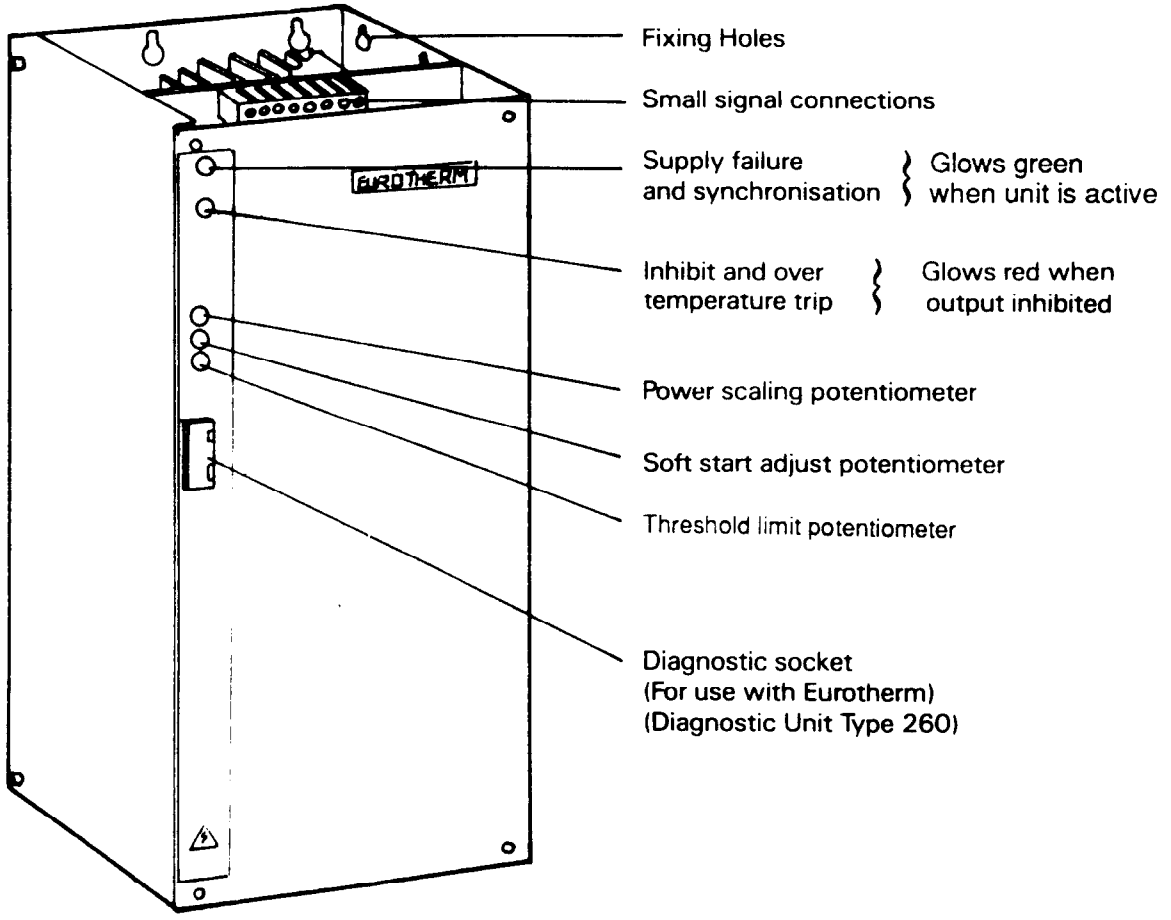
EUROTHERM

THREE PHASE THYRISTOR UNIT
TYPE 414 AND 415

INSTALLATION AND OPERATING INSTRUCTIONS



Part No. HA020163

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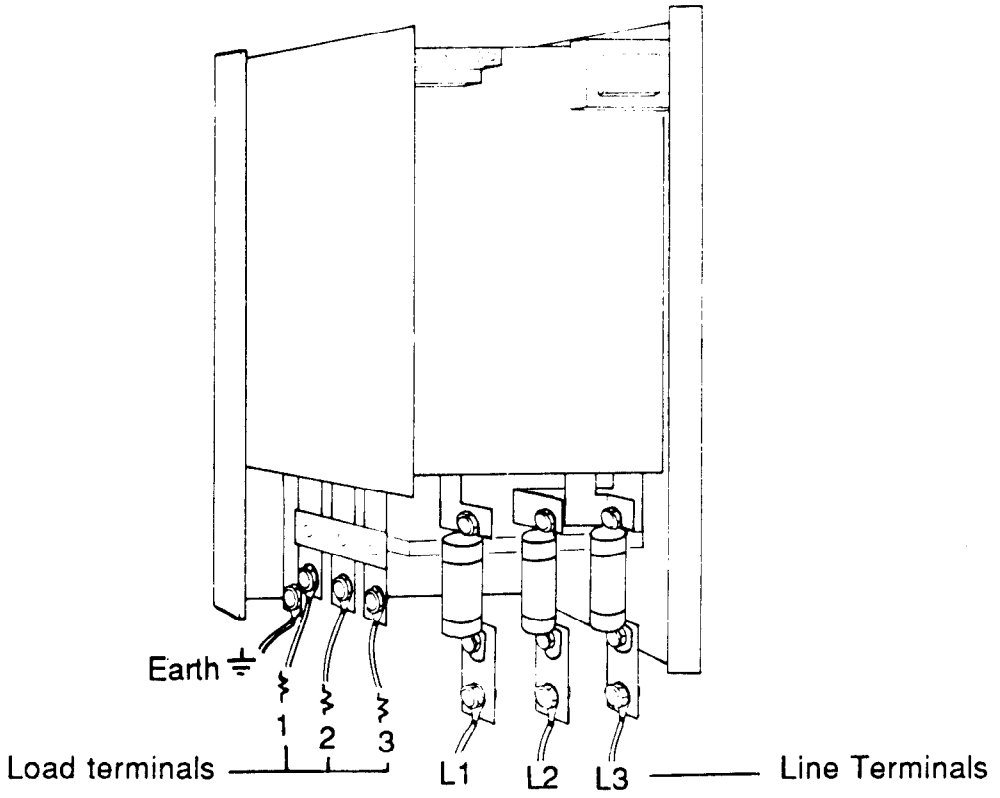
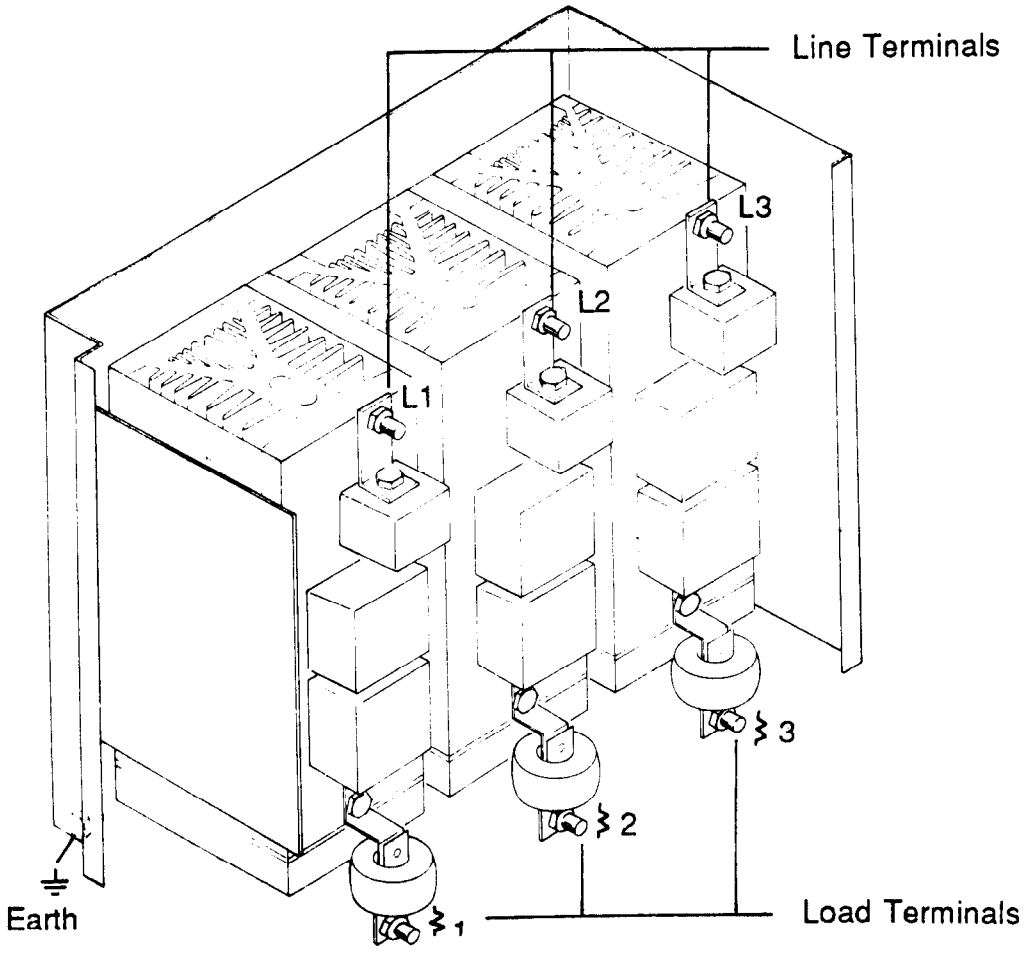


415 Main Terminal Connections



Configuration

The 414 and 415 thyristor units are supplied from the factory configured for:

A driver input signal	of 4 - 20mA
A firing mode	of Phase angle
A feedback mode	of V^2
Current limit set	for internal operation
and load configuration	for 3 wire if option "6D" is not requested

If this configuration does not suit your application then it can be changed by altering link switches situated on the control printed circuit board which runs from the back to the front of the unit just to the L.H.S. of the heat sinks when viewed from the front.

The position of the switches on the printed circuit board are shown in figure 1.

The switch positions for various configuration modes are shown in the tables below. To change the switch position depress the long wire arm by pushing the end of the wire towards the board. With the wire depressed in this manner move the end of the wire horizontal with the board in such a direction that will disengage the switch from its hook.

Switches 1-6 and 12-17 are on/off types; that is the wire is either hooked under the hook or it is in the up position not under the hook. Switches 7-11 are two way where the wire is hooked under one of two hooks, see figure 2.

Input Signal

Input	SW1	SW2	SW3	SW4
0-5V dc	Open	Open	Open	Open
1-5V dc	Open	Closed	Open	Open
0-10V dc	Closed	Open	Open	Open
0-5mA dc	Open	Open	Closed	Open
0-10mA dc	Closed	Open	Closed	Open
0-20mA dc	Open	Open	Closed	Closed
4-20mA dc	Open	Closed	Closed	Closed

Firing Mode

Mode	SW5	SW6	SW12
Phase Angle	Open	Either	Open
Phase Angle (Ramped O/P)	Open	Either	Closed
Fast Cycle	Closed	Open	Open
Fast Cycle Soft Start and stop	Closed	Closed	Open
Slow Cycle	Closed	Open	Closed
SlowCycle Soft Start and Stop	Closed	Closed	Closed

Feedback Mode

Feedback	SW7	SW8
Mean Voltage	RHS	RHS
Power Either	RHS	LHS
or	LHS	RHS
Mean Current	LHS	LHS

Limit Setting

Setting	SW9
Internal	LHS
External	RHS

Load Configuration*

Load	SW10	SW11
3 Wire	RHS	RHS
4 Wire	LHS	LHS

* If option '6D' open delta is called up then SW10 and SW11 will be in the RHS position. **DO NOT move these switches from this position.**

Limit Threshold

Control	SW 13	SW 14	SW 15	SW 16	SW 17
None	0	0	0	0	1
Current	1	0	0	0	1
Power (Demand)	0	1	0	0	1
Volts/Current Transfer	0	0	1	0	1
V/I Transfer with Power	0	1	1	0	1
Chop Off	0	0	0	1	0

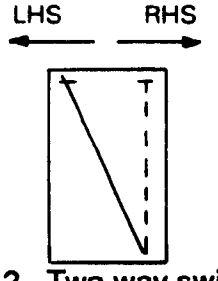


Figure 2. Two way switch links.

INPUT SIGNAL

The input Signal should be selected to match the output signal from the controller or driver. If the manual input only is going to be used with the potentiometer supply then 0-10V should be selected.

FIRING MODE

General

Selection of the firing mode is dependent on the type and size of load, its thermal characteristics and its operating requirements. All units, unless specified otherwise are despatched with the phase angle mode selected.

Phase Angle

This mode of firing will drive any load, and is the required mode for driving transformer coupled loads or loads with a significant change of resistance with temperature. This mode has a soft start time of 100ms.

Phase Angle (Ramped O/P)

This mode is the same as above but with a soft start time of 2 seconds for use where supply regulation is poor such as alternator supplies, or where load change must be slow.

Fast Cycle

If the load to be controlled is purely resistive with minimal temperature coefficient and is to be feed directly from the three phase supply an appreciable reduction in electrical interference can be achieved by selecting the fast cycling mode. This may cause supply flutuations where the supply regulation is poor.

Slow Cycle

This mode will give a further reduction in electrical interference and reduce the frequency of supply flicker. However temperature variations in sympathy with the switching rate can be experienced on small thermal mass loads.

Fast/Slow Cycle with Soft Start and Stop

For some loads which normally require phase angle control, a reduction in electrical interference may be achieved using this cycling mode with soft start. The load is cycled on and off as in the normal cycling modes but is phase angled up and down at the beginning and end of each burst. A further decrease in interference may be achieved by specifying the PS option. This will give a phase start only to each burst with an immediate stop.

FEEDBACK MODE

The correct setting of the feedback mode is again dependant on the type of load being controlled. Normally units will be shipped set to mean voltage squared.

Mean Voltage Squared

If the load is purely resistive and the resistance of the load has a very small temperature coefficent then mean voltage squared feedback is the best mode to select.

Mean Current Squared

Where the process to be controlled is proportional to current, for instance a plating bath in which the weight of metal deposited is proportional to current, then the type of feedback selected should be mean current squared

Power

On loads where the load impedance is very complex but the important parameter is the power dissipation, for example silicon carbide rod heaters, then power feedback should be selected.

Load Configuration

The switch selection for load configuration depends on the load connections to the thyristor unit only. If the thyristor unit is controlling the primary of a transformer and the secondary of the transformer is feeding power into the load, then it is the configuration of the primary windings of the transformer that determines the switch positions. Set the switch configuration to 4 wire for a star connected load with star point, where that star point is connected back to the neutral of the supply. For star connected loads where the star point is not brought out or not connected to neutral and closed delta (3 wire) loads configuration must be set to 3 wire. The remaining configuration of open delta (6 wire) requires the option 6D to be called up in the instrument code and the switches will be connected in the 3 wire position. **No attempt should be made to move the switch connections from this position.**

LIMITS

The thyristor output can be limited to a threshold value. Below is a list of threshold types selectable to suit the particular application. When despatched the limit is set to current threshold.

Limit Setting

The level of this threshold can be set by a potentiometer mounted on the front of the unit or by an external 0-10 volt signal, in which case the potentiometer will scale the range of this voltage.

Current Threshold

In this mode load current will increase until it reaches a value determined by either the limit potentiometer and/or the external limit signal. This facility can be used to hold the current below its maximum. It is operative on all firing modes but would normally be used on the phase angle firing mode.

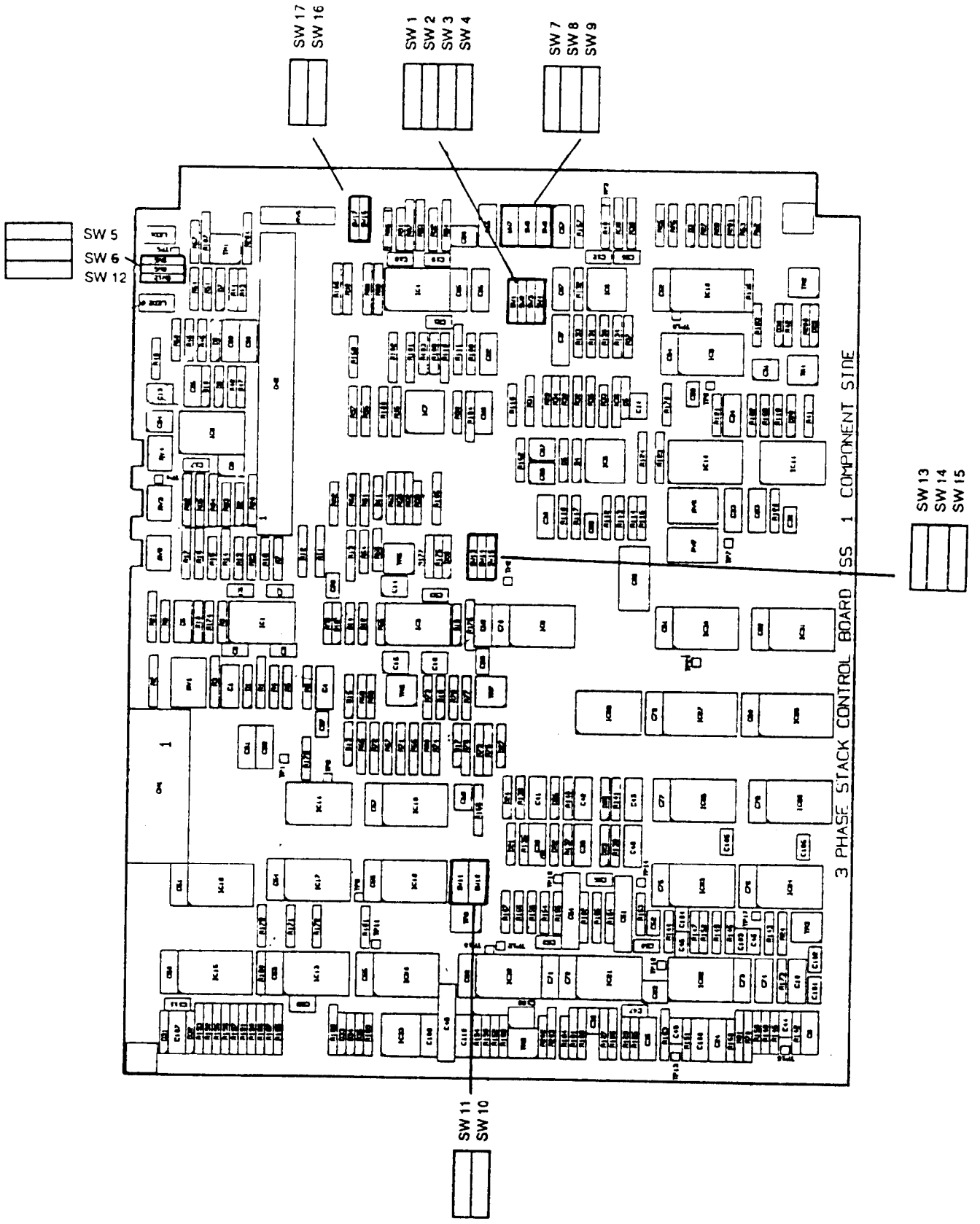


Figure 1. Configuration switch position on Control P.C.B.

Power (Demand) Threshold

In this mode the limit potentiometer and/or external limit signal set a clamp on the control or input signal preventing this demand signal from exceeding the limit value. The function of this limit mode will vary according to the feedback mode selected and is available with all firing modes.

Voltage/Current Transfer Threshold

Voltage/current transfer acts similarly to current threshold but gives better loop stability as the limited current signal is only achieved at 100% demand signal. This threshold is only available with phase angle firing and is recommended for large positive temperature coefficient loads

Voltage/Current Transfer with Power Threshold

As the name suggests this mode is a combination of the power (demand) and voltage/current transfer threshold. It is only available on the phase angle firing output and is recommended for large positive temperature coefficent loads where the power still needs to be limited when the running temperature is reached.

Chop-Off

Chop-off control will inhibit the thyristor unit if the current exceeds the unit rating. This value is factory set and not affected by the limit potentiometer. After inhibition the unit will try to turn on again. If the over current condition is still detected it will again shut-down. After a number of shut-downs normally four, the unit will stay off until a signal is applied to the reset input. If this signal is permanently connected the unit will retry indefinitly. A shut down condition is indicated by the red LED illuminating. Selection of chop-off excludes the use of any threshold control.

INSTALLATION AND DIMENSIONAL DETAILS

Mechanical

The type 414 and 415 are bulkhead mounted units using the rear fixing points. The type 414 is also fitted with alternative side fixing points. Because live parts are accesible whilst the unit is operational it must be mounted into a closed metal cabinet, security being provided by a lockable door, door interlocked circuit breaker or micro-switch operated contactor isolator.

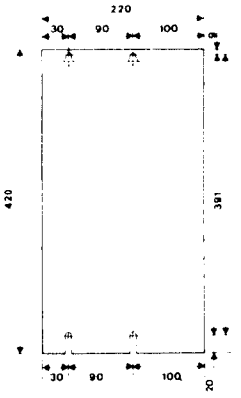
Thyristor units 414 and 415 must be mounted with the heatsink and front label vertical. No obstructions must be mounted immediately above or below the unit as this will obstruct the air flow. Cable trunking used to carry cabling to the unit should be mounted vertically, terminating at the bottom and top of the thyristor on the extreme left hand end of the unit.

If more than one thyristor unit is to be mounted in the same cabinet do not mount units directly above one another so that the exhaust air from one unit enters the unit immedialely above it.

To mount the unit drill the bulkhead as the installation diagram shows below and place the 6mm bolts through the holes and start the nut of each bolt. Offer the 414/415 unit up to these fixings, sliding the slots in the lower edge of the units over the bolt first. Gradually lower the unit down onto these bolts until the bolts of the upper fixing will slide through the key hole slots. Lower the unit until it is fully home, tighten up all fixing nuts and bolts. It should be possible to carry out the installation without removing the cover but if necessary this can be achieved by loosening the fixings, two Dzus fasteners at the right hand edge of the front of the unit and two M4 screws from the rear edge of the left hand side of the unit. This cover must be removed to make the electrical connections.

All dimensions in mm.

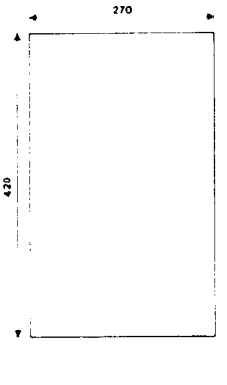
Model 414



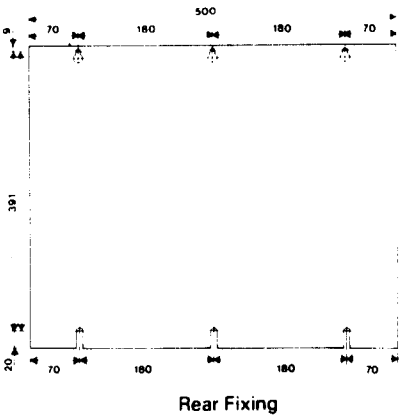
Side Fixing

Rear Fixing

Model 415



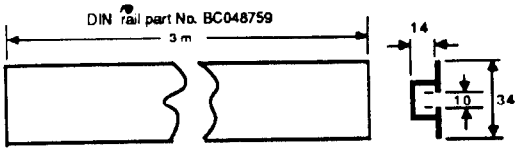
Side Fixing



Rear Fixing

These units can be mounted onto DIN rail as shown below and retained on to that rail using captive nuts part No. FZ048752.

Units must be mounted vertically as shown.
Model 414 may be rear or side mounted.
Mount with 6mm bolts (not supplied).

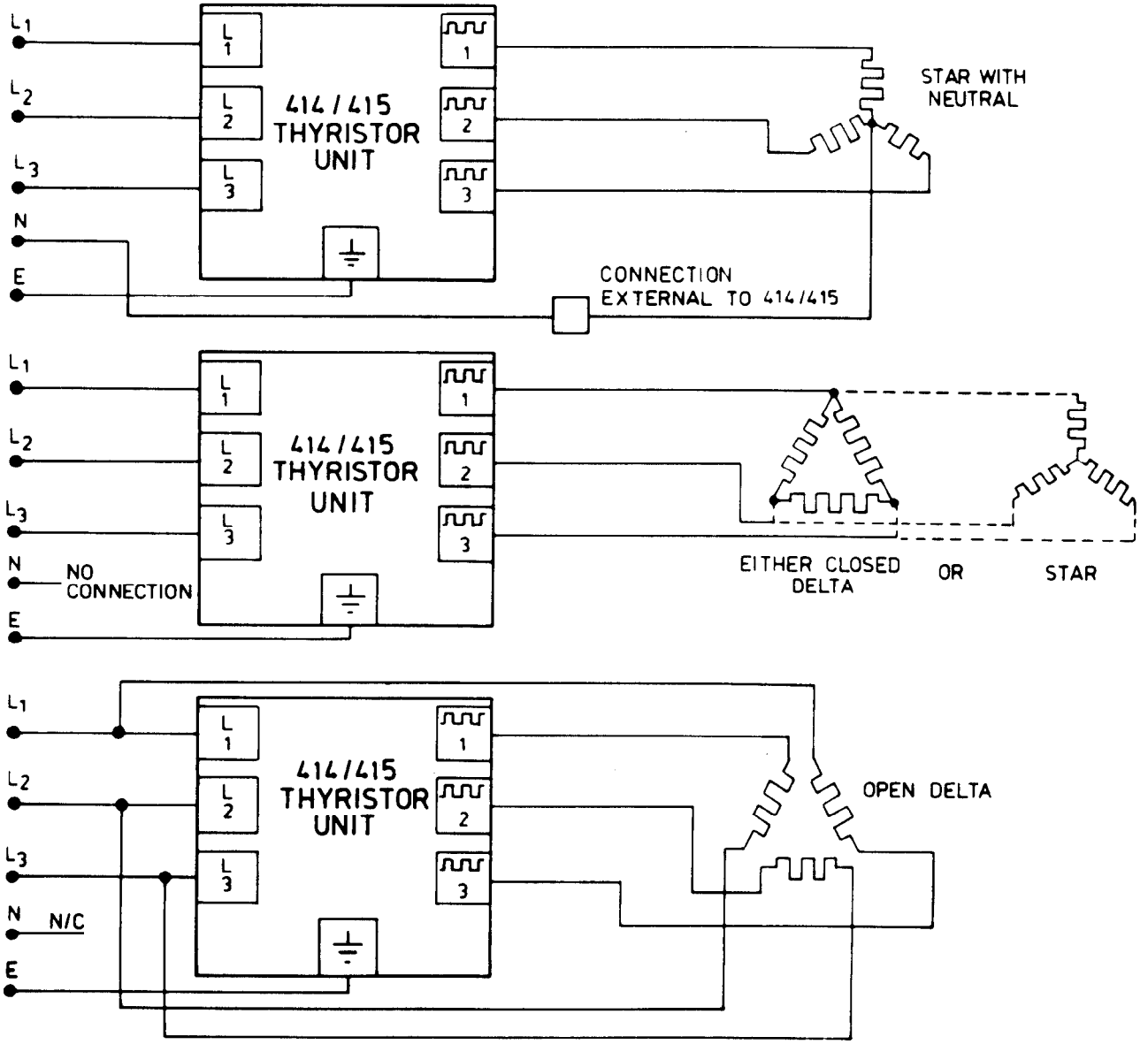


CONNECTIONS AND WIRING

Electrical

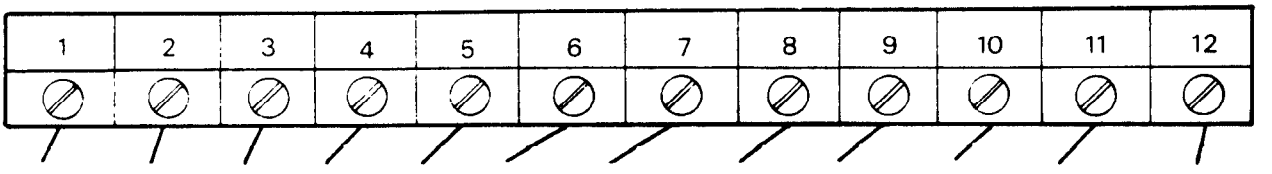
With the cover removed from the unit the heavy current connections labelled L1, L2, L3, 1, 2, 3 and EARTH can be seen. Each heavy current cable brought into the unit has to be terminated in an 8/10mm cable lug. These lugs are then bolted to the appropriate electrical connection using an 8/10mm nut and bolt. The electrical connections for the various types of load configuration are shown below and in the typical wiring diagrams. If a 4 wire connection system is being used no provision is made to terminate the neutral connection within the thyristor units and provision must be made to join the star point to neutral outside the thyristor unit. Unit type 414 uses 8mm electrical terminations whilst unit type 415 uses 10mm electrical terminations.

Heavy Current Connections



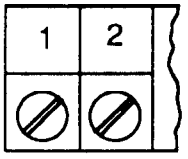
Light Current Connections

The light current or signal connections are made to a 12 way connector block situated on the top of the printed circuit board running parallal with the front panel. This connection block can be unplugged from its base by pulling the terminal block vertically upwards from the thyristor unit, this block will accommodate cable sizes up to 1.5mm square or 14 awg. The connections to this terminal block are shown below:



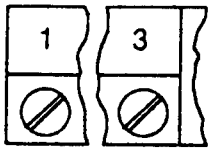
1	2	3	4	5	6	7	8	9	10	11	12
0V Signal	Control Signal (+ve)	Manual Input (+ve)	0V Signal	+10V (5mA)	Threshold Limit Input (+ve) 0-10V (1mA)	Reset (+ve) 5 to 30V (10Kohms) (Input) (Impedance)	Load Current Monitor (+ve) 0-10V (5mA)	Power Feedback Monitor (+ve) 0-10V (5mA)	0V Power	Inhibit (+ve) 5 to 30V (10Kohms) (Input) (Impedance)	Temperature Trip Indicator +15V via 1.5Kohm Pull Up Resistor = Safe Condition 0V = Alarm

Control Signal



The output power of the thyristor unit is directly proportional to the dc supply to terminals 1 and 2. Terminal 2 is always the +ve input and the amplitude and type of input depends on how the unit has been configured. When the unit arrives from the factory this input signal will be 4-20mA unless requested otherwise.

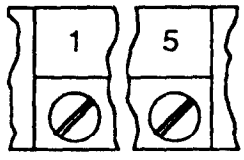
Manual Input



This input also varies the output of the unit, and if used with the control signal input then the output would be proportional to the addition of the two input signals. This input is designed as a manual input developed from a potentiometer placed across the +10 Volt and 0 Volt supply. Consequently this input is always a voltage input and terminal 3 is always +ve. The sensitivity of this input dependes on the configuration of the control input and will have the sensitivity shown in the following table:

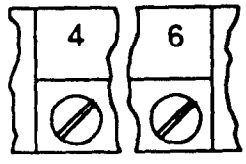
Control Signal	Manual Input
0-5V	0-5V
1-5V	1.25-6.25V
0-10V	0-10V
0-5mA	0-5V
0-10mA	0-10V
0-20mA	0-5V
4-20mA	1.25-6.25V (Approx)

Potentiometer Supply



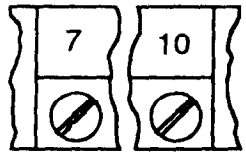
Terminal 5 carries a constant +10 volt supply with respect to the 0V line terminal 1. This 10 volt supply can be used to supply an external potentiometer and provide a setpoint to the manual input. This 10 volt supply can also be used to provide an inhibit signal into terminal 11 or a reset signal into terminal 7.

External Limit



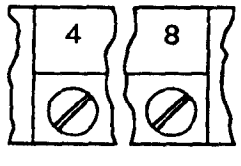
If the unit has been configured for an external limit signal then this 0-10 volt signal can be applied between terminals 6 and 4, terminal 6 being +ve and the current drain into this input is 1mA. As the input signal is reduced from 10 volts towards 0V the limit level of current into the load will also reduce. When using this external signal the internal potentiometer is still operative and the actual limit level is the product of external limit voltage times the internal potentiometer setting.

Reset Input



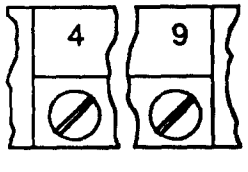
When a dc voltage in the range 5 -30V is applied between terminals 7 and 10, terminals 7 being +ve the unit will reset the latch. This latch is set by the chop-off feature. Maintaining this d.c. voltage will prevent the latch from setting. Alternatively the 10V supply on terminal 5 can be wired to terminal 7 to reset the latch.

Load Current Monitor



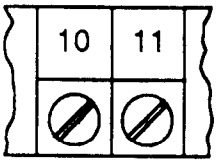
A 0-10 volt signal, terminal 8 +ve, with a current capability of 5mA is available between terminals 4 and 8. This output is proportional to the rectified sum of the three inverse pair of thyristor currents and is scaled to give 10.0 volts output when each inverse pair of thyristors are carrying the maximum current for the particular thyristor unit.

Power Feedback Monitor



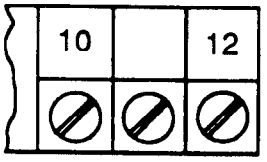
A 0-10 volt signal, terminal 8+ve, with a current capability of 5mA is available between terminals 9 and 4. This output is proportional to V^2, I^2 or VxI where V equals line 2 to 3 load voltage and I equals the sum of the three inverse pairs of thyristor currents The type of feedback mode selected determines the type of power signal obtained. The output is scaled so that with either nominal voltage on V^2 feedback or nominal current on I^2 feedback or nominal voltage and current for VxI feedback the voltage between terminals 4 and 9 is 8.4 volts.

Inhibit



Within 10ms after a dc voltage in the range 5 to 30 volts is applied between terminal 10 and 11, terminal 11 being +ve, the three load lines on the thyrisor unit will be turned off. Removing this dc voltage will reinstate power to the load. Alternatively the +10V on terminal 5 may be linked to terminal 11 to inhibit the output.

Temperature Trip Indication



A dc voltage between terminal 10 and 12 gives an indication of the state of the temperature trip mounted on to the thyristor heat sink. If this temperature trip is in the safe position a 15 volt signal will be present between terminals 10 and 12, terminal 12 +ve. If the temperature trip goes into alarm then this voltage between 10 and 12 will collapse to zero. The 15 volt signal is obtained via a 1.5K ohm pull up resistor, maximum loading = 10K ohms.

Commissioning

Once the unit has been installed and wired, power can be applied to the three incoming lines. This supply powers the electronics inside the unit and no seperate auxilary supply is necessary. Within a very short period of time the top green LED on the front of the thyristor unit should illuminate indicating that:

a) The supply voltage is above the absolute minimum acceptable (approximately 70% of nominal).

b) All phases are alive and none of the fuses within the unit are ruptured.

c) The phase lock oscillator has synchronised with the supply frequency for at least 400ms.

The red LED below the green should not illuminate. If it does illuminate it indicates that either

a) The inhibit input, terminal 11 has been activated or

b) The over temperature trip has been activated.

c) Unit shut down if chop-off mode selected. This is normal for this mode at power up. A reset must be applied to terminal 7.

The thyristor unit should now be operational, and varying the control signal or manual input should vary power into the load. The load power can be monitored by either a voltmeter placed across two of the load connections, a clip on ammeter placed around one of the load cables, or looking at the signal between terminals 4 and 9.

It should be possible to obtain maximum power into the load under these conditions as the unit is despatched with maximum limit set i.e. bottom potentiometer set fully clockwise and the power scaling (top) threshold potentiometer set to give 100% power at the thyristor nominal supply voltage. If however the supply voltage is higher than the thyristor nominal value then it will be neccessary to adjust the top potentiometer "power scaling" with the maximum demand signal so that output power just reaches its maximum power value detected by a voltmeter or ammeter on the load.

If it is necessary to limit the maximum threshold below the nominal value of the thyristor unit, this can be achieved by rotating the threshold limit potentiometer in a counter clockwise direction or decreasing the external limit signal. A true RMS reading ammeter should be used when setting the current.

When the cycling with soft start and stop mode of firing is selected, the number of cycles over which the soft start and stop occurs can be controlled by the soft start potentiometer. The range is 3 to 12 cycles. All units are despatched with the potentiometer fully clockwise to give the maximum number of cycles.

Fault Finding

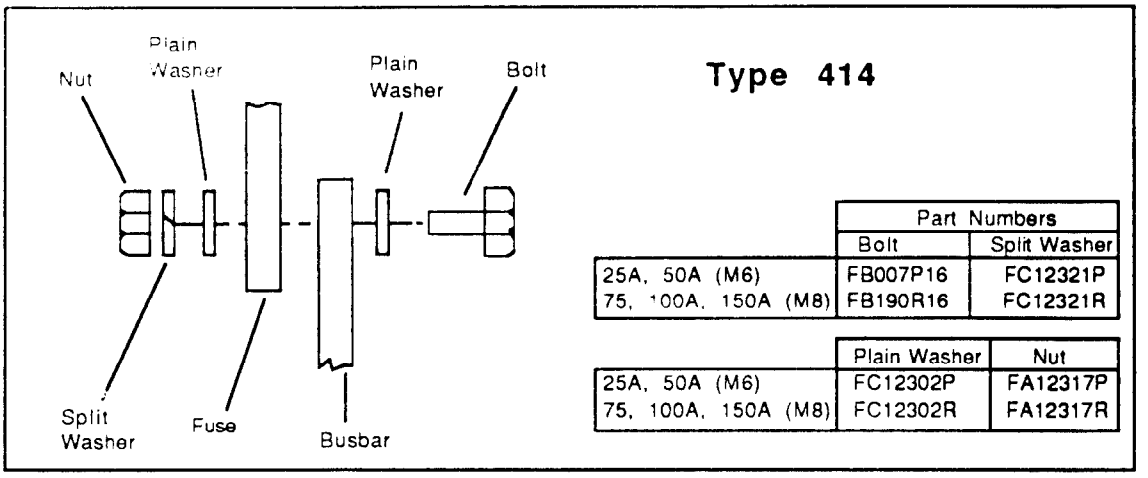
All 414/415 units are provided with a front accessible diagnostic socket. A Eurotherm type 260 diagnostic unit can be plugged into this socket and measurements of critical parts of the circuitry taken which will help to isolate a fault to the load or the thyristor unit. For more information about the measurements taken with the type 260 please refer to the maintenance manual type 414M.

Fuses

If any of the fuses within the 414/415 unit rupture they should be replaced by the Eurotherm recommended type as given in the table below:

Maximum Current Rating of Thyrisor Unit	Number of Fuses per Thyristor Unit	Fuse Type	
		Commercial Reference	Eurotherm Part Number
25A	3	32 ET	CS021876U001
50A	3	80 ET	CS021876U002
75A	3	90 EET	CS021876U003
100A	3	120 FEE	CS021876U004
150A	3	200 FEE	CS021876U005
175A	3	D 87012	CS021796U001
225A	3	E 87013	CS021796U002
330A	3	F 87014	CS021796U003
500A	3	N 78005	CS021796U004
INSTRUMENT	1	660V FA 0.25 A6x32	CH200251

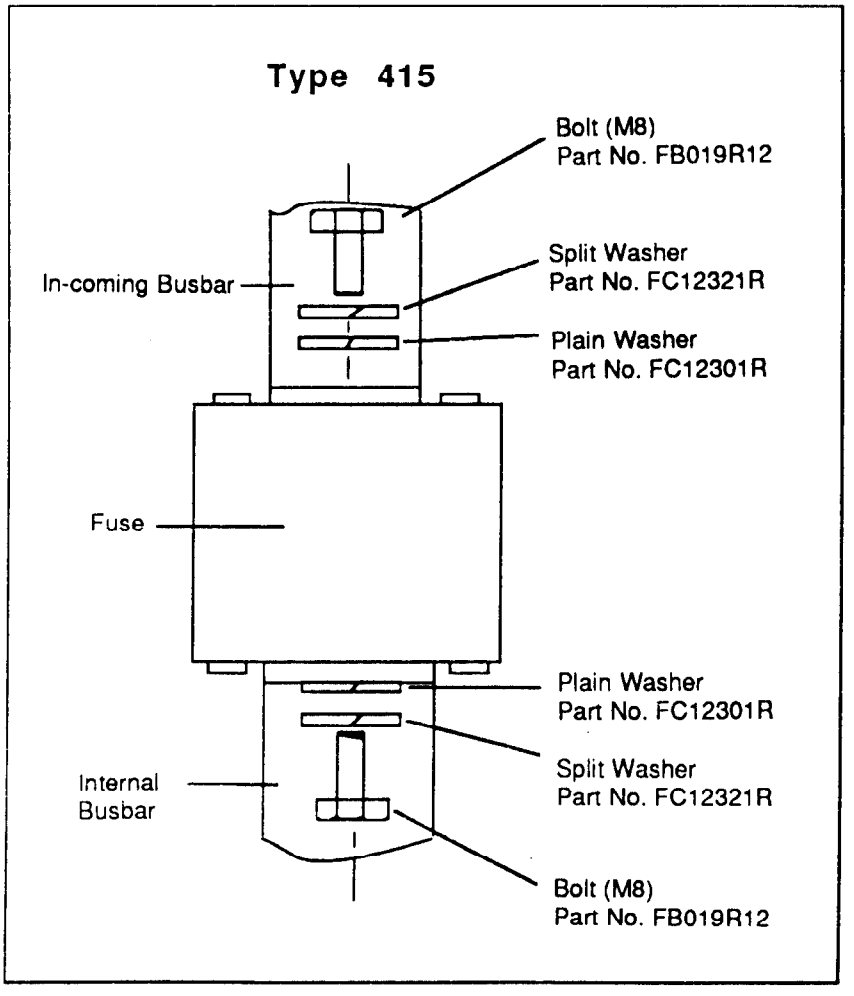
NOTE: It is essential, when replacing fuses, that the correct sequence of assembly of nuts, bolts and washers are adhered to. When reassembled, two spanners of the correct size should be used to tighten the fixing securely. Failure to comply with these instructions could cause overheating of the unit.



Type 414

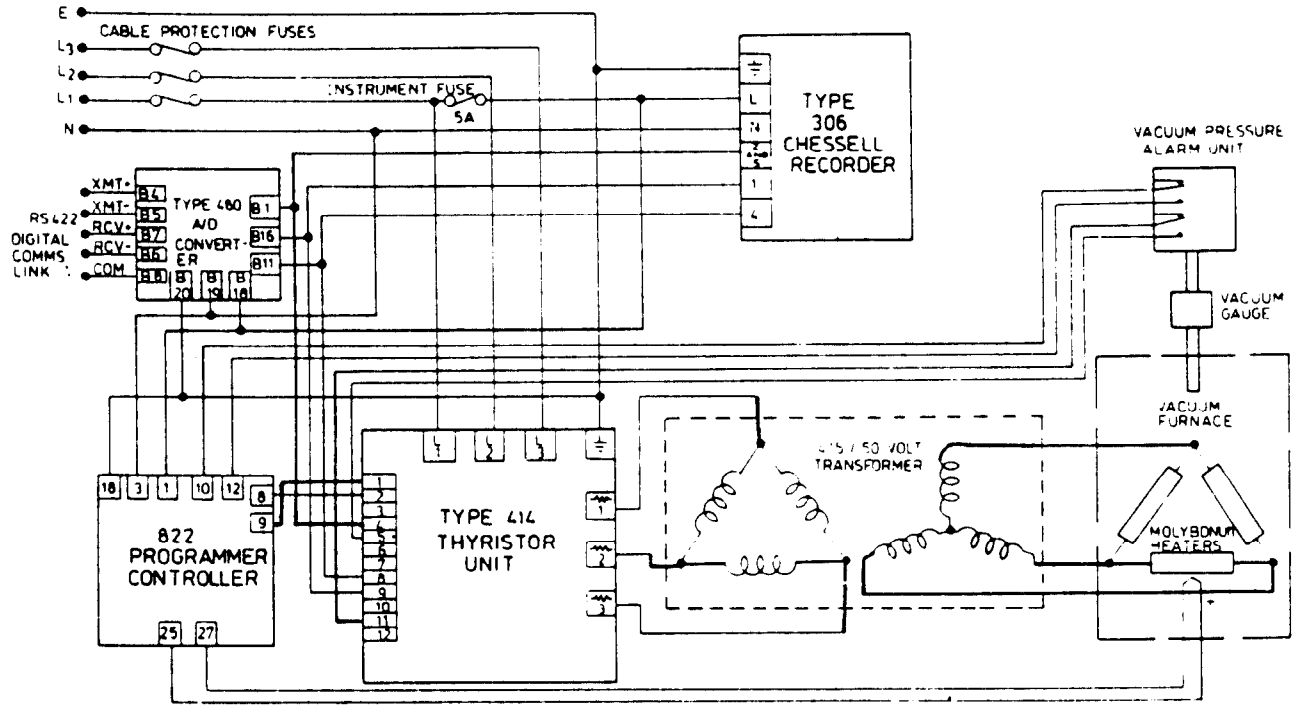
	Part Numbers	
	Bolt	Split Washer
25A, 50A (M6)	FB007P16	FC12321P
75, 100A, 150A (M8)	FB190R16	FC12321R

	Plain Washer	Nut
25A, 50A (M6)	FC12302P	FA12317P
75, 100A, 150A (M8)	FC12302R	FA12317R

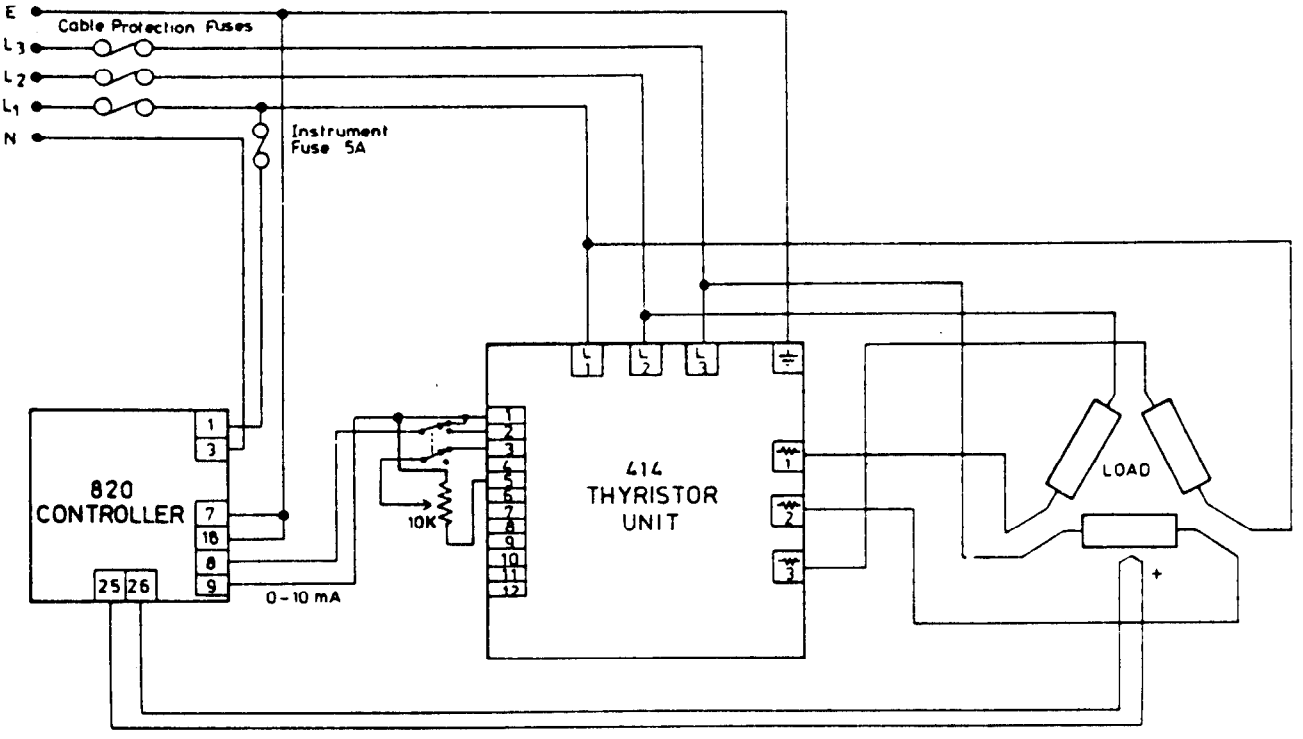


Fuse Assembly Details

Typical Schematics



Molybdenum Vacuum Furnace, controlled from a 414 Thyristor unit via a transformer, with Inhibit and Program hold on out-gassing and monitoring of power and current.



Three Phase Open Delta (6 wire) Load controlled with a 414 Thyristor unit and 820 Controller (fitted with external Auto/Manual station).

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