft Starts.

XFE138	Start Class	Maximum Motor FLC	IEC Utilisation Category	Motor Overload Class	Maximum unit current x Motor FLC	Start Time	Starts per Hr	Duty Ratio (AC53a) Bypased + Off Time (AC53b)
1	10B	154A	AC53a	10A	3.5	12	5	75%
2	10	166A	AC53a	10	3	23	5	75%
3	20	131A	AC53a	20	4	19	5	75%
4	30	124A	AC53a	30	4	29	5	75%
5	10B	171A	AC53b	10A	3.5	12	5	708S
6	10	186A	AC53b	10	3	23	5	697S
7	20	143A	AC53b	20	4	19	5	701S
8	30	134A	AC53b	30	4	29	5	691S

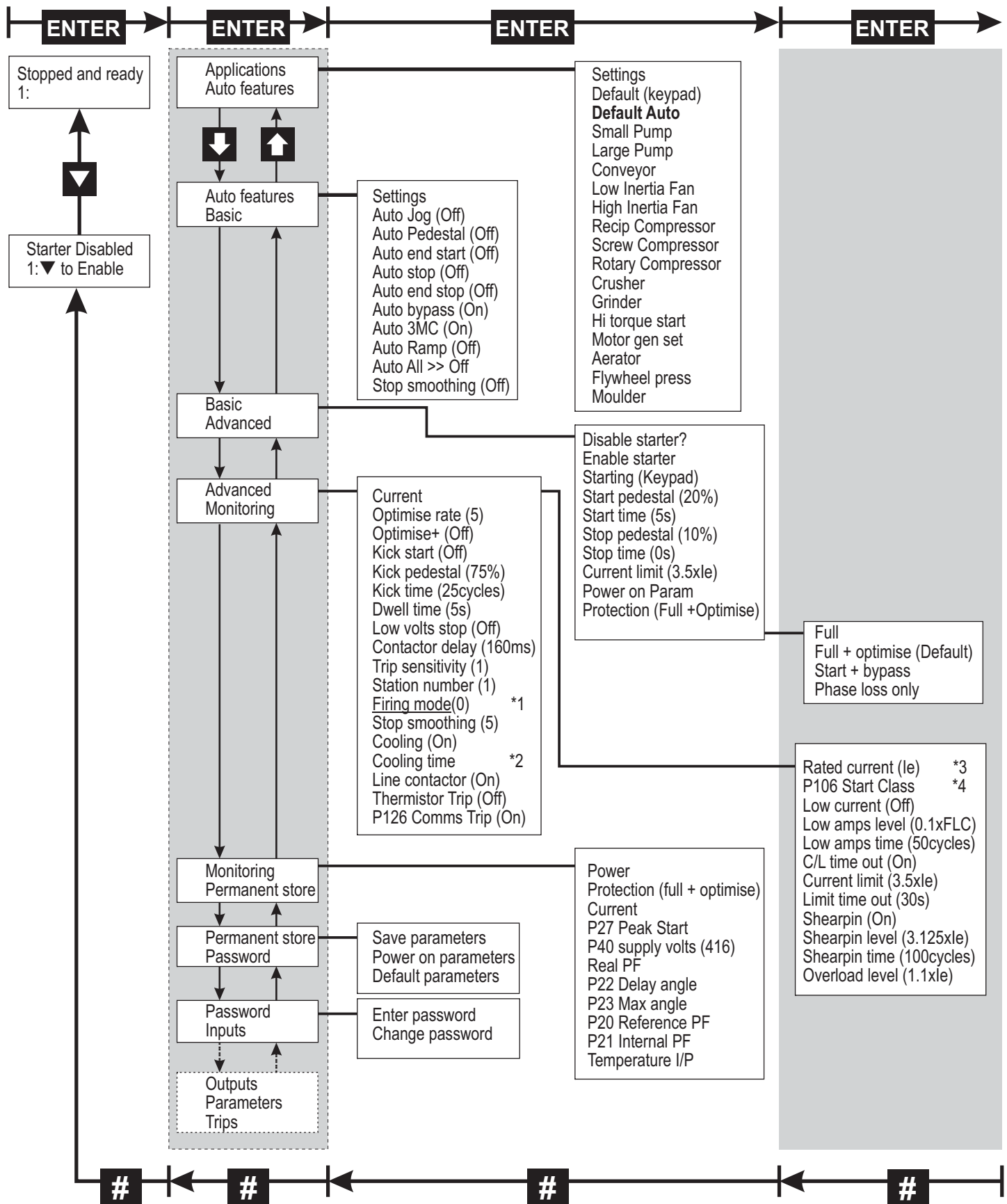| XFE210	Start Class	Maximum Motor FLC	IEC Utilisation Category	Motor Overload Class	Maximum unit current x Motor FLC	Start Time	Starts per Hr	Duty Ratio (AC53a) Bypased + Off Time (AC53b)
1	10B	370A	AC53a	10A	3.5	12	3	60%
2	10	350A	AC53a	10	3	23	3	60%
3	20	247A	AC53a	20	4	19	3	60%
4	30	248A	AC53a	30	4	29	3	60%
5	10B	390A	AC53b	10A	3.5	12	3	1188S
6	10	364A	AC53b	10	3	23	3	1177S
7	20	288A	AC53b	20	4	19	3	1181S
8	30	256A	AC53b	30	4	29	3	1171S

Setting the XFE Start Class

① With '**Starter Disabled**' shown on the display, press **ENTER** key once.

② With '**Applications**' shown on the top line of the display press ⇩ key three times until **"Advanced"** is shown at the top of the display.

③ Press **ENTER** once to show **"Current"** at the top of the display.

④ Press **ENTER** once more to show **"Rated current"** at the top of the display.

⑤ Press ⇩ key once to display **"P106 Start Class"** on the top line.

⑥ Press **ENTER** once to show **"Set Start Class"** at the top of the display. Press ⇩⇧ keys until the required class is shown. Press **ENTER**. Keypad should display **"Loading"** then **"Saved"**.

⑦ At any of the above stages pressing **#** will return the user to the previous menu. The XFE will not start until the control display indicates **'Stopped and ready'**.

Menu structure

Typical Keypad menu. Contact Fairford for more details.

ENTER → **ENTER** → **ENTER** → **ENTER** →

Stopped and ready
1:

Starter Disabled
1:▼ to Enable

Applications
Auto features

Auto features
Basic

Basic
Advanced

Advanced
Monitoring

Monitoring
Permanent store

Permanent store
Password

Password
Inputs

Outputs
Parameters
Trips

Settings
Default (keypad)
Default Auto
Small Pump
Large Pump
Conveyor
Low Inertia Fan
High Inertia Fan
Recip Compressor
Screw Compressor
Rotary Compressor
Crusher
Grinder
Hi torque start
Motor gen set
Aerator
Flywheel press
Moulder

Settings
Auto Jog (Off)
Auto Pedestal (Off)
Auto end start (Off)
Auto stop (Off)
Auto end stop (Off)
Auto bypass (On)
Auto 3MC (On)
Auto Ramp (Off)
Auto All >> Off
Stop smoothing (Off)

Current
Optimise rate (5)
Optimise+ (Off)
Kick start (Off)
Kick pedestal (75%)
Kick time (25cycles)
Dwell time (5s)
Low volts stop (Off)
Contactor delay (160ms)
Trip sensitivity (1)
Station number (1)
Firing mode(0)   *1
Stop smoothing (5)
Cooling (On)
Cooling time   *2
Line contactor (On)
Thermistor Trip (Off)
P126 Comms Trip (On)

Disable starter?
Enable starter
Starting (Keypad)
Start pedestal (20%)
Start time (5s)
Stop pedestal (10%)
Stop time (0s)
Current limit (3.5xIe)
Power on Param
Protection (Full +Optimise)

Full
Full + optimise (Default)
Start + bypass
Phase loss only

Rated current (Ie)   *3
P106 Start Class   *4
Low current (Off)
Low amps level (0.1xFLC)
Low amps time (50cycles)
C/L time out (On)
Current limit (3.5xIe)
Limit time out (30s)
Shearpin (On)
Shearpin level (3.125xIe)
Shearpin time (100cycles)
Overload level (1.1xIe)

Power
Protection (full + optimise)
Current
P27 Peak Start
P40 supply volts (416)
Real PF
P22 Delay angle
P23 Max angle
P20 Reference PF
P21 Internal PF
Temperature I/P

Save parameters
Power on parameters
Default parameters

Enter password
Change password

◄ **#** ◄ **#** ◄ **#** ◄ **#**

*1   The "Firing mode" must be set to '1' for the In-Delta configuration.
*2   The "Cooling time" is dependant on the Model range, Duty rating and Heatsink temperature.
*3   The "Rated current" setting is for reference only and is not user adjustable.
*4   "P106 Start Class" is either factory pre-set on set by the user on Initial Start-up.

4   Set-up examples

The XFE should always be **disabled** before making changes. The Soft Starter then remains unable to drive the load until it has been **enabled** via the **Basic Menu**, or the control supply is removed and reapplied, or the ▼ key is pressed when prompted. If the Remote Start/stop is active the XFE cannot be **enabled**.
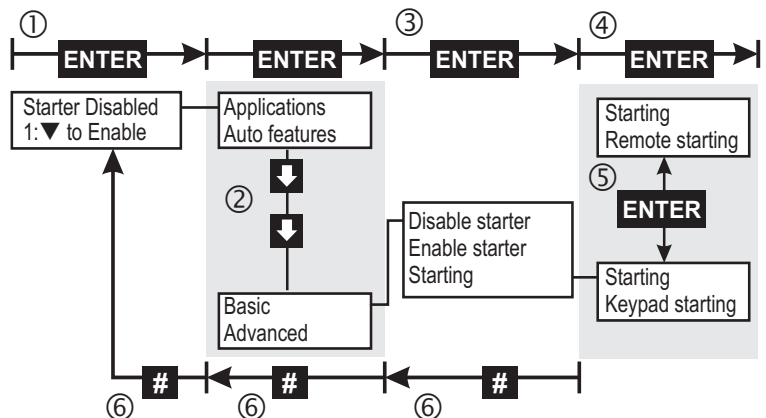
1   Setting the XFE for large pump application

① With **'Starter Disabled'** shown on the display, press **ENTER** key once.

② With **'Applications'** shown on the top line of the display press **ENTER** once.

③ With **'Settings'** shown at the top of the display press ⇩ key three times until **'Large pump'** is shown at top of display.

④ Press **ENTER** once to select large pump. The display will indicate the parameters changing in short intervals.

⑤ With the display top line indicating **'Send to store?'**, press **ENTER** to save the settings for a large pump to permanent store. Display will flash the message **'Storing'** twice to indicate this has been done.

⑥ At any of the above stages pressing **#** will return the user to the previous menu. The XFE will not start until the control display indicates **'Stopped and ready'.**
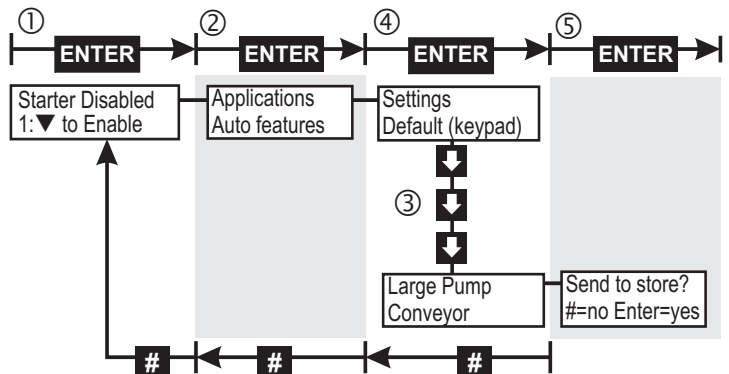
2   Setting the XFE for remote starting and stopping.

① With **'Starter Disabled'** shown on the display, press **ENTER** key once.

② With **'Applications'** shown on the top line of the display press ⇩ key twice until **'Basic'** is shown at the top of the display.

③ Press **ENTER** once to select Basic menu.

④ Press ⇩ key twice until **'Starting'** is shown at top of the display then press **ENTER** once to select starting option menu.

⑤ With display now indicating **'Starting'** on top line press **ENTER** to toggle from **'Keypad Starting'** to **'Remote Starting'** as shown on bottom line of display.

⑥ At any of the above stages pressing **#** will return the user to the previous menu.

The XFE will now start and stop remotely from the START and STOP switches shown in Figure 2.1, but will return to keypad starting if the control supply on terminals X1 and X2 is removed. Alternatively, to return to keypad starting and stopping, repeat the above procedure and select **'Keypad Starting'** at step 5. **To keep the remote start/stop setting after removal of the control supply, the settings must be permanently saved (See 3 below).**
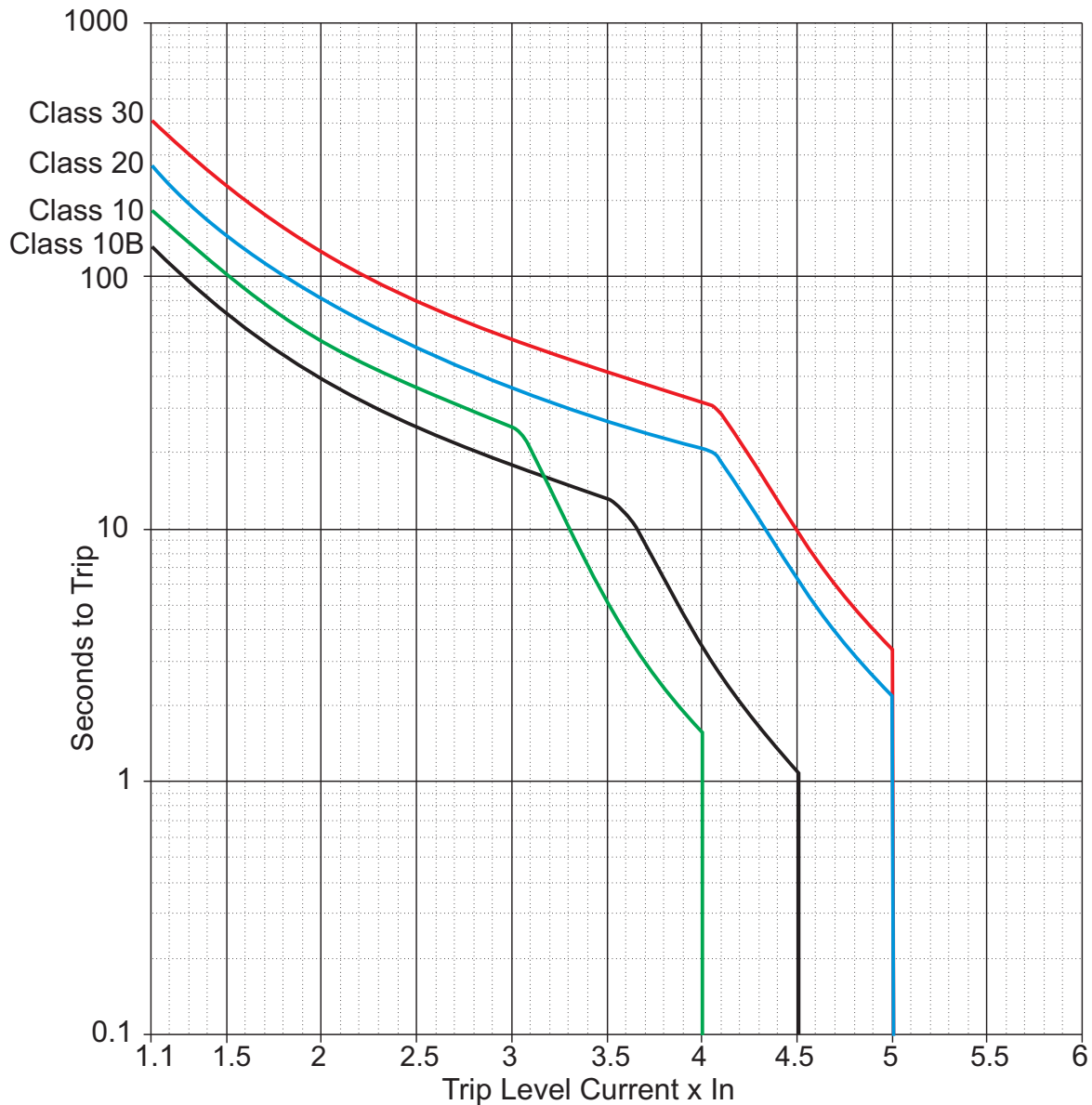
3   Permanently saving parameters set by user.

① With **'Starter Disabled** shown on the display, press **ENTER** key once.

② With **'Applications'** shown on the top line of the display press ⇩ key four times until **'Permanent Store'** is shown at top of display.

③ Press **ENTER** once to select Permanent Store menu.

④ With **'Save Param'** shown at top of display press **ENTER** once to permanently save parameters. Display will flash twice to indicate this has been done.

⑤ At any of the above stages pressing **#** will return the user to the previous menu.
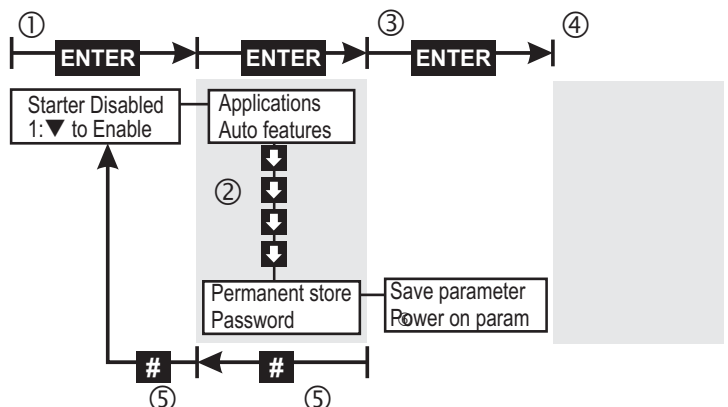
5 Product information

Overcurrent trip curve

'Current limit' and 'Overload level' settings are adjustable. The XFE monitors current in one phase only and this limits overload currents in accordance with the trip curves shown here (See Menu structure for default settings). Parameter P106 may be changed to select Class 10B, 10, 20 or 30. This will automatically change the motor current rating (Trip level) of the unit to maintain over current protection.
Note: The overload monitors one of the phases only and the 'Current Limit' level is only active during motor starting.

IMPORTANT
It is recommended that the control supply is maintained between starts to ensure the integrity of the overload, which will reset on it's removal.

Cooling
The XFE is designed so that the rated start current/time is close to the maximum allowed. If the start duty is exceeded the unit will trip. All XFE Soft Starts have a forced off cooling time between starts.
In line with the stated IEC starting duties, all XFE 100 series have an enforced off period of 2 minutes, likewise all XFE 200 and XFE 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates **"Stopped.Cooling"**, and the XFE will not respond to a start signal.

AC53a ratings are for Optimising or use without a bypass contactor.
AC53b rating is only for use with a bypass contactor and will trip if one is not used
Trip curves show the nominal times for operation from cold (40°C)

XFE Trip/Fault Codes

Fault Code	Explanation
1 Phase Loss	Input side phase loss at the ramp start, during the ramp or during normal running.
2 Too Hot	The heatsink is above the maximum allowed temperature or i/p open circuit.
3 Comms	There have been a number of serial communication errors but communications are still active.
4 SCR Firing	Short circuit thyristor during normal running.
5 SCR Signal	Short circuit thyristor or Motor side phase loss during the ramp during normal running.
6 SCR Signal	Input side phase loss during normal running. Short circuit thyristor or motor side phase loss during the ramp or during normal running.
7 Sensing Signal	Short circuit thyristor, external noise or motor side phase loss during the ramp or during normal running.
8 Motor, SCR Los	Short circuit thyristor or motor side phase loss at the start of the ramp.
9 Sensing Signal	Short circuit thyristor or external noise during the ramp or during normal running.
10 SCR Shorted	Short circuit thyristor or motor side phase loss during the ramp.
11 Low Current	Current has fallen below the **under-current** level. Only active during during normal running
12 C/L Time Out	Current limit during the ramp has exceeded the current limit **time-out** period.
13 Overload	Current has exceeded the **overload level**. Active at all stages of operation.
14 Shearpin	Current has exceeded the **shearpin** current level. Only active during normal running
15 Thermistor	Thermistor Input is open circuit or thermistor resistance has exceeded it's trip point.
16 User	A trip input from the **user** to the soft starter.
17 Comms Timeout	Serial communications have been lost.
18 Bypass failed	Bypass contactor failed to close on AC53b unit.
Stopped. Cooling	Displayed during the period for which the soft starter will not restart to allow heatsink cooling.

Items in **bold** text are user adjustable

Semiconductor Fuse types

XFE No.	Short circuit Amp RMS (kA)	SIBA Fuse	Amps
XFE102	5	2018920.63	63
XFE104	5	2018920.63	63
XFE106	5	2018920.63	63
XFE108	5	2018920.63	63
XFE110	5	2018920.80	80
XFE112	5	2018920.80	80
XFE114	5	2018920.80	80
XFE116	5	2018920.100	100
XFE118	5	2018920.100	100
XFE120	5	2018920.100	100
XFE122	10	2061032.250	250
XFE124	10	2061032.250	250
XFE126	10	2061032.250	250
XFE128	10	2061032.250	250
XFE130	10	2061032.250	250
XFE132	10	2061032.400	400
XFE134	10	2061032.400	400
XFE136	10	2061032.400	400
XFE138	10	2061032.450	450
XFE140	18	2061032.500	500

XFE No.	Short circuit Amp RMS (kA)	SIBA Fuse	Amps
XFE202	18	2061032.630	630
XFE204	18	2061032.630	630
XFE206	18	2063032.630	630
XFE208	18	2063032.800	800
XFE210	18	2063032.800	800
XFE212	30	2063032.900	900
XFE302	30	2068132.800	800
XFE304	30	2067132.1000	1000
XFE306	42	2067132.1000	1000
XFE308	42	2068132.1250	1250
XFE310	42	2068132.1250	1250
XFE312	85	2068132.1400	1400
XFE314	85	2068132.1400	1400
XFE316	85	2068132.1400	1400
XFE318	85	2068132.1400	1400
XFE319	85	2068132.1400	1400
XFE320	85	2 x 2067132.1000	2000
XFE322	85	2 x 2067132.1250	2500
XFE324	100	2 x 2067132.2000	4000
XFE326	100	2 x 2067132.2000	4000

Short circuit
co-ordination Type 1

Special purpose fuses, for the protection of semi-conductor devices, rated 700 Vac, can be used to obtain the required short circuit ratings. Suitable for use on a circuit capable of delivering not more than the RMS Symmetrical Amperes indicated in this table at maximum rated operational voltage, when protected by Semiconductor Fuse type, Manufactured by Company and Mod. No. indicated.

These fuses are for short circuit protection of the semiconductors and must be mounted externally by the user **between** the unit and the mains supply, **not between** the unit and the motor.

EMC Emission and Immunity levels

EMC compliance is in accordance with EN 60947-4-2 which refers to the following basic standards:
Note: EN 60947-4-2 is published as a harmonized standard under European Council Directive No.89/336/EEC in relation to the electromagnetic compatability.

	Basic standard	Level
IMMUNITY **Severity level 3**	IEC 61000-4-2 IEC 61000-4-6 IEC 61000-4-3 IEC 61000-4-4 IEC 61000-4-5	6kV contact or 8kV air discharge 140dBuV over 0.15-80MHz 10V/m over 80 -1000MHz 2kV/5kHz 2kV line to ground and 1kV line to line
EMISSION **Equipment Class A (Industrial)**	EN 55011	Class A

Further Information

Document No TF0120 'Guide to Soft Start Drive Product Information', describes the rating index and the meaning of other IEC 60947-4-2 product information in more detail. This is available upon request from Fairford.

Normal service conditions.

Design standards and Approvals
IEC 60947-4-2; EN 60947-4-2 'AC Semiconductor Motor Controllers and Starters'.

Ambient temperature
0°C to 40°C. Above 40°C de-rate linearly by 2% of unit FLC per °C to a maximum of 40% at 60°C.

Transport and Storage
-25°C to +60°C (continuous), -25°C to +75°C (not exceeding 24 hours).

Altitude
Above 1000m de-rate linearly by 1% of unit FLC per 100m to a maximum altitude of 2000m.

Humidity
max. 85% non-condensing, not exceeding 50% at 40°C.

Rated insulation voltage (Ui)   **690V**

Ingress Protection   IP20 or IP00   **Pollution degree**   2

Operational Voltage (Ue)   230-460VAC rms, 400-575VAC rms or 500-690VAC rms 3-Phase (-15% +10%)

Rated Frequency   50 - 60Hz +/- 2Hz   **Form Designation**   Form 1

Control Supply Us   X1, X2 115V or 230V AC rms (-15% +10%)

Control Supply Uc   S0, S1 12V/24V DC or 115/230VAC.

Auxiliary Circuits (programmable relays)   Run - 11,12,14, Top of Ramp - 21,22,24. AC1 230VAC 3A

XFE 100 Series terminals		Terminal type	Conductor type	Cable cross section*		Terminal tightening torque
				AWG	mm^2	
Power	L1, L2, L3, T1, T2, T3.	M8 metric threaded studs	Use 75°C copper (CU) conductor only and the wire shall be fitted with close eyelet lug.	1/0	50	106 lb.in. (12 Nm.)
Ground	PE	M8 metric threaded stud				

XFE 200 Series terminals		Terminal type	Conductor type	Cable cross section*		Busbar size (mm)*	Terminal tightening torque
				AWG	mm^2		
Power	L1, L2, L3, T1, T2, T3.	M8 metric threaded studs	Use 75°C copper (CU) conductor only and the wire shall be fitted with close eyelet lug or use busbar.	2 x 250MCM	2 x 120	20 x 6	106 lb.in. (12 Nm.)
Ground	PE	M8 metric threaded stud					

XFE 300 Series terminals		Terminal type	Conductor type	Busbar size (mm)*	Terminal tightening torque
Power	L1, L2, L3, T1, T2, T3.	Two off M10 nuts and bolts	Use Busbar	45 x 20 60 x 10 80 x 10	212 lb.in. (24 Nm.)
Ground	PE	M10 metric threaded stud			

All models - Terminals	Terminal type	Wire type	Cable cross section				Terminal tightening torque
			AWG		mm^2		
			Min.	Max.	Min.	Max.	
X1,X2, S0,S1 11,12,14 21,22,24	Screw clamp terminals	Solid or stranded.	22	14	0.3	2.5	4.4 lb.in. (0.5 Nm.)

To maintain approvals for cable connections, the Wire Terminals should conform to local regulations and be fitted using specified Crimping Tools as indicated by the manufacturer.

* The conductor sizes indicated in the above table are the maximum allowed for each chassis size. The actual conductor used must comply with local wiring regulations.

XFE Current Ratings

XFE No.	Continuous/Optimising				Externally Bypassed			
	-1	-2	-3	-4	-5	-6	-7	-8
	Class10B AC53a 3.5-12:75-5	Class10 AC53a 3-23:75-5	Class20 AC53a 4-19:75-5	Class30 AC53a 4-29:75-5	Class10B AC53b 3.5-12:708	Class10 AC53b 3-23:697	Class20 AC53b 4-19:701	Class30 AC53b 4-29:691
XFE102	3A	3A	3A	3A	5A	4A	3A	3A
XFE104	6A	6A	6A	6A	9A	9A	7A	6A
XFE106	8A	8A	8A	7A	12A	12A	9A	8A
XFE108	13A	13A	10A	9A	18A	19A	12A	11A
XFE110	19A	19A	18A	17A	23A	28A	21A	20A
XFE112	23A	23A	22A	21A	31A	34A	26A	24A
XFE114	27A	27A	25A	24A	35A	40A	30A	29A
XFE116	33A	33A	31A	30A	45A	49A	37A	35A
XFE118	35A	35A	30A	28A	46A	43A	33A	31A
XFE120	41A	44A	35A	33A	47A	51A	39A	37A
XFE122	44A	46A	44A	43A	56A	72A	55A	51A
XFE124	55A	55A	55A	54A	85A	89A	69A	64A
XFE126	70A	70A	59A	58A	85A	84A	63A	61A
XFE128	77A	85A	66A	64A	86A	92A	70A	67A
XFE130	88A	98A	75A	73A	94A	105A	80A	77A
XFE132	98A	108A	83A	81A	107A	117A	89A	85A
XFE134	116A	128A	99A	96A	126A	139A	106A	101A
XFE136	132A	135A	112A	106A	146A	159A	122A	115A
XFE138	154A	166A	131A	124A	171A	186A	143A	134A
XFE140	179A	190A	151A	142A	203A	215A	167A	156A

XFE No.	Continuous/Optimising				Externally Bypassed			
	-1	-2	-3	-4	-5	-6	-7	-8
	Class10B AC53a 3.5-12:60-3	Class10 AC53a 3-23:60-3	Class20 AC53a 4-19:60-3	Class30 AC53a 4-29:60-3	Class10B AC53b 3.5-12:1188	Class10 AC53b 3-23:1177	Class20 AC53b 4-19:1181	Class30 AC53b 4-29:1171
XFE202	209A	225A	174A	164A	218A	232A	178A	167A
XFE204	243A	261A	202A	190A	253A	270A	208A	195A
XFE206	314A	314A	242A	222A	330A	322A	250A	230A
XFE208	350A	320A	258A	235A	360A	344A	272A	242A
XFE210	370A	350A	274A	248A	390A	364A	288A	256A
XFE212	440A	412A	325A	295A	460A	433A	342A	305A
XFE302	500A	500A	445A	420A	520A	515A	460A	430A
XFE304	540A	540A	460A	425A	560A	562A	480A	435A
XFE306	630A	630A	480A	430A	662A	655A	500A	442A
XFE308	780A	750A	600A	530A	817A	780A	628A	543A
XFE310	795A	780A	615A	545A	825A	800A	640A	560A
XFE312	850A	850A	724A	650A	875A	895A	754A	665A
XFE314	950A	950A	810A	727A	1000A	1000A	842A	744A
XFE316	1060A	1060A	904A	812A	1100A	1115A	940A	830A
XFE318	1150A	1150A	980A	880A	1209A	1210A	1020A	900A
XFE319	1150A	1150A	980A	880A	1209A	1210A	1020A	900A
XFE320	1320A	1320A	1050A	930A	1360A	1360A	1080A	950A
XFE322	1400A	1400A	1110A	950A	1400A	1430A	1160A	970A
XFE324	1550A	1520A	1230A	1050A	1560A	1580A	1280A	1075A
XFE326	1850A	1750A	1460A	1190A	1998A	1810A	1520A	1225A

Index Ratings

In line with the stated IEC starting duties, all XFE 100 series have an enforced off period of 2 minutes, likewise all XFE 200 and XFE 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates "Stopped.Cooling", and the XFE will not respond to a start signal.
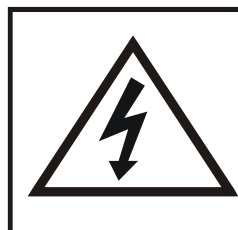
The owner, installer and user is responsible for the correct installation and use of the XFE and must ensure that only qualified personnel install the XFE and that the installation, operation and maintenance of the unit complies with the relevant Codes of Practice, Regulations and Statutory Requirements. The Manufacturer or his agent do not assume any liability, expressed or implied, for any consequence 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. To prevent an electrical shock hazard the XFE must be connected to a safety earth. The unit is not designed for use in hazardous areas. Use in such an area may invalidate the hazardous area certification.

FE FAIRFORD ELECTRONICS

Soft Starters and Energy Optimising Soft Starters

XFE

Soft Starters and Energy Optimising Soft Starters

Umotor

t

Mechanical Installation
for the XFE and XFEplus

FD842801-X

1   Mechanical Installation

1.1   Mounting

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

- The orientation of the unit has the 'TOP' uppermost .
- The location allows adequate front access.
- You can view the alphanumeric display.
- Do not install other equipment that generates a lot of heat close to the soft starter.
- Ensure that the specified clearance of above and below the soft starter is maintained, since the temperature of the cooling air can otherwise rise to inadmissible values, causing the soft starter to shut down.

1.2   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 switch-gear.
- The safe termination of cabling and/or bus-bars.
- Means to effect proper air flow through the enclosure.

1.3   Ventilation

The installer must ensure that the enclosure can maintain the operating temperature below 40 ºC or with de-rating 60 ºC . To ensure that the unit operates within a suitable temperature range, periodically measure the internal temperature of the enclosure. If you situate the unit above equipment that generates a significant amount of heat, reduce the unit full load rating. Contaminated cooling air, dust, fluff and grease, as these can cause short-circuits on the printed circuit boards (install filters, use separate ventilation airsupply)

1.4   Storage and De-rating

Above 40 ºC, de-rate linearly by 2% of Unit FLC/ ºC to maximum of 40% at 60 ºC.

	Temperature (ºC) min.	Temperature (ºC) max.
Storage, continuous	- 25	+55
Storage, not exceeding 24 hours	- 25	+70
Operating (without de-rating)	0	+40
Operating (with maximum de-rating)	0	+60

1.5 Altitude

Condition	Maximum height above sea level (m)
Operating(without derating)	1000
Operating(with maximum derating)	2000
De-rating	Above 1000m, derate linearly by 1% Unit FLC per 100m to a maximum of 2000m. For altitudes greater than 2000m, consult your supplier.

1.6 Heat output & Enclosure Ventilation

An enclosure may need additional fans to maintain the required air temperature immediately surrounding the unit if the heat output of the unit is greater than the cabinet will dissipate. This is referred to as the Ambient temperature. Use the following formula to determine the fan requirement. An allowance has been incorporated into the formula so that the figure for "Q" should be the air delivery quoted in the fan suppliers data. Refer to table 1.7 below for the heat produced by the Xfe, and note that the heat figure (Wt) is the total heat produced by everything within the enclosure. An approximation of the heat produced (Watts) by the Xfe, when in circuit, can be made by multiplying the line current by three.

When the Xfe is bypassed the heat output can be approximated with the formula:-

Watts (soft starter) = Start current x start time in seconds x number of starts per Hour / 8

$$Q = \frac{4 \times Wt}{(t_{max} - t_{amb})}$$

Q = required volume of air (cubic metres per hour - m^3/h)

Wt = heat produced by the unit and other heat sources in the enclosure (Watts)

t_{max} = maximum permissible temperature within the enclosure (40ºC for a fully rated Xfe)

t_{amb} = temperature of the air entering the enclosure (ºC)

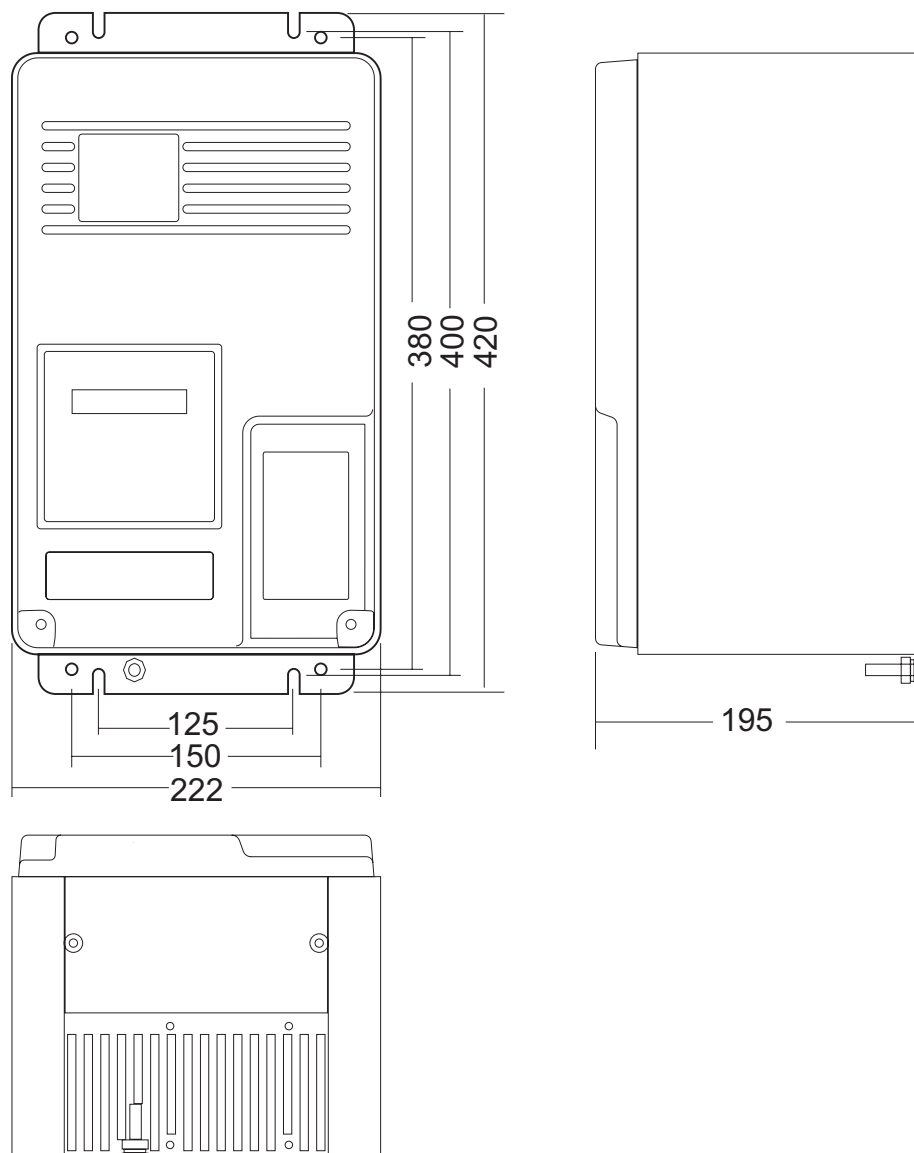If you prefer to work in CFM, substitute ºF for ºC.

1.8   **Clearance**

To maintain adequate ventilation, each model of Xfe and Xfeplus requires a minimum clearance to adjacent equipment and partitions. These clearances are specified in the table below.
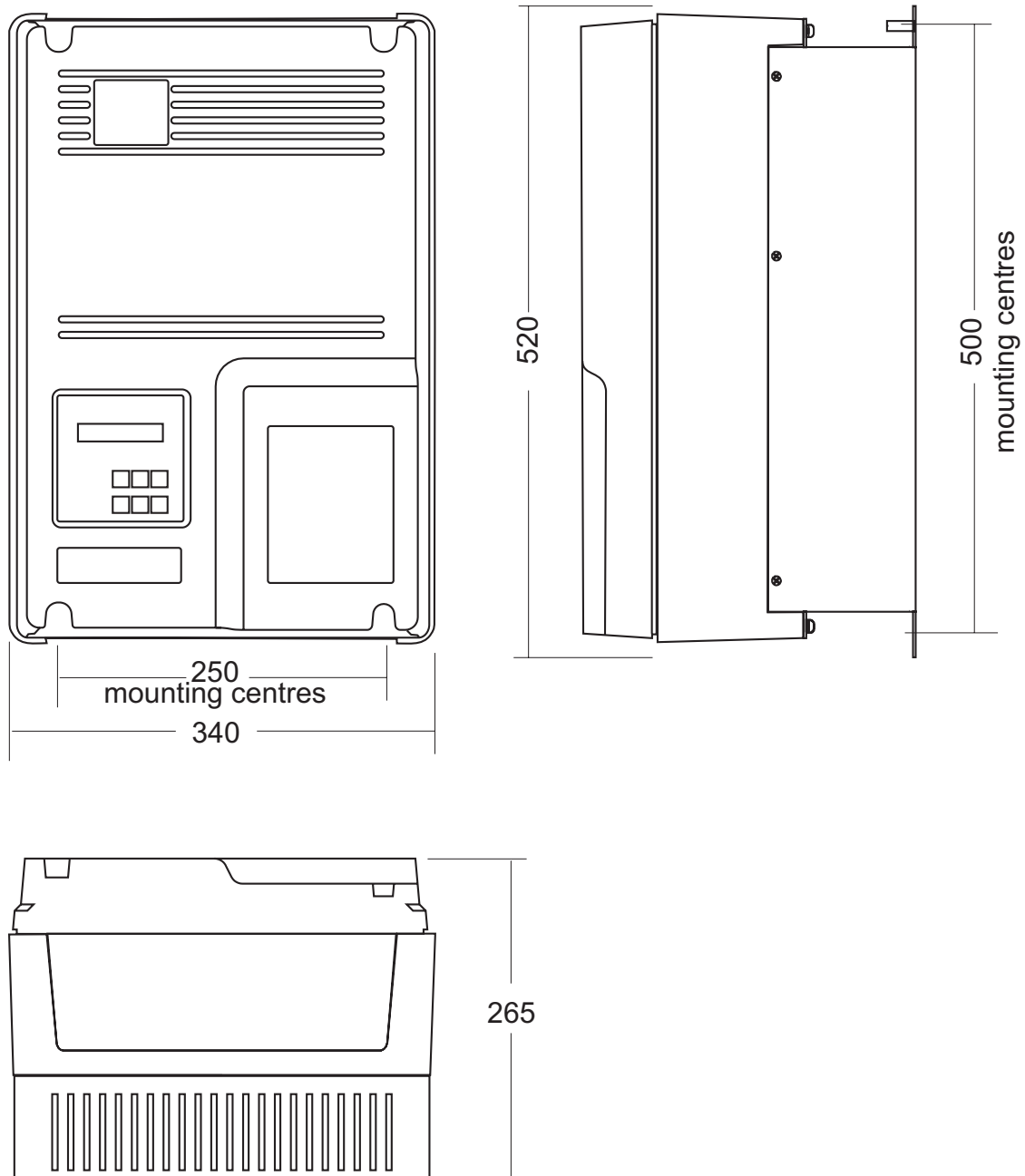

Xfe

Front View   Side View
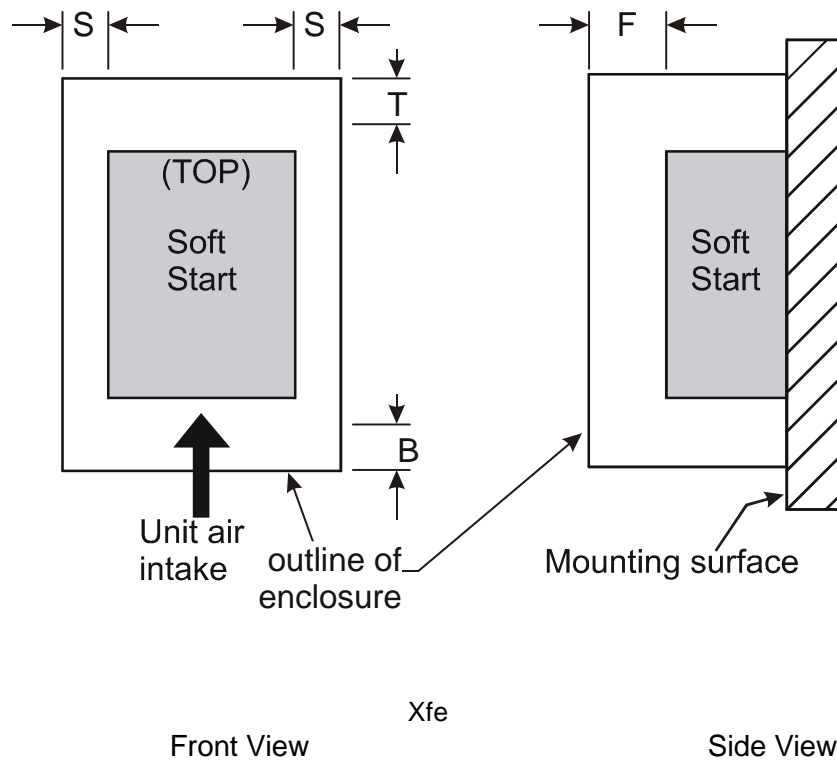
Chassis	Unit cooling Method	Minimum Clearance (mm)			
		Top (T)	Bottom (B)	Side (S)	Front (F)
Xfe102 to Xfe116	Natural convection	75	75	15	25
Xfe118 to Xfe140	Forced-air with built in fan	75	75	15	25
Xfe202 to Xfe212		75	75	15	25
Xfe302 to Xfe328		200	200	25	25

Xfe
FD842801-X

1.9 Mechanical Outline - **Xfe100 series**

| Model Number	Weight	Unit Mounting Holes	
	(Kg)	Top	Bottom
Xfe102 to Xfe124	7.3 7.3 7.3 7.3 7.3	2 holes; diameter of each hole is suitable for M6 fixings	2 holes; diameter of each hole is suitable for M6 fixings
Xfe126 to Xfe140	8.3 8.3 8.3 8.3 8.3		

1.10   Mechanical Outline - Xfe200 series

Model Number	Weight (Kg)	Unit Mounting Holes	
		Top	**Bottom**
Xfe202	15.7	2 keyholes; size of each keyhole is suitable for M6 fixings	2 open slots, each slot is suitable for M6 fixings
Xfe204	15.7		
Xfe206	22		
to	22		
Xfe212	22		

1.11 Mechanical Outline - Xfe302 to Xfe308

Xfe and Xfe+ in Chassis Size 3 comply with IP00 specification.
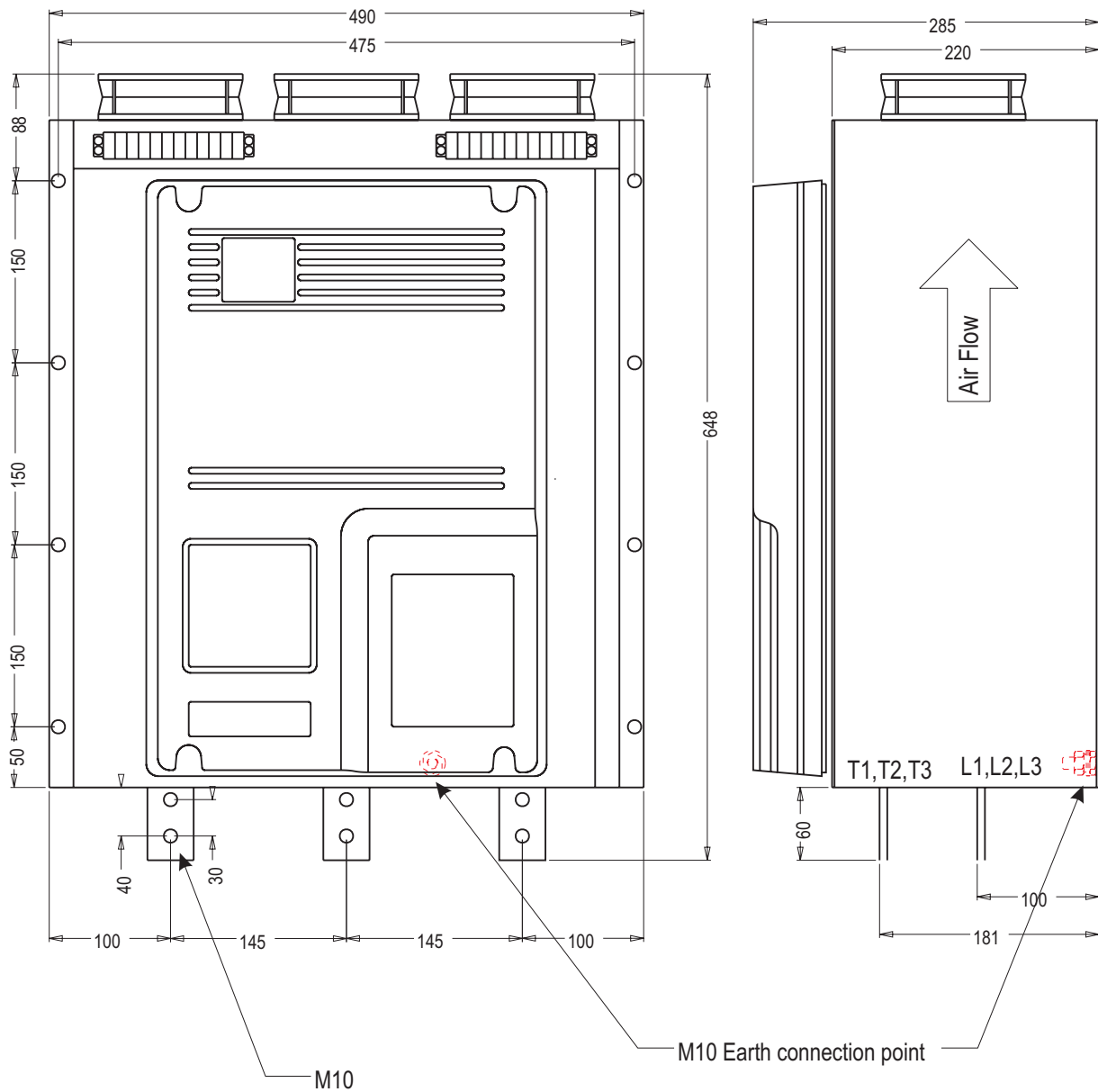
M10 Earth connection point

M10

T1,T2,T3   L1,L2,L3

Air Flow

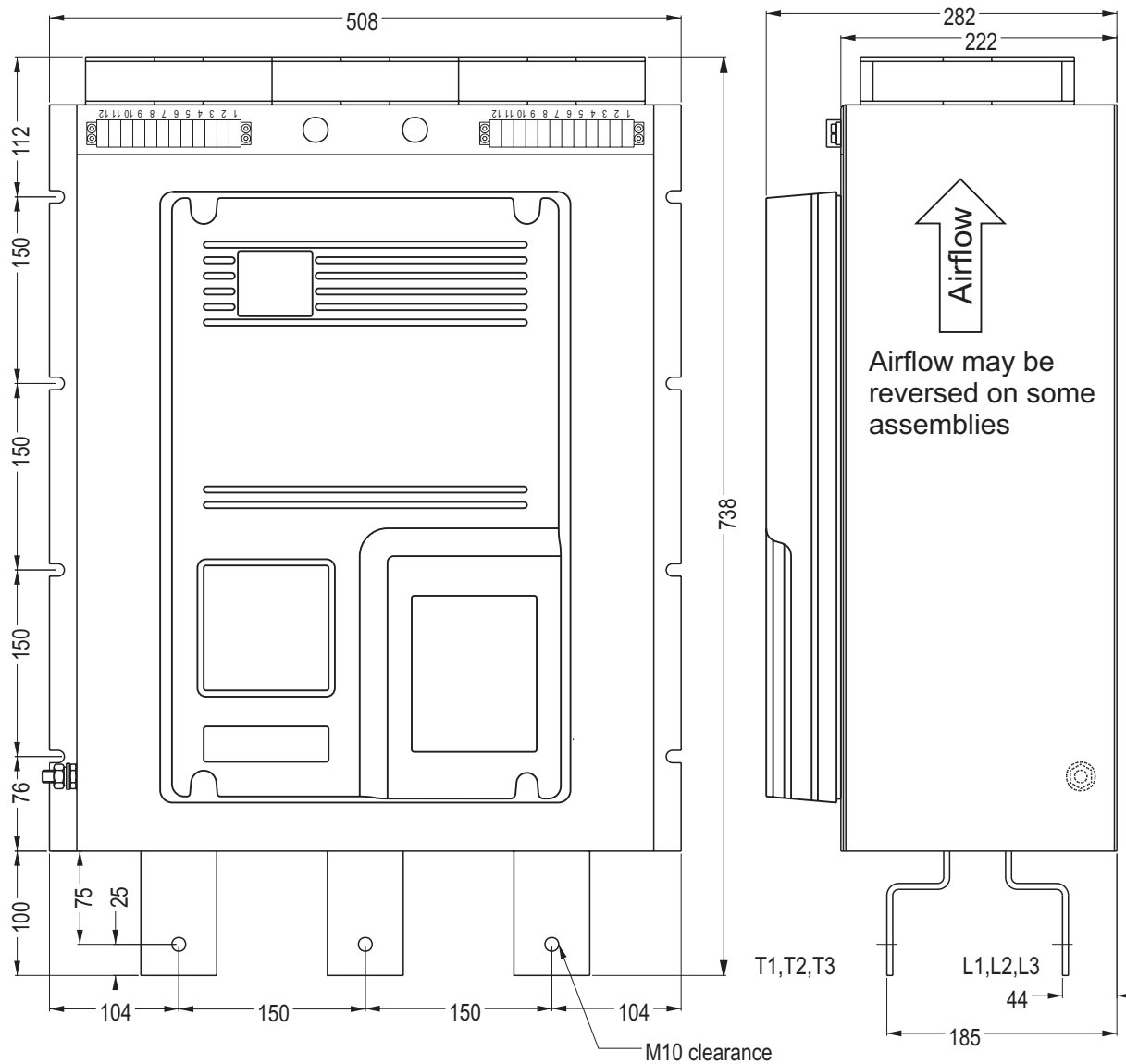Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

1.12   Mechanical Outline - Xfe310

Xfe and Xfe+ in Chassis Size 3 comply with IP00 specification.

508

282

222

112

150

150

150

76

100

738

75

25

104   150   150   104

M10 clearance

T1,T2,T3

L1,L2,L3

44

185

Airflow

Airflow may be reversed on some assemblies

Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

Xfe
FD842801-X

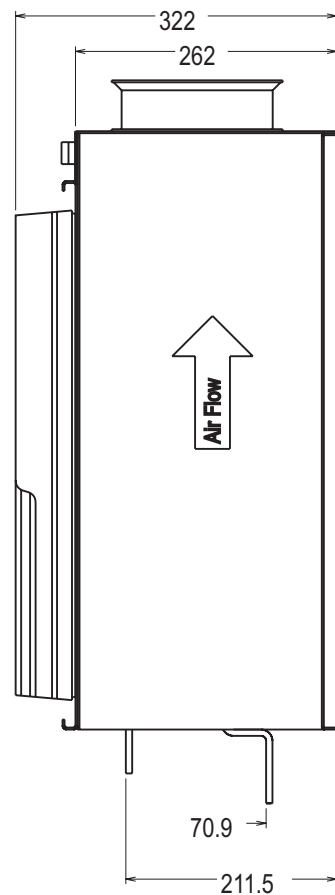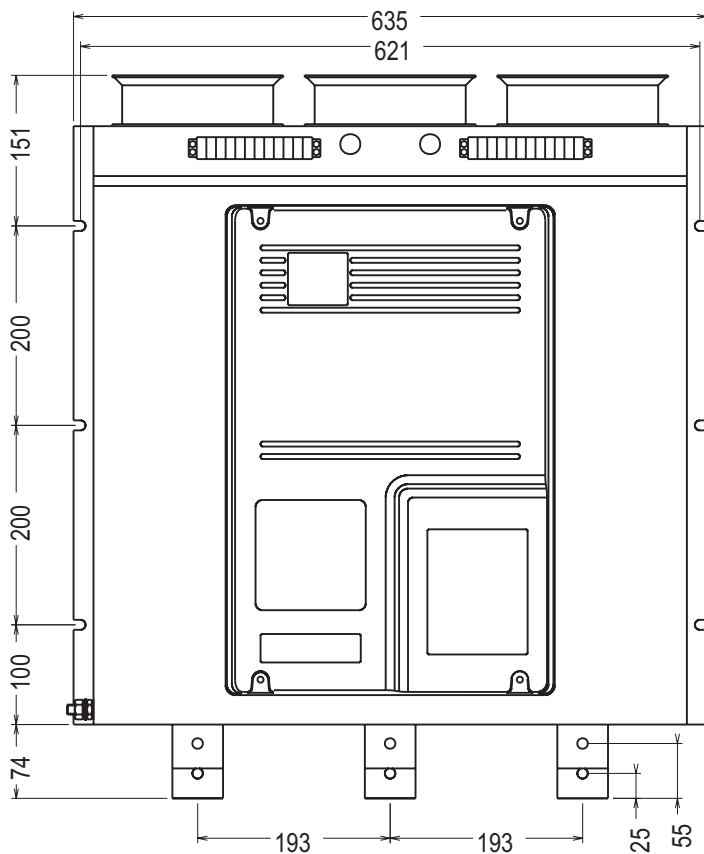## 1.13   Mechanical Outline - Xfe312 to Xfe319

Xfe and Xfe+ in Chassis Size 3 comply with IP00 specification.

Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

1.14   Mechanical Outline - Xfe320

Xfe and Xfe+ in Chassis Size 3 comply with IP00 specification.

Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

Xfe
FD842801-X

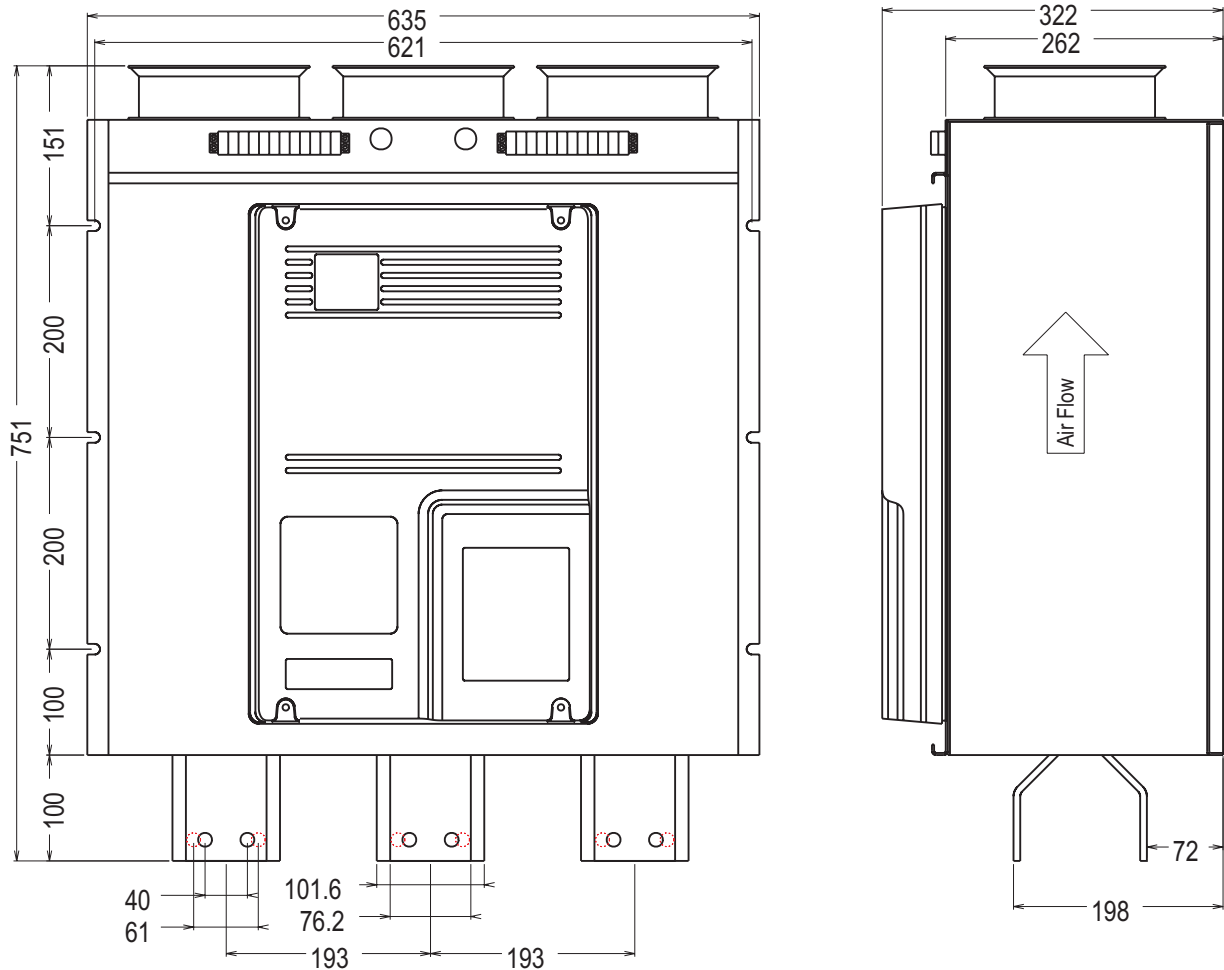## 1.15   Mechanical Outline - Xfe322 to Xfe328

Xfe and Xfe+ in Chassis Size 3 comply with IP00 specification.

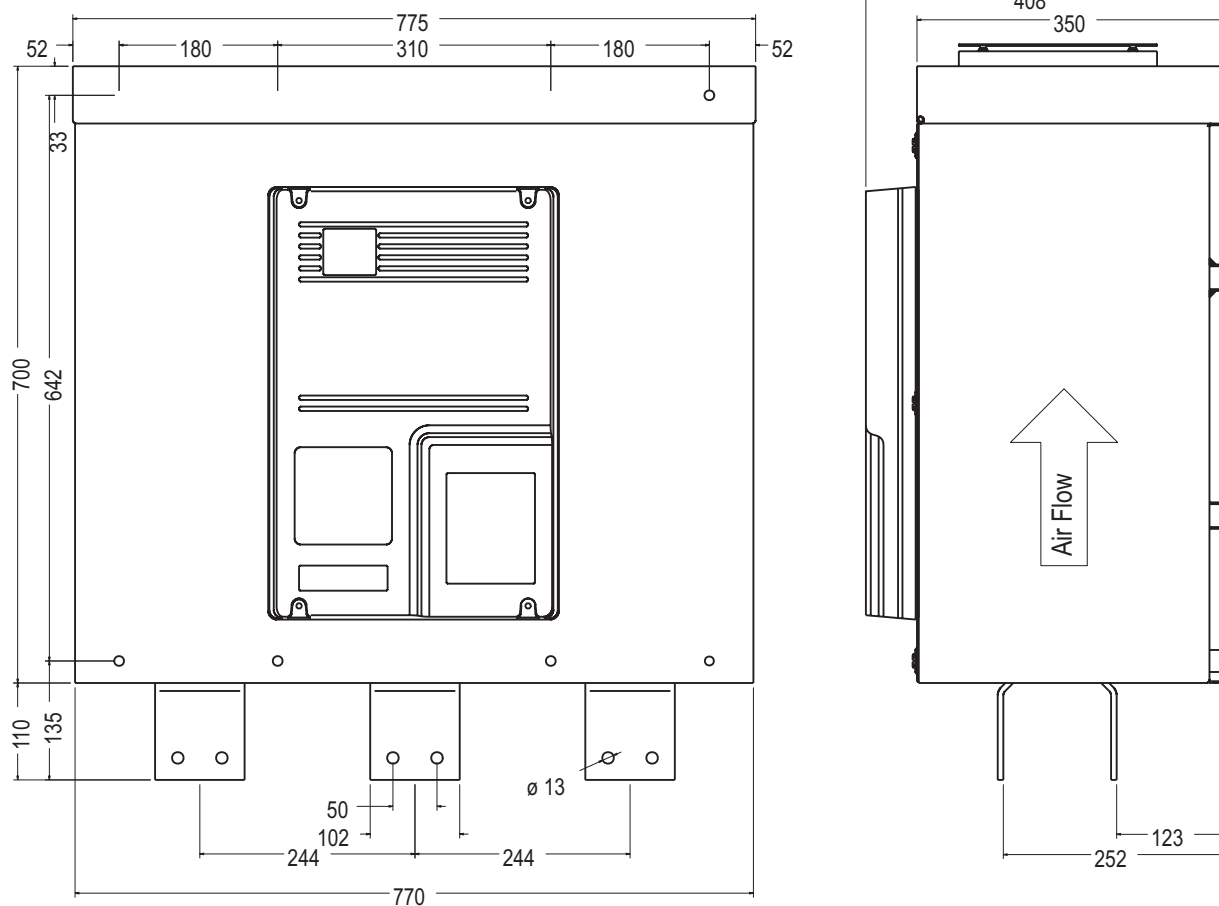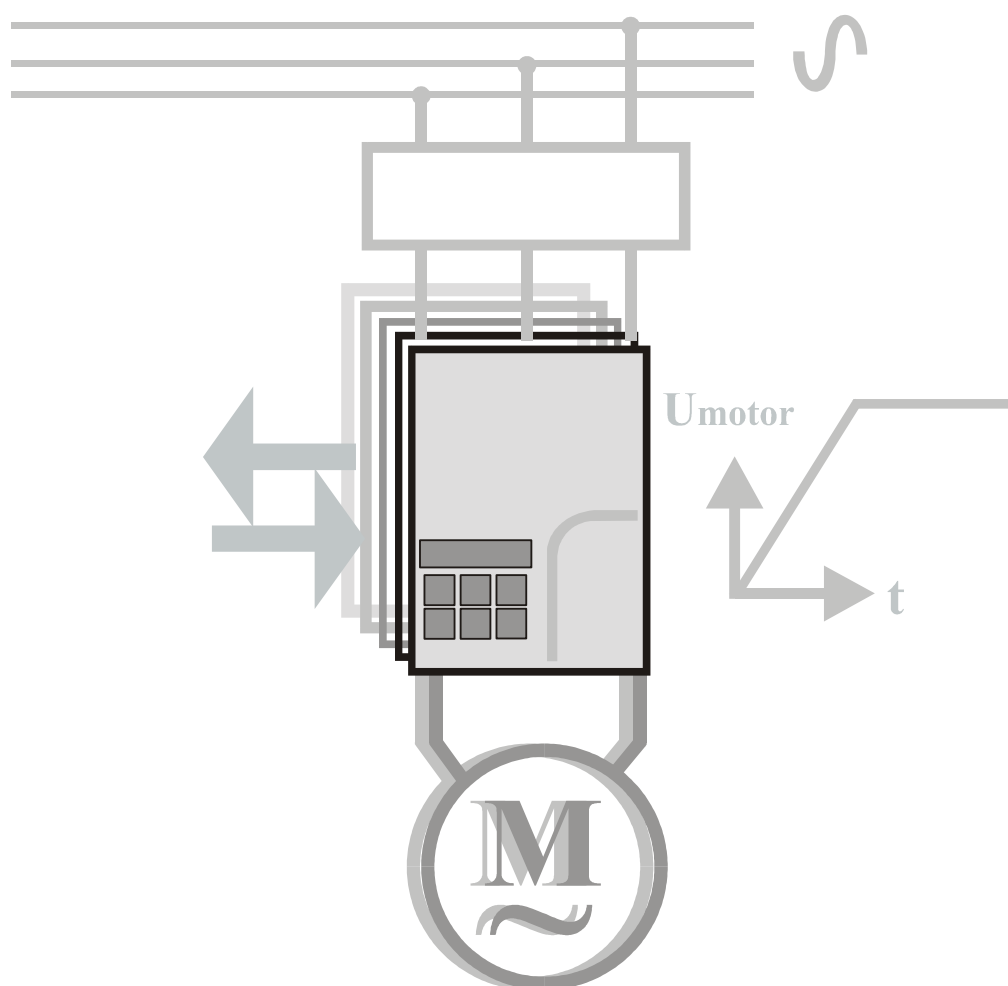Mountings suitable for M10 fixings.
Allow clearance of:-
sides - 25mm
Top & bottom - 200mm
Front - 25mm

Xfe
FD842801-X

XFE Soft Starters and Energy Optimising Soft Starters

Electrical Installation
for the XFE and XFEplus

2 Electrical Installation

2.1 Warnings

2.1.1 Isolation

Caution: The Xfe uses semiconductor devices in the main circuit and is not designed to provide isolation. For this reason isolation means must be installed in the supply circuit in accordance with the appropriate wiring and safety regulations.

2.1.2 Electrical Control Supply Requirements

All Models All electrical connections are made to power input and output terminals, control terminals and an earth stud . Before you apply the control voltage to the control supply terminals, ensure that the selector switch is set to the voltage being used. The diagrams in sections 2.5 show the location of this selector switch. Only make electrical connections to those terminals specified. If you connect to other terminals, then you may cause damage to the internal control circuitry.

2.1.3 Access

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

2.1.4 Fuse Protection

The Mains Supply and the Control Supply each require protection. Although all units have electronic overload protection for the Soft Start, the installer should always fit fuses, for motor protection, *between* the unit and the Mains Supply, *not between* the unit and the motor.

Semiconductor fuses can be supplied as an option for short-circuit protection of the semiconductors. These fuses must be fitted externally to the Xfe chassis to comply with certain standards. It is the responsibility of the installer and system designer/specifier to ensure that the required standards or regulations are not affected by so doing.

Xfe
FD842901_X

2.2 Electrical Connections

2.2.1 Electrical Supplies

The unit requires two AC supplies:-

A 3-phase balanced Mains Supply to provide the power for the controlled motor.

A single-phase supply: 115V/230V, 50Hz/60Hz, for the internal control circuitry.

The unit will not operate unless the control supply voltage is within the specified limits.

It is recommended that the control supply is maintained between starts to ensure overload integrity, as the overload will reset on control supply removal.

2.2.2 Control, Power and Earth Terminations

2.2.2.1 Control terminations

All models - Terminals	Terminal type	Wire type	Cable cross section				Terminal tightening torque
			AWG		mm^2		
			Min.	Max.	Min.	Max.	
X1,X2, S0,S1 11,12,14 21,22,24	Screw clamp terminals	Solid or stranded.	22	14	0.3	2.5	4.4 lb.in. (0.5 Nm.)

2.2.2.2 Power and Earth Terminations Xfe100 & Xfe200 series

Xfe102 to Xfe140		Terminal type	Conductor type	Cable cross section		Terminal tightening torque
				AWG	mm^2	
Power	L1, L2, L3, T1, T2, T3.	M8 metric threaded studs	Use 75°C copper (CU) conductor only and the wire shall be fitted with close eyelet lug.	1/0	50	106 lb.in. (12 Nm.)
Ground	PE ⏚	M8 metric threaded stud				

Xfe202 to Xfe212		Terminal type	Conductor type	Cable cross section		Busbar size (mm)	Terminal tightening torque
				AWG	mm^2		
Power	L1, L2, L3, T1, T2, T3.	M8 metric threaded studs	Use 75°C copper (CU) conductor only and the wire shall be fitted with close eyelet lug or use busbar.	2 x 250MCM	2 x 120	20 x 6	106 lb.in. (12 Nm.)
Ground	PE ⏚	M8 metric threaded stud					

2.2.2.3 Power and Earth terminations Xfe300 series

Xfe302 to Xfe308		Terminal type	Terminal tightening torque	Minimum busbar size (mm) for max current rating	
Power	L1, L2, L3, T1, T2, T3.	Two off M10 nuts and bolts	46 Nm. 34 lb-ft	520Amp 562Amp 662Amp	25 x 10, 40 x 5 25 x 12, 40 x 6 40 x 8, 50 x 5
Ground	PE ⏚	M8 metric threaded stud	23 Nm. 17 lb-ft	817Amp	40 x 10, 50 x 8

Xfe310		Terminal type	Terminal tightening torque	Minimum busbar size (mm) for max current rating	
Power	L1, L2, L3, T1, T2, T3.	One off M12 nut and bolt	79 Nm. 58 lb-ft	825Amp	50 x 8, 60 x 6
Ground	PE ⏚	M10 metric threaded stud	46 Nm. 34 lb-ft		

Xfe312 to Xfe319		Terminal type	Terminal tightening torque	Minimum busbar size (mm) for max current rating	
Power	L1, L2, L3, T1, T2, T3.	One off M12 nut and bolt	79 Nm. 58 lb-ft	895Amp 1000Amp 1115Amp	50 x 10, 60 x 8 50 x 12, 60 x 8 50 x 16, 60 x 10
Ground	PE ⏚	M10 metric threaded stud	46 Nm. 34 lb-ft	1210Amp	60 x 12

Xfe320		Terminal type	Terminal tightening torque	Minimum busbar size (mm) for max current rating	
Power	L1, L2, L3, T1, T2, T3.	Two off M12 nuts and bolts	79 Nm. 58 lb-ft	1360Amp	60 x 12, 80 x 8
Ground	PE ⏚	M10 metric threaded stud	46 Nm. 34 lb-ft		

Xfe322 to Xfe328		Terminal type	Terminal tightening torque	Minimum busbar size (mm) for max current rating	
Power	L1, L2, L3, T1, T2, T3.	Two off M12 nuts and bolts	79 Nm. 58 lb-ft	1420Amp 1580Amp 1810Amp	80 x 8, 100 x 5 80 x 10, 100 x 6 80 x 12, 100 x 10
Ground	PE ⏚	M12 metric threaded stud	79 Nm. 58 lb-ft		

* The conductor sizes indicated in the above table are the maximum allowed by UL for each chassis size. The actual conductor used must comply with local wiring regulations.

To maintain approvals for cable connections, the Wire Terminals should be UL Listed or Recognised Wire Connectors and Soldering Lugs, fitted to the wire with specified Crimping Tools as indicated by the manufacturer.

2.3 Standard Wiring Configurations

There are two standard wiring configurations for the connection of a motor, a motor controller (Soft Start) and the mains supply:

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

This is the recommended connection and is suitable for most motors.

Configuration 2:   In-Delta connection for Delta Connected Motors

If required the Xfe can be installed within the delta windings.

2.3.1   Wiring Diagram for In-line Connection of Motors
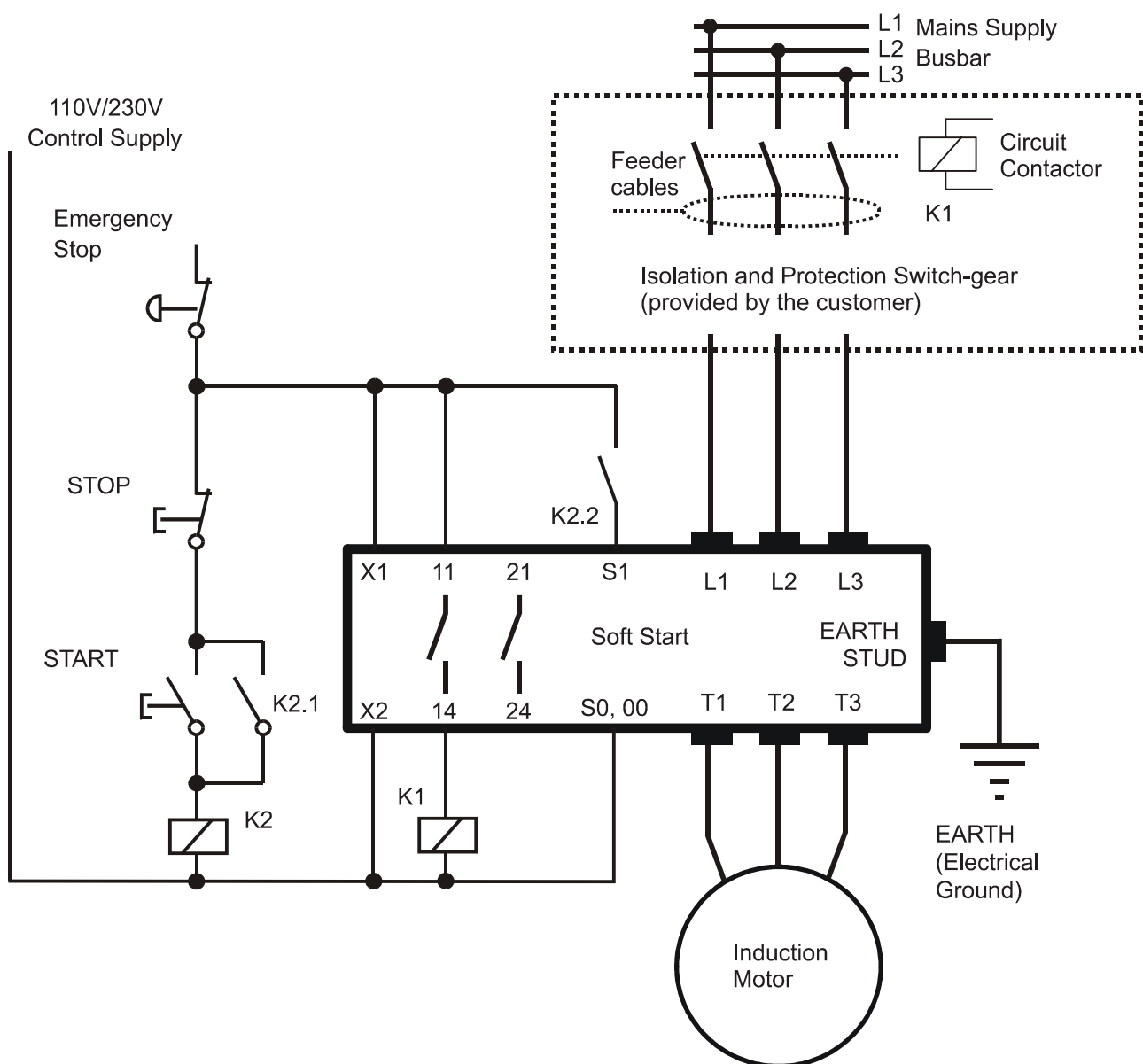
Figure 2.3.1   In-line Connection for Motors

2.3.2 Wiring Diagram for In-Delta Connection of Motors

Mains Supply (U$_e$)

Feeder cables

Isolation and Protection Switchgear (provided by customer)

K1

Control Supply (U$_s$)

X1	L1	L2	L3
X2		Soft Start	
EARTH STUD	T1	T2	T3

EARTH (Electrical Ground)

W1 V1 U1

Induction Motor

W2 V2 U2

In-delta connections for correct rotation of motor

Terml	Fwd	Rev
T1	W1	V1
T2	V1	W1
T3	U1	U1
L1	V2	W2
L2	U2	U2
L3	W2	V2
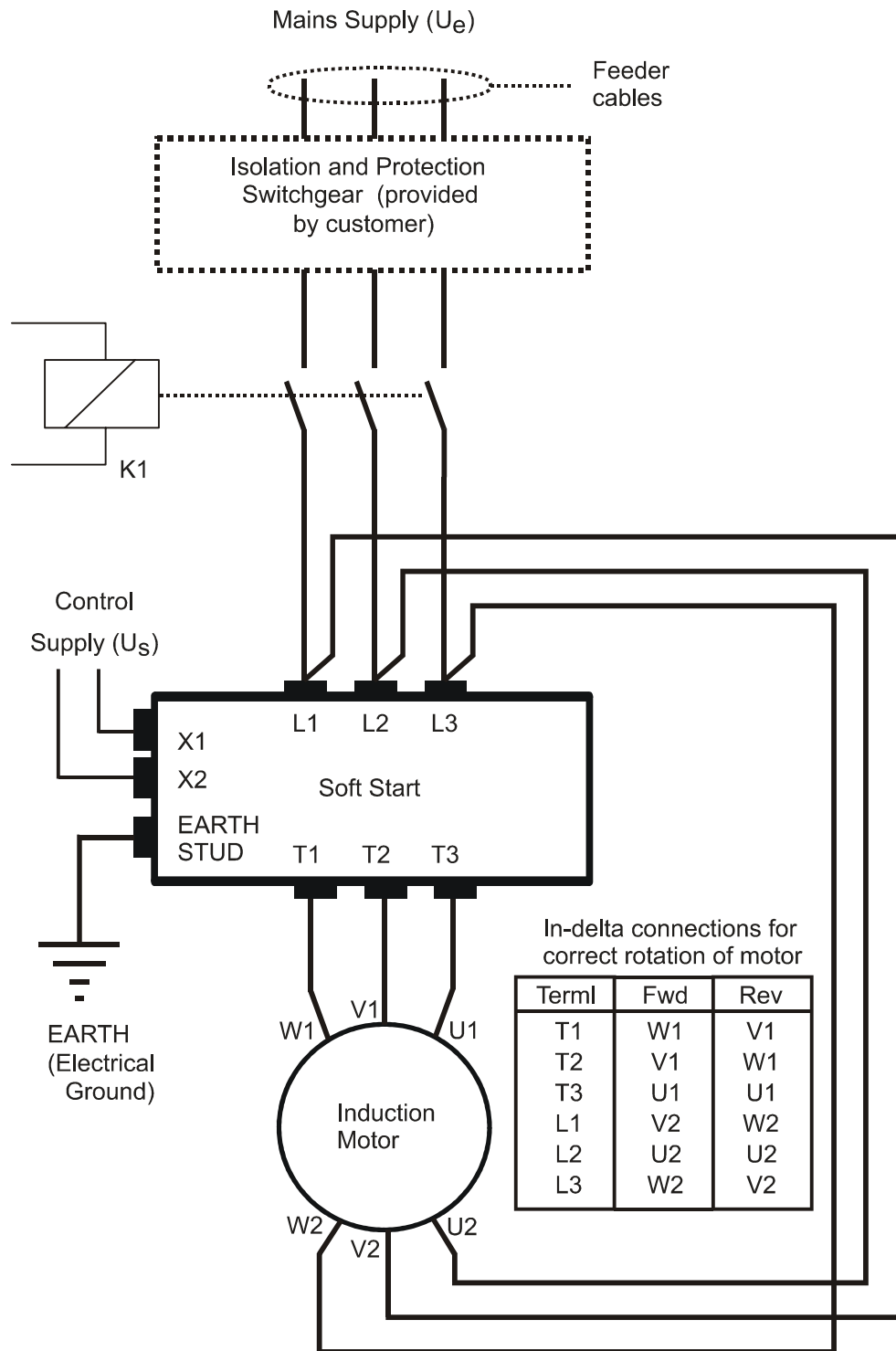
Figure 2.3.2   In-Delta connection for Delta connected induction motors

2.4   **Motor Control Circuits**

2.4.1   **Bypass Control**

A separate bypass contactor is required when using the AC53b ratings which allows a higher rated motor to be connected. This must be connected in parallel with the Xfe or Xfeplus and provides a solid connection of the motor to the mains supply which will eliminate the heating effect associated with thyristor losses. Soft-Starting and Soft-Stopping remain active as normal when the wiring is configured as in Figure 2.4.1.

At the completion of the starting ramp a bypass contactor is closed around the main connections of the Soft Start to remove the thyristors from circuit. The contactor is controlled by a programmable relay set as 'Top of Ramp', which is the default for relay K2. This configuration ensures that bypassing only occurs after the Soft Start has completed the start and the motor terminal voltage is at supply voltage.

The diagrams show typical power and contactor control circuits for bypassing.

The default software configuration will detect the use of a bypass contactor when using this circuit arrangement as "Auto bypass" is set as standard. You can also pre-set the protection mode to either "START+BYPASS" or "PHASE LOSS ONLY" for motor bypassing configurations.
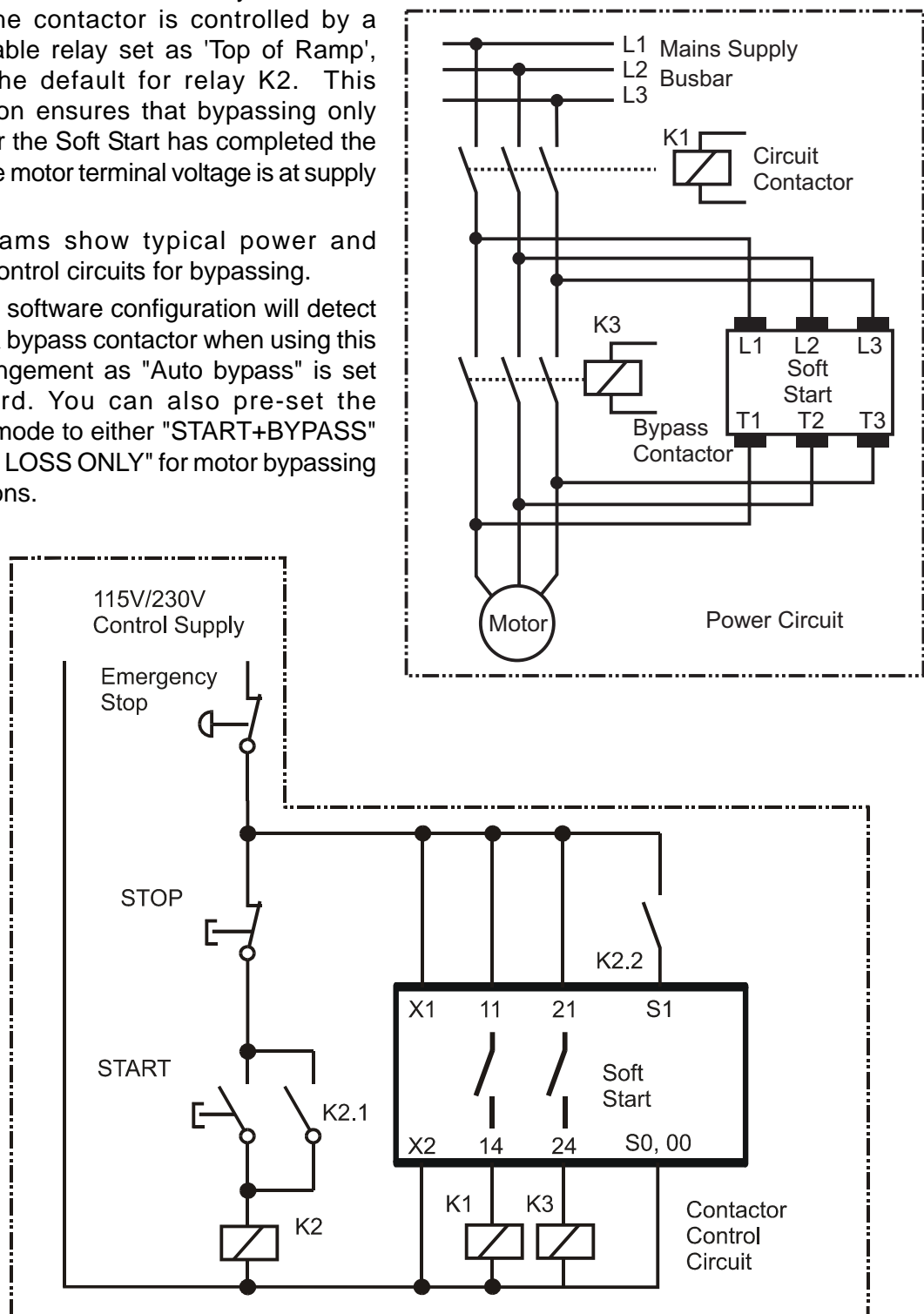
Figure 2.4.1: Power and Contactor Control Circuits for Motor Bypassing

2.4.2 Multiple Motor Starting & Stopping

The Xfe is capable of starting parallel-connected motors simultaneously provided each motor has similar characteristics and load. For such configurations the unit rating should be at least the sum of the current ratings of all the motors.

Alternatively, the Xfe can start and stop motors sequentially using bypass contactors under the control of the programmable relay set as a 'Top of Ramp' relay. The dual setting feature allows for the control of motors with different start-up requirements. Details on multiple motor applications can obtained via your supplier.

2.4.3 External Motor Protection Relay

The rating for a motor protection relay should be as for Direct-on-Line (DOL) starting, and if it is an electronic relay, then the user should confirm it's suitability for use with a soft-starter. If the motor load is high-inertia (extended start time) then a longer trip time may be required.

2.4.4 Motor Reversing

The diagram in figure 2.4.6 shows a typical motor reversing circuit using two contactors, K1 and K2, to interchange two phases of the 3-phase supply connections.

For this application the soft stop must be set to zero.

It is also recommended that: -

A period of 150 - 350 ms elapses between the FORWARD and REVERSE commands

If the reversing rate is high, the Xfe current rating may need to be increased compared to the operational current of the motor. Refer to sections 2.10.3 & 2.10.4 and also the Overcurrent trip curves shown in section 2.10.5.

The current limit and the overload must be set with more consideration to the "reverse" function rather than the "start" as the motor will initially be "plug braked" then be stationary for a moment and finally undergo a normal soft start.

2.4.5 Connection of an External Current Transformer

When using a bypass contactor with the Xfe, it is possible to connect an external current transformer (CT) to the internally mounted electronic control card. This allows more of the control functions of the unit to be used than would normally be available when the unit is bypassed. The current display is also still active. The CT used must be of the same specification as the original item fitted to the unit and the internal CT must be shorted out (preferred option) or removed. For further details, consult your supplier.

Xfe
FD842901_X

2.4.6   Wiring diagram for Motor Reversing
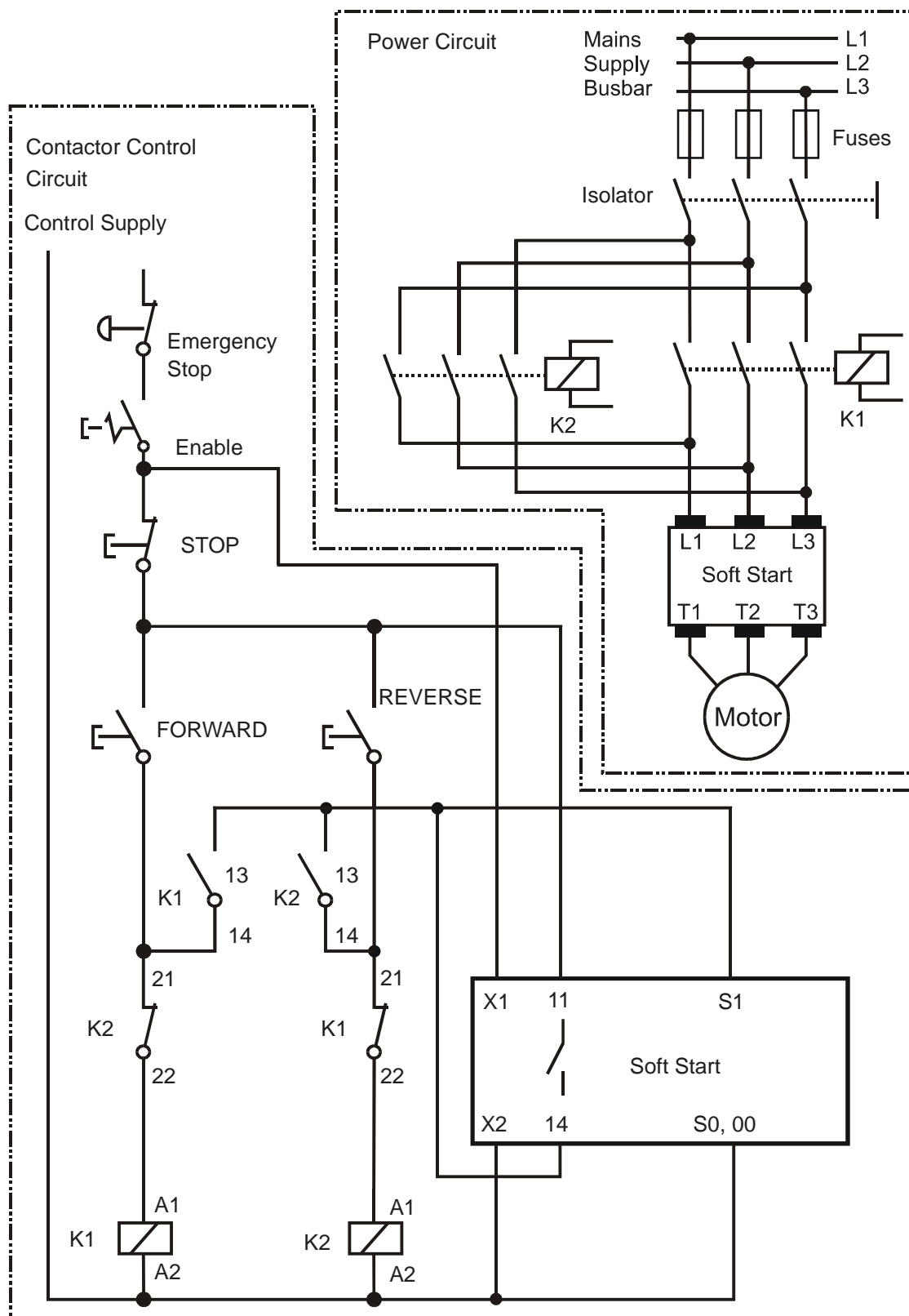
Figure 2.4.6: Typical Power and Contactor Control Circuit for Motor Reversing

2.5   Electrical Connections

Xfe and Xfeplus

2.5.1   Chassis Xfe100 series and Xfe200 series

CONTROL VOLTAGE TERMINALS X1, X2 (Input)
CONTROL VOLTAGE SELECTOR SWITCH
Ensure that the selector switch position corresponds to the control supply used, either 110V or 230V, before you apply the control supply.

POWER TERMINALS L1, L2, L3 (Input)
Isolatable 3-phase supply (via contactor, isolator, etc.). Any phase can connect to any terminal.

EARTH STUD
Electrical ground (PE)
An M8 threaded stud for connection to the system earth.

Cover (inside view)

KEYPAD CIRCUIT CARD

CABLE

ELECTRONIC CONTROL CARD
Refer to sections 2.5.3 and 2.7.1

To remove cover, unscrew 2 positions size 1 4 positions size 2

AUXILIARY FUNCTION CARD
(plus version only). Refer to section 2.5.4 and 2.7.2.

POWER TERMINALS T1, T2, T3 (Output)
Induction motor. For correct motor rotation, these connections must correspond with the supply connections at L1, L2, L3.

Figure 2.5.1 Xfe and Xfeplus Chassis Size 1 and 2 Electrical Connections

Take care, when removing and replacing the front cover, not to damage the cable that connects the Keypad and the Electronic control card.

This cable must only be connected or disconnected when the control supply is isolated from the unit, otherwise the circuitry may be damaged.

2.5.2 Chassis Size Xfe300 series

To open covers, unscrew in 4 positions

inside view of cover

KEYPAD CIRCUIT CARD behind panel

cooling fan power connection

ELECTRONIC CONTROL CARD Refer to sections 2.5.3 and 2.7.1

CONTROL VOLTAGE TERMINALS X1, X2 (Input) CONTROL VOLTAGE SELECTOR SWITCH Ensure that the selector switch position corresponds to the control supply used, either 115V or 230V, before you apply the control supply.

X1,X2

Electronic Control Card

Auxiliary Function Card

EARTH STUD Electrical ground (PE) An M8 orM10 threaded stud for connection to the system earth. Position varies with chassis size.

2 T1   1 L1   4 T2   3 L2   6 T3   5 L3

POWER TERMINALS L1, L2, L3 (Input at the back)Isolatable 3-phase supply (via contactor, isolator or breaker). Any phase rotation.

POWER TERMINALS T1, T2, T3 (Output at front) to Induction motor. For correct motor rotation, these connections must correspond with the supply connections at L1, L2, L3.

Figure 2.5.2: Xfe and Xfeplus Chassis Size 3 Electrical Connections

2.5.3   Electronic Control Card

* INTERNAL FACTORY
FITTED CONNECTIONS:
J1, J2, J3, J5, J6,
J12, J13 and J14.

Keypad connection header.

D5 (Green)Indicates the presence of the control supply.

J14*Connection to chassis mounted power device

J13*Connection to chassis mounted power device

J12*Connection to chassis mounted power device

J11

Relay K2

Relay K1

Electronic Control Card

D5

J5*
J6*

J1*

J7   Ribbon cable connector to auxiliary Function Card

J2*   J3*   J4

J8   J9   J10

22   24   21   12   14   11

nc th/sw

Thermal switch input for monitoring the unit heatsink temperature, normally-closed. (For manufacturer's use only.)

Programmable output, Relay K2. Change-over contacts that can be mapped from a selected parameter. Default: Top of Ramp

Programmable output, Relay K1. Change-over contacts that can be mapped from a selected parameter. Default: - Run Relay

Programmable Input, Control Input 1 (S1, S0). A voltage applied to these terminals will either SET or CLEAR the parameter/bit mapped by P65. Default: Start/Stop

Figure 2.5.3: Electronic Control Card Electrical Connections

2.5.4 Auxiliary Function Card
Xfeplus only

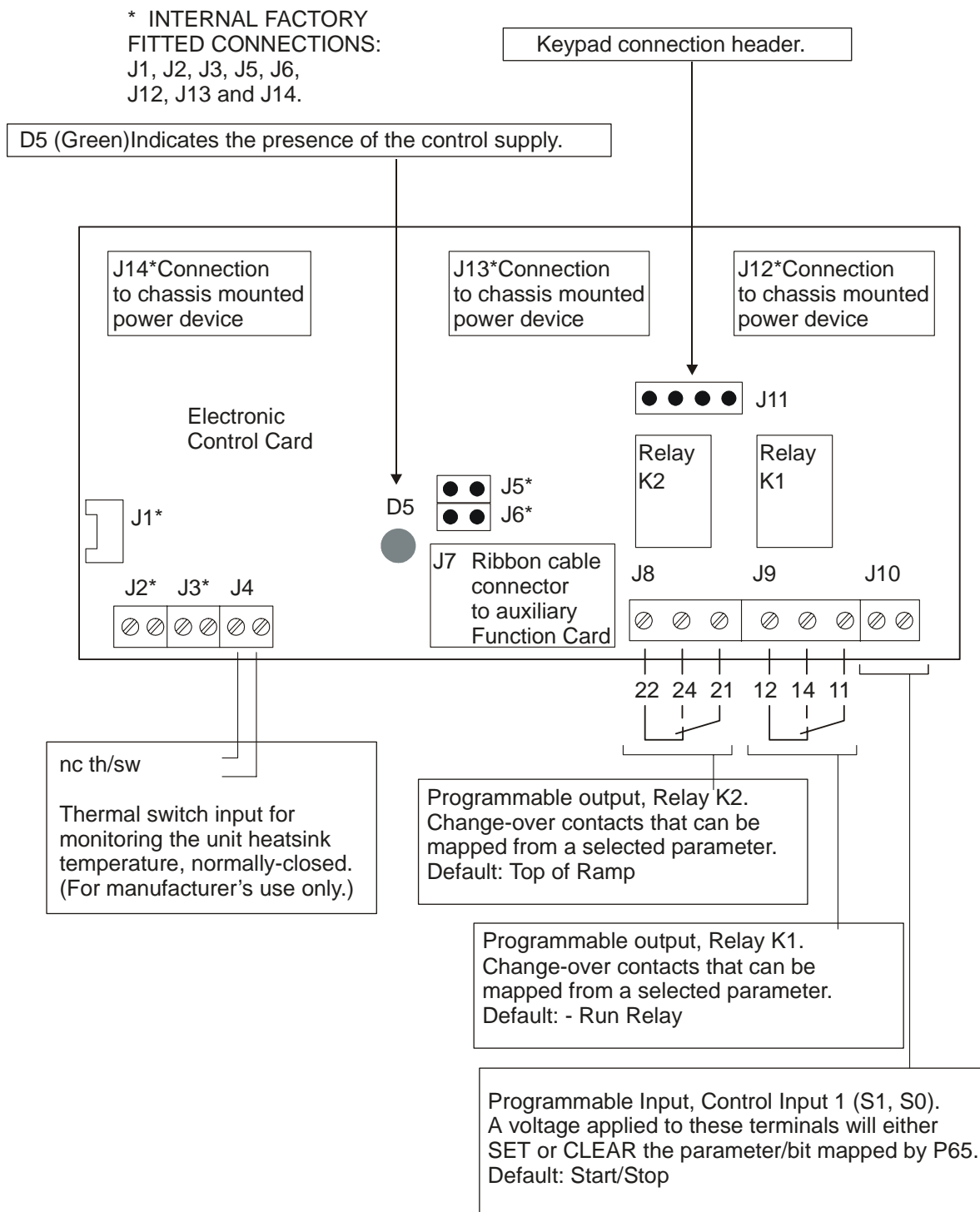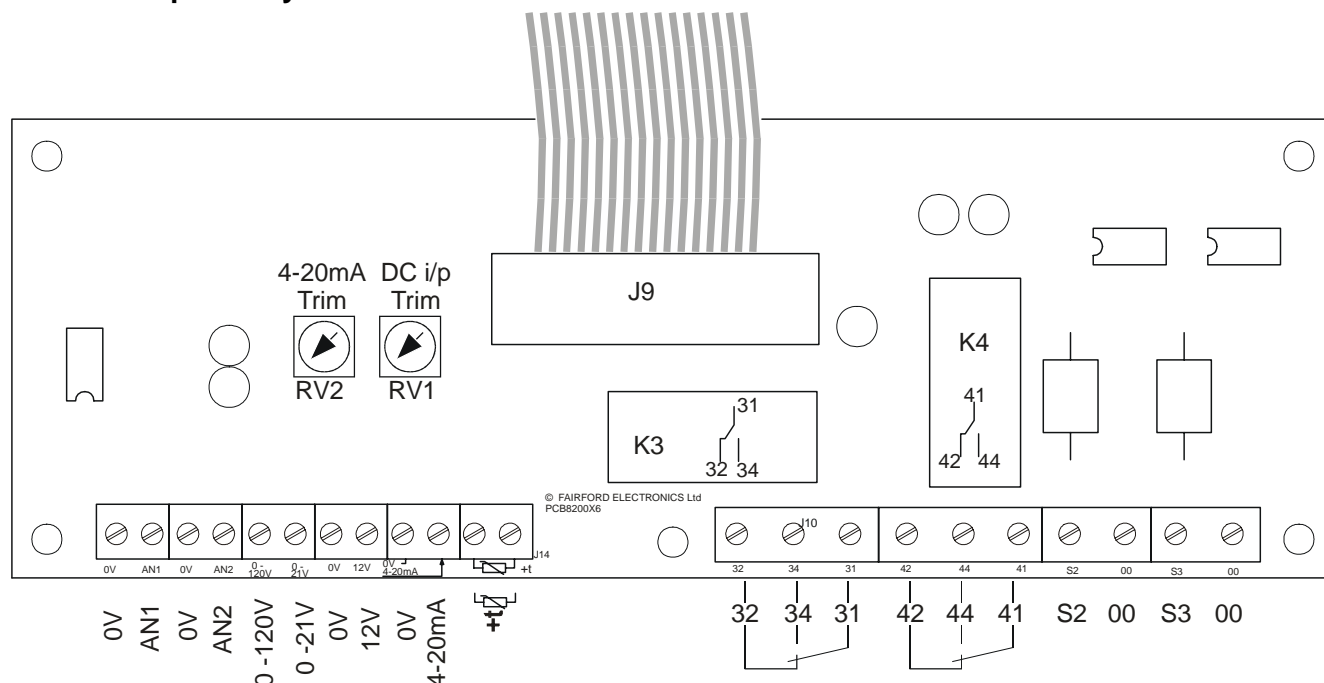| Terminal Markings	Function	Description
0V AN1	Analogue Output 1	A voltage (range 0-10V) represents the analogue value of a selected parameter. *(Advanced user facility)*
0V AN2	Analogue Output 2	A voltage (range 0-10V) represents the analogue value of a selected parameter. *(Advanced user facility)*
0-120V	No function	This is an unused terminal
0-21V	DC Input	A 0-21V that is factory pre-set for a 0-10V input range but can be trimmed up by the user to the full 0-21V range. Can be mapped to a selected parameter. *(Advanced user facility)*
0V	Zero volts	Common 0V terminal for DC input and Voltage Output.
0V 12V	Voltage Output	A voltage source (12V, 100mA max.) for use with either the 4-20mA input or the DC input. *(Advanced user facility)*
0V 4-20mA	4-20mA Input	Input for an external electronic device with analogue trimming pot. Can be mapped to a selected parameter. *(Advanced user facility)*
T1 +t T2	Thermistor Input	Two-wire input for a PTC motor thermistor. P42 indicates the relative value.
32 34 31	Programmable Output Relay K3	Relay K3 Default function - Alarm Changeover contacts that can be mapped from a selected parameter. *(Advanced user facility)*
42 44 41	Programmable Output Relay K4	Default function - Overload Integrator Changeover contacts that can be mapped from a selected parameter. *(Advanced user facility)*
S2 00	Programmable Input 2	Control Input 2 Can be mapped to a selected parameter. *(Advanced user facility)*
S3 00	Programmable Input 3	Control Input 3 Can be mapped to a selected parameter. *(Advanced user facility)*

2.6   Supply Connections

2.6.1   Electrical Supply

Power terminals 1 L1, 3 L2, 5 L3 on all units may be connected to a balanced 3-phase, 3-wire AC supply that is within the limits specified below.

Phase sequence:

The Xfe will operate with any 3-phase rotation sequence. It is important however, to ensure that the correct connections are made when used with a rotation sensitive load

2.6.2   Motor Connections

The motor connects to terminals **2 T1, 4 T2, 6 T3**. All **Xfe** units will control any standard 3-phase squirrel-cage induction motor capable of operating satisfactorily when connected to the main supply with its normal load coupled.

2.6.3   Control Supply

All units require a separate 2-wire, single-phase supply connected to terminals **X1 and X2**. At the Control Voltage Selector Switch, the user can select either 115V or 230V. The diagrams in section 2.5 show the location of the terminals X1 and X2 for each model of Xfe.

Supply voltage must be in the range 115V (-15%, +10%) or 230V (-15%, +10%).

Note: 1.   The control supply requires external fuse protection.
2.   Ensure that the control Voltage selector switch is set correctly before applying power.

Chassis size	Current rating	Nominal Power Consumption	115V fuse	230V fuse
Size 1	up to 23A	8VA	125mA	63mA
	30A & 44A	10VA	200mA	100mA
	59A to 146A	12VA	200mA	100mA
Size 2	174A to 370A	18VA	200mA	100mA
Size 3	500A to 900A	control card 8VA	125mA	63mA
		separate fan supply 140VA	2A	1A

Xfe
FD842901_X

2.7 Control Card Connections

All the control inputs and outputs are on the Electronic Control Card (ELC), mounted within the unit. Diagrams in section 2.5 show the location of the electronic control card.

2.7.1 Control Inputs

Identification	Description
nc th/sw	Thermal switch input (2 terminals). The internal thermal switch connections to monitor the unit heatsink temperature. *(For use by the manufacturer only.)*
Start/Stop 12/24V DC or 115/230V AC	Programmable Input, Control Input 1. (S1, S0) Application of a voltage between S1 and S0 will either SET (normal logic sense) or CLEAR (inverted logic sense) the parameter mapped to by parameter P65. Removal of this voltage will either CLEAR (normal logic sense) or SET (inverted logic sense) the parameter mapped to by parameter P65 The default setting is P52, Bit 4: Start/Stop, which is active only when the operator selects and enters `REMOTE STARTING` at the keypad. The application of a voltage, as specified, between these terminals, will initiate a START. The removal of this voltage will initiate a STOP.

2.7.2 Auxiliary function Card Inputs - plus models only

Additional inputs available on the Auxiliary Function Card fitted within the unit.

The Auxiliary Function Card mounts within the unit on the Xfeplus.

The diagrams in section 2.5 show the location of the auxiliary function card.

Identification	Description
0-21V with 0V	Programmable Input, DC Input. The voltage applied between 0-21V and the adjacent 0V return connection (common with 0-12V output), maps to the parameter selected by P47. Can be used for monitoring and selecting set points. Input can also be used for the control of static loads. Default setting, 0: no parameter selected.
S2, 00	Programmable Input, Control Input 2. Operation is the same as Control input 1 (S0, S1 on the main control card) Sets or clears the parameter mapped to by parameter P67
S3, 00	Programmable Input, Control Input 3. Operation is the same as Control input 1 (S0, S1 on the main control card) Sets or clears the parameter mapped to by parameter P69 Default setting, None
+t	Thermistor Input (2 terminals). For the connection of a standard PTC motor thermistor to BS4999 or IEC 34-11.
4-20mA, 0V	Programmable Input, 4-20mA Input. The signal maps to the parameter selected by P45. Can be used for monitoring and selecting set points. Input can also be used for the control of static loads. Default setting, 0: no parameter selected.

2.7.3 Control Outputs - All models

Identification	Description
12, 14, 11	Programmable Output, Relay K1. A Bit = 1 on the parameter/bit selected by P57 makes Relay K1 ACTIVE (normal logic sense) or INACTIVE (inverted logic sense). Default setting, P52, Bit 5: Main Contactor Relay change-over contacts: Contact rating:- 230VAC, 3A AC11 11 - Common. 12 - Normally-closed. 14 - Normally-open
22, 24,21	Programmable Output, Relay K2. A Bit = 1 on the parameter/bit selected by P59 makes Relay K2 ACTIVE (normal logic sense) or INACTIVE (inverted logic sense). Default setting, P8, Bit 3: Top of Ramp or Full Volts Relay change-over contacts: Contact rating:- 230VAC, 3A AC11 21 - Common. 22 - Normally-closed. 24 - Normally-open

2.7.4 Auxiliary function card Outputs - plus models only

Additional outputs available on the Auxiliary Function Card fitted within the unit.

The Auxiliary Function Card is fitted within the unit on the Xfeplus.

The diagrams in section 2.5 show the location of the auxiliary function card.

This card cannot be fitted to Xfe100 series 575 Volt and 690 Volt units.

Identification	Description
0V, AN1	Programmable Output, DAC OUTPUT 1. Analogue output. A signal that represents the analogue value of the parameter mapped from P49. Default setting, P26:- Running Current Voltage range: 0V to 10V. Maximum current: 10mA
0V, AN2	Programmable Output, DAC OUTPUT 2. Analogue output. A signal that represents the analogue value of the parameter mapped from P50. Default setting, P22:- Delay Angle Voltage range: 0 - 10V. Maximum current: 10mA
0V, 12V	A voltage source for use with either the 4-20mA or the 0-21V input. Maximum current output: 100mA
32, 34, 31	Programmable Output, Relay K3. A Bit = 1 on the parameter/bit selected by P61 makes Relay K3 ACTIVE (normal logic sense) or INACTIVE (inverted logic sense). Default setting, P9, Bit 0: Alarm Relay change-over contacts: Contact rating:- 230VAC, 3A AC11 31 - Common. 32 - Normally-closed. 34 - Normally-open
42, 44, 41	Programmable Output, Relay K4. A Bit = 1 on the parameter/bit selected by P63 makes Relay K4 ACTIVE (normal logic sense) or INACTIVE (inverted logic sense). Default setting, P9, Bit 1: Overload Integrating Relay change-over contacts: Contact rating:- 230VAC, 3A AC11 41 - Common. 42 - Normally-closed. 44 - Normally-open.

2.9 Unit and Motor Currents/Powers at rated voltages

The Amps values for the soft starter are the maximun continuous current for the model at the stated duty.

The motor ratings are the nearest values for the output powers of standard squirrel-cage motors below the unit current rating of the Xfe.

The currents quoted are for 3-phase, 4-pole motors operating on 50/60Hz supplies. Actual currents of motors may vary by ±10% depending on size and manufacturer. Motors of lower speeds generally draw higher currents for the same rated output. Typically +10% for 6-pole or +20% for 8-pole compared to 4 pole motors.

Motor ratings are in kiloWatts (kW) as defined by the IEC or Horsepower (HP) as defined by the American "National Electrical Code" and are, where possible, normal motor sizes.

2.9.1 Xfe100 series current ratings

Xfe No.	Continuous/Optimising				Externally Bypassed			
	-1	-2	-3	-4	-5	-6	-7	-8
	Class10B AC53a 3.5-12:75-5	Class10 AC53a 3-23:75-5	Class20 AC53a 4-19:75-5	Class30 AC53a 4-29:75-5	Class10B AC53b 3.5-12:708	Class10 AC53b 3-23:697	Class20 AC53b 4-19:701	Class30 AC53b 4-29:691
Xfe102	3A	3A	3A	3A	5A	4A	3A	3A
Xfe104	6A	6A	6A	6A	9A	9A	7A	6A
Xfe106	8A	8A	8A	7A	12A	12A	9A	8A
Xfe108	13A	13A	10A	9A	18A	19A	12A	11A
Xfe110	19A	19A	18A	17A	23A	28A	21A	20A
Xfe112	23A	23A	22A	21A	31A	34A	26A	24A
Xfe114	27A	27A	25A	24A	35A	40A	30A	29A
Xfe116	33A	33A	31A	30A	45A	49A	37A	35A
Xfe118	35A	35A	30A	28A	46A	43A	33A	31A
Xfe120	41A	44A	35A	33A	47A	51A	39A	37A
Xfe122	44A	46A	44A	43A	56A	72A	55A	51A
Xfe124	55A	55A	55A	54A	85A	89A	69A	64A
Xfe126	70A	70A	59A	58A	85A	84A	63A	61A
Xfe128	77A	85A	66A	64A	86A	92A	70A	67A
Xfe130	88A	98A	75A	73A	94A	105A	80A	77A
Xfe132	98A	108A	83A	81A	107A	117A	89A	85A
Xfe134	116A	128A	99A	96A	126A	139A	106A	101A
Xfe136	132A	135A	112A	106A	146A	159A	122A	115A
Xfe138	154A	166A	131A	124A	171A	186A	143A	134A
Xfe140	179A	190A	151A	142A	203A	215A	167A	156A

2.9.2 Xfe200 series current ratings

Xfe No.	Continuous/Optimising				Externally Bypassed			
	-1	-2	-3	-4	-5	-6	-7	-8
	Class10B AC53a 3.5-12:60-3	Class10 AC53a 3-23:60-3	Class20 AC53a 4-19:60-3	Class30 AC53a 4-29:60-3	Class10B AC53b 3.5-12:1188	Class10 AC53b 3-23:1177	Class20 AC53b 4-19:1181	Class30 AC53b 4-29:1171
Xfe202	209A	225A	174A	164A	218A	232A	178A	167A
Xfe204	243A	261A	202A	190A	253A	270A	208A	195A
Xfe206	314A	314A	242A	222A	330A	322A	250A	230A
Xfe208	350A	320A	258A	235A	360A	344A	272A	242A
Xfe210	370A	350A	274A	248A	390A	364A	288A	256A
Xfe212	440A	412A	325A	295A	460A	433A	342A	305A

2.9.3 Xfe300 series current ratings

This chassis size is always built to order and can therefore be made for a specific duty other than the standard ratings. Please contact your supplier for details regarding this Chassis size.

Xfe No.	Continuous/Optimising				Externally Bypassed			
	-1	-2	-3	-4	-5	-6	-7	-8
	Class10B AC53b 3.5-12:60-3	Class10 AC53b 3-23:60-3	Class20 AC53a 4-19:60-3	Class30 AC53a 4-29:60-3	Class10B AC53b 3.5-12:1188	Class10 AC53b 3-23:1177	Class20 AC53b 4-19:1181	Class30 AC53b 4-29:1171
Xfe302	500A	500A	445A	420A	520A	515A	460A	430A
Xfe304	540A	540A	460A	425A	560A	562A	480A	435A
Xfe306	630A	630A	480A	430A	662A	655A	500A	442A
Xfe308	780A	750A	600A	530A	817A	780A	628A	543A
Xfe310	795A	780A	615A	545A	825A	800A	640A	560A
Xfe312	850A	850A	724A	650A	875A	895A	754A	665A
Xfe314	950A	950A	810A	727A	1000A	1000A	842A	744A
Xfe316	1060A	1060A	904A	812A	1100A	1115A	940A	830A
Xfe318	1150A	1150A	980A	880A	1209A	1210A	1020A	900A
Xfe319	1150A	1150A	980A	880A	1209A	1210A	1020A	900A
Xfe320	1320A	1320A	1050A	930A	1360A	1360A	1080A	950A
Xfe322	1400A	1400A	1110A	950A	1400A	1430A	1160A	970A
Xfe324	1550A	1520A	1230A	1050A	1560A	1580A	1280A	1075A
Xfe326	1850A	1750A	1460A	1190A	1998A	1810A	1520A	1225A

2.9.4 IEC Motor Powers & Currents

Rated operational power		Guide numbers of rated operational currents at										
kW [1]	hp [2]	110-120 V	200 V	208 V	230 V	220-240 V	380-415 V	400 V	440-480 V	500 V	550-600 V	690 V
		A	A	A	A	A	A	A	A	A	A	A
0,06	–	–	–	–	0,35	–	–	0,2	–	0,16	–	0,12
0,09	–	–	–	–	0,52	–	–	0,3	–	0,24	–	0,17
0,12	–	–	–	–	0,7	–	–	0,4	–	0,32	–	0,23
0,18	–	–	–	–	1,0	–	–	0,6	–	0,48	–	0,35
0,25	–	–	–	–	1,5	–	–	0,85	–	0,68	–	0,49
0,37	–	–	–	–	1,9	–	–	1,1	–	0,88	–	0,64
–	1/2	4,4	2,5	2,4	–	2,2	1,3	–	1,1	–	0,9	–
0,55	–	–	–	–	2,6	–	–	1,5	–	1,2	–	0.87
–	3/4	6,4	3,7	3,5	–	3,2	1,8	–	1,6	–	1,3	–
–	1	8,4	4,8	4,6	–	4,2	2,3	–	2,1	–	1,7	–
0,75	–	–	–	–	3,3	–	–	1,9	–	1,5	–	1,1
1,1	–	–	–	–	4,7	–	–	2,7	–	2,2	–	1,6
–	1-1/2	12,0	6,9	6,6	–	6,0	3,3	–	3,0	–	2,4	–
–	2	13,6	7,8	7,5	–	6,8	4,3	–	3,4	–	2,7	–
1,5	–	–	–	–	6,3	–	–	3,6	–	2,9	–	2,1
2,2	–	–	–	–	8,5	–	–	4,9	–	3,9	–	2,8
–	3	19,2	11,0	10,6	–	9,6	6,1	–	4,8	–	3,9	–
3,0	–	–	–	–	11,3	–	–	6,5	–	5,2	–	3,8
3,7	–	–	–	–	–	–	–	–	–	–	–	–
–	5	30,4	17,5	16,7	–	15,2	9,7	–	7,6	–	6,1	–
5,5	–	–	–	–	20	–	–	11,5	–	9,2	–	6,7
–	7-1/2	44,0	25,3	24,2	–	22,0	14,0	–	11,0	–	9,0	–
–	10	56,0	32,2	30,8	–	28,0	18,0	–	14,0	–	11,0	–
7,5	–	–	–	–	27	–	–	15,5	–	12,4	–	8,9
11	–	–	–	–	38,0	–	–	22,0	–	17,6	–	12,8
–	15	84	48,3	46,2	–	42,0	27,0	–	21,0	–	17,0	–
–	20	108	62,1	59,4	–	54,0	34,0	–	27,0	–	22,0	–

Rated operational power		Guide numbers of rated operational currents at										
kW [1]	hp [2]	110-120 V	200 V	208 V	230 V	220-240 V	380-415 V	400 V	440-480 V	500 V	550-600 V	690 V
		A	A	A	A	A	A	A	A	A	A	A
15	–	–	–	–	51	–	–	29	–	23	–	17
18,5	–	–	–	–	61	–	–	35	–	28	–	21
–	25	136	78,2	74,8	–	68	44	–	34	–	27	–
22	–	–	–	–	72	–	–	41	–	33	–	24
–	30	160	92	88	–	80	51	–	40	–	32	–
–	40	208	120	114	–	104	66	–	52	–	41	–
30	–	–	–	–	96	–	–	55	–	44	–	32
37	–	–	–	–	115	–	–	66	–	53	–	39
–	50	260	150	143	–	130	83	–	65	–	52	–
–	60	–	177	169	–	154	103	–	77	–	62	–
45	–	–	–	–	140	–	–	80	–	64	–	47
55	–	–	–	–	169	–	–	97	–	78	–	57
–	75	–	221	211	–	192	128	–	96	–	77	–
–	100	–	285	273	–	248	165	–	124	–	99	–
75	–	–	–	–	230	–	–	132	–	106	–	77
90	–	–	–	–	278	–	–	160	–	128	–	93
–	125	–	359	343	–	312	208	–	156	–	125	–
110	–	–	–	–	340	–	–	195	–	156	–	113
–	150	–	414	396	–	360	240	–	180	–	144	–
132	–	–	–	–	400	–	–	230	–	184	–	134
–	200	–	552	528	–	480	320	–	240	–	192	–
150	–	–	–	–	–	–	–	–	–	–	–	–
160	–	–	–	–	487	–	–	280	–	224	–	162
185	–	–	–	–	–	–	–	–	–	–	–	–
–	250	–	–	–	–	604	403	–	302	–	242	–
200	–	–	–	–	609	–	–	350	–	280	–	203
220	–	–	–	–	–	–	–	–	–	–	–	–
–	300	–	–	–	–	722	482	–	361	–	289	–
250	–	–	–	–	768	–	–	438	–	344	–	250
280	–	–	–	–	–	–	–	–	–	–	–	–

Rated operational power		Guide numbers of rated operational currents at										
kW [1]	hp [2]	110-120 V	200 V	208 V	230 V	220-240 V	380-415 V	400 V	440-480 V	500 V	550-600 V	690 V
		A	A	A	A	A	A	A	A	A	A	A
–	350	–	–	–	–	828	560	–	414	–	336	–
–	400	–	–	–	–	954	636	–	474	–	382	–
300	–	–	–	–	–	–	–	–	–	–	–	–
315	–	–	–	–	940	–	–	540	–	432	–	313
–	450	–	–	–	–	1 030	–	–	515	–	412	–
335	–	–	–	–	–	–	–	–	–	–	–	–
355	–	–	–	–	1 061	–	–	610	–	488	–	354
–	500	–	–	–	–	1 180	786	–	590	–	472	–
375	–	–	–	–	–	–	–	–	–	–	–	–
400	–	–	–	–	1 200	–	–	690	–	552	–	400
425	–	–	–	–	–	–	–	–	–	–	–	–
450	–	–	–	–	–	–	–	–	–	–	–	–
475	–	–	–	–	–	–	–	–	–	–	–	–
500	–	–	–	–	1 478	–	–	850	–	680	–	493
530	–	–	–	–	–	–	–	–	–	–	–	–
560	–	–	–	–	1 652	–	–	950	–	760	–	551
600	–	–	–	–	–	–	–	–	–	–	–	–
630	–	–	–	–	1 844	–	–	1 060	–	848	–	615
670	–	–	–	–	–	–	–	–	–	–	–	–
710	–	–	–	–	2 070	–	–	1 190	–	952	–	690
750	–	–	–	–	–	–	–	–	–	–	–	–
800	–	–	–	–	2 340	–	–	1 346	–	1 076	–	780
850	–	–	–	–	–	–	–	–	–	–	–	–
900	–	–	–	–	2 640	–	–	1 518	–	1 214	–	880
950	–	–	–	–	2 910	–	–	1 673	–	1 339	–	970
1 000	–	–	–	–	–	–	–	–	–	–	–	–

2.10 Fusing and Overloads

2.10.1 Short-Circuit Protection

Xfe No.	Short circuit Amp RMS (kA)	Ferraz Fuse	Amps	Xfe No.	Short circuit Amp RMS (kA)	Ferraz or Siba Fuse	Amps
Xfe102	5	6,9 URB 00 D08L 050	50	Xfe202	18	6,9 URD 31 D08A 0450	450
Xfe104	5	6,9 URB 00 D08L 050	50	Xfe204	18	6,9 URD 31 D08A 0630	630
Xfe106	5	6,9 URB 00 D08L 050	50	Xfe206	18	6,9 URD 33 D08A 0700	700
Xfe108	5	6,9 URB 00 D08L 050	50	Xfe208	18	6,9 URD 33 D08A 0900	900
Xfe110	5	6,9 URB 00 D08L 100	100	Xfe210	18	6,9 URD 33 D08A 0900	900
Xfe112	5	6,9 URB 00 D08L 100	100	Xfe212	30	6,9 URD 33 D08A 0900	900
Xfe114	5	6,9 URB 00 D08L 100	100	Xfe302	30	2068132.800	800
Xfe116	5	6,9 URB 00 D08L 125	125	Xfe304	30	2067132.1000	1000
Xfe118	5	6,9 URB 00 D08L 125	125	Xfe306	42	2067132.1000	1000
Xfe120	5	6,9 URB 00 D08L 125	125	Xfe308	42	2068132.1250	1250
Xfe122	10	6,9 URD 31 D08A 0250	250	Xfe310			
Xfe124	10	6,9 URD 31 D08A 0250	250	Xfe312	85	2068132.1400	1400
Xfe126	10	6,9 URD 31 D08A 0250	250	Xfe314	85	2068132.1400	1400
Xfe128	10	6,9 URD 31 D08A 0250	250	Xfe316	85	2068132.1400	1400
Xfe130	10	6,9 URD 31 D08A 0250	250	Xfe318	85	2068132.1400	1400
Xfe132	10	6,9 URD 31 D08A 0315	315	Xfe319			
Xfe134	10	6,9 URD 31 D08A 0315	315	Xfe320	85	2 x 2067132.1000	2000
Xfe136	10	6,9 URD 31 D08A 0315	315	Xfe322	85	2 x 2067132.1250	2500
Xfe138	10	6,9 URD 31 D08A 0400	400	Xfe324	100	2 x 2067132.2000	4000
Xfe140	18	6,9 URD 31 D08A 0450	450	Xfe326	100	2 x 2067132.2000	4000

These fuses are for short circuit protection of the semiconductors and must be mounted externally by the user between the unit and the mains supply.

Suitable for use on a circuit capable of delivering not more than the RMS Symmetrical Amperes indicated in Table 2.10.1 at maximum rated operational voltage, when protected by Semiconductor Fuse type, Manufactured by Company and Mod. No. indicated in Table 2.10.1 Fuse rated 700 Vac, Amps as indicated in Table 2.10.1.

It is the responsibility of the installer and system designer/specifier to ensure that the required standards or regulations are not affected by so doing.

2.10.2 External Fuse Requirements

The rating of HRC fuses for motor protection needs to be carefully analysed when using a Soft Starter due to the longer start times which are involved. When high inertia loads (e.g. fans) are being started, special consideration should be given to fuse ratings due to the extended ramping times. Most fuse manufacturers have an "extended start" or "dual element" range of fuses intended for this type of application.

For semiconductor protection fusing, refer to the table in section 2.10.1 above.

2.10.3 Overload Current Profile and Duty Cycle AC-53a & AC53b

IEC 60947-4-2 Motor Utilisation Category: AC-53a (not operating in bypass mode)

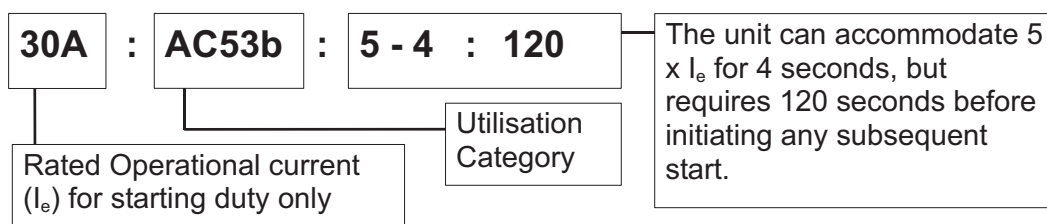IEC 947-4-2 Motor Utilisation Category: AC-53b (operating in bypass mode)

Xfe138	Start Class	Maximum Motor FLC	IEC Utilisation Category	Motor Overload Class	Maximum unit current x Motor FLC	Start Time	Starts per Hr	Duty Ratio (AC53a) Bypased + Off Time (AC53b)
1	10B	154A	AC53a	10A	3.5	12	5	75%
2	10	166A	AC53a	10	3	23	5	75%
3	20	131A	AC53a	20	4	19	5	75%
4	30	124A	AC53a	30	4	29	5	75%
5	10B	171A	AC53b	10A	3.5	12	5	708S
6	10	186A	AC53b	10	3	23	5	697S
7	20	143A	AC53b	20	4	19	5	701S
8	30	134A	AC53b	30	4	29	5	691S

Xfe210	Start Class	Maximum Motor FLC	IEC Utilisation Category	Motor Overload Class	Maximum unit current x Motor FLC	Start Time	Starts per Hr	Duty Ratio (AC53a) Bypased + Off Time (AC53b)
1	10B	370A	AC53a	10A	3.5	12	3	60%
2	10	350A	AC53a	10	3	23	3	60%
3	20	247A	AC53a	20	4	19	3	60%
4	30	248A	AC53a	30	4	29	3	60%
5	10B	390A	AC53b	10A	3.5	12	3	1188S
6	10	364A	AC53b	10	3	23	3	1177S
7	20	288A	AC53b	20	4	19	3	1181S
8	30	256A	AC53b	30	4	29	3	1171S

EXAMPLE IEC RATING INDEX

30A : **AC53a** : **3 - 35 : 99 - 10**

Utilisation Category

Rated Operational current (I_e)

For a 99% on-load factor, and 10 standard operating cycles per hour, the unit can accommodate 3 x I_e for 35 seconds.

EXAMPLE IEC RATING INDEX

30A : **AC53b** : **5 - 4 : 120**

Utilisation Category

Rated Operational current (I_e) for starting duty only

The unit can accommodate 5 x I_e for 4 seconds, but requires 120 seconds before initiating any subsequent start.
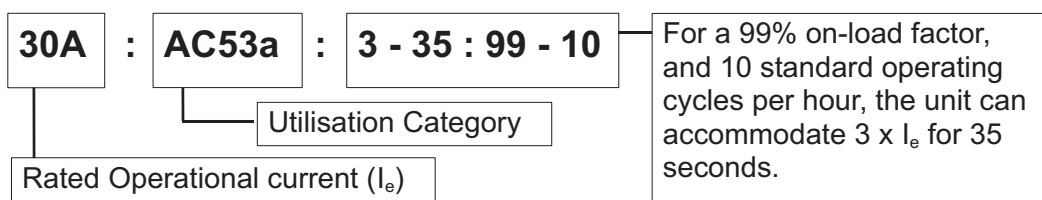
2.10.4 Overcurrent Trip Graph

'Current limit' and 'Overload level' settings are adjustable. The Xfe monitors current in one phase only and this limits overload currents in accordance with the trip curves shown here (See Menu structure for default settings).

Parameter P106 may be changed to select Class 10B, 10, 20 or 30. This will automatically change the motor current rating (Trip level) of the unit to maintain over current protection.

Note: The overload monitors one of the phases only and the 'Current Limit' level is only active during motor starting.

IMPORTANT

It is recommended that the control supply is maintained between starts to ensure the integrity of the overload, which will reset on it's removal.

Cooling

The Xfe is designed so that the rated start current/time is close to the maximum allowed. If the start duty is exceeded the unit will trip. All Xfe Soft Starts have a forced off cooling time between starts.

In line with the stated IEC starting duties, all Xfe 100 series have an enforced off period of 2 minutes, likewise all Xfe 200 and Xfe 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates **"Stopped.Cooling"**, and the Xfe will not respond to a start signal.

AC53a ratings are for Optimising or use without a bypass contactor.
AC53b rating is only for use with a bypass contactor and will trip if one is not used
Trip curves show the nominal times for operation from cold (40°C)

2.11 Trips and Faults

2.11.1 Trip and fault code table

Fault Code	Explanation
1 Phase Loss	Input side phase loss at the ramp start, during the ramp or during normal running.
2 Too Hot	The heatsink is above the maximum allowed temperature or i/p open circuit.
3 Comms	There have been a number of serial communication errors but communications are still active.
4 SCR Firing	Short circuit thyristor during normal running.
5 SCR Signal	Short circuit thyristor or Motor side phase loss during the ramp during normal running.
6 SCR Signal	Input side phase loss during normal running. Short circuit thyristor or motor side phase loss during the ramp or during normal running.
7 Sensing Signal	Short circuit thyristor, external noise or motor side phase loss during the ramp or during normal running.
8 Motor, SCR Los	Short circuit thyristor or motor side phase loss at the start of the ramp.
9 Sensing Signal	Short circuit thyristor or external noise during the ramp or during normal running.
10 SCR Shorted	Short circuit thyristor or motor side phase loss during the ramp.
11 Low Current	Current has fallen below the **under-current** level. Only active during during normal running
12 C/L Time Out	Current limit during the ramp has exceeded the current limit **time-out** period.
13 Overload	Current has exceeded the **overload level**. Active at all stages of operation.
14 Shearpin	Current has exceeded the **shearpin** current level. Only active during normal running
15 Thermistor	Thermistor Input is open circuit or thermistor resistance has exceeded it's trip point.
16 User	A trip input from the **user** to the soft starter.
17 Comms Timeout	Serial communications have been lost.
18 Bypass failed	Bypass contactor failed to close on AC53b unit.
Stopped. Cooling	Displayed during the period for which the soft starter will not restart to allow heatsink cooling.

Items in **bold** text are user adjustable

X FE Soft Starters and Energy Optimising Soft Starters

Umotor

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Applications
for the X FE and X FEplus   FD843001-X

Contents

3.1   Motor Suitability and Associated Considerations

The Xfe soft-starter is based on the "Fairford System" of microprocessor-based optimising soft-starters which have been used world-wide in more than 100,000 critical and non-critical systems. Since 1983, Fairford System soft-starters have successfully operated with almost every type of load and environment from the Antarctic to the Jungle. The design has proven to be both reliable and adaptable, and provides a powerful mechanism with which to control fixed-speed induction motors. However, due to the intrinsic differences between electronic and electro-mechanical starting systems, there are a number of simple rules and observations to follow when using the Xfe soft-starter. This section introduces guidelines for the user and those incorporating the unit as part of their system design.

3.1.1   Suitability

In principle, any induction motor can be started by a soft-starter. Normally, the breakaway torque of the load should be less than the full-load torque of the motor, unless a motor with a high locked rotor torque characteristic is employed. As a quick assessment, any load which has a low or no-load start with a moderate starting time, or which can be started with a star-delta starter, auto transformer or other forms of reduced-voltage starting, can be considered to be a potential application for a soft-starter.

3.1.2   Induction Motor Characteristics

Induction motors are required to provide sufficient torque to accelerate the motor and its load from standstill to full speed and to maintain full speed efficiently at all torque levels up to the design full load torque. Most modern induction motors have characteristics that are wholly suitable for use with soft starters, however, the characteristics vary considerably between different manufacturers and design types. It is important that the motor is capable of providing sufficient torque to drive the load at all speeds between standstill and rated speed, to enable the Xfe to function properly. It is particularly important that the motor to be soft started does not have a low pull-up or saddle torque otherwise the load may not be accelerated correctly.

The primary function of the soft-starter is to act as a torque-regulating device. It cannot apply a torque greater than that which the motor generates. For this reason, problematic applications for which many different starting methods have been tried but failed, may need analysis of the motor or load performance before a soft-start can be successfully applied.

3.1.3   Rating

For most applications, except high inertia loads, the starting demands and the inertia of the rotating masses are small enough to be insignificant. This means that no special consideration needs to be given to the rating of the soft-starter, other than to ensure that it is equal or marginally greater than the rated voltage and current of the controlled motor.

Alternatively, if the number of poles of the motor and the moments of inertia of the load (Jload) and motor rotor (Jmotor) are known, a soft-starter will be suitable if the figures comply with the criteria given in the bottom row of following table.

Number of Poles	2	4	6	8
Synchronous speed (rpm)	3000	1500	1000	750
(J_{load}) / (J_{motor}) less than	5	15	20	25

Table 3.1.3

Section 3.2.13 contains a table showing the more common applications.

3.1.4 Maximum Motor Cable Length

The length of the cable between the output terminals of the starter and the motor should not normally be greater than 100 metres.

3.1.5 Power Factor Correction Capacitors

Power factor correction capacitors applied to a single motor MUST always be connected by a separate contactor placed on the SUPPLY side of the Xfe soft-start. Capacitors should be switched in after top-of-ramp (full line voltage) is reached and switched out of circuit before a stop is initiated.

It is important that any total system PFC scheme that automatically corrects for a range of inductive loads is not operated in such a way as to leave it heavily over compensated since this might introduce oscillations leading to damaging over-voltages.

3.1.6 Lightly Loaded, Small Motors

Lightly loaded, small-sized (less than 2kW), star connected motors can produce high voltages at the motor terminals when shut down by simply opening the line contactor. As these voltages can damage the soft-starter, it is safer to control the opening of the line contactor with the soft start run relay contacts.

3.1.7 Motors Fitted with Integral Brakes

Motors that include an integral, electrically operated brake, internally connected to the motor input terminals, can only be soft-started when the brake is re-connected to the supply through its own contactor.

3.1.8 Older Motors

The action of the fully-controlled soft-starter introduces harmonic currents and voltages to the motor. It is therefore, important to ensure that the motor employs techniques such as rotor skewing in its construction to suppress the effects of harmonic fluxes and avoid rough starting. This is rarely a problem with modern motors because nearly all motors designed in the last 20 years employ these techniques.

3.1.9 Wound-rotor or Slip-ring Motors

Slip-ring induction motors ALWAYS need some resistance in the rotor circuit to ensure that sufficient rotational torque is generated to overcome any alignment torque, which is present at start-up. The resistance can be safely shorted out in the normal fashion with a contactor controlled by the programmable relay set as 'top-of-ramp' contacts.

3.1.10 Enclosures

Thyristors are not perfect conductors, and the passage of current through them causes heat dissipation in the body of the device, which in turn causes the heatsink temperature to increase. As a rough guide, the heat generated is 1 watt/amp/phase, which equates to a dissipation of 30 watts from the heatsink for a line current of 10 amps. Therefore, all cabinets or enclosures that house soft-starters should have adequate ventilation. (Refer to the Mechanical installation procedures, section 1.6 to 1.8 for more detailed information.)

3.1.11 Efficiency

Although the use of the soft-start introduces a power loss, the system still retains an overall efficiency of approx. 99.5%. If the optimising function is selected, then the gain in motor efficiency at part loads is far greater than the loss of efficiency arising from thyristor heat losses. If prolonged operation at full load is expected, the thyristor loss can be eliminated (as in some matched motor/pump drives) by closing a bypass contactor around the soft-starter. (This contactor is readily controlled by the programmable relay set as 'top-of-ramp' contacts as the circuit in section 2.4.1 shows.)

3.1.12   High-Efficiency Motors

Due to an inherently steep front to the speed/torque curve, high efficiency motors can exhibit instability when lightly loaded and the optimising rate parameter P19 may need adjusting to compensate.

3.1.13   EU Compliance with the EMC Directive

When considering the use or fitting of any Soft Starter, users and installers in European countries must comply with the EMC Directive 89/336/EEC. The manufacturer of the soft-starter has a statutory obligation to provide a guide for compliance with this directive.

For the Xfe, this guidance is given in the EMC guide which is section 4 of this manual. It is essential that users and installers understand and comply with the requirements described in these sections.

3.1.14   Fuses

Circuit protection fuses should be rated at twice the motor rated current for normal low-inertia applications. See also section 3.2.2 relating to high inertia loads.

Semiconductor fuses are available for the short circuit protection of the thyristors in the Xfe. See section 2.10 of the Electrical Installation manual for Semiconductor fuse recommendations and details of the Overload incorporated into the Xfe.

3.2 Rules for Specific Applications

3.2.1 In-Delta Operation

The Xfe control system allows the soft-start to be installed "in the delta" connections of the motor, which can permit the use of a lower current rated unit. However, in this mode of operation, it is important that the soft start is connected in accordance with the relevant wiring diagram. The connection diagram in figure 2.3.2 of the Electrical Installation manual gives detailed instruction for this configuration. If motor rotation is incorrect, the connections should be changed as detailed in fig 2.3.2. It should be noted that six connections are required between the motor and soft-start. Parameter P6 must be set to 1 for delta mode which also disables the optimising.

3.2.2 High Inertia Loads

High inertia loads such as centrifugal and axial fans, grinders, flywheel presses, etc., may require a larger size of soft-start than the motor. For example, a 75kW starter may be needed for a 55kW motor. This is necessary due to the extra heat produced by the thyristors due to the extended start times and/or higher over-currents. If very high inertia loads are involved, then an analysis of the starting characteristics should be made. This will require accurate data about the motor speed-torque and speed-current characteristics as well as the load characteristics. For further information, consult your supplier.

Consideration must also be given to thermal overload and fuse protection systems when extended start times are involved. This must be as for heavy duty starting, as a standard thermal overload will trip under these conditions. A heavy-duty start thermal overload or an electronic overload with dual settings for start and run is recommended. Modern HRC motor fuses will allow for some overload during the start, but the fuse curve, giving time/current data, will give an indication of suitability for the particular application.

3.2.3 Phase Control Operation

Certain applications such as voltage regulators, transformers, heaters, lighting banks require the load to be controlled manually or from a 4 to 20mA input. The Xfe soft-starter is designed to work with these applications. (Please refer to your supplier for further information.)

3.2.4 Resistive Loads

Many resistive loads can be controlled using the "phase angle control" feature of the Xfe. Some resistive loads may require different forms of control such as burst-firing, for which the Xfe soft starter is not designed. (Please refer to your supplier for further information.)

3.2.5 Frequent Starting

High starting frequencies require careful consideration of the soft-start thermal capabilities. In many cases a standard sized Xfe may be suitable as start times are generally shorter for this type of application. If this is not the case then a larger soft-start may be required. (Please refer to your supplier for further information.)

3.2.6 Optimising

Drives which operate for long periods of time at less than 35% of their rated capacity can benefit from the energy saving function (optimising) of the Xfe which will adjust the thyristor triggering to reduce the excitation losses of the motor. This will lower the running temperature of the machine and help to extend it's life.

3.2.7 Soft-Stopping

Soft-stopping can reduce positive surge pressures in pipelines on shutdown. It is necessary to make sure that the ramp-down time is long enough to remove the energy from the fluid before the firing of the thyristors is stopped, otherwise the surge pressure may still be present. Soft-stopping can also be successfully applied to loads such as conveyer belt systems where sensitive items such as bottles are being transported.

3.2.8 Reversing Drives and Plug-braking

Xfe soft-starters used in conjunction with contactor controlled reversing and plug-braked motors show considerable benefits to the user by reducing mechanical and electrical stresses, particularly when utilising the current limited start feature. It is required, with this type of application, to insert a 150 to 350 millisecond delay between the opening of one contactor and the closing of the other, to allow any residual flux in the rotor to die away. When plug-braking, there should be some form of zero-speed detection to stop the drive after braking has been completed, otherwise the drive may either accelerate the motor in the reverse direction or switch off before zero speed has been reached. The Xfe has a dual parameter setting feature which is particularly useful in plug-braking where the braking settings need to be different from the normal starting ramp time and current limit level. See section 2.4.4 and figure 2.4.6 of the Electrical Installation manual for details.

3.2.9 Replacement of Fluid Couplings

Soft-starters can replace fluid couplings yielding benefits of higher efficiency running and lower costs to the user. If the coupling is used to magnify the available breakaway torque, it may be necessary to replace the fitted motor with another of a larger size or one with a high starting torque characteristic before a soft-start can be employed.

3.2.10 Two-speed Motor Applications

Two speed motors, whether Dahlander connected or with dual windings, can be soft started at each speed, provided that the start is initiated when the actual motor speed is less than the synchronous speed for the winding selected. This is particularly important when changing from high to low speeds. Of particular benefit in the Xfe is the dual setting feature, which allows different operating settings for the high and low speeds and the ability to switch rapidly between them.

3.2.11 Multiple Motor Starting

See section 2.4.2 of the Electrical Installation manual for details.

3.2.12 Overhauling Loads

Certain applications can over-speed the motor as part of normal operation. Power flow is then from the motor to the supply. It is important that the optimising is disabled during the over-speed condition and reinserted during normal conditions.

3.2.13 Application Table

The table on the following page shows many common motor applications that suit the Xfe soft-starter. It lists typical breakaway torque requirements as a percentage of motor full-load torque (FLT). For the most satisfactory soft-start in a given application, the motor should have a full-voltage locked-rotor-torque (LRT) that is at least twice the breakaway torque. (E.g. For a reciprocating compressor the FLT is normally in the region of 50% motor LRT.) As a general rule, the higher the motor LRT is above the load breakaway torque, the greater the control over the starting process.

Application	Breakaway Torque (%FLT)	Remarks
Agitator	35	
Air compressor- rotary, unloaded start	25 - 35	
Air compressor- reciprocating, unloaded start	50 - 100	
Air compressor- screw type, unloaded start	30	Usually two-pole motor
Ball mill	30 - 50	Eccentric load, needs high starting torque motor
Carding machine	100	Often high inertia
Centrifuge	50 - 90	Usually high inertia
Centrifugal fan- dampers closed	10 - 25	Usually high inertia
Centrifugal fan- dampers open	10 - 25	Usually high inertia, very long ramp times
Centrifugal blower- valve closed	25 - 35	
Centrifugal blower- valve open	30 - 40	Can have long ramp time
Chillers	10 - 25	Usually started unloaded, two-pole motor
Conveyor- horizontal, unloaded	10 - 50	
Conveyor- horizontal, loaded	100 - 150	
Conveyor- vertical lifting, unloaded	50 - 85	
Conveyor- vertical lifting, loaded	100 - 175	
Conveyor- vertical lowering, unloaded	10 - 40	
Conveyor- vertical lowering, loaded	10 - 25	
Crusher (not rock)- unloaded	25 - 75	Can be high inertia
Drilling machine- unloaded	10	
Escalator- unloaded	25 - 50	Optimising feature can be effective
Fan, axial-flow propeller	20 - 40	
Feeder- screw	100 - 175	Needs high starting torque motor
Feeder- vibrating, motor driven	100 - 150	Needs high starting torque motor
Grinder- unloaded	10 - 25	Usually high inertia
Hammer mill	20 - 125	Eccentric load, needs high starting torque motor
Mills- flour etc.	30 - 50	
Mixer- dry contents	35 - 75	
Mixer- fluid contents	10 - 40	
Mixer- plastic contents	75 - 125	High torque motor offers advantage
Mixer- powder contents	75 - 125	High torque motor offers advantage
Pelletisers	50 - 100	
Press, flywheel	50 - 150	Needs high starting torque motor
Pump- centrifugal	10 - 25	Soft stopping useful
Pump- positive displacement, piston type	100 - 175	Needs high starting torque motor
Pump- vane type, positive displacement	100 - 150	Needs high starting torque motor
Rolling mill	30 - 50	
Saw, band	10 - 35	
Saw, circular	25 - 50	May be high inertia. Plug brake may be useful
Screen, vibrating	30 - 60	
Travelators, walkways	25	Unloaded starting
Transformers, voltage regulators	Nil	Change firing mode
Tumblers	30 - 100	Can be eccentric load, may need high torque motor

Table 3.2.13 Applications

3.3 Concepts and principles of fixed-speed induction motor starting and control.

Since it's invention one hundred years ago, the standard 3-phase induction motor has become one of the most familiar items of industrial equipment ever known. Due to it's simplicity of construction, low cost, reliability and relatively high efficiency, it is likely to remain the prime source of mechanical energy for the foreseeable future.

3.3.1 Introduction

Energy conversion, from the electrical supply to rotating mechanical energy, is a characteristic of all motors. To regulate energy flow, most motor circuits require a mechanism to connect and disconnect them from their electrical power source; electro-mechanical switches, known as 'Contactors', are the standard means of achieving this control. Even today, more than one hundred years after their introduction, contactor-based systems remain the most widely used method of motor control.

Nevertheless, there is a definite trend towards more sophisticated electronic systems of control being applied to fixed-speed motor drives. This section will discuss these newest forms of control - namely, electronic, microprocessor-controlled, optimising soft-starters such as the Xfe.

Note: Since there is a wealth of detailed literature available in the technical press, it is not proposed to dwell too heavily on the specifics of realising the electronic control system, but rather, to offer an outline of its various capabilities.

3.3.2 The Induction Motor

In order to appreciate the benefits of using an electronic controller, it is important to have some understanding of the characteristics and limitations of the induction motor and the electro-mechanical systems currently used to control them.

The standard, fixed-speed induction motor fulfils two basic requirements:

To accelerate itself and its load to full speed (or speeds with multi-speed motors)

To maintain the load at full speed efficiently and effectively over the full range of loadings.

Due to the constraints of materials and design, it can be difficult to achieve both objectives effectively and economically in one machine.

So, how does a motor start in the first place? As mentioned earlier, motors convert electrical energy drawn from the power supply into a mechanical form, usually as a shaft rotating at a speed fixed by the frequency of the supply. The power available from the shaft is equal to the torque (moment) multiplied by the shaft speed (rpm). From an initial value at standstill, the torque alters, up or down, as the machine accelerates, reaching a peak at about two-thirds full speed, finally to become zero at synchronous speed. This characteristic means that induction motors always run at slightly less than synchronous speed in order to develop power - the 'slip speed' and, hence the term asynchronous. The following graph is of an induction motor torque/speed curve and illustrates this most important characteristic.
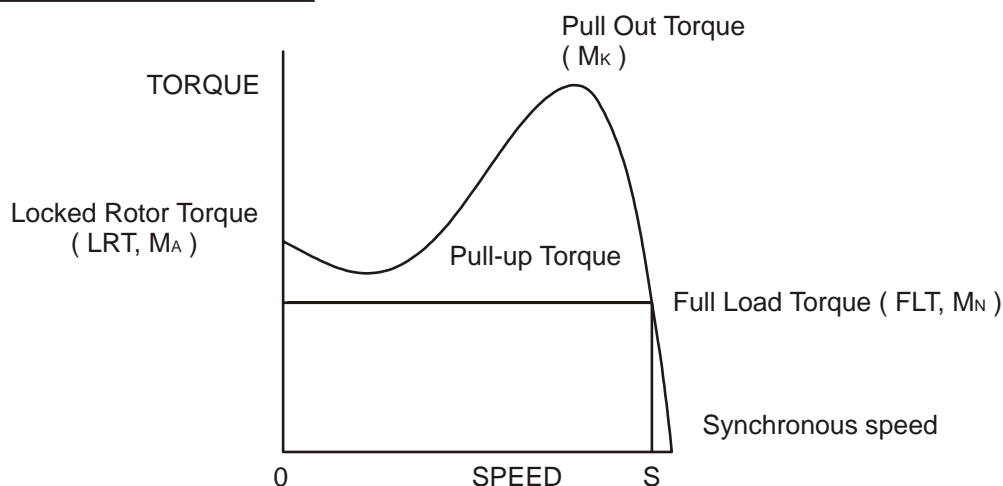
Figure 3.3.2.1 Torque/Speed Curve - Induction Motor

As for each type of motor, so each load coupled to an induction motor has its own speed/torque curve:
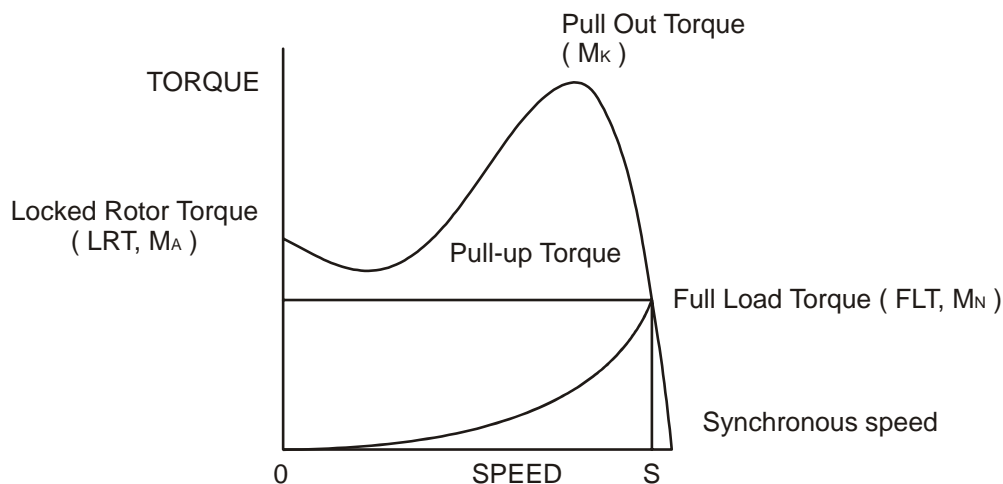

Figure 3.3.2.2 Torque/Speed Curve - Coupled Load

The acceleration of a motor-load system is caused by the difference between the developed torque (motor) and the absorbed torque (load) and is shown by the shaded area in the next figure:
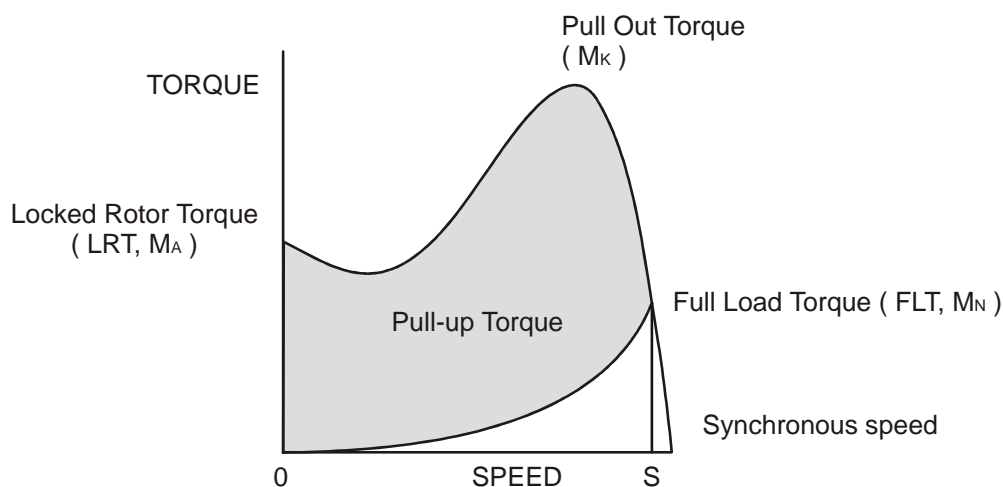

Figure 3.3.2.3 Torque/Speed Curve - Accelerating Torque

Obviously, the larger the difference, the faster the acceleration and the quicker full speed is reached - and, coincidentally, the greater the stresses experienced by the supply and drive systems during the acceleration process. An "ideal" start would accelerate the load with just sufficient force to reach full speed smoothly in a reasonable time, and with minimum stress to the supply and drive mechanisms.

Broadly speaking, the motor speed/torque characteristic is controlled by the rotor resistance - a motor with high rotor resistance can generate it's peak torque (pull-out torque) at standstill giving the high break-away torque characteristic, which reduces steadily as the speed increases and becoming zero at synchronous speed. At the other end of the scale, a motor with a very low rotor resistance will produce a low starting torque but will generate its peak torque closer to the synchronous speed. Consequently this type of motor runs at full power with higher operating efficiency and low slip speed. It is possible to combine the twin requirements of high starting torque and efficient full-speed operation within a single motor by techniques such as double-cage or deep bar design, and this, usually, is the motor characteristic chosen for lifting and hoisting applications:
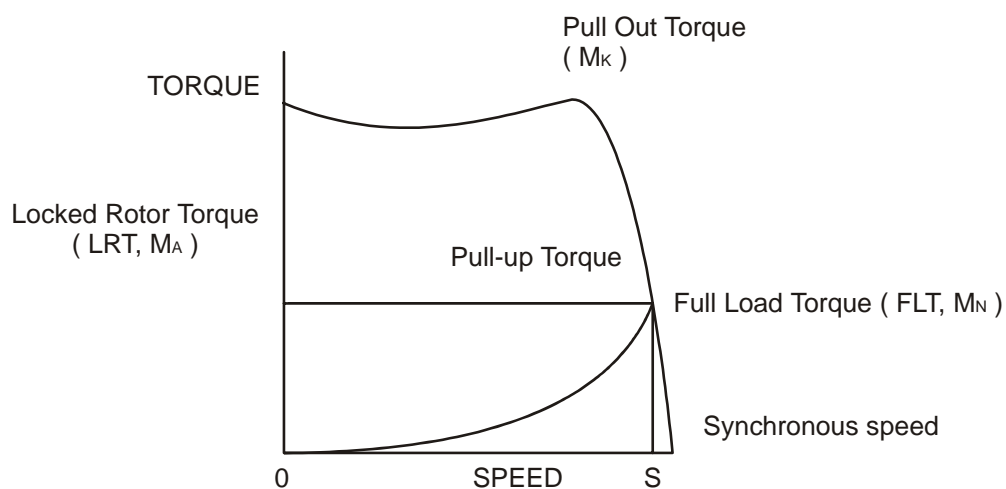

Figure 3.3.2.4 Torque/Speed Curve - High Starting Torque

However, most induction motors are designed to have a "standard" characteristic that provides a compromise between starting torque and operating efficiency. To summarise, an induction motor will only start and accelerate when it produces more torque than the connected load absorbs. This is true for all speeds - including standstill and full speed.

3.3.3   Starting Induction Motors

Starting a de-magnetised induction motor from standstill is a demanding and complex process. At the instant of switching all the energy necessary to magnetise the motor, to provide the acceleration force, and to supply the kinetic energy of the rotor and load, must be present together with the energy to overcome the mechanical and electrical losses. To do so at full supply voltage places considerable stresses on the supply, the motor windings, and the iron cores of the stator and rotor. Excessive acceleration of a rotor when the mechanical load is small can produce torque oscillations in the shaft causing severe wear to transmissions, gears and drives. Excessive acceleration when the load inertia is high such as in centrifugal fans, causes belts to slip in the pulleys, producing rapid wear and early failure.

3.3.4 Electro-Mechanical Methods Of Starting

Method A: Direct-on-Line

The most simple means of controlling energy flow to an induction motor is to interrupt the power supply by a single, solenoid operated, 3-phase switch, known as a contactor. Very widely applied, the method is known variously as "direct-on-line", "across-the-line", "direct" etc., and is the usual form of control where low cost is the first, and most important consideration. As a result, it is most often used on small motor sizes (up to approx. - 22kW), or where the supply is strong enough to withstand the inrush and starting current surges without causing unacceptable voltage drops.

The harsh, damaging effects described earlier are all imposed by direct-on-line starting and, as a control method, it is the most destructive of equipment. Its simplicity and apparent low cost, although attractive at first sight, hide large cost penalties in the shape of increased maintenance, reduced transmission equipment life and higher risk of motor failure, particularly when frequent starting and stopping is needed. In larger sized motors special strengthening is necessary, at higher cost, before they can be safely used with direct-on-line starting.

However, the shortcomings of the direct-on-line starter have been recognised ever since motors have been used and alternative systems have been developed over the years to reduce the damaging effects of this form of control.

Method B: Star-Delta and other Reduced Voltage Starting Systems

Reduced voltage starting makes use of the fact that motor torque is proportional to the square of the terminal voltage; the most familiar type of reduced-voltage starter is the star-delta starter.

Consisting of three contactors and a time switch (which can be mechanical, pneumatic, electrical or electronic), the star-delta starter changes the motor winding configuration from an initial star connection to a delta as the motor accelerates. The change-over or transition point is controlled by the time switch and is usually arranged to be approximately at 80% of full speed. The effect of starting in star is to alter the voltage across each stator winding to 58% of normal. This reduces the starting torque to a third of locked rotor torque (LRT) with a consequent reduction in starting currents and acceleration forces.

Although an apparent improvement over the direct system, significant disadvantages still remain. The transfer from star to delta momentarily removes the motor from the supply. During this time the motor is under the mechanical influence of the rotating load and, at the instant of disconnection, current will still flow in the rotor bars due to the time delay necessary for the magnetic flux to die away. Therefore, there is a residual flux "frozen" on the surface of the rotating rotor, which cuts the stator windings, generating a voltage whose frequency depends on the rotor speed. If the load inertia is small, such as in a pump, or if the friction is high, there could be a significant loss of speed during the time the supply is disconnected.

In this case, when the reconnection to delta is made, a large phase differential can exist between the supply and the rotor fluxes. This can give rise to very large current surges (as much or more than full-voltage locked rotor current), together with massive transient torque oscillations, which can peak at levels in the region of fifteen-times full-load torque. Although the effects described are only present for a very short period of time (about one fifth of a second), they are sources of great stress and damage to the whole drive system, and where frequent starting is necessary, invoke high maintenance costs. The current surges, in the form of a very high level short duration "spikes", are an increasing problem in these days of computer control systems and other "sensitive" electronic equipment. The voltage disturbance on the supply is very difficult to filter out and can cause severe problems, especially when larger motors are involved.

There are methods of control, for example, the Wauchope starter, which eliminate or reduce the reconnection transients. However, such starters are expensive and have reliability implications; for these reasons they are not widely applied.

The star-delta starter also has disadvantages due to the restricted starting torque available (if you need 40% LRT to break-away, you can only increase the motor size, or revert to direct-on-line). Combined with the severe effects of the re-switching surges, and the additional costs of bringing six conductors from the motor to the starter instead of only three, star-delta only offers an imperfect solution to the problem of starting the induction motor.

Method C: Primary Resistance Starter

It has long been recognised that the transition step in the star-delta system was a source of problems such as welded contactors, sheared drive shafts etc., and for many years a method of stepless control has been available in the form of the primary resistance starter.

This type of controller inserts a resistance in one, or more often in each, of the phase connections to the stator at start-up, after which it is progressively reduced and shorted out at the end of the acceleration process. Frequently, the resistances are movable blades that are gradually inserted into an electrolyte liquid. The mechanism is usually large and expensive, both to purchase and to maintain, and considerable heat is created by the passage of current through the electrolyte resistor. This limits the starting frequency (because the electrolyte has to condense back to liquid before a new start can proceed), and these restrictions prevent this starter from being a popular option when selecting a control system. However, it has the distinction of being the smoothest and least stressful method of accelerating an induction motor and its load.

Method D: Other Electro-Mechanical Systems

Other control methods such as auto-transformer starting (popular in North America), primary reactance starting etc., are employed to a greater or lesser extent, to compensate for some of the disadvantages of each type of starter discussed. Nevertheless, the fundamental problems of electro-mechanical starters remain, and it is only in the last decade or two that their dominance has been challenged by the introduction of power semiconductors controlled by electronics.

3.3.5 The Semiconductor Motor Controller

During the 1950's, much effort was put into the development of a four-layer transistor device which had the power to switch large currents at high voltages when triggered by a very small pulse of current. This device became known as the silicon controlled rectifier (SCR), or in Europe, the 'Thyristor'; it is the basis on which all soft starting systems are built. The characteristic of most interest is the ability of the thyristor to switch rapidly (in about 5 millionths of a second) from "OFF" to "ON" when pulsed, and to remain "ON" until the current through the device falls to zero, - which conveniently, happens at the end of each half-cycle in alternating current supplies.

By controlling the switch-on point of a thyristor relative to the voltage zero crossing in each half wave of an alternating current, it is possible to regulate the energy passing through the device. The closer the turn-on point is to the voltage zero crossing point, the longer the energy is allowed to flow during the half-cycle. Conversely, delaying the turn-on point reduces the time for the energy to flow. Putting two thyristors back-to-back (or anti-parallel) in each of the phase connections to a motor, and by precisely controlling their turn-on points, an electronic soft starter continuously adjusts the passage of energy from the supply so that it is just sufficient for the motor to perform satisfactorily.

So, for instance, by starting with a large delay to the turn on point in each half cycle, and progressively reducing it over a selected time period, the voltage applied to the motor starts from a relatively low value and increases to full voltage. Due to the motor torque being proportional to the square of the applied voltage, the starting torque follows the same pattern giving the characteristic smooth, stepless start of the soft-starter.

3.3.6 Running Induction Motors

Once a start has been completed the motor operating efficiency becomes of interest. When working at or near full load, the typical 3-phase induction motor is relatively efficient, readily achieving efficiencies of 85% to 95%. However, as shown below, motor efficiency falls dramatically when the load falls to less than 50% of rated output.
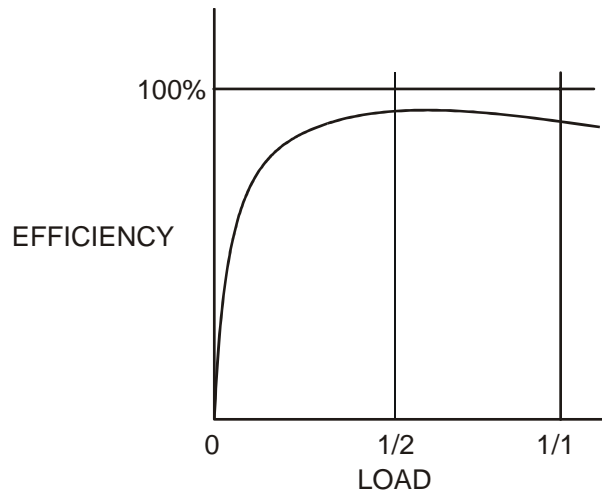

Figure 3.3.6.1 Motor Efficiency/Load Characteristic

In fact, very few motors actually experience consistent fully rated operation, the vast majority operate at much lower loads due to either over-sizing (a very frequent situation), or natural load variations. For Fan and Pumping applications, the affinity laws will allow the inverter drive to show very considerable energy savings over virtually all other methods of control through varying the speed of the motor in response to changes in load. Where motor speeds cannot be varied, an optimising version of semiconductor motor controller, such as the Xfe will also produce energy savings in lightly loaded motors. Less sophisticated systems of soft-starter remain at full conduction and the motor then behaves as if it were connected directly to the mains supply. However, at light loads and mains voltages, induction motors always have excess magnetic flux, and efficiency loss and power factor degradation result. By detecting the load at any instant, and adjusting the motor terminal voltage accordingly, it is possible to save some of the excitation energy and load loss, and improve motor power factor when the motor is running inefficiently at light loads.
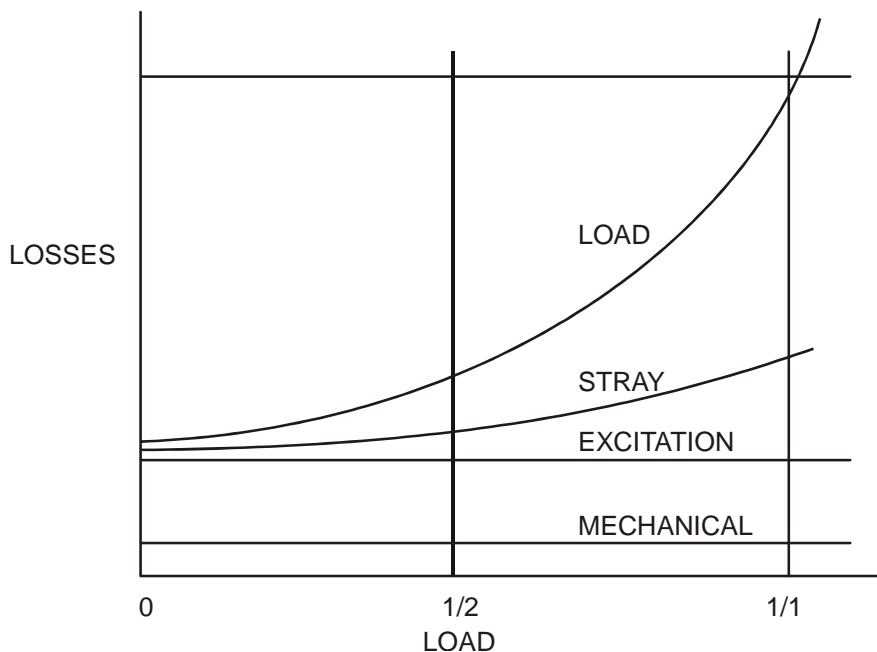

Figure 3.3.6.2 Motor Efficiency/Loss Characteristic

All Xfe soft-starters are microprocessor controlled, and this gives them a number of advantages. Firstly, there are no adjustments to be made for the energy saving function: all calculations necessary to find the best degree of phase-back of the thyristors for any load condition is made by the microprocessor. Secondly, the start always synchronises with the supply voltage and a special structure of turn-on pulses virtually eliminates the inrush currents normally associated with motor start-up; this happens every time. Lastly, there is the absolutely stepless starting process, found only with the primary resistance or reactance electro-mechanical starters - but without the wasted energy, and with the opportunity to control the maximum current allowed to flow during the starting process. Other features such as soft stopping are included to give considerable control over all modes of induction motor operation.

3.3.7 Reliability Considerations

An aspect of electronic controllers for induction motors which is of increasing concern is that of reliability. There is little point in installing an expensive item of electronic equipment to save potentially considerable amounts of money if the device is unreliable to the point that vital processes are constantly interrupted.

There are electronic products in the market place which appear to offer soft starting cheaply. They almost always rely on less advantageous technologies such as analogue control, or half-control, where one of the two thyristors in each phase is replaced with a diode. There are systems which only control the energy flow in one phase while the other two are directly connected. Owing to the variable quality and performance of many so-called inverters and soft-starters available to the unsuspecting purchaser, international standards for these products have been developed.

So far, IEC 60947-4-2 - 'AC Semiconductor Motor Controllers and Starters' defines the soft-starter in every important respect, including thermal and overload performance as well as electromagnetic compatibility. By ensuring that any motor controller equipment purchased conforms to IEC 60947-4-2, a user should be reasonably safeguarded from shoddy or inadequate products when specifying equipment for future installations.

A particular advantage of the use of the optimising soft starter is its impact on the maintenance requirements of associated electro-mechanical equipment. Optimising lowers the surface temperature of the motor by reducing the losses within the motor. This prolongs the motor life - and reduces heating of the surrounding atmosphere in the process. If the atmosphere is subject to air conditioning, reducing the heat input will reduce the air conditioning costs. Reduced starting and running currents reduces cable losses and, contactor switching operations are carried out under the most advantageous conditions. No current flows on switch-on since all switching is carried out by the thyristors - virtually eliminating the need for contact replacement.

Indeed, there are a growing number of installations where contactors are no longer employed, being replaced by controllable circuit breakers or isolators instead.

In summary, electronic controllers for most fixed-speed applications are opening new ways of increasing the efficient operation of induction motors, as well as offering significant benefits in control. Intending users need to ensure themselves of the quality and performance of any products they expect to fit and this can be reasonably expected if compliance with the appropriate IEC standards is demanded.

3.4 Principles of the Optimising Mode

3.4.1 Principles

Every wound-field electric motor must consume some minimum amount of energy to provide a magnetic field which enables it to work at all. With DC motors the field is under separate control, so that the amount of magnetising energy can be adjusted to be sufficient to overcome losses and provide an armature reaction appropriate to the load. The squirrel cage AC induction motor has no such provision, with the result that at any load less than it's rated full load (at full speed), energy is wasted. When a squirrel-cage motor is supplied at a constant terminal voltage, as when it is connected directly to the supply without a controller of any kind, the strength of the field flux is fixed by the supply voltage. At normal running speed the field will take a fixed quantity of energy regardless of the torque demanded by the mechanical load. The energy required to support the load torque is determined by the torque demand. As load torque increases, the rotor slows down a little (ie 'slip' increases), causing the induced rotor currents to increase also, and so to increase the torque. These additional currents in the rotor are balanced by additional current in the stator coils. Conversely, if load torque demand falls, the slip decreases, the rotor currents decrease, and the current in the stator decreases accordingly. But at constant terminal voltage, the current, and therefore the energy, providing the stator field flux remains unchanged at any level of load torque demand. As a consequence, the efficiency of an induction motor falls as the load falls.

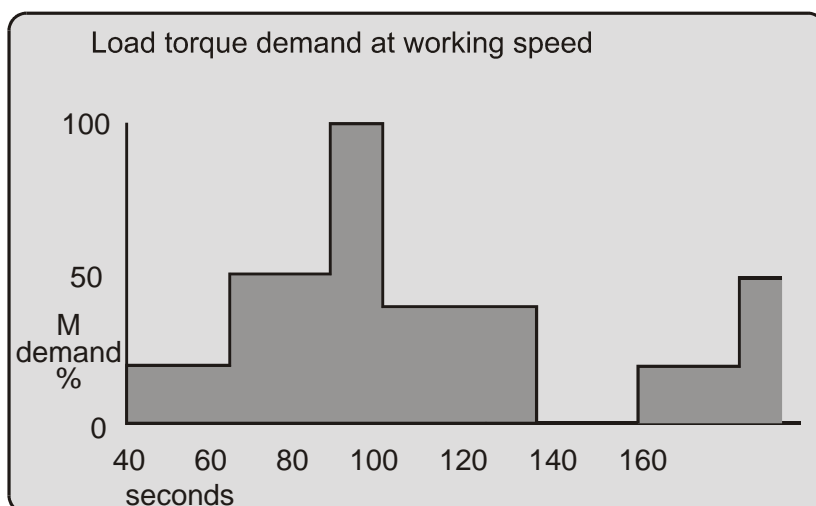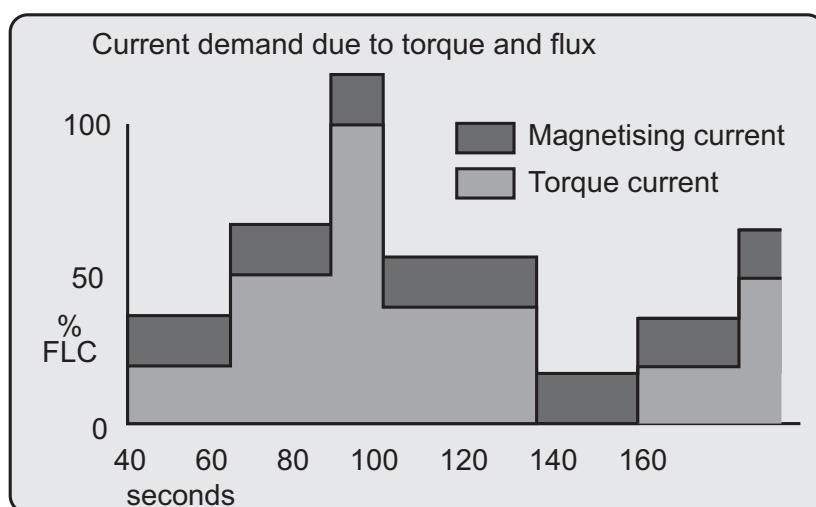Fig. 3.4.1.1 shows a typical duty cycle for a machine load, where the torque demand varies.

Load torque demand at working speed

Fig 3.4.1.2 shows the torque demand converted to an equivalent current with the motor magnetising current added

Current demand due to torque and flux

3.4.2   Advantages of Energy Optimising

A soft starter with an energy-optimising feature alters the motor operation. The energy-optimising function reduces the terminal voltage applied to the motor so that the energy needed to supply the field is more-closely proportioned to the torque demand. The effect is shown in the Figure below.

The present considerations do not affect soft starting options or strategies. When the motor terminal voltage is at its 'nominal' or rated value and when the load is the maximum for which the motor is rated, the operating point of the motor on the current curve is at point A.
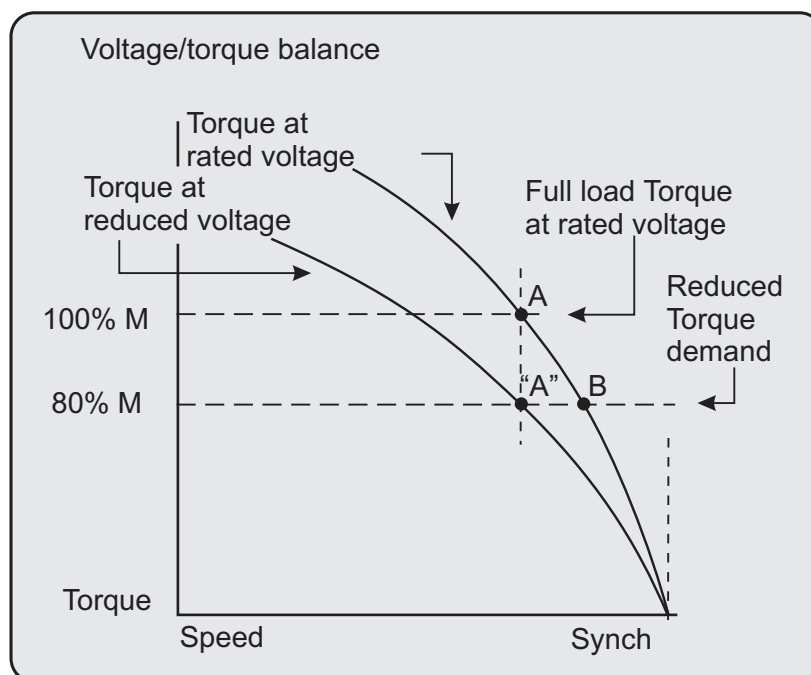
Fig. 3.4.2.1 'full speed' end of the conventional torque/current curves.

If the load falls, a motor supplied at a fixed voltage will speed up slightly, the current demand will reduce, and the operating point moves along the curve to point "B". Because the torque developed by a motor is proportional to the square of the applied voltage, lowering the terminal voltage reduces the torque. If the reduced voltage is correctly chosen, the working point at the reduced torque demand becomes the point "A". By reducing the terminal voltage, the motor has in effect been 'changed' for one which has a lower rated power output. A reduced terminal voltage also means a reduced field energy requirement and this simple relationship enables the optimising function to maintain the efficiency of the motor over nearly the whole of the load range from 'no load' upwards. In practical terms, 'no load' means no external load. There are the internal mechanical and electrical losses to be overcome - friction and windage of the rotor at speed, and the electrical heating and hysteresis losses. The ideal response to the 'no load' condition would be to supply precisely the amount of magnetising current needed to provide the armature reaction to balance the losses. This is what the energy-optimising feature of a soft starter seeks to do, continuously and automatically.

3.4.3   Additional Benefits in Practice

It is usual to select a standard motor with a rating somewhat higher than the maximum demand of the driven load. The motor selected for any given application will almost certainly be over-rated for this reason alone and therefore, when supplied at rated voltage, energy could be saved even at full load. Furthermore, there are those applications where the size of motor has to be chosen to provide for high loadings, which occur only intermittently or for an arduous start, although the load demand at other times is much less.

3.4.4   **Optimising with the Xfe**

During start-up, the Xfe software computes and stores, by a patented method, a reference value for the power factor. When the motor has reached full speed and is driving the load at the torque demanded, it enters the 'motor running' stage. At this stage, if required, the motor may also operate in 'Optimising Mode'. Entering this mode can be pre-set from the Xfe keypad and stored for automatic operation, which will suit the majority of applications where it is required. This is the default operating mode for the Xfe. It can also be toggled on and off whilst running by using either the OPTIMISE button on the keypad or, with the Xfeplus version, through external circuitry connected to one of the programmable inputs and controlled by the driven process.

In this mode the reference power factor is continuously compared with the running power factor. From the comparison, the software continuously computes and adjusts the firing point of the thyristors so that the best power factor is maintained. This method of continuous control minimises the energy wastage caused by overfluxing the motor. It also maintains the power factor at the most appropriate value for every condition of load demand. This can effect a significant reduction in the kVA demand.

This is an operating condition that may, at light or partial load conditions, provide the benefit of energy saving and if selected, is continuous from the dwell period until a STOP command is initiated or the mode is disabled. It should be noted that this function is inhibited by the software if the current being drawn by the motor exceeds 80% of the set current of the Xfe. At full volts, when the motor enters it's running stage, with the optimising mode selected,

The method of power factor management described does not affect motor performance, neither does it detract from the motor's capability to respond to changes in load demand. This feature of the Xfe soft-starter is a purely electrical function which has the effect of ensuring that, at all times, the motor delivers the torque demanded, but allows it to draw only the precise amount of magnetising current required to support that torque output. Without this feature, the motor would draw the maximum magnetising current regardless of load.

The optimising function cannot improve the power factor beyond what it would ordinarily be at full load, but it does make the optimum improvement possible at any part-load.

3.4.5   How Much Energy?

The amount of energy used by a squirrel cage induction motor operating with a soft starter in energy-optimising mode is shown in the following Figure, for the same duty cycle as Fig. 3.4.1.2. By reducing the voltage when torque demand is below maximum, the magnetising current is proportioned to the torque current.

Compare Fig. 3.4.5.1, energy-optimising, with Fig. 3.4.1.2, non-optimising. (These graphical representations are illustrative only and not to scale.) To arrive at any exact figure for the energy saved requires each individual case to be examined in detail, taking into account the motor rating, type, and any special characteristics, Load, load characteristics, duty cycle, supply voltage, supply authority tariffs and the user's particular terms.

Fig 3.4.5.1 Energy savings
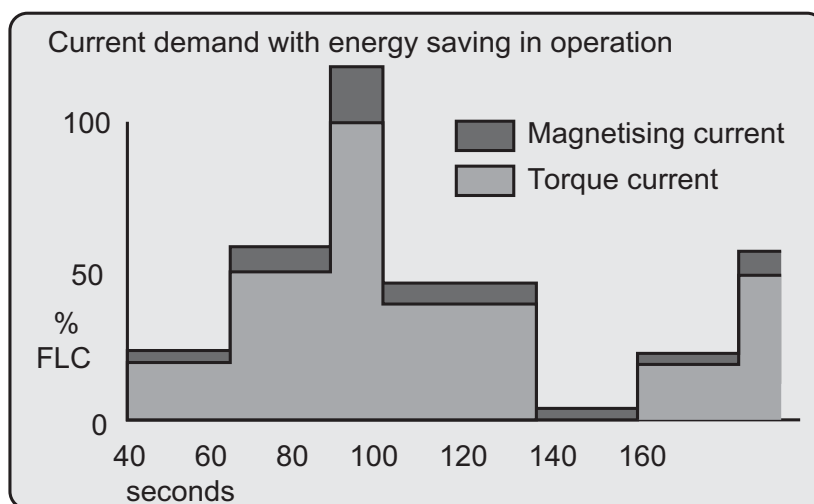
The calculations to cover all the likely or possible conditions would be laborious. An empirical method for arriving at a usefully realistic estimate has been devised by Fairford Electronics Ltd. Used with a proper sense of engineering circumspection, the following tables allow a user to gain a reasonably close estimate of the saving to be achieved within the motor by using The Xfe optimising soft starter. The method does not include any additional savings and benefits conferred by other sources, such as -

Reduction of *heating losses* in cabling because of the lower voltages;

Potential reduction of *maximum demand* charges;

Further energy saving and other benefits deriving from the soft starting process itself

Reduced *total energy-demand,*

reduced *wear and tear,*

reduced *maintenance* and *replacement* costs.

3.4.6   Estimating Energy Savings

Basis for estimation

3-phase squirrel cage induction motor, standard type.

Supply: 380 to 440V, 50Hz.

Supply voltage >min. working voltage on motor rating plate.

Operation 30% rated nameplate full load.

Motor size			Estimated savings % rated kW
	KW	HP	
Less than	5	7.5	10
	22.5	30	6.5
	55	75	3.5
	110	150	2.5
More than	110	150	1.5

Table 3.4.6.1 Estimations

Motor poles		% slip	
Poles	Add - % kW	% slip	Add - % kW
2	-0.5	0.5	-0.5
4	0	2	0
6	0.5	3.3	0.5
8	1	5	1

Table 3.4.6.2 Modifying factors

Examples of estimated saving

1   A 37.5 kW 4-pole motor

   From Table 1, use the estimated saving figure for the next higher rating, ie 55 kW.

The saving would be, approximately   3.5% x 37.5 kW = 1.3125 kW

2   A 37.5 kW 2-pole motor

From Table 1, use the estimated saving figure for the next higher rating, ie 55 kW.

From Table 2, apply the pole-number factor of -0.5 %.

The saving would be, approximately   (3.5 % - 0.5 %) x 37.5 kW = 1.125 kW

3   A 37.5 kW 2-pole 'low slip' motor

From Table 1, use the estimated saving figure for the next higher rating, ie 55 kW.

From Table 2, apply the pole-number factor of -0.5 % and the %-slip factor of-0.5%.

The saving would be, approximately   (3.5 % - 0.5 % - 0.5 %) x 37.5 kW = 0.938 kW

Appendix A: Glossary of Terms

Breakaway Torque — The minimum torque required to achieve rotor movement for the motor with its load.

Current Limit — The current at which the ramp is held. For the Xfe, current limit is only active during start-up where it contributes to the motor control function. This feature is particularly useful when starting high-inertia loads that require an extended start-up period. (See also Overload Level.)

Direct-On-Line (DOL) — The direct connection and disconnection of a motor from the AC mains supply by means of a contactor or switch. Acceleration and operation is at full mains voltage only.

Inrush Current or Locked Rotor Current
The current that flows at the instant of connection of a motor to the power source. It is limited by the impedance presented by a de-energised motor and the applied voltage. Usually expressed as a multiple of motor full-load current.

Kick-start — Kick-start voltage is the percentage of supply voltage applied before commencing ramp-up when a load has a high breakaway torque and the standard settings of pedestal voltage may not allow sufficient torque to be developed by the motor to cause acceleration.

Overload Level — The level of current at which the controller overload begins to integrate. For the Xfe, the overload detector is always active and provides protection against prolonged over-current operation.

Pedestal Voltage — The voltage that the unit applies to the motor at start-up. It is expressed as a percentage of the rated supply voltage.

Power Factor — The ratio, expressed as a trigonometric cosine, of the real power consumption to the apparent power consumption.

Top of Ramp (TOR) — The unit achieves Top of Ramp (TOR) when it completes the start-up stage of motor control. This occurs when the voltage applied to the motor first equals the mains supply voltage.)

Soft-start — Soft-start is the regulation by electronic means, of the supply voltage from an initial low value to full voltage during the starting process. This over-comes the inherent drawbacks of a switched supply. The motor torque is modified in proportion to the square of the voltage applied.

Trip — A trip occurs when the unit removes power to the motor because its operation equals the limit imposed by one of its self-protection features.
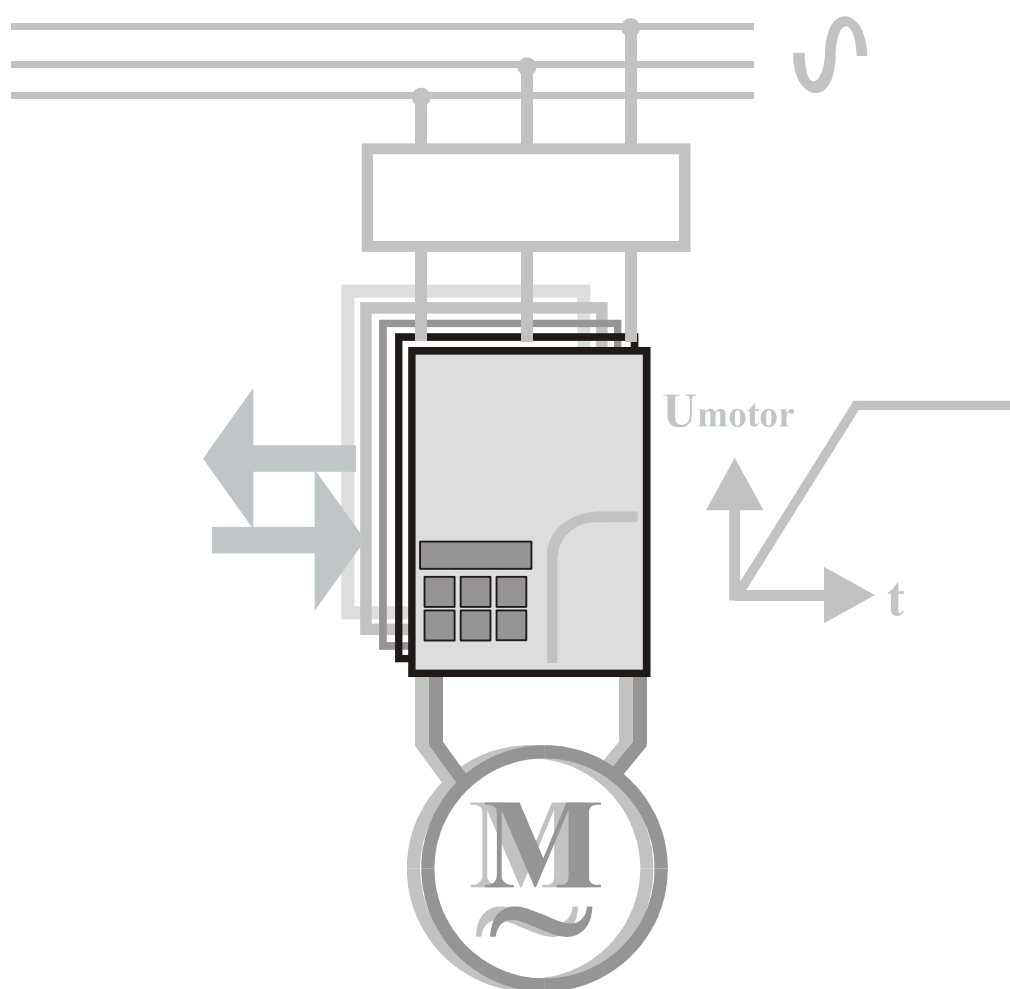
Appendix B: Power Factor Conversion Chart

Real PF (Parameter 39) is displayed in degrees.

The table below can be used to convert this value (θ, in degrees) to the power factor ($\cos \theta$).

Degrees	Power Factor	Degrees	Power Factor	Degrees	Power Factor
0	1.00	30	0.87	60	0.50
1	1.00	31	0.86	61	0.48
2	1.00	32	0.85	62	0.47
3	1.00	33	0.84	63	0.45
4	1.00	34	0.83	64	0.44
5	1.00	35	0.82	65	0.42
6	0.99	36	0.81	66	0.41
7	0.99	37	0.80	67	0.39
8	0.99	38	0.79	68	0.37
9	0.99	39	0.78	69	0.36
10	0.98	40	0.77	70	0.34
11	0.98	41	0.75	71	0.33
12	0.98	42	0.74	72	0.31
13	0.97	43	0.73	73	0.29
14	0.97	44	0.72	74	0.28
15	0.97	45	0.71	75	0.26
16	0.96	46	0.69	76	0.24
17	0.96	47	0.68	77	0.22
18	0.95	48	0.67	78	0.21
19	0.95	49	0.66	79	0.19
20	0.94	50	0.64	80	0.17
21	0.93	51	0.63	81	0.16
22	0.93	52	0.62	82	0.14
23	0.92	53	0.60	83	0.12
24	0.91	54	0.59	84	0.10
25	0.91	55	0.57	85	0.09
26	0.90	56	0.56	86	0.07
27	0.89	57	0.54	87	0.05
28	0.88	58	0.53	88	0.03
29	0.87	59	0.52	89	0.02

X FE Soft Starters and Energy Optimising Soft Starters

Electro-Magnetic Compatability
for the X FE and X FE plus

FD843101-X

4 Electro-Magnetic Compatibility (EMC)

As supplied, all Xfe and Xfeplus units meet the standards of emission and immunity levels defined in the IEC 60947-4-2 and EN 60947-4-2 product standards for AC Semiconductor Motor Controllers and Starters. However, the emc performance of the controller can be significantly affected by the manner in which it is incorporated into the system in which it is intended to operate. To prevent inadvertent degradation of emc performance, attention must be given to motor cable lengths, wiring configurations, the nature of the power supply, etc., at the design, construction and implementation stages of a project.

4.1 Introduction

It is widely accepted that electromagnetic compatibility between electronic and electrical products is a desirable objective. Technical standards are increasingly stipulating levels of EMC performance which compliant products are required to meet. The decision by the European Union (EU) to implement a community-wide directive covering EMC caused considerable activity amongst electrical and electronic equipment manufacturers and suppliers to identify, understand and mitigate the sources of electromagnetic interference within their products and systems.

4.2 Applicable Standard within the EU

The product standard which defines EMC performance for soft-starters is IEC 60947-4-2 'AC Semiconductor Motor Controllers and Starters'. (The Official Journal of the EC will list this standard as EN 60947-4-2.) The Xfe has been type tested in accordance with the test procedures and levels laid down in the product standard.

4.3 Mandatory Requirements within the EU

(Applicable to any person involved in the installation and operation of the equipment.)

The EU Directive 89/336/EEC, describes the required EMC, performance of all electrical equipment which is to be connected to a low voltage supply network. It imposes an obligation on the manufacturer of the soft-starter to provide sufficient information for installers, system integrators, users and anyone else connected with the installation and operation of the equipment. This section provides the technical information to support the obligation of the manufacturer.

From the manufacturer the provision and maintenance of compatibility extends to the panel-builder, assembler, system integrator, and ultimately, to the installer and user. Anyone involved in the installation and operation of the equipment, through a lack of knowledge, misdirection or for other reasons, can completely negate the initial EMC performance of the equipment.

4.4 Guidance for Installation Personnel and System Designers

For safety reasons, all Xfe products are intended to be installed and set to work by skilled personnel who are capable of interpreting and following EMC guidelines correctly. Any person not fully trained in the appropriate technology should not attempt the installation.

If you do not understand, or if you are unclear about any part of these guidelines, then please consult your supplier. Often, consultation with the supplier can avoid unnecessary problems in specifying and installing the correct combination of equipment.

4.5   EMC - Basic Criteria

The electromagnetic compatibility of a product is defined by two criteria:

1   Immunity to electromagnetic disturbances generated externally to the product

2   The type and amount of conducted and radiated electromagnetic emissions emanating from the product.

Ascertaining the nature of the power supply is of primary consideration when deciding on appropriate EMC requirements. The requirements for equipment installed in heavy industrial environments (fed from their own isolated low voltage power supply) differ from those installed in residential, commercial, light industry and health-care applications (directly connected to a public low-voltage network).

Generally, industrial installations require higher immunity levels and permit higher levels of conducted and radiated emissions than those for non-industrial installations. On the other hand, lower levels of emissions output, and lower immunity levels, are specified for installations connected directly to the public low-voltage network.

4.6   Purchasing Implications of Meeting an EMC Standard

Before purchasing components for the installation, the specifier must evaluate the expected source of power for the Soft Starter and understand exactly the implications for meeting EMC requirements. It is likely that failure to do so will result in the purchase and installation of inappropriate equipment. Close consultation with your supplier will avoid these unnecessary problems, particularly when you do not understand, or are unclear about any part of the guidelines given later in this section.

If you have any doubt, please ask.

IMPORTANT:

The information and guidance given in section 4.7 forms part of the statutory requirements of the European Union Directive 89/336/EEC on EMC.

4.7   Basic EMC Considerations

4.7.1   Immunity

The product standard for immunity requirements is EN 60947-4-2:1996. All Xfe soft-starter products meet, or exceed the industrial level immunity requirements laid down in this standard.

4.7.2   Emissions

Emissions are classified as low frequency, (below 9kHz), known as harmonics, and high or radio frequency, (above 9kHz). Both radio-frequency emissions and low frequency harmonics are generated by the action of the Xfe soft-starter.

4.7.3   Emissions - Harmonics

Harmonics arise from the intentional delay relative to the voltage wave zero, in the turn-on of the semiconductor switches in order to vary the voltage at the motor terminals. This introduces supply discontinuities and so generates harmonics. However, the configuration of the Xfe soft-starter power circuits as a fully-controlled regulator (W3C), and the mode of pulsing used results in minimised harmonic effects. This means that only non-triplen, (integer multiples of the third harmonic), odd harmonic frequencies are created, starting with, and diminishing rapidly from the fifth harmonic, and virtually disappearing by the nineteenth harmonic.

Note The generic limits for harmonics for soft-starters which operate with a power level greater than 1kW are under consideration. Until these have been defined, harmonic filters are not required for any Xfe soft-starter.

4.7.4 Emissions - Radio Frequency (RF)

Radio frequency emissions are propagated in two ways:

Conduction along the leads supplying the soft-starter.

Radiation from the operating equipment.

They also have two sources:

Source 1: The high frequency currents associated with the control electronics (this includes the microprocessor)

Source 2: The action of the semiconductor devices forming the power switching elements located in the controller main circuits.

The radiation measurements made from operating versions of Xfe soft-starters show levels lower than the allowed limits. Further, enclosures (or cubicles) of metallic construction provide additional shielding for Xfe soft-starters mounted within them. The only radiated interference effect that might arise from a soft-starter would be if mobile telephones, walkie-talkies etc. were to be used in very close proximity to a unit which was operating with the enclosure door open. For this reason, any enclosure must display a label that brings the possibility of electromagnetic interference to the attention of the operator under these circumstances.

4.7.5 Emissions - Conducted

Conducted emissions are able to travel great distances and may cause interference to any neighbouring consumers connected to the common low-voltage supply network.

Allowable levels for conducted emissions generated by semiconductor motor controllers and starters are influenced by the nature of the low-voltage power distribution network. The determining factor is whether the source of power is,

either(a)   A private supply with a single consumer whose Point of Common Coupling (PCC) is at a high or medium voltage transformer.

or,   (b)   A public low-voltage network with more than one consumer, where the individual PCC is made directly to the network itself.

The first type of supply is identified as "Industrial" and requires the use of soft-starters compliant with EN 60947-4-2 Table 14: 'Equipment Class A Emission Levels'.

The second type of supply is identified as "Residential" and requires the use of Equipment Class B Apparatus. Xfe soft-starters are able to comply with either classification provided the appropriate action is taken. (Section 4.7.7 describes the strategies for attaining and maintaining compliance.)

4.7.6 Important Systems Information:

The specification limits for both equipment classes assume systems are earthed at the star-point of the supply transformer through low impedance connections.

Certain industries, particularly continuous process industries, employ distribution systems that operate either with an earth through a high impedance or without an earth at all. These systems may cause severe problems of operator safety when fitted with capacitive high frequency filters -such systems are not considered in this document.

In the case of an isolated or high impedance earthed system, seek advice from your supplier before fitting a capacitive high frequency filter to a Xfe soft-starter. It is essential that the specifying authority, user or installer has a clear knowledge of the type of network to which the product is to be fitted before making decisions as to which EMC strategy to adopt.

As supplied, all Xfe products comply with the conducted emissions requirements for Equipment class A soft starters as defined by EN 60947-4-2:1996 Table 14. However, the length and type of cable connecting the motor to the starter module materially affects the level of emissions generated, and can amplify them greatly. The standard also allows different levels of emissions depending on motor rated current, which also affects the need to fit filters. The EN 60947-4-2:1996 standard only requires consideration of steady-state conditions for EMC purposes and

expressly excludes varying conditions such as those during ramp-up and ramp-down. Therefore, closing a bypass contactor around the module during the run condition will remove the need for any high frequency filters. However, some of the features (protection, optimising etc.), which are active during the run state, are disabled when the bypass contactor is closed. Users need to assess the cost and merit of fitting a bypass contactor compared with the cost of a filter when it is required.

Finally, statistics show that the number of disturbances arising from soft-starters, operating in a very wide variety of applications and networks throughout the world, is insignificant. Where EMC disturbances occur, it is very unlikely that they can be genuinely attributed to a soft-starter.

4.7.7 Strategies in Attaining and Maintaining EMC Compliance

Where possible, minimise the effect of electrical interference by incorporating the strategies listed below.

• Locate the Xfe soft-starter unit as close as reasonably possible to the motor terminal box in order to minimise cable length.

• Ensure that, within any enclosure, the control wiring does not run parallel to the power wiring. Where this is unavoidable, then maintain a 100 mm separation between control cables and power cables.

• Where possible, ensure that the control wiring crosses at right-angles to the power wiring; this reduces the cross-coupling between cables.

• Screen any cables carrying sensitive signals. The digital control inputs to a Xfe are opto-isolated and do not normally require buffering (e.g. through a small relay) or screening.

Compliance in residential environments (Equipment class B) can be achieved by one of two methods:

a) Bypassing the soft-starter with an AC1 rated contactor controlled by the programmable relay set to the 'top-of-ramp'. (The ramp-up and ramp-down features remain effective in this configuration)

b) By running the soft starter in phase loss only mode.

Where a special purpose system filter has been applied at the point of common coupling, additional filtering of individual drives is not necessary and may introduce undesirable effects due to resonance.
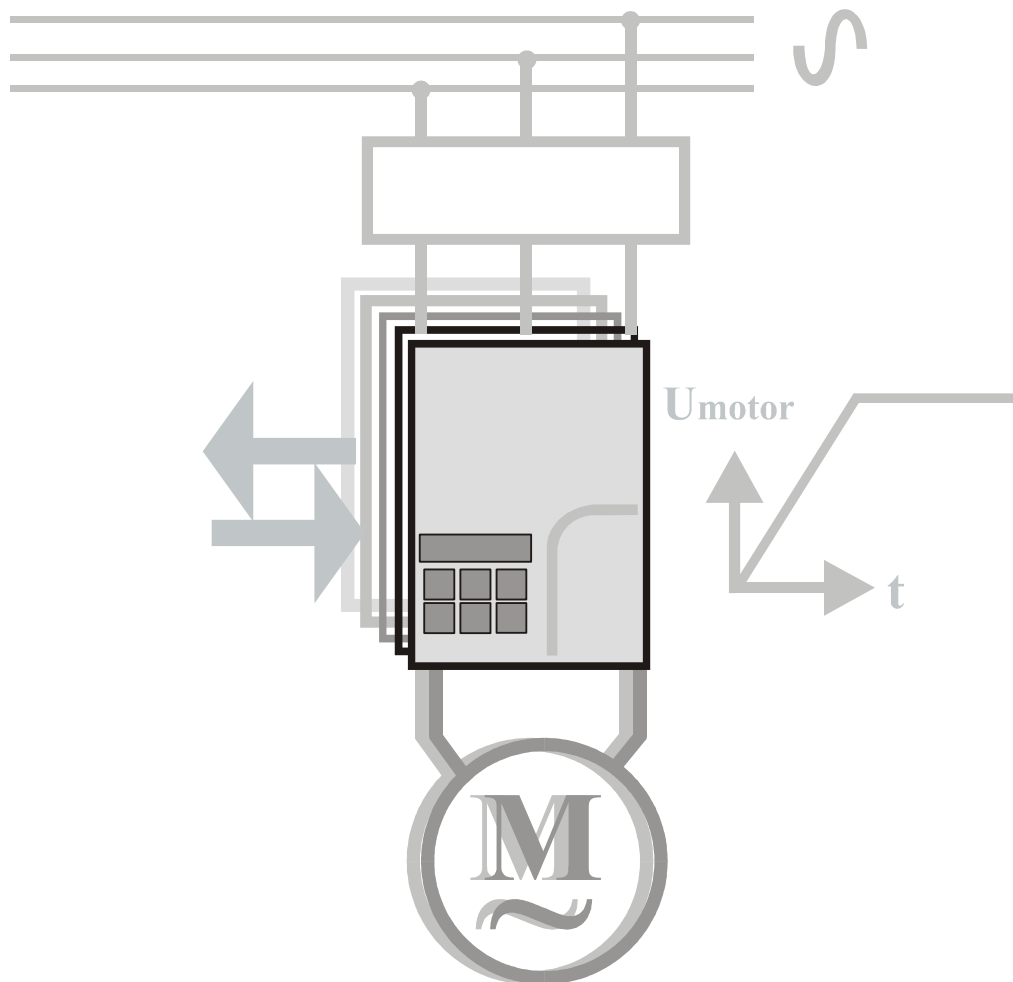
For the purposes of EMC, the connections between the Xfe controller and motor are considered to be an extension of the enclosure and preferably should be contained within earthed metallic trucking or conduit. Armoured cable, providing it is correctly terminated, may be used although the EMC performance will be slightly inferior. Screened cable is not necessary.

An alternative method of achieving the residential environment EMC requirements is to insert a special purpose filter designed for use with variable-frequency drives. Care must be taken to ensure that the short-term current rating of the filter will allow for the starting currents experienced. If this method is adopted, it is essential that the motor/controller connections are kept within 10 metres.

All associated electrical and electronic equipment near to the controller complies with the emission and immunity requirements of the EMC Directive.

FAIRFORD ELECTRONICS

X FE   Soft Starters and Energy Optimising Soft Starters

Programming Guide
for the X FE and X FE plus

FD843201-F

5 Programming

5 Programming

5.1 Versions

This manual applies to the following versions of software;

5MC software version: 5MC V 67.03

Keypad software version: V1.072

Menu software version: Menu V1.022

5.1.1 Useful Information

Further useful information can be found in the following documents which are available on the website, http://www.fairford.co.uk;

The Basic Guide to the Installation and Operation of the Xfe Soft Starter

Xfe Mechanical Installation Manual

Xfe Electrical Installation Manual

Xfe Applications Manual

Xfe Electro-Magnetic Compatibility Manual

Xfe Modbus Manual

XFE Parameter Listing

XFE Bit Parameters

Applications Data Listing

5.1.2 Conventions

The following typographical conventions are used in this manual;

1. Characters that are quoted directly from the Xfe's display are quoted in a fixed width font. This includes menu names:

        Basic

parameter names:

        Start Time

parameter values:

        5 Seconds

status information:

        Stopped and ready

2. Buttons on the keypad/keypod to be pressed by the user will be indicated by their name, **Enter**, in **bold** `fixed width font`, or by the appropriate symbol; thus ▼ also in **bold**, for the decrement or move down button.

3. Where "Xfe+", or "applies to plus units only" is shown in the text it indicates that the functionality described by that section applies to Xfe+ units only, and **not** the standard Xfe unit.

5.1.3 Quick Start

Once the unit is wired as per instructions in the Basic Guide or the Electrical Installation manual, then simply select a suitable application from the `Applications` menu (see section **5.4.3**), and the unit can then be started with the keypad. This will give a good basic setup, but in some instances fine tuning will be required.

Xfe
FD843201_F

5.2 User Interface

5.2.1 The Keypad and Keypod

There are two types of user interface for use with the Xfe - the **keypad** (refer to **Figure 5.2.1**) and the **keypod** (refer to **Figure 5.2.1a**). The **keypad** is the user interface which is internally mounted on the Xfe. The **keypod** is the user interface which is remotely mountable (up to 10 metres from the starter). Only one interface may be used at any time.

All parameters that control the operation of the Xfe can be accessed via the interface. Parameters[1] and their values are shown on the interface display, and any changes to parameter values are effected by the using the buttons on the interface. The interface has three basic modes of operation;

• **System Status Mode**

• **Menu Navigation Mode**

• **Data Entry Mode**
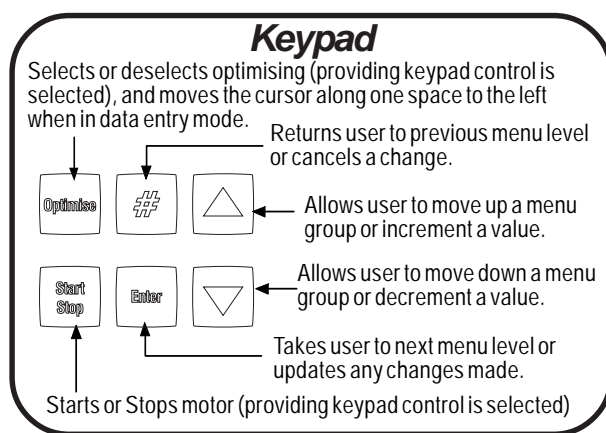
Figure 5.2.1 Keypad
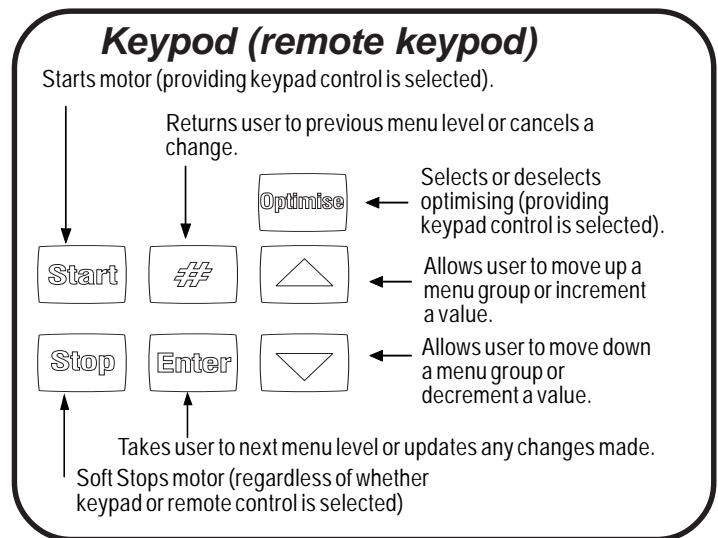
Figure 5.2.1a Keypod

Explanation of the modes mentioned above can be found in sections **5.2.3, 5.2.4**, **5.2.5**.

5.2.2 Menu Structure

The menu structure of the user interface gives the operator two main routes via which they may change the operation of the Xfe the text based menus or the number based parameter list. The menu items and parameters* which are most commonly used by the operator all reside in a text based menu structure which can be seen in Figure **5.2.2**, on the page opposite. (**Note;** the values that appear in brackets after some entries are the default values of the menu items or parameters concerned). The number of menu items and parameters accessible from here is a little over half the total number of parameters available to the user in the Xfe. Access to all the parameters is available via the `Parameters` submenu, where each parameter has a name and a number assigned to it.

*Refer to section **5.6.1** for the definition of a parameter used in this manual.

[1] A full list of parameters can be found in a printed extract of FD8416, available on the website as 'XFE_Parameter_List.pdf' and 'XFE_Bit_Parameter_List.pdf'.

Xfe Menu Structure

Level 0	Level 1	Level 2	Level 3

Level 0

Stopped and ready
1:

or

Starter Disabled
1:▼ to Enable

Level 1

Applications
Auto features

▼ ▲

Auto features
Basic

Basic
Advanced

Advanced
Monitoring

Monitoring
Permanent store

Permanent store
Password

Password
Inputs

Inputs
Outputs

Outputs
Parameters

Parameters
Trips

Trips

Level 2

Settings
Default (keypad)
Default Auto
Small Pump
Large Pump
Conveyor
Low Inertia Fan
High Inertia Fan
Recip Compressor
Screw Compressor
Rotary Compressor
Crusher
Grinder
Hi torque start
Motor gen set
Aerator
Flywheel press
Moulder

Settings
Auto Jog (Off)
Auto Pedestal (Off)
Auto end start (Off)
Auto stop (Off)
Auto end stop (Off)
Auto bypass (On)
Auto 3MC (On)
Auto Ramp (Off)
Auto All >> Off
Stop smoothing (Off)

Current
Optimise rate (5)
Kick start (Off)
Kick pedestal (75%)
Kick time (25cycles)
Dwell time (5s)
Low volts stop (Off)
Contactor delay (160ms)
Trip sensitivity (1)
Station number (1)
Firing mode(0)
Stop smoothing (5)
Cooling (On)
Cooling time
Line contactor (On)
Thermistor Trip (Off)
P126 Comms Trip (On)

Disable starter?
Enable starter
Starting (Keypad)
Start pedestal (20%)
Start time (5s)
Stop pedestal (10%)
Stop time (0s)
Current limit (3.5xle)
Power on Param
Protection (Full +Optimise)

Save parameters
Power on parameters
Default parameters

Enter password
Change password

Power
Protection (full + optimise)
P26 Current
P27 Peak Start
P40 supply volts (416)
Real PF
P22 Delay angle
P23 Max angle
P20 Reference PF
P21 Internal PF
Temperature I/P

Digital i/p 1
Digital i/p 2
Digital i/p 3
Temperature i/p
4-20 mA i/p
DC i/p

K1
K2
K3
K4
Analogue o/p 1
Analogue o/p 2

P1 to P21
P22 to P40
P41 to P60
P61 to P80
P81 to P100
P101 to P...

Trips
Trip Sensitivity
P126 Comms Trip
Cooling
Thermistor Trip
C/L Timeout
Low Current
Shearpin
Overload
Sensing Signal

Level 3

Full
Full + optimise (Default)
Start + bypass
Phase loss only

Rated current (le)
P106 Start Class
Low current (Off)
Low amps level (0.1 x le)
Low amps time (50 cycles)
C/L time out (On)
Current limit (3.5 x le)
Limit time out (30s)
Shearpin (On)
Shearpin level (3.125 x le)
Shearpin time (100 cycles)
Overload level (1.1 x le)

Map to
Bit Number
Polarity

Temperature i/p
Set Level

4-20mA i/p
Map to
Set Level

DC i/p
Map to
Set Level

Map from
Bit Number
Polarity[4]

Parameter viewing and/or
manipulation

Trip-1
Trip-2
Trip-3
Trip-4
Trip-5

Figure 5.2.2 Menu Structure

Notes for Figure 5.2.2

1. Parameters that are listed in boxes with white writing on a dark background, thus;

<div style="text-align:center;">

White

</div>

will only be effective if the Auxiliary Function Card is fitted, as they are for use in conjunction with the extra hardware functionality that pcb provides.
2. The menu structure may change in future versions and in software upgrades to the present version.
4. The Output relays can also be set to energise on the following pre-programmed events.

K=Run Relay	K=I/P1
K=Bypass Relay	K=60Hz
K=Alarm	K=Shearpin
K=CurrentLimitng	K=C/L Timeout
K=OvldIntgrating	K=Thermistor
K=Stall	K=Overload
K=Cooling	K=ThermalSwitch
K=EnableStatus	K=RYB

(Messages are shown as they are seen on the display).
These choices are available in the menu structure but are shown here for clarity. See also section **5.3.9**

5.2.3 System Status Mode

Following the initial boot-up report (see section **5.2.9**) the unit enters the status mode. In this mode the operating status of the unit is constantly displayed, resulting in a number of status messages;

   Non-Running Status -   both of two messages indicate that the unit is not running the load at present, but Stopped and Ready indicates the unit is enabled, and Starter Disabled indicates that the unit is disabled, (see section **5.4.1**).

   Fault number Fault description -   this message indicates that a fault has occurred, giving the fault number and a short fault description such as "#1 Phase Loss". The second line of the message tells the user to reset the unit with the **#** key.

   Temporary Comms Status Errors   -   these messages, CRC Error, Slave Busy, Illegal Address, Illegal Function tell the user when there has been a Modbus Comms Error. Refer to the Modbus Manual for more details.

   Running Status -   this message indicates which running mode the unit is in either, **"Starting"**, **"Full Volts"**, or **"Optimising".** The second line of the message gives a current indication in Amps. If an overload condition exists then a bar graph indicating the state of overload integration will be shown across both lines on the right hand side of the display.

5.2.4 Menu Navigation Mode

The Menu Navigation Mode is entered as soon as the **Enter** button is pressed in System Status Mode. In this mode the user can navigate through all levels of the menu structure using the relevant buttons on the keypad, see Figure **5.2.1/5.2.1a** .

5.2.5 Data Entry Mode

The Data Entry Mode is entered as soon as the bottom level of the menu structure for that particular menu branch is reached, i.e. a menu item or parameter name is displayed in the top line of the keypad display, and the associated value is displayed in the bottom line of the display. Not all parameter values can be changed by the user, as some are read-only.

A user can tell whether the menu item or parameter is writeable as there will be a flashing cursor present on the bottom line of the display if writing is permitted. Writeable values may be changed by using the up and down keys (for a numerical value) or by pressing **Enter** (for a change in a logic value). In the first case (a numerical value) the **Enter** key must be pressed to confirm the changed value. The user interface display will flash once to confirm the change.

5.2.6 Changing Parameter Values.

All parameters can be read by the user, and some parameters can also be written to by the user. The full list of parameters and their values can be found in the `Parameter` menu and subsequent sub-menus. The most commonly read and written to parameters can also be found under the other Level 1 (see Figure **5.2.2**) menus such as `Basic` and `Applications`. A simple example of how to view and change a parameter value is given in section **5.4.3** .

5.2.7 Soft Starter Data Types

There are basically four types of data held in parameters, Analogue, Multiple, Percentile and Bit data. Their definitions are given below.

Analogue data - one of a range of values between two extremes, usually 0-255, 0-50 or 0-10, that represent units such as volts, amps, seconds etc For example:- `Start Time (Stopped & ready -> Basic -> Start Time)` would be set at 5 seconds as default but can be set to a maximum of 255 seconds.

Multiple data - a multiple of an absolute quantity. For example:- the running current displayed by the unit is a multiple of the value of the unit's `Rated Current` (e.g. 1.0 x `Rated Current` to 8.0 x `Rated Current`). Normally the unit's `Rated Current` approximates to motor Full Load Current.

Percentile data - percentage value of an absolute quantity, ranging from 0 - 100%. For example, the `Kick Pedestal (Stopped & ready -> Advanced-> Kick Pedestal)` is the percentage of supply voltage applied to the unit during an optional start-up 'kick'.

Bit data - this represents the selection or non-selection, turning 'On' or turning 'Off' of whichever bit parameter is in question.

5.2.8 Bit Masks

Some parameters can also be addressed via the appropriate Bit Parameter, instead of or as well as being accessed via the more commonly used menus. These Bit Parameters can only be accessed by the `Parameters` menu, i.e. for the Auto Config Bit Parameter the menu path would be; `Stopped & ready -> Parameters -> P1 to P20 -> P18 Auto Config`. The user would then see a display similar to the one below;

Parameter Name;	**P18 Auto Config**
Bit data;	**00000110 Flags**

Bit number;	**7......0**

Note; only the text in the shaded box would actually be displayed by the user interface.

5.2.8   continued

A cursor would be flashing at the character on the display which represents the Least Significant Bit (LSB, also known as bit 0; i.e. the 0 or 1 on the right hand side of the eight 0's and/or 1's). This character is actually underlined for clarity in the example above.

The cursor represents the user's current input point, the value of the bit highlighted by the cursor can now be changed. To move the cursor one place to the left the user needs to press the **Optimise** key, and the user will then be able to edit bit 1. Pressing the **Optimise** key repeatedly will continue to move the cursor one place to the left until bit 7, or the Most Significant Bit (MSB; the 0 or 1 on the left of the eight 0's and/or 1's) is reached, after which pressing the **Optimise** button again will wrap the cursor around to bit 0.

To continue with the example let us suppose that the user wishes to enable the Auto Pedestal (bit 7) and disable the Auto Bypass (bit 2). First, the user should press the **Optimise** button twice to move the cursor two places to the left, to bit 2. Then to change the value of bit 2 from '1' to '0', the user would simply press the ▼ key once. To move the cursor to the Auto Pedestal bit (bit 7), the user would now need to press the **Optimise** button five times. Then to turn on the Auto Pedestal bit, just pressing the ▲ key once will change the bit to the required value. To confirm the changes made the user would then press the **Enter** button. Not pressing the Enter would effectively cancel the changes made by the user.

5.2.9   Keypad/Keypod boot-up messages

When the control supply to the Xfe is switched on, the user interface will go through a boot-up procedure during which it will display some information relevant to the Xfe's current state. The messages are displayed during the boot-up procedure in the order that they are listed below . A brief explanation of each message is included.

`1 Find Starter`	This message indicates that the keypad is looking for a starter (soft start unit), starting with a station number of 1. If it is unable to find a starter with that station number, it will move onto station number 2 etc.. until 32, the highest valid station number, is reached. See section **5.3.4** for further details.
`Password is Set` `6A  AC53A  10B`	This message appears if the password has been set. Followed by the Unit rating
`XFE104` `6A  AC53A  10B`	If the password is not set The model number is shown Followed by the unit rating
`Stopped & ready` `1:`	Stopped and ready is displayed after the end of a successful boot-up procedure. The number on the second line is the station number of the unit that the keypad/keypod is currently talking to.

5.3   Using the Menus

This section gives a brief description of the individual menus and the functions that their parameters perform.

5.3.1   The Applications Menu

This menu contains a list of typical applications for which a set of parameters have been predefined by the manufacturer. This feature provides a quick and easy way of setting up the unit. There are three exceptions to this list: the first menu item, `Settings`, provides a brief report on the basic settings of the unit (see below and section **5.4.6**); the second menu item, `Default (keypad)`, provides a way of loading the default parameter values with `Keypad Starting` as the choice for the starting option (see section **5.4.4**); the third menu item, `Default Auto`, loads default parameter values and additionally turns on a number of features from the Auto Features menu. Further details can be found in the following documents, XFE Applications Data and the XFE Bit Parameters.

Apart from these exceptions, the parameters that will be altered when one of the typical applications (small pump etc..) is selected are again listed in the documents XFE Applications Data and the 5MC Bit Parameters which can be found on the website.

Settings report; below is a list detailing the report given by the `Settings` menu item. When accessed it will display some information relevant to the Xfe's current state. The messages are displayed in the order that they are listed below . A brief explanation of each message is included (see section **5.4.6** on how to access this report).

	This message shows the keypad software version number and it's release date .
`5MC V 67.03`	This message gives the version number of the software in the 5MC control board.
`Menu V1.017`	This message gives the version number of the navigating menu.
`Remote/` `Keypad Starting`	This message indicates whether the Starting Parameter has been set to keypad, or remote starting.

`Full/`
`Full&Opt/`
`Start&Bypass/`
`Phase Loss Only`
	This message shows what protection mode has been set in the Protection Parameter.

`Small Pump`	This next message will show what (if any) application has been set from the Application menu (Small Pump is shown as an example). If no application has been set then the display will appear blank for a couple of seconds.
`Temp/Alt Derated`	This message will be displayed if the unit has been derated for temperature or altitude. If no derating has been set then the display will appear blank for a couple of seconds.

5.3.2   The Auto Menu

The Auto Menu contains commonly used parameters that may be automatically adjusted by the unit. A brief description of each entry is given below.

`Settings` -   When active this menu item will provide a brief report on which, if any, `Auto` options have been switched `On`. A downwards facing arrow will appear on the right hand side of the top line of the user interface display. Whilst this icon is present all of the `Auto` options that appear on the bottom line of the display have been switched `On`.

`Auto Jog`   -   This menu item turns `On` and `Off` automatic Jog detection. When a soft stop time of greater value than zero (0) is set and `Auto Jog` is turned `On`, a stop request received by the unit within 0.5 seconds of a start request, forces the unit to execute a zero (0) second stop. This menu item is intended to be used for short term jogging of light loads. The default value for this menu item is `Off`.

`Auto Pedestal`   -   This menu item turns `On` and `Off` the automatic overriding of the start pedestal. When `On` the unit approximately detects the start of motor rotation and tries to adjust the pedestal to suit. The default value for this menu item is `Off`.

`Auto End Start` -   This menu item turns `On` and `Off` the automatic detection of motor full speed during the start-up. Having detected motor full speed achieved before the end of the programmed ramp, this menu item brings forward the end of the ramp cutting short an overlong programmed start. The default value for this menu item is `Off`.
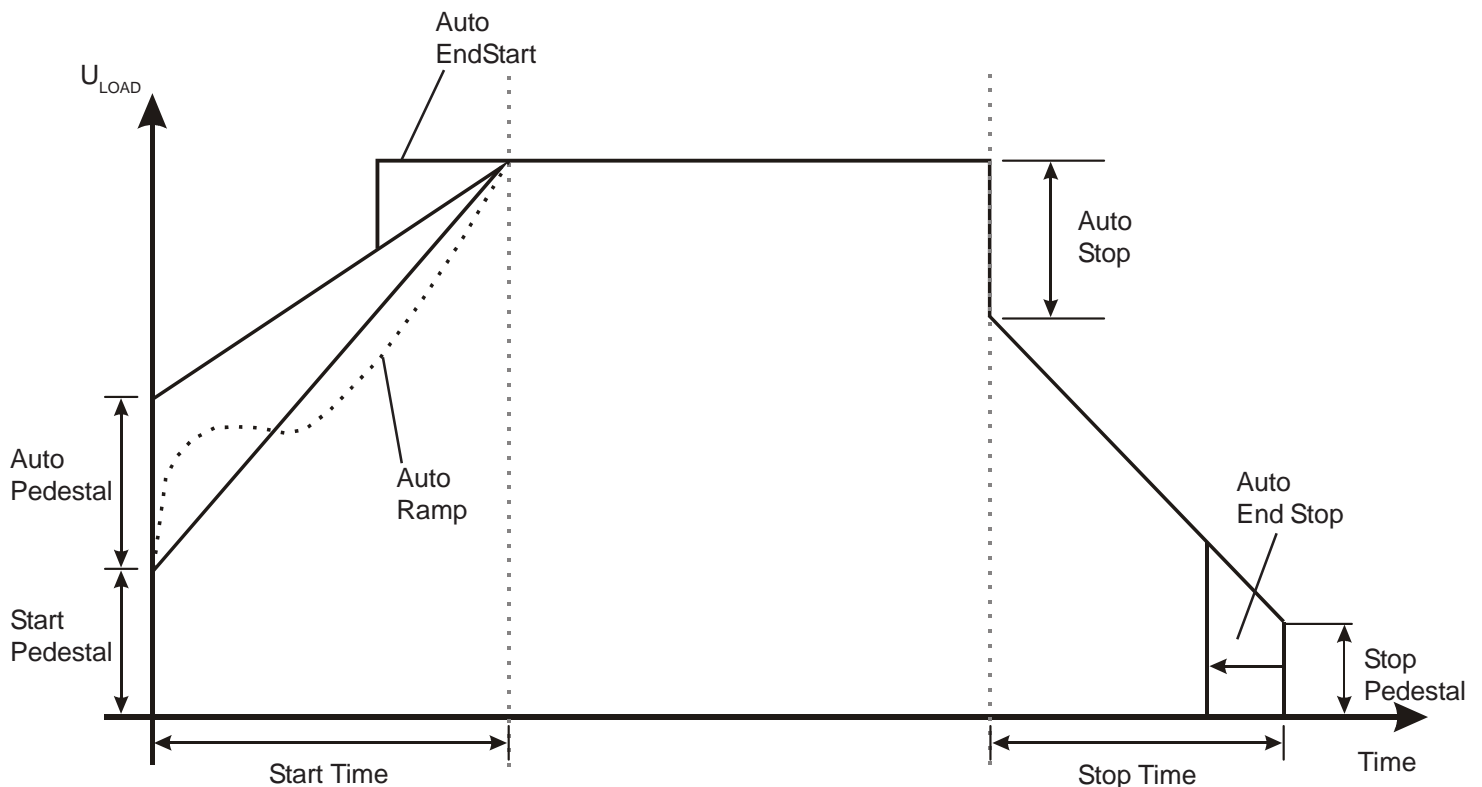
Figure 5.3.2 'Autos' Menu Explained

`Auto Stop` - This menu item turns `On` and `Off` the automatic adjustment of the soft stop. When `On` the unit attempts to automatically adjust the soft stop profile to suit the load. The default value is `Off`.

`Auto End Stop` - This menu item turns `On` and `Off` the automatic detection of a stalled motor during soft stop. When `On` and the motor has stopped before the end of the unit's programmed soft stop the unit will attempt to detect the stall and turn off the thyristors thus truncating the soft stop time. The default value for this menu item is `Off`.

`Auto Bypass` - This menu item turns `On` and `Off` the automatic detection of a bypass contactor. When `On` a bypass contactor will be detected. The default value for this menu item is `On`.

`Auto 3MC` - This menu item turns `On` and `Off` the automatic removal of the low voltage ramp for high pedestal starts. When this menu item is turned `On` and the `Start Pedestal` is set to 50% or more then a greater starting torque is applied to the load. The default value for this menu item is `On`.

`Auto Ramp` - This menu item automatically detects motor acceleration and dynamically adjusts the ramp to give smoother acceleration. This menu item works in conjunction with the Start Time parameter (P12) which should be set to the estimated start time of the load. This would be suitable for starts with varying loads. The default value for this menu item is `Off`.

`Auto All - Off` - This menu item turns `Off` all the `Auto` options (all options contained in this submenu except `Stop Smoothing`). The only action of this menu item is to turn `Off` all the `Auto` options when the menu item is activated.

`Stop Smoothing` - This menu item turns `On` and `Off` the soft `Stop Smoothing` function. When turned `On` this menu item attempts to eliminate any oscillations that may occur when the unit soft stops with an unstable load. The default value for this menu item is `Off`.

5.3.3   The Basic Menu

The Basic menu holds the parameters which control the primary functions of the unit (see Figure **5.3.3**). Changing the values of these parameters will vary the starting and stopping duties, the trip protection set for the unit and the source of the start signal (`Keypad` or `Remote`). The following section briefly details what each menu item in the menu will do.

`Disable Starter?`   -   This parameter disables the starter. Whilst the unit is disabled it will not comply with a start signal. Disabling the starter also allows the user to change certain parameters which cannot be changed whilst the unit is enabled (such as Password, and Station Number).

`Enable Starter ?`   -   This parameter enables the starter. Whilst the unit is enabled it will comply with a start signal. Some parameters cannot have their values changed whilst the unit is enabled.

`Starting`   -   This sets the source for the start signal. If set to `Keypad` the unit will start/stop when the **Start/Stop** button on the user interface is pressed. If set to `Remote` the unit will start when signalled to do so by an external circuit.

`Start Pedestal` -   This is the percentage of the unit's rated supply voltage, that is applied to the load before the ramp starts.

`Start Time`   -   This is the time the unit takes to ramp up from the `Start Pedestal` (U_{START}) to the maximum applied voltage (U_{MAX}).

`Stop Pedestal`   -   This is the percentage of the unit's rated supply voltage that the applied voltage falls to, at the end of the stop ramp (U_{STOP}).

`Stop Time` -   This is the time the unit takes to ramp down from the maximum applied voltage (U_{MAX}) to the `Stop Pedestal` (U_{STOP}).

Figure 5.3.3 'Basic' Menu Explained
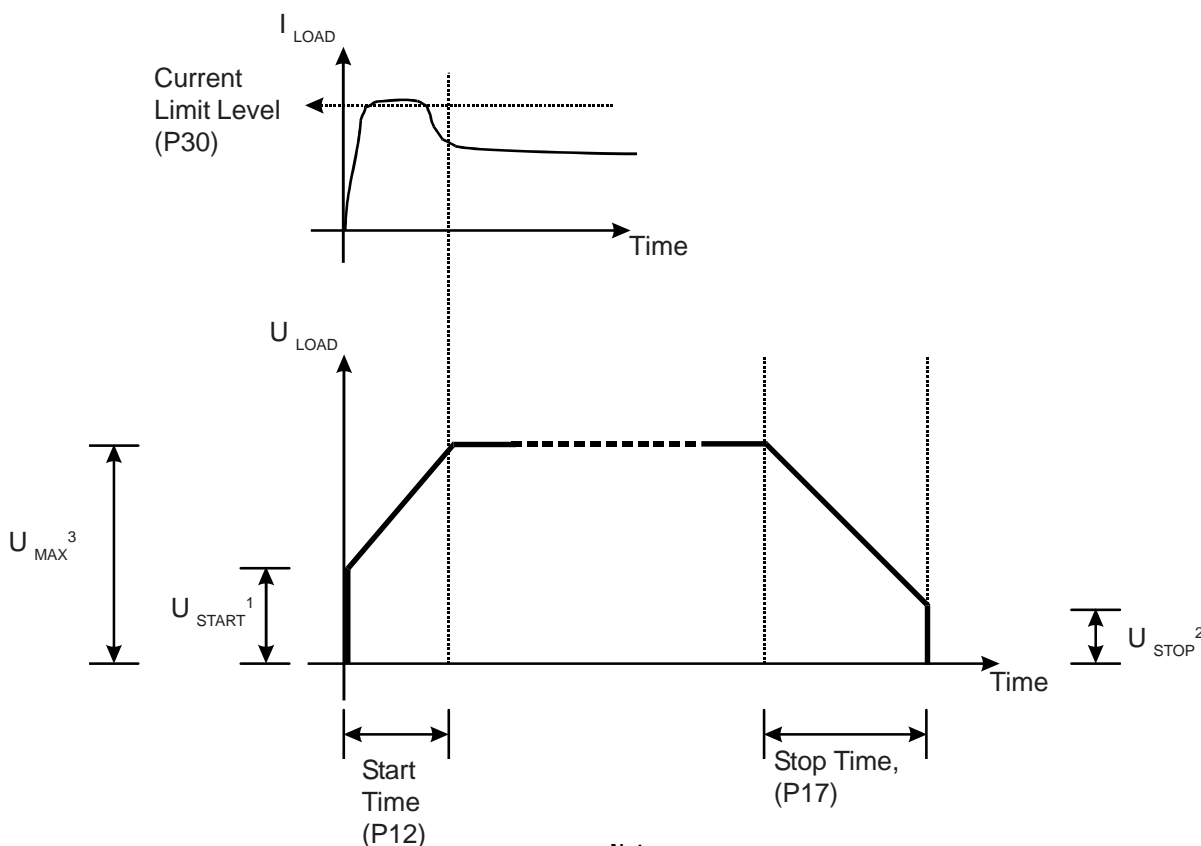
Notes;

1. This is the Start Pedestal voltage (P 11).

2. This is the Stop Pedestal voltage (P 16).

3. This is the supply voltage minus the voltage that is dropped across the Xfe.

`Current Limit` - This is the level of current at which the unit stops ramping up the voltage applied to the load, and prevents the ramp from continuing within a time limit. At the end of the time limit (`Limit Time Out`, P31, see section **5.3.5**) the unit will either stop or continue depending on the value of `C/L Time Out` in the `Current` menu (section **5.3.5**). The default for this parameter is 3.5 × Full Load Current.

*Notes: **1**. The actual current drawn by the load may exceed the Current Limit Level slightly as the unit manages the current limit through control of the delay angle. **2**. Current Limit is only active during starting.*

`Power On Parameters` - This recalls the values from the last permanently saved parameter set and loads them into the current configuration.

`Protection` - This sets the trip modes which are available to the user and also enables the user to turn on and off the Optimising Function. The available protection modes are;

`full`   all trips enabled, optimising function turned off;

`full + optimise` all trips enabled with optimising function turned on;

`start + bypass`   all trips enabled during start and trips 4 -10 (see section **5.3.11**) turned off during bypass;

`phase loss only` trips 4 -10 are turned off, all others enabled.

5.3.4   The Advanced Menu.

The Advanced Menu holds parameters that only need to be changed to solve specific sets of circumstances. The list that follows briefly explains what each menu item does.

`Current` - Provides access to the `Current` (as in Amps) submenu.

`Optimising Rate` - This parameter is an arbitrary number which dictates the speed at which the unit will phase back the firing angle during optimising. The smaller the number the faster the unit will reach it's final optimising voltage. Some unstable loads benefit from a slower optimising rate (which equates to a larger `Optimising Rate` (number)), for example reciprocating compressors and piston pumps which can experience very quick changes in load. The default for this parameter is set to five (5).

`Kick Start` - This menu item turns the Kick Start function `On` or `Off`. The Kick Start applies a short-lived voltage kick at the beginning of the start ramp to dislodge 'sticky' loads. This is turned `Off` by default.

`Kick Pedestal` - This parameter sets the voltage level for the Kick, as a percentage of U_{MAX}. The default value is 75%.

`Kick Time` - This parameter sets the duration of the Kick in supply frequency cycles. I.e., UK supply frequency is 50Hz, so one cycle takes 20ms to pass, so the default Kick Time of 25 cycles equates to 500ms.

`Dwell Time` - This parameter sets the time given for a load to settle down after the unit has reached Top of Ramp and before the unit enters Optimising mode (if set).

`Low Volts Stop` - This menu item turns `On` or `Off` the Low Voltage Stop function. When On this allows soft stop pedestals of less than 40% to be set. Soft stop pedestals of 40% and less can be set with the `Low Volts Stop` set to `Off`, but they will be treated by the unit as a 40% soft stop pedestal. By default this menu item is turned `Off`.

`Contactor Delay` - Sets the length of the delay between the Relay K1 closing (which brings in the main contactor in the standard wiring configuration, see Electrical Installation), and the start of the ramp (see Figure **5.3.4**). This is to allow for any contact bounce in the main contactor the unit starts firing to prevent nuisance tripping. By default this parameter is set to 160mS.

Programming

`Trip Sensitivity` - Sets a tolerance level for the unit's sensitivity towards trips. The higher the value of this parameter the less sensitive the unit is to trip conditions. Set to one (1) by default.

`Station Number` - Holds the local network ID for the unit. Set to one (1) by default.

`Firing Mode` - Holds a value which corresponds to one of the two different firing modes which are intended for use with the following load types;

`Firing Mode 0`, for normal squirrel cage motors connected in *star* or *delta* (with the soft start unit outside the *star* or *delta* configuration);

`Firing Mode 1`, for applications where the soft start is connected inside the *delta* configuration of a squirrel cage motor;

Figure 5.3.4 The Advanced Menu
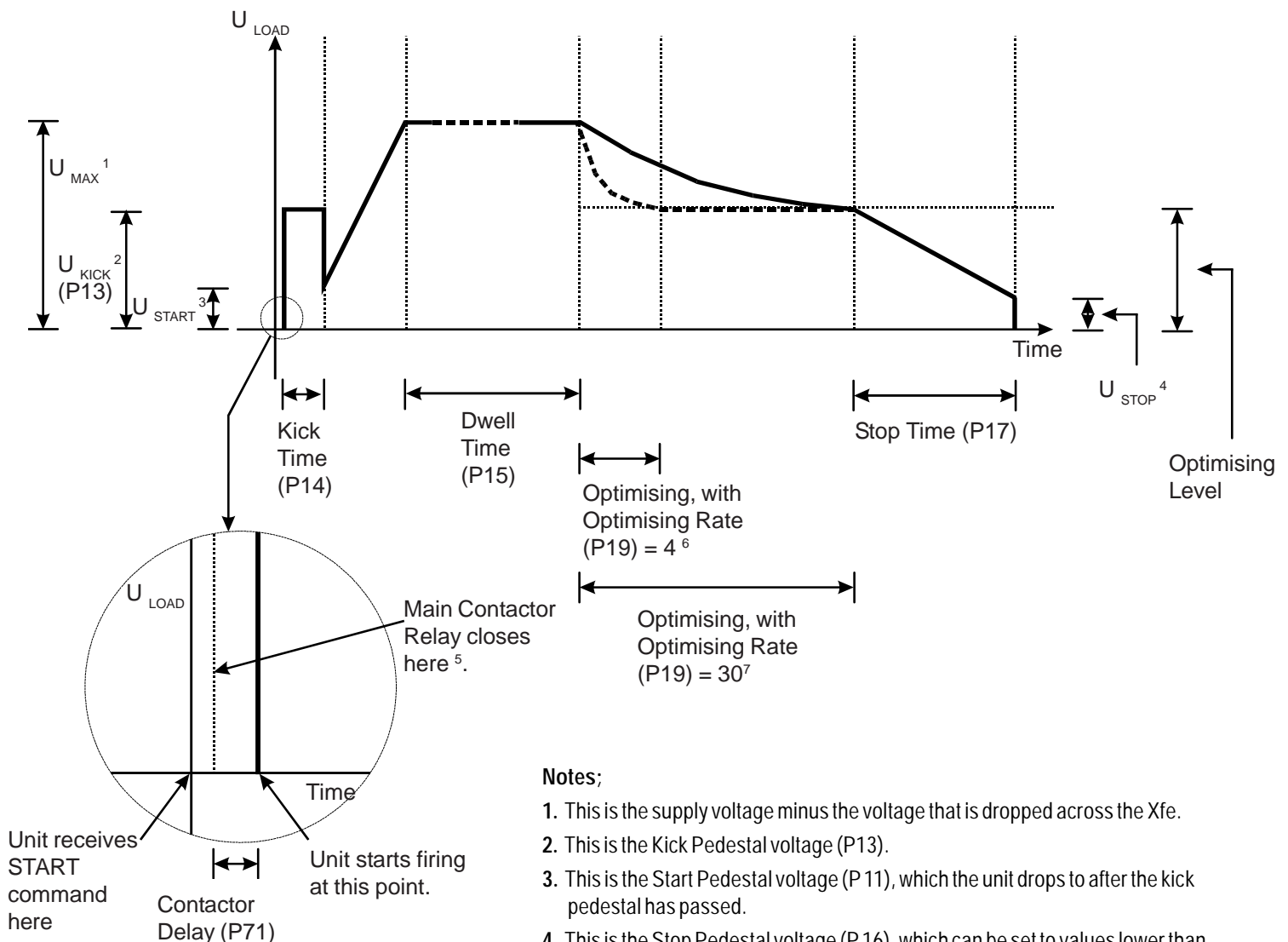
Notes;

1. This is the supply voltage minus the voltage that is dropped across the Xfe.

2. This is the Kick Pedestal voltage (P13).

3. This is the Start Pedestal voltage (P 11), which the unit drops to after the kick pedestal has passed.

4. This is the Stop Pedestal voltage (P 16), which can be set to values lower than 40% of U_{MAX} if Low Volts Stop is on.

5. This relay brings in the contactor that supplies the three phase AC mains to the unit in the standard wiring configuration (see **Electrical Installation** section **2.3.1**)

6. Represented by the thick dotted line.

7. Represented by the thick unbroken line.

NB. Please note that the above diagram is intended for use as a **GUIDE ONLY**.

`Stop Smoothing` -   This parameter stores a value which is used by a software filter to smooth any irregularities during a soft stop, caused by an unstable load. This parameter is used in conjunction with `Low Volts Stop` (see above) and also `Stop Pedestal` (see section **5.3.3**). `Low Volts Stop` must be turned `On` and `Stop Pedestal` set to 40% or less, for `Stop Smoothing` to have any effect. The maximum numerical value that `Stop Smoothing` can be set to is fifteen (15), which gives the minimum amount of soft stop smoothing. This parameter is set to five (5) by default.

`Cooling`   -   This menu item turns `On` and `Off` the `Cooling` function. Once this menu item has been turned `On` and the unit has been started and subsequently stopped, the `Cooling` function inhibits the start command (not allowing the unit to start), until the time held in `Cooling Time` has elapsed (measured from the last stop signal). During this period the unit displays `Stopped. Cooling` . This menu item is mainly for use in commissioning soft start units that have large thyristor stacks, it's purpose being to avoid damage to the thyristors during the commissioning process. For all units this menu item is turned `On` by default.

`Cooling Time`   -   The Xfe is designed so that the rated start current/time is close to the maximum allowed. If the start duty is exceeded the unit will trip. All Xfe Soft Starts have a forced off cooling time between starts.

In line with the stated IEC starting duties, all Xfe 100 series have an enforced off period of 2 minutes, likewise all Xfe 200 and Xfe 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates `Stopped.Cooling` and the Xfe will not respond to a start signal.

`Line Contactor`   -   This menu item turns `On` and `Off` the `Line Contactor` function, which selects the use by the customer of an in-line contactor in his wiring configuration. This menu item is `On` by default. **Note:** the Electricity At Work regulations of 1989 infer that any solid state starter cannot be considered as being a switching off device, and therefore an in line contactor should be used (regulation 12). However, if the decision is made to use a breaker instead, a new mode has been introduced so that the softstart can trip the breaker via the alarm relay when it is in the `Stopped and ready` state (see section **5.2.3**). This helps to eliminate the problems that arise when the breaker is closed and a faulty softstart has short circuit devices. The breaker option is selected by turning this menu item, `Line Contactor`, `Off`, or by enabling **bit 3 of `User Flags 4 (P121)`**.
An in-line contactor **MUST** be used with 'In Delta' mode and the use of an in-line contactor is **always** recommended.

`Thermistor Trip` **(Xfe+)**   -   This menu item turns `On` and `Off` the `Thermistor Trip` function. When the customer plugs the output of his motor thermistor into the relevant contacts on the add-on card (see the Electrical Installation Manual, sections **2.5.4** and **2.7.2**), and this trip is activated, then the starter will trip whenever the thermistor goes 'over-temperature'. This set to `Off` by default.

`P126 Comms Trip`   -   This menu item turns `On` and `Off` the Modbus protocol `CommXfes Trip`. When activated the soft start unit must have serial communication every five seconds or the unit will trip. For further details see section **5.2.3** and the Modbus Manual. This menu item is `On` by default.

5.3.5   The Current Sub Menu

The `Current` sub menu contains all the parameters associated with the Unit Full Load Current, and it's associated trip levels. A short explanation of each item in the menu is given below.

`Rated current`   -   Sets the value of the soft starter's rated current. It cannot be altered by the customer.

`P106 Start Class`   -   Selects Class 10B, 10, 20 or 30. This will automatically change the motor current rating (Trip level) of the unit to maintain over current protection

`Low current`   -   This menu item turns `On` and `Off` the `Low Current` trip. A `Low Current` trip occurs when the current output measured by the unit falls below the level specified by the `Low amps level` parameter for a length of time specified by the `Low Amps Time` parameter. The default value is `Off`.

`Low amps level` -   Specifies the current level below which a `Low Current` trip can occur. The default value is $0.1 \times$ Unit Full Load Current.

`Low amps time`   -   The time that the current must remain below the level specified by the `Low Amps Level` before a `Low Current` trip occurs. The time is specified in supply frequency cycles. The default value is 50 cycles.

`C/L time out`   -   This menu item turns `On` and `Off` the `Current Limit Time Out` trip. A `Current Limit Time Out` trip will occur if this menu item is set to `On`, and the load is demanding more current than the level specified in the `Current Limit` parameter, for longer than the time specified in the `Limit Time Out` parameter. If the `C/L Time Out` menu item is set to `Off` then no trip would occur in a similar situation. The default value for this menu item is `On`. (See Figure **5.3.5b** below).

`Current limit`   -   This parameter sets the level in Amps at which the unit will begin current limiting. The default is equivalent to $3.5 \times$ Unit Full Load Current, but is expressed in Amps.

`Limit time out`   -   This parameter sets the time in seconds that the unit must be in a current limit situation for a current limit trip to occur. The default value for this parameter is thirty seconds.

Low Amps Time = Min [2]
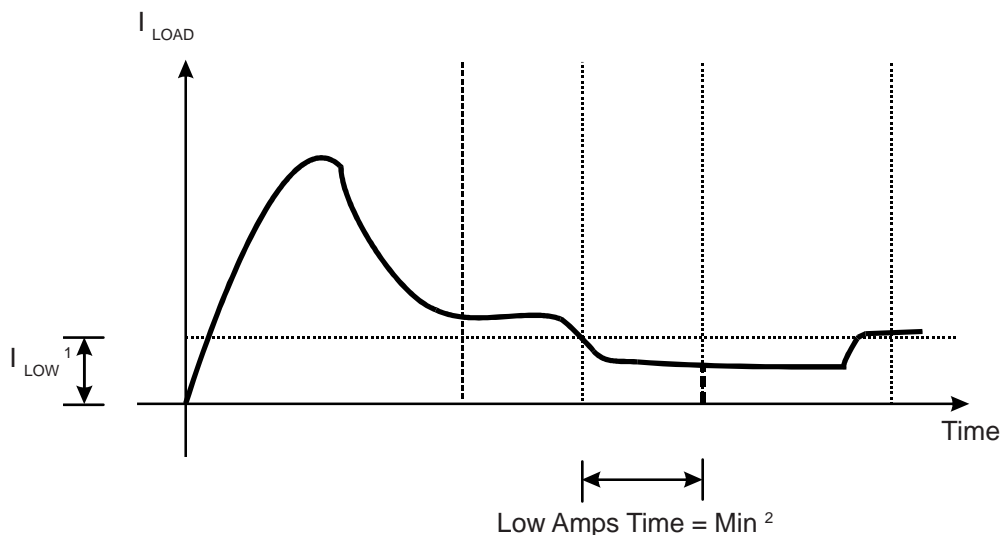
Low Amps Time = Max [3]

Notes

1. I_{LOW} = Low Amps Level.

2. If I_{LOAD} drops below 'Low Amps Level' and 'Low Current' is set to 'on', and 'Low Amps Time' is set to minimum then the unit will trip as indicated by the short thick dotted line.

3. If 'Low Amps Time' is set to maximum and I_{LOAD} rises above 'Low Amps Level' before 'Low Amps Time' has elapsed then the unit will not trip.

Figure 5.3.4.a Low Current Protection

`Shearpin`   -   This menu item turns `On` and `Off` the Shearpin trip. The `Shearpin` trip is intended to catch transient current peaks which exceed the value specified in the `Shearpin Level` parameter for a time that is specified in the `Shearpin Time` parameter. The default value is `On`. **Note** - the `Shearpin` trip is automatically turned off during starting and stopping. See also the **Special Case** in the `Overload Level` entry on the next page.
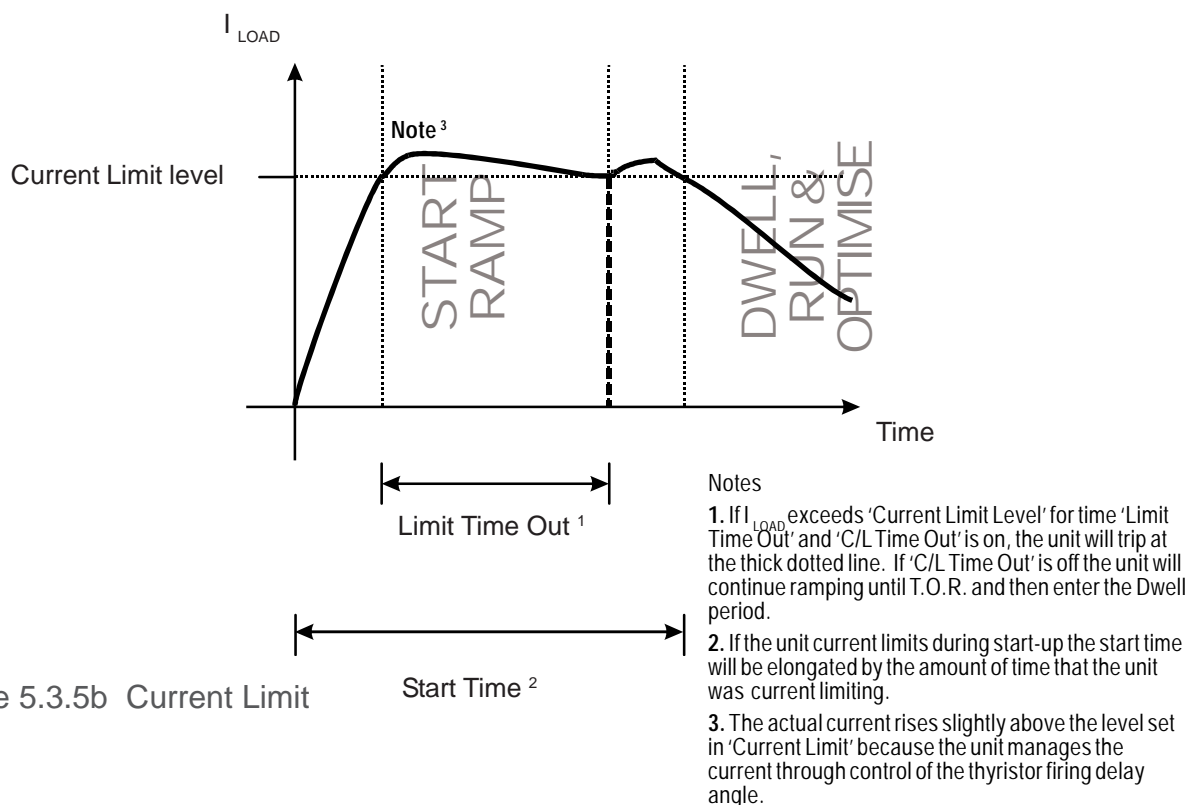
Figure 5.3.5b Current Limit

Notes

1. If I_{LOAD} exceeds 'Current Limit Level' for time 'Limit Time Out' and 'C/L Time Out' is on, the unit will trip at the thick dotted line. If 'C/L Time Out' is off the unit will continue ramping until T.O.R. and then enter the Dwell period.

2. If the unit current limits during start-up the start time will be elongated by the amount of time that the unit was current limiting.

3. The actual current rises slightly above the level set in 'Current Limit' because the unit manages the current through control of the thyristor firing delay angle.

`Shearpin Level` -   This parameter holds the level in Amps at and above which a `Shearpin` trip condition will exist. The default is equivalent to $3.125 \times$ Unit Full Load Current, but is expressed in Amps.

`Shearpin Time`   -   This parameter holds the time in supply frequency cycles that a `Shearpin` trip condition must exist before a trip occurs. The default value is one hundred cycles (at the supply frequency).

Notes
1. $I_{SHEARPIN}$ = Shearpin Level.
2. If I_{LOAD} exceeds $I_{SHEARPIN}$ for a time equal to 'Shearpin Time', and 'Shearpin' is set to 'on', then the unit will trip as indicated.
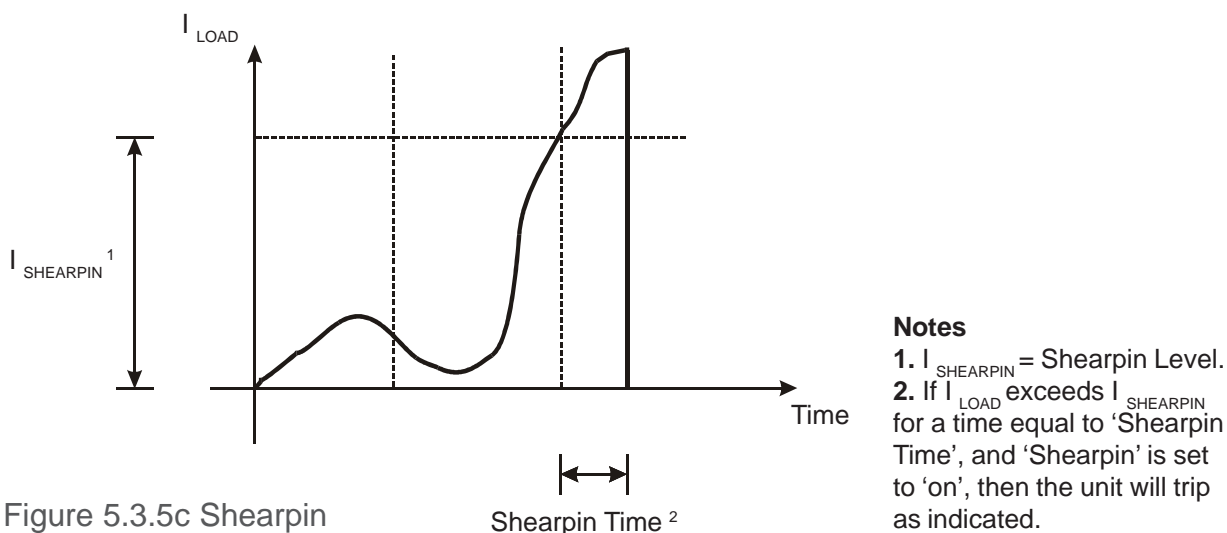
Figure 5.3.5c Shearpin

Overload Level - This parameter holds the level in Amps at which an Overload trip will start integrating (see the graph below). The default value for this parameter is 1.1 × Unit Full Load Current, but is expressed in Amps.
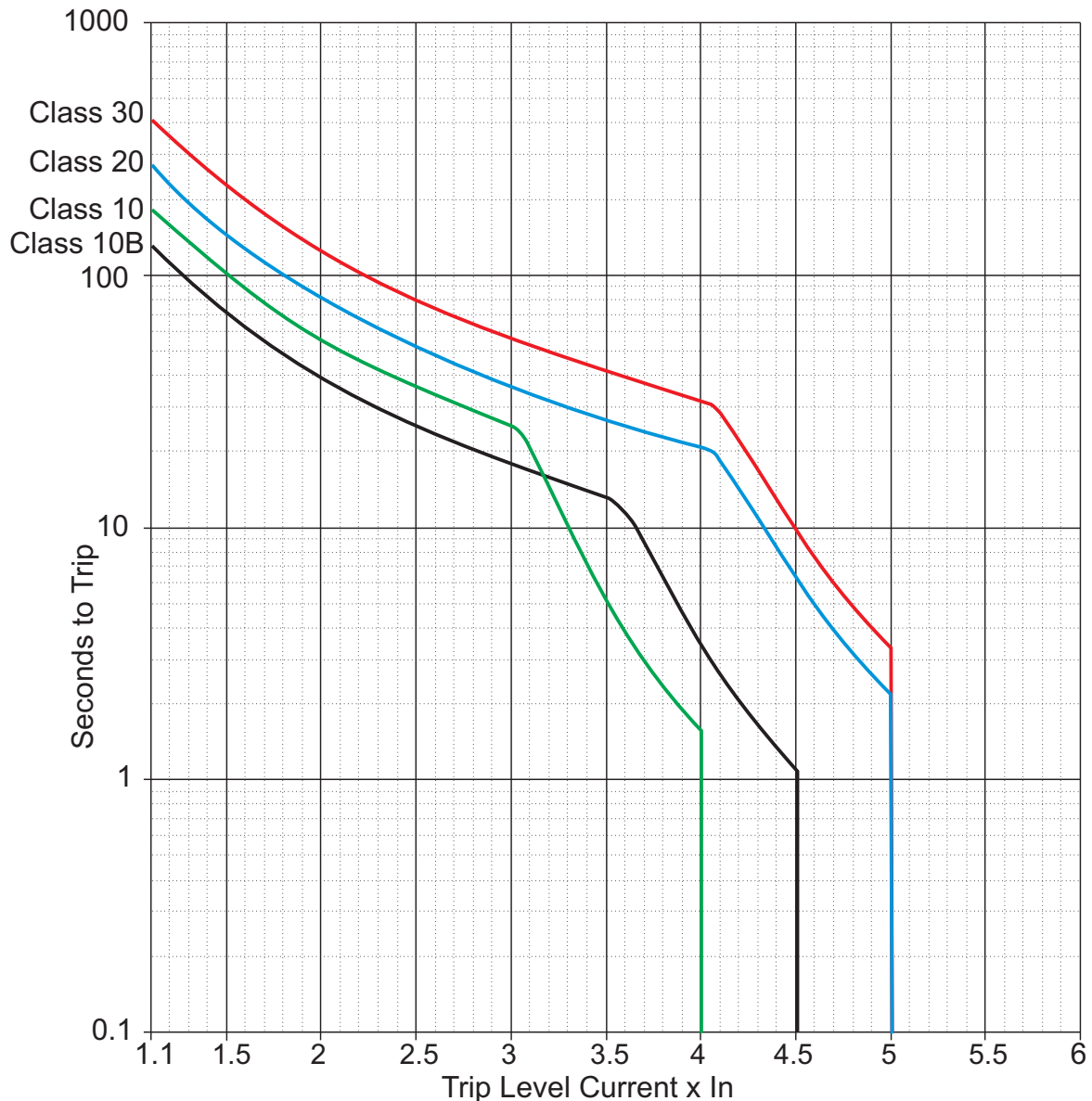
Figure 5.3.5d Overload Trip Graph

The Xfe monitors current in one phase only and this limits overload currents in accordance with the trip curves shown here See default settings.

Stopped.Cooling

The Xfe is designed so that the rated start current/time is close to the maximum allowed. If the start duty is exceeded the unit will trip. All Xfe Soft Starts have a forced off cooling time between starts. In line with the stated IEC starting duties, all Xfe 100 series have an enforced off period of 2 minutes, likewise all Xfe 200 and Xfe 300 series have an enforced off period of 7 minutes set as standard. During this period the display indicates "Stopped.Cooling", and the Xfe will not respond to a start signal.

AC53a ratings are for Optimising or use without a bypass contactor.
AC53b rating is only for use with a bypass contactor and will trip if one is not used
Trip curves show the nominal times for operation from cold (40°C)

5.3.6 The Monitoring Menu

`Power` - Displays the estimated Input Power to the Xfe. Can also be viewed when the motor is running by pressing the '#' button. See also `P40 supply volts` in this menu.

`Protection`

This sets the trip modes which are available to the user and also enables the user to turn on and off the Optimising Function. See section **5.3.12** for trip code descriptions
The available protection modes are

`full`	All trips are enabled, optimising function turned off.
`full + optimise`	All trips enabled with optimising function turned on;
`start + bypass`	All trips enabled during start and trips 4 -10 turned off during bypass;
`phase loss only`	trips 4 -10 are turned off, all others enabled.

`P26 Current`   Displays the current flowing through the Xfe.
                       See `Advanced` menu for Current settings

`P27 Peak Start`   Displays the maximum current recorded by the Xfe

`P40 Supply Volts`   Enters and displays the nominal supply voltage. Default is 416V. Measure actual voltage (phase to phase) and enter to get more accurate `Power` display

`Real PF`   This value is displayed in degrees and can be converted to a power factor value using Appendix B: Power Factor Conversion Chart from Section 3 Applications of the manual

`P22 Delay angle`   This gives the thyristor firing delay angle

`P23 Max angle`   Displays the maximum Allowed firing delay angle during running

`P20 Reference PF`   Number used by the Xfe when Optimising

`P21 Internal PF`   Number used by the Xfe when Optimising

`Temperature I/P`   Displays the state of the Thermal switch(s) on the internal heatsink.

5.3.7   Permanent Store Menu

`Save Parameters` -   Saves all the parameter settings to a permanent store. This means that if the control supply is removed from the main control board, the parameters will still remain stored and will be recalled the next time the unit boots up. See section **5.4.5**.

`Power on Parameters`   -   Recalls all the parameter settings from the last `Save Param` and loads the current parameters with these recalled values.

`Default Parameters` -   Loads all the parameters with the factory default values. The `Starting` parameter is set to `Remote` by this menu item, (`P51`, bit 7).

5.3.8   The Password Menu

`Enter Password` -   Unlock a unit by entering a previously set password. When the unit is `locked` the user can read all parameters as usual, but cannot write to any parameters. The unit **can** be started and stopped whilst it is locked.
The default setting is for the unit to have no password set, (see section **5.4.10**).

`Change Password`   -   Change a previously set password, enter a password for the first time or clear the password. This last action is performed by changing the password to zero (0) and pressing `Enter`. This clears any set password, but the control supply must be cycled or the unit reset by pressing the ▲   and ▼ buttons at the same time after the password has been cleared (see section **5.4.9**).

5.3.9   The Inputs Menu

`Digital i/p 1` -   Gives access to the programming parameters for the first programmable input (see section **2.5.3** of Electrical Installation). A worked example showing how to program a digital input is given in section **5.5.4**.

`Digital i/p 2` **(Xfe+)** -   Gives access to the programming parameters for the second programmable input (see section **2.5.4** of Electrical Installation). A worked example showing how to program a digital input is given in section **5.5.6**.

`Digital i/p 3` **(Xfe+)** -   Gives access to the programming parameters for the third programmable input (see section **2.5.4** of Electrical Installation). A worked example showing how to program a digital input is given in section **5.5.5**.

`Temperature i/p`   -   Gives access the heatsink temperature in ºC from a suitable temperature sensor (fitted at the factory). It is also possible to set the heatsink temperature above which the unit will not start, set via the Set Level submenu. This temperature sensor is not fitted as standard (normally a thermal switch is fitted) so this menu item will not normally not be of any use to the customer.

`4-20mA i/p` **(Xfe+)**   -   Gives access to the programming parameters for the 4 - 20mA input (see section **2.5.4** of Electrical Installation). A worked example showing how to program the 4 - 20mA input is given in section **5.5.8**.

`DC i/p` **(Xfe+)**   -   Gives access to the programming parameters for the DC input (section **2.5.4** of Electrical Installation). A worked example showing how to program the DC input is given in section **5.5.9**.

5.3.10 The Outputs Menu

`K1` and `K2`	Program K1 and K2 relays see section **2.7.3** of Electrical Installation
`K3 and K4` **(Xfe+)** -	Program the K3 and K4 relays see section **2.7.4** of Electrical Installation.

At the bottom of the submenu is a list of programming short cuts which will set up the relay for the user see below.

A worked example showing how to program a relay is given in section **5.5.3**.

`Run Relay`	-	Usually for controlling the main contactor, energises whilst the unit is running.
`Bypass Relay`	-	Usually for controlling the bypass contactor, energises when the unit reaches TOR.
`Alarm`	-	Energises when an Alarm condition is present.
`CurrentLimitng`	-	Energises when the unit is current limiting.
`OvldIntgrating`	-	Energises when the Xfe's overload is integrating.
`Stall`	-	Energises when the motor is stalling.
`Cooling`	-	Energises when the Xfe is cooling (start inhibited).
`Enable Status`	-	Energises when the Xfe is enabled.
`I/P1`	-	Energises when `I/P1` Flag =1
`50Hz`	-	Energises when `50Hz` Flag =1
`Shearpin`	-	Energises when the `Shearpin` Flag =1
`C/L Timeout`	-	Energises when the `C/L Timeout` Flag =1
`Thermistor`	-	Energises when the `Thermistor` Flag =1
`Overload`	-	Energises when the `Overload` Flag =1
`ThermalSwitch`	-	Energises when the `ThermalSwitch` Flag =1
`RYB`	-	Energises when the `RYB` Flag =1

A worked example showing how to program a relay is given in section **5.4.11**.

`K3 and K4` **(Xfe+)**	Programmed as the K3 and K4 relays on the Plus units only See section **2.7.4** of Electrical Installation. A worked example showing how to program a relay is given in section **5.5.3**.
`Analogue o/p 1` **(Xfe+)** `Analogue o/p 2`	Programs the analogue outputs on the Plus units See section **2.7.4** of Electrical Installation. A worked example showing how to program an analogue output is given in section **5.5.10**.

5.3.11 The Parameters Menu

This menu contains a number based, complete listing of all parameters, menu items and their values. Those parameters and menu items which can be written to, can be written to here as well as in the main text-based menu section. The parameters are listed in numerical order, and an explanation of what each parameter does, it's default value, units etc..., can be found in 'The_Xfe_Parameter_List', a document on the website.

5.3.12 The Trips Menu

This menu holds all the parameters that are associated with control of the various trips

`Trips` - This sub menu accesses a trip history of the last five trips. These trips are recorded automatically and need no intervention from the user. They are useful in fault-finding a unit.

`Trip-1`	-	Parameter records the trip number of the last recorded trip.
`Trip-2`	-	Parameter records the trip number of the second last recorded trip.
`Trip-3`	-	Parameter records the trip number of the third last recorded trip.
`Trip-4`	-	Parameter records the trip number of the fourth last recorded trip.
`Trip-5`	-	Parameter records the trip number of the fifth last recorded trip.

Note that most trips can be turned off, either via this trips menu or within the specific menu for the related trips.

Below is a list of each trip as displayed by the Xfe and breif explanation

`1 phase Loss`
Input side (L1, L2, L3) supply phase missing/loss at ramp start, during the ramp or during normal running (see **Note** section **5.3.4**, `Line Contactor`).

`2 Too Hot`
The heatsink is above the maximum allowed temperature. Fan cooled units are fitted with an internal temperature sensor or thermal switch.
The unit will trip if it detects an over temperature signal or if the input is open circuit.

`3 Comms`
There have been a number of communication errors but comms are still active.
See also `17 Comms Timeout`.

`4 SCR Firing`
Short circuit thyristor during normal running,

`5 SCR Signal`
Short circuit thyristor or motor side phase loss during normal running,

`6 SCR Signal`
Input side phase loss during normal running or short circuit thyristor or motor side phase loss during the ramp or during normal running,

`7 Sensing Signal`
Short circuit thyristor, external noise or motor side phase loss
during the ramp or during normal running,

`8 Motor,SCR Los`
Short circuit thyristor or motor side phase loss at the start of the ramp,

`9 Sensing Signal`
Short circuit thyristor or external noise during the ramp or during normal running.

`10 SCR Shorted`
Short circuit thyristor or motor side phase loss during the ramp,

`11 Low Current`
The unit will trip if the current falls below a previously set level (`P28 LowAmps Level`) for a specified time (`P29 Low Amps Time`). Only active during normal running.

12 C/L Time Out
Unit trips during start ramp if the current reaches the `Current limit` level
(P30 default 3.5 x Ie) for a time specified in `Limit Time Out` (P31 default 30 sec).

13 Overload
The unit will trip if the current exceeds the overload limits at any stage of running.
These are defined by `P106 Start Class` and `Overload Level` (P34 default 1.1 x Ie)
see Figure **5.3.5d** Overload Trip Graph.

14 Shearpin
If enabled, this trips when the current exceeds the set `Shearpin level` (P32 default 3.125 x
Ie) for a time set in `Shearpin time` (P33 default 100 cycles), (see Figure **5.3.5c** shearpin).

15 Thermistor **(Xfe+ only)**
Disabled as default. If a thermistor has been fitted and connected to the Auxiliary Function Card,
the unit will trip if the resistance of the thermistor exceeds the trip point

16 User
Can be triggered by the customer through the serial comms, or via a programmable input.

17 Comms Timeout
This trip occurs if occurs if there is no communication on the serial connection for more than five
seconds. Disable by setting `P126 Comms Trip` to 0. See also `3 Comms` trip.

18 Bypass failed
Bypass contactor failed to close on AC53b rated unit

Stopped Cooling
Displayed during the period for which the soft starter will not restart to allow heatsink cooling.
Not strictly a trip but does prevent the unit from responding to a start signal

`Trip Sensitivity`	See section **5.3.4**
`P126 Comms Trip`	See section **5.3.4**
`Cooling`	See section **5.3.4**
`Thermistor Trip`	See section **5.3.4**
`C/L Timeout`	See section **5.3.5**
`Low Current`	See section **5.3.5**
`Shearpin`	See section **5.3.5**
`Overload`	This switches `On` and `Off` the `Overload` Trip, see section **5.3.5**. **Special case:** if a load current exceeding 7.2 x FLC occurs for longer than 60 mS, a `Shearpin Trip` is forced whenever the `Overload` is `On`.
`Sensing Signal`	Switches `On` and `Off` Trip 7. This may be useful if there is excessive noise on the supply causing spurious `Trip 7 Sensing Signal` trips.

5.4 Setup Examples

This section holds common programming examples that any customer might wish to use. They explain how to set up the Xfe for common tasks. Further, more advanced examples are given in section **5.5.2** and following.

5.4.1 Enabling and Disabling the Xfe

In this software release, the Xfe has an additional safety feature, the Enable/Disable parameter; the effect of this parameter is that the user cannot start the Xfe (*running the motor*) without enabling the unit first.

Whenever the control supply to the Xfe is turned on, the unit powers up in an enabled state. The display will tell the user if the unit is enabled - if it is enabled the display will look like this;

or whether it is disabled, when the display will look like this;

```
Stopped and ready
1:
```

```
Starter Disabled
1: ▼ To Enable
```

If the unit has been disabled, there are two ways to enable the unit; one by pressing the down button when presented with the `Start Disabled` screen above, and the second by following the instructions below.
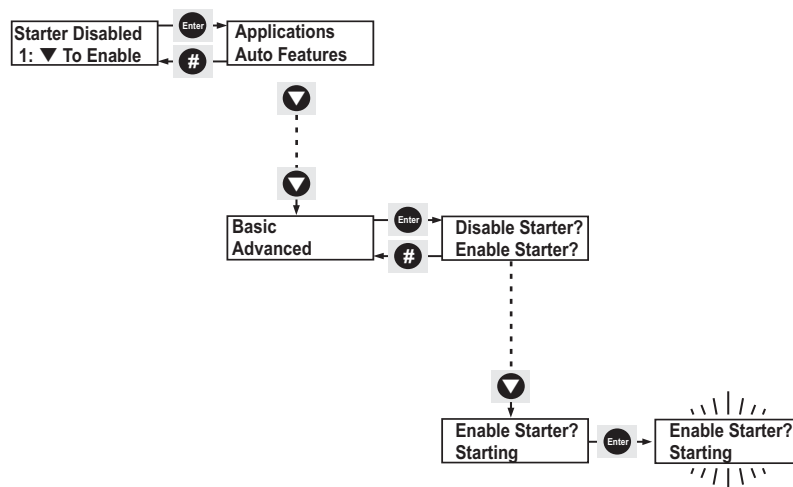
With `Starter Disabled` on the screen, press the `Enter` button once. Press the down button three times until `Basic` is on the top line of the display. Press the `Enter` button once, and with `Disable Starter?` showing press the down button once until `Enable Starter?` is on the top line of the display. Press the `Enter` button once and the display will flash once confirming the change

There is only one menu-driven way to disable the unit, and that follows the same procedure as above, except choosing `Disable Starter?` at the point where `Enable Starter?` was chosen.

There is another situation in which the user may need to disable the starter, that is when trying to write to a parameter to which write access is denied when the unit is enabled. Given such a situation (for instance, trying to load default parameters), the unit will ask the user whether they wish to disable the starter. The user must then reply with the **Hash** (#) button to answer no, and the **Enter** button to answer yes. Note; if the Xfe is disabled whilst running the load, it will stop running the load as soon as it is disabled.

To sum up, when the unit is disabled, all writeable parameters can be written to. When the unit is enabled, most, but NOT all, writeable parameters can be written to. Examples of parameters that cannot be written to whilst the unit is enabled, are the password and the currently loaded application: also default parameter values cannot be loaded whilst the unit is enabled.

5.4.2   How to read the Setup Examples

Each example consists of numbered step by step instructions which take the user through every action needed to complete the particular programming example. In addition there are diagrams which reference the text. The form these diagrams take are briefly explained below. (Note that the actual instructions in the diagrams in this section, **5.4.2** , are for display only and are not intended to make sense as instructions.)

NB If the unit needs to be 'Disabled' (see section **5.4.1**) before carrying out the instructions, the example will say so in it's introduction.

The first diagram in every example section will be the Stopped and Ready screen or the Starter Disabled screen. The box represents what will be seen on the display before the action detailed in line 1 has been performed. The box to the right (showing **Applications/Auto Features**) shows what will be displayed after the action in line 1 has been performed.

A circled number refers to the text for that section at the line number given. In this position, the circled number indicates that instruction 1 is associated with the Enter button, so the instruction will probably read," Press the Enter button."

The arrow that is part of the button icon shows the direction of diagram flow if that button is pressed.

These icons represent the buttons on the keypad and keypod. Refer to section **5.2.1**.

Instruction 3 is associated with the Enter button at this position.

Instruction 2 will state, "Press the down button until ✱ ✱ ✱ ✱ ✱ appears on the top line"

This is the screen that will be displayed after instruction 2 has been completed and before instruction 3 has been started.

This is the screen that will be displayed after instruction 3 has been completed.

A dotted arrow in this position, i.e. pointing downwards, means that the diagram continues on the following page.

Press the # button to cancel the instruction, or the Enter button to confirm it.

⑨ **Map From** ← **#** **Map From** → **Enter** → **Map From**
Bit Number | **52 Parameter** | **10 Parameter** ⑧

▼ ▲

⑦ Instruction 7 will state, "Press the up button this many times." This instruction is associated with the up button icons at this position.

▲

⑩ **Map From**
9 Parameter

A dotted arrow in this position, i.e. pointing horizontally, means that the diagram is continuing from another page, and that this is the start point for this page.

These icons represent the buttons on the keypad and keypod. Refer to section **5.2.1**

▼

⑪ **Bit Number** → **Enter** → **Bit Number** → ▼ → **Bit Number** → **Optimise** → **Bit Number** → ▲ → **Bit Number**
Polarity → **#** | **00000001 Mask** ⑫ | **00000000 Mask** ⑬ | **00000000 Mask** ⑭ | **00100000 Mask**

⑮ **Enter**

⑯ When the circled number in this position it is associated with the lower (button) icon, the # button in this case.

The screen on the left is displayed before instruction 13 has been started and the screen on the right after it has been completed.

Bit Number
00010000 Mask

This graphic represents the screen flashing, which it will do to confirm that an instruction or a change in value has been accepted.

Note; in the following examples, the **default** parameters are assumed to have been loaded before the start of the example, unless otherwise stated. This is to provide a common reference point for the instructions.

5.4.3 Loading the 'large pump' application into memory.

There are a number of pre-programmed applications included for speed and ease of setup. The parameters loaded by each selection characterise the standard setup of each particular application.

Note: This example assumes that the unit has been disabled (see section **5.4.1**).

1. With Starter Disabled shown on the display, press the **Enter** button once.

2. With Applications shown on the top line of the display, press the **Enter** button once.

3. With Settings shown at the top of the display press ▼ button four times until large pump is shown at top of display.

4. Press **Enter** once to select large pump. The display will indicate which parameters are to be changed.

5. With the top line of the display showing Send to store?, press **Enter** to save the settings for a large pump.(If the **#** button is pressed instead at this point the unit will flash the message Cancelled three times). The display will flash the message Storing twice to indicate this has been done.

6. At any of the above stages pressing **#** will return the user to the previous menu. The unit will not start until the display indicates Stopped and ready.

Note. There is no need to save the changed parameter values as they are automatically saved at instruction 5.
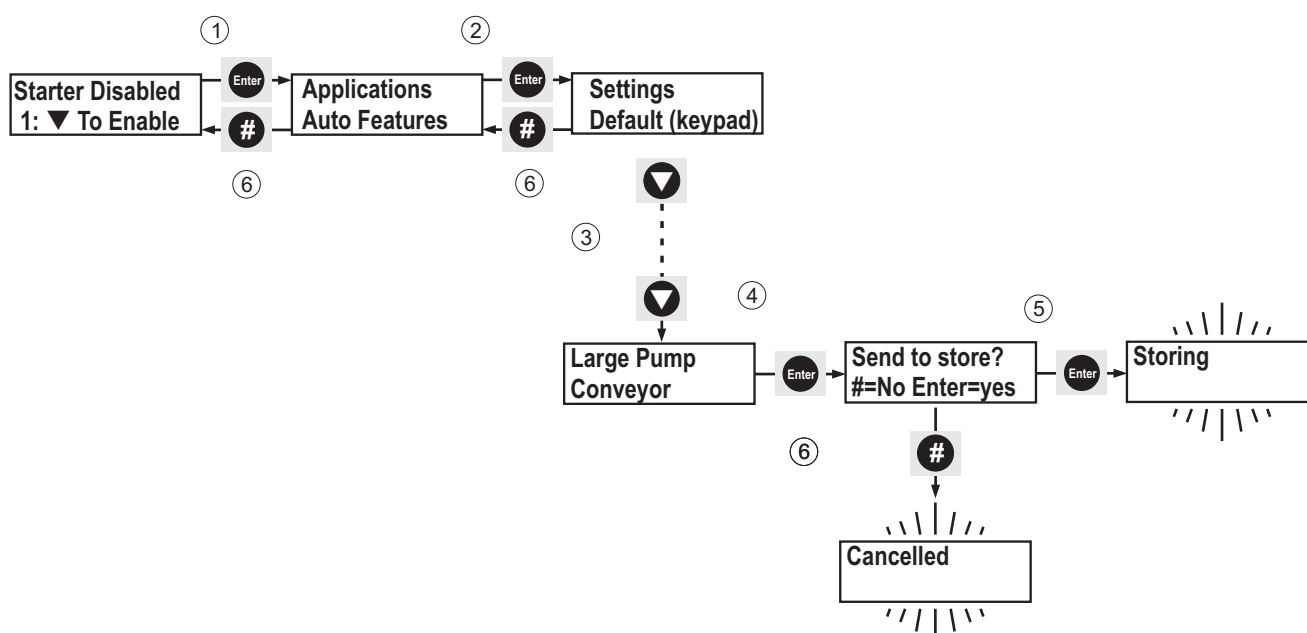
5.4.4   Changing from 'Keypad Starting' to 'Remote Starting'.

With 'Keypad Starting' set the unit is started from the keypad/keypod. Whilst 'Remote Starting' is set the unit is started with a start signal between **S0** and **S1**. 'Remote Starting' is the factory default value.

1. With `Stopped and ready` shown on the display, press the **Enter** once.

2. With `Applications` shown on the top line of the display press ▼ button twice until `Basic` is shown at top of display.

3. Press **Enter** once to select `Basic` menu.

4. With `Starting` shown at top of display press **Enter** once to select the `Starting` option.

5. With the display now showing `Starting` on the top line press **Enter** to toggle the bottom line of display from `Keypad Starting` to `Remote Starting`.

6. At any of the above stages pressing **#** will return the user to the previous menu.

7. The plink will now start and stop remotely from the customer's switches (see section **2.3.1**, of Electrical Installation) but will return to `Keypad Starting` if the control supply on terminals X1 and X2 is removed and a `Save Param` has not been performed. Alternatively, to return to `Keypad Starting`, repeat the above procedure and select `Keypad Starting` at step 5. **To keep the** Remote starting **setting after removal of the control supply, the settings must be permanently saved** (See section **5.4.5** below).
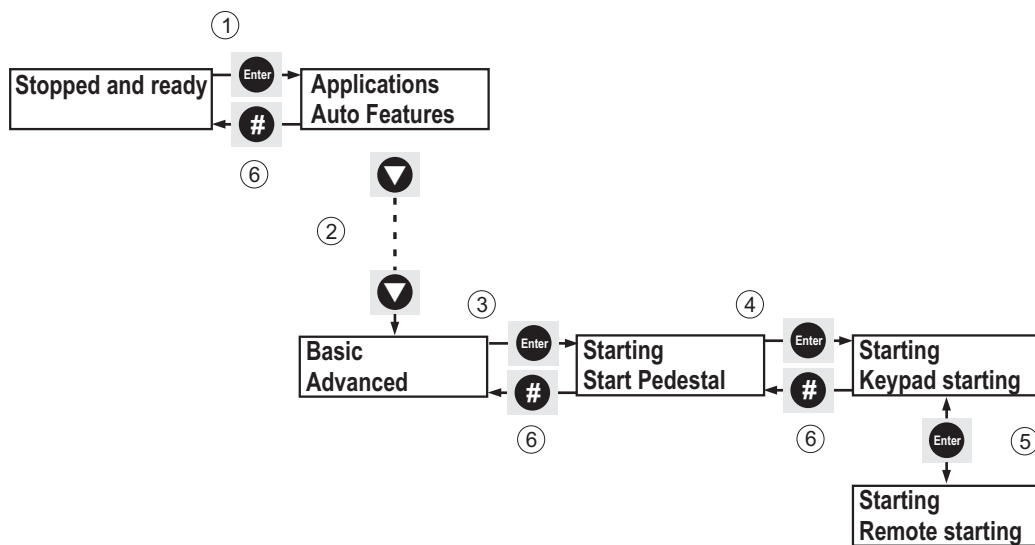
5.4.5 Permanently saving parameters set by the user.

To save parameters set by the customer, follow this procedure.

Note: This example assumes that the unit has been disabled (see section **5.4.1**)

1. With Starter Disabled shown on the display, press **Enter** button once.

2. With Applications shown on the top line of the display press ▼ button four times until Permanent Store is shown at top of display.

3. Press **Enter** once to select Permanent Store menu.

4. With Save Param shown at top of display press **Enter** once to permanently save parameters. The display will flash twice to indicate this has been done.

5. At any of the above stages pressing **#** will return the user to the previous menu.
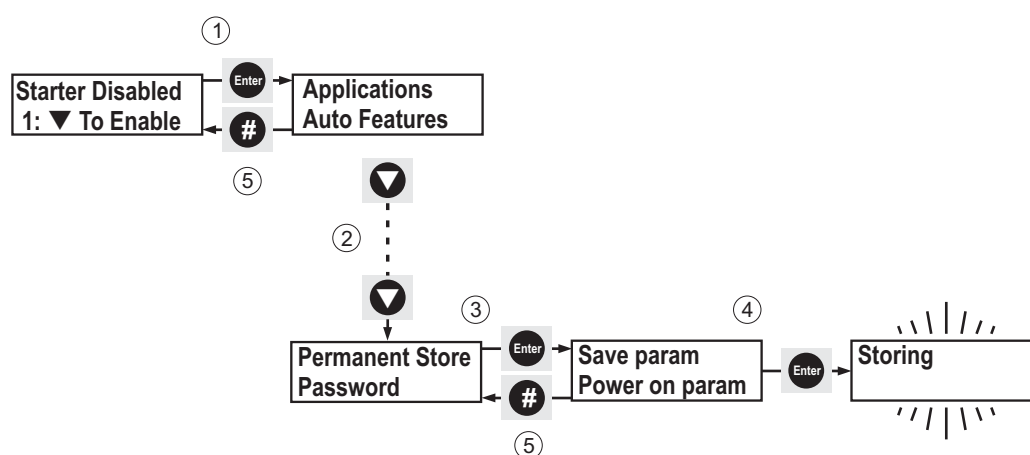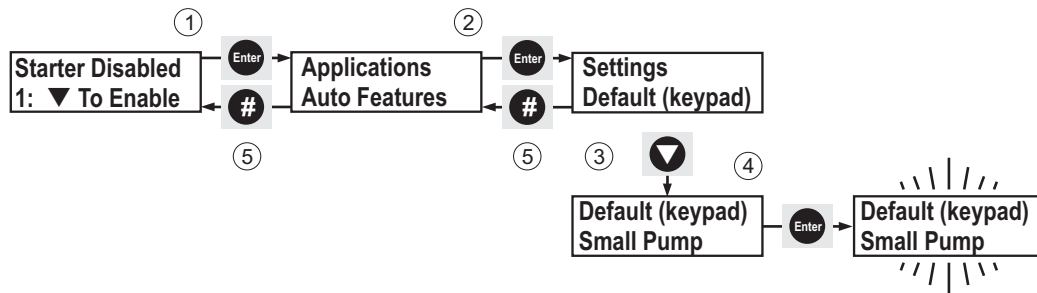
5.4.6   Loading the default parameter values with 'Keypad Starting' option.

Note: This example assumes that the unit has been disabled (see section **5.4.1**).

1.   With `Starter Disabled` shown on the display press the **Enter** button once.
2.   With `Applications` shown on the top line of the display, press the **Enter** button again.
3.   With `Settings` on the top line of the display, press the ▼ button until `Default (keypad)` is shown on the top line of the display.
4.   Press the **Enter** button once, and the display will flash three times, indicating that the default parameters (with keypad starting) have been loaded.
5.   Press the **#** button twice to return to `Stopped and ready`.

Note; there is no need to save the parameters as they have automatically been saved when the system was reset to default values.

5.4.7 Loading the default parameter values with 'Remote Starting' option.

Note: This example assumes that the unit has been disabled (see section **5.4.1**).

1.   With `Stopped and ready` shown on the display press the **Enter** button once.

2.   With `Applications` shown on the top line of the display, press the ▼ button until `Permanent Store` is on the top line of the display.

3.   Press the **Enter** button once.

4.   Press the ▼ button until `Default Param` is shown on the top line of the display.

5.   Press the **Enter** button once, the display will flash indicating that default parameters have been loaded. The display will then show the selected starting option (`Remote`) and the selected protection option (`Full + Optimise`) before returning `Default Param` to the top line of the display.

6.   Press the **#** button twice to return to `Stopped and ready`.

Note; there is no need to save the parameters as they have automatically been saved when the system was reset to default values.
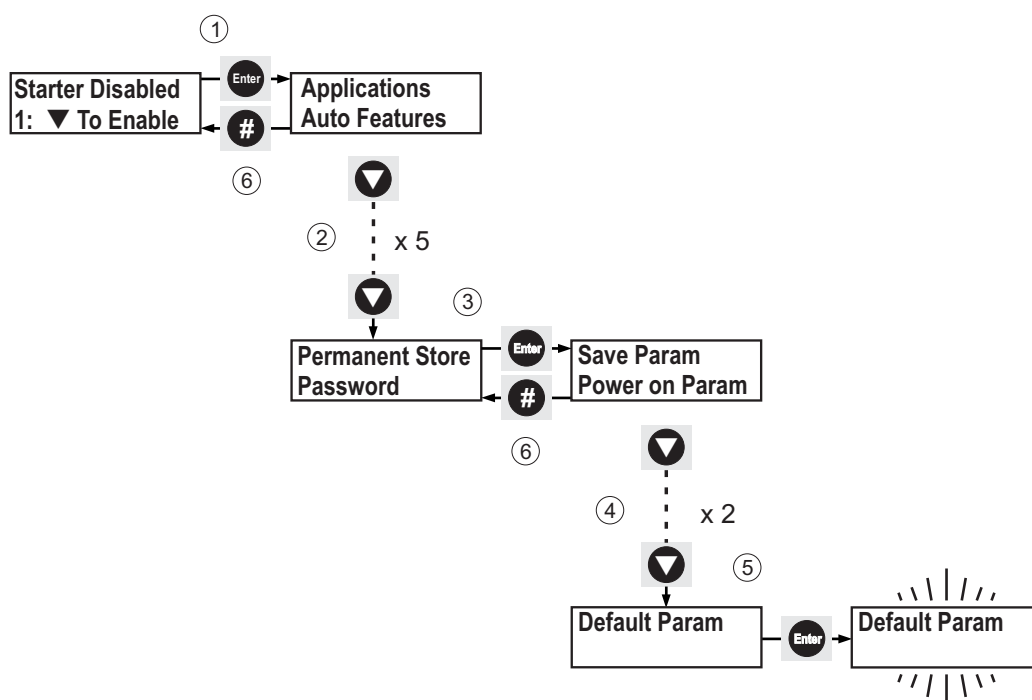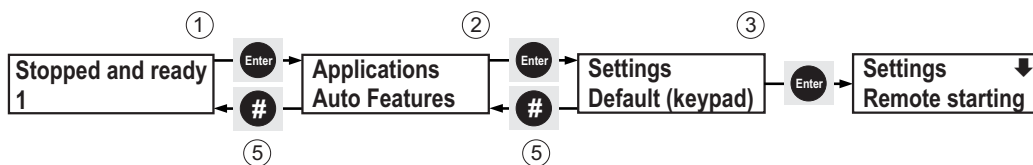
5.4.8 Viewing basic operating parameter values via the Settings menu option.

1. With `Starter Disabled` shown on the display press the **Enter** button once.
2. With `Applications` shown on the top line of the display,
    press the **Enter** button again.
3. With `Settings` on the top line of the display, press the **Enter** button and a downwards pointing arrow will appear on the right hand-side of the top line. Whilst this icon is displayed, the bottom line of the display will show a brief list of some of the basic parameters and their current values, including; the software version numbers; the starting option (`Remote` or `Keypad`); the current protection mode; the selected application (if none, the lower line of the display will remain blank for a moment); and whether any derating has been applied to the unit (if none, the lower line of the display will remain blank for a moment). When the arrow icon has disappeared, the report showing the basic parameters has finished and the user is the back in Menu Navigation mode, (see section **5.3.1**).
4. This menu item is read-only.
5. Press the **#** button twice to return to `Stopped and ready`.

Note; as this menu item is read-only, it cannot be saved.

5.4.9   Changing a password.

Note: This example assumes that the unit has been disabled (see section **5.4.1**) and if necessary has already been unlocked (see section **5.4.10**).

1.   With `Starter Disabled` displayed press the **Enter** button once.
2.   With `Applications` shown on the top line of the display, press the ▼ button until `Password` takes it's place on the top line.
3.   Press the **Enter** button once to select the `Password` menu.
4.   Press the ▼ button once and `Change Password` will be displayed on the top line.
5.   Press **Enter** once to select `Change Password`. A cursor will be visible on the bottom line of the display.
6.   Use the ▲ or ▼ button to enter a new password number.
7.   Press the **Enter** button once.
8.   The display will flash `New Password!` twice to confirm that the change has been made.
9.   Press the **#** button three times to return to `Starter Disabled`.
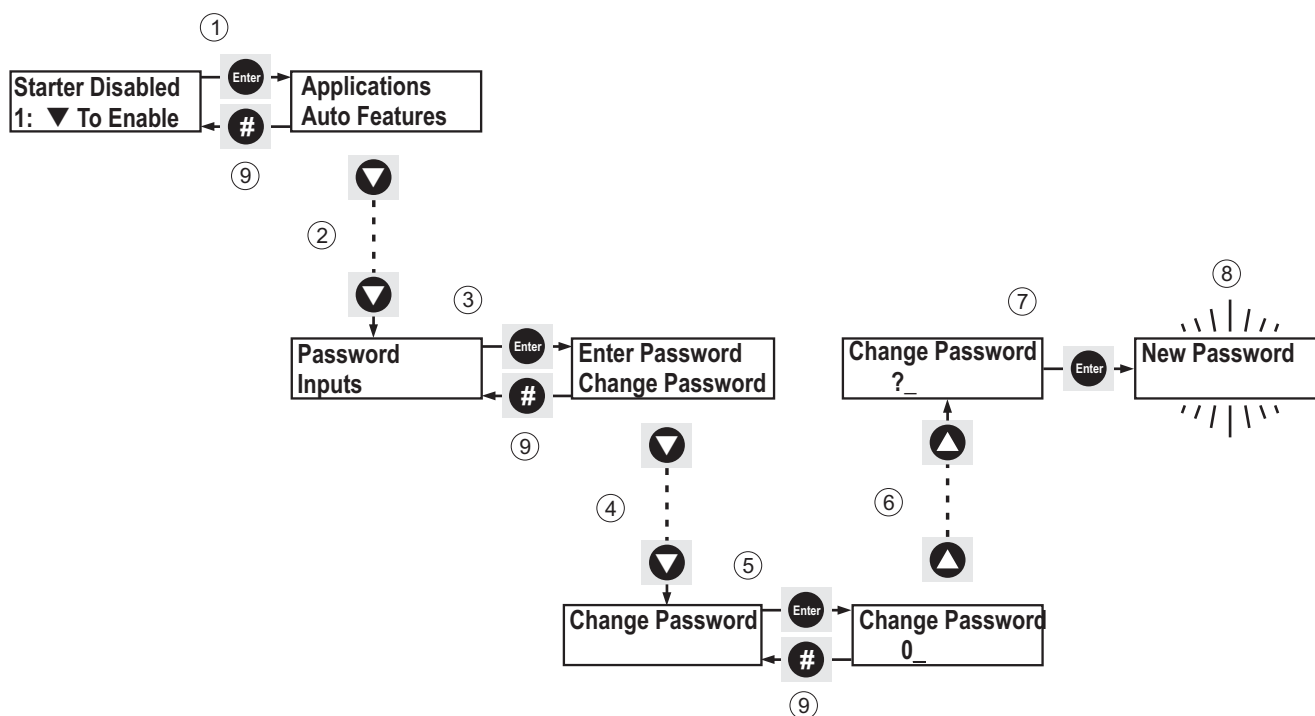

Notes

1.   The unit must be unlocked (section **5.4.10**) in order to change the password.
2.   Setting the password to zero (0) deletes any set password and leaves the unit un-locked AFTER the control supply has been cycled or the keypad/keypod has been reset.
3.   It is not necessary to save the password as it is stored automatically every time that it's value is changed.

5.4.10 Unlocking and locking the keypad.

1.   With `Stopped and ready` displayed press the **Enter** button once.

2.   With `Applications` shown on the top line of the display, press the ▼ button until `Password` takes it's place on the top line.

3.   Press **Enter** once to select the `Password` menu.

4.   Press **Enter** with `Enter Password` shown on the top line of the display. The unit will display its security status, `Locked` on the bottom line of the display. A cursor will also be visible on the bottom line of the display.

5.   Use the ▲ or ▼ button to enter the password.

6.   Press the **Enter** button once.

7.   If the correct password has been entered, the unit will display it's security status, `Un-locked` on the bottom line of the display. To lock the unit again, simply use the ▲ and ▼ buttons to enter any value, apart from zero (0) and the password. Press the **Enter** button once and the display will now say that it is `locked`.

8.   Press the **#** button three times to return to `Stopped and ready`.
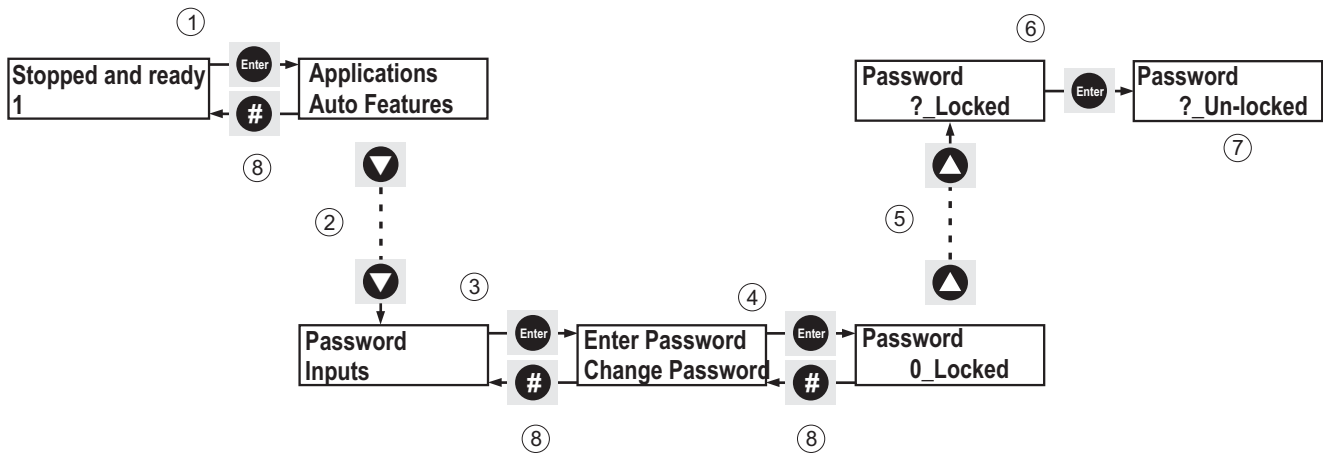
Note; if the control supply on an un-locked unit (i.e. the password has been set previously and then entered to unlock the unit) is cycled, upon reboot the unit will be in a locked state.

5.4.11 Using the pre-programmed relay options.

This example shows the user how to program any relay on the unit to via the pre-programmed options.

The option shown in the example below is the `Alarm` but the instructions apply equally for all the pre-programmed relay options (see section **5.3.9**) and for all the relays as they are all programmable.

1. With `Stopped and ready` shown on the display press the **Enter** button once.
2. With `Applications` shown on the top line of the display press the ▼ button until `Outputs` is shown at the top of the display.
3. Press **Enter** once to select the `Outputs` menu.
4. With `K1` on the top line of the display press the ▼ button until `K2` is shown at the top of the display.
5. Press **Enter** once to select `K2`.
6. With `Map From` on the top line of the display press the ▼ button times until `K=Alarm` is shown on the top line of the display.
7. Press **Enter** once to select `K=Alarm`. The display will flash twice to confirm the user's selection.
8. Press the **#** button three (3) times to return to `Stopped and ready`.

   To keep the above settings they must be permanently saved. See section **5.4.5**
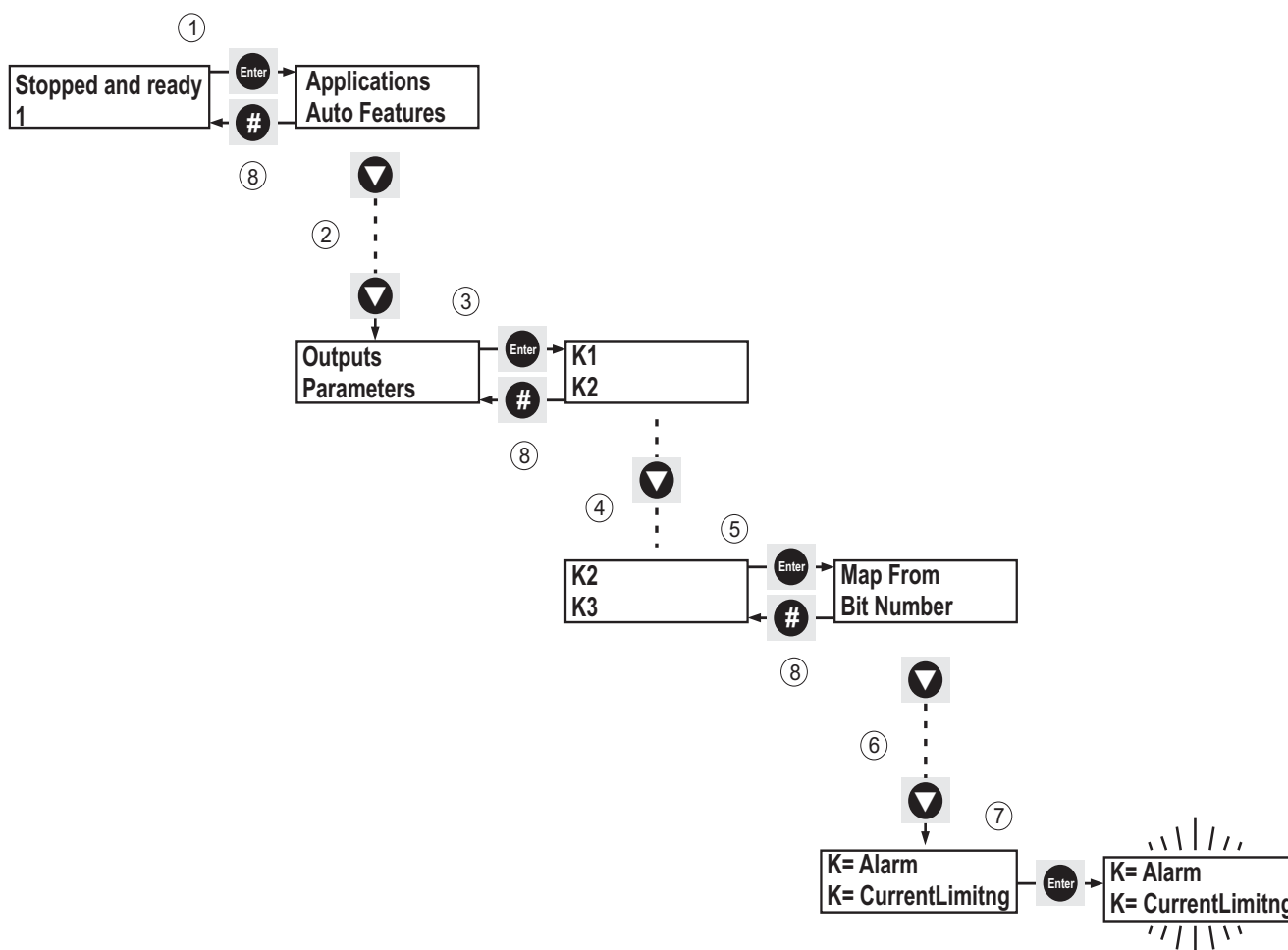
5.4.12 Setting the Low Amps Level, and using the K2 relay to display the status of Low Current bit.

This example shows the user how to set the Low Amps Level, and how to monitor the status of the Low Current bit via the K2 relay (see section **5.3.5**).

1. With Stopped and ready shown on the display press the **Enter** button once.
2. With Applications shown on the top line of the display press the ▼ button until Advanced is shown on the top line.
3. Press the **Enter** button once to select the Advanced menu.
4. With Current on the top line of the display, press **Enter** once to select the Current menu.
5. With Rated Current on the top line of the display press the ▼ button until Low Amps Level is shown on the top line.
6. With Low Amps Level on the top line of the display press **Enter** once.
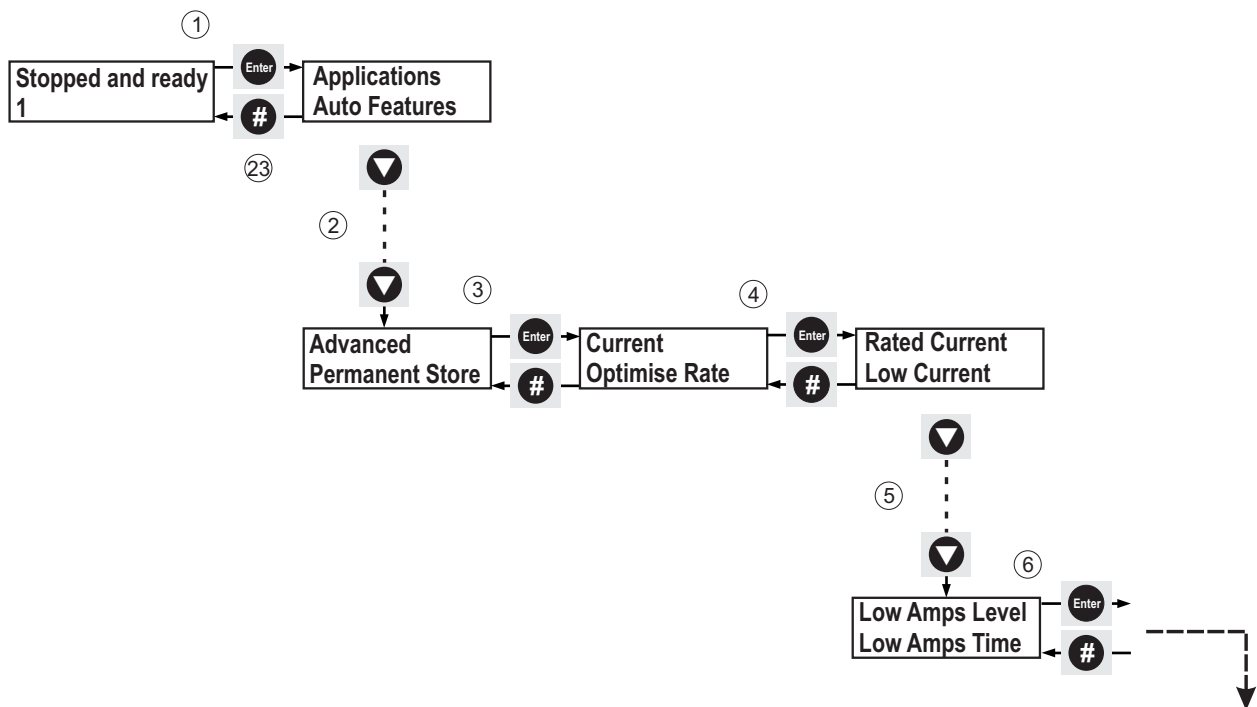
7   With `Low Amps Level` showing on the top line press the ▼ or ▲ buttons until the level required is set.

8   Press **Enter** once to confirm the change. The display will flash to confirm that the change has been made.

9   Press the **#** button twice to return to the `Advanced` menu.

10   With `Advanced` on the top line of the display press the ▼ button until `Outputs` is displayed on the top line.

11   Press the **Enter** button once to select `Outputs`.

12   Press the ▼ button until `K2` is shown on the top line of the display.

13   Press the **Enter** button once to select `K2`.

14   With `Map From` on the top line of the display, press **Enter** once.

15   With `8 Parameter` showing press the ▲ button until `112 Parameter` is displayed.

16   Press the **Enter** button once to confirm the change, the display will flash once.

17   Press the **#** button once to return to `Map From`.
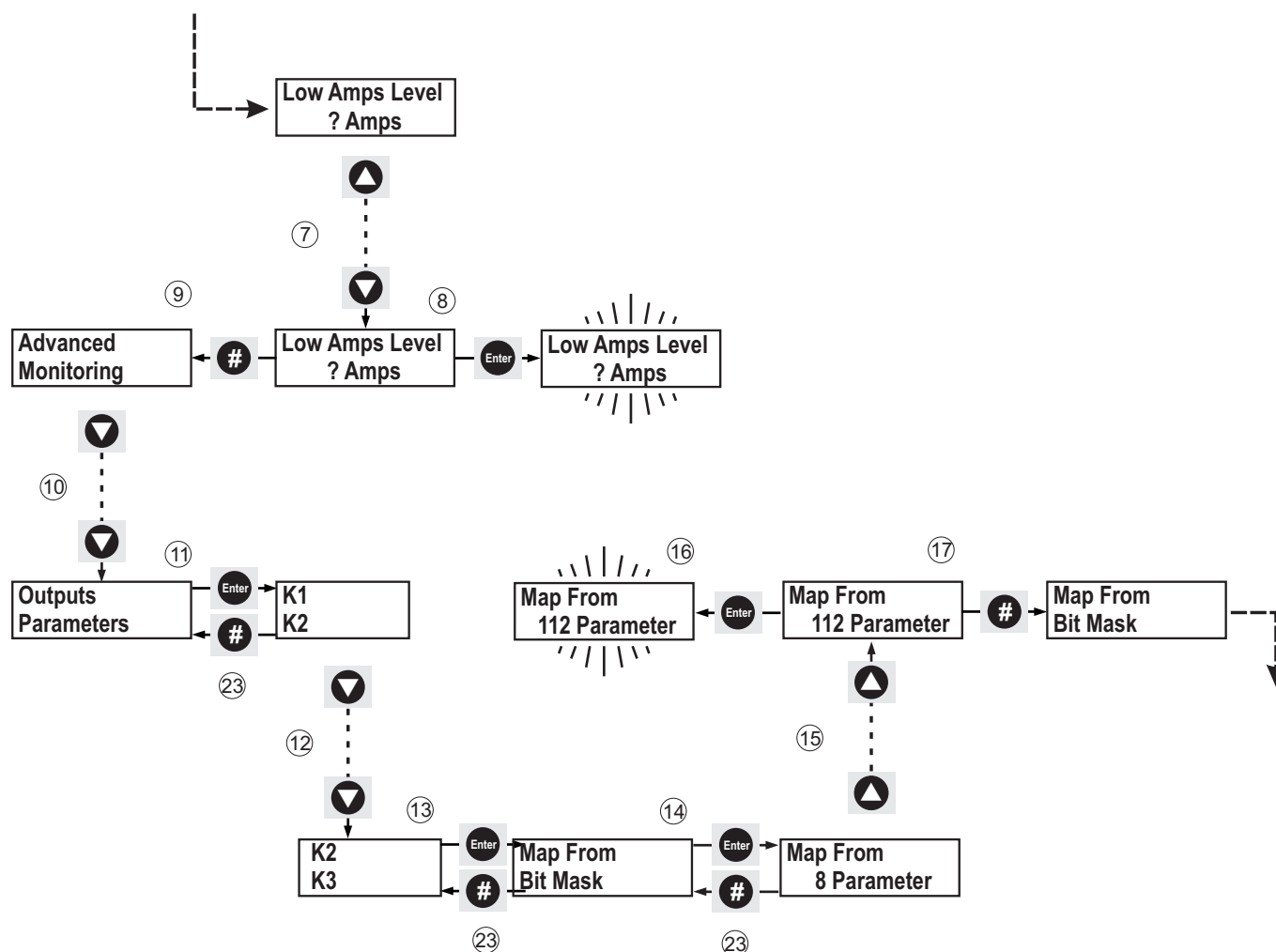
18   With `Map From` on the top line of the display, press the ▼ button once.

19   Press the **Enter** button once to select `Bit Number`.

20   Press the **Optimise** button three times to move the cursor to bit 3.

21   Press the ▲ button to change the bit state to one (1). (This may not be necessary, bit 3 may already be a one). **Note:** only one bit in any relay bit mask may be set to a positive bit state (set to one (1)), at any one time. To turn off any other bits, simply use the **Optimise** button to navigate to the required bit, and press the ▼ button to change it's bit state to zero (0).

22   Press the **Enter** button to confirm any changes, the display will flash.

23   Press the **#** button four times to return to **Stopped and ready**.

To keep the above settings they must be permanently saved. See section **5.4.5**
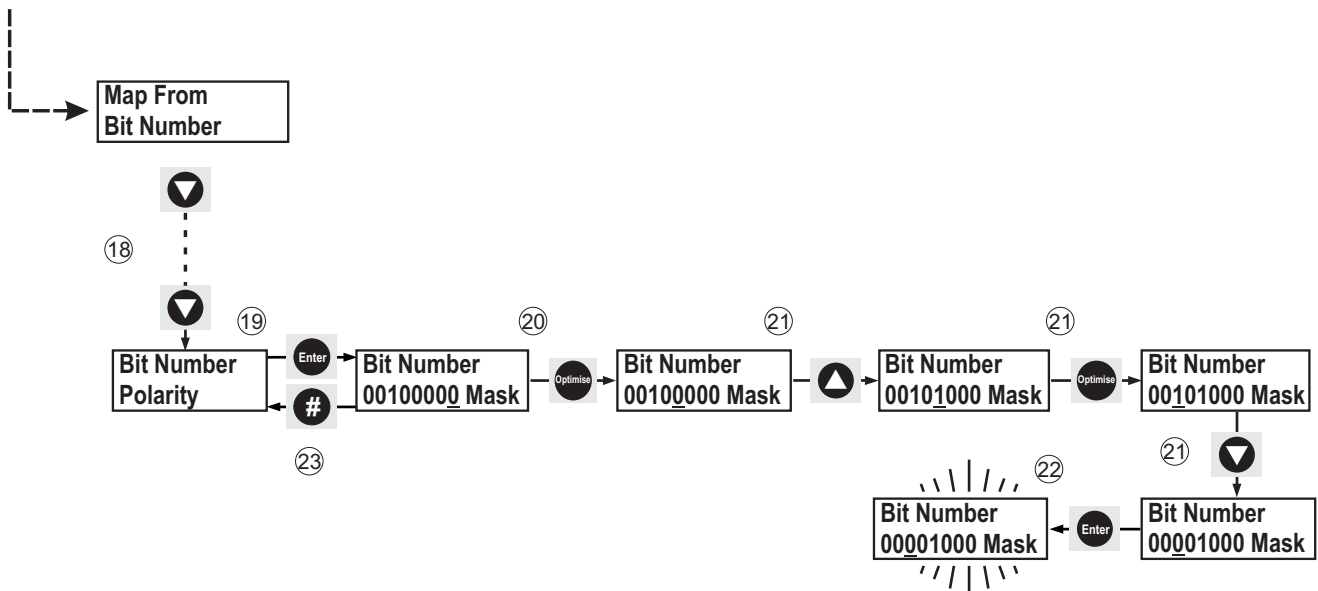
5.4.13 Using the K2 relay to mimic Programmable Input 1.

This example shows the user how energise a relay via the start signal.

1   With `Stopped and Ready` shown on the display press the **Enter** button once.
2   With `Applications` shown on the top line of the display press the ▼ button until `Outputs` is shown at the top of the display.
3   Press **Enter** once to select the `Outputs` menu.
4   With `K1` on the top line of the display press the ▼ button until `K2` is shown at the top of the display.
5   Press the **Enter** button once to select `K2`.
6   With `Map From` on the top line of the display press **Enter** once.

Xfe
FD843201_F
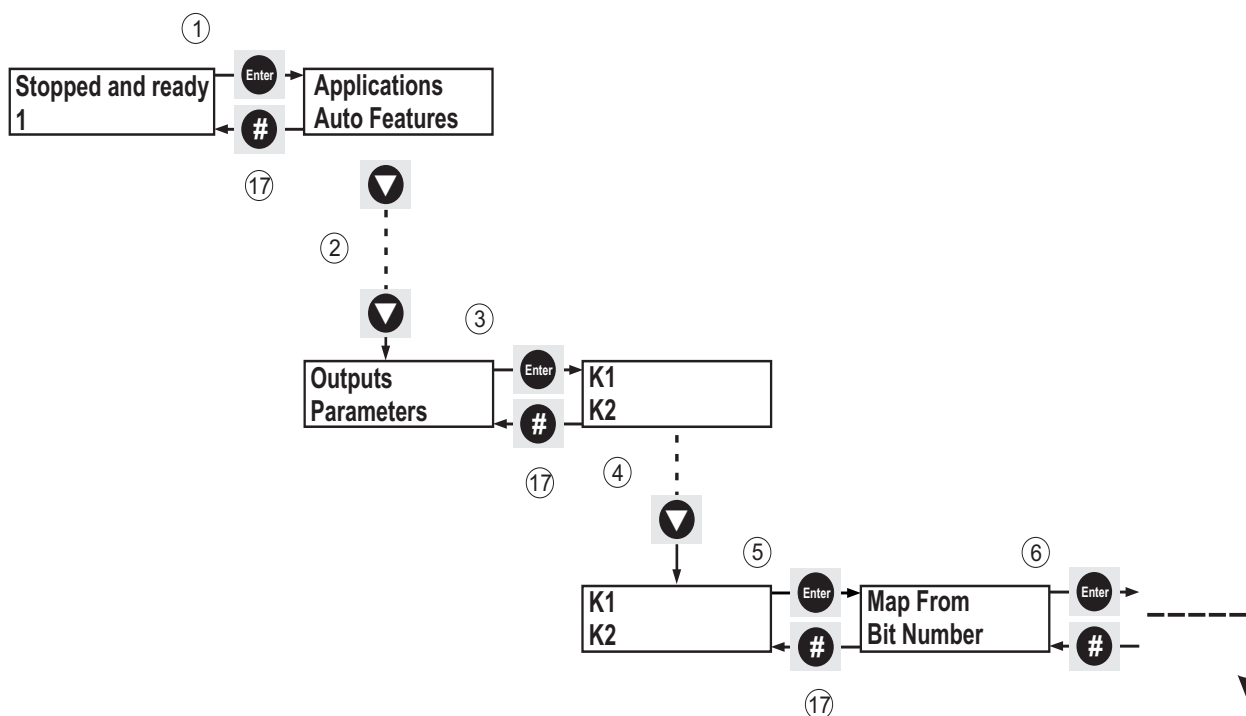
7   With `8 Parameter` showing press the ▲ button until `10 Parameter` is displayed.

8   Press **Enter** once to apply the change

9   Press **#** once to return to `Map From`.

10   With `Map From` on the top line of the display press ▼ button once until `Bit Number` is displayed.

11   Press **Enter** once to select `Bit Number`.

12   Press the **Optimise** button three times so the cursor is displayed on bit 3.

13   Press the ▼ button once to change the bit state to zero (0).

14   Press the **Optimise** button once so the cursor is displayed on bit 4.

15   Press the ▲ button once to change the bit state to one (1).

16   Press **Enter** once to accept the change.

17   Press **#** four times to return to `Stopped and Ready`.

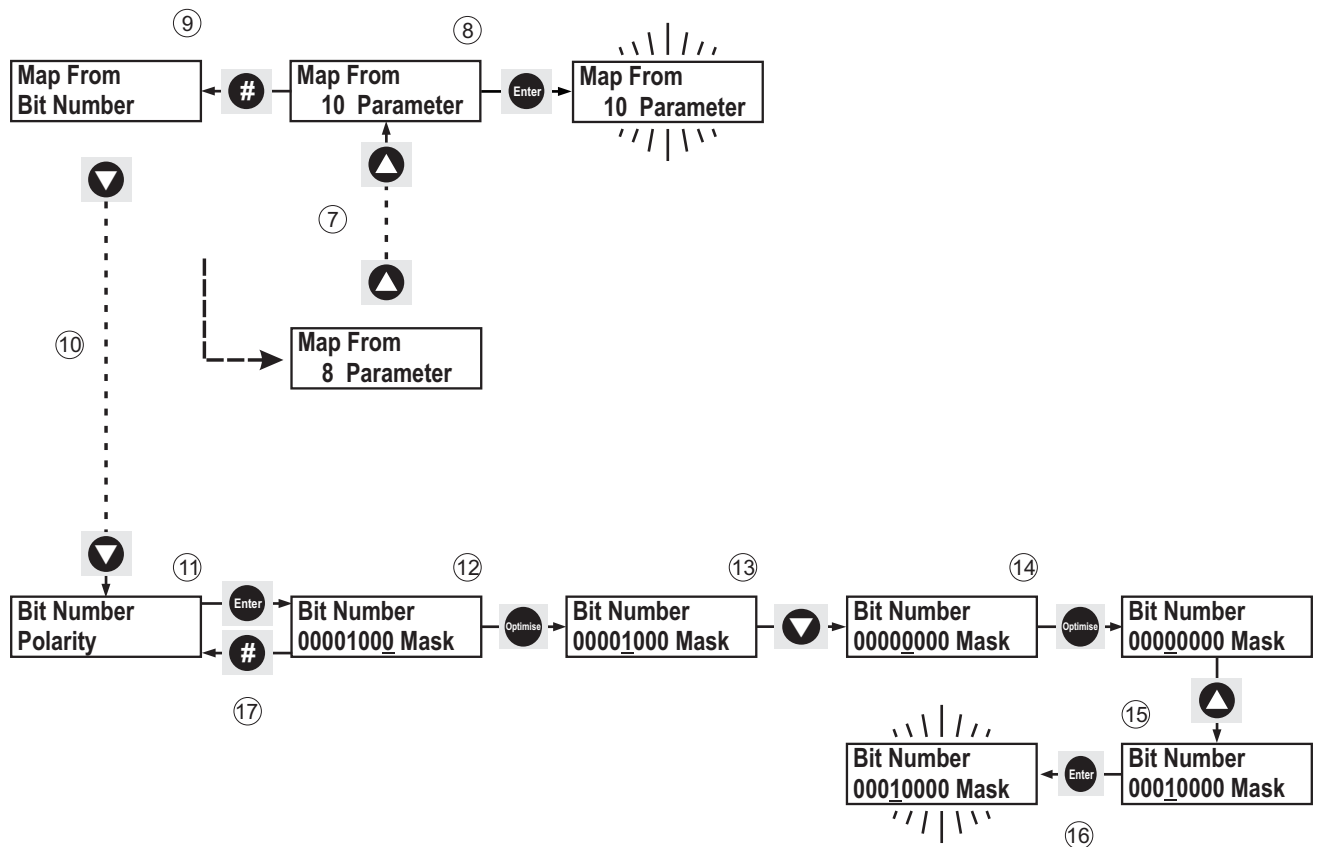To keep the above settings they must be permanently saved. See section **5.4.5**

5.5 Advanced Setup Examples

5.5.1 Using an Alternative Parameter Group

For applications that require the control of two motors or where the user requires different control characteristics for a single motor at different stages of the duty cycle, the Xfe soft starter offers two parameter groups. The Primary parameter group holds the parameters considered necessary for motor starting and stopping, and it is this group that the starter defaults to. The Secondary parameter group is a mirror of the parameters in the first parameter group, but **NOT** necessarily a mirror of the values in the first parameter group. The parameters in each group are shown below.

Parameter	Primary Group	Secondary Group
Protection Mode	P7	P78
Start Pedestal	P11	P79
Start Time	P12	P80
Kick Pedestal	P13	P81
Kick Time	P14	P82
Dwell Time	P15	P83
Stop Pedestal	P16	P84
Stop Time	P17	P85
Auto Config	P18	P86
Low Current Level	P28	P87
Low Current Time	P29	P88
Current Limit Level	P30	P89
Current Limit Time	P31	P90
Shearpin Level	P32	P91
Shearpin Time	P33	P92
Overload Level	P34	P93
Overload Delay	P35	P94
User Flags 1	P51	P95
User Flags 2	P52	P96

Table 5.5.1; Primary and Secondary Parameter Groups

Xfe
FD843201_F

The Primary group parameters can also be changed via the menu structure, however the Secondary group parameters can only be changed via the dedicated parameter numbers. As a default the soft starter uses the Primary group of parameters. The user can select from between each group from either the keypad or using one of the programmable control inputs.

5.5.2 Changing the Parameter Group after Top of Ramp.

In this example the user is shown how to change parameter groups whilst running, if, for example, two overload values were required, one for starting and the other for running.

1   With `Stopped and ready` shown on the display press the **Enter** button once.

2   With `Applications` shown on the top line of the display press the ▼ button until `Parameters` is shown at the top of the display.

3   Press **Enter** once to select the `Parameters` menu.

4   With `P1 - P20` shown on the display press the ▼ button until `P81 - P100` is shown at the top of the display.

5   Press **Enter** to select `P81 - P100`.

6   With `P81 Kick Ped 2` at the top of the display press the ▼ button until `P97 U1 I/P srce` is shown on the top line of the display.

7   Press **Enter** to select `P97 U1 I/P srce`.
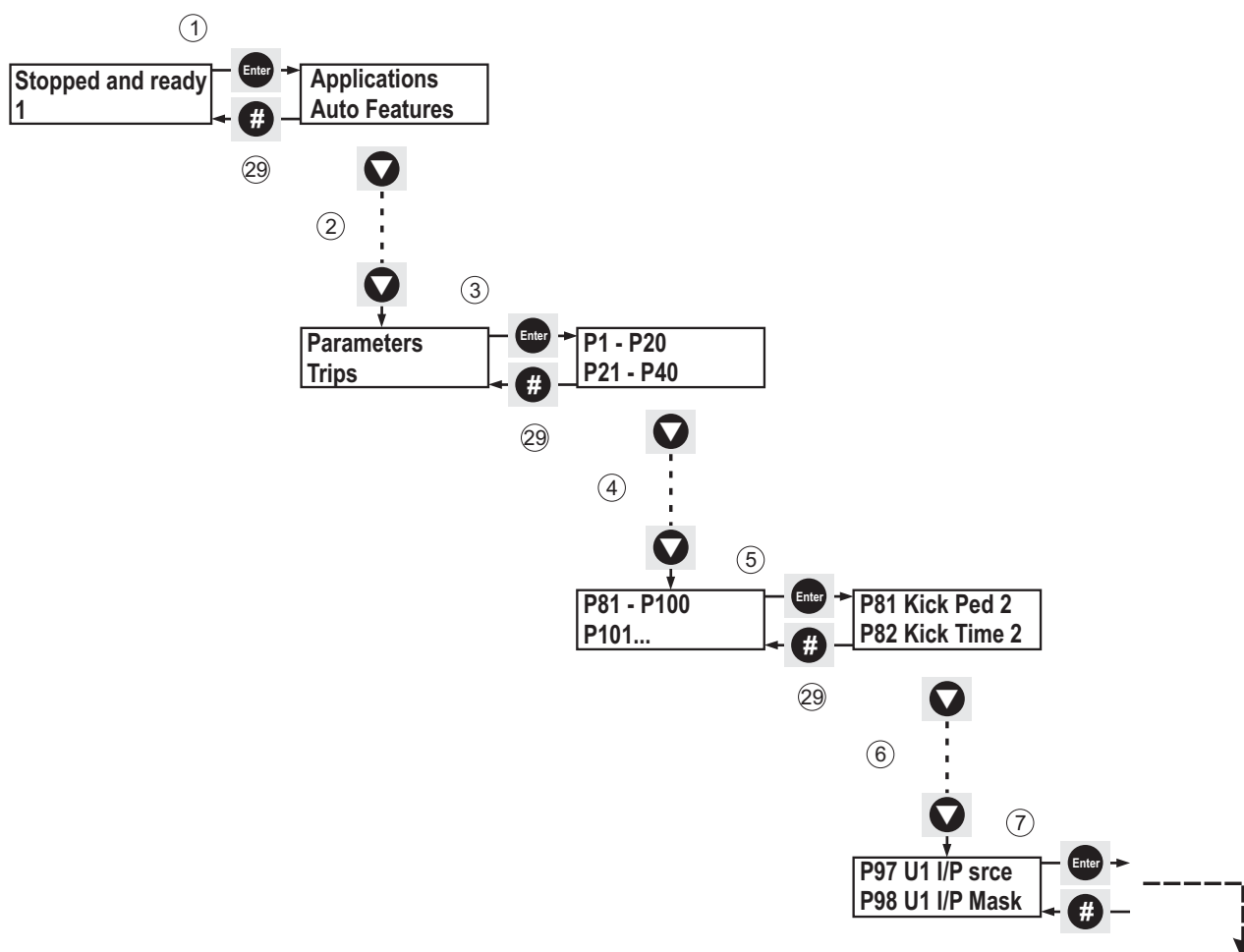
8   With `0 Parameter` shown on the display press the ▲ button until `8 Parameter` is displayed.

9   Press **Enter** once to accept the change.

10   Press **#** once to return to `P97 U1 I/P srce`.
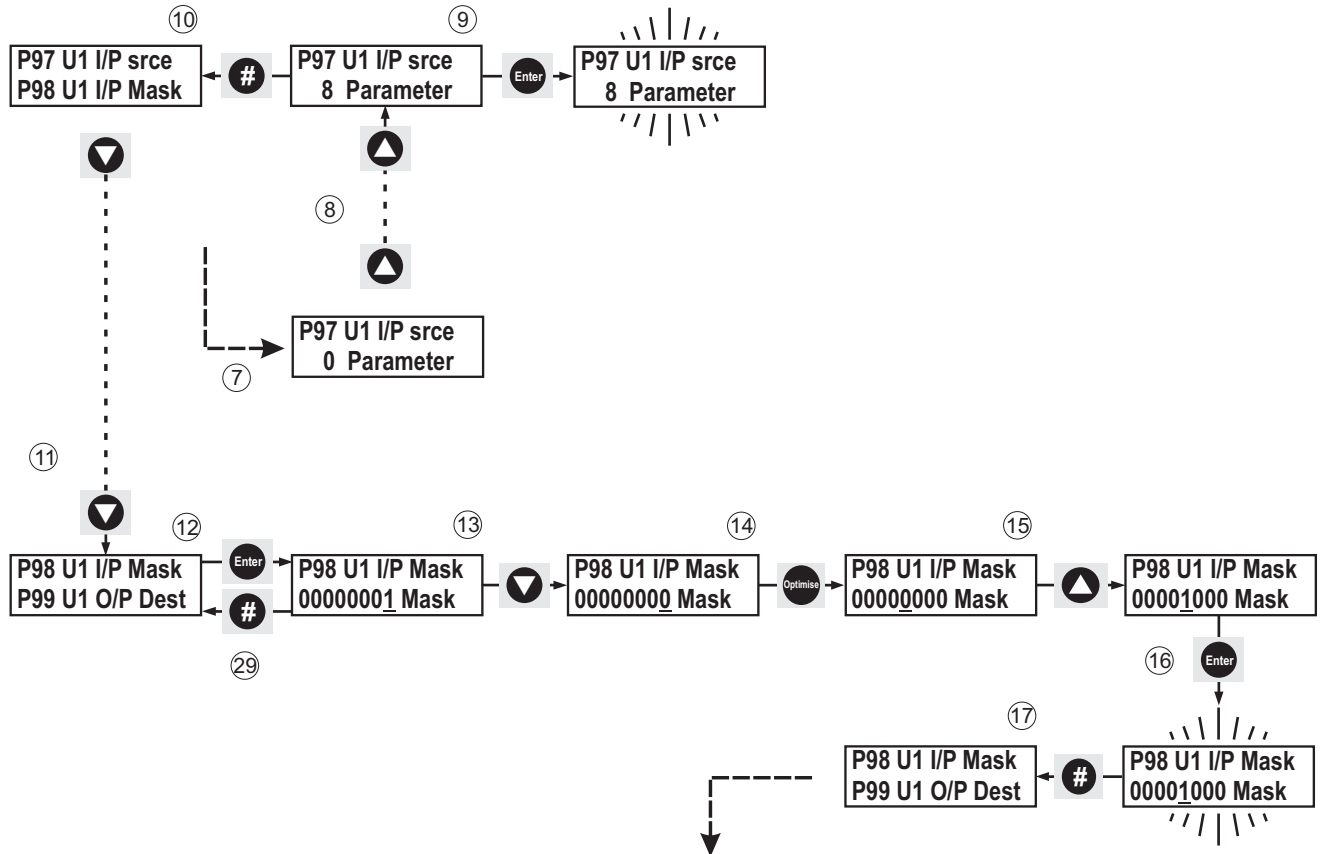
11   Press the ▼ button once until `P98 U1 I/P Mask` is shown at the top of the display.

12   Press `Enter` to select `P98 U1 I/P Mask`.

13   Press the `Optimise` button three times so that the cursor is displayed on `bit 3`.

14   Press the ▲ button once to change the bit state of `bit 3` to one (1).

15   Press **Enter** once to confirm the changes.

16   Press **#** once to return to `P98 U1 I/P Mask`.

17   Press the ▼ button once so that P99 U1 O/P Dest is shown at the top of the display.

18   Press **Enter** to select P99 U1 O/P Dest.

19   With 0 Parameter shown on the display press the ▲ button until 52 Parameter is displayed.

20   Press **Enter** once to accept the change.

21   Press **#** once to return to P99 U1 O/P Dest.

22   Press ▼ once until P100 U1 O/P Mask is shown at the top of the display.
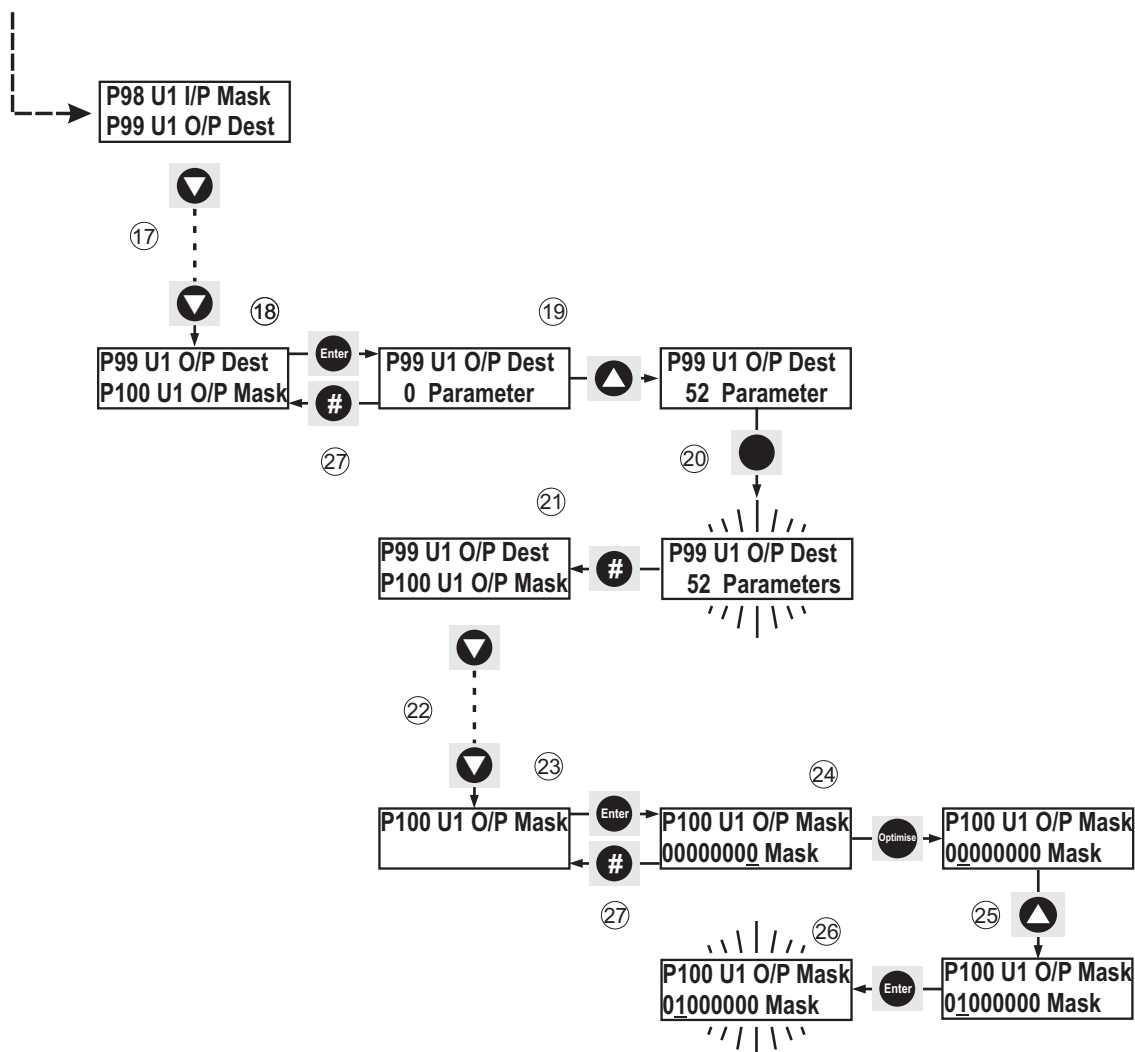
23   Press **Enter** to select P100 U1 O/P Mask.

24   Press the **Optimise** button six times so that the cursor is displayed on bit 6.

25   Press the ▲ button once to change the bit state of bit 6 to one (1).

26   Press **Enter** once to accept the change.

27   Press **#** four times to return to Stopped and Ready.

To keep the above settings they must be permanently saved. See section **5.4.5**

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5.5.3 Using the K3 relay to indicate a Stall (plus units only)

Here the user is shown how to output the unit's stall signal. This might be used by a customer to monitor a motor's stall status.

This can now be done via the `Outputs` menu then `K3`. See section 5.3.10

1   With `Stopped and Ready` shown on the display press **Enter** button once.
2   With `Applications` shown on the top line of the display press ▼ button until `Outputs` is shown at the top of the display.
3   Press **Enter** once to select the `Outputs` menu.
4   With `K1` on the top line of the display press ▼ button until `K3` is shown at the top of the display.
5   Press **Enter** once to select `K3`.
6   With `Map From` on the top line of the display press **Enter** once.
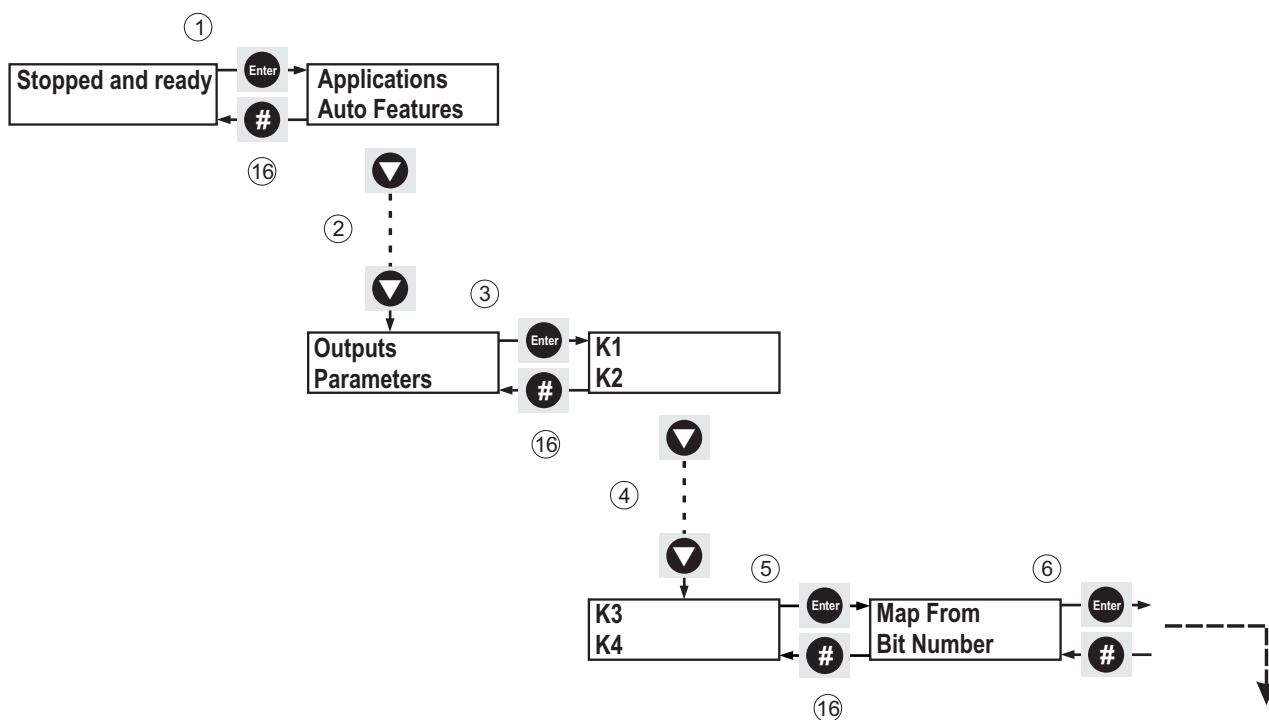
7   Check that `9 Parameter` is showing - if it isn't press the ▼ button until it is displayed.

8   Press **Enter** once to apply any changes and the display will flash once to confirm the changes have been accepted.

9   Press **#** once to return to `Map From`.

10   With `Map From` on the top line of the display press the ▼ button once until `Bit Number` is displayed.

11   Press **Enter** once to select `Bit Number`.

12   With the cursor on the LSB press the ▼ button once to change the bit state to zero (0).

13   Press the **Optimise** button until the cursor is displayed on bit 2.

14   Press the ▲ button once to change the bit state to one (1).

15   Press **Enter** once to apply the change. The display will flash once to confirm the change has been accepted.

16   Press **#** four times to return to `Stopped and ready`.
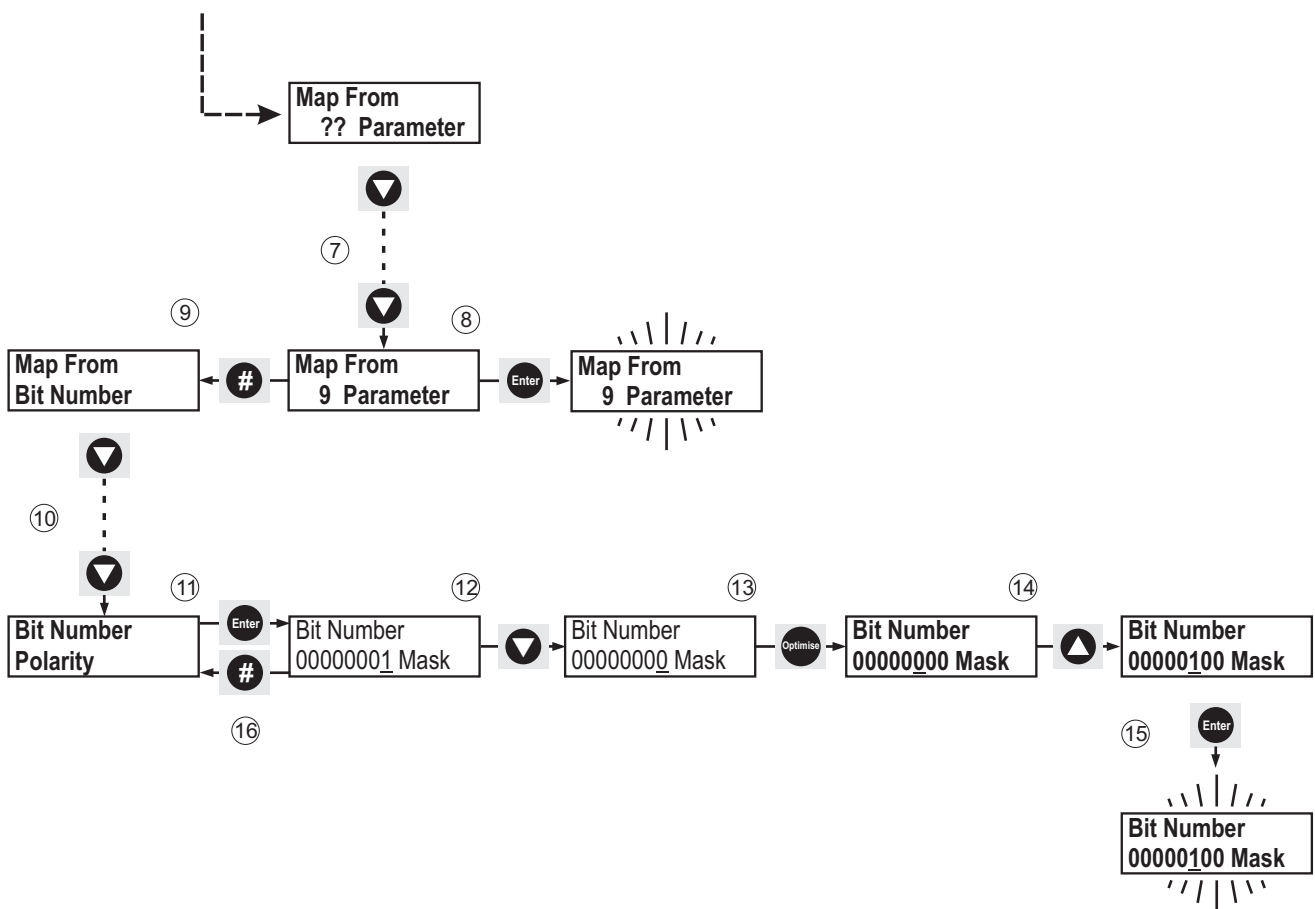
To keep the above settings they must be permanently saved. See section **5.4.5**

5.5.4   Selecting Optimising with Programmable Input 1.

This example programs the **S1** input to turn the Optimising function Off and On. When the specified voltage is applied and removed to and from the S1 input, the energy optimising function is turned Off and On (note the inverse action - apply voltage = Optimising Off).

1   With `Stopped and Ready` shown on the display press **Enter** button once.

2   With `Applications` shown on the top line of the display press ▼ button until `Inputs` is shown at the top of the display.

3   Press **Enter** once to select the `Inputs` menu.

4   With `Digital i/p 1` on the top line of the display press **Enter** once.

5   With `Map To` on the top line of the display press **Enter** once.

6   With `52 Parameter` showing press the ▼ button until `7 Parameter` is displayed.

7   Press **Enter** once to accept the change.

8   Press **#** once to return to `Map To`.
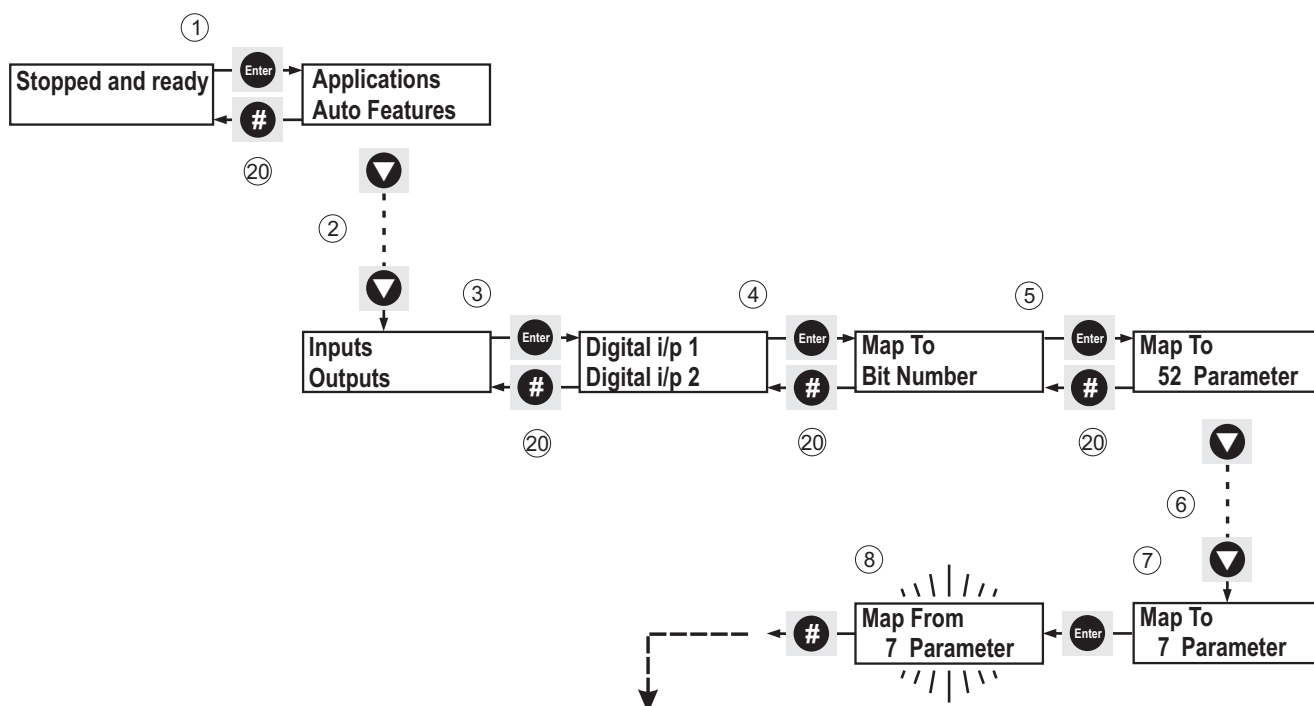
9   With Map To on the top line of the display press the ▼ button once until Bit Number is displayed.

10   Press **Enter** once to select Bit Number.

11   Press the **Optimise** button four times so that the cursor moves to bit 4.

12   Press the ▼ button once to change the bit state of bit 4 to zero (0).

13   Press the **Optimise** button three times so the cursor moves to bit 7.

14   Press the ▲ button once to change the bit state of bit 7 to one (1).

15   Press **Enter** once to accept the change. The display will flash once to confirm the change has been accepted.

16   Press # once to return to Bit Number.

17   With Bit Number on the top line of the display press the ▼ button once until Polarity is displayed on the top line.

18   Press **Enter** once to select Polarity.

19   With Positive logic displayed press **Enter** once to change to Inverse logic. The display will flash once to confirm the change has been accepted.

20   Press # four times to return to Stopped and ready.

To keep the above settings they must be permanently saved. See section **5.4.5**
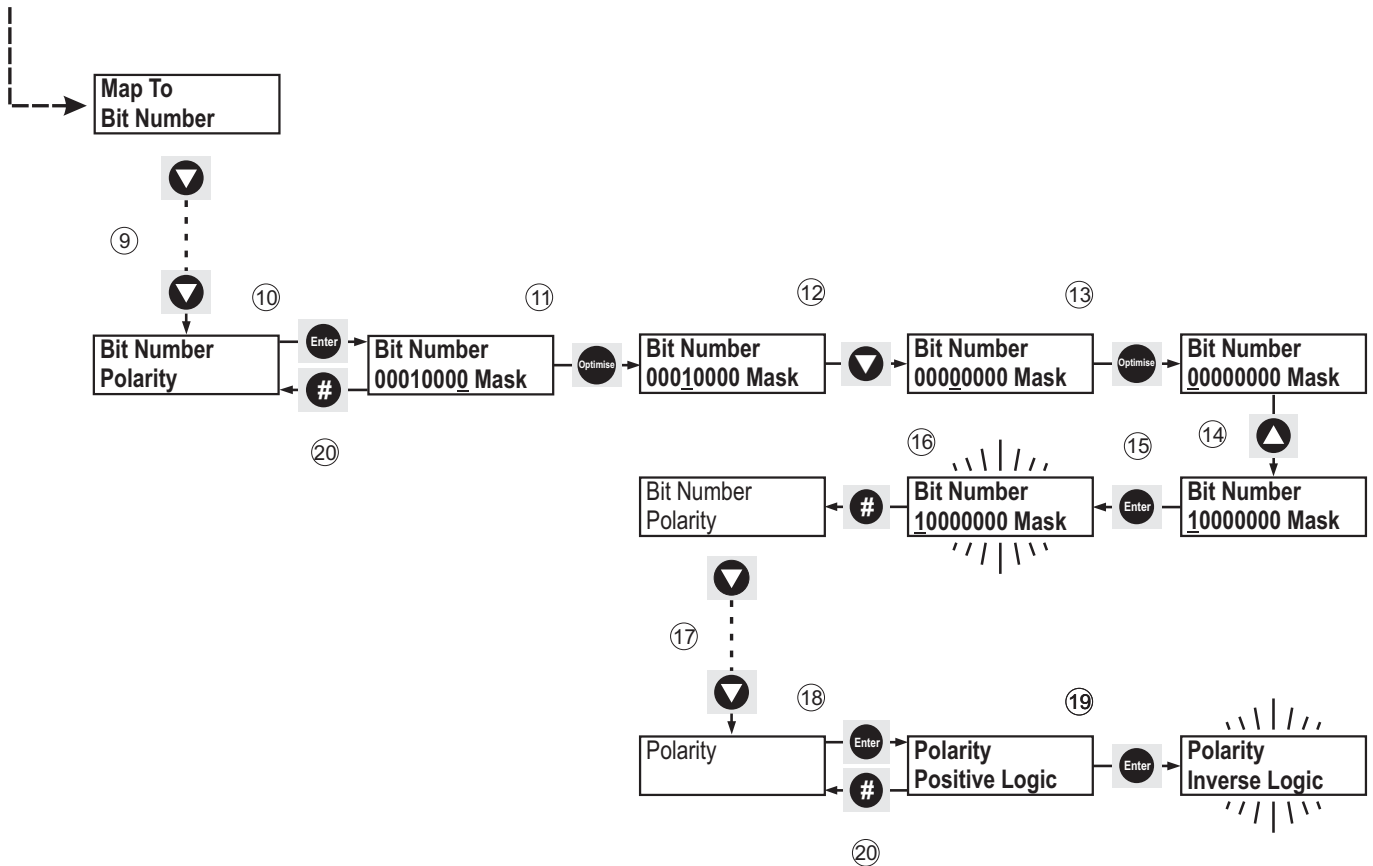
5.5.5 Selecting a 'Kick' Start with Programmable Input 3 (plus units only)

If the start-up characteristics of the load vary, i.e. 'sticky' and non-sticky, the user will be able to use the input to select a kick start for a 'sticky' load.

1. With Stopped and Ready shown on the display press **Enter** button once.
2. With Applications shown on the top line of the display press the ▼ button until Inputs is shown at the top of the display.
3. Press **Enter** once to select the Inputs menu.
4. With Digital i/p 1 on the top line of the display press the ▼ button until Digital i/p 3 is displayed.
5. With Digital i/p 3 on the top line of the display press **Enter** once.
6. With Map To on the top line of the display press **Enter** once.
7. With 0 Parameter showing press the ▲ button until 51 Parameter is displayed.
8. Press **Enter** once to accept the change.
9. Press **#** once to return to Map To.

10   With `Map To` on the top line of the display press ▼ button once until `Bit Number` is displayed.

11   Press **Enter** once to select `Bit Number.`

12   Press the ▲ button once to change the bit state of the LSB to one (1).

13   Press **Enter** once to accept the change.

14   Press **#** four times to return to `Stopped and Ready.`

To keep the above settings they must be permanently saved. See section **5.4.5**

5.5.6 Selecting a Parameter Group with Programmable Input 2, (plus units only)

The user will be able to choose between two pre-programmed parameter groups, using the second programmable input. These parameter groups will have been pre-programmed by user to suit different load conditions.

1   With `Stopped and Ready` shown on the display press the **Enter** button once.

2   With `Applications` shown on the top line of the display press the ▼ button until `Inputs` is shown at the top of the display.

3   Press **Enter** once to select the `Inputs` menu.

4   With `Digital i/p 1` displayed press ▼ button until `Digital i/p 2` is displayed.

5   With `Digital i/p 2` on the top line of the display press **Enter** once.

6   With `Map To` on the top line of the display press **Enter** once.

7   With `0 Parameter` showing press the ▲ button until `52 Parameter` is displayed.

8   Press **Enter** once to accept the change. The display will flash once to confirm the change has been accepted.

9   Press **#** once to return to `Map To`.
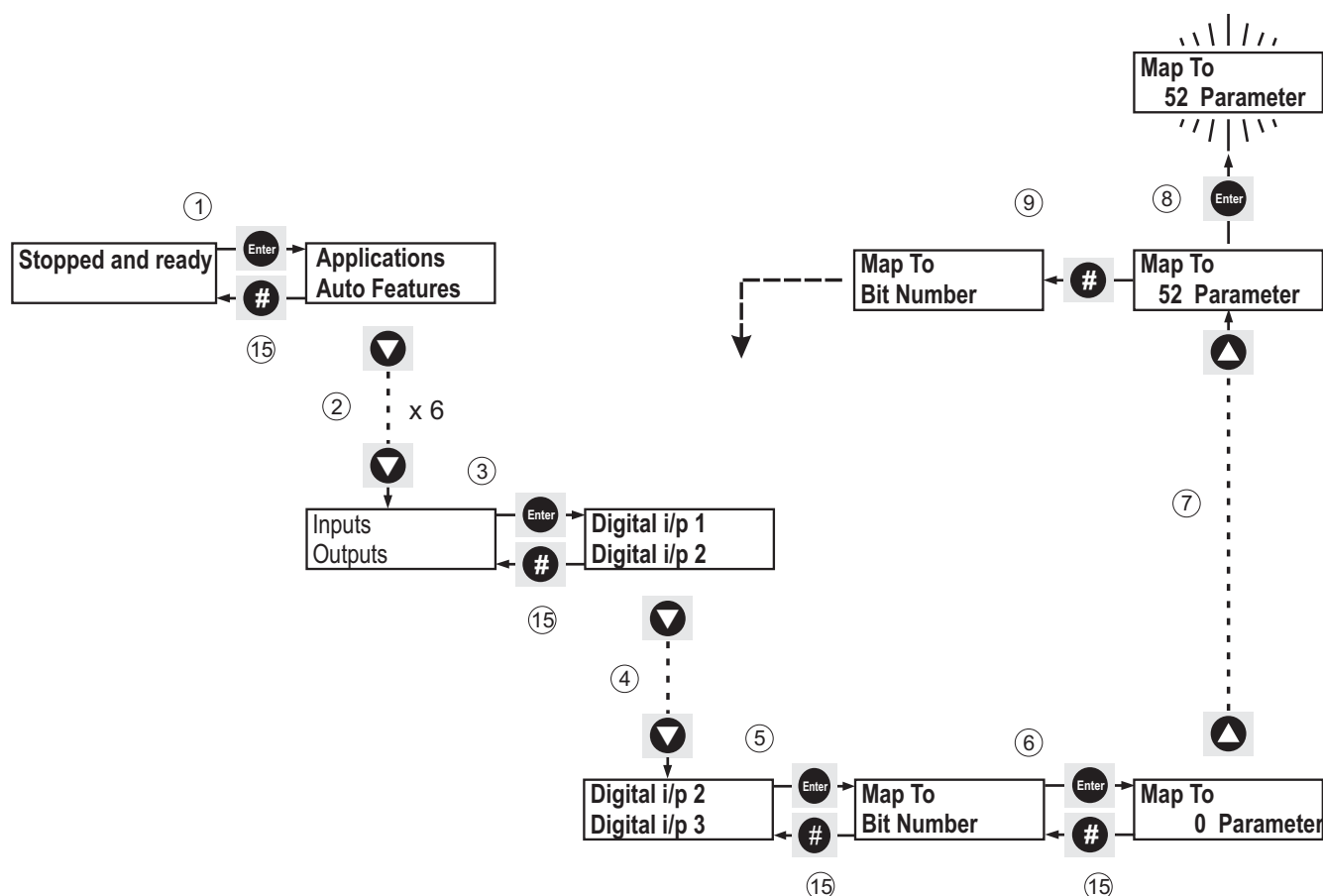
10   With `Map To` on the top line of the display press the ▼ button once until `Bit Number` is displayed.

11   Press **Enter** once to select `Bit Number`.

12   Press the **Optimise** button six times so the cursor is displayed on bit 6.

13   Press the ▲ button once to change the bit state of bit 6 to one (1).

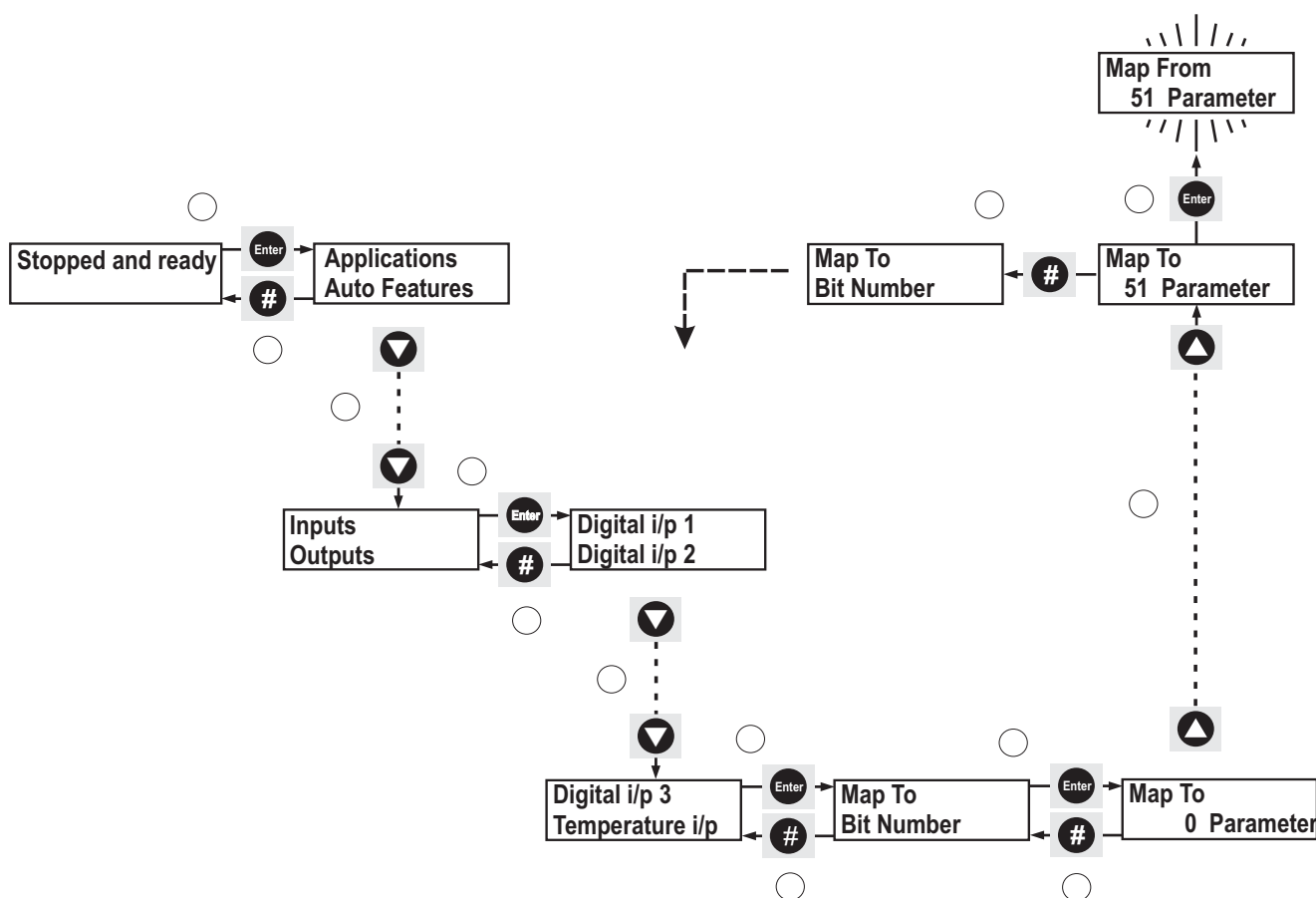14   Press **Enter** once to accept the change. The display will flash once to confirm the change has been accepted.

15   Press **#** four times to return to `Stopped and Ready`.

To keep the above settings they must be permanently saved. See section **5.4.5**
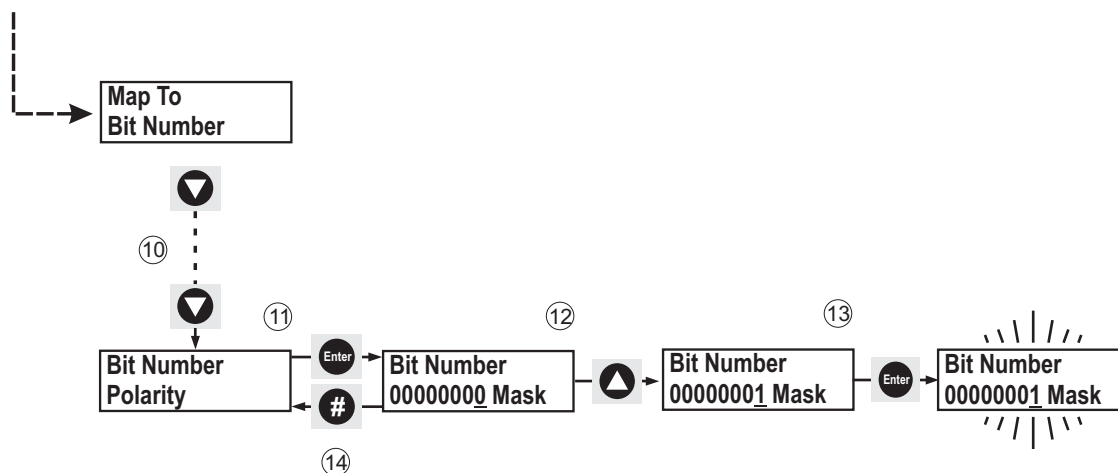
5.5.7 Using the K3 relay to indicate the Main Contactor status, (plus units only)

1. With `Stopped and Ready` shown on the display press the **Enter** button once.
2. With `Applications` shown on the top line of the display press the ▼ button until `Outputs` is shown at the top of the display.
3. Press **Enter** once to select the `Outputs` menu.
4. With `K1` on the top line of the display press the ▼ button until `K3` is shown at the top of the display.
5. Press **Enter** once to select `K3`.
6. With `Map From` on the top line of the display press **Enter** once.

7 Press the ▲ or ▼ buttons until `52 Parameter` is displayed on the bottom line of the display.

8 Press the **Enter** button once to apply the change. The display will flash once to confirm the change has been accepted.

9 Press **#** once to return to `Map From`.

10 With `Map From` on the top line of the display press the ▼ button once so that `Bit Number` is displayed on the top line.

11 Press **Enter** once to select `Bit Number`.

12 With the cursor on the LSB, Press the ▼ button once to change the bit state to zero (0).

13 Press the **Optimise** button until the cursor is displayed on bit five .

14 Press the ▲ button once to change the bit state to one (1).

15 Press **Enter** once to accept the change.

16 Press **#** four times to return to `Stopped and Ready`.
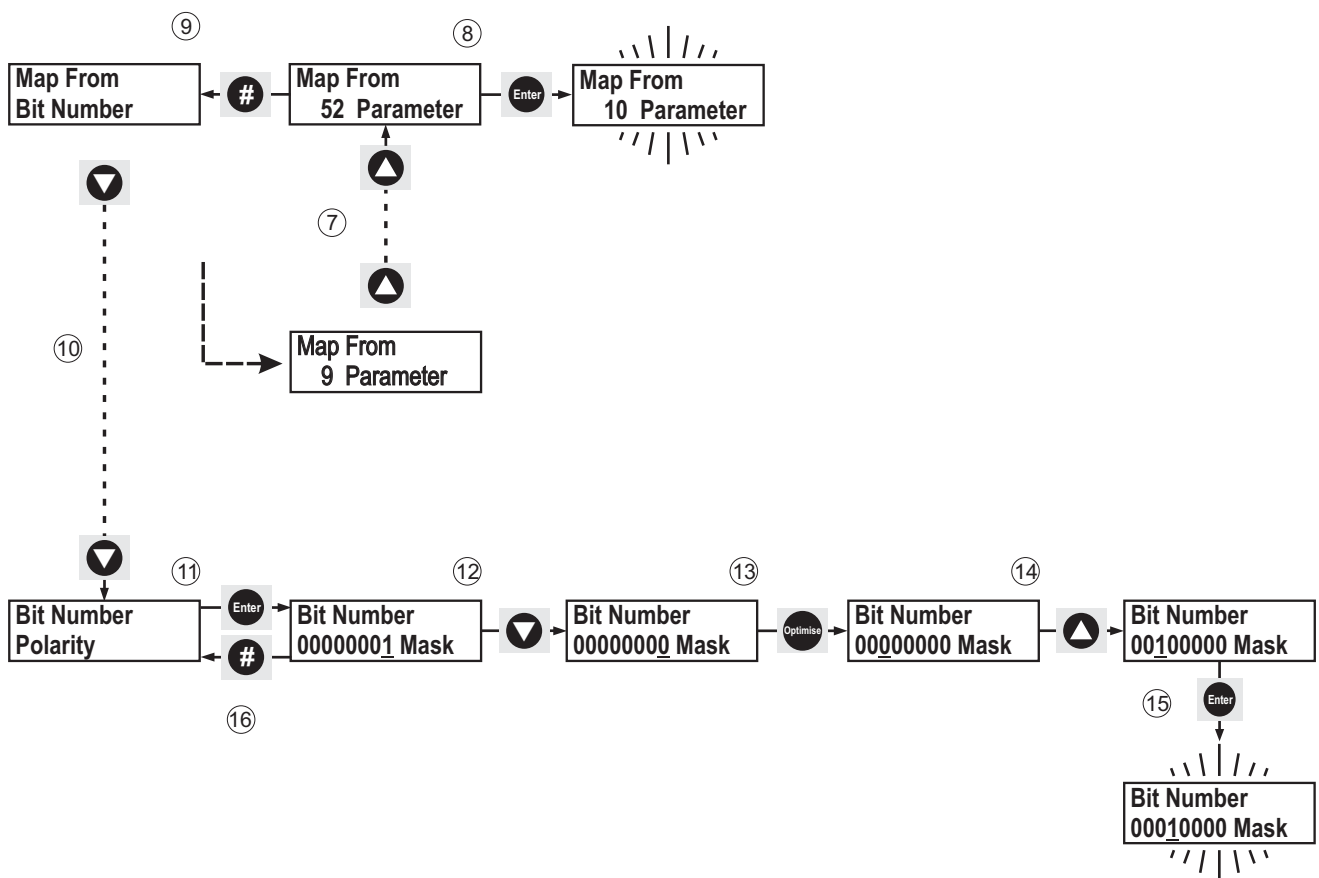
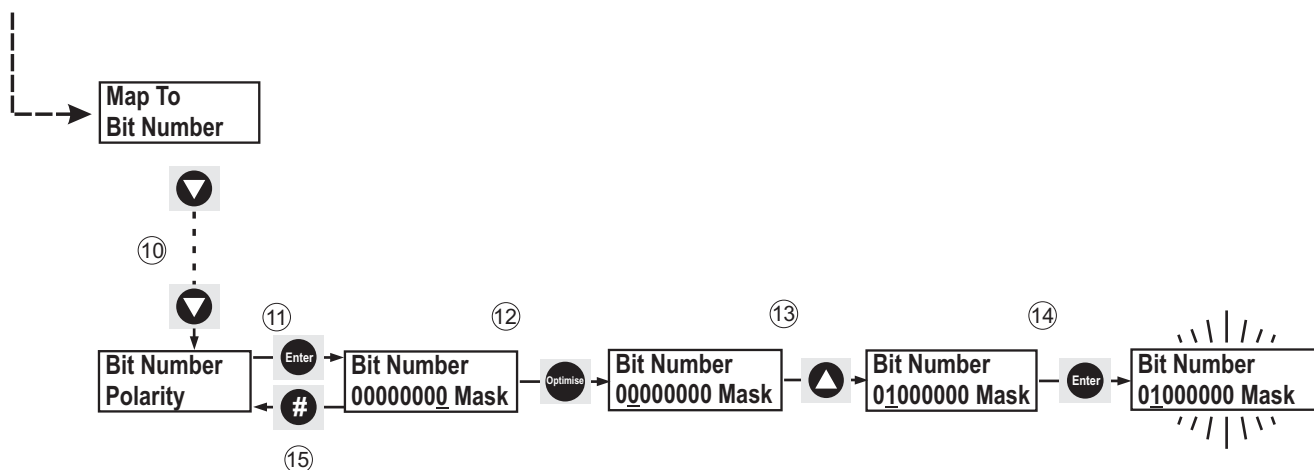To keep the above settings they must be permanently saved. See section **5.4.5**

5.5.8 Using the 4-20mA input to monitor a level, (plus units only).

The unit can monitor the voltage level of the 4-20mA input and can be programmed to set a bit when that input level reaches a certain value. This bit can then be used to energise a relay, for example the K3 relay.

1   With `Stopped and ready` on the top line of the display, press **Enter**.

2   With `Applications` on the top line of the display, press the ▼ button until the display reaches `Inputs`.

3   With `Inputs` on the top line, press the **Enter** button.

4   Press the ▼ button until `4-20mA i/p` is on the top line of the display.

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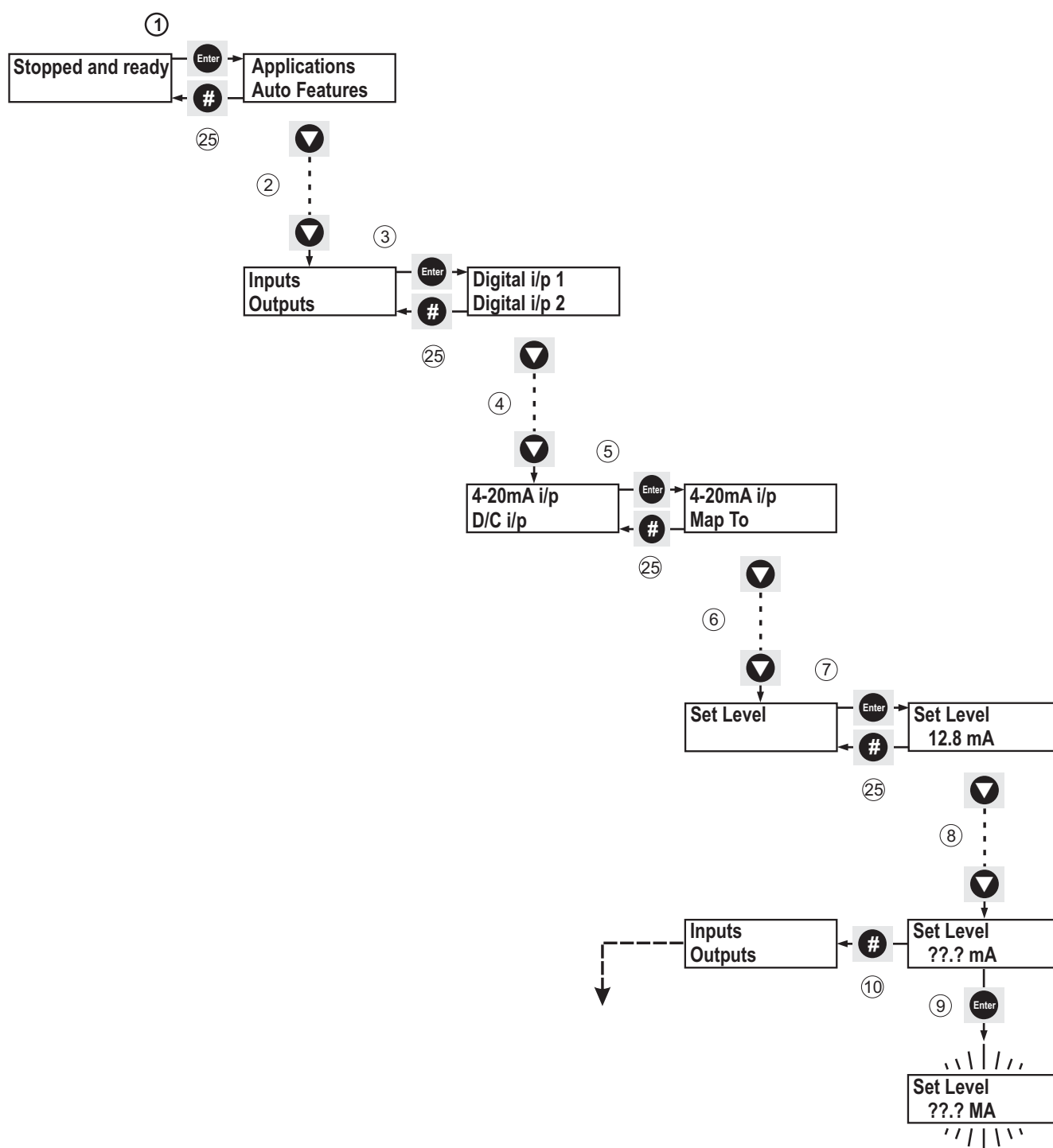
5   Press the **Enter** button.

6   Scroll down with the ▼ button until Set Level is on the top line.

7   Press the **Enter** button.

8   Using the ▲ and ▼ buttons set the level at which the unit is required to switch over from a zero (0) to a one (1).

9   Press the **Enter** button once to confirm the change.

10   Press the **#** button three times to return to the Inputs menu.

11   Press the ▼ button until Outputs is on the top line of the display.

12   Press the **Enter** button.

13   With K1 on the top line, press the ▼ button until K3 is on the top line.
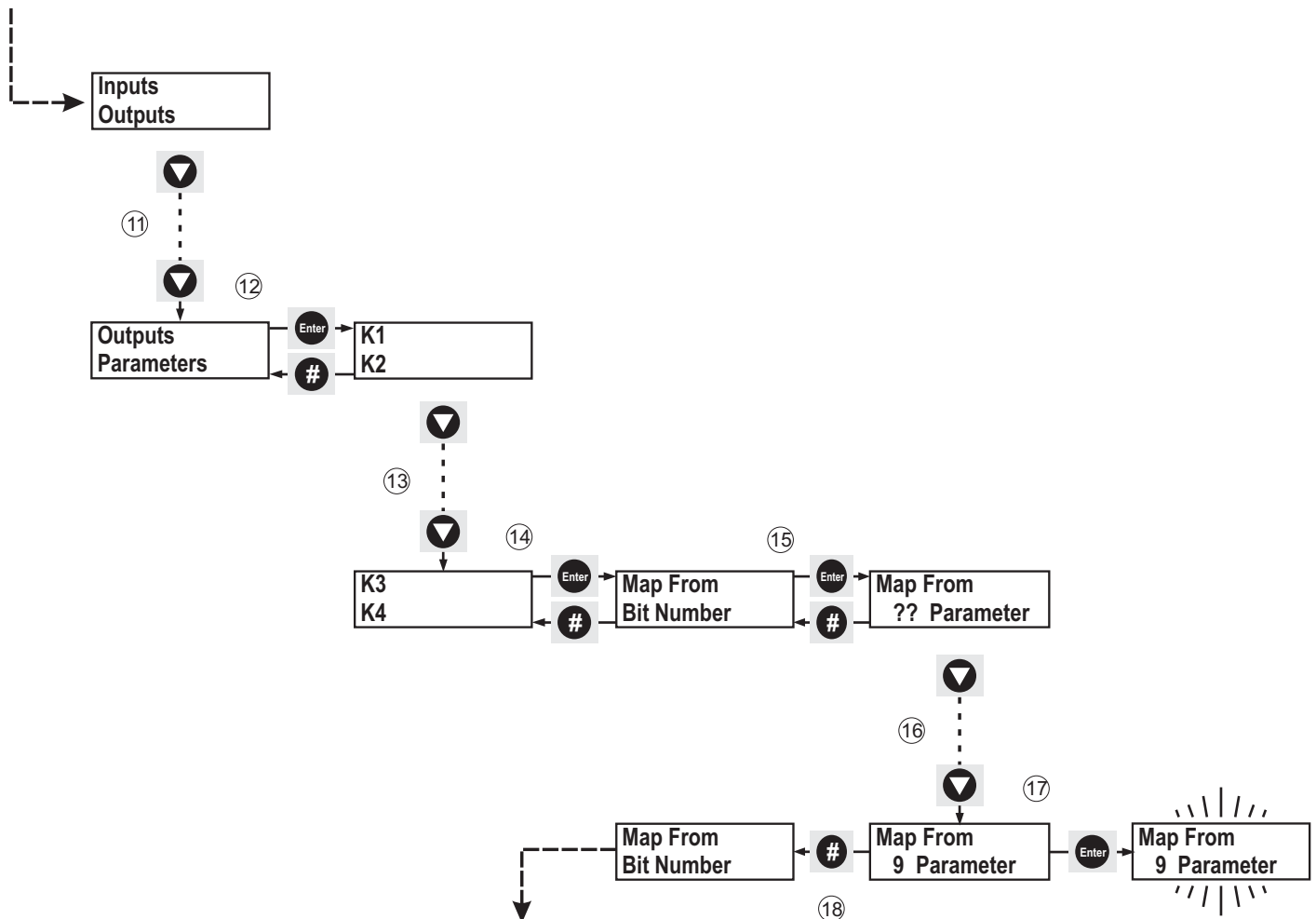
14   Press the **Enter** button.

15   With Map From on the top line, press **Enter**.

16   Make sure that 9 Parameter is showing, use the ▲ and ▼ buttons to change the display until it is showing.

17   Press **Enter** once to confirm the change.

18   Press **#** once to return to **Map From**.

19   Press the ▼ button until Bit Number is on the top line of the display.

20   Press the **Enter** button once to select Bit Number.

21   With the cursor on the LSB, press the ▼ button once to change the bit value to
       zero (0).

22   Press the **Optimise** button seven times to move the cursor to bit 7.

23   Press the ▲ button once to change the bit state of bit 7 to one (1).

24   Press **Enter** once to apply the changes. The display will flash once to confirm the
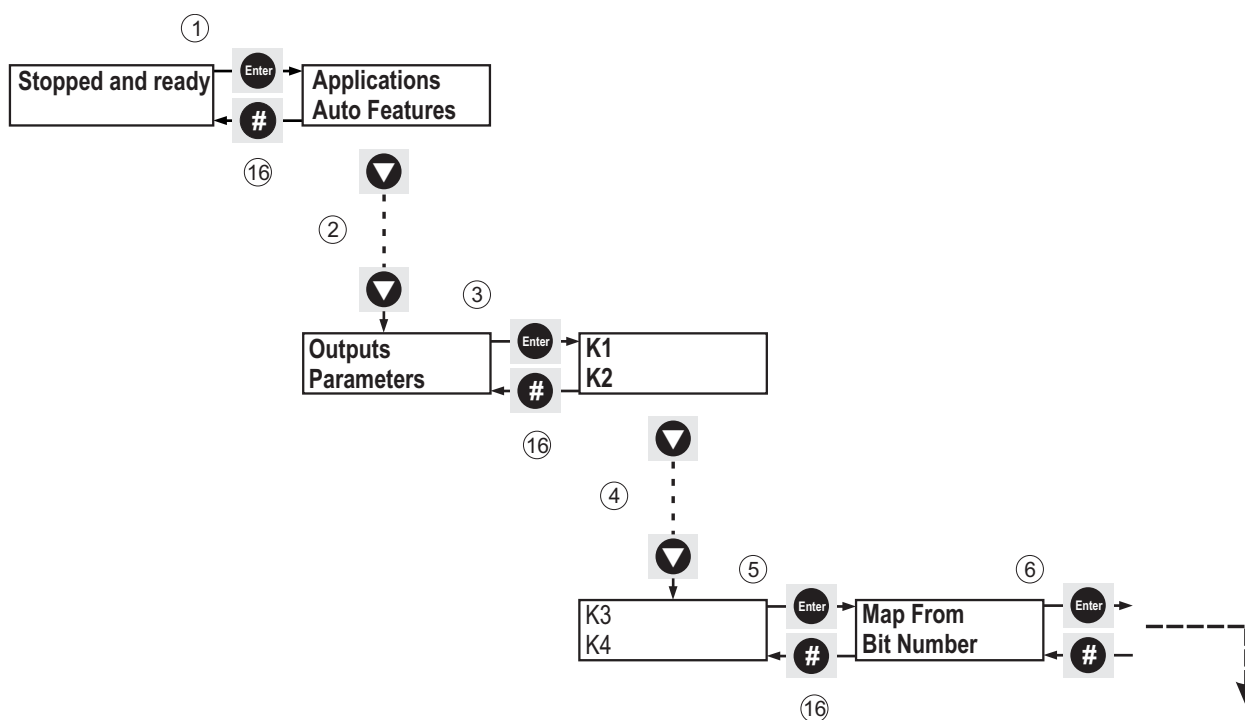   change has been accepted.

25   Press **#** until Stopped and ready is displayed.
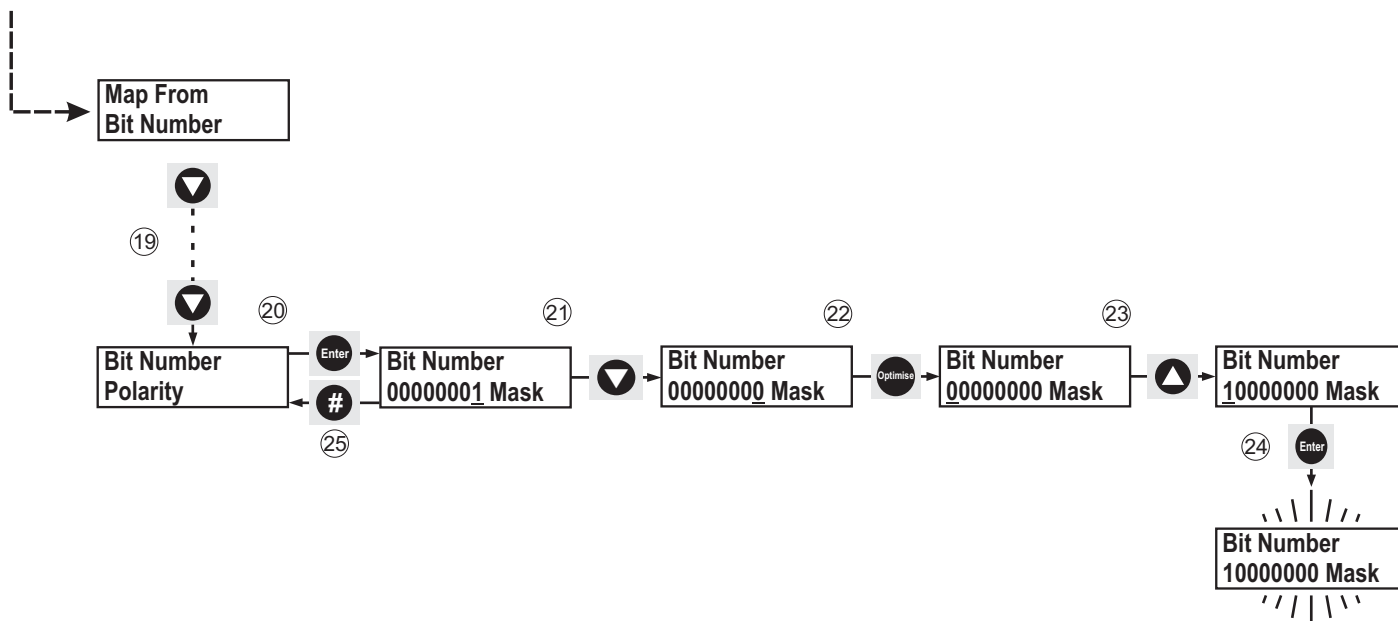
To keep the above settings they must be permanently saved. See section **5.4.5**

5.5.9 Using the DC input to set a parameter's value, (plus units only).

In this example the Start Time (P12) is adjusted by means of the 0-10v DC Programmable Input. The following instructions describe how to program the input for this type of application.

1   With Stopped and ready displayed, press the **Enter** button once.

2   With Applications at the top of the display, press the ▼ button until Inputs shows on the top line of the display.

3   Press **Enter** once.

4   With Digital i/p 1 showing, press the ▼ button until DC i/p is on the top line of the display.

5   Press Enter once.

6   Scroll down with the ▼ button until Map To is on the top line of the display.

7   Press **Enter** once.

8   Using the ▲ and ▼ buttons select 12 Parameter.

9   Press **Enter** to apply the change. The display will flash once to confirm the change has been accepted.

10 Press **#** four times to return to Stopped and ready. Adjusting the DC i/p will now adjust the start time.
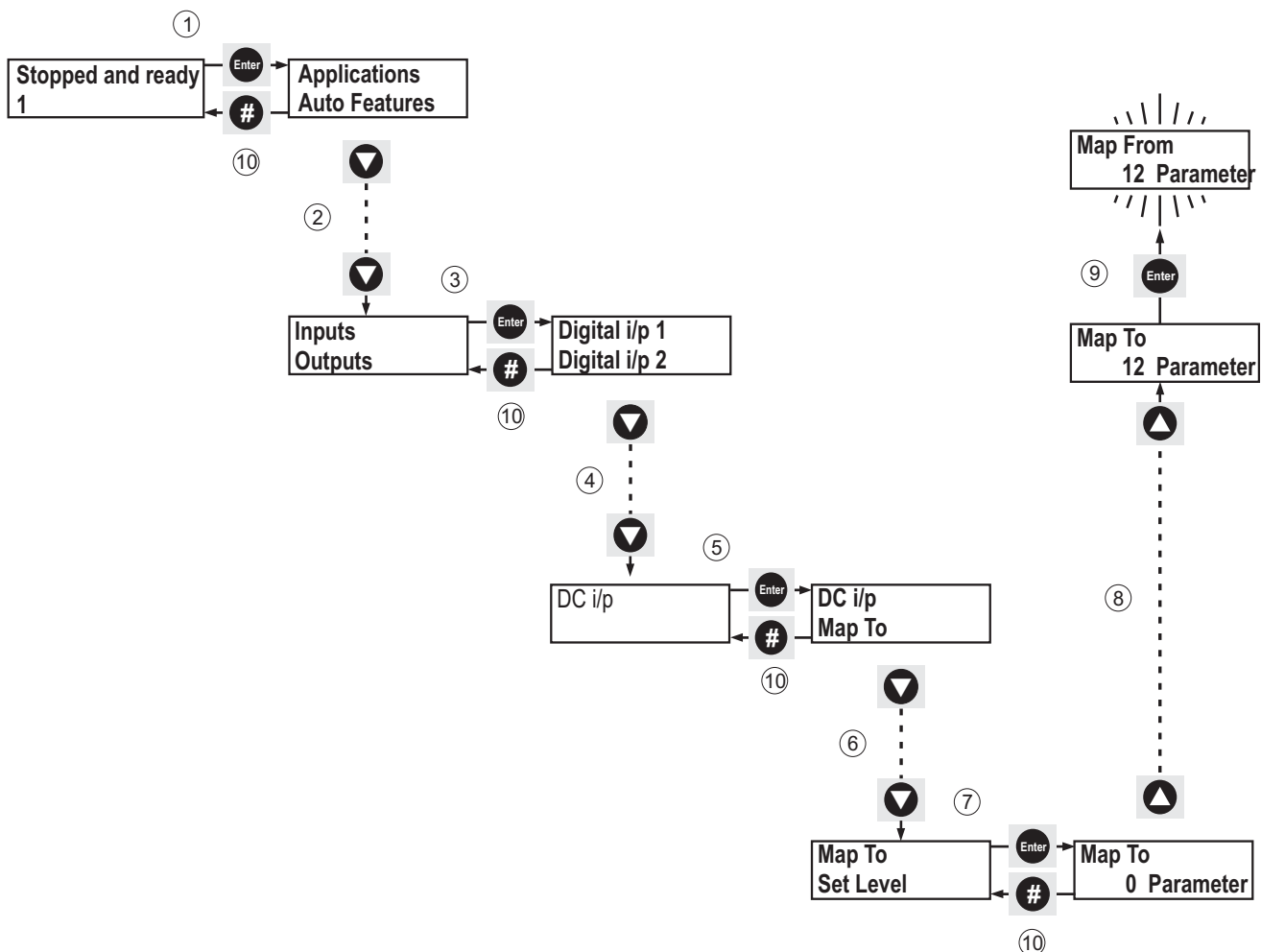
To keep the above settings they must be permanently saved. See section **5.4.5**

5.5.10 Mapping the Load Current to Analogue Output 2, (plus units only).

In this example the user will be able to take some real-time information from the unit and transfer it to the outside world in the from of an analogue signal.

1 With `Stopped and ready` displayed, press the `Enter` button once.

2 With `Applications` at the top of the display, press the ▼ button until `Outputs` appears on the top line of the display.

3 Press the `Enter` button once.

4 With `K1` on the top line of the display, press the ▼ button until `Analogue o/p 2` appears on the top line.

5 Press the `Enter` button once.

6 Use the ▲ or ▼ buttons to select `26 Parameter`.

7 Press `Enter` to apply the change. The display will flash once to confirm the change has been accepted.

8 Press the # button until `Stopped and ready` appears on the top line.
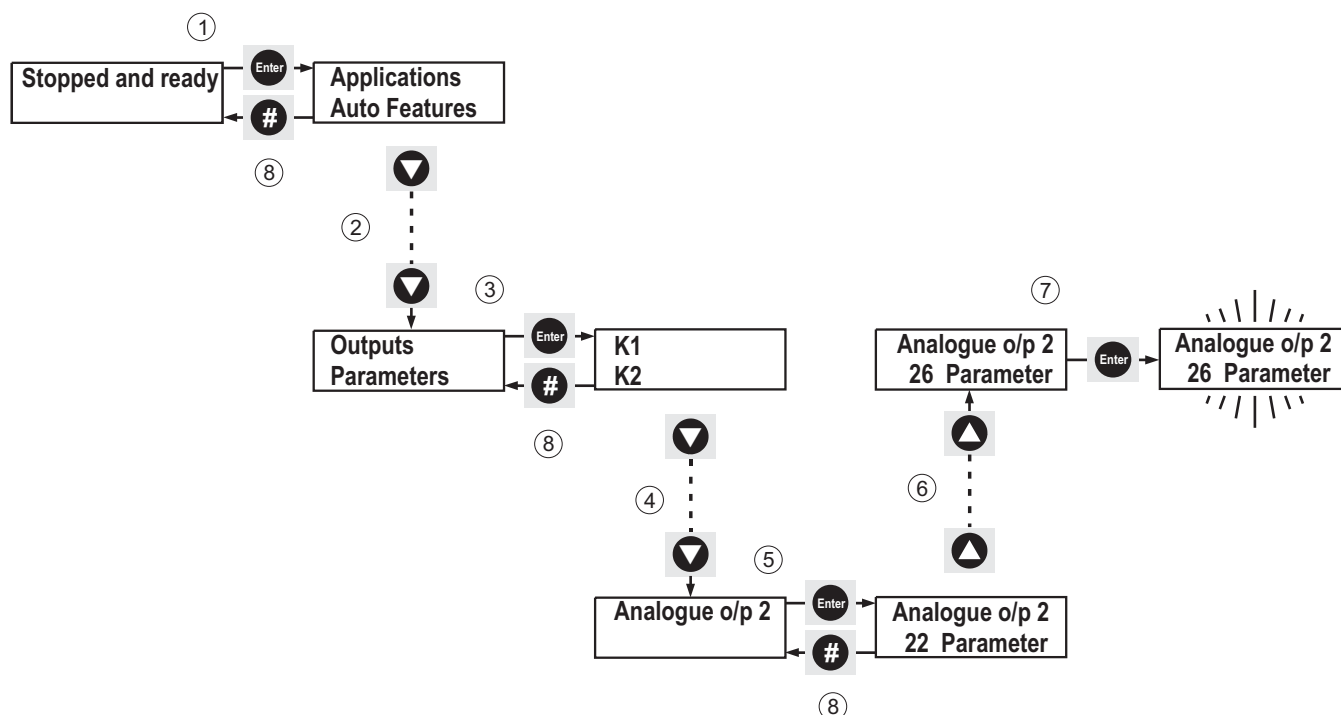
To keep the above settings they must be permanently saved. See section **5.4.5**

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5.5.11 Mapping Programmable Input 2 to the User Trip, (plus units only)

This example shows the user how to program the Xfe to accept a trip input from an external source.

1   With `Stopped and ready` shown on the display press the **Enter** button once.

2   With `Applications` shown on the top line of the display press the ▼ button until Inputs is shown on the top line.

3   Press the **Enter** button once to select the `Inputs` menu.

4   With `Digital i/p 1` on the top line of the display, press the ▼ button until `Digital i/p 2` is displayed.

5   With `Digital i/p 2` on the top line of the display, press the **Enter** button once.

6   With `Map To` on the top line of the display, press the **Enter** button once.

7   With `0 Parameter` showing, press the ▲ button until `53 Parameter` is displayed.

8   Press the **Enter** button once to confirm the change, the display will flash once in acknowledgement.

9   Press the **#** button once to return to `Map To`.
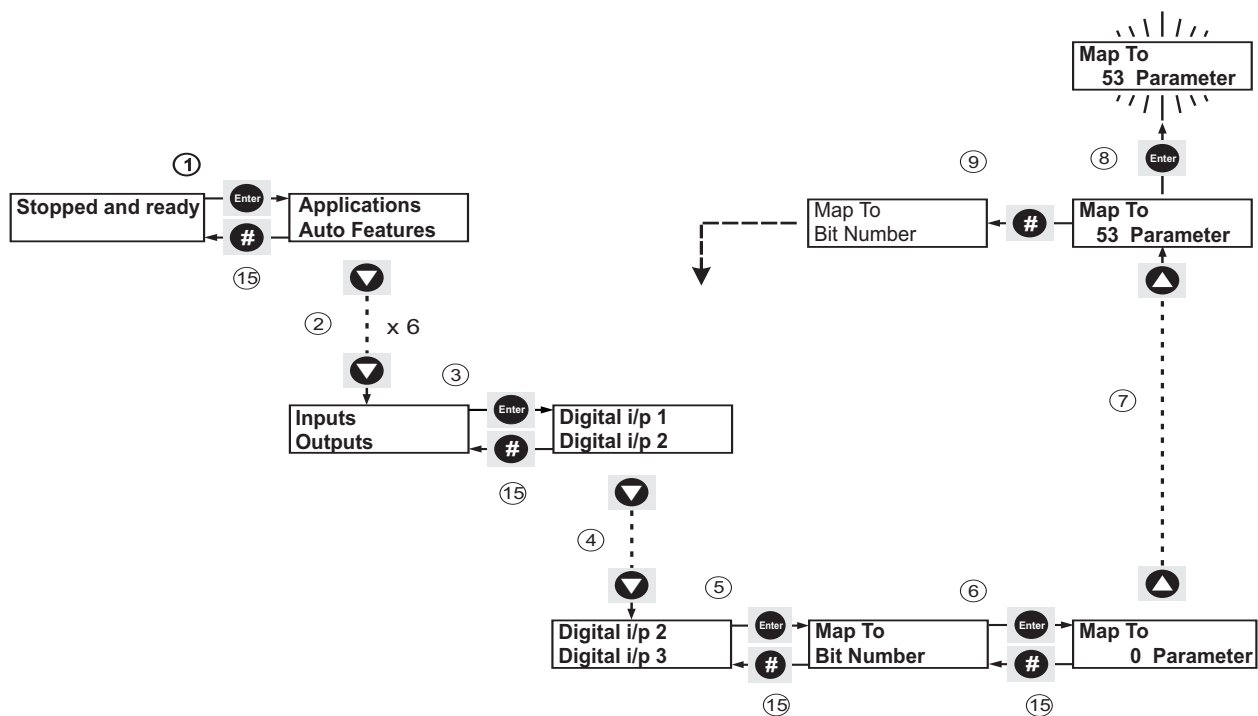
10   With Map To on the top line of the display press the ▼ button once until Bit Number is displayed on the top line.

11   Press the **Enter** button once to select Bit Number.

12   Press the **Optimise** button three times so the cursor key moves to bit three.

13   Press the ▲ button once to change the bit state to one (1)

14   Press the **Enter** button once to confirm the change, the display will flash once in acknowledgement.

15   Press the **#** button four times to return to Stopped and ready.
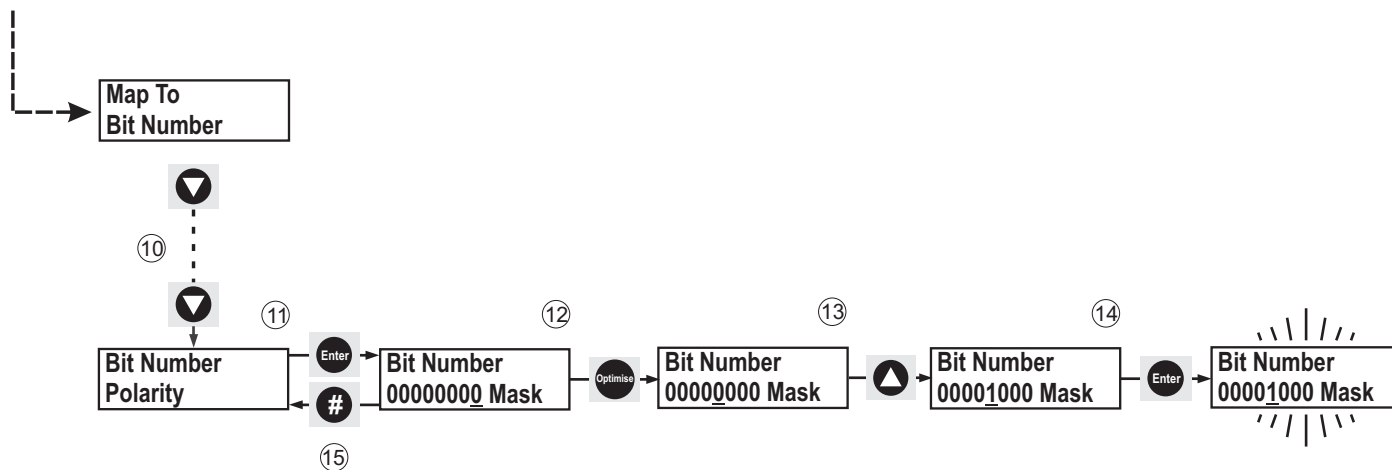
To keep the above settings they must be permanently saved. See section **5.4.5**

5.6.1   Definitions

Auxiliary Function Card

An optional expansion card that extends the functionality of the Xfe. See the Electrical Installation Manual, sections **2.5.4**, **2.7.2** and **2.7.4**.

Dwell

This is the period between **Top of Ramp** and **Run** which is designed to give unstable loads a chance to settle down.

Index Rating

The **Index Rating** defines the duty of the starter. For a fuller explanation of the term refer to TF0120 available on the website.

Jog

Small movements of a three phase induction motor usually used when commissioning the motor or load.

Keypad

The keypad is the internally mounted user interface. Through this interface the user can start/stop, program and query the unit's status. Fitting of the keypad precludes fitting of the keypod.

Keypod

The keypod is the externally mounted user interface. It can be mounted at a maximum distance of 10 metres from the unit. Through this interface the user can start/stop, program and query the unit's status. Fitting of the keypod precludes fitting of the keypad.

Kick Start

This is an optional extra 'kick' of voltage to start 'sticky' loads.

Load Current

The current drawn by the application or load.

Optimise

This is an optional energy saving feature. Refer to section **3.4** of the **Applications** manual for a detailed explanation.

Overload

An **Overload** is a sustained over-current, with a duration of seconds or minutes rather than cycles, but generally drawing less current than a **Shearpin**, that might or might not end in a trip. Changes in the load characteristics might cause an overload.

Parameter

A parameter is a menu item that directly relates to an internal parameter of the soft starter.

Plus Unit

A Xfe that has had the Auxiliary Function Card (also known as add-on card) fitted.

Rated Current

This is the nominal current (in Amps) that the unit has been designed to run at.

Shearpin

Shearpin is also an over-current but of a much shorter duration, cycles rather than seconds, and is generally a higher current than an **Overload**.

Stall

The point at which the load placed on a motor threatens to stop a motor's rotational movement.

5.6.1   continued

Static

Static as in static loads. This term refers to loads with no moving parts, so induction motors, linear motors etc... are non static loads. An example of a static load would be a resistor bank.

Top of Ramp

This is the point at which the soft starter reaches maximum output voltage.

Unit Full Load Current

This is another name for the **Rated Current** of the unit.

Writeable Parameters

A parameter that can be written to by the user as well as being read by the user, as opposed to a read-only parameter which can only be read by the user.

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Std ☑ **PNU** **0** dummy parameter

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description Dummy used for mapping unused bit parameters etc.

Std ☑ **PNU** **1** STATION NUMBER

| **Default** | 1 | **Max** | 32 | **Min** | 1 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description This is the local Network ID of this card

Std ☑ **PNU** **2** COUNTRY

| **Default** | 44 | **Max** | 255 | **Min** | 1 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description International telephone code for Country
e.g. England = 44. Only allowed English for XFE
This is used by keypads to decide on language to use.

Std ☑ **PNU** **3** SOFTWARE TYPE

| **Default** | 67 | **Max** | 5 | **Min** | 5 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description Generic Software type 6 something.

Std ☑ **PNU** **4** SOFTWARE VERSION

| **Default** | 3 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description Basically an issue number for a particular software type.

Std ☑ **PNU** **5** PASSWORD

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Used by keypad has no effect on the 5MC.
Keypad see's 0 as no password set.

Std ☑ **PNU** **6** FIRING MODE

| **Default** | 0 | **Max** | 1 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description 0 = normal Motor (outside delta or star)
1 = Delta (inside delta no optimising)

Std ☑ **PNU** **7** PROTECTION MODE

| **Default** | 192 | **Max** | 192 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Controls which trips are available.
FULL (64) = Full protection with full volts after top of ramp
FULL+OPTIMISE (192) = full protection + optimise
START+BYPASS (128)= Protection during start then bypass
PHASE LOSS ONLY (0) = I/p Phase loss detection only

Start and Optimise mode is forced to Full Protection for firing modes other than 0, in phase loss only after TOR bottom 12.5% current is ignored.

Std ☑ **PNU** **8** STATUS 1

Default	1	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read Only	**Scaling**	1

Description no description

Std ☑ **PNU** **9** STATUS 2

Default	0	**Max**	99	**Min**	1	**Units**	flags	**Type**	Read Only	**Scaling**	1

Description no description

Std ☑ **PNU** **10** STATUS 3

Default	0	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read Only	**Scaling**	1

Description no description

Std ☑ **PNU** **11** SOFT START PEDESTAL

Default	20	**Max**	60	**Min**	10	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description Starting point of soft start as percentage of supply volts

---

Std ☑ **PNU** **12** SOFT START TIME

Default	5	**Max**	255	**Min**	1	**Units**	Secs	**Type**	Read/Write	**Scaling**	1

Description Soft start Period over which unit ramps voltage to motor

Normally start times are in the range 5-30 seconds, long ramptimes over 1minute are for special applications only. The start (without current limit) is purely a voltage ramp. For lightly loaded motors they will normally reach full speed before the end of a long ramp.

Std ☑ **PNU** **13** KICK PEDESTAL

Default	75	**Max**	90	**Min**	60	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description short Kick of voltage at start of ramp to dislodge sticky load.

Std ☑ **PNU** **14** KICK TIME

Default	25	**Max**	40	**Min**	10	**Units**	cycles	**Type**	Read/Write	**Scaling**	1

Description Number of cycles for which kick is applied (if selected).

Std ☑ **PNU** **15** DWELL TIME

Default	5	**Max**	255	**Min**	1	**Units**	Secs	**Type**	Read/Write	**Scaling**	1

Description Period of time following soft start allowed for load to settle before optimising commences (if selected).

Std ☑ **PNU** **16** SOFT STOP PEDESTAL

Default	10	**Max**	60	**Min**	10	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description percentage of supply voltage at which the soft stop will cease. The actual value is affected by certain load variations.

Std ☑ **PNU** **17** SOFT STOP TIME

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | Secs | **Type** | Read/Write | **Scaling** | 1 |

Description period over which the soft stop ramp is performed.

Std ☑ **PNU** **18** Auto Config

| **Default** | 6 | **Max** | 255 | **Min** | 0 | **Units** | flags | **Type** | Read/Write | **Scaling** | 1 |

Description no description

Std ☑ **PNU** **19** OPTIMISE RATE

| **Default** | 5 | **Max** | 30 | **Min** | 4 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description speed at which the 5MC will drop back the voltage during optimising. Some unstable loads benefit from a slower optimising rate.

Std ☑ **PNU** **20** REFERENCE PF

| **Default** | 146.76 | **Max** | 146.76 | **Min** | 0 | **Units** | degrees | **Type** | Read Only | **Scaling** | 0.57554 |

Description Power factor which the 5MC has calculated as the target for the optimising control loop.

Std ☑ **PNU** **21** INTERNAL PF

| **Default** | 146.76 | **Max** | 146.76 | **Min** | 0 | **Units** | degrees | **Type** | Read Only | **Scaling** | 0.57554 |

Description The power factor of the load now.

Std ☑ **PNU** **22** FIRING DELAY ANGLE

| **Default** | 146.76 | **Max** | 146.76 | **Min** | 0 | **Units** | degrees | **Type** | Read Only | **Scaling** | 0.57554 |

Description The firing delay angle (thyristor off time).

Std ☑ **PNU** **23** MAXIMUM OPTIMISING DELAY ANGL

| **Default** | 57.554 | **Max** | 146.76 | **Min** | 17.27 | **Units** | degrees | **Type** | Read Only | **Scaling** | 0.57554 |

Description Max allowed firing delay angle during optimising.

Std ☑ **PNU** **24** RATED CURRENT(HUNDREDS)

| **Default** | 0 | **Max** | 3000 | **Min** | 0 | **Units** | Amps | **Type** | Read/Write | **Scaling** | 100 |

Description Units rated current is stored in two bytes parameter 24 & 25, Parameter 24 holds the number of hundreds.These parameters should not be changed since they go hand in hand with the burden resistors fitted to the board.

Std ☑ **PNU** **25** RATED CURRENT AMPS

| **Default** | 5 | **Max** | 99 | **Min** | 1 | **Units** | Amps | **Type** | Read/Write | **Scaling** | 1 |

Description Units rated current is stored in two bytes parameter 24 & 25, Parameter 25 holds the number of units. These parameters should not be changed since they go hand in hand with the burden resistors fitted to the board.

Std ☑ **PNU** **26** RUNNING CURRENT

Default	0	**Max**	7.9688	**Min**	0	**Units**	Amps	**Type**	Read Only	**Scaling**	0.03125

Description This is the current that the motor is taking, as monitored in one phase. This is the source parameter for the overload, current limit, shearpin, under current trip etc. The multiplier is the rated current of the unit and the divisor is the "full load current steps". "Full load current steps can be found by using the model (PNU105) and start index (PNU106) values in conjunction with the table in XFE General Application note APP00041.

Std ☑ **PNU** **27** PEAK START CURRENT

Default	0	**Max**	255	**Min**	0	**Units**	Amps	**Type**	Read Only	**Scaling**	1

Description This is the peak current seen by the unit during the last start. Scaling is as per the running current

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Std ☑ **PNU** **28** LOW CURRENT LEVEL

Default	0.0938	**Max**	0.7813	**Min**	0.031	**Units**	x Ie	**Type**	Read/Write	**Scaling**	0.03125

Description This parameter if enabled sets a level of current under which the unit will trip. The level is not active during the starting or stopping phases. For Scaling factors and limits see XFE General Application note APP00041

The low current level flag is continually updated even if tripping is disabled.

Std ☑ **PNU** **29** LOW CURRENT TIME

Default	50	**Max**	255	**Min**	5	**Units**	cycles	**Type**	Read/Write	**Scaling**	1

Description The number of cycles for which an under current situation must exist before tripping.

Std ☑ **PNU** **30** CURRENT LIMIT LEVEL

Default	3.5	**Max**	4.5	**Min**	0.5	**Units**	x Ie	**Type**	Read/Write	**Scaling**	0.03125

Description Level at which the the softs start ramp will be held. For Scaling factors and limits see XFE General Application note APP00041

The current limit only holds the ramp if it's level is reached. The current naturally falls as motor speed increases allowing the ramp to continue.

Std ☑ **PNU** **31** CURRENT LIMIT TIME

Default	30	**Max**	255	**Min**	5	**Units**	Secs	**Type**	Read/Write	**Scaling**	1

Description The maximum time allowed for the current limit before it trips or continues the ramp regardless of motor current level.

Std ☑ **PNU** **32** SHEARPIN LEVEL

Default	3.125	**Max**	5	**Min**	0.5	**Units**	x Ie	**Type**	Read/Write	**Scaling**	0.03125

Description Level of current which will cause a quick trip. Not active during start or stop. For Scaling factors and limits see XFE General Application note APP00041

Std ☑ **PNU** **33** SHEARPIN TIME

Default	100	**Max**	255	**Min**	5	**Units**	cycles	**Type**	Read/Write	**Scaling**	1

Description Number of cycles a Shearpin current must be present before tripping.

The shearpin is only active during the running phase not start or stop.
The shearpin flag is updated even if tripping is not enabled.

Std ☑ **PNU** **34** START OF OVERLOAD LEVEL

| **Default** | 1.0938 | **Max** | 2 | **Min** | 0.594 | **Units** | x le | **Type** | Read/Write | **Scaling** | 0.03125 |

Description Level at which the on board single phase overload starts to integrate. For Scaling factors and limits see XFE General Application note APP00041

This Overload does NOT replace an overload for the motor. The overload is designed to detect Soft start overloads.

Std ☑ **PNU** **35** SPARE

| **Default** | 140 | **Max** | 140 | **Min** | 10 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description

Std ☑ **PNU** **36** % OVERLOAD

| **Default** | 0 | **Max** | 100 | **Min** | 0 | **Units** | % | **Type** | Read Only | **Scaling** | 0.39216 |

Description Status value showing how close the overload is to tripping. (100 = tripped)

Std ☑ **PNU** **37** CHASSIS TEMPERATURE

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description This parameter indicates the heatsink temperature when used with a suitable sensor.

Presently (00/06/20) the 5MC uses a thermal switch so the values shown are 0 or 255.

Std ☐ **PNU** **38** User Flags 5

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | flags | **Type** | Read/Write W | **Scaling** | 1 |

Description various control flags

Std ☐ **PNU** **39** PowerFactor

| **Default** | 0 | **Max** | 127.5 | **Min** | 0 | **Units** | degrees | **Type** | Read Only | **Scaling** | 0.5 |

Description The real power factor

Std ☑ **PNU** **40** Volts

| **Default** | 416 | **Max** | 510 | **Min** | 110 | **Units** | Volts | **Type** | Read/Write W | **Scaling** | 2 |

Description manually entered supply Voltage. Also works in conjunction with bit 1 user flags 5 for high voltages above 500V.

Std ☐ **PNU** **41** DC I/P

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | Volts | **Type** | Read Only | **Scaling** | 1 |

Description 0-10V input for load monitoring or phase angle setpoint etc. (can be adjusted to max scale 21V)

Std ☐ **PNU** **42** Thermistor

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description Monitors the Thermistor I/p (for use with standard motor thermistors). The values are not all that useful as thermistors act much like a switch.

Std ☐ **PNU** **43** 4-20mA i/p

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | mA | **Type** | Read Only | **Scaling** | 1 |

Description Monitors the 4 to 20mA input. Note this input is referenced to the PCB 0V and so cannot be used to daisy chained sensors.

Std ☑ **PNU** **44** TEMP TRIP LEVEL

| **Default** | 58.8 | **Max** | 499.8 | **Min** | 39.2 | **Units** | degrees | **Type** | Read/Write | **Scaling** | 1.96 |

Description The value at which parameter 37 causes a trip

Std ☐ **PNU** **45** 4-20MA MAP

| **Default** | 0 | **Max** | 125 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description Value is parameter to which the 4-20mA data will be sent.

Std ☐ **PNU** **46** 4-20MA SET LEVEL

| **Default** | 10.24 | **Max** | 20.32 | **Min** | 0.08 | **Units** | mA | **Type** | Read/Write | **Scaling** | 0.08 |

Description value is level at which the 4-20mA level bit will be set.

Std ☐ **PNU** **47** DC INPUT MAP

| **Default** | 0 | **Max** | 125 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description Value is parameter to which the DC input data will be sent.

Std ☐ **PNU** **48** SET LEVEL DC I/P

| **Default** | 5.0196 | **Max** | 9.9608 | **Min** | 0.039 | **Units** | Volts | **Type** | Read/Write | **Scaling** | 0.03922 |

Description value is level at which the DC-I/p level bit will be set.

Std ☐ **PNU** **49** MAP DAC O/P 1

| **Default** | 26 | **Max** | 125 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description The value is the parameter number which will be the source for DAC 1.

Dac 1 normally displays running current as 0-10V

Std ☐ **PNU** **50** MAP DAC O/P 2

| **Default** | 22 | **Max** | 125 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description The value is the parameter number which will be the source for DAC 2.

Dac 2 normally displays delay angle as 0-10V

Std ☑ **PNU** **51** USER FLAGS 1

| **Default** | 142 | **Max** | 255 | **Min** | 0 | **Units** | flags | **Type** | Read/Write | **Scaling** | 1 |

Description More system status flags

Std ☑ **PNU** **52** USER FLAGS 2

Default	0	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description Even more status flags , This flag must be 0 when parameters are saved.

Std ☑ **PNU** **53** USER FLAGS 3

Default	51	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description no description

Std ☑ **PNU** **54** I/O POLARITY

Default	127	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description sets the I/o polarity, for Led,K1-4 and I/p1-3
That is 1 to 1 or 1 to 0.

Std ☐ **PNU** **55** Spare

Default	329.28	**Max**	499.8	**Min**	272.4	**Units**	degrees	**Type**	Read/Write	**Scaling**	1.96

Description Unused in this version

Std ☐ **PNU** **56** SPARE

Default	1	**Max**	255	**Min**	0	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description SPARE

Std ☑ **PNU** **57** MAP K1 TO

Default	52	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description Value is parameter number which is the Source for the K1 bit.
Parameter 58 holds the mask for mapping to

Std ☑ **PNU** **58** K1 BIT MASK

Default	32	**Max**	255	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description Parameter 58 holds the mask for mapping K1 From.

Std ☑ **PNU** **59** MAP k2 TO

Default	8	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description Value is parameter number which is the Source for the K2 bit.
Parameter 60 holds the mask for mapping K2 to.

Std ☑ **PNU** **60** K2 BIT MASK

Default	8	**Max**	128	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description Parameter 60 holds the mask for mapping K2 From.

Std ☐ **PNU**   **61**   MAP K3 TO

Default	9	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description   Value is parameter number which is theSource for the K3 bit.
Parameter 61 holds th mask for mapping K3 to

Std ☐ **PNU**   **62**   K3 BIT MASK

Default	1	**Max**	3	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description   Parameter 63 holds the mask for mapping K3 From.

Std ☐ **PNU**   **63**   MAP K4 TO

Default	9	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description   Value is parameter number which is theSource for the K4 bit.
Parameter 64 holds th mask for mapping K4 to.

Std ☐ **PNU**   **64**   K4 BIT MASK

Default	2	**Max**	3	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description   Parameter 64 holds the mask for mapping K4 From.

Std ☑ **PNU**   **65**   I/P1 MAP TO

Default	52	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description   Value is parameter number which is the destination for the I/p1 bit.
Parameter 66 holds the mask for mapping I/p1 into.

This is normally the start/stop I/p (remote).
It would be unusual for it to be anything else.

Std ☑ **PNU**   **66**   I/P1 BIT MASK

Default	16	**Max**	128	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description   Parameter 66 holds the mask for mapping I/p1 into.

Std ☑ **PNU**   **67**   I/P2 MAP TO

Default	0	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description   Value is parameter number which is the destination for the I/p2 bit.
Parameter 68 holds the mask for mapping I/p2 into.

Std ☑ **PNU**   **68**   I/P2 BIT MASK

Default	0	**Max**	128	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description   Parameter 68 holds the mask for mapping I/p2 into.

Std ☐ **PNU** **69** I/P3 MAP TO

Default	0	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description Value is parameter number which is the destination for the I/p3 bit.
Parameter 70 holds the mask for mapping I/p3 into.

Std ☐ **PNU** **70** I/P3 BIT MAP

Default	0	**Max**	128	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description Parameter 70 holds the mask for mapping I/p2 into.

Std ☑ **PNU** **71** CONTACTOR DELAY

Default	160	**Max**	800	**Min**	20	**Units**	mS	**Type**	Read/Write	**Scaling**	4

Description Following a start command this is the delay allowed for the main incomming contactor to close. After this time a phase loss detection routine checks for the incomming supply.

Std ☑ **PNU** **72** TRIP SENSITIVITY

Default	1	**Max**	15	**Min**	1	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description An arbitrary number to adjust the sensitivity of some of the fault trips. The larger the number the slower the trip.

Std ☑ **PNU** **73** LAST TRIP

Default	0	**Max**	15	**Min**	1	**Units**	trips	**Type**	Read Only	**Scaling**	1

Description the number of the last trip

E1 Phase Loss
E2 Too Hot
E3,5,6 SCR Signal
E4 SCR Firing
E7,8,9 Sensing Signal
E10 SCR Shorted
E11 Low Current
E12 C/L Time Out
E13 Overload
E14 Shearpin
E15 Thermistor
E16 External trip
E17 Comms Timeout
E18 Bypass Failed

Std ☑ **PNU** **74** 2ND LAST TRIP

Default	0	**Max**	15	**Min**	1	**Units**	trips	**Type**	Read Only	**Scaling**	1

Description the number of the 2nd to last trip

E1 Phase Loss
E2 Too Hot
E3,5,6 SCR Signal
E4 SCR Firing
E7,8,9 Sensing Signal
E10 SCR Shorted
E11 Low Current
E12 C/L Time Out
E13 Overload
E14 Shearpin
E15 Thermistor
E16 External trip
E17 Comms Timeout
E18 Bypass Failed

Std ☑ **PNU** **75** 3RD LAST TRIP

Default	0	**Max**	15	**Min**	1	**Units**	trips	**Type**	Read Only	**Scaling**	1

Description the number of the 3rd to last trip

E1 Phase Loss
E2 Too Hot
E3,5,6 SCR Signal
E4 SCR Firing
E7,8,9 Sensing Signal
E10 SCR Shorted
E11 Low Current
E12 C/L Time Out
E13 Overload
E14 Shearpin
E15 Thermistor
E16 External trip
E17 Comms Timeout
E18 Bypass Failed

Std ☑ **PNU** **76** 4TH LAST TRIP

Default	0	**Max**	15	**Min**	1	**Units**	trips	**Type**	Read Only	**Scaling**	1

Description the number of the 4th to last trip

E1 Phase Loss
E2 Too Hot
E3,5,6 SCR Signal
E4 SCR Firing
E7,8,9 Sensing Signal
E10 SCR Shorted
E11 Low Current
E12 C/L Time Out
E13 Overload
E14 Shearpin
E15 Thermistor
E16 External trip
E17 Comms Timeout
E18 Bypass Failed

Std ☑ **PNU** **77** 5TH LAST TRIP

Default	0	**Max**	15	**Min**	1	**Units**	trips	**Type**	Read Only	**Scaling**	1

Description the number of the 5th to last trip

E1 Phase Loss
E2 Too Hot
E3,5,6 SCR Signal
E4 SCR Firing
E7,8,9 Sensing Signal
E10 SCR Shorted
E11 Low Current
E12 C/L Time Out
E13 Overload
E14 Shearpin
E15 Thermistor
E16 External trip
E17 Comms Timeout
E18 Bypass Failed

Std ☑ **PNU** **78** PROTECTION MODE 2

Default	192	**Max**	192	**Min**	0	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description Protection mode to use with second parameter set
Controls which trips are available.
FULL (64) = Full protection with full volts after top of ramp
FULL+OPTIMISE (192) = full protection + optimise
START+BYPASS (128)= Protection during start then bypass
PHASE LOSS ONLY (0) = I/p Phase loss detection only

Edit in P Menu

Std ☑ **PNU** **79** START PED 2

Default	50	**Max**	60	**Min**	10	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description start pedestal to use with 2nd parameter set

Edit in P Menu

Std ☑ **PNU** **80** START TIME 2

Default	5	**Max**	255	**Min**	1	**Units**	Secs	**Type**	Read/Write	**Scaling**	1

Description Start time to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **81** KICK PED 2

Default	75	**Max**	90	**Min**	60	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description kickstart pedestal to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **82** KICK TIME 2

Default	25	**Max**	40	**Min**	10	**Units**	cycles	**Type**	Read/Write	**Scaling**	1

Description kickstart time to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **83** DWELL 2

| **Default** | 5 | **Max** | 255 | **Min** | 1 | **Units** | Secs | **Type** | Read/Write | **Scaling** | 1 |

Description Dwell time to use with the second parameter set.

Edit in P Menu

Std ☑ **PNU** **84** STOP PED 2

| **Default** | 10 | **Max** | 60 | **Min** | 10 | **Units** | % | **Type** | Read/Write | **Scaling** | 1 |

Description Stop pedestal to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **85** STOP TIME 2

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | Secs | **Type** | Read/Write | **Scaling** | 1 |

Description Stop timel to use with the second parameter set.

Edit in P Menu

Std ☑ **PNU** **86** Auto Config 2

| **Default** | 6 | **Max** | 255 | **Min** | 0 | **Units** | flags | **Type** | Read/Write | **Scaling** | 1 |

Description Auto configuration flags to use with the second parameter set.

Edit in P Menu

Std ☑ **PNU** **87** UNDER CURRENT 2

| **Default** | 0.125 | **Max** | 1 | **Min** | 0 | **Units** | x le | **Type** | Read/Write | **Scaling** | 0.03125 |

Description Under current level to use with the second parameter set. For Scaling factors and limits see XFE General Application note APP00041

Edit in P Menu

Std ☑ **PNU** **88** UNDER CURRENT TIME 2

| **Default** | 50 | **Max** | 255 | **Min** | 5 | **Units** | cycles | **Type** | Read/Write | **Scaling** | 1 |

Description Under Current time to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **89** CURRENT LIMIT 2

| **Default** | 4 | **Max** | 7.9688 | **Min** | 0.5 | **Units** | x le | **Type** | Read/Write | **Scaling** | 0.03125 |

Description Current limit value to be used with the second parameter set. For Scaling factors and limits see XFE General Application note APP00041

Edit in P Menu

Std ☑ **PNU** **90** CURRENT LIMIT TIME 2

| **Default** | 15 | **Max** | 255 | **Min** | 5 | **Units** | Secs | **Type** | Read/Write | **Scaling** | 1 |

Description Current limit timeout to use with the second parameter set

Edit in P Menu

Std ☑ **PNU** **91** SHEARPIN 2

Default	3	**Max**	5	**Min**	0.5	**Units**	x le	**Type**	Read/Write	**Scaling**	0.03125

Description Shearpin Level to use with the second parameter set For Scaling factors and limits see XFE General Application note APP00041

Edit in P Menu

Std ☑ **PNU** **92** SHEARPIN TIME 2

Default	50	**Max**	255	**Min**	5	**Units**	cycles	**Type**	Read/Write	**Scaling**	1

Description Shearpin Time to use with the second parameter set.

Edit in P Menu

Std ☑ **PNU** **93** OVERLOAD LEVEL 2

Default	1.0938	**Max**	2	**Min**	0.5	**Units**	x le	**Type**	Read/Write	**Scaling**	0.03125

Description Overload Level to use with the second parameter set For Scaling factors and limits see XFE General Application note APP00041

Edit in P Menu

Std ☑ **PNU** **94** SPARE

Default	140	**Max**	140	**Min**	10	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description

Std ☑ **PNU** **95** USER FLAGS 1,2

Default	134	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description User flags 1 to use with secondary parameter set.

Edit in P Menu

Std ☑ **PNU** **96** USER FLAGS 2,2

Default	64	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description user flags 2 to use with the secondary parameter set.

Edit in P Menu

Std ☑ **PNU** **97** ipf1_addr

Default	0	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 97,98,99,100.
97,98 give source flag address
97=parameter 98 = bit mask
99,100 give the destination flag address.
99=parameter 100 = bit mask

Edit in P Menu

Std ☑ **PNU** **98** ipf1_mask

Default	0	**Max**	128	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 97,98,99,100.
97,98 give source flag address
97=parameter 98 = bit mask
99,100 give the destination flag address.
99=parameter 100 = bit mask

Std ☑ **PNU** **99** opf1_addr

Default	0	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 97,98,99,100.
97,98 give source flag address
97=parameter 98 = bit mask
99,100 give the destination flag address.
99=parameter 100 = bit mask

Std ☑ **PNU** **100** opf1_mask

Default	0	**Max**	255	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 97,98,99,100.
97,98 give source flag address
97=parameter 98 = bit mask
99,100 give the destination flag address.
99=parameter 100 = bit mask

Std ☑ **PNU** **101** ipf2_addr

Default	0	**Max**	125	**Min**	0	**Units**	prmtr	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 101,102,103,104.
101,102 give source flag address
101=parameter 102 = bit mask
103,104 give the destination flag address.
103=parameter 104 = bit mask

Std ☑ **PNU** **102** ipf2_mask

Default	0	**Max**	20	**Min**	0	**Units**	mask	**Type**	Read/Write	**Scaling**	1

Description User flag mapping through parameters 101,102,103,104.
101,102 give source flag address
101=parameter 102 = bit mask
103,104 give the destination flag address.
103=parameter 104 = bit mask

Std ☑ **PNU** **103** opf2_addr

| **Default** | 0 | **Max** | 125 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description User flag mapping through parameters 101,102,103,104.
101,102 give source flag address
101=parameter 102 = bit mask
103,104 give the destination flag address.
103=parameter 104 = bit mask

Std ☑ **PNU** **104** opf2_mask

| **Default** | 0 | **Max** | 11 | **Min** | 0 | **Units** | mask | **Type** | Read/Write | **Scaling** | 1 |

Description User flag mapping through parameters 101,102,103,104.
101,102 give source flag address
101=parameter 102 = bit mask
103,104 give the destination flag address.
103=parameter 104 = bit mask

Std ☐ **PNU** **105** Model

| **Default** | 0 | **Max** | 40 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description XFE model number use with XFE General Application Note APP00041 to calculate current scaling factor

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Std ☐ **PNU** **106** Class

| **Default** | 0 | **Max** | 7 | **Min** | 0 | **Units** | prmtr | **Type** | Read/Write | **Scaling** | 1 |

Description XFE Overcurrent protection Class index use with XFE General Application Note APP00041 to calculate current scaling factor.

Std ☐ **PNU** **107** Spare

| **Default** | 0 | **Max** | 0 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Spare

Std ☐ **PNU** **108** Spare

| **Default** | 0 | **Max** | 0 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Spare

Std ☐ **PNU** **109** Spare

| **Default** | 0 | **Max** | 0 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Spare

Std ☐ **PNU** **110** Spare

| **Default** | 0 | **Max** | 0 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Spare

Std ☑ **PNU** **111** user parameter

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description This parameter may be set by the user via the serial link.

Std ☑ **PNU** **112** STATUS 4

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | flags | **Type** | Read Only | **Scaling** | 1 |

Description More useful control flags

Std ☐ **PNU** **113** SPARE

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read Only | **Scaling** | 1 |

Description Unused

Std ☑ **PNU** **114** Soft stop Profile

| **Default** | 0 | **Max** | 100 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Soft stop Profile

Std ☑ **PNU** **115** selected app

| **Default** | 0 | **Max** | 255 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Value selected from application table. Not implimented on some versions of software.

Std ☑ **PNU** **116** 5mc inhibit time

| **Default** | 0 | **Max** | 63.75 | **Min** | 0 | **Units** | Minutes | **Type** | Read/Write | **Scaling** | 0.25 |

Description time for which the unit is not allowed to restart. Mainly for larger stacks to avoid destroying thyristors during commisioning.
Value depends on Unit size.

Std ☐ **PNU** **117** System use only

| **Default** | 0 | **Max** | 3 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Unused

Std ☑ **PNU** **118** System use only

| **Default** | 0 | **Max** | 32 | **Min** | 16 | **Units** | Amps | **Type** | Read/Write | **Scaling** | 1 |

Description Unused
Unused

Std ☐ **PNU** **119** System use only

| **Default** | 26 | **Max** | 125 | **Min** | 0 | **Units** | none | **Type** | Read/Write | **Scaling** | 1 |

Description Unused

Std ☑ **PNU** **120** STATUS 5

Default	0	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read Only	**Scaling**	1

Description Yet more status flags

Std ☑ **PNU** **121** USER_FLAGS4

Default	0	**Max**	255	**Min**	1	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description Yet more control flags

Std ☑ **PNU** **122** ss_smoothing

Default	5	**Max**	15	**Min**	1	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description Arbitrary filter to smooth soft stop jitters caused by unstable load.

Std ☑ **PNU** **123** Temp/Alt Derate

Default	0	**Max**	50	**Min**	0	**Units**	%	**Type**	Read/Write	**Scaling**	1

Description Reduce certain parameters (current limit etc.) by this % for high temperature or altitude, Set derate then load an application, this would then be derated.

The derate is only applied as an application is loaded.

Std ☐ **PNU** **124** OffLineCommand

Default	0	**Max**	255	**Min**	0	**Units**	none	**Type**	Read/Write W	**Scaling**	1

Description Certain system functions are carried out by writing to this register. See the command table. This parameter is write only, data read back from this parameter has no meaning.

1=Disable 2=Enable 3=BusStarting 4=RemoteStaring 5=ResetStarter 6=ResetTrip 7= BusStart 8= BusStop 9=Load Eerom From Defaults 10= Load Ram From Eerom 11= Save Ram to Eerom

---

Std ☐ **PNU** **125** Bus BaudRate

Default	0	**Max**	255	**Min**	0	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description 0 = 9600 baud do not change.

Only Active With certain Comms Options

Std ☐ **PNU** **126** Bus Action on Fail

Default	0	**Max**	255	**Min**	0	**Units**	none	**Type**	Read/Write	**Scaling**	1

Description Action following a bus failure 0= no trip 1 = trip

Only Active With certain Comms Options

Std ☐ **PNU** **127** Hidden Trip Flags

Default	0	**Max**	255	**Min**	0	**Units**	flags	**Type**	Read/Write	**Scaling**	1

Description Enable / disable certain trips not for general use contact Fairford

This Parameter is really for diagnostic purposes only!

Note:
1. Some parameters are not accessible on the keypad only through comms.
2. Some parameters are not available in all software releases.
3. Unused or Spare Parameters should not be adjusted.
4. On XFE Starters Current parameter scaling and limits vary from size to size see APP00041

Parameter	**8**	*STATUS 1*		Default	
Bitmask		**Name**	**Type**	**= ON**	**Description**
00000001	**(** 1**)**	Stopped	Status	☐	start/stop signal inactive thyristors off main contactor open
00000010	**(** 2**)**	Starting	Status	☐	Starter is in start ramp
00000100	**(** 4**)**	Current Limit	Status	☐	During a softstart indicates motor has reached Current limit level and ramp is being held.
00001000	**(** 8**)**	Top Of Ramp	Status	☐	The unit has finished the start ramp and any current limit
00010000	**(** 16**)**	Dwell	Status	☐	Period of timre at the the end of the start ramp where the motor is held at full volts before entering optimising to allow the load to stabilise
00100000	**(** 32**)**	Full Conduction	Status	☐	Thyristors are fully on
01000000	**(** 64**)**	Energy Saving	Status	☐	Starter is monitoring the motor power factor and adjusting applied voltage to bring it close to optimum.
10000000	**(** 128**)**	Stopping	Status	☐	The starter is performing a stop ramp

Parameter	**9**	*STATUS 2*		Default	
Bitmask		**Name**	**Type**	**= ON**	**Description**
00000001	**(** 1**)**	Alarm	Status	☐	Starter has detected a fault and has tripped
00000010	**(** 2**)**	Overload Integrating	Status	☐	The on board overload has detected over current and is integrating
00000100	**(** 4**)**	Stall	Status	☐	The starter has detected that the motor speed is slipping
00001000	**(** 8**)**	Forced Override	Status	☐	The starter has turned off optimising since the current has risen above 80% FLC
00010000	**(** 16**)**	Noise	Status	☐	The starter is experiencing poor mains reference signals
00100000	**(** 32**)**	Inhibit Start	Status	☐	The start is inhibited for a period to keep the unit within its allowable start duty.
01000000	**(** 64**)**	DC I/p level reached	Status	☐	The DC I/p has risen above the level specified in parameter 48
10000000	**(** 128**)**	4-20mA level reached	Status	☐	The4-20mA I/p has risen above the level specified in parameter 46

Parameter	10	*STATUS 3*			
Bitmask		**Name**	**Type**	**Default = ON**	**Description**
00000001	**(** 1**)**	K1	Status	☐	Status of relay K1
00000010	**(** 2**)**	K2	Status	☐	Status of relay K2
00000100	**(** 4**)**	K3	Status	☐	Status of relay K3 (QFE+)
00001000	**(** 8**)**	K4	Status	☐	Status of relay K4 (QFE+)
00010000	**(** 16**)**	I/P 1	Status	☐	Status of input 1
00100000	**(** 32**)**	I/P 2	Status	☐	Status of input 2 (QFE+)
01000000	**(** 64**)**	I/P 3	Status	☐	Status of input 3 (QFE+)
10000000	**(** 128**)**	RED LED (unused)	Status	☐	

Parameter	18	*Auto Config*			
Bitmask		**Name**	**Type**	**Default = ON**	**Description**
00000001	**(** 1**)**	Auto Ramp	read/write	☐	Gently ramps the voltage to the starter acting a bit like an automatic current limit.
00000010	**(** 2**)**	Auto 3MC	read/write	☑	Enable automatic removal of low voltage ramp for high start pedestals
00000100	**(** 4**)**	Auto Bypass	read/write	☑	Enable automatic bypass contactor detection
00001000	**(** 8**)**	Auto Jog	read/write	☐	Enable automatic Jog detection. A stop request within about 0.5 seconds of a start request are forced to 0 stop time
00010000	**(** 16**)**	Auto Endstop	read/write	☐	Enable Detect stalled motor during softstop and turn off thyristors
00100000	**(** 32**)**	Auto Stop	read/write	☐	Detect variations in pf during stop smooth stall
01000000	**(** 64**)**	Auto Endstart	read/write	☐	Enable detection of full speed during start and complete start ramp
10000000	**(** 128**)**	Auto Pedestal	read/write	☐	Enable approximate detection of motor rotation at start and adjust pedestal to suit.

Parameter	38	*User Flags 5*		Default = ON	
Bitmask		**Name**	**Type**		**Description**
00000010	**(** 2**)**	High Voltage	read/write	☐	Set this flag to allow voltage parameter to represent voltages above 460V
00000100	**(** 4**)**	PIO	read/write	☐	Set this flag if using a pre 2006 I/O add on card

Parameter	51	*USER FLAGS 1*		Default = ON	
Bitmask		**Name**	**Type**		**Description**
00000001	**(** 1**)**	Kickstart	read/write	☐	Selects Kickstart (except in 3MC mode)
00000010	**(** 2**)**	Current Limit Timeout selected	read/write	☑	Selects Trip or continue on Current Limit timeout
00000100	**(** 4**)**	Overload selected	read/write	☑	Selects Overload operation
00001000	**(** 8**)**	shearpin Selected	read/write	☑	Selects Shearpin operation
00010000	**(** 16**)**	Under Current Selected	read/write	☐	Selects UnderCurrent operation
00100000	**(** 32**)**	Thermistor Selected	read/write	☐	Selects Thermistor operation
01000000	**(** 64**)**	Unused	Status	☐	
10000000	**(** 128**)**	Terminal Starting	Status	☑	1=Start/stop through on board terminals 0=Starting through Bus

Parameter		52	*USER FLAGS 2*		Default	
Bitmask			**Name**	**Type**	**= ON**	**Description**
00000001	**(**	1**)**	Low Voltage SoftStop	read/write	☐	Selects low voltage phase of stopping ramp
00000010	**(**	2**)**	Not Global enable 1	read/write	☐	Active low enable signal from Terminal
00000100	**(**	4**)**	Not Global enable 2	read/write	☐	Active low enable signal from bus
00001000	**(**	8**)**	Pod Start/stop	read/write	☐	Bus start/stop request
00010000	**(**	16**)**	Board Start/stop	read/write	☐	Terminal start/stop request
00100000	**(**	32**)**	Main Contactor	Status	☐	Status of main incomming contactor signal
01000000	**(**	64**)**	Second Parameter Set	read/write	☐	Second parameter set will be loaded at start
10000000	**(**	128**)**	Zero Start time	read/write	☐	Starter goes directly to full conduction at start (for multiple motor soft stopping)

Parameter		53	*USER FLAGS 3*		Default	
Bitmask			**Name**	**Type**	**= ON**	**Description**
00000001	**(**	1**)**	pf1 pol	read/write	☑	Polarity of programmable flags (1)
00000010	**(**	2**)**	pf2 pol	read/write	☑	Polarity of programmable flags (2)
00000100	**(**	4**)**	User Current limit	read/write	☐	Bus requests a Start ramp hold
00001000	**(**	8**)**	User trip	read/write	☐	Bus requests a trip
00010000	**(**	16**)**	Invert Controller input	read/write	☑	Controller set point source is inverted before use in servo loop
00100000	**(**	32**)**	Inhibit Restart	read/write	☐	Inhibited restart control is enabled
01000000	**(**	64**)**	Unused	Status	☐	

Parameter	54	*I/O POLARITY*			
Bitmask		Name	Type	Default = ON	Description
00000001	(1)	K1 Polarity	read/only	☑	
00000010	(2)	K2 Polarity	read/only	☑	
00000100	(4)	K3 Polarity	read/only	☑	
00001000	(8)	K4 Polarity	read/only	☑	
00010000	(16)	I/P 1 Polarity	read/only	☑	
00100000	(32)	I/P 2 Polarity	read/only	☑	
01000000	(64)	I/P 3 Polarity	read/only	☑	
10000000	(128)	LED Polarity (unused)	read/only	☐	

Parameter	86	*Auto Config 2*			
Bitmask		Name	Type	Default = ON	Description
00000001	(1)	Auto Ramp	read/write	☐	Gently ramps the voltage to the starter acting a bit like an automatic current limit.
00000010	(2)	Auto 3MC	read/write	☑	Enable automatic removal of low voltage ramp for high start pedestals
00000100	(4)	Auto Bypass	read/write	☑	Enable automatic bypass contactor detection
00001000	(8)	Auto Jog	read/write	☐	Enable automatic Jog detection. A stop request within about 0.5 seconds of a start request are forced to 0 stop time
00010000	(16)	Auto Endstop	read/write	☐	Enable Detect stalled motor during softstop and turn off thyristors
00100000	(32)	auto Stop	read/write	☐	Detect variations in pf during stop smooth stall
01000000	(64)	Auto Endstart	read/write	☐	Enable detection of full speed during start and complete start ramp
10000000	(128)	Auto Pedestal	read/write	☐	Enable approximate detection of motor rotation at start and adjust pedestal to suit.

Parameter	95		*USER FLAGS 1,2*		Default = ON	Description
Bitmask			**Name**	**Type**		
00000001	**(**	1**)**	Kickstart (2)	read/write	☐	
00000010	**(**	2**)**	Current Limit Selected (2)	read/write	☑	
00000100	**(**	4**)**	Overload selected (2)	read/write	☑	
00001000	**(**	8**)**	shearpin Selected (2)	read/write	☐	
00010000	**(**	16**)**	Under Current Selected (2)	read/write	☐	
00100000	**(**	32**)**	Thermistor Selected (2)	read/write	☐	
01000000	**(**	64**)**	Unused	Status	☐	
10000000	**(**	128**)**	Remote Starting (2)	read/write	☑	

Parameter	96		*USER FLAGS 2,2*		Default = ON	Description
Bitmask			**Name**	**Type**		
00000001	**(**	1**)**	Low Voltage SoftStop (2)	read/write	☐	
00000010	**(**	2**)**	Not Global enable 1 (2)	read/write	☐	
00000100	**(**	4**)**	Not Global enable 2 (2)	read/write	☐	
00001000	**(**	8**)**	Pod Start/stop (2)	read/write	☐	
00010000	**(**	16**)**	Board Start/stop (2)	read/write	☐	
00100000	**(**	32**)**	Main Contactor (2)	Status	☐	
01000000	**(**	64**)**	Second Parameter Set (2)	read/write	☑	
10000000	**(**	128**)**	Zero Start time (2)	read/write	☐	

Parameter		112	*STATUS 4*		Default = ON	
Bitmask			**Name**	**Type**		**Description**
00000001	**(**	1**)**	60 Hz	Status	☐	The unit is using 60Hz parameters
00000010	**(**	2**)**	RYB Sequence	Status	☐	The phase rotation detected at start was …
00000100	**(**	4**)**	Shearpin	Status	☐	Indicates current is above shearpin level
00001000	**(**	8**)**	Under Current	Status	☐	Indicates current is below under current level
00010000	**(**	16**)**	Thermistor	Status	☐	Thermistor is overtemperature or I/p's are open circuit
00100000	**(**	32**)**	Timeout	Status	☐	Current limit has timed out
01000000	**(**	64**)**	Overload	Status	☐	Overload has passed trip level
10000000	**(**	128**)**	Thermal Switch	Status	☐	Heatsink is above max allowed temperature

Parameter		120	*STATUS 5*		Default = ON	
Bitmask			**Name**	**Type**		**Description**
00000001	**(**	1**)**	Over Temperature	Status	☐	Inhibits re-start if set. Effectivley The heatsink is too hot to start but is ok to run.
00000010	**(**	2**)**	Offline Command Fail	read/only	☐	The last offline command failed , automatically reset when the next command is attempted.
00001000	**(**	8**)**	Fan Status	read/only	☐	

Parameter	121	*USER FLAGS4*			
Bitmask		Name	Type	Default = ON	Description
00000001	(1)	Impact Load	read/write	☐	Limit max delay adjustment in optimising for highly volatile loads
00000100	(4)	Auto SoftsStop Smoothing	read/write	☐	enable Soft stop smoothing for pumps
00001000	(8)	Breaker Present	read/write	☐	Is the system to be used with a trippable breaker. Although selected by certain users this is not a prefered option, it is recommended that a line contactor is used as a switching off device.
00100000	(32)	Quick Ramp Times	read/write	☐	This bit selects ramp times to be 10 times faster than the value entered although min = 0.3sec
01000000	(64)	Two Stop Bits	read/write	☐	When set the comms will have two stop bits.
10000000	(128)	Auto Stop2	read/write	☐	Alternative Stopping method

Parameter	127	*Hidden Trip Flags*			
Bitmask		Name	Type	Default = ON	Description
00000001	(1)	Trip 1 Enabled	read/write	☑	Enable or disable Trip 1 Phase Loss
00000010	(2)	Trip 8 Enabled	read/write	☑	Enable or disable Trip 8 Motor side Thyristor Loss
00000100	(4)	Trip 9 Enabled	read/write	☑	Enable or Disable Thyristor Sensing Trip Type A
00001000	(8)	Trip 10 Enabled	read/write	☑	Enable or Disable Thyristor Sensing Trip Type B
00010000	(16)	Trip 4 Enabled	read/write	☐	Enable or Disable Thyristor Sensing Trip Type C
00100000	(32)	Trip 5 Enabled	read/write	☑	Enable or Disable Edge Sensing Trip
01000000	(64)	Trip 6 Enabled	read/write	☑	Enable or Disable Sensing Trip Type A
10000000	(128)	Trip 7 Enabled	read/write	☑	Enable or Disable Sensing Trip Type B

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Software Version   **6703**

Name   Small Pump

Start Pedestal %	10 %	**Stop Pedestal**	10	%
Start Time	5 S	**Soft Stop Time**	30	S
Current Limit Level	3.5 * FLC	**Current Limit Time**	25	S

Optimise Rate   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☑ **Auto Stop**

☑ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☐ **Auto ramp** ☑ **Auto End Stop**

Notes

Name   Large Pump

Start Pedestal %	10 %	**Stop Pedestal**	10	%
Start Time	7 S	**Soft Stop Time**	45	S
Current Limit Level	3.5 * FLC	**Current Limit Time**	25	S

Optimise Rate   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☑ **Auto Stop**

☑ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☐ **Auto ramp** ☑ **Auto End Stop**

Notes

Name   Low inertia Fan

Start Pedestal %	30 %	**Stop Pedestal**	0	%
Start Time	15 S	**Soft Stop Time**	0	S
Current Limit Level	3.5 * FLC	**Current Limit Time**	30	S

Optimise Rate   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☑ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   High Inertia Fan

Start Pedestal %	40 %	**Stop Pedestal**	0	%
Start Time	3 S	**Soft Stop Time**	0	S
Current Limit Level	3.5 * FLC	**Current Limit Time**	60	S

Optimise Rate   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☑ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

FD8416 ApplicationsData

Software Version   **6703**

Name   Conveyor

Start Pedestal %	10 %	**Stop Pedestal**	0 %
Start Time	10 S	**Soft Stop Time**	7 S
Current Limit Level	3.5 * FLC	**Current Limit Time**	30 S
Optimise Rate		☑ **Auto Pedestal**	☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☑ **Auto Stop**

☐ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☐ **Auto ramp** ☑ **Auto End Stop**

Notes

Name   Reciprocating Compressor

Start Pedestal %	45 %	**Stop Pedestal**	0 %
Start Time	3 S	**Soft Stop Time**	S
Current Limit Level	3.5 * FLC	**Current Limit Time**	25 S
Optimise Rate	15	☑ **Auto Pedestal**	☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   Screw Compressor

Start Pedestal %	40 %	**Stop Pedestal**	0 %
Start Time	7 S	**Soft Stop Time**	0 S
Current Limit Level	7.8125 * FLC	**Current Limit Time**	25 S
Optimise Rate		☑ **Auto Pedestal**	☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   Rotary Compressor

Start Pedestal %	35 %	**Stop Pedestal**	0 %
Start Time	7 S	**Soft Stop Time**	0 S
Current Limit Level	3.5 * FLC	**Current Limit Time**	25 S
Optimise Rate		☑ **Auto Pedestal**	☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

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Software Version   **6703**

Name   Crusher

Start Pedestal %	40	%	**Stop Pedestal**	0	%
Start Time	3	S	**Soft Stop Time**	0	S
Current Limit Level	3.5	* FLC	**Current Limit Time**	60	S

Optimise Rate [ ]   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes [ ]

Name   Grinder

Start Pedestal %	40	%	**Stop Pedestal**	0	%
Start Time	3	S	**Soft Stop Time**	0	S
Current Limit Level	3.5	* FLC	**Current Limit Time**	60	S

Optimise Rate [ ]   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes [ ]

Name   Hi Torque Start

Start Pedestal %	60	%	**Stop Pedestal**	0	%
Start Time	3	S	**Soft Stop Time**	0	S
Current Limit Level	4.375	* FLC	**Current Limit Time**	12	S

Optimise Rate [ ]   ☑ **Auto Pedestal**   ☐ **Auto Jog**

☑ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes [ ]

Name   MG Set

Start Pedestal %	40	%	**Stop Pedestal**	0	%
Start Time	5	S	**Soft Stop Time**	0	S
Current Limit Level	2.8125	* FLC	**Current Limit Time**	25	S

Optimise Rate 0   ☐ **Auto Pedestal**   ☐ **Auto Jog**

☐ **Auto End Start**   ☐ **Auto 3MC**   ☐ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes [ ]

FD8416 ApplicationsData

Software Version   **6703**

Name   Aerator

Start Pedestal %	10 %	**Stop Pedestal**	10	%
Start Time	60 S	**Soft Stop Time**	60	S
Current Limit Level	3 * FLC	**Current Limit Time**	60	S
Optimise Rate	5	☐ **Auto Pedestal**	☐ **Auto Jog**	

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☑ **Auto Stop**

☑ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   Press

Start Pedestal %	40 %	**Stop Pedestal**	10	%
Start Time	3 S	**Soft Stop Time**	0	S
Current Limit Level	3 * FLC	**Current Limit Time**	60	S
Optimise Rate	5	☑ **Auto Pedestal**	☐ **Auto Jog**	

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   Moulder

Start Pedestal %	10 %	**Stop Pedestal**	10	%
Start Time	10 S	**Soft Stop Time**	0	S
Current Limit Level	3 * FLC	**Current Limit Time**	30	S
Optimise Rate	5	☐ **Auto Pedestal**	☐ **Auto Jog**	

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing** ☐ **Low Volt SoftStop**   ☐ **Auto ramp** ☐ **Auto End Stop**

Notes

Name   Default Auto

Start Pedestal %	10 %	**Stop Pedestal**	10	%
Start Time	10 S	**Soft Stop Time**	10	S
Current Limit Level	5 * FLC	**Current Limit Time**	10	S
Optimise Rate	0	☑ **Auto Pedestal**	☐ **Auto Jog**	

☐ **Auto End Start**   ☐ **Auto 3MC**   ☑ **Auto bypass**   ☑ **Auto Stop**

☑ **SoftStop Smoothing** ☑ **Low Volt SoftStop**   ☑ **Auto ramp** ☐ **Auto End Stop**

Notes

FD8416 ApplicationsData

Software Version   **6703**

Name   Default

Start Pedestal %   20 **%**   **Stop Pedestal**   10 **%**

Start Time   5 **S**   **Soft Stop Time**   0 **S**

Current Limit Level   3.5 *** FLC**   **Current Limit Time**   30 **S**

Optimise Rate   5   ☐ **Auto Pedestal**   ☐ **Auto Jog**

☐ **Auto End Start**   ☑ **Auto 3MC**   ☑ **Auto bypass**   ☐ **Auto Stop**

☐ **SoftStop Smoothing**   ☐ **Low Volt SoftStop**   ☐ **Auto ramp**   ☐ **Auto End Stop**

Notes

Soft Starters and Energy Optimising Soft Starters
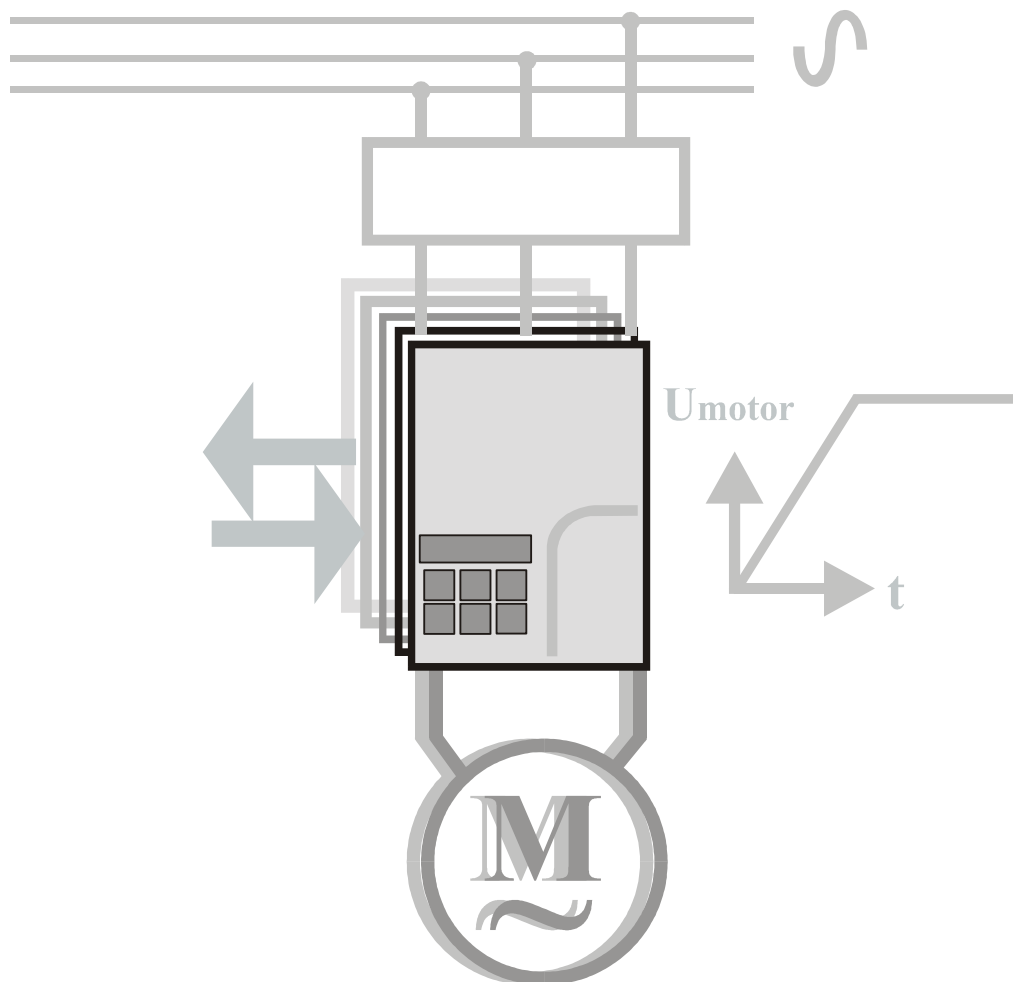
Technical Data for 5MC Based Soft Starters
Modbus Protocol Manual FD5100 issue07

WARNING	The owner, installer and user is responsible for the correct installation and use of the 5MC and must ensure that only qualified personnel install the 5MC and that the installation, operation and maintenance of the unit complies with the relevant Codes of Practice, Regulations and Statutory Requirements. The Manufacturer or his agent do not assume any liability, expressed or implied, for any consequence 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. To prevent an electrical shock hazard the 5MC must be connected to a safety earth. The unit is not designed for use in hazardous areas. Use in such an area may invalidate the hazardous area certification.

6   **The Modbus Protocol**   5

6 The Modbus Protocol

6.1 Overview

The 5MC has built in serial communications this has been changed from Version 55 onwards to be a compatible subset of the widely recognised Modbus RTU protocol (slave).

The serial communications is accessible from the keypad connector or with an additional interface card (RS485) the 5MC may be connected to a PC or suitable PLC network.

6.2 Quick Start

Work should only be carried out on the 5MC with all electrical power disconnected

1) Communication settings
    a) 9600 baud, 8 databits, 1 stop bit, no parity
    b) network station number = 1

2) Before Connecting a Comms interface use the standard keypad to make any changes for your bus system.
    a) Set parameter 1 to the required network station number (slave address) now unless station 1 is spare on the network.
    b) If not continously polling the unit at least once every 2 seconds set PNU126 to 0 turning off comms timeout trip
    c) Make any changes to Parameter 121, $20 (Coil 974).
        0 = 1 Stop bit
        1 = 2 Stop bits
    d) Store changes to eerom (save ram).

3) The 5MC standard keypad **MUST BE DISCONNECTED** while any optional communication interface is fitted unless the interface provides a suitable connector. See the relevant application note (APP00002) for connection of the various interface cards.

4) Details of registers and Flags are available in the FD8416 series of documents.

5) Register and coil addresses start at zero; register zero is addressed as zero, **register one is addressed as one** …

Allowed address ranges are Register numbers 0…127, EEROM Registers 1000…1127, Coils (flags) 0…1024.

6) Registers are mapped one to one, that is register one on the keypad is register one on the Modbus.

7) Flags on the Modbus are read as holding registers i.e. read register 9 to read status2 flags. For writing flags are mapped one to one so for example the the Kick Start Flag bit 0 of User Flags 1 (P51) is bit no 51 * 8 + 0 = Flag 408.

6.3 Specification

1. Refer to Modicon Modbus Protocol Reference Guide PI-MBUS-300 for full protocol specification.

2. Baud rate is 9600.

3. 8 data bits, no parity, 1 stop (default) or 8 data bits, no parity, two stop bits.

4. Modbus timeout is 3.5 character times, the in message timeout is also 3.5 character times unlike the standard which is 1.5 character times. Further it is also possible that the 5MC will be appreciably delayed in responding to a telegram if it is checking a fault condition.

5. Broadcast is not supported.

6. 5MC parameters retain their normal numbers (0-127).

7. Flag parameters are bit positions starting at parameter 0 bit 0

8. Register numbers are 0…127

9. Coils (flags) 0…1024

10. Offline eerom Registers are 1000…1127

11. Supports

Function 03 read holding registers up to 4 words (8 parameters) in number.

Function 05 preset single coil.

Function 06 preset single register (byte).

Function 07 exception status.

Function 16 preset multiple registers upto 3 words (6 parameters).

Error 01 illegal function (write to read only parameter)

Error 02 illegal data address (bad parameter number)

Error 03 illegal data (trying to read or write too much data)

Error 06 slave busy

Error 07 negative acknowledge

6.4   **Function 03 - Read holding registers** Starter 01 PNU 01, 02

This function is used to read a group of up to eight parameters from the 5MC.

The allowable address range for this function is 0-127 for working parameters and 1000 – 1127 for offline eerom parameters.

5MC parameters are bytes, Modbus reads the values from the slave as words so to speed up communications two 5MC parameter bytes are packed into each Modbus word. The lowest parameter is in the data Hi of the word and the next parameter is in the data Lo. This also means that even when the read request is for one register two 5MC parameters are read, up to 4 contiguous words (8 parameters) may be read with one query.

Modbus function 3 transaction table

Query	
Field	Hex Byte
Slave Address	**01**
Function	**03**
Start Address Hi	**00**
Start Address Lo	**01**
No of registers Hi	**00**
No of registers Lo	**01**
CRC Lo	**??**
CRC Hi	**??**

Response	
Field	Hex Byte
Slave Address	**01**
Function	**03**
Byte Count	**02**
Data Hi	**01**
Data Lo	**2C**
CRC Lo	**??**
CRC Hi	**??**

6.5   **Function 05 - Preset Single Coil** Starter 01 coil (flag) 408

This function is used to set or clear a single Flag, a flag is a bit within parameters 0-127. Only flags in parameters known internally to be flag registers and marked for read write may be preset with this function. Therefore the range of available flags is 0-1024.

The normal response for correct operation is an echo of the data. This function is only available for software versions 56 and 67

Modbus function 5 transaction table

Query	
Field	Hex Byte
Slave Address	**01**
Function	**05**
Coil Address Hi	**01**
Coil Address Lo	**98**
Force Data Hi	**FF**
Force Data Lo	**00**
CRC Lo	**??**
CRC Hi	**??**

Response	
Field	Hex Byte
Slave Address	**01**
Function	**05**
Coil Address Hi	**01**
Coil Address Lo	**98**
Force Data Hi	**FF**
Force Data Lo	**00**
CRC Lo	**??**
CRC Hi	**??**

5MC
FD510007

6.6   Function 06 - Preset Single Register Starter 01 PNU 12, Data 09

This function is used to set the value of a single parameter. **It differs from the modbus protocol** in that only the data Lo byte of the query is written to the parameter address. The data Hi byte is ignored.

The normal response for correct operation is an echo of the data.

Modbus function 6 transaction table

Query	
Field	Hex Byte
Slave Address	01
Function	06
Address Hi	00
Address Lo	0C
Force Data Hi	00
Force Data Lo	09
CRC Lo	??
CRC Hi	??

Response	
Field	Hex Byte
Slave Address	01
Function	06
Address Hi	00
Address Lo	0C
Force Data Hi	00
Force Data Lo	09
CRC Lo	??
CRC Hi	??

6.7   Function 07 - Exception status Starter 01

This functions format is as per the modbus standard but the bits in the value returned have different meanings shown below. This is the quickest of the modbus functions and should be used in the context of the 5MC to check if a station is present or check if it is busy

Modbus function 7 transaction table

Query	
Field	Hex Byte
Slave Address	01
Function	07
CRC Lo	41
CRC Hi	E2

Response	
Field	Hex Byte
Slave Address	01
Function	07
Exception Data	00
CRC Lo	??
CRC Hi	??

6.7   continued

Returned Exception Data

Bit	Meaning
0	Enabled
1	Stopped
2	Starting
3	Current Limiting
4	TOR (Start Complete)
5	Cooling
6	Alarm
7	Offline Command Failed

6.8   Function 16 - Preset Multiple Registers Starter 01 PNU 10 - 13, Data undefined

This function is used to set the values of multiple parameters. **It differs from the modbus protocol** in that since all parameters are bytes they are packed into the 16 bit register space lowest parameter number to hi byte then the next parameter in the low byte and so on up to 3 contiguous words (6 parameters) may be preset with one query.

Modbus function 16 transaction table

Query	
Field	Hex Byte
Slave Address	**01**
Function	**10**
Address Hi	**00**
Address Lo	**0A**
No. of Regs Hi	**00**
No. of Regs Lo	**02**
Byte Count	**04**
Data Hi	**??**
Data Lo	**??**
Data Hi	**??**
Data Lo	**??**
CRC Lo	**??**
CRC Hi	**??**

Response	
Field	Hex Byte
Slave Address	**01**
Function	**10**
Address Hi	**00**
Address Lo	**0A**
No. of Regs Hi	**00**
No. of Regs Lo	**02**
CRC Lo	**??**
CRC Hi	**??**

5MC
FD510007

6.9   Returned Errors

If there is a communication error in the query the 5MC does not reply.

If the network communication is Ok but for some reason the 5MC cannot correctly execute the query then it will return an error reply. In an error reply the function byte is returned OR'ed with $80 and the following byte contains the error number. The table below shows the query/reply that would be expected if the slave was busy

Modbus function 7 transaction table showing error response

Query	
Field	Hex Byte
Slave Address	**01**
Function	**07**
CRC Lo	**41**
CRC Hi	**E2**

Response	
Field	Hex Byte
Slave Address	**01**
Function	**87**
Exception Data	**06**
CRC Lo	**??**
CRC Hi	**??**

| Number	Modbus	Meaning
1	Illegal Function	Writing
2	Illegal Data Address	Out of allowed parameter range
3	Illegal Data	Too many data bytes in query
6	Slave Busy	Slave is performing a long command

6.10   5MC Commands

The 5MC Modbus series software has a new mechanism for carrying out common functions or offline ones which take a long time and requires the 5MC to be off and disabled. Commands are now carried out by writing various values to a Command Register (parameter 124). For example writing a 1 to PNU124 using function 6 disables the starter

Once a value has been written to This special register further Modbus queries will receive an error "slave busy" until the command execution is completed. If an error occurred during the execution of the command (say the unit was not disabled before execution) then the Offline Command failed flag will be set. If function 7 has been used to poll the 5MC then once the busy period is over this flag is available in the returned status byte position $80.

Parameter 124 Command Codes

| Number	Command	Active	Meaning
1	Disable Starter	Always	Stop the 5MC responding to start commands, remote or local. If running the 5MC will stop immediately. The status of any start signal is not changed.
2	Enable Starter	Always	The 5MC will respond to new or existing start commands
3	Bus Starting	Always	The 5MC responds to start requests from the keypad/Bus port.
4	Remote Starting	Always	The 5MC responds to start requests from the hardware input
5	Reset Starter	Always	The 5MC is forced to a cold start
6	Reset Trip	Always	Resets the 5MC to stopped and ready state
7	Bus Start	When Enabled	If Starting = bus & unit is enabled, 5MC will start
8	Bus Stop	When Enabled	5MC will always stop
9	Factory Default	When Disabled	The working ram is loaded with factory default values, this may take up to 5 seconds
10	Power On Default	When Disabled	The working ram is loaded with the permanent store values
11	Save ram	When Disabled	The working ram is saved to the permanent store for future use, this may take up to 5 seconds
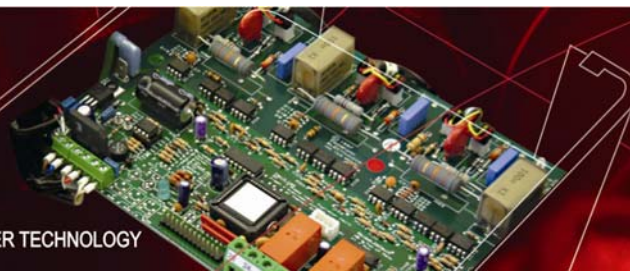
Modbus Communications – RS485 Add On Card for the QFE/XFE Range of Soft Starters
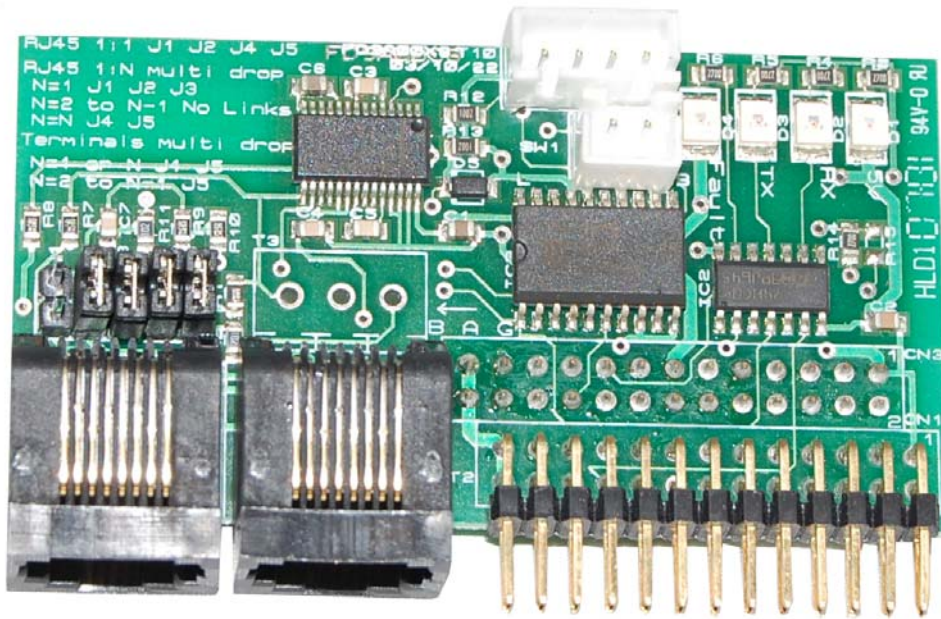
The ability to set up, control and monitor single or multiple QFE/XFE Soft starters has now been introduced.

With the addition of the AP9A00 serial card it now allows control to be switched between an integral Keypad or alternately through an external isolated Modbus network.
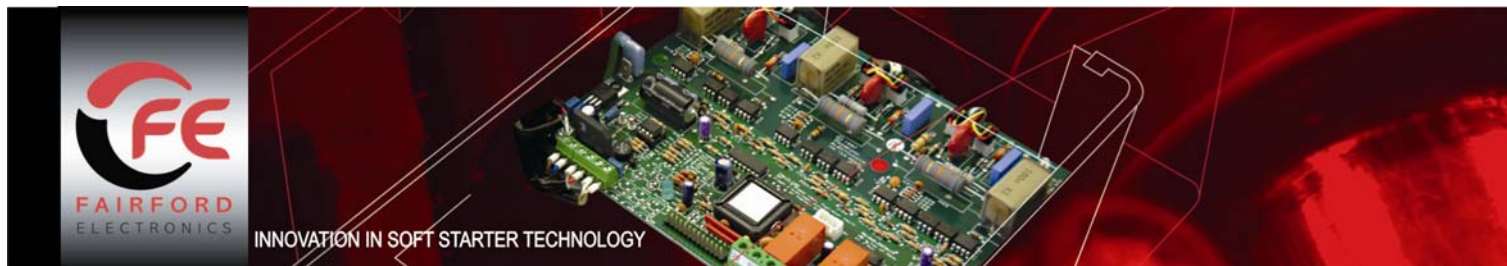
Modbus Communications for the QFE/XFE range of Soft Starters

- The AP9A00 is for use with version 5511 or above firmware.
- It provides an RS485 interface with 50V isolation for demanding industrial applications.
- The interface is suitable for connection to the Remote Keypod or a standard Modbus networks running at 9600 baud 8N1.

Communications Technical Specification

Location of AP9A00 Serial card fitted on Standard 5MC card

5MC Card

Keypad Cable

AP9A00 Serial Card

Alternative Network Screw Terminals

Std CAT 5E Network Cables

Network Application AP9A00 fitted with screw terminal and using twisted pair cabling

Modbus Master PLC or HMI

PLC

b a

Terminating resistor

Network Start

5MC Soft Start Station 1

Links fitted to AP9A00 : All middle Starters None

b a g   AP9A00 RJ,ST Comms card

5MC Soft Start Station 2

Links fitted to AP9A00 : All middle Starters NONE

b a g   AP9A00 RJ,ST Comms card

5MC Soft Start Station 3

Links fitted to AP9A00 : Last Starter J4,J5

b a g   AP9A00 RJ,ST Comms card

Network End
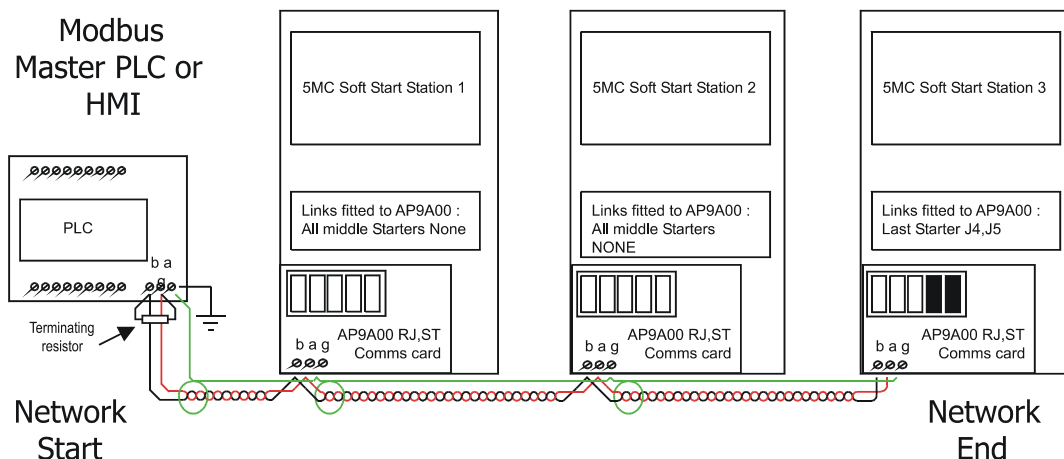
SD0008603

Remote Keypod for the QFE/XFE Range of Soft Starters

Easy Installation - Easy Set Up – Reliability

Panel mounting

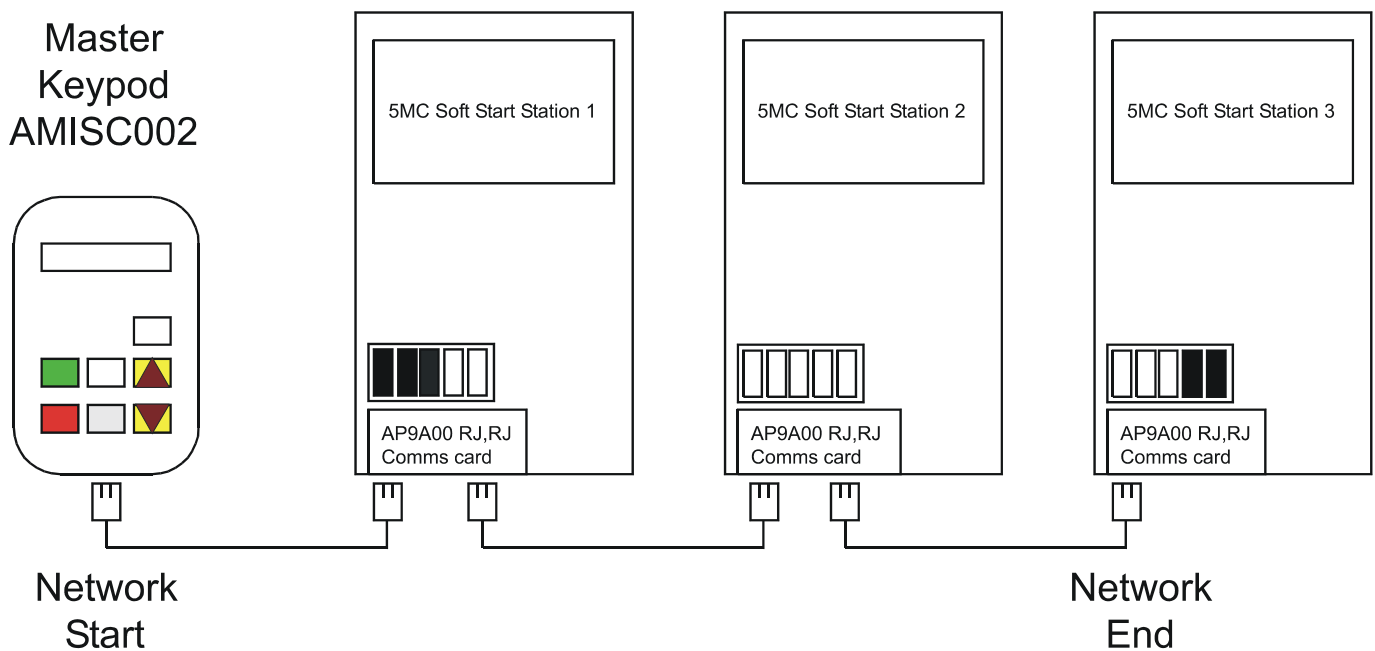## The Keypod is invaluable for multiple installations and can eliminate many control items.

Remote Keypod
For the QFE/XFE Range of Soft Starters

- Can be used on a one to one basis, or one Keypod can control several Soft Starters

  - Seven buttons with individual Start and Stop

    - Display via a 2 line 32 character LCD

  - Eliminates panel mounted Start and Stop push buttons,
    Ammeters, Run, Top of Ramp and Alarm Lamps

- The Keypod gives continuous display of motor phase current and control status
  Starting, Stopping, Full Volts, Optimising, Current Limitation,
  Overload and Fault Indication

Keypod Concept

Master Keypod AMISC002

5MC Soft Start Station 1

5MC Soft Start Station 2

5MC Soft Start Station 3

AP9A00 RJ,RJ Comms card

AP9A00 RJ,RJ Comms card

AP9A00 RJ,RJ Comms card

Network Start

Network End

SD0005303

**Application Note : APP0000208 Simple Softstart Network.doc** 26/02/2008

5MC SoftStarters, as standard are controlled by a Modbus serial protocol (see FD5100 Modbus Manual). The addition of an AP9A00 Serial card allows this control to be switched between the integral keypad or alternatively through an external isolated RS485 network.

The AP9A00 circuit board and AMISC002 Keypod have been designed to connect via a standard CAT5 RJ45 terminated ethernet cable. Additionally the AP9A00 is fitted with a second RJ45 connector allowing a number of soft starters to be connected together. Alternatively standard twisted pair wiring may be used via the secondary screw terminals. When specifying a Simple Starter Network 3 main parts are required

1: SoftStarts fitted with AP9A00 comms cards.
2: Modbus Master or AMISC002 Keypod.
3: Cabling
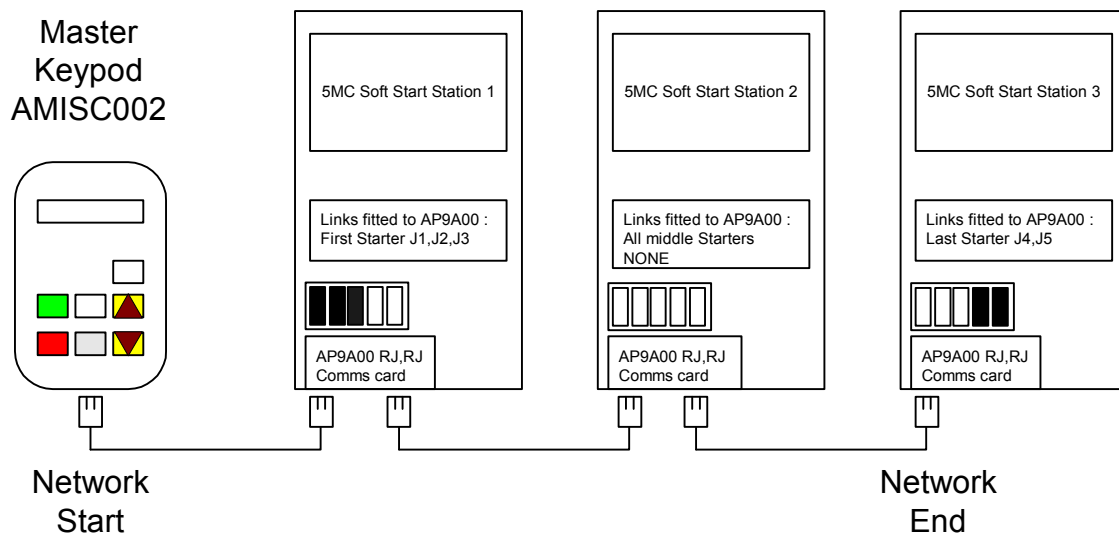
Network Application AP9A00 fitted with screw terminal and using twisted pair cabling

Application Note : APP0000208 Simple Softstart Network.doc   26/02/2008
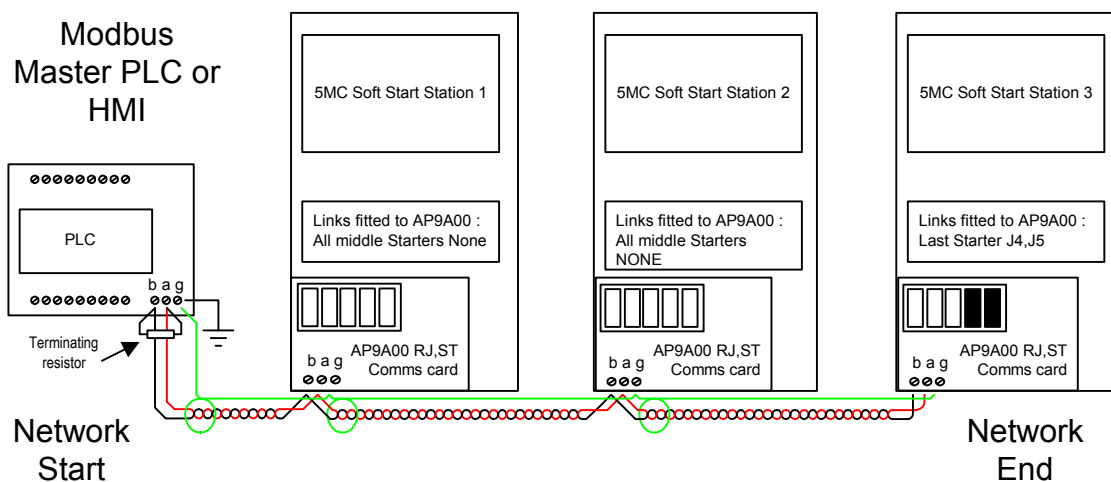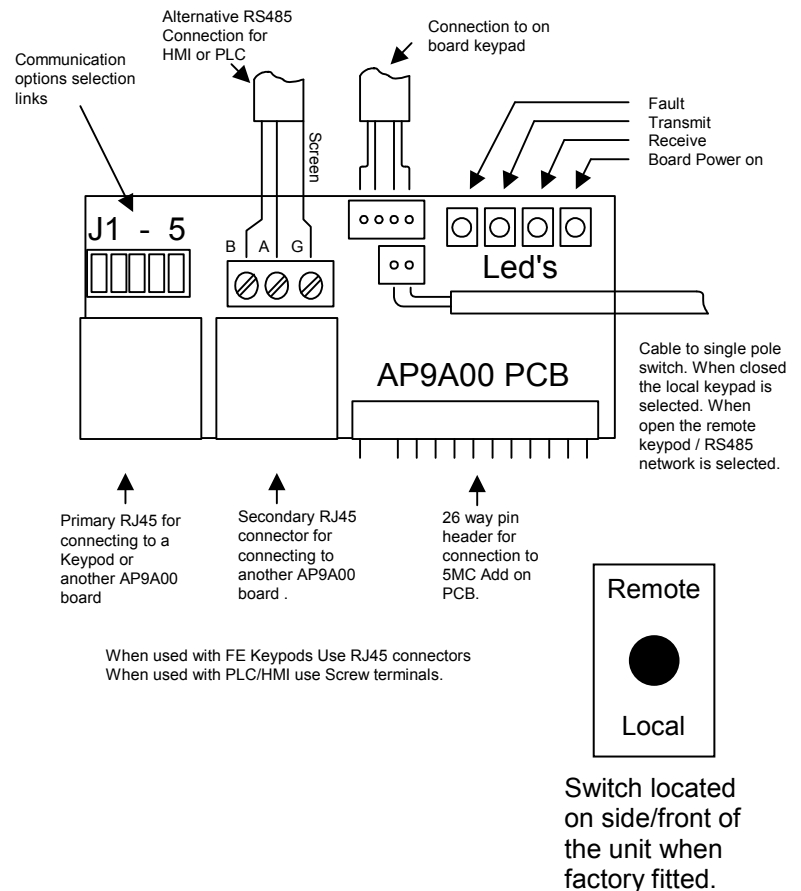
J1 –J5 Link Options

- L1: when linked 12V is passed through to the RJ45 connectors. This is for use with the FE net only, it supplies power to the remote Keypod, even then only the unit closest to the Keypod should have this link fitted.

- L2: when linked the on board 1k grounding resistor is shorted out. This is for use with FE net only, even then only the unit closest to the Keypod should have this link fitted.

- L3: when linked the serial comms isolated ground is connected to the local unit ground. If multiple MAX3157 (isolated comms) chips are connected one must have this link shorted.

- L4: when linked a 100 ohm terminating resistor is connected between the A and B RS485 lines on both the RJ45 and screw terminal connections. For RS485 networks only the nodes at each physical end of the network have terminating resistors fitted.

- L5: when linked a 1k resistor is connected between screw terminal G and local ground. Normally only one of the units would have this link fitted.

- For Keypod RJ45 1 to 1 connection with starter fit links 1,2,4,5

- For PLC/HMI twisted pair connection 1 to 1 with starter fit terminating resistor (may be internal) at PLC/HMI end and links 4 &5 on starter.

1. AP9A00 cards must be version   X8+
2. AP9A00 isolation level   50V
3. Maximum number of starters   8
4. 5MC minimum software level   56.09 OR 67.03
5. Keypod minimum software level   1.070
6. Standard settings are   9600 baud,8,n,1
7. Cable   RJ45 Twisted pair CAT5 Ethernet
8. Maximum network length must not exceed 25M.
9. The keypod is only able to control one starter at a time.
10. While the keypod is showing the starter status, pressing the up arrow changes to the next connected starter.
11. Most Communication parameters require the unit to be disabled before adjustment is allowed.
12. When initially setting up the network one starter at a time is added and it's **unique** station number must be allocated.
13. It is important to keep the network cabling separate from any power and electric control wiring.
14. On factory fitted units an external switch Local/Remote is provided to switch between internal keypad and external RS485 /Keypod.

Communication options selection links

Alternative RS485 Connection for HMI or PLC

Connection to on board keypad

J1 - 5   B A G   Screen   Led's

Fault
Transmit
Receive
Board Power on

AP9A00 PCB

Cable to single pole switch. When closed the local keypad is selected. When open the remote keypad / RS485 network is selected.

Primary RJ45 for connecting to a Keypod or another AP9A00 board

Secondary RJ45 connector for connecting to another AP9A00 board .

26 way pin header for connection to 5MC Add on PCB.

When used with FE Keypods Use RJ45 connectors
When used with PLC/HMI use Screw terminals.

Remote
●
Local

Switch located on side/front of the unit when factory fitted.

AP9A00 Circuit board in fitted position on 5MC card

APCB9A00X8 circuit board