ems European Ltd

EnviroStart + Three Phase Soft Start Installation & Commissioning Guide

Version 6 October 2003

3 Phase EnviroStart-Plus Soft Start

IMPORTANT WARNING

Failure to read and comply with this manual may result in damage to the EnviroStart Unit and driven equipment and may render the warranty invalid.

1. **Only a competent electrician should carry out the electrical installation.**
2. **EnviroStart must be earthed with an earthing conductor connected to the earthing terminal.**
3. **Before installation check the motor rating plate and Section Two of this manual to ensure that the EnviroStart is correctly rated for the application.**
4. **Internal components and circuit boards (except the isolated I/O terminals and the PCB) are at mains potential when the EnviroStart is connected to a three-phase supply. The voltage is extremely dangerous and may cause death or severe injury if you come into contact with it.**
5. **When the EnviroStart is connected to the mains, the motor connections U, V and W should be treated as being live even if the motor is not running.**
6. **The control I/O terminals are isolated from mains potential but the relay outputs may have dangerous voltages present even if the mains are not connected.**
7. **Do not make any connections when the EnviroStart is connected to live mains.**
8. **Do not make voltage withstand tests on any part of the EnviroStart without isolating the unit.**
9. **Do not touch IC-circuits on the PCB. Certain items are static-sensitive and static voltage discharge may destroy the components.**
10. **Make sure no power-factor correction capacitors are connected to the motor cable except in a safe manner. (See body text of this document for details).**
11. **Make sure the cover is closed before applying mains voltage to the EnviroStart.**

CONTENTS

1 INTRODUCTION

1.1 FEATURES

The **EnviroStart** is a high specification digital Motor Soft-Start available in models suitable for motors up to 1,400A.

- CONFIGURABLE SOFT START (Ramp times from 0.5 – 240s)
- CONFIGURABLE INITIAL PEDESTAL VOLTAGE SETTING (25 – 75% of full voltage)
- INDEPENDENTLY CONFIGURABLE SOFT STOP CAPABILITY (0.5 – 120s)
- START CURRENT LIMIT SETTING (1.5 – 5x FLC of unit)
- CONFIGURABLE KICK-START (Fully definable from 0.25 – 2s)
- DIRECT ON LINE SETTING (Emergency pass through)
- FAULT DETECTION BYPASS (Disables fault detection after motor TOR reached)
- STALLED-ROTOR OR SLOWING-ROTOR PROTECTION
- AUTO LOCK OUT ON HEATSINK OVERTEMP (PCB or external reset, with PCB LED)
- READY, TOP OF RAMP AND RUN RELAYS. (2x N/O, 2x N/C 2kVA contacts on each)
- FULL SYSTEM STATUS LED's
- FULL LOGIC SCR SWITCHING AND FAULT DETECTION
- ON PCB FULL SYSTEM RESET BUTTON
- SIMPLE TO INSTALL AND COMMISSION
- RUGGED HOUSING, IP43, NEMA 1. (Can be fitted into cabinet to increase to IP65)
- ON-BOARD CONFIGURABLE SUPPLY VOLTAGE AND FREQUENCY SETTINGS
- 220V/400V AND 400V/690V Switchable MODELS AVAILABLE (Configurable on PCB)
- 570V MODELS AVAILABLE

2 RATING INFORMATION

2.1 CORRECT ENVIROSTART SELECTION

The **EnviroStart** must be rated according to the motor rated current (FLC).

However, on certain applications it may be necessary to oversize the unit to cope with the maximum operating parameters associated with particularly heavy-duty operations such as high repetitive on-load starts or elevated ambient operating conditions. (For this see de-rating details shown on relevant specification sheets).

Please note that these environmental factors (temperature, ventilation, altitude, ambient temperature & relative humidity) do affect sizing and failing to take proper notice of such conditions will invalidate any warranty associated with the system as supplied. Where the **EnviroStart** is expected to operate outside the normal specifications and you are uncertain as to the selection of a unit please contact EMS (European) or your local Distributor, we will always be happy to assist to ensure your application is correctly supported.

2.2 VOLTAGE RATING: 240V/415V, 415V/690V & 570V

The general ratings in this installation and commissioning guide are based on typical four-pole motor characteristics. The **EnviroStart Plus** will however work effectively on two; six and eight pole motors provided they are synchronous in operation.

Ratings are based on the motor rated current. The cable and fuses have to be sized in accordance with the rated output of the unit applicable to the voltage selected on the PCB. Recommendations with regard to fuse and cable ratings are made within this guide however it is the responsibility of the installation engineer to ensure that all such fittings are properly rated and specified in accordance with local requirements and conditions.

2.3 CE DECLARATION OF CONFORMITY

CE

MANUFACTURERS DECLARATION OF CONFORMITY

This declaration covers all **EnviroStart** units.

This product fulfils the following European Community Directives when applied as follows:

Low Voltage Directive

The above products fulfil the Low Voltage Directive 73/23/EEC and 93/68/EEC amendment for industrial equipment, however, they must be installed to general good electrical engineering practices and regulations by a suitably qualified person with strict reference to the instructions in the product's Technical Manual.

EMC Directive

The above products are intended to be a component in a system or a machine. They must be mounted into an appropriate enclosure and system designed to fulfill the CE directives plus IEC and local industrial standards. Units must be installed by a suitably qualified person to comply with general good electrical engineering practices and regulations with strict reference to the instructions in the product's Technical Manual. To meet all EMC directives, the above products are available with an optional RFI Filter.

The above is based on test results from an independent test laboratory (Steatite Group Ltd.) to test specification EN50081-2, EN50082-1 and EN50082-2.

Dated: July 2003.

3 GENERAL SPECIFICATION

3.1 TECHNICAL SPECIFICATION

SUPPLY VOLTAGE	220V or 400V selected by PCB links (570V & 690V Units Available)
FREQUENCY	50 or 60Hz selected on PCB.
START DUTY	4 x continuous rating for 5s, 3 x for 20s, 2 x for 20s (5 to 37kW units) 5 x continuous rating for 5s, 3 x for 30s, 2 x for 60s (55 to 800kW units)
STARTS PER HOUR	12 evenly spaced starts per hour.
ENERGY CONTROL LIMITING	30%, 40%, 50%, 70% (Unit auto levels from this set level to maximum power dependant upon motor torque demand)
PEDESTAL VOLTAGE RANGE	25 -100% of supply voltage, 6% -100% available torque. (100% is with DOL start selected
RAMP UP TIME RANGE	0.5 - 240s
RAMP DOWN	0.5 – 120s independent of Ramp Up time
KICK START	Switch selected
KICK START LEVEL	Independently selectable at 70% or 90% of maximum supply voltage
KICK START TIME	0.25, 0.5, 1 or 2s
CURRENT LIMIT TIME	Current limit control on ramp up to 240s from start enable
CURRENT LIMIT RANGE	1.5 – 5.0 x unit rated FLC (infinite adjustment with on PCB pot)
STALLED ROTOR DETECT	Unit shutdown in event of rotor stall
COOLING	Naturally cooled isolated heatsink up to 45A Fan cooled 60A and above (Independent 240/110V supply required)
THERMAL CUT OUT	Automatically cuts out and latches out in event of >90^{o}C on heatsink.
POWER SWITCHING	Fully base-isolated twin thyristor Paks or independent Puks
CONTROL CIRCUITRY	24MHz clocked Atmel CMOS MPU
CONTROL SUPPLY	Derived from three phase input
FAULT DETECTION	Shut down if:- Supply or Feed Phase Loss, Motor O/C or S/C Winding, Stalled Rotor, Thyristor Fault or PCB Logic Fault
LED INDICATIONS	Power On, Motor Run, Motor Top of Ramp, Current Limit Exceeded, Ramp in Progress/Energy Save/Direct on Line
ON PCB RELAYS	System Ready, Motor Run/Fault and Motor Top of Ramp
RELAY CONTACT RATING	2kVA, 250V AC with 2 N/O and 2 N/C contacts
MECHANICAL PROTECTION	IP43, NEMA 1 sheet metal enclosure or high impact ABS cover on heat sink backplane (depending on kW rating)
OPERATING TEMP.	0^{o}C - +40^{o}C @ < 95%RH. (De-rate 20%/10^{o}C above +40^{o}C)
STORAGE TEMP.	-10^{o}C - +60^{o}C
ALTITUDE	2000m above sea level – De-rate Amps by 1%/100m above 2000m
EU DIRECTIVES	Meets all necessary EMC and Low Voltage Directives
UL LISTING	Listed for US and Canadian use - File E192379 (55 to 800kW units)

3.2 HIGH SPEED FUSES – (55 to 800kW Models)

The **EnviroStart** has provision for integral High Speed Semiconductor Fuses. These are not fitted as standard. Customers requiring integral fuses for the output feed to the motor must specify this at the time of order. In general, if BS88, motor rated fuses are fitted to the incoming supply of the unit as is recommended within IEE 16th Ed. Regulations, (this being the applicable regulations document in the UK), then these additional fuses are not necessary.

There is no provision for integral uses to be fitted to the output of the 5.5 to 37kW EnviroStart units.

3.3 HARMONICS

EnviroStart like all electronic systems does produce low level harmonics during Ramp Up, Ramp Down and Energy Control and when not at full or zero volts.

UK electricity council engineering recommendations contained within their documents G5/3 and G5/4 (2002), specifies that the short term generation of harmonics by any electronic system on a typical 100kVA supply should not exceed 56A of 5th harmonic and 40A of 7th harmonic. Assuming a 415V supply this equates to one motor of around 145A, therefore the maximum 5th harmonic is 37% and the 7th 28%. The specification also details that the concern is primarily with the possibility of damage to frequency dependent components (such as capacitors) through long-term exposure to such harmonics.

As the EnviroStart units produce negligible harmonic levels during normal running it is excluded from the constraints of such specifications by definition; however with our policy of ensuring maximum compliance and minimum environmental pollution our design standards ensure that we fall well below the limits set. Typical test values* of harmonic currents on an **EnviroStart** controlled motor operating in Energy Save Mode yielded <8% for 5th Harmonic and <1% for 7th harmonic, significantly within the accepted and specified limits.

Maximum limits are unlikely to be exceeded in normal operation even during ramp up and ramp down periods

**Based on tests carried out on a 22kW motor by University Of Surrey Industrial Electronics Group November 1988, verified on current Generation V product in July 2003.*

3.4 HEAT LOSES

For heat calculation purposes it should be assumed that EnviroStart units have a power loss of 1.2W/A per phase at full conduction, (3.6W/A total for the three phases). These losses cause heat to be generated that is safely dissipated through the aluminium heatsink. See Section 4.9.

3.5 HEAT DISSIPATION

In order to keep the unit operating within its design limits any proposed additional enclosure must be capable of safely dissipating the energy generated by the **EnviroStart**.

When fitting systems up to 205A FLC into enclosures, (to extend protection from the standard IP43 up to IP65/NEMA 2), the fitting louvers of the minimum specification (described in Section 3.9 - Table of Power Losses) both above and below the **EnviroStart** as sited within the cabinet will normally be sufficient to ensure effective heat dissipation.

With units of >205A, additional fans must be fitted to the cabinet in addition to those fitted to the **EnviroStart**. The following information will help the user to select a fan to keep the temperature rise within the control panel to a 10°C rise above external ambient.

3.6 SELECTING A FAN

Take the heat dissipation figure of the required **EnviroStart** model from Section 3.10, Table of Power Losses. Compare this figure with the fan heat disposal figure in Section 3.9, Table of Fan Data and select a fan with a greater heat disposal figure than that calculated.

For example, **EnviroStart** 90kW Model gives a heat dissipation figure of 632W, requiring a 7600N model fan with filter equivalent to cooling of 805W.

3.7 CONTROL PANELS WITH MULTIPLE ENVIROSTARTS

If more than one **EnviroStart** is to be installed in a single enclosure the heat dissipation figures should be added together before selecting cooling system requirements.

3.8 COOLING FAN POSITION

The fans should be positioned below the **EnviroStart** power assembly to allow cool air to be drawn into the path of the power assembly fans. Outlet Filters or louvers should be positioned close to the top of the enclosure and in the path of the airflow. These should be approximately double the fan apertures to ensure that the air flow is as free as possible.

3.9 CABINET COOLING FAN DETAIL

The fans should be positioned in the cabinet, wherever possible, below the **EnviroStart**. The aperture to which the fans are fitted should always be large enough to allow free flow of air, any filters fitted should be selected to minimise their interruption to air flow. Such filters should be regularly inspected to ensure that they are clean.

PAPST FAN MODEL NO.'S	FLOW RATE EXC. FILTER (L/s.)	FLOW RATE INC. FILTER (L/s.)	HEAT DISP. EXC. FILTER (W)	HEAT DISP. INC. FILTER (W)
8500N/8550N	10.4	8.3	117	93
4600N/4650N	38.7	31	477	382
7600N/7650N	87.3	71	1,010	805
7400N/7450N	106	85	1,166	935
6028S/6078	106	93.3	1,283	1,026

3.10 POWER LOSSES

MODEL	POWER ASSEMBLY LOSSES IN W.	CONTROL & FAN LOSSES	TOTAL LOSSES	MINIMUM LOUVRE AREA (TWO REQUIRED)
TPSS - 5.5	45	10	55	0.0156 Sq. M
TPSS - 7	58	10	68	0.0156 Sq. M
TPSS - 11	90	10	100	0.0156 Sq. M
TPSS - 15	108	10	118	0.0156 Sq. M
TPSS - 22	162	10	172	0.0156 Sq. M
TPSS - 30	216	50	266	0.0625 Sq. M
TPSS - 37	270	50	320	0.0625 Sq. M
TPSS - 55	306	50	356	0.0625 Sq. M
TPSS - 63	432	50	482	0.0625 Sq. M
TPSS - 75	522	50	572	0.0625 Sq. M
TPSS - 90	612	50	662	0.1 Sq. M
TPSS - 110	738	50	788	0.1 Sq. M
TPSS - 132	918	70	988	See Sections 3.6 - 3.8
TPSS - 150	1,044	70	1,114	See Sections 3.6 - 3.8
TPSS - 186	1,224	85	1,309	See Sections 3.6 - 3.8
TPSS - 225	1,476	85	1,561	See Sections 3.6 - 3.8
TPSS - 260	1,710	85	1,795	See Sections 3.6 - 3.8
TPSS - 315	2,088	135	2,223	See Sections 3.6 - 3.8
TPSS - 375	2,412	135	2,547	See Sections 3.6 - 3.8
TPSS - 450	2,880	160	3,040	See Sections 3.6 - 3.8
TPSS - 500	3,440	160	3,600	See Sections 3.6 - 3.8
TPSS - 630	3,960	260	4,220	See Sections 3.6 - 3.8
TPSS - 800	4,500	300	5,100	See Sections 3.6 - 3.8

USE TABLE OF FAN DATA IN SECTION 3.9 TO SELECT CORRECT CABINET FAN

4 INSTALLATION

4.1 IMMUNITY FROM INTERFERENCE

EnviroStart generally has a high level of immunity to externally generated interference. However the following good practices should be observed:

4.2 COIL SUPPRESSION

Any coil that is connected to the **EnviroStart**, shares a common control supply or is mounted in the same enclosure must be suppressed using appropriate R-C filter circuits.

4.3 LIGHTNING STRIKES/VERY HIGH VOLTAGE TRANSIENTS

In areas subject to frequent lightning strikes or other high voltage transients, a suitably rated metal oxide varistor (MOV) or transient voltage suppressor (TVS) should connect each input line to earth.

4.4 CONTROL VOLTAGE TRANSIENTS

Where the control supply to the **EnviroStart** is thought to be subject to mains-borne interference a suitable line filter with transient interference suppression should be fitted between the control supply and the **EnviroStart**.

4.5 INPUT/OUTPUT CONTROL CONNECTIONS

To avoid 'interference pick up' all input and output control cables should be kept as short as possible and should wherever possible, be shielded. If noise free lines cannot be guaranteed, an interposing relay with suitable suppression must be used, mounted as close to the **EnviroStart** as possible.

4.6 EMISSIONS

EnviroStart units produce relatively low Radio Frequency Interference (RFI) compared with frequency inverters and no external filters are required in normal circumstances.

4.7 BY-PASS CONTACTOR

In the unlikely event that the **EnviroStart** is only used for 'soft-starting', a by-pass contactor can be used to short the unit at top of ramp to eliminate the need for cooling.

The by-pass contactor should be Motor DOL rated. Normally it will not be switching current but it will be expected to be able to do so under fault conditions.

4.8 VENTILATION

The **EnviroStart** must be mounted vertically with the cooling fans, (if fitted), directing the air upwards. A free space of 85 mm must be allowed above and below the unit. See section 3.4 through 3.10 for further information.

4.9 COS. PHI CORRECTION (Power Factor Correction)

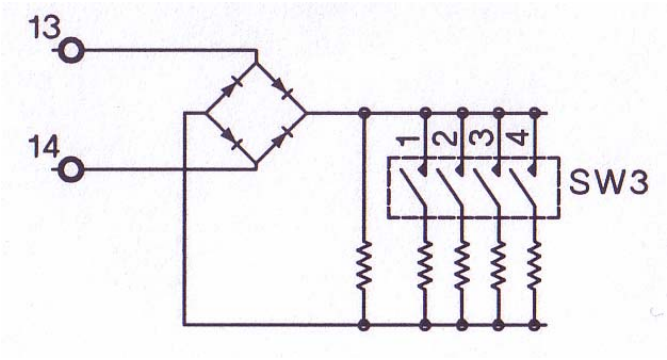
Power factor correction capacitors **must never** be connected to the output of the **EnviroStart**. They must be fitted to the supply side of the line contactor and switched by the line contactor so they are never in direct line with the EnviroStart.

4.10 BURDEN RESISTOR SETTINGS

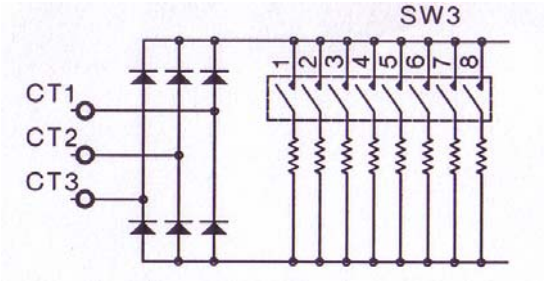
In order for the system software to be able to properly manage the ramp up and over current protection it is necessary that the burden resistor value be set correctly for the size of motor it is operating. The burden resistor works in parallel with the over current limit potentiometer VR1 during ramp up and is therefore important for the effective operation of the system if current limiting is required during this ramp up period.

Burden resistor values are selected on the Burden Resistor DIP Switch located on the PCB according to the following table:

Unit Size	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8
400-TPSS - 5.5	OFF	OFF	OFF	OFF				
400-TPSS - 7	OFF	OFF	OFF	ON				
400-TPSS - 11	OFF	OFF	ON	OFF				
400-TPMSS - 15	OFF	OFF	ON	ON				
400-TPSS - 22	OFF	ON	OFF	ON				
400-TPSS - 30	ON	ON	OFF	OFF				
400-TPSS - 37	ON	ON	ON	OFF				
400-TPSS - 55	OFF	ON	OFF	ON	OFF	OFF	OFF	ON
400-TPSS - 63	OFF	OFF	OFF	ON	OFF	OFF	ON	OFF
400-TPSS - 75	OFF	OFF	OFF	OFF	ON	ON	ON	OFF
400-TPSS - 90	OFF	ON	OFF	ON	OFF	OFF	OFF	ON
400-TPSS -110	OFF	OFF	ON	ON	ON	ON	OFF	ON
400-TPSS - 132	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
400-TPSS - 150	OFF	ON	OFF	OFF	OFF	OFF	OFF	OFF
400-TPSS - 186	OFF	ON	OFF	ON	OFF	OFF	OFF	OFF
400-TPSS - 225	OFF	OFF	OFF	ON	OFF	ON	OFF	OFF
400-TPSS - 260	OFF	OFF	ON	OFF	ON	ON	OFF	OFF
400-TPSS – 315	OFF	ON	OFF	OFF	ON	OFF	OFF	ON
400-TPSS - 375	OFF	ON	ON	ON	OFF	OFF	ON	OFF
400-TPSS - 450	OFF	OFF	OFF	ON	OFF	OFF	OFF	ON
400-TPSS – 500	OFF	ON	ON	ON	OFF	OFF	OFF	ON
400-TPSS - 630	OFF	ON	OFF	OFF	OFF	OFF	ON	ON
400-TPSS - 800	ON	ON	ON	ON	ON	ON	ON	ON



5.5kW Through 37kW Burden Resistor Configuration and CT Connection



55kW Through 800kW Burden Resistor Configuration and CT Connection

4.11 SLIP-RING MOTORS

EnviroStart units are suitable for Slip Ring Motors provided that a single stage resistance is added (during starting) to the rotor circuit, this having a resistance of approximately 10-20% rotor Ohms, (RΩ). This is typically going to be 0.3 – 0.5Ω. This gives the motor a similar torque characteristic to that of a standard squirrel cage motor. Care must be taken when fitting EnviroStart units to slip ring motors. If you are in any doubt please contact your local Distributor or Agent or contact EMS (European) directly.

Some slip ring motors not only have passive induced current in the rotor at start up but have a direct DC injection through the start up phase. Such motors can also be started with EnviroStart units however care must be taken to ensure that the EnviroStart is correctly sized to fit the motor FLC. If you are in any doubt please contact your local Distributor or Agent or contact EMS (European) directly.

4.12 LOAD SIZE

The **EnviroStart** unit must be connected to a motor for the system to operate. The motor and the **EnviroStart** should be matched for both kW and FLC rating. Motors, which regularly operate at below 5% of their kW rating, are not suitable for use with **EnviroStart** control as this low level operation may cause instability of thyristor firing resulting in the motor stalling.

It is important to make an assessment of the load type and start frequency as well as the operating ambient conditions when selecting a suitable EnviroStart unit. High frequency of starts, elevated ambient temperatures or significant altitude should be treated carefully and consideration given to selecting the next size of EnviroStart up from that which would be selected simply on kW or FLC ratings alone.

4.13 CABLE AND INPUT FUSE RATINGS

Incoming fuses and power cables must comply with the ratings as shown in the table below. It is recommended that all cable be tri-rated compliant with BS6231 and that all fuses be motor rated, bolt fitting, compliant with BS88 Part 2.

Model	Fuse Rating	Cable Rating		Model	Fuse Rating	Cable Rating
400-TPSS - 5.5	16A	14A/0.75mm		**400-TPMEC/SS - 132**	250M300A	259A/70mm
400-TPSS - 7	20M32A	21A/1.5mm		**400-TPMEC/SS - 150**	315M400A	321A/95mm
400-TPSS - 11	25A	30A/2.5mm		**400-TPMEC/SS - 186**	355A	374A/120mm
400-TPSS - 15	32M50A	41A/4mm		**400-TPMEC/SS - 225**	400A	440A/150mm
400-TPSS - 22	50A	53A/6mm		**400-TPMEC/SS - 260**	500A	500A/185mm
400-TPSS - 30	63M100A	75A/10mm		**400-TPMEC/SS – 315**	560A	600A min
400-TPSS - 37	80A	75A/10mm		**400-TPMEC/SS - 375**	670A	700A min
400-TPSS - 55	100M160A	100A/16mm		**400-TPMEC/SS - 450**	800A	850A min
400-TPSS - 63	125A	136A/25mm		**400-TPMEC/SS – 500**	900A	950A min
400-TPSS - 75	160A	167A/35mm		**400-TPMEC/SS - 630**	1100A	1200A min
400-TPSS - 90	200M250A	204A/50mm		**400-TPMEC/SS - 800**	1400A	1500A min
400-TPSS -110	200M250A	204A/50mm				

5 CONNECTION

5.1 TERMINAL FUNCTION AND LOCATION

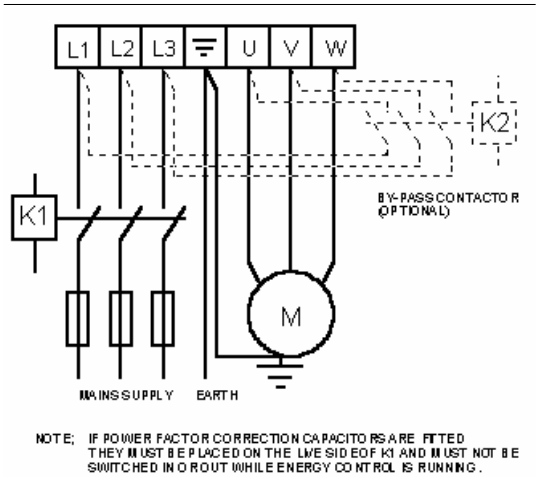
TERMINAL	LOCATION	FUNCTION
L1/L2/L3	Power Assembly	Red/Yellow/Blue Phase Supply
U/V/W	Power Assembly	Red/Yellow/Blue Phase Output to Motor
240V or 110V	Power Assembly	Cooling Fan Supply Voltage (55kW and above)
Earth	Power Assembly	Earth Connection to Unit
TS1 and TS2	PCB	Thermistor feed to PCB (55kW and above)
K1 (U) & G1	PCB	Thyristor 1 Cathode and Gate
K2 (L1) & G2	PCB	Thyristor 2 Cathode and Gate
K3 (V) & G3	PCB	Thyristor 3 Cathode and Gate
K4 (L2) & G4	PCB	Thyristor 4 Cathode and Gate
K5 (W) & G5	PCB	Thyristor 5 Cathode and Gate
K6 (L3) & G6	PCB	Thyristor 6 Cathode and Gate
1, 2, 3, 4[1]	PCB	Start (must be kept closed for motor to run)
5,6,7,8[2]	PCB	Emergency Run
9 & 11	PCB	AC Mains Supply (220, 400, 570V , 690V selected on PCB)
10	PCB	DC Common Rail
12	PCB	DC Input 8V – 30V (External PCB logic circuit supply)
15, 16, 17	PCB	TOR Relay Changeover Contact Pair
18,19, 20	PCB	TOR Relay Changeover Contact Pair
21,22, 23	PCB	Run/Fault Relay Changeover Contact Pair
24, 25, 26	PCB	Run/Fault Relay Changeover Contact Pair
27, 28,29	PCB	Power On/Ready Relay Changeover Contact Pair
30, 31, 32	PCB	Power On/Ready Relay Changeover Contact Pair
33,34,35,36[3]	PCB	Thermal Trip External Connector (55kW and above)
CT1 or 13	PCB	CT1 +tve Input
CT2	PCB	CT2 +tve Input (55kW and above)
CT3 or 14	PCB	CT Common Input
220V	PCB	PCB Supply Control Transformer Tapping 220V
400V	PCB	PCB Supply Control Transformer Tapping 400V
OV	PCB	PCB Supply Control Transformer OV

NOTES

1. Terminals 1, 2, 3, 4 should be permanently linked (via switch or link) per the diagrams below to cause the motor to start. The circuit is designed to accommodate, direct switching, NPN, (sink) or PNP (source) switching should it be necessary to switch directly from a PLC or other micro device. When the connection between the terminals is open circuit but the unit is still powered up the motor will stop.

2. Terminals 5, 6, 7, 8 should be permanently linked (via switch or link) per the diagrams below to enable the emergency run function. The circuit is designed to accommodate, direct switching, NPN, (sink) or PNP (source) switching should it be necessary to switch directly from a PLC or other micro device. When the connection between the terminals is open circuit but the unit is still powered up the motor will stop.
3. Terminals 33, 34, 35, 36 should be permanently linked (via switch or link) per the diagrams below to reset the thermal overload trip. The circuit is designed to accommodate, direct switching, NPN, (sink) or PNP (source) switching should it be necessary to switch directly from a PLC or other micro device. When the connection between the terminals is made the thermal trip will reset, if the control function on connection 1, 2, 3, 4 is closed at this time then the motor will restart.

5.2 MAINS CONNECTION SCHEMATIC DRAWING

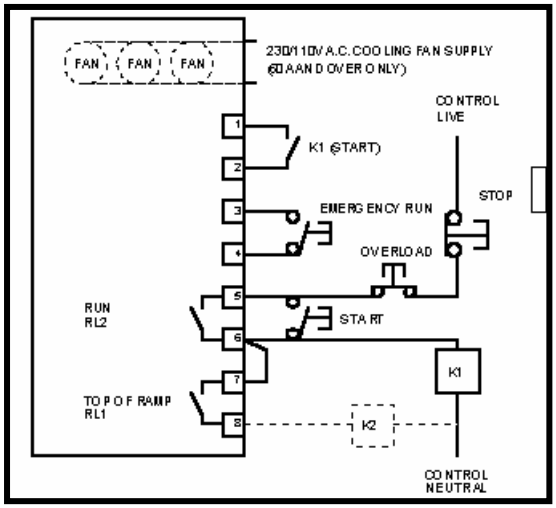


NOTES

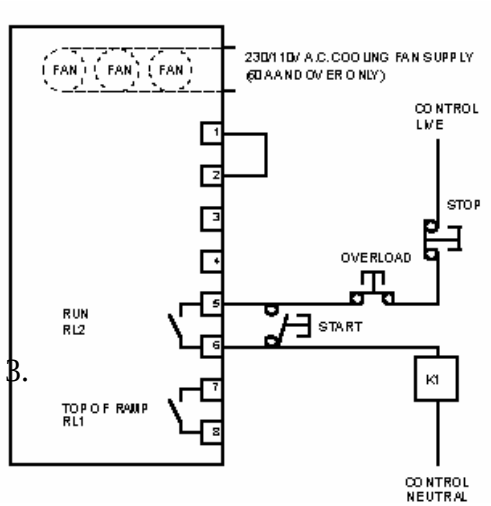
1. The start connection across Terminals 1-2 (K1 Auxiliary) can be permanently linked to start up as soon as K1 closes.
2. RL2 acts as a retaining contact for the start pushbutton. In the event of a fault, RL2 will open 5-6 and de-energise K1, provided the start pushbutton is not made.
3. Under an emergency condition the **EnviroStart** can be made to operate as a 'contactor' by connecting terminals 3 and 4.

   Care should be taken if this is done as the unit will ignore any faults in other parts of the system.

5.3 CONTROL CONNECTIONS UTILISING ALL FEATURES



5.4 CONTROL CONNECTIONS MINIMUM REQUIREMENTS

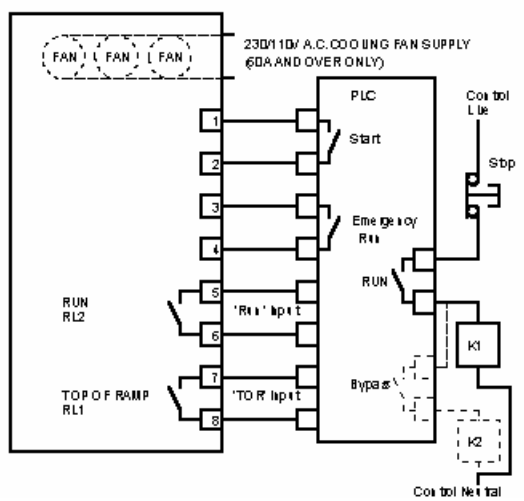


3.

NOTES

1. The unit will start up as soon as K1 closes.
2. RL2 acts as a retaining contact for the start pushbutton. In the event of a fault, RL2 will open 5-6 and de-energise K1, provided the start pushbutton is not made.

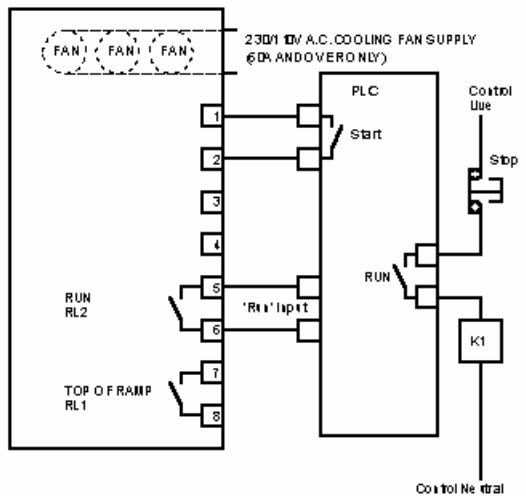
5.5 CONTROL CONNECTIONS – AUTOMATIC START/EMERGENCY RUN



NOTES

1. The unit will start as soon as K1 closes and then “start” is made, The **EnviroStart** will stop when “start” is opened.
2. If the RUN input is not made shortly after the start signal is given there is a fault and the PLC should open K1 and lock out.
3. Under an emergency condition the unit can be forced into continuous conduction by connecting terminals 3 and 4. Care should be taken when doing this as the **EnviroStart** will ignore any external faults whilst operating in this condition.

5.6 CONTROL CONNECTIONS AUTOMATIC START



NOTES

1. The **EnviroStart** will start as soon as K1 closes and then “start” is made. The **EnviroStart** will stop when “start” is opened.
2. If the RUN input is not made shortly after the start signal is given there is a fault and the PLC should open K1 and lock out.

COMMISIONING

5.7 PRE-COMMISSIONING CHECKS

IMPORTANT*:* Before installation checks the motor rating plate and Section 2 of this manual to ensure that the EnviroStart is correctly rated for the application.

1. Check that the voltage for the PCB and frequency selection is correct.
2. Ensure that fans (if fitted) are connected to the correct voltage and are free to rotate
3. Ensure that all Switch, Jumper and Potentiometer settings are set to default. (Table 6.1)
4. Check that the unit is connected correctly as per the proceeding connection diagrams.
5. Ensure any PFC Capacitors if fitted are placed on the input side of the unit and are only switched in or out when the **EnviroStart** is not running, that is that they are before the line contactor.
6. Ensure that a suitable time has elapsed since the **EnviroStart** was last run/started.

5.8 COMMISSIONING INSTRUCTIONS

1. Check that all settings are at 'Default' and the pre-commissioning steps have been followed.
2. Give the start command.
3. This setting should gi**ve satisfactory start with most applications. If it does and you want to enable current limiting then stop the motor and move straight to 11 below.**

Carry Out the following procedure only if the default start sequence established proves unsatisfactory, this may occur if you have a high inertia load. The following does not have any form of current limit enabled and therefore may not be suitable should you be trying to limit current excursion during start up.

4. Ensure the current limit potentiometer VR1 is fully clockwise at its maximum setting.
5. Set switches 1, 2 and 3 to the minimum ramp time of 0.5s
6. Set switches 8, 9 and 10 to give the maximum pedestal voltage
7. Start the motor. The motor should begin to rotate immediately. If a delay of greater than a few seconds occurs before rotation occurs, switch off, If LED1 flashes reverse two of the input phases and re-start.
8. With these settings the unit should start and ramp very rapidly to full speed. If it does not then you should check supply and feed connections are the correct way round and that all connections are made and that all phases are available on the input, L1, L2 and L3 side of the thyristors.
9. If the direction of rotation is incorrect, possibly because of your changing two of the input phases per instruction above, then change over two of the output phase connections marked U, V and W.
10. If the unit starts satisfactorily then increase the ramp time from 0.5s to a suitable setting, 10s or 20s are typical, and step by step reduce the pedestal voltage setting until a smooth start is achieved

These settings once found, should give a satisfactory start.

Carry out the following procedure if you want to limit the current at start up.

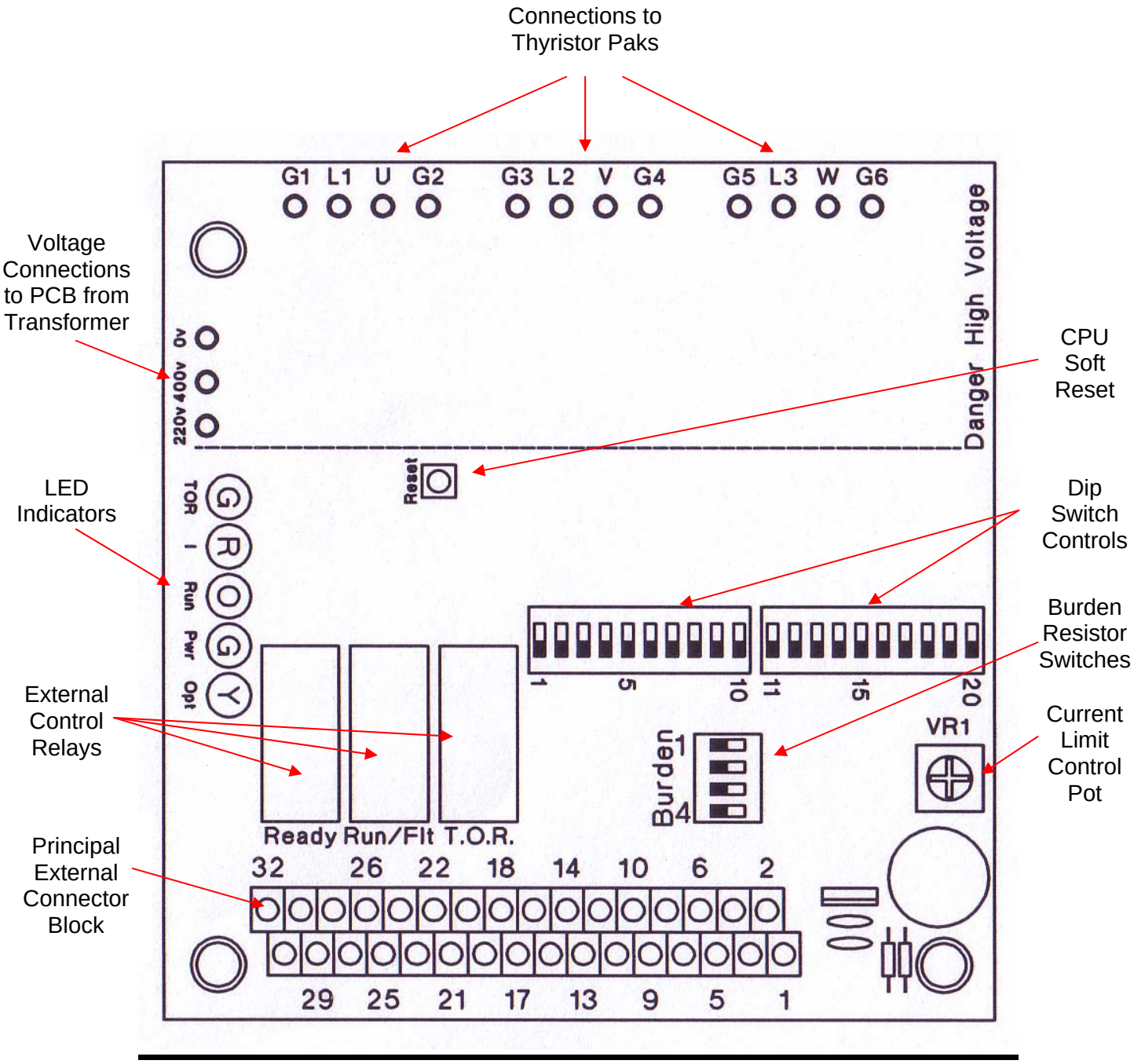
11. Turn the current limit potentiometer to minimum, fully anti-clockwise; this is the maximum current limit setting.
12. Start the motor; it is likely that the motor will not rotate. This is expected.
13. Slowly turn the potentiometer VR1clockwise until the motor starts to move, then turn through approximately a further 10^{o} at which point the motor should have sufficient current to accelerate the load to full speed smoothly. This point is the point at which the EnviroStart is providing sufficient power to start the load whilst limiting the current by the maximum amount. The Current Limit should not be set too low, as this will cause motor overheating and tripping of the thermal overload in the supply system.
14. With the Current Limit set, the ramp time may need reducing to give the required starting time.
15. Should you want you can monitor the current at start up using a fast acting current clamp meter or DVM set to peak current hold. The clamp should be placed on one of the output feed cables to the motor.

5.9 SETTING FEATURES

When satisfactory start is achieved the user control functions can be set following the details contained within Section 6 of this Guide.

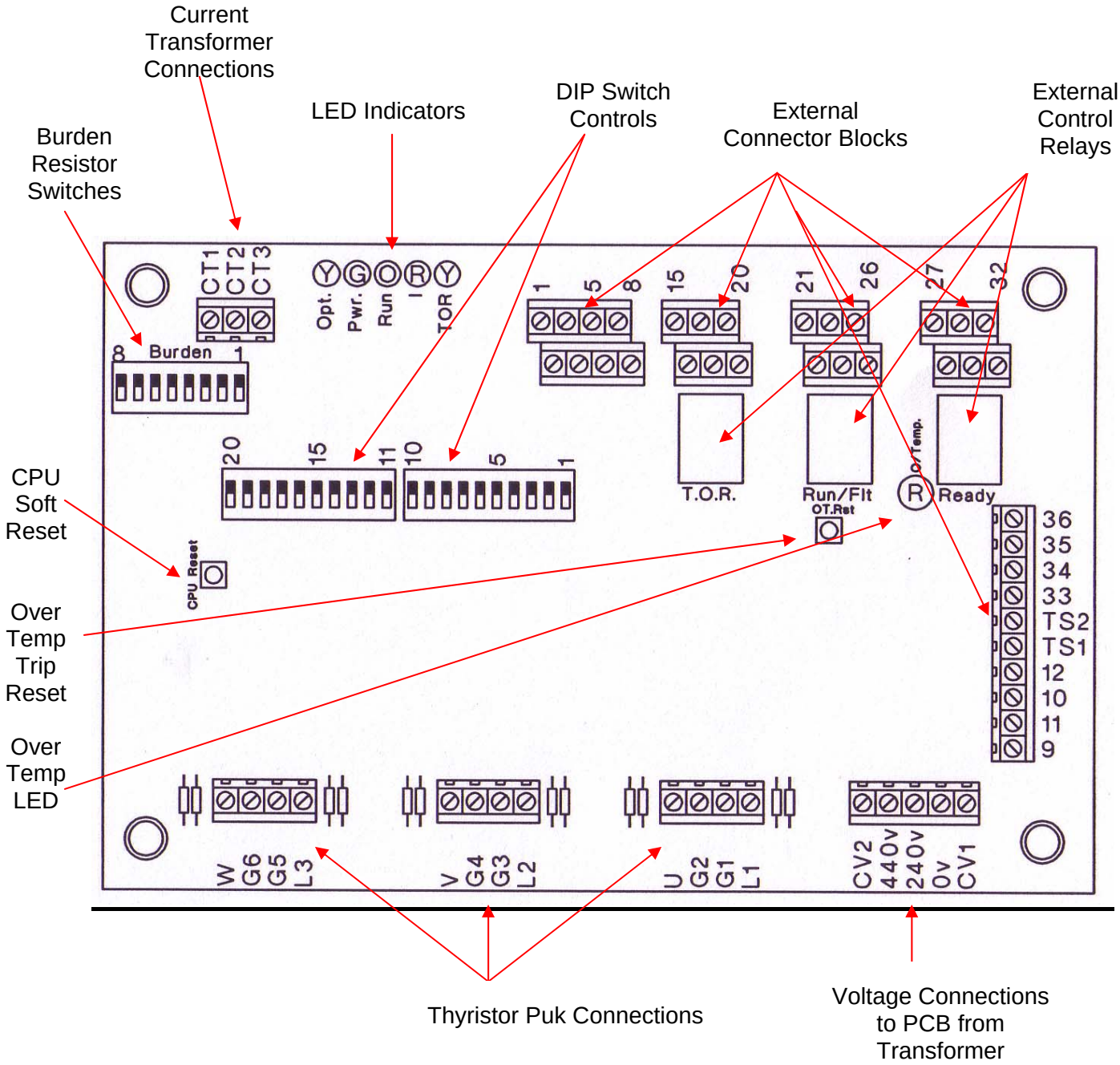
5.10 PCB SWITCH AND CONTROL LOCATION

TPSS-5.5 to TPSS-37 PCB DETAILS



5.11 PCB SWITCH AND CONTROL LOCATION

TPSS-55 to TPSS-800 PCB DETAILS



6 USER CONTROL FEATURES

6.1 DEFAULT SETTINGS

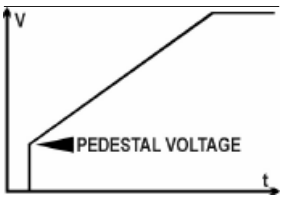
The unit is set to the 'Default Settings' before leaving the factory. These should be tried first and further adjustments only made where necessary to 'fine tune' the **EnviroStart**.

ADJUSTMENT	FUNCTION	DEFAULT SETTING	RESULT	SEE SECTION
Switches 1, 2 & 3	Ramp Up Time	OFF, ON, OFF	Ramp set at 20s.	6.3
Switch 4	Ramp Time x 4	OFF	No multiplication	6.20
Switches 5, 6 & 7	Ramp Down Time	OFF, ON, OFF	Ramp set at 40s	6.6
Switches 8, 9 & 10	Initial Pedestal Voltage	ON, OFF, OFF	Set at 40% Voltage	6.2
Switch 11	Load Monitoring	OFF	Normal	6.14
Switch 12	50/60Hz Select	OFF	50Hz	6.4
Switch 13	Fault Detection	ON	Enabled ar all times	6.13
Switch 14	Kick Start Enable	OFF	Kick Start Off	6.10
Switch 15	Kick Start Level	OFF	70% Voltage	6.10
Switches 16 & 17	Kick Start Time	ON & ON	Set at 0.25s	6.11
Switch 18	Emergency Run	OFF	No Emergency Run	6.20
Switch 19	Not Connected			
Switch 20	Not Connected			
Potentiometer VR1	Current Limit	Fully Clockwise	Maximum Power at Start of Ramp	6.5

SEE SECTION 5.10 AND 5.11 FOR A DIAGRAM TO LOCATE THE ABOVE SWITCHES ON THE RELEVANT PCB.

Note that changes in switch settings will not take effect if made while the unit is driving a motor. Except for switch 20, optimisation enabled/disabled, switch 13, load monitoring and VR1, current limit set, the motor must be stopped and re-started for changes to take effect.

6.2 PEDESTAL VOLTAGE



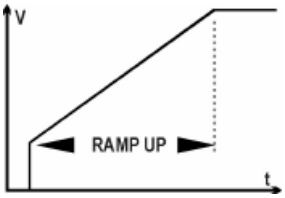
This sets the initial voltage that is applied to the motor. This is adjusted to a level so that the motor starts to accelerate smoothly and immediately.

It should normally not be necessary to adjust Pedestal voltage except where motors are started on-load with high loads. If there is a delay between startup and the motor starting to turn, increase the Pedestal Voltage until this disappears.

Switch settings are as follows:

SWITCH 8	SWITCH 9	SWITCH 10	PEDESTAL VOLTS
ON	ON	OFF	25 %
ON	OFF	OFF	40 % (Default)
OFF	ON	OFF	55%
OFF	OFF	OFF	70%
OFF	OFF	ON	100% (DOL start)

6.3 RAMP UP TIME



The Ramp Up Time switches adjusts the time from the initial pedestal setting to full output voltage.

Switch settings as follows:

SWITCH 1	SWITCH 2	SWITCH 3	RAMP UP TIME
OFF	OFF	OFF	60s
OFF	OFF	ON	30s
OFF	ON	OFF	20s (Default)
OFF	ON	ON	10s
ON	OFF	OFF	5s
ON	OFF	ON	3s
ON	ON	OFF	1s
ON	ON	ON	0.5s

6.4 SUPPLY FREQUENCY SELECT

This switch function should be set to reflect the supply frequency of the three-phase mains supply.

SWITCH 12
Selects either 50Hz or 60Hz supply
Default is 50Hz

6.5 CURRENT LIMIT

Motors started direct on line, (DOL), typically draw a peak starting current of about 8x their rated FLC.

In conjunction with the other control functions associated with the motor start as defined by a solid state control, such as ramp time and pedestal voltage, **EnviroStart** can be set to limit the starting current during this initial phase of the motor operation.

When the current limit potentiometer, VR1, is turned away from its default condition of fully clockwise then a variable degree of current limit will be enabled which will extend from a maximum current excursion of approximately 5x motor FLC when the potentiometer is fully clockwise to a limit of approximately 1.5x motor FLC when the potentiometer is fully anticlockwise. **EnviroStart** monitors the current drawn by the thyristors during ramp up, if the current exceeds the limit set by VR1 then the ramp is stopped and voltage held constant until the current falls below the preset limit, following which time the ramp up is continued.

After 30s, the current limit is released, if top of ramp has not been reached at that stage, to ensure the full and smooth acceleration of the motor to full synchronous speed.

Current limit is useful to start high inertia loads where supply restrictions place may have placed limits on maximum starting current allowed.

For normal loads set VR1 fully clockwise to disable current limiting and provide maximum power to the motor defined by only the initial pedestal voltage and ramp period settings.

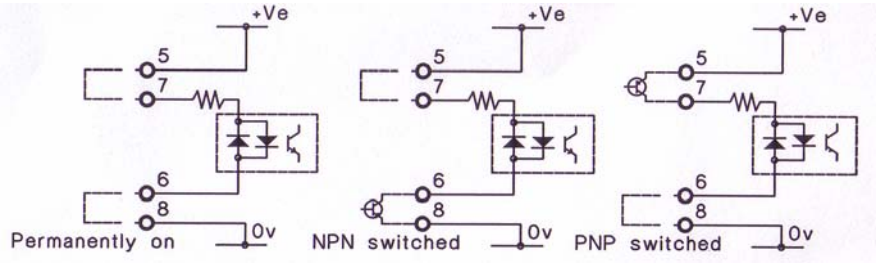
6.6 SOFT STOP ENABLE

The Ramp Down Time is enabled using switches 5, 6 and 7. It is possible to select ramp down times between 1s and 120s. The time period is multiplied by a factor of 4 if switch 4 is in the ON position. (Thus reflecting the multiplier applied to the Ramp Up Time). The ramp down time is wholly independent of the ramp up time. The motor will re-start when a new start signal is applied to connector pins 1 through 4.

The ramp down feature is designed to consist of three stages. With the motor running and with a continuing start signal link on connector 1 through 4, a momentary signal needs to be applied to connectors 5 though 6, (see below), the soft stop function then latches. The voltage to the motor feed immediately drops to 60% of maximum supply voltage, the control then linearly decreases the voltage from that 60% to 40% of maximum supply voltage in the time as set by switches 5 and 6. Once the unit reaches 40% of maximum supply voltage the system stops firing the thyristors and stops the motor fully.

The input circuit is capable of handling both direct switching, having connector pins 6 and 8 linked and then making the link between connector pins 5 and 7, (this need only be

momentary), either via a switch or alternatively being supplied from a logic high, (feed) or logic low, (sink) from a PLC system.



Soft Stop Latch Input

Switch settings are as follows

SWITCH 5	SWITCH 6	SWITCH 7	Ramp Down Time
OFF	OFF	OFF	120s
OFF	OFF	ON	60s
OFF	ON	OFF	40s (Default)
OFF	ON	ONN	20s
ON	OFF	OFF	10s
ON	OFF	ON	6s
ON	ON	OFF	2s
ON	ON	ON	1s

6.7 SYSTEM READY RELAY (Contacts 27 though 32)

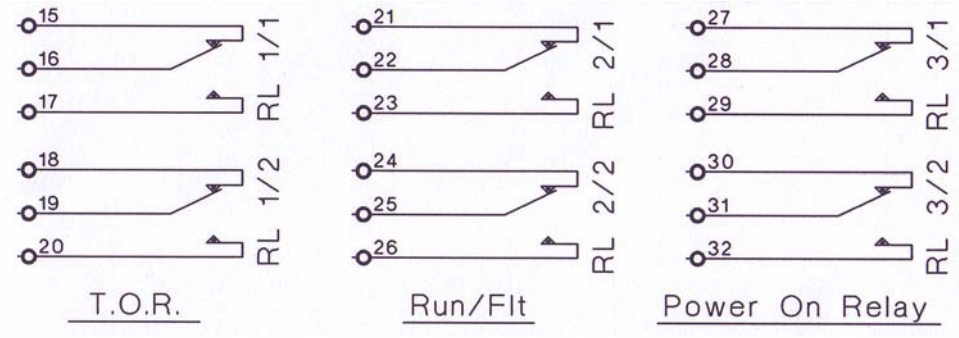
Energises when power is applied to the EnviroStart and indicates that the PCB and all logic functions are operational. It is an indication of the system being available for operation and remains throughout the running of the unit.

6.8 RUN/FAULT RELAY (Contacts 21 through 26)

Energises when the **motor the EnviroStart is controlling is running. It does not indicate that the motor is at speed; just that it is turning. It can be used in reciprocal fashion to provide a fault indication should that be required.**

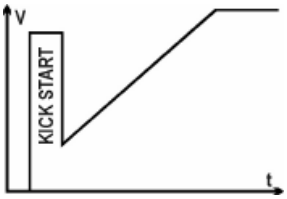
6.9 TOP OF RAMP RELAY(Contacts 15 through 20)

Energises when the motor the EnviroStart is controlling has reached top of ramp and is at synchronous speed. The logic does not allow this relay to operate until the ramp up time period as defined by switches 1, 2 and 3 has elapsed though on lightly loaded motors full speed may have been reached prior to this time.



Relay Configuration

6.10 KICK START



In some high stiction, high static friction or high torque, loads, a better mechanical start can sometimes be achieved by using the Kick Start feature to overcome the resistive torque.

If the load is not of this type, this feature should be turned off.

Switch settings as follows

Kick Start	Switch 14 enables Kick Start function when ON (Default is OFF)
Kick Start Level	Switch 15 sets Kick Start volts to 70% when OFF. 90% when ON

6.11 KICK START TIME

The period that the kick start remains in place is adjustable to allow sufficient “kick” to be given to the motor in the initial few revolutions.

Switch settings are as follows

SWITCH 16	SWITCH 17	KICK START TIME
ON	ON	0.25s (Default)
ON	OFF	0.5s
OFF	ON	1s
OFF	OFF	2s

6.12 LED INDICATORS

LED 1	Ramp Up/Energy Save/DOL	Illuminates constantly during ramp up Flashes asynchronously if emergency run is selected
LED 2	Power On	Illuminates when unit is powered and ready to operate
LED 3	Run	Illuminates when motor unit is controlling is running
LED 4	Current Limit	Illuminates when line current is at the set current limit level
LED 5	Top Of Ramp	Illuminates when **motor unit is controlling is at full speed**

6.13 FAULT DETECTION

EnviroStart has fault detection circuits to protect itself from a short circuit switching device or a loss of a supply or improper phase differential on either the supply or the feed to the motor being driven. Fast changing loads can, in rare cases, cause nuisance tripping during operation. Setting switch 7 OFF, whilst reducing the overall protection to the motor and the control circuit, can be used to avoid this. Fault detection is still present during starting.

This fault detection circuit should not be seen or used as a replacement for a proper motor overload circuit prior to the incoming line fusing.

Switch settings as follows

SWITCH 13	FAULT DETECTION
ON	On at all times
OFF	On during Start up and Off while running

6.14 CURRENT MONITORING

On certain types of motors the **EnviroStart** may not be able to monitor motor current correctly, causing the current to become unstable as the feedback into the microprocessor may falsely identify that insufficient power is being applied to the motor for a given load. Reducing the sensitivity of the processor in this area by switching DIP 13 ON can often eliminate this problem

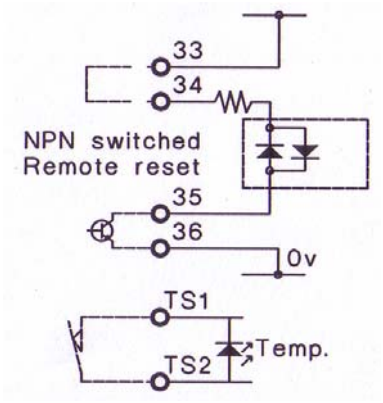
Switch settings as follows

SWITCH 11	CURRENT MONITORING
OFF	Default
ON	Reduced Sensitivity

6.15 OVER TEMPERATURE TRIP (55 to 800kW)

If the **EnviroStart** heatsink goes above 90°C, the heatsink over-temperature trip will open and turn off the **EnviroStart**. The thermal overloads themselves will automatically reset once the temperature drops below 70°C however the motor will not automatically restart until such time as the over temperature reset button on the PCB is made. (For convenience an external switch contact is provided on connectors **33 through 36.**

Note that over temperature trips are not fitted to units of 5.5 through to 37kW.



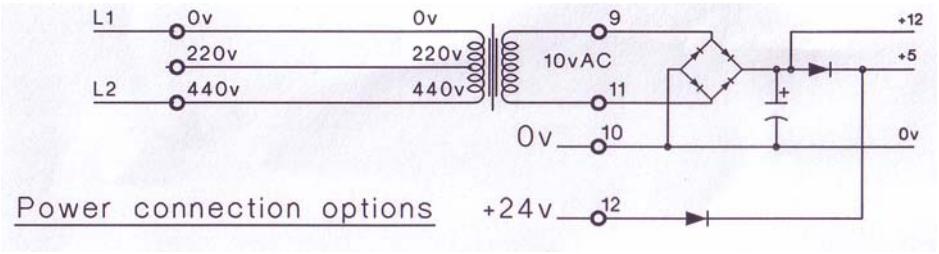
6.16 VOLTAGE SELECTION

WARNING: Please check this setting before first starting the unit.

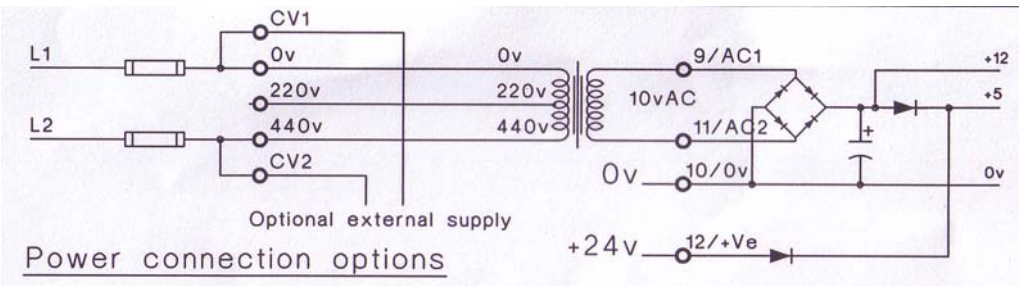
All 220/400V units are shipped with the voltage default at 400V, (or in the case of 400/690V units, at 690V).

Should you require that the operating voltage of the unit be changed, to 200V in the case of the 400V units or to 400V in the case of the 690V units, change the position of the push-on connectors found to the underside of the PCB.

In the case of 690V units we do not supply a 690V to 10V transformer and as such it will be necessary for you to provide one of the following independent supplies, 220V, 400V or 12 to 24V AC; this will power the control circuit. In the case of the 220V or 400V AC supply this is direct to the input of the fitted transformer, in the case of the 12 to 24V this is fed to connector pins **9 though 12.**



5.5 though 37kW PCB Power Connections



55 though 800kW PCB Power Connections

6.17 STALLED-ROTOR OVER-CURRENT PROTECTION

The system software is capable of detecting the lack of synchronous rotation in the motor the EnviroStart is feeding. In such an event the software will check the status functions of all the outputs and if they are found to be satisfactory then it will assume that the rotor is stalled or being stalled in some manner and in order to protect the system and the motor it will shut down the feed current eliminating the possibility of motor burn out through mechanical jam of any form.

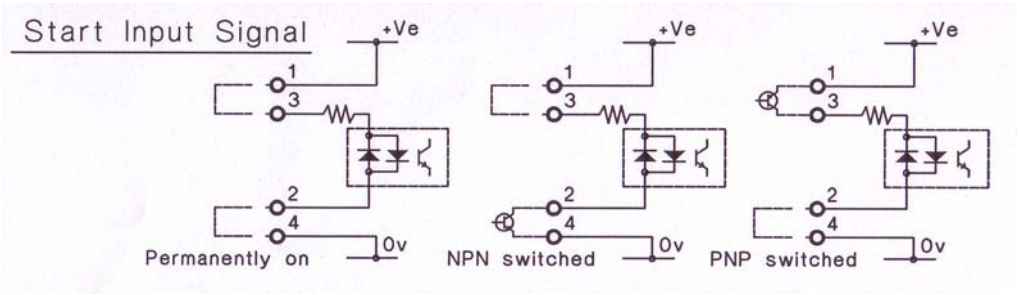
In the event of the system stopping in this way the motor should be checked and free rotation ensured before such time as the unit is restarted. The EnviroStart will need to be reset when it has stopped in this way, this can be done by either powering the system down or by pressing the restart button on the PCB.

Before resetting the EnviroStart and restarting the motor always ensure that the motor is safe to operate.

6.18 START AND STOP FUNCTION

The controlled motor is started and stopped by making contact between connector pins 1 and 3 on the PCB. This is a zero voltage contact set. It is important that no control current or voltage be fed to these terminals as this will result in damage to the control microprocessor.

The input circuit is capable of handling both direct start, having connector pins 2 and 4 linked and then making the link between connector pins 1 and 3 either via a switch or permanently so that the motor starts on power being supplied or from a logic high, (feed) or logic low, (sink) from a PLC system.



Start Function

6.19 EMERGENCY RUN FUNCTION

In the event of control circuit failure it is possible to force the thyristors into full permanent conduction allowing the motor to start and run direct on line, (DOL). This feature is enabled when switch 18 is put into the ON position. In this condition it is not necessary to have a start signal or condition on pins 1 through 4.

In this condition the Yellow LED illuminates aperiodically, flashing three times in quick succession followed by an off period of twice the on period of the three flashes. It is not recommended that units be left operating in the Emergency Run condition for any extended period of time however periods of 336hrs is acceptable.

During the time that the unit is operating in Emergency Run you should expect the system to generate greater heat than it would during normal operation, this is to be expected as the thyristors are firing continuously.

6.20 RAMP UP TIME MULTIPLIER

This facility on switch 4, multiplies the ramp up time set by switches 1, 2 and 3, (and if enabled the ramp down) by a factor of 4 such that the ramp up time can be extended to 240s and the ramp down to 120s.

INSTALLATION AND COMMISSIONING GUIDE

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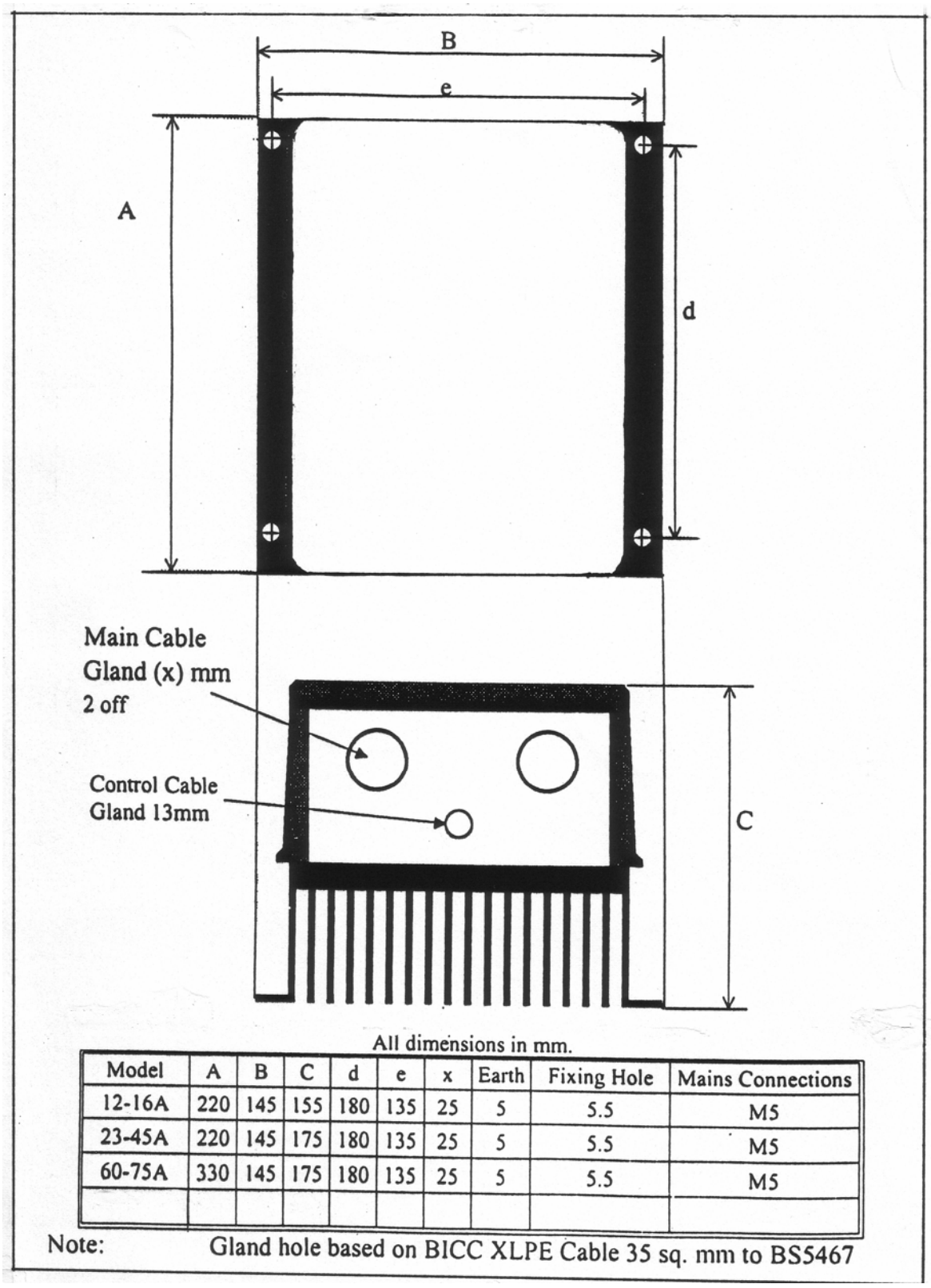
Appendix 1

Mechanical Drawing 11 – 75A (not to scale)

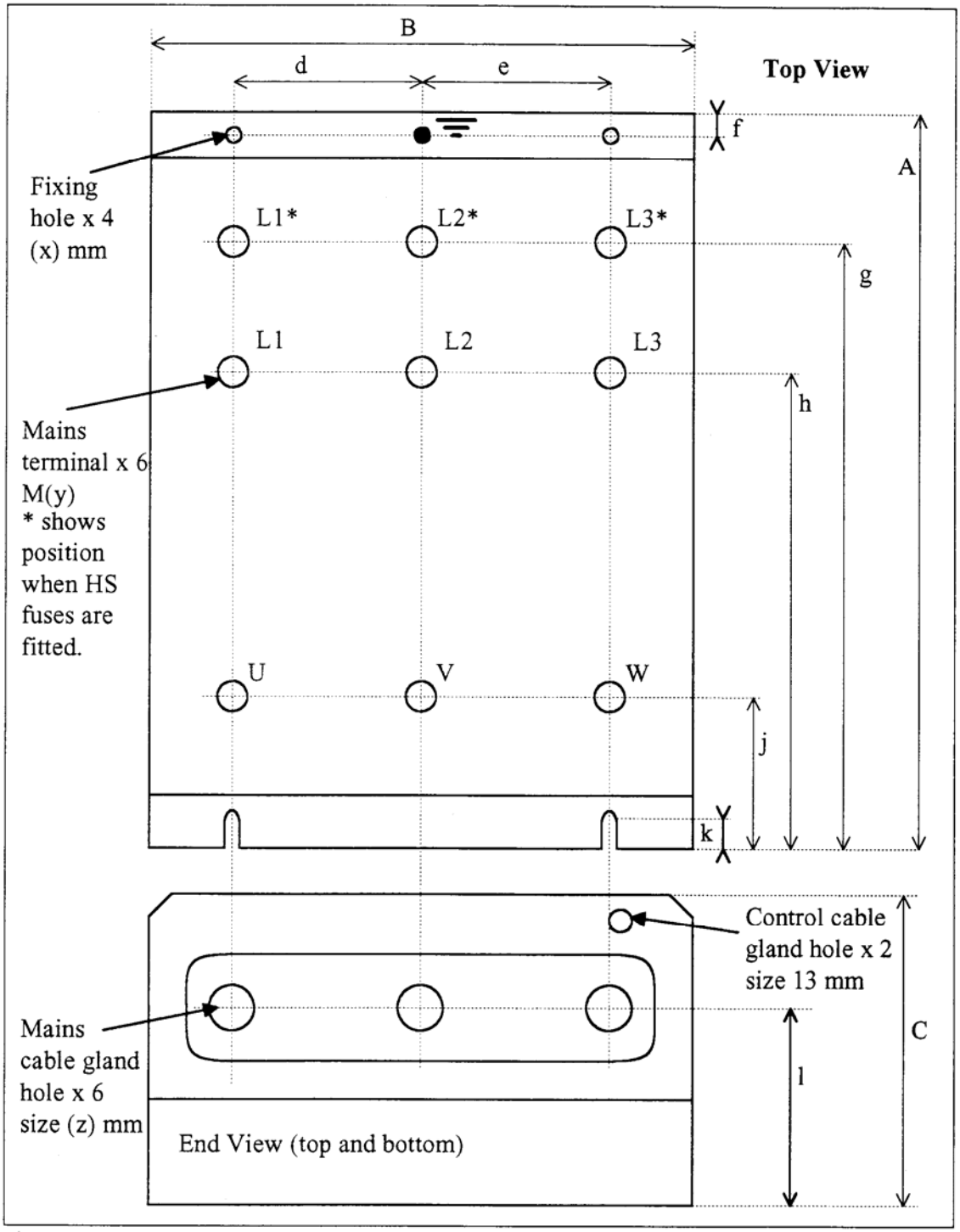


All dimensions in mm.

Model	A	B	C	d	e	x	Earth	Fixing Hole	Mains Connections
12-16A	220	145	155	180	135	25	5	5.5	M5
23-45A	220	145	175	180	135	25	5	5.5	M5
60-75A	330	145	175	180	135	25	5	5.5	M5

Note: Gland hole based on BICC XLPE Cable 35 sq. mm to BS5467

Mechanical Drawing 85 – 205A (not to scale)

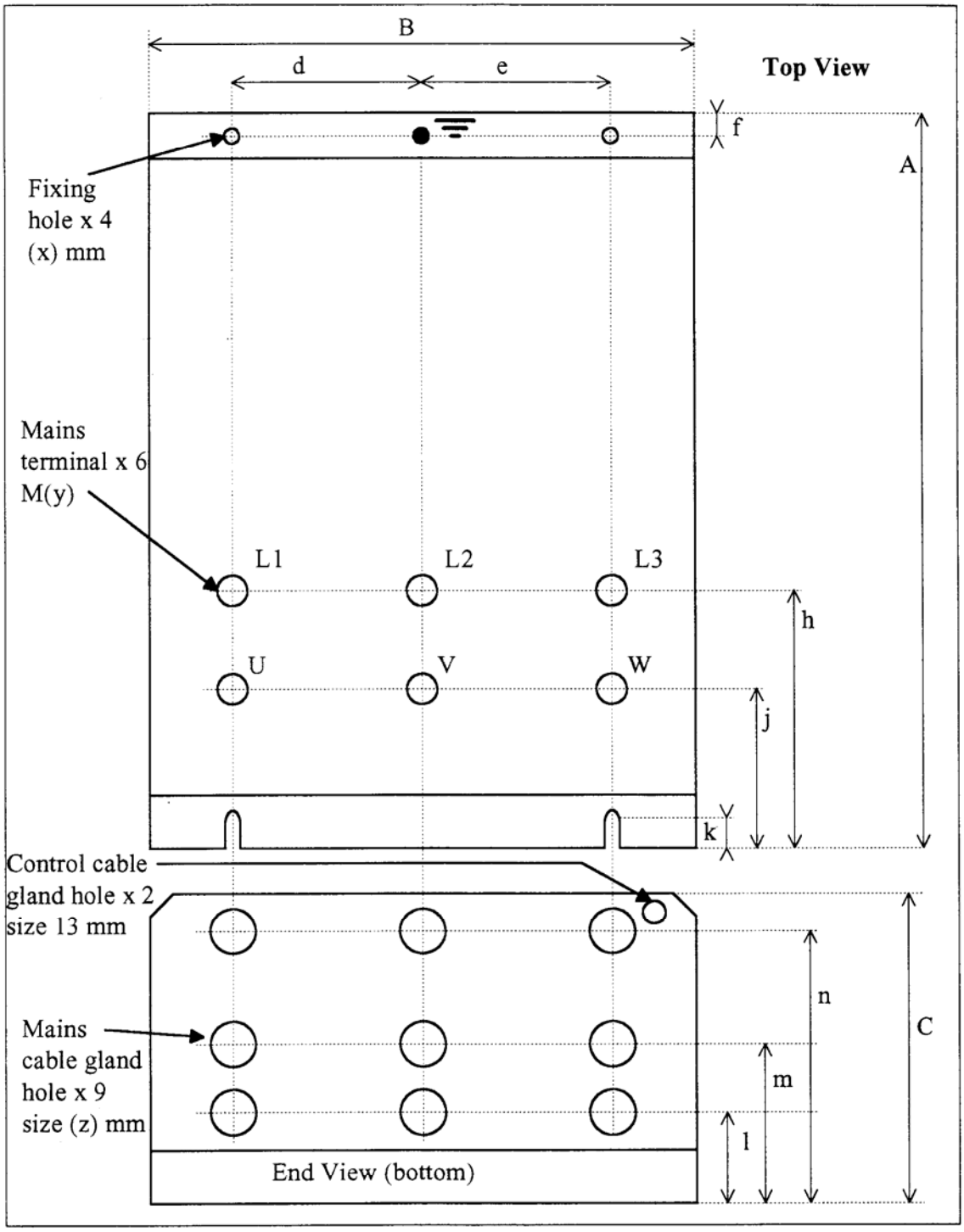


All dimensions in mm.

Model	A	B	C	d	e	f	g	h	j	k	l	x	y	z	Earth
16-45A	325	164	195	50	50	7	250	198.5	65	10	78	6	6	30	6
60-205A	430	254	280	70	70	7	351	271	65	10	178	6	8	30	6

Note - Height of L1, L2, L3, L1*, L2*, L3*, U, V, W corresponds to l.

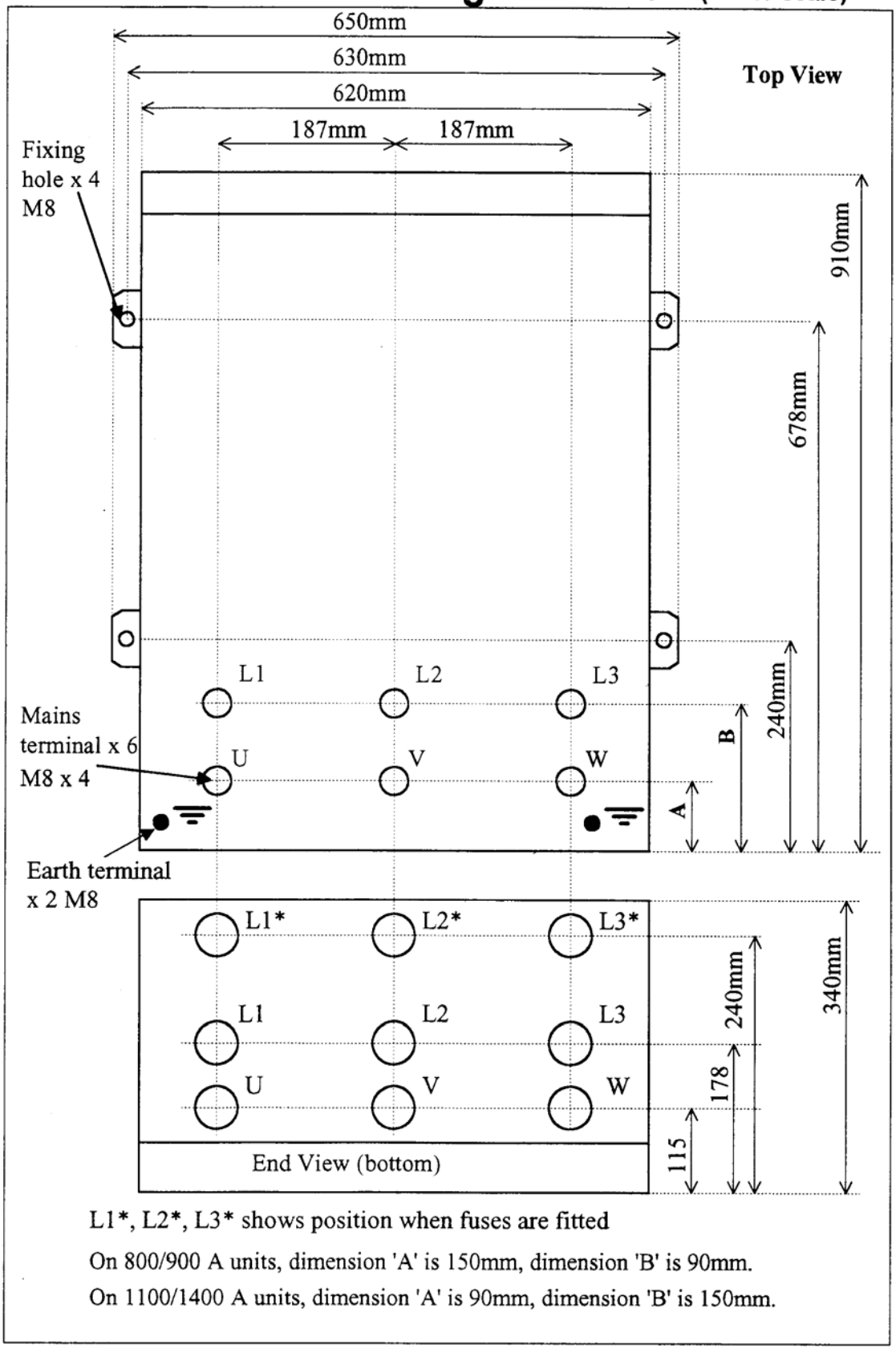
Mechanical Drawing 255-670A (not to scale)



All dimensions in mm.

Model	A	B	C	d	e	f	h	j	k	l	m	n	x	y	z	Earth
255-410A	580	368	228	116	116	8	118	90	10	56	101	168	8	2 x 8	30	8
475-670A	720	462	253	135	135	8	133	101	10	68	120	195	8	2 x 8	40	8
Note - Height of L1, L2, L3 without fuses corresponds to m, with fuses to n, U, V, W corresponds to l																

Mechanical Drawing 800-1400A (not to scale)



L1*, L2*, L3* shows position when fuses are fitted

On 800/900 A units, dimension 'A' is 150mm, dimension 'B' is 90mm.

On 1100/1400 A units, dimension 'A' is 90mm, dimension 'B' is 150mm.

Appendix 2

THE TESTING AND REPLACEMENT OF THYRISTORS

Thyristor Short Circuit Test

With the rate/cathode connections disconnected from the control PCB measure the resistance between the input and the output of each phase of the power assembly in turn and in both directions, (positive to negative and negative to positive). A healthy reading will be in excess of IOOkΩ. Any short circuit thyristors should be replaced. Care must be taken to re-connect the gate and cathode connections correctly.

Thyristor Gate-Cathode Test

With the gate and cathode leads disconnected from the control PCB measure the resistance between the two leads. This should be between 7 and 60Ω. If the meter reads open circuit first check the cable continuity and the crimp connectors on the device. Any open circuit thyristor should be replaced.

Thyristor Removal.

Up to 205A the power assemblies on the Soft Starters and Motor Energy Controls use isolated two-thyristor Pak devices. These devices are manufactured, as an anti-parallel pair so must be changed complete.

Power assemblies of 205A and above use individual hockey-puk devices that are sandwiched between two aluminium heatsinks. Each thyristor is clamped by two fixing bolts, with a centre bolt compressing spring washers in order to give an indication of correct clamping tension. The centre bolt is not a fixing bolt its only purpose is to set the tension on the spring loaded washers so when the fixing bolts are tightened to the correct torque the centre tab washer is freed. The torque setting on the centre bolt is factory set under no circumstances should be loosened or the torque setting on the spring washers will be lost.

When dismantling, the two fixing bolts should be loosened evenly. Note the polarity of the devices, they are an anti-parallel pair and should be replaced as such.

Re-assembly of Pak Devices

Re-assembly of the power assemblies using Pak devices is very simple. Smear a small amount of heatsink compound onto the base of the new device before fixing. Torque settings are as below..

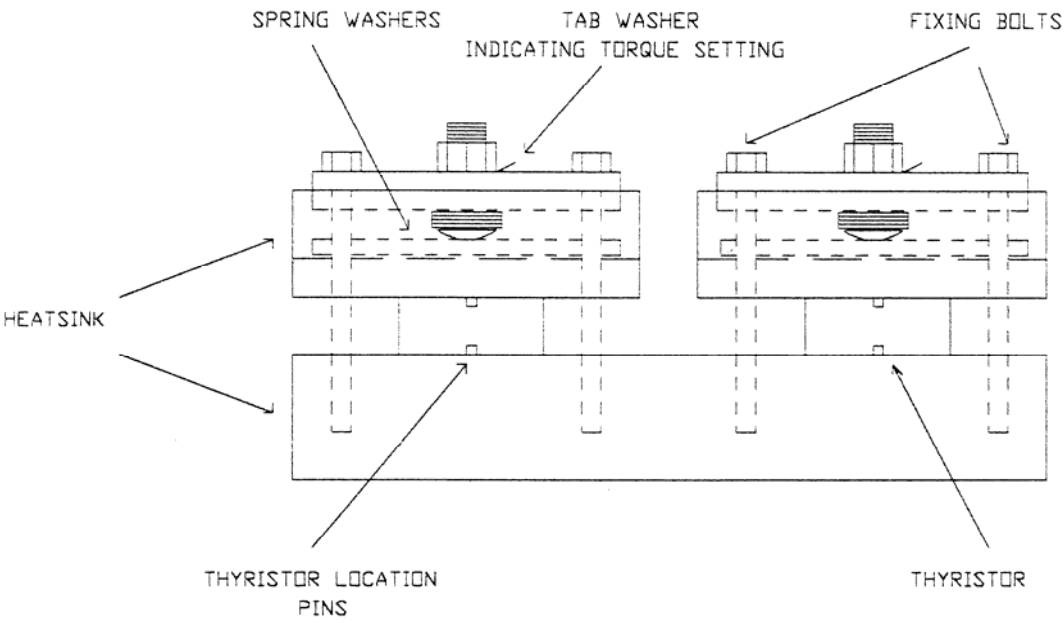
Thyristor to heatsink 6Nm

Screw terminals on Pak 1Nm

Power assembly re-assembly, "Hockey **puck"** devices.

Connect the gate and cathode leads to the new device. Smear the top and bottom of the new device with a small amount of heatsink compound that must be electrically conductive. Fit the device on the lower heatsink taking care the device is the correct way around and is Fitted correctly on the location pin. Fit the top heatsink and tighten evenly the two fixing bolts. Correct tension is achieved when the spring washers compress enough to just loosen the tab washer under the centre nut.

'Hockey Puck' Stack Assembly



Note - the thyristors should be re-connected as follows:

K1 - U

K2 – L1

K3 - V

K4 – L2

K5 - W

K6 – L3

Control PCB

The control PCB is the least likely item to develop a fault and should only be suspected if all other avenues of investigation concerning the fault have proven negative. Faulty PCBs should be returned to the manufacturer for repair or replacement as there are no user serviceable parts on the PCB.

Appendix 3

GENERAL SPECIFICATION

MODEL	CURRENT	kW @ 400V	kW @ 570V	kW @ 690V	kW @ 240V	WEIGHT kg	CT Specified	FANS
400-TPMEC-5.5	11	5.5	6	7.5	2.2	10	LA2100	N/A
400-TPMEC-7	16	7.5	9	11	4	10	LA2100	N/A
400-TPMEC-11	23	11	13	15	5.5	10	LA2100	N/A
400-TPMEC-15	30	15	18.5	22	7.5	10	LA2100	N/A
400-TPMEC-22	45	22	26	30	11	15	LA2100	N/A
400-TPMEC-30	60	30	37	45	15	15	LA2100	1 X 120mm
400-TPMEC-37	75	37	45	55	22	15	LA2100	1 X 120mm
400-TPMEC-55	105	55	63	75	30	15	LA2107	2 x 120mm
400-TPMEC-63	120	63	75	90	37	15	LA2108	2 x 120mm
400-TPMEC-75	145	75	90	110	45	15	LA2108	2 x 120mm
400-TPMEC-90	170	90	110	132	55	16	LA2108	2 x 120mm
400-TPMEC-110	205	110	132	150	63	16	LA2108	2 x 120mm
400-TPMEC-132	255	132	150	186	75	28	TX008	3 x 120mm
400-TPMEC-150	290	150	186	225	90	28	TX008	3 x 120mm
400-TPMEC-186	340	186	225	260	110	28	TX008	3 x 120mm
400-TPMEC-225	412	225	260	315	132	28	TX008	3 x 120mm
400-TPMEC-260	475	260	315	375	150	45	TX008	3 x 150mm
400-TPMEC-315	580	315	375	450	186	45	TX008	3 x 150mm
400-TPMEC-375	670	375	450	500	215	45	TX008	3 x 150mm
400-TPMEC-450	800	450	500	630	260	120	TX009	2 x 220mm
400-TPMEC-500	900	500	630	750	315	120	TX009	2 x 220mm
400-TPMEC-630	1100	630	750	900	375	120	TX009	2 x 220mm
400-TPMEC-800	1400	800	900	1200	450	120	TX009	2 x 220mm

The kW ratings are all based on calculations scheduled with a standard four pole motor operating at a nominal $T_{ambient}$ of $+20^{o}C$ at sea level. All units should be selected based on the current rating of the motor to which they are fitted.

Appendix 4

FAN SPECIFICATION

PAPST Nr.	GD RECTIFIER Nr	ENVIROSTART	Free Air Flow Rate	Physical Size
4600N/4650N	550010A/ 550010B	30kW - 225kW	160 m^3/hour	120 mm
7400N/7450N	550006A/550006B	260kW – 375kW	350 m^3/hour	150 mm
N/A	550002A /550002B	450kW – 800kW	900 m^3/hour	220 mm

Should you need to change any of the fans within your EnviroStart system please ensure that units compatible with the above are used. It is not possible to exchange fans for units of different physical size without damaging the EnviroStart unit.