OZtherm™

Digital Power Controller

F-330

3 PHASE S.C.R. CONTROLLER

INSTALLATION AND COMMISSIONING MANUAL

DESIGNED
and
MANUFACTURED
by

Fastron
Electronics

Fastron Electronics

- Power Semiconductors
- Electrical Measurement
- Process Control

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RE: UNIT WITH OPTION A AND PW

NOTE: **THIS UNIT IS CONFIGURED TO BE USED ON 3 WIRE LOAD (STANDARD DELTA)**

HOWEVER, IT CAN BE USED ON 6 WIRE LOAD APPLICATION (REFER PG 7), BY TRANSFERRING FEEDBACK CABLE (BROWN) FROM QC4 (VFB,DC+) TO QC10, ON PCBF311A0.

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RE: FAN COOLED UNIT

NOTE: **CONNECT NEUTRAL TO TERMINAL PROVIDED (MARK "N") IN ORDER TO OPERATE FAN.**

HOWEVER, IF NEUTRAL TERMINAL IS NOT PROVIDED, THEN NEUTRAL CONNECTION IS UNNECESSARY.

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F330 INSTALLATION AND COMMISSIONING MANUAL
REVISION 1.1 JUNE 1994

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1.0 OZTHERM POWER PRODUCTS

Thyristor based power controllers offer numerous benefits.
They are a reliable replacement for electromechanical contactors , being virtually maintenance free.
Thyristor based power controllers are ideal for controlling complex loads , such as heating elements that change resistance over time or temperature , transformer coupled loads , plating rectifiers and fast systems.

1.1 PRINCIPAL OF OPERATION

Oztherm power controllers consist of two main parts , the control electronics and the power switching electronics.
Thyristors , also known as SCRs , are used as the power switching devices.
A thyristor functions like a diode that can be "turned on" by a momentary pulse to its gate.When a thyristor has been turned on via its gate and its anode is positive relative to its cathode it will conduct.
The thyristor turns itself off when there is near zero current through it.
To control full wave AC over the positive and negative half cycle two thyristors arranged in inverse parallel are required.
The control electronics provide the firing impulses for the thyristor gates.The control input signal is measured and the timing of the gate firing impulses are varied in response to it.

Two types of firing mode are available on Oztherm power controllers.
Phase angle control works by varying the conduction angle of the AC sine wave.
Burst control modulates power by turning the thyristors on and off for whole AC cycles.The control electronics turn the thyristors on at zero voltage and off at zero current. The output is the ratio of OFF time to ON time.
F300 series power controllers use the phase angle firing mode.
F400 series controllers use the burst firing mode.

1.2 SELECTING A POWER CONTROLLER

The following points are important in specifying a power controller for an application.

SELECTING THE CORRECT CONTROLLER FOR HEATING ELEMENT TYPES

Heating elements can be broadly divided into three categories:-

CLASS A
These elements have negligible resistance variation with either temperature or time. Examples include: Nickel/Chromium or similar alloys.

CLASS B

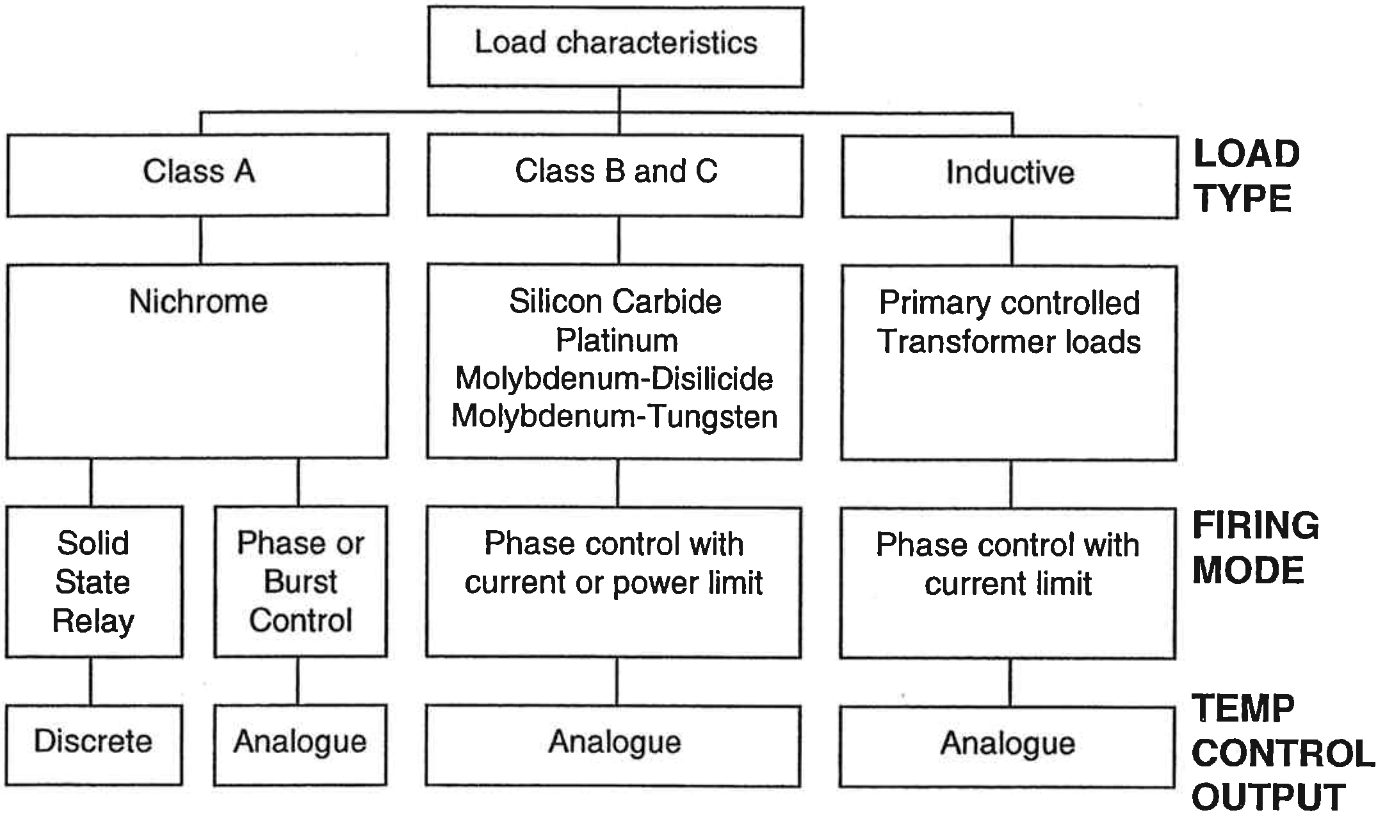
These elements have a low cold temperature resistance that increases greatly at operating temperature. Examples include:
Molybdenum Disilicide
Platinum
Molybdenum Tungsten

Class B elements usually require current limit on start up, as their low cold resistance results in high currents at the operating supply voltage.These elements may also require a stepdown transformer to match the supply voltage to the rated element voltage.
Because current limit is required,and the element voltage ratings are less than line voltage,phase angle control is the recommended firing mode.

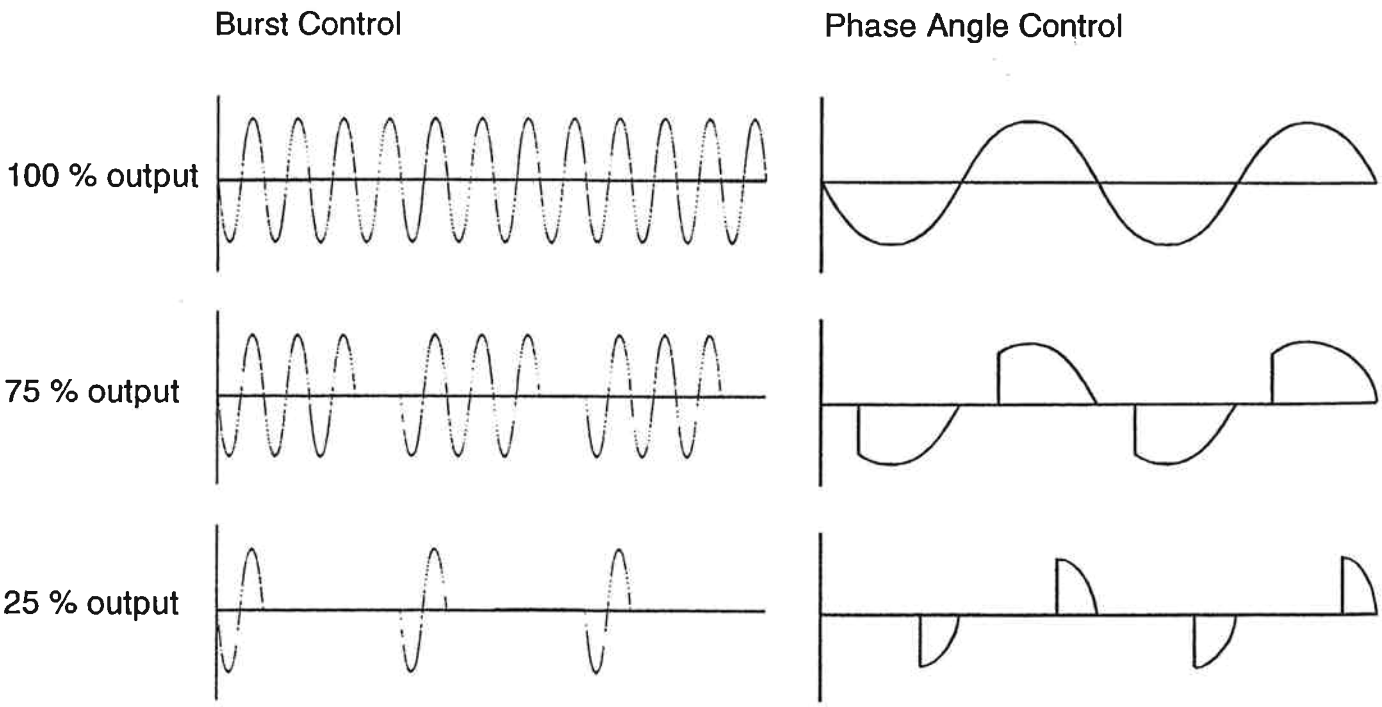
CLASS C

The resistance of these elements increases greatly with time in use (typically 2 to 4 times) and with temperature.Silicon carbide is a common example .The power controller must be sized so that it can deliver the higher currents required to maintain the desired power when the elements are new.
The power limit (PW) option is recommended for this class of element as it compensates for element ageing and limits the maximum load power (see appendix 3).

CONTROLLER SELECTION AND ELEMENT TYPE



VOLTAGE WAVEFORMS FOR BURST AND PHASE ANGLE CONTROL



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2.0 DESCRIPTION OF OPTIONAL FUNCTIONS

2.1 CURRENT LIMIT (C)

Current limit is often used with class B heating elements.On cold start up , low element resistance causes excessive current.The current limit option restricts maximum current until the elements reach operating temperature.
F311 and F330 controllers also have a current trip function which disables the controller if the trip current is exceeded.
Current transformers are supplied loose with this option.

2.2 CURRENT LIMIT (CE)

Same as option C but for DC loads i.e. where the controller is used as a rectifier.
A hall effect current sensor is required with this option. The hall effect sensor is not included in the price of the option but may be ordered separately from Fastron Australia.

2.3 CONSTANT CURRENT (CC)

This option gives a constant current output proportional to the control input signal.It is primarily used in plating rectifier applications.
Current is measured via current transformers on the AC side.Current transformers are supplied loose.
A current trip function is also supplied.

2.4 CONSTANT CURRENT (CCE)

This is similar to option CC but uses a hall effect sensor on the DC side for more accurate control.
A current trip function is also supplied.A hall effect current sensor is required with this option. The hall effect sensor is not included in the price of the option but may be ordered separately from Fastron Australia.

2.5 SEMICONDUCTOR PROTECTION FUSING (F)

Standard cartridge fuses and circuit breakers are too slow to protect thyristors.
Semiconductor protection fuses are required for thyristor protection.These fuses are for thyristor protection only and do not protect associated wiring except in the case of a short circuit.Wiring protection should also be installed in accordance with local regulations.
Fuses are supplied loose with mounting hardware.
Note: semiconductor fuses will run warm as they are designed for free air installation. They should not be installed in a cartridge type fuse holder.

2.6 POWER LIMIT (PW)

Fluctuations in supply voltage or load impedance will result in variations in the power developed through the heating elements.
This option measures load voltage and current and limits output power .
When used with class C elements power limit increases the output voltage to compensate for element ageing , eliminating the need for transformer tap changes or other manual adjustments.
The power feedback option must be used in combination with options C or CE and options A , D or DE.

2.7 AVERAGE CURRENT METER OUTPUT (MI) *

Provides a non isolated 0-1 mA meter output corresponding to the average of RMS output currents in the three phases.
Option C , CC , CE or CCE required.

2.8 AVERAGE VOLTAGE METER OUTPUT (MV) *

Provides a non isolated 0-1 mA meter output corresponding to average of output voltages in the three phases.
Option A , D or DE required.

2.9 AVERAGE POWER METER OUTPUT (MP) *

Provides a non isolated 0-1 mA meter output corresponding to average of output power in the three phases.
Option PW required.

2.10 CONTROL SIGNAL METER OUTPUT (MD) *

Provides a non isolated 0-1 mA meter output corresponding to control input signal.
* Options MI , MV , MP and MD are mutually exclusive.Only one of these options may be specified.

2.11 THERMAL CUTOUT (T)

If the safe operating temperature of the controller is exceeded the thermal cutout disables the unit until the temperature drops. Thermal cutout is often used to disable a fan cooled unit if the fan is blocked or stopped for any reason. This cutout will prevent thermal damage to the unit. This option is automatically specified with a fan cooled unit.

2.12 AC VOLTAGE REGULATION (A)

Maintains output voltage constant relative to the control input signal irrespective of supply fluctuation.

2.13 DC VOLTAGE REGULATION (D)

Maintains DC output voltage constant relative to control input signal irrespective of supply fluctuation.Useable range is 20 to 100% of rated output voltage.
Applications include battery chargers , rectifiers etc.

2.14 DC VOLTAGE REGULATION (DE)

Similar to option D but utilises a hall effect voltage sensor to increase useable range to 0 to 100% of rated output voltage. A hall effect current sensor is required with this option. The hall effect sensor is not included in the price of the option but may be ordered separately from Fastron Australia.

2.15 PHASE LOSS (PH)

Provides a volt free relay contact output to indicate supply phase loss.This contact is latched and will indicate a momentary loss of phase.

2.16 FOUR WIRE LOAD (FW)

Must be specified if three phase plus neutral load is to be used.

2.17 DEMAND SHARING (DS)

An auxiliary current limit normally used with generator supplied power to prevent overload. Applications include remote area power systems and maximum demand tariff installations.

Demand Sharing acts in a similar manner to Current Limit (option C). When the current of the total supply exceeds a preset level (eg maximum generator output) the power controller will reduce its output to keep the supply current below the maximum level so as not to overload a generator, or so as to keep the supply current below maximum demand level for installations on maximum demand electricity tariff.

Current transformer should be rated for full generator output current or for full supply current as appropriate.Current transformer is not supplied.

2.18 SLOW CYCLE (S)

Slow cycle time proportioning burst control with phase angle ramp up & down.
Proportional cycle time is adjustable to 30 seconds.
This option is usually used in areas where the power supply is “soft” or on loads with high inrush currents.

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3.0 INSTALLATION & WIRING

3.1 LOCATION

Power controller mounting location is important.
The controller must be oriented so that the cooling fins are aligned vertically.On fan cooled models the fans should be blowing upward towards the top of the enclosure.Fan inlets should be free from any obstruction.
The enclosure must be adequately ventilated.Maximum ambient temperature at full rated current for F330 controllers is 50 degrees C unless otherwise specified.Some enclosures may require fan forced cooling.
As a rule of thumb about 1 watt of heat is dissipated per amp conducted through the controller.
The controller must not be installed in excessively humid or corrosive atmospheres.
Where excessive vibration is present the controller should be mounted using shock isolation techniques.

3.2 WIRING

All wiring to the controller should comply with AS3000 (or the relevant national standard). Power cable connections must be tight to minimise heating , electrical compound should be used to improve thermal and electrical conductivity.
Refer to diagram for correct power wiring.Note that the phase referencing must be exactly as drawn.If phase referencing is incorrect the POWER OK led will be unlit and the controller will not work.
Control input signal wiring must be run separately from power wiring.Screened cable is recommended for this purpose. If screened cable is not available then a twisted pair should be used.

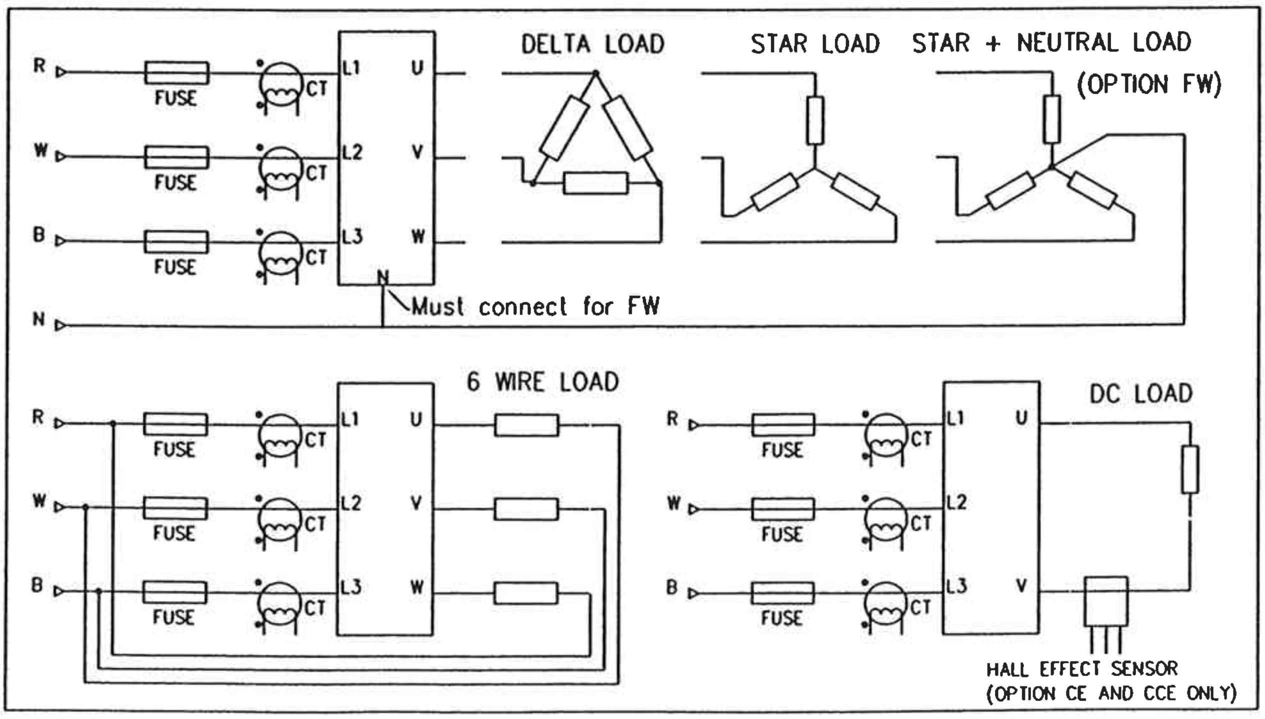
3.3 TRANSFORMER COUPLED LOADS

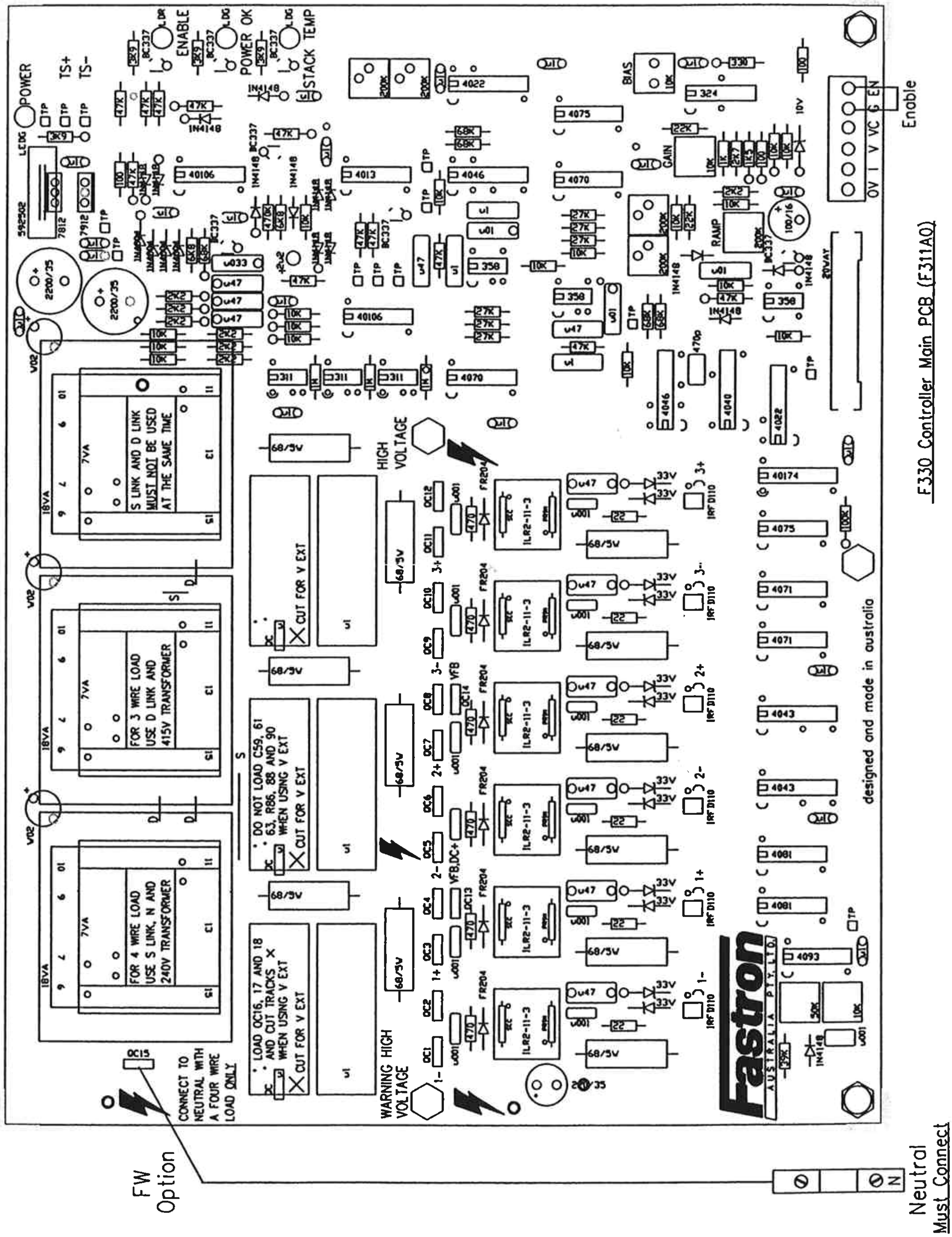
The F330 power controller can be safely used with primary control of transformer coupled loads with the following recommendations.

The normal transformer configuration is delta-star wound. Delta-star and delta-delta transformers can safely be used with the F330 power controller (although delta-delta transformers can have circulating currents which lead to excessive core and winding heating, so these types of transformers are generally not used). Star-delta and star-star transformers can be used but the star point on the primary must be connected to neutral and option FW specified on the F330 power controller.

The F330 controller can be run on the secondary of any transformer as long as the voltage on the F330 power controller is the same as the secondary voltage of the transformer.

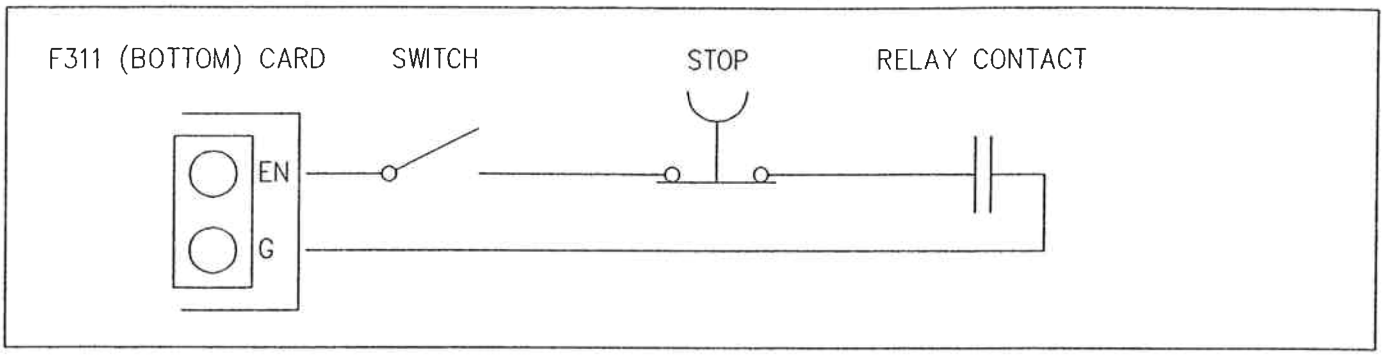
Current or power limit options should always be specified due to the high potential fault currents that are possible with primary control of transformer coupled loads as a safety measure.




F330 Controller Main PCB (F311A0)
designed and made in australia
Fastron
AUSTRALIA PTY. LTD.
POWER
ENABLE
POWER OK
STACK TEMP
TS+
TS-
BIAS
GAIN
RAMP
Enable
0V I V VC 6 EN
HIGH VOLTAGE
WARNING HIGH VOLTAGE
S LINK AND D LINK MUST NOT BE USED AT THE SAME TIME
FOR 3 WIRE LOAD USE D LINK AND 415V TRANSFORMER
FOR 4 WIRE LOAD USE S LINK, N AND 240V TRANSFORMER
* DO NOT LOAD C59, 61
* 63, R86, 88 AND 90
WHEN USING V EXT
X CUT FOR V EXT
* LOAD OC16, 17 AND 18
* AND CUT TRACKS X
WHEN USING V EXT
X CUT FOR V EXT
CONNECT TO NEUTRAL WITH A FOUR WIRE LOAD ONLY
OC15
FW Option
Neutral Must Connect

3.4 ENABLE LINK

The ENABLE link must be closed for the controller to operate. The ENABLE link can be conveniently used as an interlock by wiring limit switches , push buttons etc. in series with it.
Note: any interlocks wired to the ENABLE link must be volt free.



3.5 CURRENT TRIP OUTPUT

A volt free change over contact is provided for current trip output.Current rating is 1A @ 240 VAC

3.6 PHASE LOSS OUTPUT

(Applicable to option PH only)

A volt free change over contact is provided for phase loss output.Current rating is 1A @ 240 VAC

3.7 CURRENT TRANSFORMERS

(Applicable to options C , CC , PW only)

CTs must be installed exactly as shown in the diagram.
The polarity of all three CTs must be consistent.
When using the controller with a 6 wire delta load the CTs must be installed on the phase , not the line unless larger CTs have been specified.

3.8 HALL EFFECT SENSORS

(Applicable to options CE , CCE & DE only)

Install the hall effect sensor on the DC bus , observing the correct polarity , as shown in diagram. A +/-15V DC (160mA maximum) supply is provided for powering the sensor.

3.9 METER OUTPUT

(Applicable to options MI , MV , MP & MD only)

Note that these outputs are not isolated and must not be commoned up with the control input or any other signals.

3.10 FUSES

(Applicable to F option only)

Fuses must be installed exactly as shown in diagram.
Fuse ratings are calculated for free air and must be installed on the standoffs provided.Do not use fuse holders.
Semiconductor protection fuses are designed to protect the SCRs in the power controller from surge or ambient currents.They are underrated to prevent nuisance fuse blowing and therefore cannot be relied on for steady state overload protection. Separate fusing or circuit breakers must be installed to protect wiring.

4.0 ADJUSTMENTS AND CALIBRATION

WARNING-Controller adjustment requires access to control cards with lethal AC voltages present.High voltage sections of the control card are marked. Adjustments must only be made by qualified persons taking the appropriate precautions.

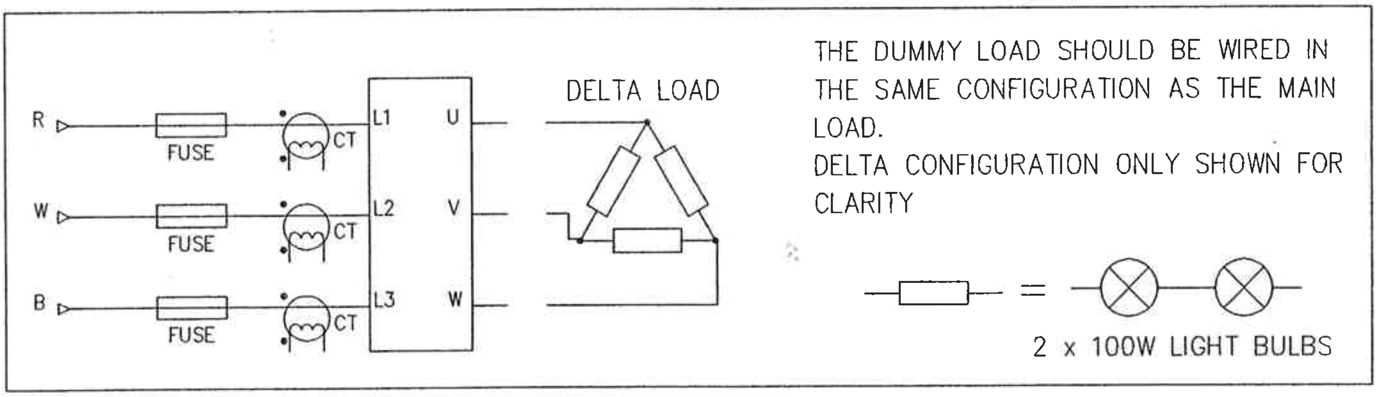
4.1 BEFORE STARTING

With the power off loosen the four half turn captive screws on the controller cover and remove it. The adjustment potentiometers will be found on the bottom circuit card marked F311 unless the top option card F312 is included.If the F312 card is present then all adjustments are on it.

4.2 DUMMY LOAD

To function correctly the controller must be connected to a load. Many heating elements can be damaged by excessive power, voltage or current.
To avoid damage to heating elements it is recommended that for initial adjustment of BIAS , GAIN and RAMP a "dummy" load be connected.
A suitable "dummy" load is six 240V light bulbs wired in delta as per diagram.
After initial adjustment the dummy load can be removed and the working load can be reconnected.
The dummy load cannot be used to adjust current limit/trip due to the small current it draws.

Dummy load wiring:



4.3 ADJUSTMENTS TO VOLTAGE OUTPUT MODELS

(Applies to all controllers except those specified with options CC or CCE)
Note: ZERO, SPAN, and RAMP adjustments must always be done before current or power limit is adjusted.

4.3.1 BIAS ADJUSTMENT (ZERO)

Set the GAIN potentiometer fully anticlockwise.
Using a portable calibrator or similar , input the minimum control input signal.Adjust the BIAS potentiometer for zero voltage across the controller output terminals.

4.3.2 GAIN ADJUSTMENT (SPAN)

Wind the GAIN potentiometer fully anticlockwise and apply the maximum control input signal. Adjust the GAIN potentiometer until the maximum desired voltage is measured across the controller output terminals.
Check output voltage at minimum and maximum control input and readjust BIAS and GAIN if necessary.

4.3.3 RAMP ADJUSTMENT

The RAMP potentiometer sets the response of the controller output to the control input signal. Adjust the RAMP potentiometer until the desired level of response has been reached. Response time can be checked by introducing a step control input signal change to the controller and measuring the output response time.

4.3.4 CURRENT LIMIT

(Applies only to options C & CE only)

Set the LIMIT potentiometer fully anticlockwise and the FB-G (feed back gain) and TRIP potentiometers fully clockwise. With the control input signal set to maximum gradually turn the LIMIT potentiometer clockwise until the required current limit level , measured through the load , has been reached. When the controller is limiting the current the LIMIT led will light.

NOTE:The current wave form through the power controller will not , in general , be sinusoidal.Current measurement using conventional ammeters can be grossly inaccurate. For accurate current measurement a true RMS meter such as the HEME Analyst 2000P should be used.

If the output oscillates under current limit turn the FB-G potentiometer anticlockwise until the current output is stable.

4.3.5 POWER LIMIT

(Applies to option PW only)

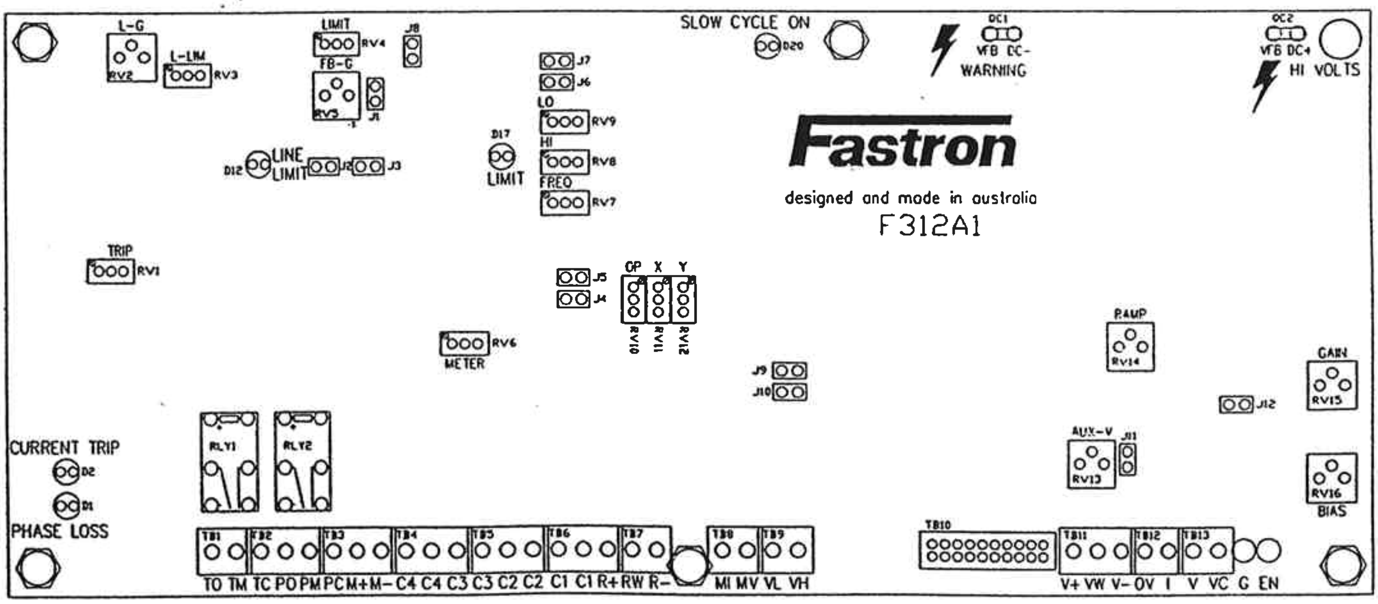
Set the LIMIT potentiometer fully anticlockwise and the FB-G (feed back gain) and TRIP potentiometers fully clockwise. With the control input signal set to maximum gradually turn the LIMIT potentiometer clockwise until the required power limit level , measured through the load , has been reached.

If the output oscillates under current limit turn the FB-G potentiometer anticlockwise until the power output is stable.

4.3.6 CURRENT TRIP

With the control input signal set to maximum and the controller outputting full current to the load gradually turn the TRIP potentiometer anticlockwise until the TRIP is activated (indicated by TRIP led).TRIP is now set at maximum current.Turn trip potentiometer another one to two turns clockwise.If the odd nuisance trip still occurs turn the TRIP potentiometer a further half to one turn clockwise. On current trip the trip relay energises and the controller is disabled.Both are latched. Current trip may be reset by opening the ENABLE link or by turning off the mains supply.

F312 Board potentiometer layout



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4.4 ADJUSTMENTS TO CONTROLLERS USED IN CONSTANT DC CURRENT MODE

(Applies to options CC & CCE only)

The following adjustments should be carried out with the DC load connected.
Current should be measured with either a true RMS ammeter on the incoming AC side and extrapolated or a hall effect type ammeter on the DC output.
Note: incoming AC RMS phase current to a 3 phase DC bridge is 82% of the DC output current

4.4.1 BIAS ADJUSTMENT (ZERO)

Set the GAIN & AUX-V potentiometers fully anticlockwise , and the BIAS potentiometer in the centre position .
Using a portable calibrator or similar , input the minimum control input signal.Gradually turn the AUX-V potentiometer clockwise until the output current is about 5 amps then adjust the BIAS potentiometer for zero current through the load.

4.4.2 GAIN ADJUSTMENT (SPAN)

Apply the maximum control input signal and turn the GAIN potentiometer fully clockwise . Gradually turn the AUX-V potentiometer clockwise until about 5 amps more than the maximum desired output current is measured , taking care not to exceed the maximum load current .

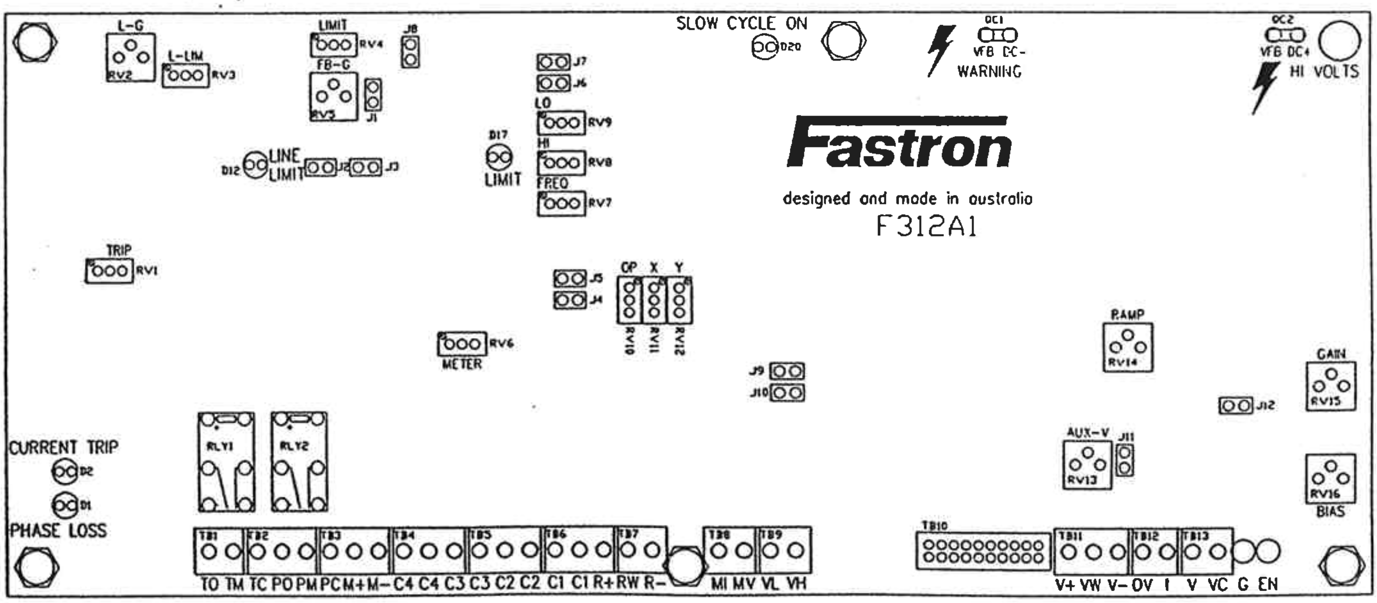
Now adjust the GAIN potentiometer so that the output current is at the maximum desired level.

Finally recheck output current at minimum and maximum control input and readjust BIAS and GAIN as necessary but do not readjust the AUX-V potentiometer.

4.4.3 RAMP ADJUSTMENT

The RAMP potentiometer sets the response of the controller output to the control input signal. Adjust the RAMP potentiometer until the desired level of response has been reached. Response time can be checked by introducing a step control input signal change to the controller and measuring the output response time.

F312 Board potentiometer layout



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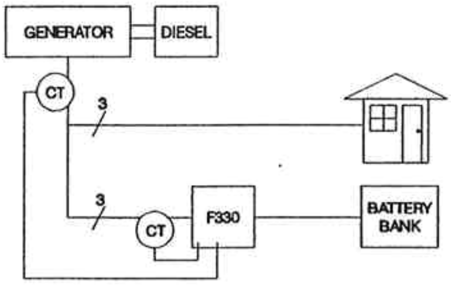
4.5 DEMAND SHARING ADJUSTMENT

The L-G potentiometer adjusts the reduction of current rate of the power controller when the demand sharing current level is reached. The L-LIM potentiometer adjusts the current level at which the power controller current output is reduced.

This adjustment should always be performed last after BIAS, GAIN and RAMP have been adjusted.

Set the L-G and L-LIM potentiometers fully clockwise.
Using a portable calibrator or similar, input the maximum control signal. Run the generator or supply to about 5 amps over the maximum output level and adjust the L-LIM potentiometer so that the generator output or total supply current is at the maximum desired level.

If the house draws too much load from the supply the OZTHERM Power Controller reduces the battery charging current so as not to overload the generator.

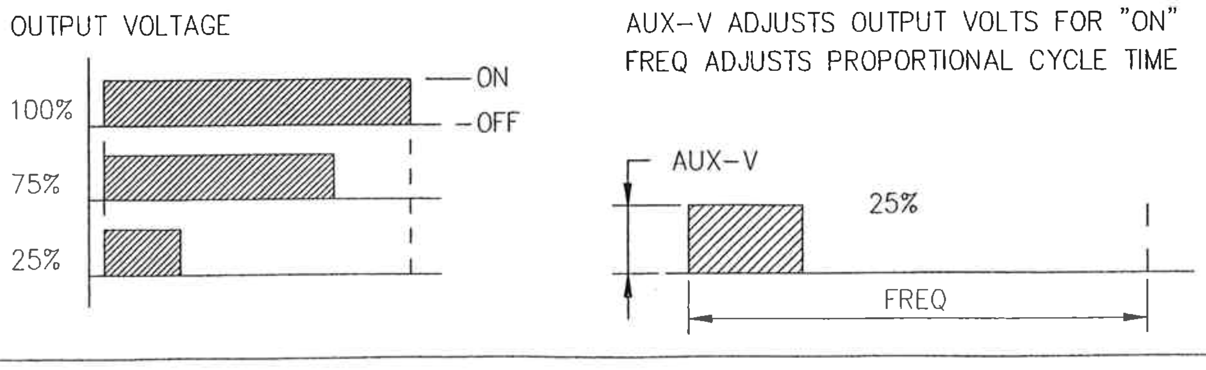


4.6 SLOW CYCLE ADJUSTMENT

It is recommended that the dummy load is used for adjustment of the SLOW CYCLE option.
This adjustment should be performed before current or power limit is adjusted.
The FREQ potentiometer adjusts the proportional cycle time
The AUX-V potentiometer adjusts the "on" output voltage

Set the AUX-V, HI and FREQ potentiometers fully clockwise and the LO potentiometer fully anticlockwise.
Using a portable calibrator or similar, input the minimum control input signal. Adjust the BIAS potentiometer so that the SLOW CYCLE ON led is always off. Apply the maximum control input signal and adjust the GAIN potentiometer so that the SLOW CYCLE ON led is always on. If The SLOW CYCLE ON led sometimes still turns off then adjust the HI potentiometer anticlockwise a few turns and readjust the GAIN potentiometer.
Adjust the AUX-V potentiometer anticlockwise to the desired maximum output voltage level if required. (usually the AUX-V potentiometer is left fully clockwise for full line voltage output).
The FREQ potentiometer can be adjusted anticlockwise for a shorter proportional cycle time if required.

Current limit and trip are adjusted as before if specified (see option C)
Current limit can be configured in two modes. Mode one limits instantaneous output current by reducing the output voltage by phase angle control. Link J6 should be "in" for output voltage reduction upon current limit. Cut J6 if not required.
Mode two reduces the "on" time thereby reducing the average output current. Link J7 should be in for "on" time reduction upon current limit.
Note that both mode one and mode two can be used simultaneously.



4.7 METER ADJUSTMENTS

(Applies to options MI , MV , MP & MD only)

Full scale output is adjusted by the METER potentiometer . There is no zero bias adjustment.
Output is 1mA full scale.

4.7.1 OPTION MI

Run the controller up to maximum operating current and adjust the METER potentiometer for full scale meter deflection.

4.7.2 OPTION MV

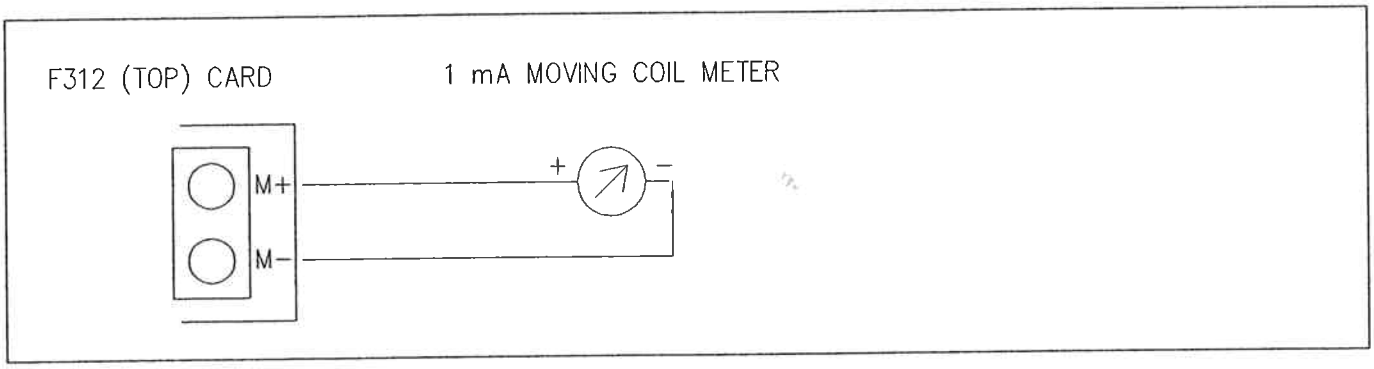
Run the controller up to maximum operating voltage and adjust the METER potentiometer for full scale meter deflection.

4.7.3 OPTION MP

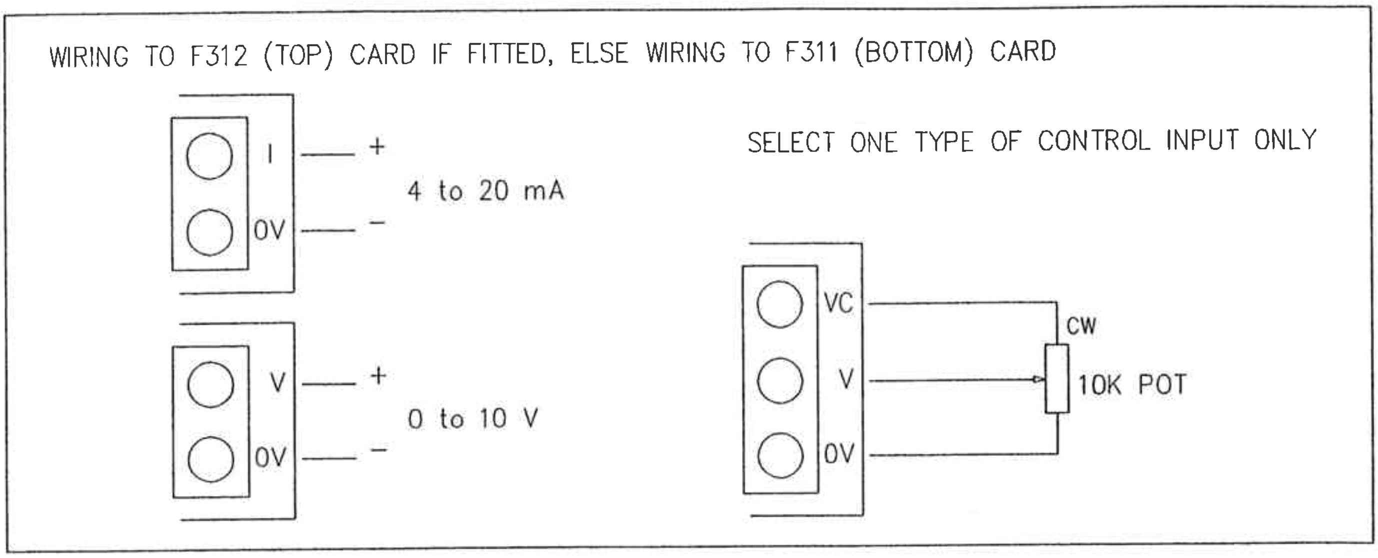
Run the controller up to maximum operating power and adjust the METER potentiometer for full scale meter deflection.

4.7.4 OPTION MD

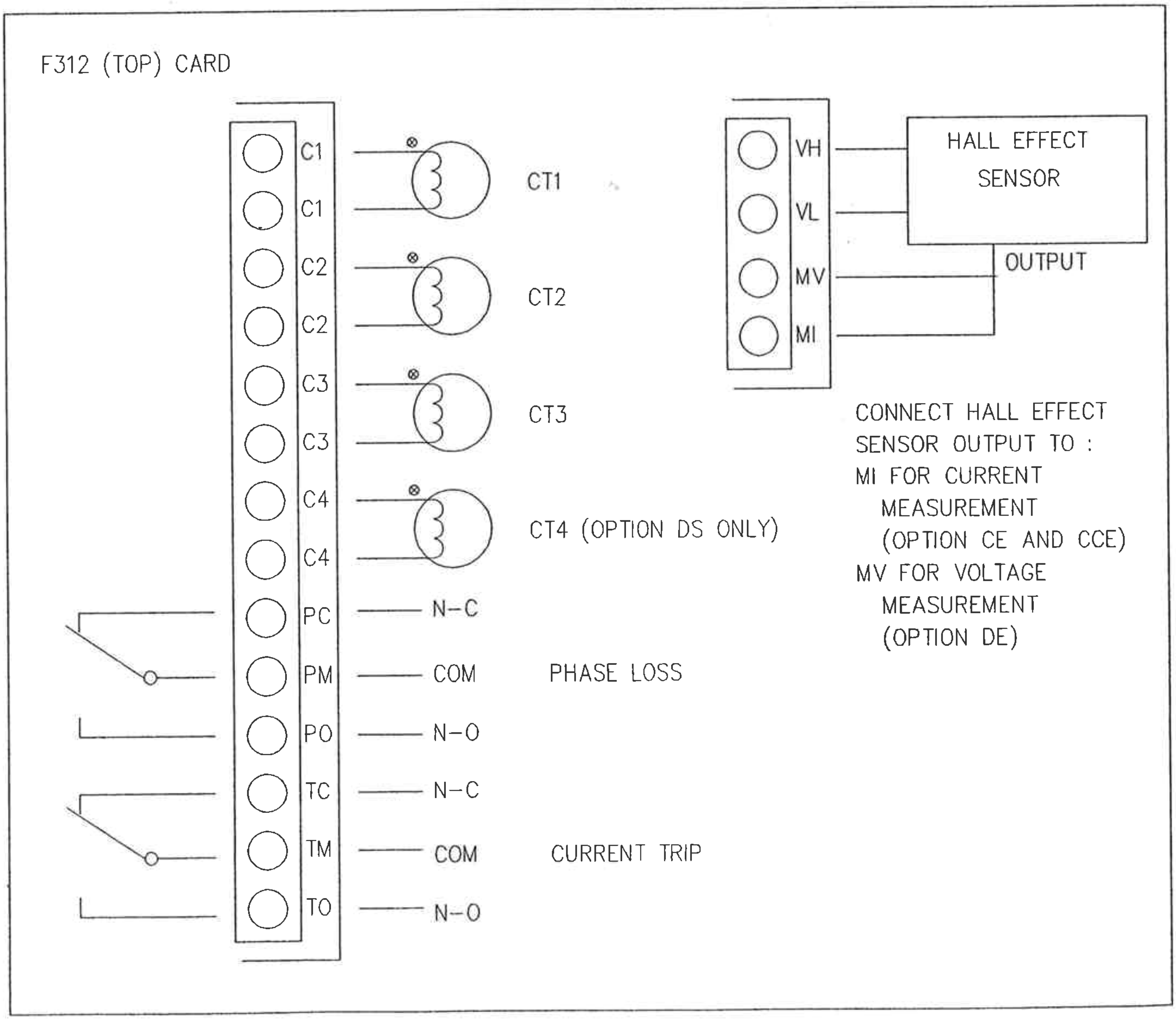
Apply the maximum control input signal and adjust the METER potentiometer for full scale meter deflection.



4.8 CONTROL INPUT WIRING



4.9 RELAY AND METER OUTPUT, CURRENT TRANSFORMER AND HALL EFFECT WIRING



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5.0 SPECIFICATIONS

Control Mode	Phase angle. (soft start provided as standard)
Control Range	0 - 100%
Maximum Current	20 -1100 amperes per phase (higher currents available on request)
Power Supply	110/240/415 volts A.C . 50 HZ. +/- 10% (60 HZ. and other voltages available on request)
Transient Protection	Internal R.C snubber 68 ohms / .1 micro-farad
Control Input	4 - 20 milliamps (receiving impedance 100 ohms) 0 - 10 volts (receiving impedance 10K ohms) 10K ohms potentiometer
Adjustments	Ramp (soft start time) 1-20 seconds Zero (- 20% to +20%) ; span (0 - full scale)
Ambient Temperture	0 - 50 degrees Celsius (Maximum temperture of cooling air)
Temperture Range	0 - 50 degs. celcius
Ambient Humidity	0 - 85% relative humidity
Power Factor	Unity

6.0 DIMENSIONS AND MOUNTING DETAILS

Shown mounted vertically in cabinet

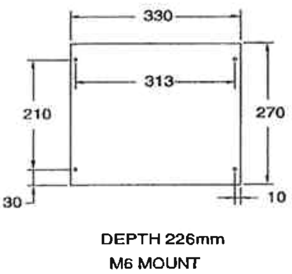

Fig.5

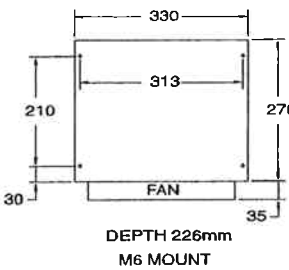

Fig.6

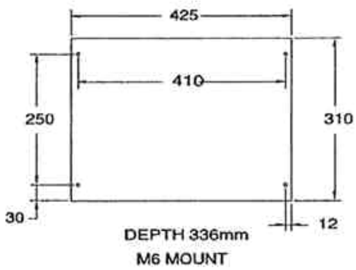

Fig.7

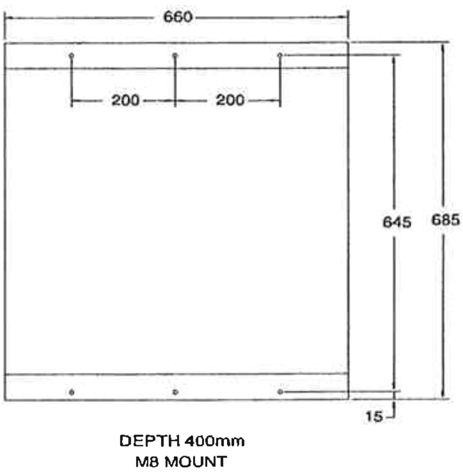

Fig.8

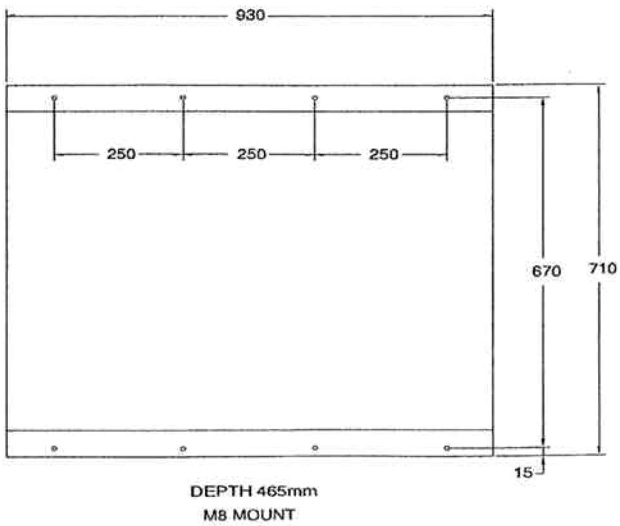

Fig.9

7.0 TROUBLE SHOOTING GUIDE

FAULT	POSSIBLE CAUSE	REMEDY
No output from controller	Power wiring incorrect or out of sequence	Check POWER OK led. Swap two input phases if unlit
	ENABLE link open	Close link and check any interlocks wired in series with the ENABLE link
	Over temperature cutout TEMP activated	Turn off power and allow unit to cool down
	No control input signal	Ensure input signal is present and polarity is correct
	Current trip is activated	Check TRIP led. If lit find and correct source of trip. Break and make ENABLE link or turn off power to reset
	One input phase lost or missing	Check PHASE LOSS led. If lit determine missing phase and reconnect
		Check POWER OK led. If unlit, check fuses with power off. Determine cause of blown fuse and replace if necessary
	Load circuit open	Check load circuit continuity and repair if necessary

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7.0 TROUBLE SHOOTING GUIDE (continued)

FAULT	POSSIBLE CAUSE	REMEDY
Controller not modulating with respect to control input signal	No control input signal	Ensure input signal is present and polarity is correct
	Current limit set too low	Check current limit LIMIT led and readjust current limit if necessary
	Power limit set too low	Check power limit LIMIT led and readjust power limit if necessary
	Current transformer disconnected or damaged or incorrectly installed	Inspect current transformer and wiring and correct if necessary
	Hall effect sensor disconnected or damaged or incorrectly installed	Inspect hall effect sensor and wiring and correct if necessary
	Load circuit open	Check load circuit continuity and repair if necessary
	Current trip is activated	Check TRIP led. If lit find and correct source of trip. Break and make ENABLE link or turn off power to reset
	One input phase lost or missing	Check PHASE LOSS led. If lit determine missing phase and reconnect
Load current not balanced or non zero at minimum control signal level	BIAS and GAIN not set correctly	Readjust BIAS and GAIN if necessary
	Load wiring not correct	Check load wiring (especially 6 wire) with power off and correct if necessary
	Current transformer disconnected or damaged or incorrectly installed	Inspect current transformer and wiring and correct if necessary
	Hall effect sensor disconnected or damaged or incorrectly installed	Inspect hall effect sensor and wiring and correct if necessary

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APPENDIX 1

USEFUL FORMULAS

Line voltage VL = 1.73 x Phase voltage VP
Line current IL = 1.73 x Phase current IP
Peak voltage Vpeak = 1.414 x Rms voltage Vrms
Total power delivered to the load Ptot = 1.73 x VL x IL for balanced 3 wire resistive loads
= 1.73 x VL x IL x cos(a)
= 3 x VP x IL = 3 x VL x IP
= 3 x VP x IL x cos(a) = 3 x VL x IP x cos(a)
Line current = Ptot / (1.73 x VL) = Ptot / (3 x VP)
Ohms law : V = I x R
P = V x I = I x I x R = V x V / R
Resistors in series: Total resistance Rtot = resistance one R1 + resistance two R2 + ...
Resistors in parallel: Total resistance Rtot = 1 / (1 / R1 + 1 / R2 + ...)
V rms = 1.1 x V average for a pure sine wave
I rms = 1.1 x I average for a pure sine wave
pi = 3.1416

APPENDIX 2

CONVERSION FORMULAS FOR FAN FLOW RATES

FROM	TO	MULTIPLY BY
Cubic m / min	CFM (cubic feet / minute)	35.3
	L / sec (litres per second)	16.67
	m / sec (metres per second) 120 mm fan	1.577
	m / sec (metres per second) 92 mm fan	2.679
	m / sec (metres per second) 80 mm fan	3.579

APPENDIX 3

CONTROLLER SIZING FOR SILICON CARBIDE LOADS

The elements should be sized so that the starting voltage is in the range of line voltage / 2 to 2.8 approximately to allow for ageing . From the watts per square centimeter rating of the element the starting current can be calculated using ohms law above. The Power Controller should be rated for this current level and option P (power limit) specified in the part number.

For 415 VAC with a delta connected load the starting voltage range is from 150 to 210 VAC approximately. For 415 VAC with a star connected load the starting voltage range is from 86 to 120 VAC approximately. Elements outside this range may need a transformer for voltage matching. Elements of lower voltage may be connected in series as required to meet the requirements of the starting voltage ranges above and remove the need for a transformer.The Silicon Carbide elements are extremely sensitive to an excess of power being applied to them, and they may fracture or break as a consequence. A safety factor of 10 to 25 % of the maximum power rating for the element should be used.

For a Kanthal element (2 W/square cm, 1000 square cm, 186 Volts) :
Maximum power = 2 W/square cm x 1000 square cm = 2000 W
Allow for safety of 80 % the maximum power = 2000 x 0.8 = 1600 W
Current = Power / Voltage = 1600 / 186 = 8.6 Amp per element (phase current)
For three phase line current, phase current x 1.73 = line current = 8.6 x 1.73 = 14.9 Amps per phase
The first controller above this current rating should be used ; ie the 20 Amp power controller.
This example assumes the elements are connected in delta (415 VAC maximum element voltage available). For a star connected load (240 VAC maximum element voltage available) an element with a starting voltage of 240 / 2.5 or 96 V (approx) should be selected.

Please contact the factory if you have any queries regarding element selection or controller selection.

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APPENDIX 4

APPROXIMATE THERMAL CALCULATIONS FOR FAN COOLED ENCLOSURES

H = heat loss from power controller (kW)
T1 = inlet air temperature (deg C)
T2 = outlet air temperature (deg C)
V = volumetric flow through enclosure, fan flow required (cubic m / s)
Cp = a constant = 1.01 (kJ / kg x K)
P = density of air = 1.13 at 40 deg C and at sea level (kg / cubic m)

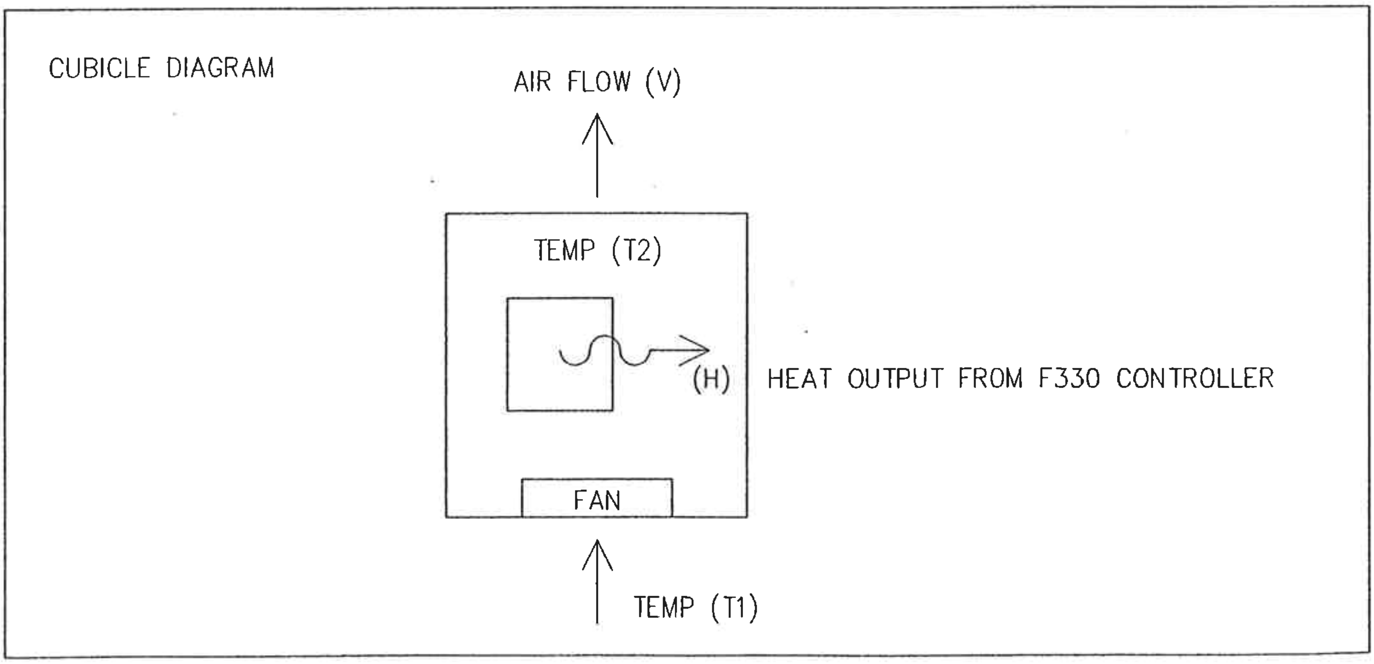
1: Calculate H, heat dissipated by power controller and fuses. As a rule of thumb the controller dissipates 1 Watt of heat per amp per phase. The exact figure at full load can be obtained Appendix 5. Fuse heating should be added, see appendix 6.
For a 100 Amp controller H = 1Watt / amp x 100 Amp / phase x 3 phases = 1 x 100 x 3 = 300 Watt + Fuse heating of 3 x 17 Watt per fuse = 351 Watt
from the definitions above, H is in kW so 351 Watt = 0.351 kWatt

2: T1 is the maximum external ambient air temperature. 40 deg C is usually a good conservative number
T2 should be the maximum operating temperature of the F330 power controller. 50 deg C is standard for all OZTHERM power controllers

3: For heat balance:
H = V x P x Cp x (T2 - T1)
or V = H / (P x Cp X (T2 - T1))

for the above example:
P = 1.13
Cp = 1.01
T2 - T1 = 50 - 40 = 10 deg C
H = 0.351 kWatt from step one

so: V= 0.351 / (1.13 x 1.01 x 10) = 0.0308 cubic m/s
multiply by 60 for cubic m / minute = 1.85 cubic m/min



APPENDIX 5

PART NUMBER BREAKDOWN

F330 - [ ] - [ ] - [ ] -

Code	DESCRIPTION	Fuse Rating	Case Size	Weight KG	Cable Termination mm^2	Dissipation Watts	I^2t Thyristor Rating
1	110 volt A.C line input						
2	240 volt A.C line input						
4	415 volt A.C line input						
20	20 amperes A.C line current	25	fig.5	10	2.5 - 6.	119	610
30	30 amperes A.C line current	35	fig.5	10	2.5 - 6.	134	2,300
40	40 amperes A.C line current	45	fig.5	10	10 - 16.	165	5,000
50	50 amperes A.C line current	55	fig.5	10	10 - 16.	188	9,100
70	70 amperes A.C line current	75	fig.5	10	10 - 25.	232	16,200
80	80 amperes A.C line current	90	fig.5	10	10 - 25.	241	97,000
100F	100 amperes A.C line current - fan	100	fig.6	12	M6 bolt	333	16,200
120	120 amperes A.C line current	125	fig.7	26	M10 bolt	393	24,000
130	130 amperes A.C line current	150	fig.7	26	M10 bolt	386	97,000
150F	150 amperes A.C line current - fan	150	fig.7	28	M10 bolt	505	24,000
150	150 amperes A.C line current	175	fig.7	26	M10 bolt	502	168,000
175	175 amperes A.C line current	200	fig.7	26	M10 bolt	482	245,000
200F	200 amperes A.C line current - fan	250	fig.7	28	M10 bolt	657	84,000
240F	240 amperes A.C line current - fan	250	fig.7	28	M12 bolt	755	97,000
280F	280 amperes A.C line current - fan	300	fig.7	28	M12 bolt	995	168,000
340F	340 amperes A.C line current - fan	375	fig.7	28	M12 bolt	1016	245,000
400F	400 amperes A.C line current - fan	400	fig.8	60	M10 bolt	1600	106,000
500F	500 amperes A.C line current - fan	500	fig.8	60	M10 bolt	1780	238,000
650F	650 amperes A.C line current - fan	350x2	fig.8	60	M10 bolt	2384	781,000
750F	750 amperes A.C line current - fan	400x2	fig.8	60	M10 bolt	2479	2x10^6
900F	900 amperes A.C line current - fan	500x2	fig.9	98	M10 bolt	3523	781,000
1100F	1100 amperes A.C line current - fan	600x2	fig.9	98	M10 bolt	3810	2x10^6

Code	Description	
A	A.C Voltage regulation.	
C	Current limit and trip.	A.C. current measurement
CC	Voltage limit and current trip. Current source.	A.C. current measurement
CCE	Voltage limit and current trip. Current source.	D.C. current measurement
CE	Current limit and trip.	D.C. current measurement
D	D.C Voltage regulation.	
DE	D.C Voltage regulation.	
DS	Demand sharing.	
F	High speed fuses.	
FW	4 wire load.	Three phase and neutral
MD	Meter output of input control signal.	
MI	Meter output of average current.	Requires C, CC, CCE or CE option.
MP	Meter output of average power.	Requires PW option.
MV	Meter output of average voltage.	Requires A, D or DE option.
PH	Phase loss output.	
PW	Power limit.	Requires A and C option.
S	Slow cycle.	
T	Thermal cutout.	Standard on fan cooled models.

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APPENDIX 6

FUSE HEATING AND DIMENSIONS

CONTROLLER CURRENT	FUSE	WATTS PER FUSE	TOTAL 3 PHASE WATTS
20 AMP	25 AF	12	36
30 AMP	35 AF	12	36
40 AMP	45 AF	12	36
50 AMP	55 AF	16	48
70 AMP	75 AF	17	51
80 AMP	90 AF	17	51
100 AMP	110 AF	17	51
120 AMP	125 BF	31	93
130 AMP	150 BF	33	99
150 AMP	150 BF	33	99
150 AMP	175 BF	35	105
175 AMP	200 BF	37	111
200 AMP	250 BF	37	111
240 AMP	250 BF	37	111
280 AMP	300 BF	39	117
340 AMP	375 BBF	66	198
400 AMP	400 BBF	70	210
500 AMP	500 BBF	75	225
650 AMP	350 BBF x 2	132	396
750 AMP	400 BBF x 2	150	450
900 AMP	500 BBF x 2	150	450
1100AMP	600 BBF x 2	150	450

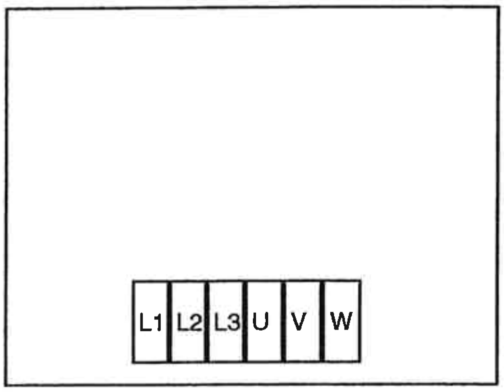
FUSE SIZE	MOUNTING CENTRES	BOLT SIZE	HEIGHT	WIDTH	DEPTH
AF	63.5 mm	M5 - M6	76 mm	17 mm	20 mm
BF	86 mm	M8 - M10	113 mm	38 mm	43 mm
BBF	86 mm	M8 - M10	113 mm	38 mm	86 mm

APPENDIX 7

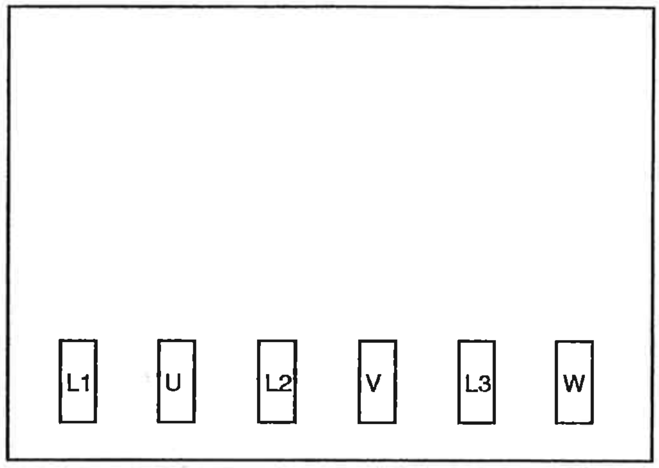
MAINS TERMINAL LAYOUT

Shown mounted vertically in cabinet

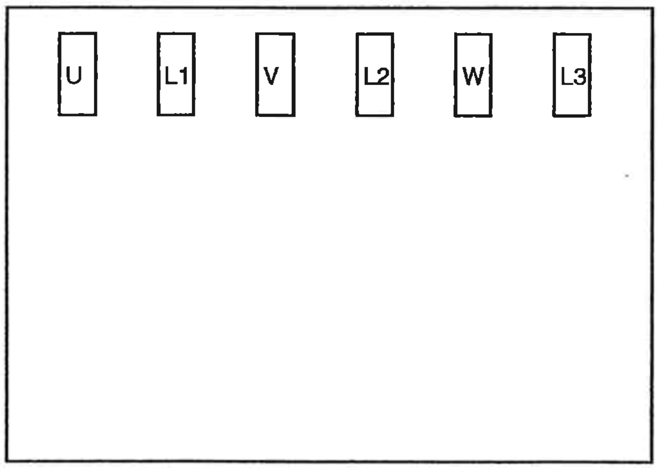
20 to 100 Amp controllers



120 to 340 Amp controllers



400 to 1100 Amp controllers



Controllers up to 340 amp have bottom entry for cable connection and top cable entry for controllers over 400 amp. Appendix 5 (page 20) has information regarding cable termination in square mm, and section 6 (page 15) has external dimensions for the F330 power controllers.

All control wiring (including Current Transformer and Hall Effect Sensor wiring where appropriate) is bottom entry also direct to circuit board.

Fuses are external to the F330 power controller and should be mounted using the standoffs provided (option F only) for controllers up to 340 amp and internal for controllers over 400 amp.

Airflow to the F330 power controller should not be obstructed and if mounting the F330 power controller in an enclosure then Appendix 4 (page 19) has details on heat loss and enclosure sizing.

PRODUCTS AND SERVICES

POWER ELECTRONIC COMPONENTS

BRIDGE RECTIFIERS	- Single and Three Phase
CHOKES	- Line, RFI, EMC
DIODES	- Std., Fast. (Stud, Puk, Module)
FANS/ACCESSORIES	- AC/DC to 150mm dia.
FILTERS	- Line, RFI, EMC
FUSES	- Semiconductor Protection
HEAT SINK	- Extruded, Cast & Fabricated types machined to order
IGBT's	- 1, 2 & 6 pack modules
POWER CAPACITORS	- Power, PFC, DC Link and Electrolytic types
PULSE TRANSFORMERS	- PCB type, leaded and SMD
SCR / DIODE BRIDGES	- Single / Three Phase - Half / Full Control
SOLID STATE RELAYS	- AC & DC Input / Output - PCB & Module Type
THYRISTORS	- Std., Fast (Stud, Puk, Module)
SCR / DIODE MODULES	- Std., Fast
VARISTORS	- High power module type, versions with thermal disconnect

AUTOMATION / INSTRUMENTS / PROCESS CONTROLLERS

SMART RELAYS	- Millenium EVO 24 I/O Programable Relays
PROCESS CONTROLLERS	- Pressure, R. Humidity, other.
ELECTRICITY METERS	- I, V, kW, kWh, kvar, kvarh, PF, Freq, THD, Pulse, Comms, Load Shedding - Panel & Din Mount Type
PROGRAMABLE LOGIC CONTROLLERS(PLC)	- Crouzet 26 I/O, Compact, Blind, Expanadable 3G, Bluetooth versions
HMI TOUCH SCREENS	- Ethernet, Modbus, 4,7,10 Inch
TEMP. CONTROLLERS	- Shinko, Single / Multi-Point - Pattern Control

POWER SUPPLIES / SIGNAL CONDITIONERS / MONITORING RELAYS

CURRENT TRIP MODULES	- Measurement / Alarm
LOOP POWER SUPPLIES	- Process type, 24V/ 4 - 20mA
MONITORING RELAYS	- V, I, Watts, Temp, Level etc.
SENSOR POWER SUPPLY	- +/- 15v for Hall Effect Sensors
TEMPERATURE TRANSMTR	- Thermocouple / RTD
VOLTAGE TRIP MODULES	- Measurement / Alarm
SIGNAL CONDITIONERS	- DC/AC, I/V, Trip/Reset and Alarms

SENSORS / PROBES / TRANSDUCERS

CURRENT AC / DC	- Hall Effect Sensors, CT types
DCCT's	- Hall Effect Sensors
LEVEL	- Paddle Switch Type
POWER (kW, kWh, kVa,kVarh)	- Process Level O/P and Pulse
RELATIVE HUMIDITY	- Room/Duct Sensors
TEMPERATURE	- Thermocouples, RTD's, Infra-Red
VOLTAGE AC / DC	- Hall Effect Sensors, VT types - Oztherm (Fastron in-house design)

POWER SEMICONDUCTOR HEAT-SINK ASSEMBLIES AND ACCESSORIES

HEAT SINK ASSEMBLIES	- AC, Single/ 3 Phase & multi-phase - DC Bridge and DC switch - Convection, Fan forced, oil or water cooled
WATER COOLERS	- Non-isolated & Isolated water path
SEMICONDUCTOR CLAMPS	- Single and Double sided
SNUBBERS	- AC Single / 3 Phase / DC
DC SUBSTATION DIODES	- Blocking Diode Cubicles

SOLID STATE SWITCHES AND POWER CONTROLLERS

SOLID STATE CONTACTORS	- AC/DC Input or Output - Single, 3 Phase - Solid State Relay & Thyristor Types.
THYRISTOR CONTROLLER (SCR)	- Single & 3 Phase - Phase Angle, Burst Control - OZtherm Brand (Fastron in-house design)

SOFTWARE

ENERGY MONITORING	- Ergo Energy monitoring software - Cloud or local data collection options - Real-time monitoring and profiling - Wi-Lem Wireless Energy Moitoring - Crouzet Smartphone PLC app
POWER QUALITY	- RS485 MOBUS / Ethernet TCP/IP Comms - Power Quality Analysers, MiQEN and MiSMART software.
DATA ACQUISITION	- Electrical and Process Parameters
TEMPERATURE MONITORING & CONTROL	- Single and Multi-point - Pattern Control
DATA LOGGING	- Historical Analysis - Trending & Reporting

SYSTEMS SOLUTIONS & ENGINEERING SERVICES

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POWER SEMICONDUCTOR REPLACEMENT; TESTING AND MATCHING TO CRITICAL PARAMETERS
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Ergo Series	Energy monitoring real time software including data recovery and graphic functions for single or multi site environments with live dashboard, costing, alarming, reporting and bill checking options, specialising in custom applications. **Designed and Manufactured by** Fastron Electronics
Hirect Hind Rectifiers Ltd.	Power Semiconductors including Thyristors and Diodes for applications in Rectifiers, Converters, Power Supplies for Industrial, Traction and test and instrumentation equipment.
HOBUT	Ring and Split core CT's, Shunts and Meters, DC kWh Meters
IXYS	Discretes, IGBTs, Power Modules, Bridge Rectifiers & AC Controllers, Thyristor and Diode modules, Specialist Semiconductors including Silicone carbide
infineon	IGBTs, Power Modules, Bridge Rectifiers & AC Controllers, Thyristor and Diode modules, IGBT driver boards, Stacks and Assemblies. eupec
Iskra® Iskra Sistemi	Monitoring, Control and Measurement of electrical parameters related to Energy Monitoring and Power Quality including Power Factor Correction products. Single and 3 phase Energy Meters, Measuring Centres and Network Analyzers with MiQEN and MiSMART software; Measuring Transducers. MV and LV, PFC capacitors and contactors. DC Link capacitors. Synchronisation Meters.
Itelcond	Electrolytic Capacitors for DC Link, Ripple, and AC Filter Application
Leclanché Capacitors, A Fischer & Tausche Company	Power Capacitors for critical applications and extreme environments including snubber energy absorbers
LEM	Voltage & Current Transducers for industrial drives, robots & cranes, cable cars & ski lifts, elevators & escalators, ventilation & conditioning, medical systems and power supplies for computer & mobile systems. Battery Monitoring system and Wi-Lem Energy Monitoring Solutions.
MAGNELAB	Rope CT's, Rogowski Coils with Integrators, Standalone Integrators, Teardrop Coils, Standard CT's
ND Metering Solutions	Electricity Measurement, including Voltage, Current, Power, Power Factor, Total Harmonic Distortion, with analogue outputs and MODBUS / Ethernet communications available for all of your energy measurement requirements. Current and Voltage Transducers, Clamp on Current Sensors.
OZtherm	SCR (thyristor) Power Controllers complete with Control Electronics and Power Semiconductor heat sink assembly, (Phase angle, burst firing, ON/OFF switching) Solid State Contactors, Signal Conditioners and custom products. **Designed and Manufactured in Australia**
POWERSEM	Power Modules and Solid State Relays, 3 phase and single phase for ac/dc motor drives, welding, power supplies, and UPS, used in temperature, medical, traffic signals and home appliance applications.
PROTON-ELECTROTEX	High Power Thyristors, (phase control, fast and ultrafast), Diodes (rectifier, avalanche and welding types), IGBT's and heat sink and assemblies.
RADA Engineering	Custom Heatsink Extrusions, Bonded Heatsink, Water cooled Heatsink, Thermal Analysis Services
Rishabh Instruments	CT's, Shunts, Signal Conditioners, Electrical Energy Meters and Software Systems Solutions for Measurement, Test and Energy Management applications in the industrial, commercial and government sectors.
SCHURTER	Surge Suppression, Chokes, EMC Filters, Power Input Filter, Pulse Transformers.
Sensata Technologies	Solid State Relays, I/O Modules, Filters, Heat Sinks, Din Rail Mounting systems, for low power and high power electrical switching and control applications. SCR/Diode Bridges and Modules. crydom
Shinko	Temperature, Process and Humidity Controllers, Sensors and Recorders for a wide range of applications including furnaces, boilers, ovens, kilns and extruders as well as a range of Signal Conditioners.
SanRex	Silicone Carbide Mosfets & Schottky Diodes, Power Modules, Fast Diodes, Bridge Rectifers, Controlled Rectifers, SCR's, Power Supplies for Plasma heating, Metal Finishing, and Power Regulation
Trent	Semiconductor Fuses for power control applications. **Designed and Manufactured by** Fastron Electronics Private label name brand replacement(NBR) Semiconductors and Solid Sate Relays
VARSI	High energy Varistors and thermal disconnects for voltage transient suppression used in telecommunications, rectifier electronics, power electronics, measurement & control, process systems, computers, medical, automotive, test and instrumentation.

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