S O M A R

Three Phase Intelligent Motor Controllers.

Powerboss®

Compact

Installation and Commissioning Guide

''Failure to read these instructions prior to installation and use may result in damage to the starter and or the driven equipment and may render the warranty invalid''

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INTRODUCTION

THE PROBLEMS WITH INDUCTION MOTORS

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

The main problems are the motor's inability to match motor torque to load torque both during starting and running and the high starting current. During starting the motor usually produces 150 - 200% torque (see Figure 1) accelerating the load to full speed in a fraction of a second, which can cause damage to the drive train. At the same time the motor can commonly draw 8 times nominal current (In) causing supply stability problems (see Figure 2).

When the motor is operating at light load for extended periods the motor's efficiency falls due to the over-fluxing of the windings for the particular torque required to drive the load. At a constant terminal voltage this flux, often referred to as magnetising current, is fixed and accounts for around 30-50% of the motors total losses.

Figure 1

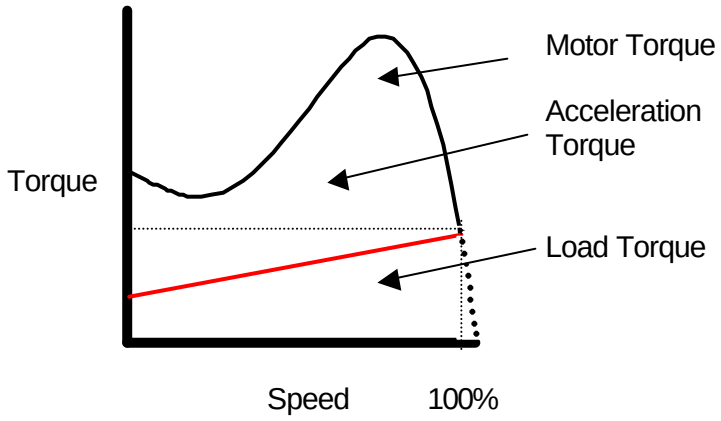
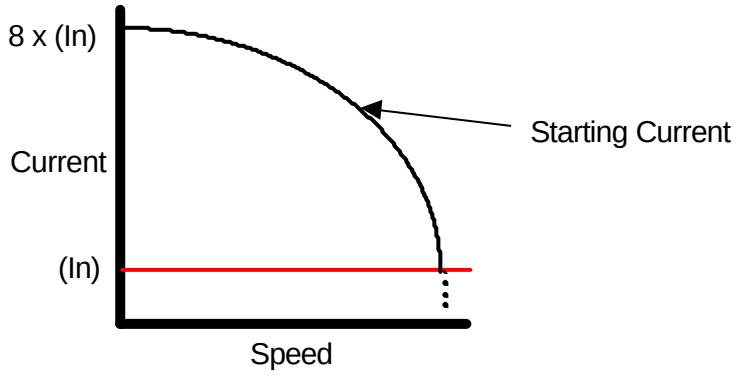


Figure 2



STARTING INDUCTION MOTORS - THE POWERBOSS SOLUTION

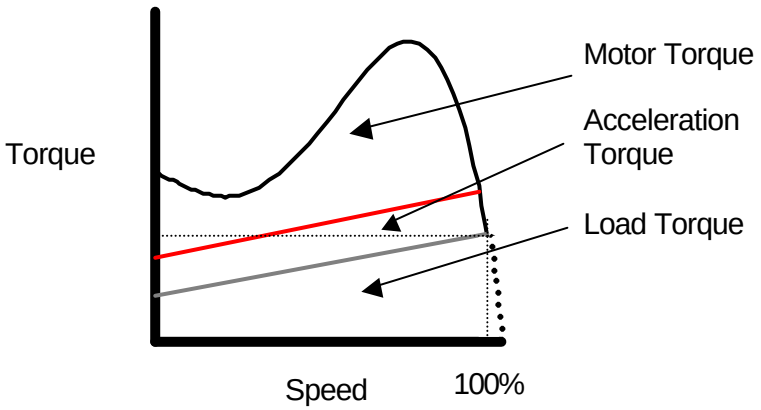
In common with all soft start devices Powerboss uses thyristor's to accurately control the voltage applied at the motor terminals.

A characteristic of the thyristor to switch rapidly from "OFF" to "ON" when pulsed, and to remain "ON" until the current through the device falls to zero at the end of each half-cycle in the AC supply, is called self commutation.

By controlling the switch-on point relative to the voltage zero crossing in each half cycle of the supply, it is possible to regulate the current flowing through the thyristor. The closer the turn-on point is to the end of the cycle the smaller the value of current that will be allowed to flow. Conversely, the closer the turn-on point is to the beginning of the cycle the higher the value of current will be. Using this principle and by connecting two thyristor's in anti-parallel to each of the phase connections to a motor Powerboss can continuously adjust the voltage to the motor terminals by precisely controlling the thyristor's turn-on points. This provides just sufficient voltage for the motor to accelerate the load. See Figure 3.

So, for instance, by starting with a large delay to the turn on point in each half cycle, and progressively reducing it over a selected time period, the voltage applied to the motor starts from a relatively low value and increases to full voltage. Due to the motor torque being proportional to the square of the applied voltage, the starting torque increases in a stepless manner ensuring a soft start for both the motor and the driven load.

Figure 3



MOTOR EFFICIENCY – THE POWERBOSS SOLUTION

When working at or near full load, the typical 3-phase induction motor is relatively efficient, achieving efficiencies of between 80% to 92%. However, as shown in Figure 4 below, motor efficiency falls dramatically when the load falls to less than 50% of rated output. In fact, very few motors actually experience consistent fully rated operation, the vast majority operate at much lower loads due to either over-sizing (a very frequent situation), or natural load variations.

In applications where motor speeds do not need to be varied, the optimisation software in the Powerboss will produce energy savings in lightly loaded motors.

Less sophisticated soft-starters remain at full conduction and the motor then behaves as if it were connected directly to the mains supply. However, at light loads at full mains voltages, induction motors always have excess magnetising current (see Figure 5). By detecting the load at any instant, and adjusting the motor terminal voltage accordingly, Powerboss is able to save some of the excitation energy and load loss, and improve motor Power Factor when the motor is running inefficiently at light loads.

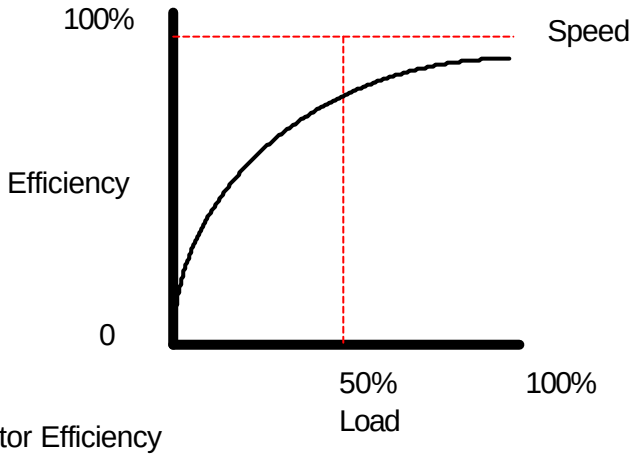


Figure 4.
Induction Motor Efficiency

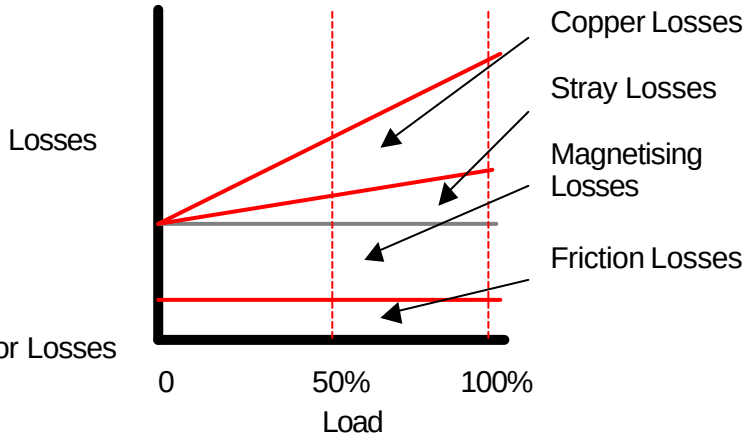


Figure 5.
Induction Motor Losses

POWERBOSS COMPACT PRODUCT SPECIFICATIONS

Parameter	Description
Supply Voltage	380 – 440V +10% / -15% (220V special order)
Supply Frequency	47/63 Hz
Ambient Temperature	-10 - +40 Deg C Reduce kW Rating 2% per Deg C up to 50 Deg C
Storage Temperature	-40 - +60 Deg C
Relative Humidity	<95% No condensation allowed
Altitude	Maximum 1000 m. Reduce kW Rating by 1% per additional 100 M
Starting Duty	2.5 X unit rating in amperes for 60 Sec 3 X unit rating in amperes for 30 Sec 4 X unit rating in amperes for 10 Sec 5.5 X unit rating in amperes for 5 Sec
Starts per Hour	12 evenly spaced starts per hour at the 'Starting Duty' ratings See page 9 & 10 example application ratings
Pedestal Voltage	30 – 70% of supply voltage
Starting Torque	9 – 49% of the DOL starting torque
Ramp Up Time	0.5 – 120 Sec
Ramp Down Time	0.5 – 120 Sec
Current Limit	30% DOL current for 60 Sec 40% DOL current for 30 Sec 50% DOL current for 10 Sec 70% DOL current for 5 Sec
Fault Detection	Shut down for loss of phase and short-circuit Thyristor
Cooling	Naturally cooled <42 amps, force cooled >53 amps
LED Indications	Power on, Run, Ramp up, Ramp down, Fault and Optimising/Top of ramp
Relays	Run, Fault/Top of ramp
Relay Contact Rating	1.2KVA, 250V AC Max
Control Voltage	Not needed – Powered from mains supply
Fan Voltage	110/220V as specified
Enclosure	IP20
EU Directives	EN50082-2, EN55011, 73/23/EEC

POWERBOSS COMPACT SELECTION GUIDE

Chassis Size HxWxD mm		Model	Weight kg	Rating Amps	Rating kW @ 220V	Rating kW @ 380/440v	Protection	Cooling
H 270 W 130 D 115	SIZE 1	PBC 2.2	3.5	4	1.1*	2.2	IP20	Natural
		PBC 4	3.5	9	2.2*	4	IP20	Natural
		PBC 5.5	3.5	11	3*	5.5	IP20	Natural
		PBC 7.5	4	15	4*	7.5	IP20	Natural
		PBC 11	4	23	5.5*	11	IP20	Natural
		PBC 15	4	30	7.5*	15	IP20	Natural
		PBC 22	4	42	11*	22	IP20	Natural
H 385 W 130 D 215	SIZE 2	PBC 30	9.9	53	15*	30	IP20	Forced
		PBC 37	9.9	65	22*	37	IP20	Forced
		PBC 55	9.9	97	30*	55	IP20	Forced

WARNING

*** UNITS MUST BE SPECIFICALLY ORDERED TO RUN AT 220V**

LOAD AND DUTY CYCLE TABLE

Application	Load Type	Inertia	Starts / Hour	Start Type
Centrifugal Pump	Low	Low	<20 >20	Standard Heavy
Positive Displacement Pump	Medium	Low	<12 >12	Standard Heavy
Submersible Pump	Medium	Low	<12 >12	Standard Heavy
Reciprocating Compressor	Medium	Medium	<10 >10	Standard Heavy
Screw Compressor	Medium	Medium/High	<6 >6	Standard Heavy
Axial Fan - No Load Start	Low	High	<4 >4	Standard Heavy
Axial Fan - Full Load Start	Medium	High	<4 >4	Heavy Very Heavy
Blower	Low	Low	<20 >20	Standard Heavy
Centrifuge	Low	Very High	<2	Very Heavy
Conveyor Off Load Start	Low	High	<10 >10	Standard Heavy
Conveyor On Load Start	High	High	<6 >6	Heavy Very Heavy
Steel Press	Low	High	<6 >6	Standard Heavy
Escalator	Low	High	<6 >6	Standard Heavy
Plastic Extruder Off Load Start	Low	Low	<20 >20	Standard Heavy
Grinders	Low	High	<6 >6	Standard Heavy
Circular Saw	Low	Low	<20 >20	Standard Heavy

POWERBOSS COMPACT STARTING DUTY TABLE

Model	Motor Current Rating Standard	Motor Current Rating Heavy	Motor Current Rating Very Heavy
PBC 2.2	4	3	2.5
PBC 4	9	6	4
PBC 5.5	11	8	6
PBC 7.5	15	10	7.5
PBC 11	23	15	10
PBC 15	30	19	15
PBC 22	42	28	20
PBC 30	53	38	28
PBC 37	65	47	35
PBC 55	97	68	50

SIZING POWERBOSS COMPACT FOR A PARTICULAR DUTY

Determine the load type from the Load and Duty Cycle Table paying particular attention to the starts per hour rating on page 9, and then select a unit according to the **Motor Current** from the above Table.

Example; Load Type - Reciprocating Compressor, 18 starts per hour
Start Type = Heavy
Motor Current = 15

Unit required is a PBC11.

If a particular application is not listed on page 9 refer to the Starting Duty and Starts per Hour listed in the **POWERBOSS COMPACT PRODUCT SPECIFICATIONS** on page 7.

INSTALLATION

IMPORTANT SAFETY NOTICE

SAFETY AT WORK

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

a) Only qualified persons install the unit;

b) No adjustments should be made with the unit live;

c) The installation complies with the information contained in this publication; and

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

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

MANUFACTURERS DECLARATION OF CONFORMITY

This is to certify that the products described in this manual conform to the requirements of the following standards in respect of the low voltage directive, 73/23/EEC.

EN 60947-4-2 **AC Semiconductor motor controllers and starters.**

This is to certify that the products described in this manual conform to the requirements of the following standards in respect of the European EMC directive, EN50082-2 CLASS A, EN55011 CLASS A.

SIGNED A. F. SMITH AUGUST 2000.

PRIOR TO INSTALLATION

1. Carefully remove the unit from the packaging and check that the parts supplied identify with the delivery note and the purchase order. Check that the parts supplied identify with the kW size of the motor.
2. Check the **Voltage** and **Current** ratings of the unit correspond with the motor name plate details.
3. Check the **Voltage** rating of the cooling fans if fitted.
4. Check that there are no loose parts or objects within the unit.
5. Check sufficient space exists to correctly install the unit.
6. Check you have sufficient tools to correctly install the unit.

MECHANICAL INSTALLATION

Unless the unit is fitted within a suitable enclosure the following should be avoided.

1. Exposure to rain, spray or wet areas.
2. Exposure to explosive and/or corrosive atmospheres.
3. Atmospheres containing a high proportion of conductive dust.
4. Extremes of temperature and/or humidity beyond published limits.

WALL MOUNTING

Fix the unit to a flat vertical surface using the mounting holes provided using adequately sized mounting bolts. Please see page 36 for details.

Care should be taken to ensure the orientation of the unit is correct and a gap of 80mm (100mm for PBC 30 and above) is maintained above and below the Powerboss. This is to ensure a safe exit path for the heat generated by the semiconductors within the unit.

MOUNTING POWERBOSS COMPACT WITHIN AN ENCLOSURE

If the unit has been purchased purely for the soft start features and optimisation is not required, the unit can be bypassed using a contactor driven by the Top of Ramp relay provided within the unit. This will negate the need to fit additional cooling fans to the enclosure. See connection drawing on page 21 for details.

COOLING POWERBOSS COMPACT WITHIN AN ENCLOSURE

If the optimisation feature is required the installer must ensure that the temperature within the enclosure is kept below the maximum permitted for Powerboss (see page 7).

Care should be taken to include any other heat producing equipment within the enclosure into the calculation.

The following formula should be used to calculate the minimum airflow through the enclosure.

$$AF = \frac{W}{T_{enc} - T_{amb}}$$

AF = Required airflow in cubic metres per hour

W = Heat produced within the enclosure

T_{enc} = Maximum enclosure ambient temperature

T_{amb} = Temperature of external air

Perform the minimum airflow calculation using the power dissipation information provided in the Powerboss Compact Heat Dissipation Table, the resultant figure should then be used to select a cooling fan from the Fan Selection Table on page 15.

POWERBOSS COMPACT HEAT DISSIPATION TABLE

Model	Power Dissipation in Watts
PBC 2.2	15
PBC 4	32
PBC 5.5	40
PBC 7.5	54
PBC 11	82
PBC 15	108
PBC 22	150
PBC 30	190
PBC 37	235
PBC 55	350

FAN SELECTION TABLE

PAPST Model No.		Air Flow With Filter 50Hz			Air Flow With Filter 60Hz		
Fan Model 110V	Fan Model 220V	L/sec	CFM	M3Hr	L/sec	CFM	M3Hr
8506N	8556N	13	24	57	15	28	67
4600N	4650N	40	82	159	47	96	186

ELECTRICAL INSTALLATION

LIGHTNING STRIKES / VERY HIGH VOLTAGE TRANSIENTS

In areas subject to frequent lightning strikes or other very high voltage transients, a suitably rated Metal Oxide Varistor (MOV) should connect each input line to earth. The Varistors **should not be mounted** within the Powerboss enclosure.

CONTROL VOLTAGE TRANSIENTS

Where the supply voltage to the Powerboss is thought to be subject to EMI a suitable line filter with transient voltage suppression should be fitted on the control supply.

COIL SUPPRESSION

It is good practice for any AC relay or contactor coil either connected to Powerboss or sharing a common control supply to be fitted with a RC suppresser. DC coils should be fitted with a suitable flywheel diode.

INPUT / OUTPUT CONTROL CONNECTIONS

To avoid ' pick up' it is good practice to keep all control connections as short as possible and to run them separately from the main motor cables. If this cannot be guaranteed an interposing relay fitted with suitable suppression must be used, mounted as close to the Powerboss as possible.

HARMONICS

In common with all Thyristor based switching devices Powerboss produces harmonics during Ramp Up, Ramp Down and in the Optimising mode. The only significant harmonics generated are the 5^{th} and the $7^{th.}$
The UK Electricity Council Engineering Recommendations G5/3 state that the harmonic content on a typical 100KVA supply, should not exceed 56 amps of the 5^{th} harmonic and 40 amps of the 7^{th} harmonic. Assuming a 400V supply this equates to a motor load of about 145 amps, 75kW.
Therefore the maximum allowable 5^{th} harmonic would be 37% and the 7^{th} harmonic around 28%.
Typical test values* of harmonic current on a motor operating in the optimising mode would be 8% of the 5^{th} and 1% of the 7^{th} harmonic. Clearly the recommendations are unlikely to be exceeded in normal operation.

* Based on tests carried out on a 22kW motor by the University of Sussex Industrial Electronics Group November 1988.

POWER FACTOR CORRECTION CAPACITORS

Power factor correction capacitors, if fitted, should be connected to the live side of K1 and switched in or out before starting Powerboss
Never connect Power Factor Correction Capacitors to the output terminals of the Powerboss.

THERMAL PROTECTION SWITCH

The thermal protection switch (if fitted) is the automatic reset type and should be wired into the control circuit in such a way as not to allow an automatic re-start in the event of a trip.

ADDITIONAL EQUIPMENT

All necessary electrical connections for mains, earth and control wiring are provided for in the Powerboss unit. However the following additional components will need to be provided.

1. Isolator.
2. Cable protection fuses.
3. AC3 rated contactor.
4. Motor overload.

WARNING

POWERBOSS COMPAT USES THYRISTOR SWITCHING DEVICES IN ITS MAIN CIRCUIT AND IS NOT DESIGNED FOR ISOLATION. A SUITABLY RATED MECHANICAL ISOLATION METHOD MUST BE EMPLOYED IN LINE WITH THE MAIN INPUT TERMINALS TO THE UNIT.

EARTHING

WARNING

THIS EQUIPMENT MUST BE EARTHED.

CONNECT THE EARTHING STUD WITHIN THE UNIT TO A SUITABLE LOW IMPEDANCE EARTH AS IS REQUIRED BY STATUTORY REGULATIONS COVERING THE INSTALLATION OF ELECTRICAL EQUIPMENT.

FUSE PROTECTION

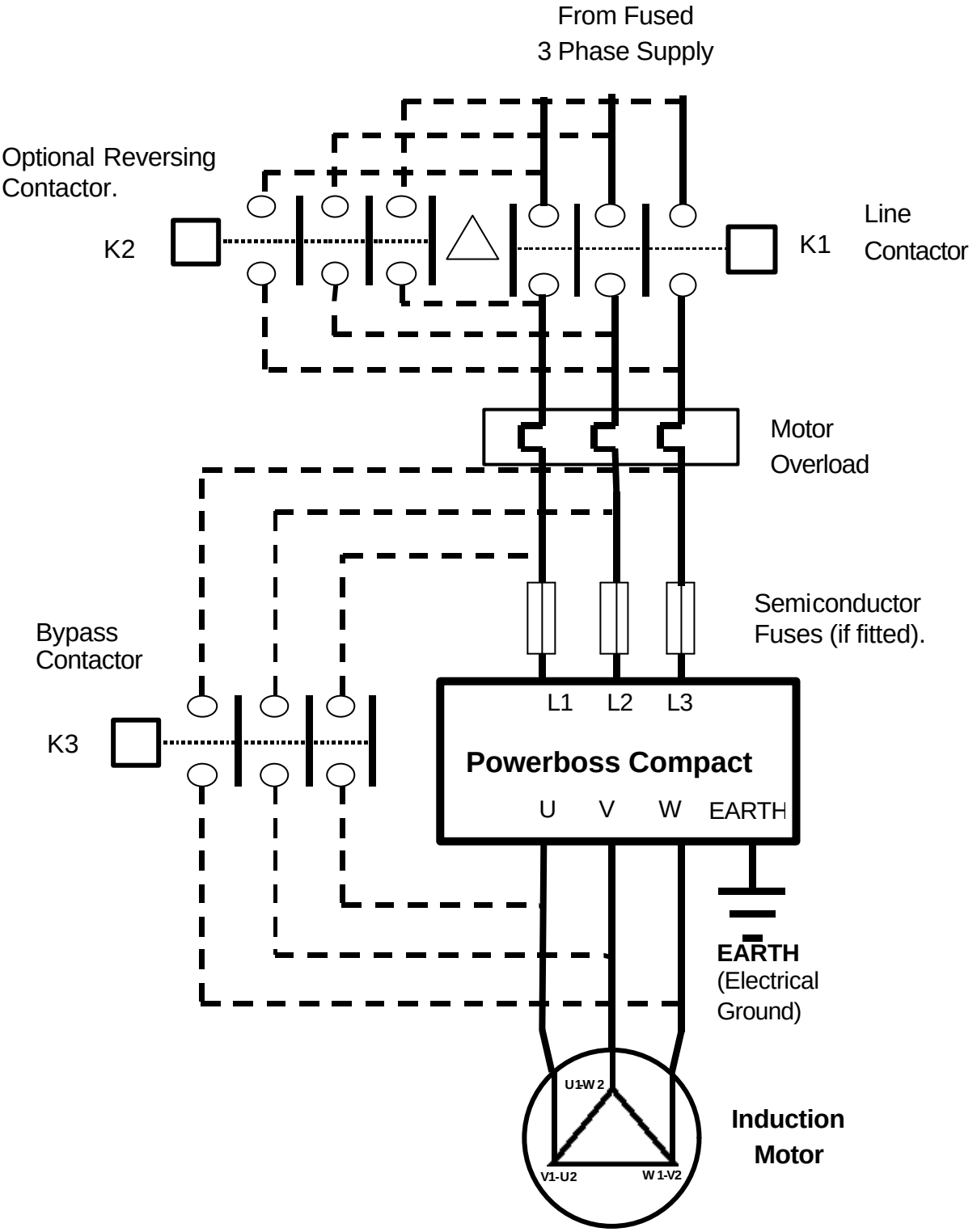
The mains supply and the control supply each require fuse protection. The installer should always fuse the mains supply with motor rated fuses before the input to the unit.

Semiconductor fuses are available as an optional extra and must be mounted external to the unit.

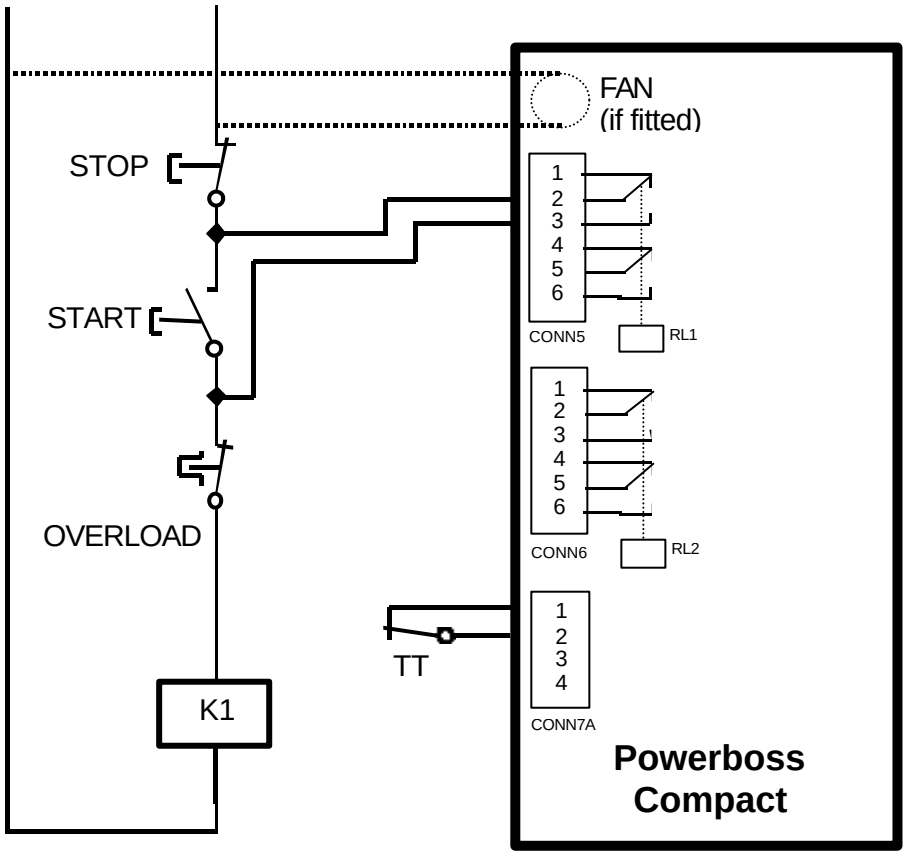
WARNING

SEMICONDUCTOR FUSES SHOULD NOT BE USED IN PLACE OF CABLE PROTECTION FUSES.

POWERBOSS COMPACT MAINS CONNECTION DRAWING



MINIMUM CONTROL CIRCUIT REQUIREMENTS

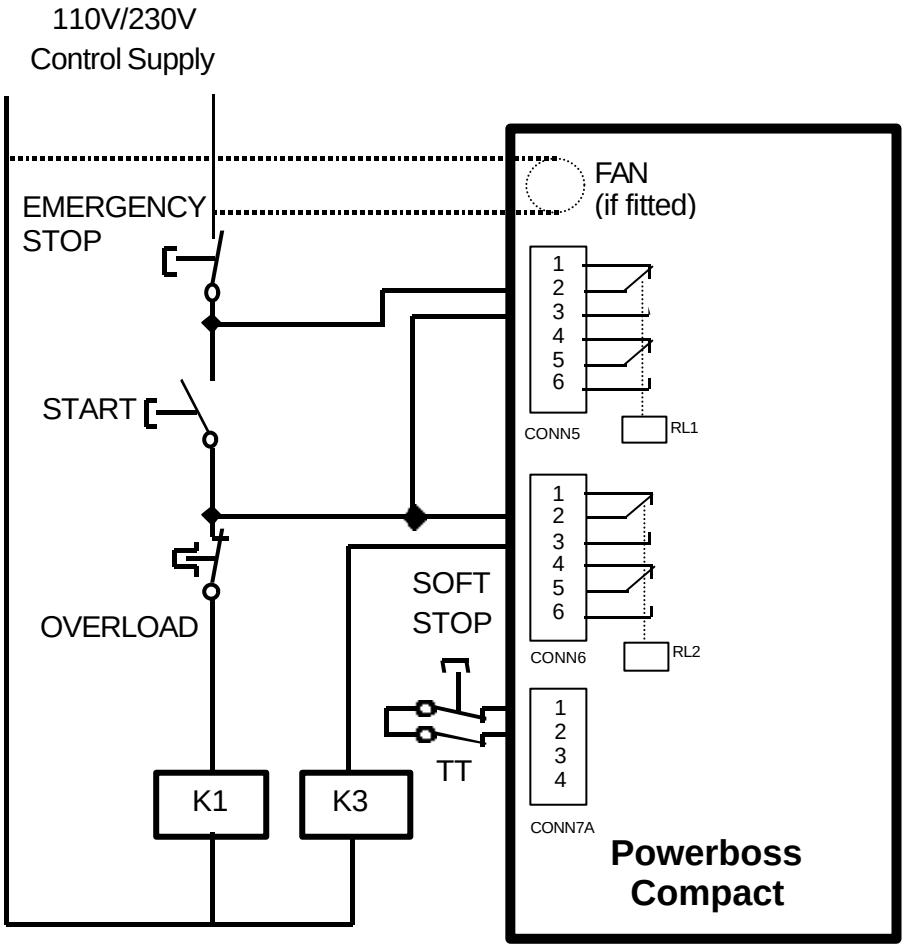


WARNING

THE THERMAL PROTECTION SWITCH, TT (IF FITTED) IS THE AUTOMATIC RESET TYPE, IT SHOULD BE WIRED TO PREVENT THE UNIT FROM AUTOMATICALLY RE-STARTING IN THE EVENT OF AN OVER TEMPERATURE TRIP.

TERMINALS 1 & 2 SHOULD BE LINKED IF TT NOT FITTED.

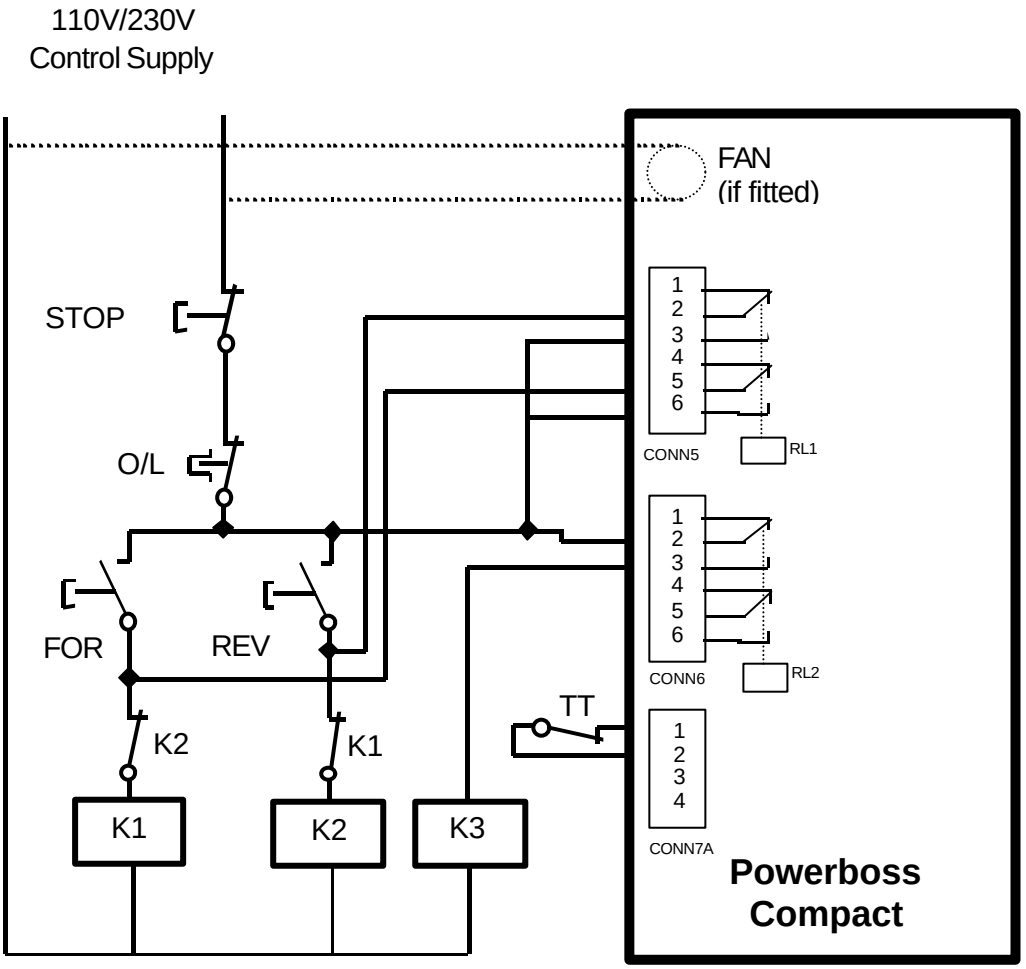
CONTROL CIRCUIT REQUIREMENTS FOR SOFT STOP AND BYPASS



WARNING

THE THERMAL PROTECTION SWITCH, TT (IF FITTED) IS THE AUTOMATIC RESET TYPE, IT SHOULD BE WIRED TO PREVENT THE UNIT FROM AUTOMATICALLY RE-STARTING IN THE EVENT OF AN OVER TEMPERATURE TRIP.

CONTROL CIRCUIT REQUIREMENTS FOR REVERSING AND BYPASS

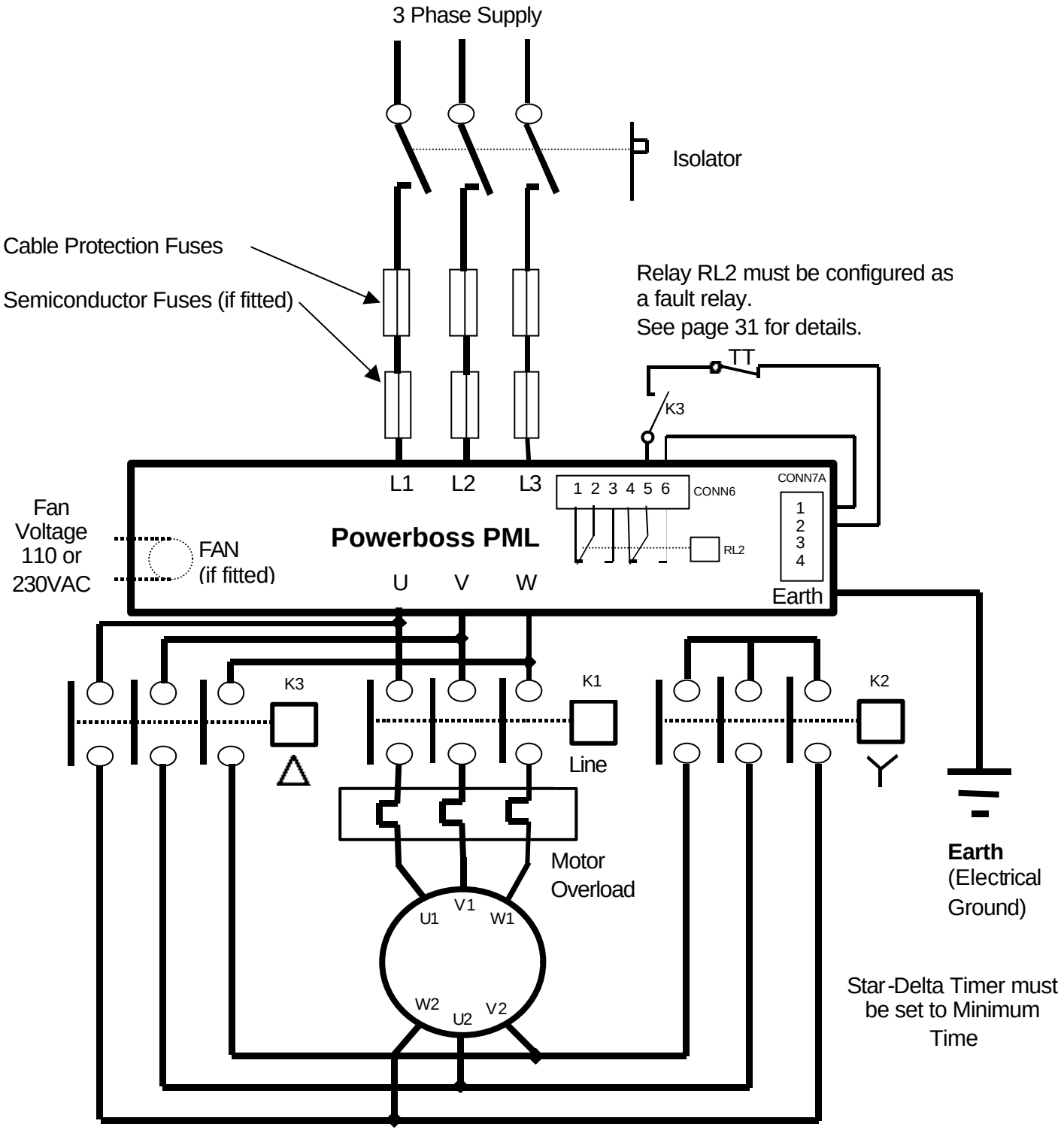


WARNING

THE THERMAL PROTECTION SWITCH, TT (IF FITTED) IS THE AUTOMATIC RESET TYPE, IT SHOULD BE WIRED TO PREVENT THE UNIT FROM AUTOMATICALLY RE-STARTING IN THE EVENT OF AN OVER TEMPERATURE TRIP.

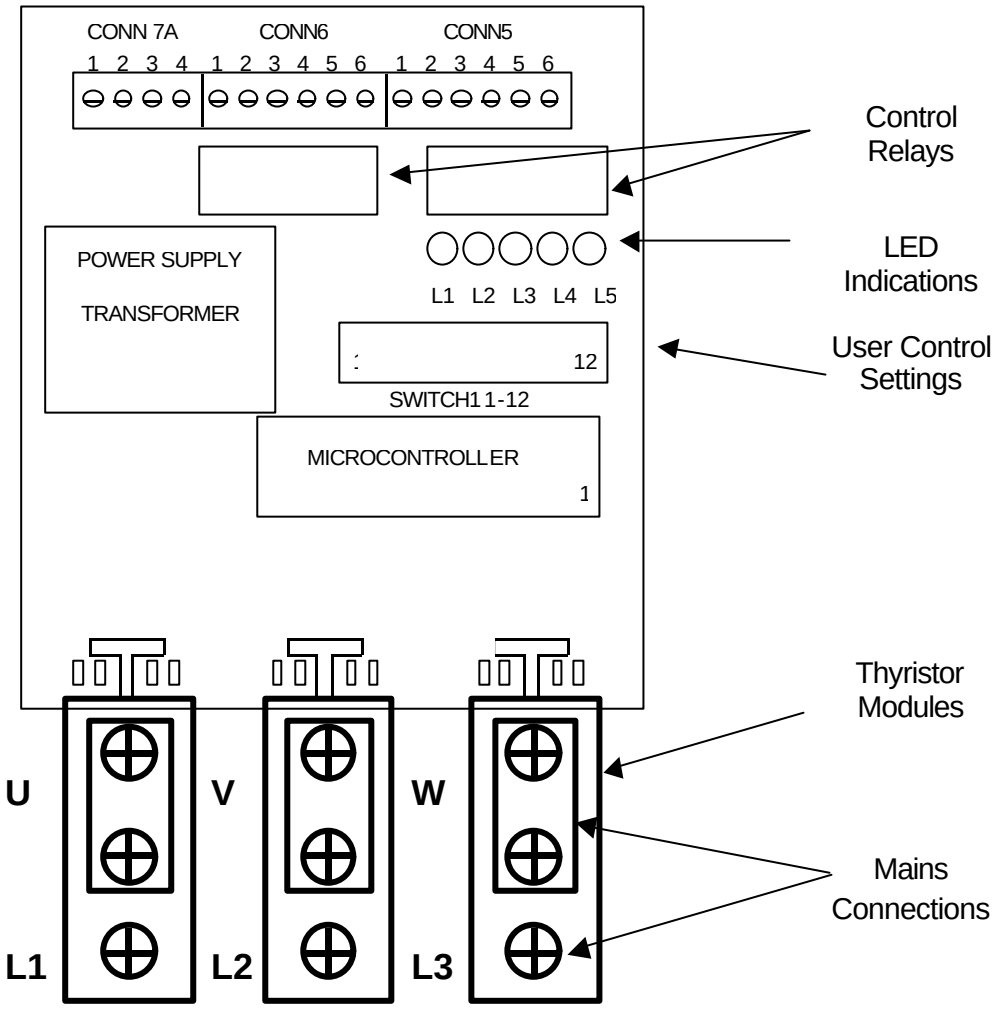
TERMINALS 1 & 2 SHOULD BE LINKED IF TT NOT FITTED.

MINIMUM CIRCUIT REQUIREMENTS FOR STAR /DELTA INSTALLATION



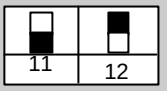
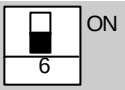
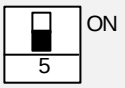
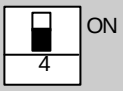
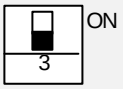
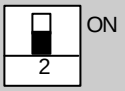
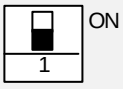
USER CONTROL SETTINGS

POWERBOSS COMPACT PCB USER ADJUSTMENTS MAP



DEFAULT SWITCH SETTINGS TABLE

All units are set to the 'default settings' before leaving the factory. These settings should be tried first and further adjustments made only where necessary to fine-tune the starter.

DEFAULT SETTINGS			
ADJUSTMENT	**FUNCTION**	**SWITCH POSITION**	**RESULTANT VALUE**
SWITCH 1-11 OFF SWITCH 1-12 ON	PEDESTAL VOLTS		40% VOLTAGE 16% TORQUE
SWITCH 1-8 ON SWITCH 1-9 ON SWITCH 1-10 OFF	RAMP TIME		RAMP UP 20 SEC.
SWITCH 1-7 OFF	STOP SELECT		COAST TO STOP
SWITCH 1-6 OFF	OPTIMISE ENABLE		OPTIMISE ENABLED
SWITCH 1-5 OFF	OPTIMISE MINIMUM VOLTAGE		67% VOLTAGE SELECTED
SWITCH 1-4 OFF	CURRENT LIMIT ENABLE		CURRENT LIMIT DISABLED
SWITCH 1-3 OFF	EMERGENCY RUN		EMERGENCY RUN DISABLED
SWITCH 1-2 OFF	RELAY RL2 SELECT		TOP OF RAMP RELAY SELECTED
SWITCH 1-1 OFF	50/60HZ		50HZ SELECTED

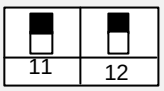
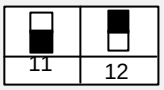
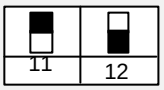
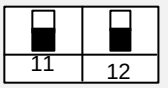
SEE APPLICATION GUIDE ON PAGE 30 FOR SET-UP INFORMATION.

DESCRIPTION OF USER CONTROL SETTINGS

PEDEST AL VOLTAGE

Sets the initial voltage that is applied to the motor. This should be adjusted to a level so that the motor starts to accelerate smoothly and immediately at switch on.

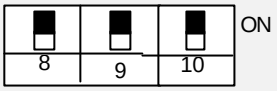
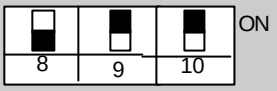
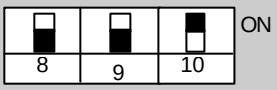
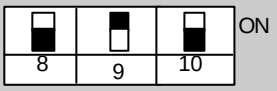
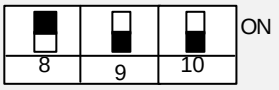
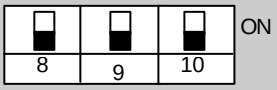
The switch settings are as follows.

ADJUSTMENT	FUNCTION	SWITCH POSITION	RESULTANT VALUE
SWITCH 1.11 ON SWITCH 1.12 ON	PEDESTAL VOLTS		30% LINE VOLTS 9% DOL TORQUE
SWITCH 1.11 OFF SWITCH 1.12 ON	PEDESTAL VOLTS		40% LINE VOLTS (DEFAULT) 16% DOL TORQUE
SWITCH 1.11 ON SWITCH 1.12 OFF	PEDESTAL VOLTS		50% LINE VOLTS 25% DOL TORQUE
SWITCH 1.11 OFF SWITCH 1.12 OFF	PEDESTAL VOLTS		70% LINE VOLTS 49% DOL TORQUE

SEE APPLICATION GUIDE ON PAGE 30 FOR SET-UP INFORMATION.

RAMP UP

The Ramp Up switches adjust the time from the initial Pedestal Voltage setting to full output voltage. Setting a specific Ramp Up time will not guarantee that the motor will accelerate to full speed at the set Ramp time because the motor torque may not be directly proportional to the load torque.

ADJUSTMENT	FUNCTION	SWITCH POSITION	RESULTANT VALUE
SWITCH 1-8 ON SWITCH 1-9 ON SWITCH 1-10 ON	RAMP UP TIME		0.5 SECONDS
SWITCH 1-8 OFF SWITCH 1-9 ON SWITCH 1-10 ON	RAMP UP TIME		2 SECONDS
SWITCH 1-8 ON SWITCH 1-9 OFF SWITCH 1-10 ON	RAMP UP TIME		5 SECONDS
SWITCH 1-8 OFF SWITCH 1-9 OFF SWITCH 1-10 ON	RAMP UP TIME		10 SECONDS
SWITCH 1-8 ON SWITCH 1-9 ON SWITCH 1-10 OFF	RAMP UP TIME		20 SECONDS (DEFAULT)
SWITCH 1-8 OFF SWITCH 1-9 ON SWITCH 1-10 OFF	RAMP UP TIME		30 SECONDS
SWITCH 1-8 ON SWITCH 1-9 OFF SWITCH 1-10 OFF	RAMP UP TIME		60 SECONDS
SWITCH 1-8 OFF SWITCH 1-9 OFF SWITCH 1-10 OFF	RAMP UP TIME		120 SECONDS

SEE APPLICATION GUIDE ON PAGE 30 FOR SET-UP INFORMATION.

RAMP DOWN

The Ramp Down time is the same as the selected Ramp Up time and cannot be altered separately. Ramp Down is a mirror image of the Ramp Up profile and will only provide a 'soft stop' against high static friction loads such as a centrifugal pump.

STOP SELECT

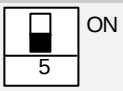
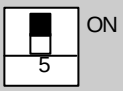
Switch 1-7 enables the Ramp Down function when ON. The motor will Coast To Stop (default) with the switch OFF. To use the Ramp Down feature the unit must be started and stopped using terminals 1 and 2 on CONN7A. See page 20.

OPTIMISE ENABLE

Switch 1-6 enables the Optimising function when OFF (default). Selecting the ON position will apply full voltage to the motor after the Ramp Up time has elapsed. If the unit is to be bypassed with a contactor after the Ramp Up time has elapsed this function must be disabled.

MINIMUM VOLTAGE BACKSTOP

On some motor load combinations instability may be experienced due to the motors speed torque curve. Setting the minimum backstop voltage to a higher level will help to minimise this problem.

ADJUSTMENT	FUNCTION	SWITCH POSITION	RESULTANT VALUE
SWITCH 1-5 OFF	VOLTAGE BACKSTOP %		67%
SWITCH 1-5 ON	VOLTAGE BACKSTOP %		83%

SHOCK LOAD DETECTION

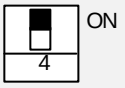
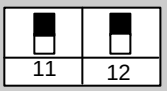
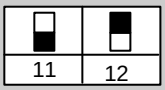
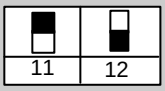
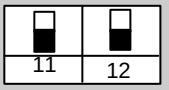
On software versions 2.2 and above the unit can be configured to operate on cyclic shock loads such as Injection Moulding Machines. Closing terminals 3 and 4 on terminal block CONN7A will enable this feature.

CURRENT LIMIT ENABLE

The Current Limit Enable switch 1-4, when set to the ON position will hold the selected Pedestal Voltage setting for a given time as listed below, after which the voltage will be increased by the selected Ramp Up time. This feature is useful for accelerating high inertia loads with a reduced starting current.

WARNING

PARTICULAR ATTENTION SHOULD BE PAID TO THE POWERBOSS COMPACT SELECTION TABLE BEFORE USING THIS FEATURE AS THE RESULTANT CURRENT MAY DAMAGE THE UNIT, SEE PAGES 9 AND 10 FOR DETAILS.

ADJUSTMENT	FUNCTION	SWITCH POSITION	TIME IN CURRENT LIMIT	RESULTANT VALUE
SWITCH 1-4 ON	CURRENT LIMIT ENABLE		N/A	CURRENT LIMIT ENABLED
SWITCH 1-11 ON SWITCH 1-12 ON	30% DOL CURRENT		60 SEC.	1.8 - 2.4 X FLC* 9% DOL TORQUE
SWITCH 1-11 OFF SWITCH 1-12 ON	40% DOL CURRENT		30 SEC.	2.4 - 3.2 X FLC* 16% DOL TORQUE
SWITCH 1-11 ON SWITCH 1-12 OFF	50% DOL CURRENT		10 SEC.	3 – 4 X FLC* 25% DOL TORQUE
SWITCH 1-11 OFF SWITCH 1-12 OFF	70% DOL CURRENT		5 SEC.	4.2 – 5.5 X FLC* 49% DOL TORQUE

***NOTE**

The starting currents shown are based on standard squirrel cage motors with a DOL current of between 6 and 8 times nominal current (In).

EMERGENCY RUN

If a fault occurs, setting Switch1-3 to the ON position will enable the motor to start under a 'short circuit Thyristor' condition. This is achieved by bypassing the fault routines within the software and applying full voltage to the motor, allowing the motor to continue to run. LED's L2 and L4 will alternately flash when Emergency Run is selected.

WARNING

BEFORE SELECTING THIS FEATURE ALL ASSOCIATED EQUIPMENT SHOULD BE CHECKED TO ASCERTAIN THAT IT IS IN A SAFE WORKING CONDITION.

PROGRAMMABLE RELAY RL2 SELECT

Switch1-2 will enable the user to select either of the following two options as follows.

ADJUSTMENT	FUNCTION	SWITCH POSITION	RL2 OPTION
SWITCH1-2 OFF	RL2 SELECT		TOP OF RAMP RELAY (DEFAULT)
SWITCH1-2 ON	RL2 SELECT		FAULT RELAY

The Top of Ramp Relay can be used as an output to signal 'at full volts' when the start is completed.

SUPPLY FREQUENCY SELECTION

ADJUSTMENT	FUNCTION	SWITCH POSITION	FREQUENCY
SWITCH1-1 OFF	50Hz SELECT		50Hz
SWITCH1-1 ON	60Hz SELECT		60Hz

APPLICATION SET-UP GUIDE

Application	Pedestal %V	Ramp Time Seconds	Current Limit	Current Limit Value
Centrifugal Pump	30%	20	No	N/A
Positive Displacement Pump	40%	10	No	N/A
Submersible Pump	40%	10	No	N/A
Reciprocating Compressor	50%	5	No	N/A
Screw Compressor	50%	5	No	N/A
Axial Fan - No Load Start	N/A	30	Yes	30%
Axial Fan - Full Load Start	N/A	30	Yes	50%
Blower	40%	10	No	N/A
Centrifuge	N/A	60	Yes	70%
Conveyor Off Load Start	30%	20	No	N/A
Conveyor On Load Start	50%	20	No	N/A
Steel Press	N/A	30	Yes	50%
Escalator	40%	10	No	N/A
Plastic Extruder Off Load Start	40%	10	No	N/A
Grinders	N/A	60	Yes	50%
Circular Saw	40%	20	No	N/A

The above set-up guide will provide a good starting point for commissioning Powerboss Compact on a particular load type.

START AND STOP INPUT

To start the unit, close terminals 1 and 2 on terminal block CONN7A, if no fault is present the unit will start at the programmed settings. **The mains supply and the motor must be present to allow the unit to start.**

To stop the unit open terminals 1 and 2 on CONN7A, if the default setting on switch1-7 is selected the unit will coast to stop. If the soft stop feature is chosen all the necessary circuitry is provided within the unit to control both the line and bypass contactors.

PROGRAMMABLE INPUT

An unused digital input is provided on terminals 3 and 4 on terminal block CONN7A. This can be factory configured to provide access to customer specified features.

RUN RELAY

The run relay, RL1, energises when the unit is running. It can be used as a 'circuit healthy relay' to give indication and to retain the line contactor so that the contactor de-energises should a fault occur. **During normal operation K1 will de-energise under zero current.**

PROGRAMMABLE RELAY

See the section on relay RL2 select on page 29.

LED INDICATIONS

PCB MARKING	FUNCTION	COLOUR	LED FUNCTION
L1	Run	Green	Illuminates when the unit is given the start command and no fault is detected.
L2	Fault	Red	Illuminates when a fault is detected.
L3	Power On	Green	Illuminates when mains power is applied.
L4	Start	Yellow	Illuminates when the unit is Ramping Up, extinguishes after the programmed ramp time.
L5	Optimise	Green	Illuminates when the unit is at full output voltage (Top of Ramp), then flashes when optimisation is occurring.

COMMISSIONING

PRE-COMMISSIONING CHECKS

1. Ensure that the terminal block CONN1 is configured correctly.
2. Ensure that Fans (if fitted) are connected to the correct voltage.
3. Ensure ALL switch settings are set to default or if your load type is listed in the set-up guide on page 30 start with the recommended values.
4. Check that the unit is connected correctly as per the preceding connection diagrams.
5. Ensure any Power Factor Correction Capacitors are connected on the input side of the line contactor and are only switched in or out when the unit is not running.
6. Do not exceed the recommended starts per hour while commissioning.

STARTING POWERBOSS COMPACT FOR THE FIRST TIME

1. Check that all the pre-commissioning checks have been followed.
2. **Give the start command**, the unit should accelerate the load smoothly to full speed, only if starting is not satisfactory should the following procedures be carried out.

i) Set switch1-8/9/10 to the maximum Ramp Up time.
ii) Set switch1-11/12 to the minimum Pedestal voltage.
iii) Start the unit.
The motor should begin to rotate immediately, if a delay occurs switch off and set switch1-11/12 to the next highest setting. Repeat until the initial start is satisfactory paying particular attention to the rated starts per hour.
iv) With the Pedestal Voltage set the Ramp Up time can now be adjusted on switch1-8/9/10.The Ramp Up time should be set to a value that accelerates the motor to full speed as quickly as is practical to achieve a smooth start.
v) The other switches can then be employed to configure the unit for the required duty.

STARTING HIGH INERTIA LOADS

WARNING.

BEFORE ATTEMPTING TO START A HIGH INERTIA LOAD IT IS ESSENTIAL TO CHECK THAT POWERBOSS COMPACT IS RATED FOR THE REQUIRED DUTY, SEE PAGES 8, 9 AND 10 OF THIS MANUAL.

i) Set the Current Limit Enable switch1-4 to the ON position.
ii) Set switch1-8/9/10 to the minimum Ramp Up time.
iii) Set switch1-11/12 to the minimum Pedestal voltage, the lower the voltage the longer the acceleration that can be permitted by the unit.
iv) Start the unit.
The motor should begin to rotate immediately, if a delay occurs switch off and set switch1-11/12 to the next highest setting. Repeat until the load has satisfactorily accelerated to full speed, paying particular attention to the rated starts per hour.

SERVICE AND MAINTENANCE

WARNING

THIS EQUIPMENT MUST BE SERVICED BY QUALIFIED PERSONNEL ONLY. BEFORE ANY WORK ON THE UNIT IS UNDERTAKEN ALL ELECTRICAL SUPPLIES MUST BE ISOLATED AND A 5 MINUTE PERIOD OBSERVED TO ALLOW CAPACITOR FILTERS TO DISCHARGE BEFORE WORKING ON THE UNIT.

GENERAL

Powerboss Optimisers and soft starters have shown themselves to be very robust and reliable provided they are used within their design capability. The unit requires very little maintenance, however the checks listed below should be performed at half yearly intervals.

i) Check that the environment has not changed and that no restriction has occurred to the fan or cooling apertures.
ii) Check all connections for tightness.
iii) Check all connections for signs of oxidation. A small amount of non-conducting grease can be smeared on the power connections to prevent oxidation.
iv) Check mains and control wiring for signs of deterioration.
v) Visually inspect the control PCB for signs of deterioration, the PCB can be cleaned with a dry airline if required.
vi) Replace fan filters if required.

FAULT FINDING

Before moving to the fault finding procedure the following checks should be performed.

i) Check that supply and motor cables are connected correctly to the terminals of the unit. Powerboss Compact will not work within the delta loop.
ii) Check external control circuitry.
iii) All fuses including the semiconductor type (if fitted) should be checked for continuity with a DVM.
iv) If an electronic overload is fitted check with the manufacturer that it is suitable for use with a chopped waveform, some electronic overloads interpret a chopped waveform as a single-phase condition.

WARNING
NEVER USE A HIGH VOLTAGE INSULATION TESTER SUCH AS A MEGGER AS THIS MAY CAUSE IRREPAIRABLE DAMAGE TO THE UNIT.

FAULT FINDING PROCEDURE TABLE

FAULT	POSSIBLE CAUSE	
Power On LED not illuminated	i)	Mains supply not present, check fuses
	ii)	Faulty control PCB
Powerboss Compact will not start, fault LED illuminated	i)	Mains supply not present, check fuses
	ii)	Motor phase not connected
	iii)	Short circuit thyristor(s)
	iv)	Faulty control PCB
Powerboss Compact will not start, fault LED not illuminated	i)	Start circuit on CONN7A not closed
	ii)	Faulty control PCB
Powerboss Compact trips during start, fault LED illuminated	i)	Faulty fuse
	ii)	Short circuit thyristor(s)
Powerboss Compact trips during running, fault LED not illuminated	i)	Over-temperature trip (TT)
	ii)	Motor overload trip
	iii)	Motor thermistor trip (if fitted)
	iv)	Faulty control PCB
Powerboss Compact trips during running, fault LED illuminated	i)	Faulty fuse
	ii)	Short circuit thyristor(s)

NOTE.

THE CONTROL PCB IS THE LEAST LIKELY ITEM TO DEVELOP A FAULT AND SHOULD ONLY BE SUSPECTED IF ALL OTHER AVENUES OF INVESTIGATION HAVE BEEN EXHAUSTED.

FAULTY PCB's SHOULD BE RETURNED TO THE MANUFACTURER FOR REPAIR OR REPLACEMENT. PCB'S ARE SOLDERED TO THE THYRISTOR ASSEMBLY AND MUST BE RETURNED COMPLETE.

TESTING AND REPLACING THYRISTORS

THYRISTOR SHORT CIRCUIT TEST

Before performing this test remove all power connections to the unit. Using a good quality DVM measure the resistance between the input and output of each thyristor. A healthy device will give a reading in excess of 100k ohm. Short circuit thyristors should be replaced.

THYRISTOR GATE TEST

Using a good quality DVM measure between the following terminals on the control PCB.

Red phase	K1-G1 and K2-G2.
Yellow phase	K1-G1 and K2-G2.
Blue phase	K1-G1 and K2-G2.

Each thyristor should give a reading between 6 and 50 ohms; any readings above or below this figure indicate a damaged thyristor.

THYRISTOR REMOVAL AND REPLACEMENT – SEMIPACK TYPES

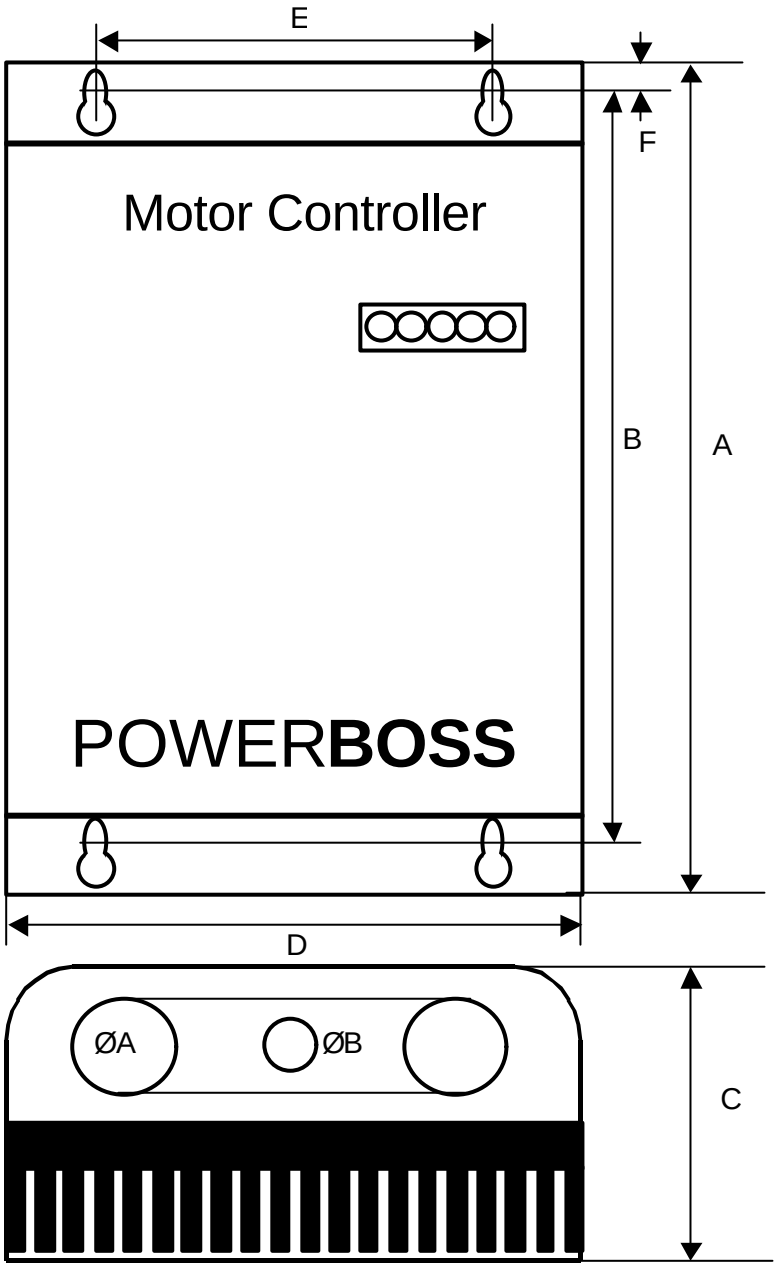
Throughout the Powerboss Compact range all thyristor switching devices are the isolated Semipack type and configured as an anti-parallel pair. To remove the thyristor first de-solder the gate/cathode connections from the PCB taking care not to damage the PCB, they are keyed and can only be re-connected correctly, then remove the heatsink retaining screws.

Remove the shorting copper link from the thyristor terminals and fit to the new thyristor. Smear a light film of heatsink compound on the bottom of the thyristor and fix to the heatsink, tightening the retaining screws evenly to a torque of 6 Nm.

Lastly re-solder the gate/cathode connections and clean the PCB with a solder flux residue removing agent.

Ensure the PCB is dry before applying Power to the unit.

DIMENSIONS PBC2.2 – PBC55



DIMENSIONS									
TYPE	A	B	C	D	E	F	ØA	ØB	Kg
PBC 2.2 - 22	270	250	115	130	80	10	25	12.5	4
PBC 30 - 55	385	365	215	130	80	10	30	12.5	10.2
ALL MOUNTING HOLES 4MM CLEARANCE									