CT Soft Start

CT Soft Start

USER'S GUIDE

Energy Optimising
SOFT STARTERS
for
STANDARD AC MOTORS

Safety at Work

It is the responsibility of the owner, installer and user to ensure that the installation of the equipment and the way in which it is operated and maintained complies with the requirements of the Health & Safety at Work Act in the United Kingdom and applicable legislation, regulations and codes of practice in the UK or elsewhere.

Only qualified personnel should install this equipment, after first reading and understanding the information in this publication. The installation instructions should be adhered to. Any question or doubt should be referred to the supplier of the equipment.

Operational Safety

Some versions of the system software can be configured to provide an auto-restart feature. Users and operators must always take all necessary precautions to prevent damage to equipment and especially to prevent the risk of injury to personnel working on or near the motor and the driven equipment.

The stop and start inputs should not be relied upon alone to ensure the safety of personnel. If a safety hazard could arise from the unexpected starting of the motor, an interlock mechanism should be provided to prevent the motor from running except when it is safe.

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Contents

Chapter ***Page***

1

The **CT Soft Start** 3

2

SPECIFICATIONS AND DATA

Specifications 8

Installation Data 9

Current Ratings 10

3

INSTALLATION PROCEDURES

Mechanical Installation 11

Electrical Installation 11

Control Terminals 13

Output Relay Terminals 15

Link (Jumper) Positions 15

LED Indications 15

Electromagnetic Compatibility (EMC) 16

4

SETTING UP PROCEDURES

Preliminary Adjustments 17

Power Supply Frequency 17

Control Supply 17

Starting Command 17

Stopping Command 17

Ramps 18

Starting Ramp 18

Stopping Ramp 18

Current Limitation 19

Supplementary Optional Features 20

Illustrations

1 The **CT Soft Start** stages of soft start and operation 3

2 The Effect of Ramp Time on Starting Current 4

3 Physical Dimensions of soft start Chassis 12

4 Typical Power and Control Connections 13

5 Power and Control Terminals — *3MC+* 14

6 Power and Control Terminals — *4MC* and *690V* 14

7 Frequency Selection and Start Ramp Time DIP Switch Settings 18

8 Stopping Ramp Time and Current Limit Time-out DIP Switch Settings 18

9 Bypass Contactor Schematics 19

Control Techniques Worldwide

List of Names and Addresses of Distributors End pages

INTRODUCTION

A Brief Review of Motor Starting

This summary of the starting performance of induction motors with permanently-coupled loads is given in the belief that if the underlying principles are understood, better use and application of equipment will follow. Soft starting of industrial machinery driven by standard squirrel-cage induction motors provides valuable economies of electrical energy. Optimum benefits are gained when a motor duty involves frequent start-stop cycles, but are still likely to be worthwhile in systems which are in continuous operation.

Energy

The AC induction motor with a permanently-coupled load, when it is operated without the benefit of a soft starter, draws a high starting current — typically five or more times greater than its full load current. Reduced-voltage starting decreases the current demand.

An induction motor connected directly to the power mains draws a constant magnetising current at full speed, no matter what the load. At anything less than full rated load, the power factor of an induction motor is less than its rated power factor because the torque-producing current decreases as the load decreases, but the magnetising current does not change. The lighter the load the worse the power factor.

Motors selected from a standard range are almost always chosen with a rated power in excess of maximum load demand, with the result that in any installation the motors seldom operate at their full rated load. In consequence, they can never achieve their rated power factor even at maximum load demand. If the load is variable, the waste of energy is worse.

Electrical energy supply tariffs for industrial users almost invariably carry a penalty — higher cost per unit — for consumption at low power factors. Further, the cost charged is increased if demand exceeds a maximum limit.

Stress

The mechanical shock delivered to the rotor, couplings, any intermediate gearing, and the driven load by a high starting current is most severe when the motor is started direct-on-line. Even reduced-voltage starting devices such as star-delta or auto-transformer starters still impose shock loads because of the very high current peaks which cause severe transient torques at the moments of intermediate switching. The effect of such repeated shock loadings is to decrease the life of components and increase the cost of maintenance.

Advantages of Soft Starting

The soft starter enables the user to control the starting current to the practical minimum needed to achieve break-away, and to hold back the current during acceleration to a level compatible with the type of load and the needs of the process. This regulates the flow of energy used in achieving the normal running speed, and reduces mechanical stresses to the minimum.

Further, the **CT Soft Start** has a software-controlled response at full speed, economising energy by optimising the power factor, whatever the load. Because of the tendency to overspecify motor rated power, this feature has benefits for most installations, not only those where load is variable.

Soft starting offers improvement in the overall cost of operating industrial installations. The **CT Soft Start** enables the user to achieve these savings of overall running cost. All chassis as standard are equipped for a practical range of external controls. Optional software is available to provide additional control to match closely the requirements of an individual load or process system.

The following pages describe how the soft starter works, how to install the equipment and how to apply the controls. Users are recommended always to discuss with the supplier any unusual application.

CHAPTER 1

The **CT Soft Start**

The soft starter chassis for optimising the starting of an AC induction motor consists of a range of printed circuit boards (PCB), power thyristors, heatsink and control transformer. The range is designed to cover motor voltages from 230V to 690V 3-phase AC, and power ratings from 2.2kW to 600kW (1015 amps).

All soft starters incorporate a microprocessor which delivers the basic soft starting and optimising features. Additional optional software may be applied, extending the functions of the system to achieve the responses necessary for any particular application. The general description below covers all features; the descriptions in this Chapter show which are standard for each particular soft starter in the range, and which are applied by additional cards.

The responses of a **CT Soft Start** energy-optimising soft starter are partly pre-programmed and partly controlled by the user. On-board programming switches and links, and external control circuits, provide the means by which the user configures the soft starter (and additional software, where applicable) for specific application requirements.

There are three distinct stages, Fig. 1, in the run cycle —

- Ramp — Open or Closed Loop,
- Dwell,
- Energy optimising,

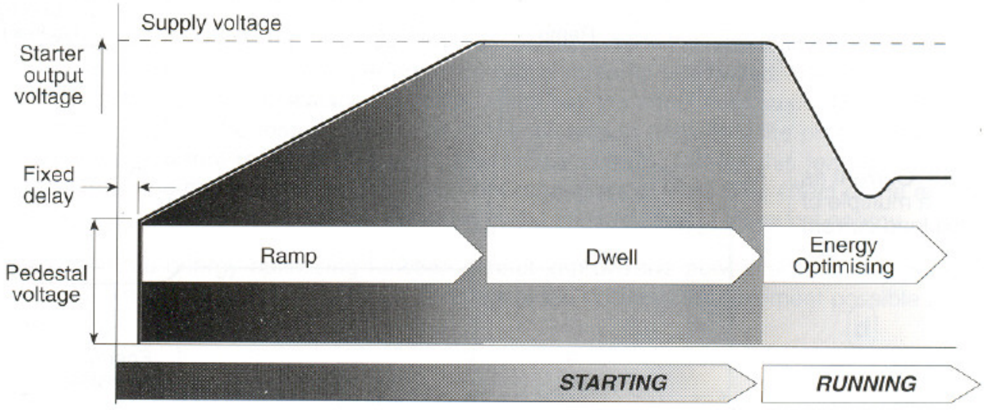
During normal operation, after the starting sequence is complete, there are several operating modes, standard for all soft starters —

- Fault detection and system shutdown,
- Override,
- Soft stop,
- Energy optimisation.

Optional additional features of certain soft starters are —

- Current-controlled starting,
- Top-of-ramp relay,
- Fault relay.

Fig. 1 The Operating Stages



1 The SOFT STARTING SEQUENCE

1.1 RAMP

— Open Loop Configuration *(STANDARD FOR ALL SYSTEMS)*

From the instant that the start command is given, the system software first imposes a fixed delay (Fig.1) of 3-400ms for self-monitoring. It then causes a voltage to be applied to the motor terminals to achieve breakaway torque — this is the pedestal voltage illustrated in Fig 1.

The voltage is then ramped up linearly, providing a stepless increase of motor terminal voltage from the pedestal voltage up to maximum voltage. At the end of the ramp period, the voltage applied to the motor terminals by the controlled thyristor is equal to the input voltage from the power supply.

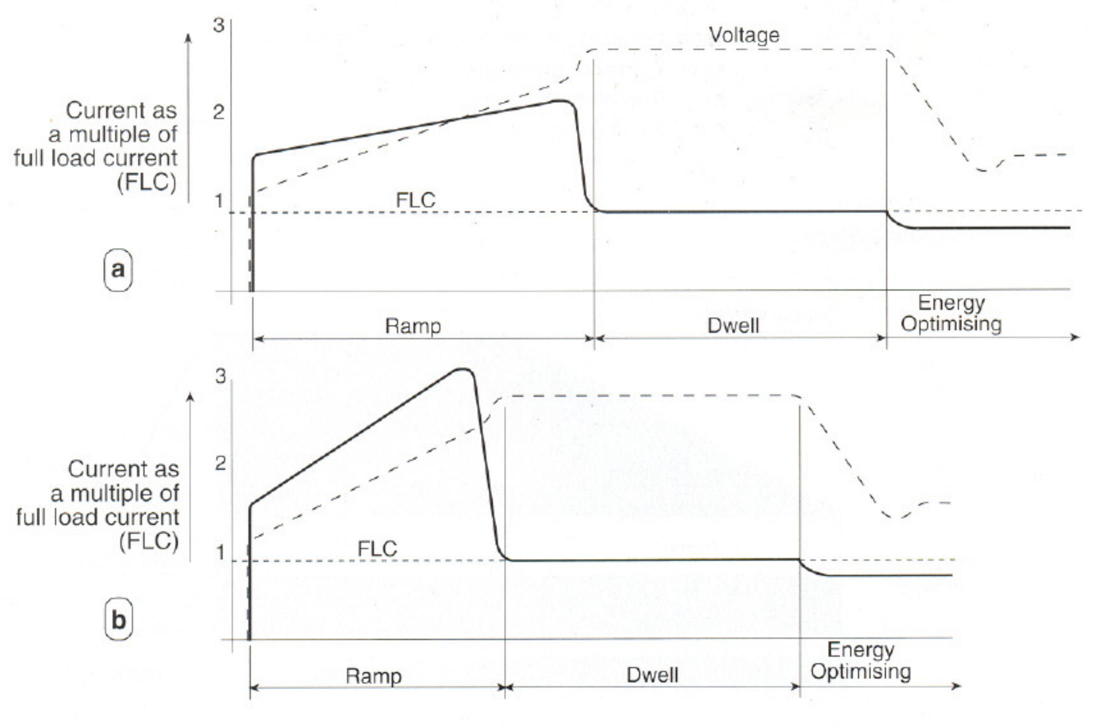
As standard, the pedestal voltage is 40% of supply input voltage. Optional software provides for applications where a different pedestal voltage would be an advantage, for example, in accelerating sensitive loads.

The current drawn by any given motor accelerating from rest in open loop is dependent upon the selected ramp time. The shorter the ramp time, the greater the peak starting current, Fig. 2.

Why choose one ramp time rather than another? For every motor and driven load system there is a natural ramp time at which the acceleration of motor and load matches the rate of increase of the output voltage of the soft starter. Selecting a short time will increase the rate of acceleration and the starting current drawn; a longer time will prolong the time before the load reaches full speed, and will reduce the starting current — which may be an advantage, depending upon the particular application and perhaps on what is convenient for matching with related process equipment.

External indication that the ramp period is complete is provided by an on-board relay *(not 3MC+)*. An example of the use of the top-of-ramp relay would be to operate a by-pass contactor (refer to page 19).

Fig. 2 Open loop starting current controlled by ramp time. **a** *— long ramp time;* **b** *— short ramp time.*



— *Closed Loop Configuration* *(ALL SYSTEMS EXCEPT 3MC+)*

This configuration of the soft starter is used in applications where the driven load has a particularly high inertia or is otherwise difficult to start as, for example, in a stirrer application where the medium is glutinous and stiff at the beginning of the process.

The acceleration time of such loads is apt to lag behind the rate of increase of ramp voltage, even if a long ramp time is chosen. With such loads it may, however, be necessary to select a short ramp time to ensure sufficient starting torque. A short ramp will raise the voltage quickly but the nature of the load prevents the motor speed matching it. The result may be excessive current demand.

This problem is overcome by the optional current limit feature, which stops the ramp when the current output reaches a preselected level. The ramp is then held until the current falls naturally. As a safety feature in case of a locked rotor or too low a current-limit setting, the ramp is held for a maximum of 25 seconds after which it will ramp up to full voltage to allow the normal operation of the protection, such as fuses, etc. A further option provides for extending the current-limit hold time (refer to page 20).

The current limitation feature is active only during the ramp period of the soft start sequence.

Closed loop control requires continuous measurement and feedback of the current delivered to the motor terminals. A current transformer (CT) is installed for this purpose in the thyristor output conductors. The output of the CT is fed back to the PCB.

1.2 The Dwell Period *(STANDARD FOR ALL SYSTEMS)*

The dwell period begins when the output voltage reaches maximum — equal to the power supply line voltage — and the dwell period is equal to the selected ramp time, or is ten seconds approximately if the selected ramp time is less than 10 seconds.

The dwell period maintains the voltage constant at maximum to allow time for the motor and its driven load to settle to a steady state after acceleration is complete and before the soft starter automatically enters the energy optimising mode.

1.3 Energy Optimising *(STANDARD FOR ALL SYSTEMS)*

The optimising stage is the normal operating condition of the **CT Soft Start**, when the motor is up to speed and driving the load at whatever torque output is demanded. The energy-optimising process is continuous after the dwell period until a stop command is given.

During the ramp period, the system software computes a reference value of the power factor. For energy optimising, this value is continuously compared with the running power factor. From the comparator output the software continuously computes, adjusts and updates the firing points of the power thyristors so that the total energy delivered to the motor corresponds to the load torque demand without wasting energy in overfluxing the motor. The power factor at the supply terminals is in this way maintained at the highest possible value for every condition of load demand.

Management of the power factor in no way detracts from the capability of the motor to respond to load demand. The performance of the motor is unaffected. This feature of the **CT Soft Start** is a purely electrical function which has the effect of ensuring that at all times the motor delivers the torque demanded, but is allowed 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 effect of the energy-optimising function is a cumulative economy in the consumption of electrical energy.

Note that the energy 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.

2 SPECIAL FEATURES and OPTIONS

2.1 Fault Protection *(STANDARD FOR ALL SYSTEMS)*

As standard, the **CT Soft Start** detects a thyristor short circuit and a phase loss (open circuit) in both the input to and the output from the thyristors.

When a phase loss or thyristor short circuit fault is detected, a system shutdown occurs, disabling the thyristor bridge and also the normal start (internal 'run') relay. The soft starter will then not respond to a start command and must be reset. A reset is performed by 'powering-off' and on — disconnecting and reconnecting the main power supply.

A 'fault operated' status signal is provided by on-board relay contacts *(4MC and 690V chassis only. On 3MC+ chassis there is a LED indication).*

An external, in-line motor-protection relay output can be used to operate the soft starter shutdown if desired.

CT Soft Start electronic overload trip is available for all chassis modules as an optional addition (refer to page 20).

2.2 Override *(STANDARD FOR ALL SYSTEMS)*

In some applications it may be desirable to bypass the soft starter so that the motor is connected solidly to the mains supply. When the soft start is by-passed but not disabled, the fault protection and energy-optimising functions must be overridden. The bypass and override function are usually employed in applications where thyristor heating is a problem, for example when a chassis is installed in an IP54 enclosure. Input terminals on the PCB are provided which, when linked out or shorted by an external control contact, disable the system fault detection and energy-optimising functions.

In *4MC* and *690V* systems, use can be made of the top-of-ramp relay as a control output to initiate the operation of a bypass contactor. Use should then be made of an auxiliary contact on the contactor to operate the override function.

2.3 Soft Stop *(STANDARD FOR ALL SYSTEMS)*

The effect of the soft stop function is to prevent an undesirably sudden deceleration of the load. It can be useful in various mechanical handling and conveyor systems, and in many hydraulic pumping operations, where a sudden removal of drive input can induce undesirable effects, such as fluid hammer in pipelines.

The soft stop function can be initiated at any stage following the completion of the ramp, even when the soft starter is bypassed. The function is initiated by an external control signal. The standard soft stop ramp period is double the starting ramp time for *3MC+* systems. *4MC* and *690V* systems are equipped to allow independent selection of ramp-down time. The soft stop ramp operates to reduce the motor terminal voltage from maximum voltage down to 40% of maximum, at which point the thyristors are disabled. The motor and load will then coast to standstill.

The soft stop can, as an additional option, incorporate an auto-restart feature, enabling the drive system to be set up to perform a repetitive duty cycle based on an external stop signal input (refer to page 20).

3 STANDARD SYSTEM CONFIGURATIONS — GENERAL

1 Frequency

Soft starters are suitable for operation from 50Hz or 60Hz supplies. The appropriate frequency is selected by adjustment of a DIP switch on the PCB.

2 Phase Rotation

Soft starters deliver the same phase-rotation sequence, input to output. They are not sensitive to input phase rotation. To ensure that motor rotation is not changed on existing installations, the phase sequence should be maintained through the input and output conductors to the motor. It is essential that the incoming supply is connected to L1, L2, L3, and U, V, W are connected to the motor. Change the motor rotation, if desired, in the usual way by exchanging any two phases of the input to the motor *OR* the starter *BUT NOT BOTH.*

3 Reversing

If the application involves reversing, a standard reversing contactor should be installed with the switchgear in the supply to the soft starter, NOT in the output. A time delay of not less than 0.5 seconds should be allowed for change-over before a start signal is given to the soft starter.

4 Soft Starter Bypass

When the motor is up to speed the soft starter can be bypassed by means of a contactor controlled by the top-of-ramp output contacts (*4MC* and *690V* only). The OVER-RIDE input must also be selected.

5 Motor Configuration

Motors can be controlled in either star (wye) or delta connection.

6 Motors in Parallel

Connection of two or more motors in parallel with one soft starter is not advised unless the *motors and the characteristics of their loads* are identical. Otherwise it is unlikely that load will be shared satisfactorily. Motors which are identical and are mechanically coupled to a single load should give a satisfactory response. The rating of the soft starter must be suitable for the *total* load.

Alternatively, a single soft starter can be configured to start a number of different motors in sequence, by the use of bypass contactors. In this case, the soft starter must be rated for the largest motor and most severe starting duty.

7 Slip Ring Motors

Soft starters may be used to control slip ring motors provided that adequate rotor resistance is retained to provide starting torque. When the motor is at speed and stable, the starting resistors can be bypassed.

8 Power Factor Correction Capacitors

UNDER NO CIRCUMSTANCES should power factor correction capacitors be installed on the output side of a soft starter. The **CT Soft Start** optimises the running power factor of a motor, but cannot improve it beyond its rated power factor.

If power factor correction capacitors are to be installed, the design must ensure that resonant oscillation ('ringing') at the moment of energising is minimised to prevent overvoltages that could damage the thyristors, and also to ensure that the capacitors are not affected by the harmonics generated by soft starter operation. If the capacitors and the soft starter are to be energised in sequence, there must be at least *one second delay* before the soft start is initiated. A time-delay device in the external 'start' circuit is recommended.

CHAPTER 2
SPECIFICATIONS & DATA

1 SPECIFICATIONS

Power Supply

Balanced 3-phase AC, 3-wire, 50Hz or 60Hz.

Power and Voltage Range

Chassis type	*Motor power kW*	*Voltage range V±10%*
3MC+	2.2 to 600	230 and 400 440 to 480
4MC	2.2 to 600	230 and 400 440 to 480
690V	15 to 1000	525 to 690

Motor

Any standard 3-phase squirrel-cage type of induction motor. Number of poles is not significant.

Starting Duty — all chassis

10 starts per hour maximum, equally-spaced, as follows —

5 x FLC for 5 seconds

3 x FLC for 30 seconds

2 x FLC for 60 seconds

Phase Sequence

Any input sequence is acceptable. Motor rotation is determined by cable connections. Refer to Chapter 1.3.2 page 7 and Chapter 3 page 11.

Environment

Ambient temperature — 0°C min; 60°C max.

Ambient relative humidity — max 85%, non-condensing.

Derating

For ambient temperature — Above 35°C, derate by 2%FLC per 1°C linearly to a maximum of 50%FLC at 60°C.

For altitude — Above 1000m, derate by 1%FLC per 100m linearly.

Enclosure

As standard, all chassis are constructed in compliance with IP00 specification for ingress protection. Protection complying with IP43 is optionally available.

Storage

Store in a dry, clean environment free from dust. Allow air circulation. Temperature -40°C min., +70°C max.

External Control Switches

Switches used for the external control circuits may be toggle switches, pushbutton contacts, auxiliary switch or relay contacts as convenient.

Cooling

Chassis are naturally-ventilated or fan-cooled. Power to drive the cooling fans is derived on board and requires no additional or separate wiring on soft starters up to 186kW (*3MC+* and *4MC*). Above 186kW and on all *690V* soft starters an external 110V/220V control supply is required.

2 *INSTALLATION DATA*

Current Ratings

Input and output power cable sizes are the same.

Table of Current Ratings — page 10.

Power Fuses

Motor protection equipment should be selected as for Direct-on-Line starting.

Control Wiring

Control cabling 1.5mm^2.

Refer also to Electromagnetic Compatibility, page 16.

Control Power

3MC+ and *4MC* chassis up to and including 186kW are SELF-POWERED.

Chassis modules rated above 186kW, and ALL *690V* chassis, require a separate control supply, voltage 110V or 220V AC. Refer to Chapter 3, Control Terminals page 13 and Link Positions, page 15.

Control Circuits

Output relay contact rating — 3 amps AC1, 400V AC.
— 3 amps AC11, 220V AC.

Input contact rating — 5V, 10mA DC.

Current Ratings

Motor Rating kW	Efficiency	Power Factor	Typical Motor Full Load Current (amps) at... 220V	380V	400V	415V	690V
2.2	0.8	0.8	9	5.3	4.8	4.8	3
4	0.82	0.86	15	8.6	8.2	7.9	5
5.5	0.84	0.87	21	11	11	10	6
7.5	0.86	0.88	28	15	14	14	8
11	0.88	0.89	39	21	20	20	12
15	0.89	0.89	52	29	27	26	16
22	0.9	0.9	75	41	39	38	23
30	0.9	0.9	100	56	53	52	31
37	0.91	0.86	125	72	68	66	40
45	0.92	0.87	150	86	82	79	47
55	0.92	0.85	180	107	102	98	59
60	0.92	0.85	180	117	111	107	65
75	0.92	0.85	250	146	138	133	80
90	0.93	0.85	300	174	165	159	96
110	0.93	0.89	360	202	192	185	111
132	0.93	0.89	430	242	230	222	133
150	0.94	0.89	480	274	260	251	151
186	0.94	0.89	587	340	323	311	187
200	0.94	0.89	631	365	347	334	201
225	0.94	0.89	710	411	390	376	226
280	0.95	0.9	864	500	475	458	275
315	0.95	0.9	970	562	533	514	309
355	0.95	0.9	1092	632	601	579	348
375	0.95	0.9	1153	668	634	611	368
400	0.95	0.9	1230	712	677	652	392
425	0.95	0.9	1307	757	719	693	417
450	0.95	0.9	1384	801	761	734	441
475	0.95	0.9	1461	846	804	775	466
500	0.95	0.9	1538	890	846	815	490
525	0.95	0.9	1615	935	888	856	515
550	0.95	0.9	1692	979	930	897	539
575	0.95	0.9	1769	1024	973	938	564
600	0.95	0.9	1846	1068	1015	978	588
625	0.95	0.9	1922	1113	1057	1019	613
650	0.95	0.9	1999	1157	1100	1060	637
675	0.95	0.9	2076	1202	1142	1101	662
700	0.95	0.9	2153	1247	1184	1141	686
725	0.95	0.9	2230	1291	1226	1182	711
750	0.95	0.9	2307	1336	1269	1223	736
775	0.95	0.9	2384	1380	1311	1264	760
800	0.95	0.9	2461	1425	1353	1304	785
825	0.95	0.9	2538	1469	1396	1345	809
850	0.95	0.9	2614	1514	1438	1386	834
875	0.95	0.9	2691	1558	1480	1427	858
900	0.95	0.9	2768	1603	1523	1468	883
925	0.95	0.9	2845	1647	1565	1508	907
950	0.95	0.9	2922	1692	1607	1549	932
975	0.95	0.9	2999	1736	1649	1590	956
1000	0.95	0.9	3076	1781	1692	1631	981

CHAPTER 3

INSTALLATION PROCEDURES

SAFETY

Voltages present in the soft starter module can cause serious injury and may be lethal. Open-chassis units should be installed in an enclosure designed to prevent accidental contact with live components. When chassis are ordered with the standard optional enclosure, the ingress protection complies with IP43. The manufacturer accepts no liability for the safety of any installation, or any personnel engaged in activities connected with it.

1 MECHANICAL INSTALLATION

The chassis must be rigidly attached to a vertical surface, and upright as shown in Fig. 3. The cable entry is at the bottom of the module.

For ventilation, adequate space should be allowed below, above and to either side of the module. Minimum clearance from adjacent equipment is 150mm (6in) above and below, and 25mm (1in) to either side. Note that heat-generating equipment located below a soft starter may affect its rating and should preferably be located to one side or above.

2 ELECTRICAL INSTALLATION

Hazardous Areas

Because the output of thyristors is characterised by harmonics which may affect rotor temperature under normal load conditions, the installation of any soft starter should be in accordance with guidelines issued by BASEEFA and the requirements of the certification of any Ex-protected induction motors.

Earthing

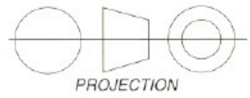
Soft starter chassis are designed to accept and deliver a balanced three phase supply. There is no provision for a neutral conductor. All chassis are fitted with duplicate earth terminal studs. For safety, the chassis of the soft starter and the frame of the motor should be solidly connected to a proper earth in accordance with the regulations in force at the location of the installation.

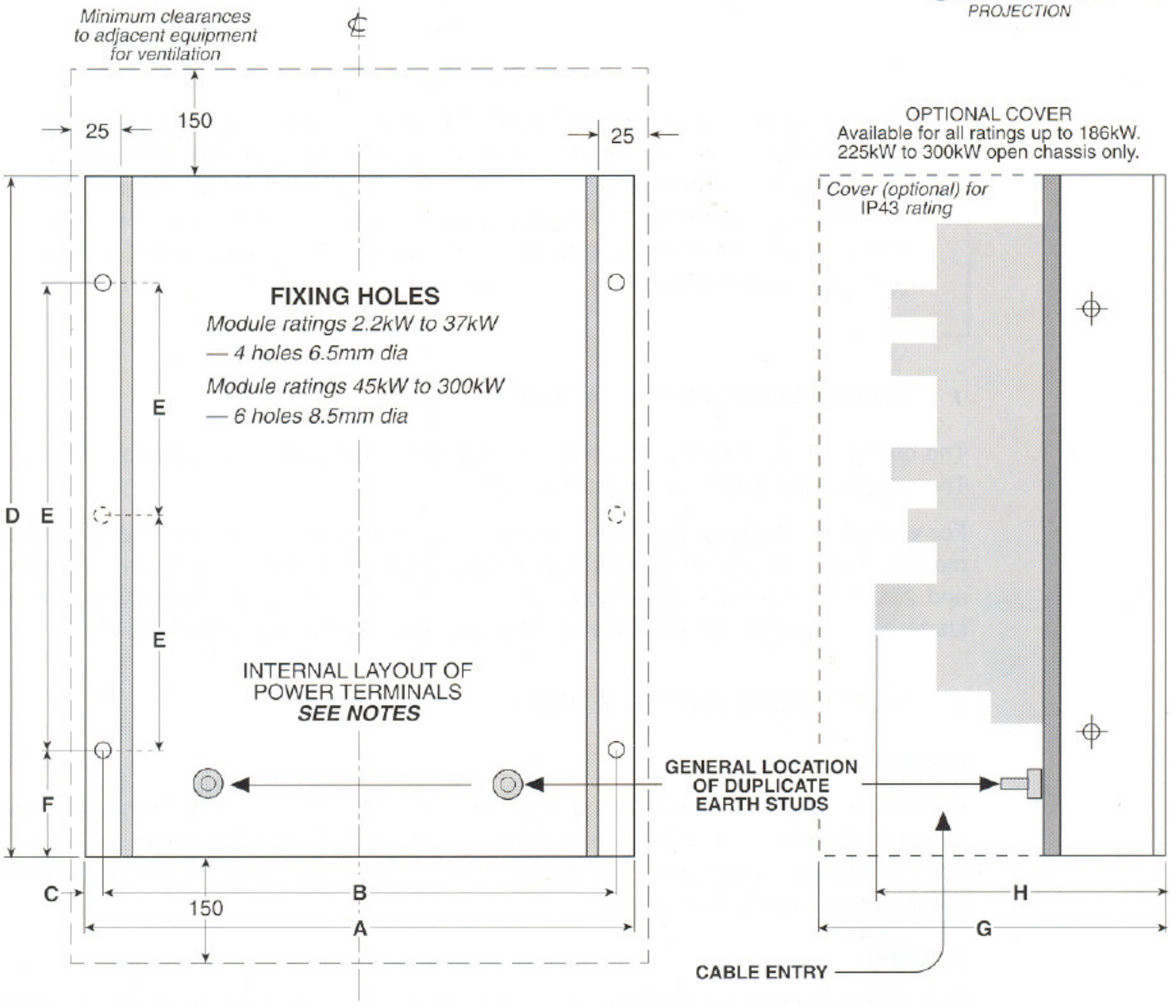
Power Terminals

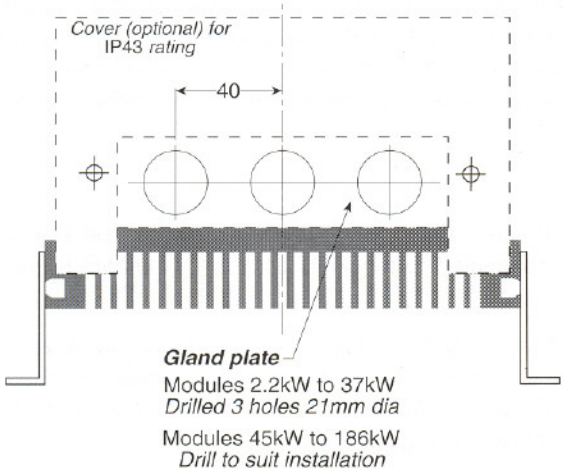
Power input and output terminals are located in the lower part of the soft starter chassis. The incoming power supply is connected to terminals L1, L2, L3. Output to the motor is taken from terminals U, V, W.

Note that on chassis modules from 2.2kW to 37kW, labelled terminal blocks are provided. For the larger units from 45kW up, cabling is connected direct to busbars. INSTALLERS ARE WARNED TO PAY PARTICULAR ATTENTION TO THE RELATIVE POSITIONS OF THE INPUT AND OUTPUT TERMINALS, Figs. 3, 5 and 6.

Fig. 3 Dimensions for Installation.
NOT TO SCALE
Dimensions in mm







DIMENSIONS

Module Rating	A	B	C	D	E	F	G	H
2.2kW to 7.5kW	240	224	8	300	220	40	175	137.5
11kW to 22kW	240	224	8	300	220	40	175	137.5
30kW to 37kW	340	324	8	400	220	40	189	137.5
45kW to 75kW	340	320	10	400	175	25	240	185
90kW to 186kW	450	430	10	600	250	50	263	263
225kW to 300kW	490	474	8	590	400	130	NA	380

NOTES

Power terminals

Modules 2.2kW to 37kW
Terminal blocks layout —

L1	L2	L3		U	V	W
Input from supply				*Output to motor*		

Modules 45kW to 300kW
Busbar connections
Terminal stud size M8
Layout —

U	L1	V	L2	W	L3

Earth terminals

Modules 2.2kW to 22kW
Terminal block connection

Modules 30kW to 300kW
2 terminal studs size M8

CONTROL TERMINALS

Terminal Number	*I/O*	*Function and Features*	
All Systems			
1 to 4		Connections to Phase 1 output thyristor	
5 to 8		Connections to Phase 2 output thyristor	
9 to 12		Connections to Phase 3 output thyristor	
21, 22	I	—	9V AC power input to PCB
23, 24	I	RUN	Contact maintained closed to RUN
25	I	STOP	Logic signal, active LOW
26	I	OVERRIDE	Logic signal, active LOW
27	O	ALARM	Logic signal, active LOW
28	I	CURRENT LIMIT	Logic signal, active LOW
29	O		5V 100mA DC
30	—		0V common
31	—		0V common
32	I	SOFT STOP	Logic signal, active HIGH
3MC+			
33	O	TOP OF RAMP	Logic signal, active HIGH
34	O	*Not in use*	
4MC and 690V			
33	—	*Not in use*	
34	O	—	12V 100mA DC
CL→	O	Output from Current Limit circuit	
CT1, CT2	I	Inputs from current transformers	

Fig. 4 Typical power and control supply arrangement.

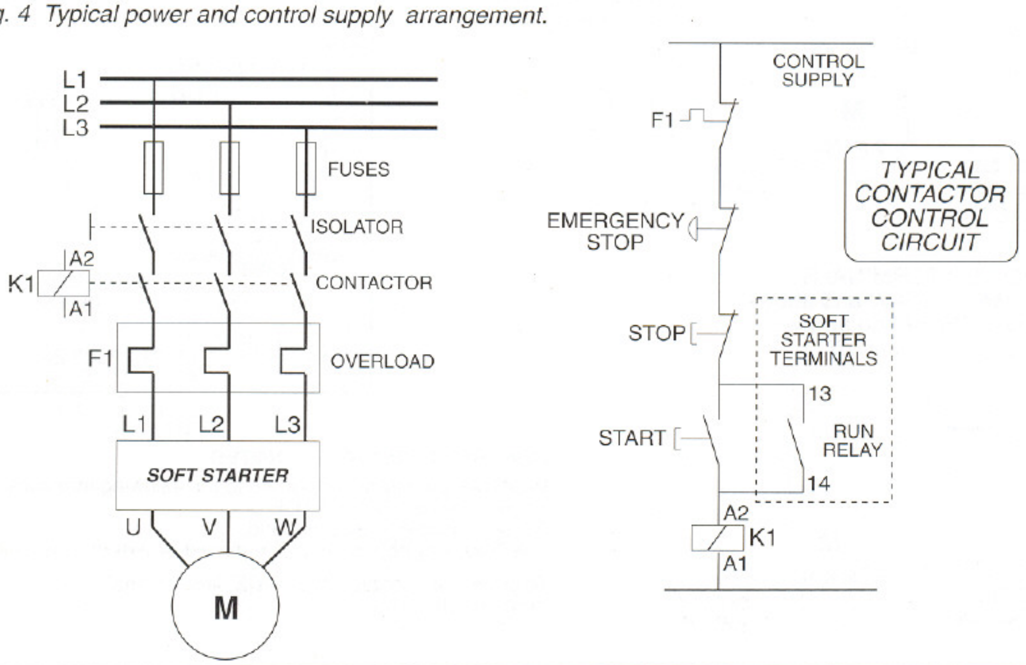
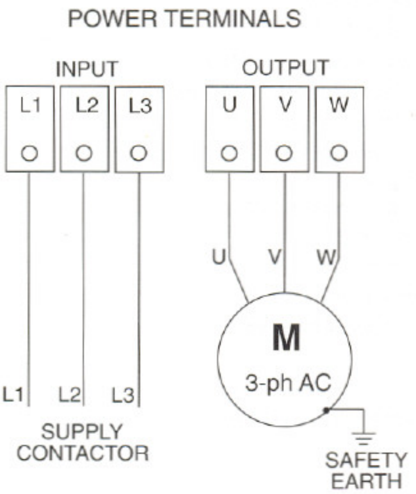
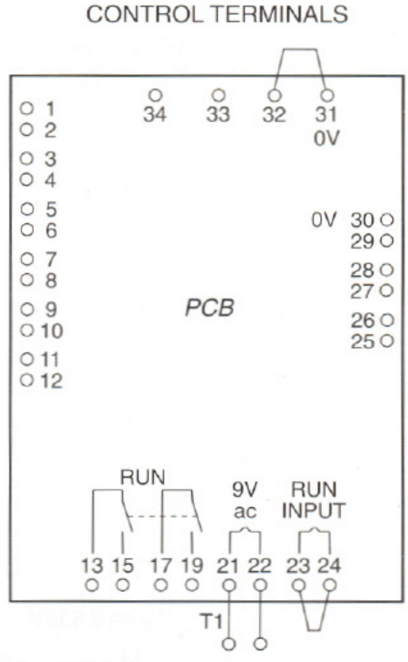


Fig. 5 Power and control terminals — 3MC+ Modules.



CONTROL SUPPLY

All modules rated above 186kW require an external control supply (110V or 220V).

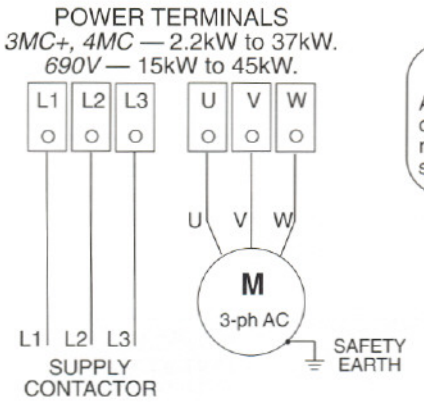


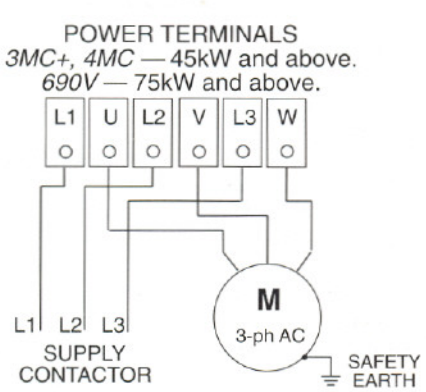
CONTROL TERMINALS — **NOTES**

Wire links are fitted as standard to the following terminals —
31-32 to disable SOFT STOP.
23-24 to enable RUN command.
The links may be retained, or replaced by external switching.

To provide automatic OVERRIDE, link terminal 26 to 0V (terminal 30 or 31).

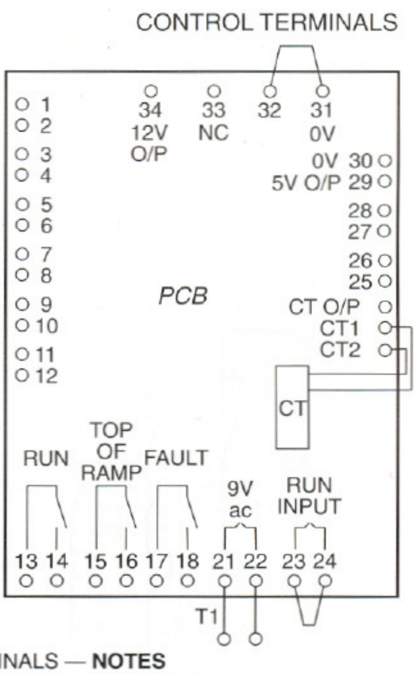
Fig. 6 Power and control terminals — 4MC and 690V Modules.





CONTROL SUPPLY

All 690V modules and all others rated above 186kW require an external control supply (110V or 220V).



CONTROL TERMINALS — **NOTES**

Wire links are fitted as standard to the following terminals —
31-32 to disable SOFT STOP.
23-24 to enable RUN command.
The links may be retained, or replaced by external switching.

To provide automatic OVERRIDE, link terminal 26 to 0V (terminal 30 or 31).

OUTPUT RELAY TERMINALS

NOTE — All relay contacts normally open (N/O). Rating, page 9.

	3MC+	*4MC*	*690V*
Run Relay			
Terminal Nos	13 & 15; 17 & 19	13 & 14	13 & 14
Top of Ramp Relay			
Terminal Nos	*Not available*	15 & 16	15 & 16
Alarm Relay — *Refer to LINK J9*			
Terminal Nos	*Not available*	17 & 18	17 & 18

LINK (Jumper) POSITIONS

Position	*Function*
3MC+	
J1	*Adjusted during manufacture*
J2	Remove if bypass contactor is to be used.
J3	Remove if card 1602 is to be fitted
J5 to J9	*Not in use*
4MC and 690V	
J1	*Adjusted during manufacture*
J2	*Not used*
J3	*Adjusted during manufacture*
J4	Position 'N' for normal-voltage software. Position 'L' for low-voltage software
J5	Remove link to disable the on-board current limit circuit.
J6	Insert link when CT has 5A secondary.
J7	Insert link when CT has 1A secondary.
J8	Insert link when CT has 25mA secondary.
J9	*Position* 'A' — terminals 17 & 18 are ALARM OUTPUT *Position* 'T' — terminals 17 & 18 are TOP OF RAMP OUTPUT

LED INDICATIONS

LED	*Colour*	*Indication*
All Systems		
LD1	*Red*	Fault detected.
LD2	*Green*	Soft start system is active.
3MC+		
LD3	—	*Not used*
4MC and 690V		
LD3	*Red*	Current limitation function is active.
3MC+ and 4MC		
LD4 to LD10	—	*Not used*
690V		
LD4	*Yellow*	SOFT STOP input is closed.
LD5	*Yellow*	CURRENT LIMIT input is closed.
LD6	*Yellow*	OVERRIDE input is closed.
LD7	*Yellow*	STOP input is closed.
LD8	*Yellow*	ALARM relay is energised (contacts closed).
LD9	*Yellow*	TOP OF RAMP relay is energised (contacts closed).
LD10	*Yellow*	RUN relay is energised (contacts closed).

3 ELECTROMAGNETIC COMPATIBILITY

To a greater or lesser extent, all electrical and electronic equipment is a source of, and is affected by, electromagnetic disturbance. For example, the operation of a contactor may generate quite severe disturbance through contact arcing and the energising and de-energising of the operating coil. Yet the contactor itself is relatively unaffected by (immune from) electromagnetic interference (EMI). In addition to man-made sources, natural phenomena such as lightning are a source of EMI.

With the increasing use of electronic, and particularly digital electronic, equipment throughout industry the effects of EMI are more significant and have become the subject of limiting legislation in various parts of the world. The European Community EMC Directive and the Federal Communications Laws in the USA are examples of this trend.

EMI is spread across the entire frequency spectrum from DC (0Hz) to hundreds of GHz, but for practical purposes is divided into 'low frequency' (<10kHz) and 'high frequency'. Consideration must be given to abatement of emissions and also to immunity.

Immunity is the ability to perform in an environment in which defined levels of EMI are present. All products are carefully designed to reduce their sensitivity to EMI and are type-tested to prove compliance. However, it must be borne in mind that there is always a level of disturbance that will cause malfunction of sensitive electronic apparatus in spite of its being designed for immunity. It is therefore in the interest of the user when installing the equipment to take precautions to mitigate the effects of EMI. Most of such precautions can be described as 'good practice', such as not laying communications wiring looms physically parallel to avoid cross-coupling, removing stub-connections to prevent their operating as aerials, and allowing time-delays to permit switching transients to die away before a control signal is transmitted.

Other standard 'good practices' are maintaining at least 100mm separation between control and power conductors, siting conductor paths to cross at right-angles as nearly as possible, and strict observance of screening requirements for both enclosures and conductors. Multiple earthing and the use of snubber circuits will also be helpful in preventing the unwanted effects of EMI.

Emissions of <2kHz frequency are known as harmonics, and arise from the delayed turn-on of semiconductor switches (thyristors) in a power circuit. Fully-controlled thyristors in each phase considerably reduce the spectrum and amplitude of the harmonic currents generated.

Harmonics can also cause distortion of the supply, especially if the supply system is weak as in installations dependent on local generation and unsupported by a distribution network. Most industrial installations, however, have a strong supply and studies have shown that the level of distortion caused by the action of the Optimising Function is small enough to be ignored. Special limitations may apply locally to harmonics generation, but requirements in general are based on IEC specifications under which no limits currently apply to equipment intended for industrial use if of a power rating >1kW. Nevertheless, the total voltage distortion should never be allowed to exceed 10 per cent.

High frequency EMI is transmitted by both conduction and radiation. Siting the equipment in an appropriately-designed enclosure is usually adequate to suppress or reduce the unwanted radiated emissions. Care should be taken not to operate other sensitive equipment when unshielded soft starters are operating — for example by leaving cubicle doors open.

High power soft starters have operated in proximity to other types of electronic equipments such as PLCs, variable speed drives, and so on for many years with very little adverse experience. In industrial environments without such electronic equipment no preventative action is usually necessary. But where domestic or commercial users of power are connected to same network as soft starters, filtering and other suppression techniques may be found necessary. For further information consult the supplier of the soft starter.

CHAPTER 4

SETTING UP PROCEDURES

1 *PRELIMINARY ADJUSTMENTS*

ENSURE THAT —

THE STARTING DUTY IS NOT EXCEEDED (Refer to page 8)

THE FOLLOWING ADJUSTMENTS ARE MADE BEFORE ATTEMPTING TO OPERATE THE MOTOR UNDER SOFT STARTER CONTROL.

1.1 *POWER SUPPLY FREQUENCY — ALL SYSTEMS*

SELECT the frequency of the power supply — 50Hz or 60Hz — by adjusting switch 1 at the left side of the DIP switch block (located on the PCB) Fig. 7.

1.2 *CONTROL SUPPLY*

3MC+ and *4MC* systems rated up to and including 186kW are SELF POWERED and do not require an external control supply.

All *690V* chassis, and all *3MC+* and *4MC* systems rated above 186kW require an external power supply at 110V or 220V AC. Minimum current rating 5A.

CONNECT to 'CONTROL VOLTS' terminals.

1.3 *STARTING COMMAND — ALL SYSTEMS*

As standard, all chassis are supplied with a wire link connecting terminals 23 and 24. If this link is left in place, the soft start sequence will be initiated immediately the soft starter is energised from the power supply.

If the soft starter is not to be switched by the supply circuit switchgear, a separate and distinct RUN command is required. Remove the link from terminals 23 and 24 and connect a control circuit.

Switches used for the external control circuits may be toggle switches, pushbutton contacts, auxiliary switch or relay contacts, as convenient. Refer to page 9 for ratings.

NOTE The external command signal applied to the RUN terminals must have a duration of not less than 300ms if an impulse signal is to be used. The external RUN command switch can, if desired, remain closed during motor operation. IN ALL CASES, terminals 23 and 24 must be CLOSED (by a control contact, or linked together) for the starter to run. Opening these terminals disables the thyristors.

1.4 *STOPPING COMMAND — ALL SYSTEMS*

The following are the options for stopping the system —

1 Disconnect the three-phase power supply. The motor and load will coast to rest.

2 Open the RUN input, terminals 23-24. The motor and load will coast to rest.

3 Apply a STOP command, logic low at terminal 25. This alternative disables the thyristors, allowing the motor and load to coast to rest, and sets the ALARM output.

4 When terminals 31 (0V)-32 are opened, the motor and load will decelerate at a rate dependent on the inertia of the system and the stopping ramp time. Refer to section ***2 Ramps***, page 18.

Fig. 7 Starting Ramp Time Settings

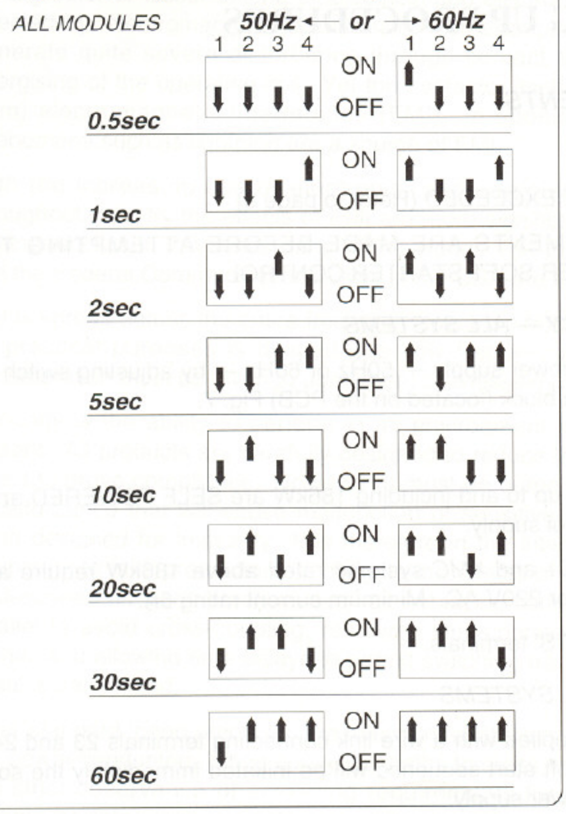
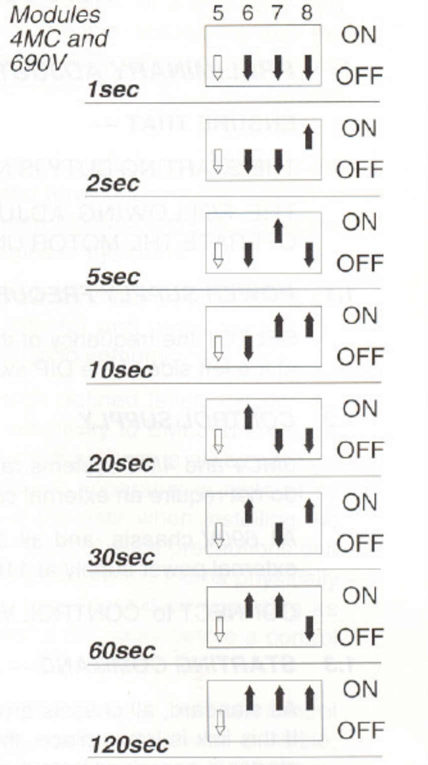


Fig. 8 Soft Stop Ramp Time Settings and Current Limit Time-out (Switch 5)



2 *RAMPS*

ENSURE THAT THE MOTOR IS CONNECTED TO ITS NORMAL LOAD BEFORE MAKING ADJUSTMENTS TO STARTING AND STOPPING RAMPS.

2.1 *STARTING RAMP — ALL SYSTEMS*

All systems apply a starting ramp automatically on receiving a START command. The optional ramp time is selectable over a range from 0.5 to 60 seconds.

SELECT the starting ramp time by means of DIP switches 2 to 4, Fig. 7 page 18.

Starting current is dependent on the selected ramp time for all systems: the longer the ramp time the lower the peak starting current — refer to Figs. 2 and 3 and the description on page 4.

NOTE For smaller motors — 5kW and under — a ramp time of 1 to 5 seconds is typical for loads which do not involve an high starting friction. For 'sticky' loads a short ramp in conjunction with Current Limitation may be necessary.

4MC AND 690V SYSTEMS are equipped with an adjustable potentiometer which permits the starting current to be limited — refer to Section ***3 Current Limitation***.

2.2 *STOPPING RAMP — ALL SYSTEMS*

When a STOP command is given either by disconnecting the power supply or by opening the RUN control circuit, the motor and load will coast to rest.

Some applications may benefit from applying a soft stop on selected occasions. This is achieved by connecting a normally-closed external control contact between terminal 32 and 31 (0V). Opening this contact will ramp the voltage down.

3MC+ SYSTEMS automatically apply a ramp-down time which is twice the length of the selected starting ramp.

4MC AND 690V SYSTEMS are equipped with a DIP switch block which enables the stopping ramp-down time to be selected independently of the starting ramp time.

SELECT the stopping ramp-down time by means of DIP switches 6 to 8, Fig. 8.

NOTE A stopping ramp is effective only if the time selected is longer than the time taken to coast to rest with power removed. It does not act as a brake. To RESET the system, disconnect and reconnect the power supply.

3 *CURRENT LIMITATION — 4MC AND 690V SYSTEMS ONLY*

An adjustable potentiometer mounted as standard on the PCB enables a limiting value to be applied to the starting current. This feature is valuable in the starting of loads with a high-inertia characteristic, when the time to achieve running speed is less important than current limitation.

ADJUST with the motor stopped. Rotate the potentiometer adjusting spindle FULLY COUNTER-CLOCKWISE.

The starting ramp time should be set to a recommended value of 1 second. The potentiometer should initially be set to the lowest output, ie turned fully counterclockwise.

Apply a START command and observe that the Current Limit LED LD3 (*RED*) is on. The motor may turn slowly or not at all.

Turn the potentiometer slowly clockwise until the motor begins to accelerate. Continue to turn the potentiometer a little more at a time until the motor is able to accelerate to full speed.

Apply a STOP command, and allow adequate time for the thyristors to cool.

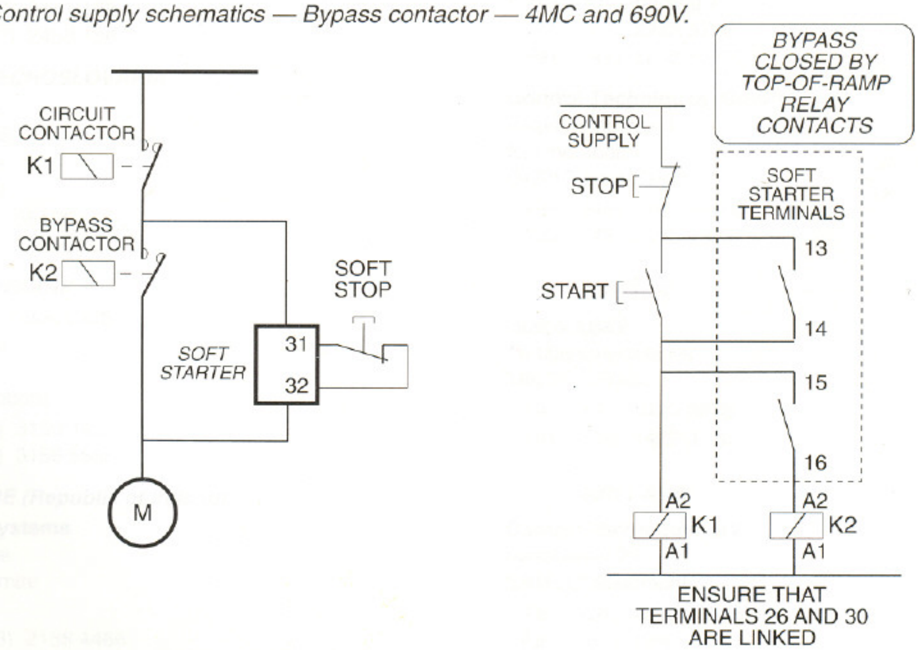
Apply a START command and observe the acceleration of the system. The motor should normally reach full speed in under 20 seconds from start. If it takes longer, the potentiometer setting should be turned further in a clockwise direction.

If the system is in Current Limit control mode for more that 25 seconds, *either* it will override Current Limit and continue the voltage ramp, *or* it will shut down, depending upon the setting of DIP switch 5 (Fig. 8, page 18).

The settings are — OFF: Trip after 25 seconds.

ON: Continue ramp after time-out is complete.

Fig. 9 Control supply schematics — Bypass contactor — 4MC and 690V.



3 SUPPLEMENTARY OPTIONAL FEATURES

3.1 OVERLOAD TRIP

An optional electronic overload detection card (FEL3702, 3703 or 3704) is available for applications where it is desirable to trip the motor without operating a conventional in-line motor protection relay. On the occurrence of an overload, the software disables the soft starter, and provides a 'trip operated' status signal at terminals 17 and 18 and the motor will coast to rest.

3.2 EXTENDED RAMP

For special applications, software which provides a longer-than-standard Ramp can be supplied. Please refer to the supplier of the soft starter.

3.4 REDUCED PEDESTAL VOLTAGE

For special applications, software which provides a lower-than-standard Pedestal Voltage can be supplied. Please refer to the supplier of the soft starter.

3.5 EXTENDED CURRENT LIMIT HOLD TIME

For special applications, software which provides a longer-than-standard time for which Current Limit is held can be supplied. Please refer to the supplier of the soft starter.

3.6 SOFT STOP AUTO-RESTART

For special applications, software which provides an Auto-Restart automatically after a soft stop can be supplied. Please refer to the supplier of the soft starter.

3.7 OTHER SOFTWARE OPTIONS ARE AVAILABLE

Special software, modified to meet requirements, can be supplied to satisfy unusual industrial applications. Please specify details to the supplier of the soft starter.

ADDENDUM TO CT SOFT START USERS GUIDE
ISSUE 1 APRIL 1993

03.11.93
ISSUE 3

PAGE 8 SPECIFICATIONS AND DATA

POWER SUPPLY

Power supply specification should read
"Balanced 3 phase AC 3 wire 50Hz or 60Hz ±6% "

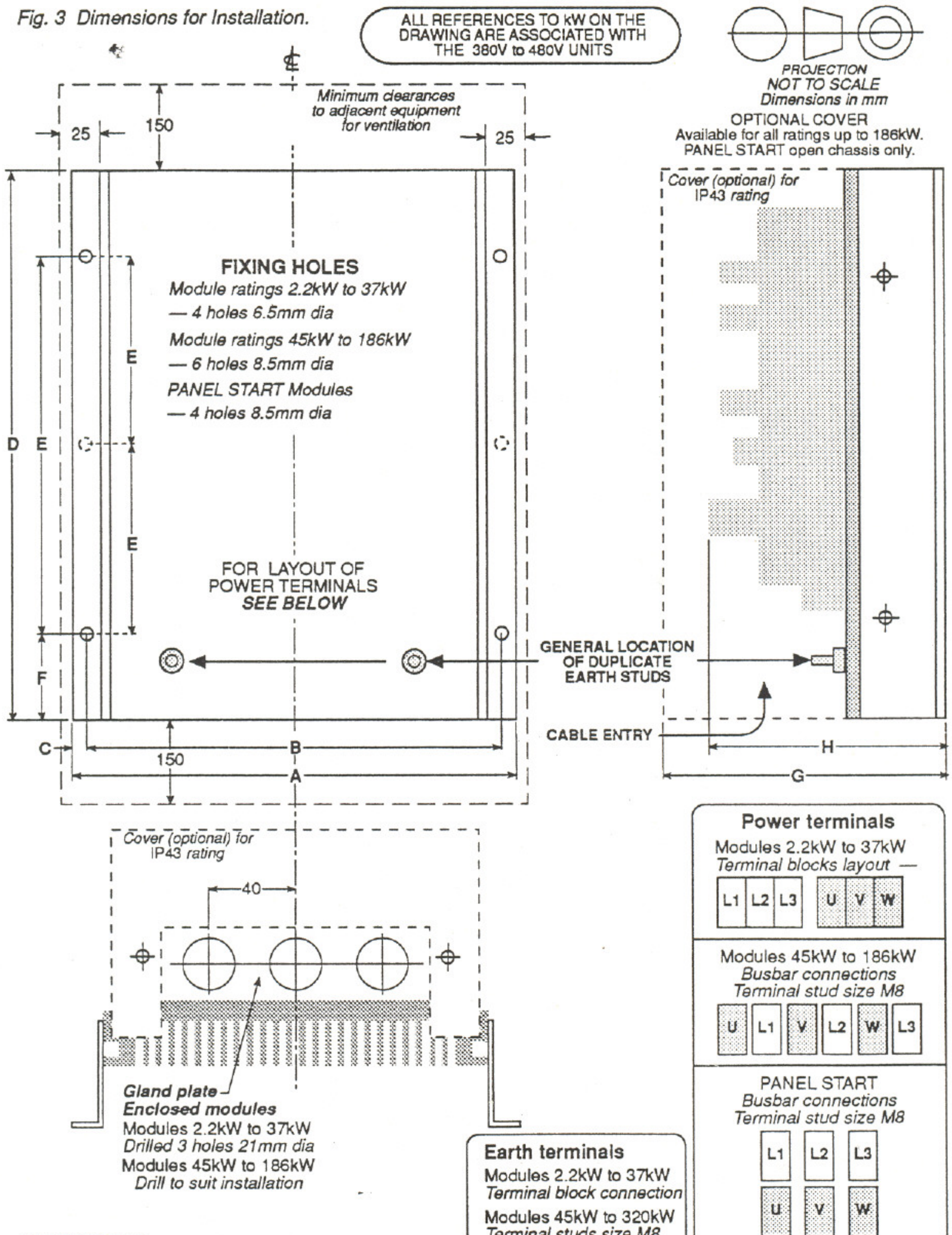
POWER AND VOLTAGE RANGE

For 690V units the voltage range is 525 to 690V -10% +5%

PAGE 12 SEE NEW PAGE HEREWITH

PAGE 13 SEE NEW PAGE HEREWITH

Fig. 3 Dimensions for Installation.



DIMENSIONS

Module Rating			A	B	C	D	E	F	G	H
230V AC	**380V - 480V AC**	**525V - 690V AC**								
2.2kW to 11kW	2.2kW to 22kW		240	224	8	300	220	40	175	137.5
15kW	30kW to 37kW		240	224	8	300	220	40	195	157.5
22kW to 37kW	45kW to 75kW	15kW to 75kW	340	320	10	400	175	25	240	185*
45kW to 90kW	90kW to 186kW	110kW to 280kW	450	430	10	600	250	50	263	263
PANEL START OPTION										
90kW to 186kW	160kW to 320kW	300kW to 600kW	500	472	14	415	225	60	NA	300

* 191mm for 690V units.

CONTROL TERMINALS

Terminal Number	*I/O*	*Function and Features*	
All Systems			
1 to 4		Connections to Phase 1 output thyristor	
5 to 8		Connections to Phase 2 output thyristor	
9 to 12		Connections to Phase 3 output thyristor	
21, 22	I	—	9V AC power input to PCB
23, 24	I	RUN	Contact maintained closed to RUN
25	I	STOP	Logic signal, active LOW
26	I	OVERRIDE	Logic signal, active LOW
27	O	ALARM	Logic signal, active LOW
28	I	CURRENT LIMIT	Logic signal, active LOW
29	O		5V 100mA DC
30	—		0V common
31	—		0V common
32	I	SOFT STOP	Logic signal, active HIGH
3MC+			
33	O	TOP OF RAMP	Logic signal, active HIGH
34	O	*Not in use*	
4MC and 690V			
33	—	*Not in use*	
34	O	—	12V 100mA DC
CL→	O	Output from Current Limit circuit	
CT1, CT2	I	Inputs from current transformers	

CHASSIS TERMINALS

L1 L2 L3	Input from power supply system
U V W	Output to motor
13 and 14	Run Relay contacts
95 and 96	Thermal Switch contacts (fan-cooled modules only)

Fig. 4 Typical power and control supply arrangement.