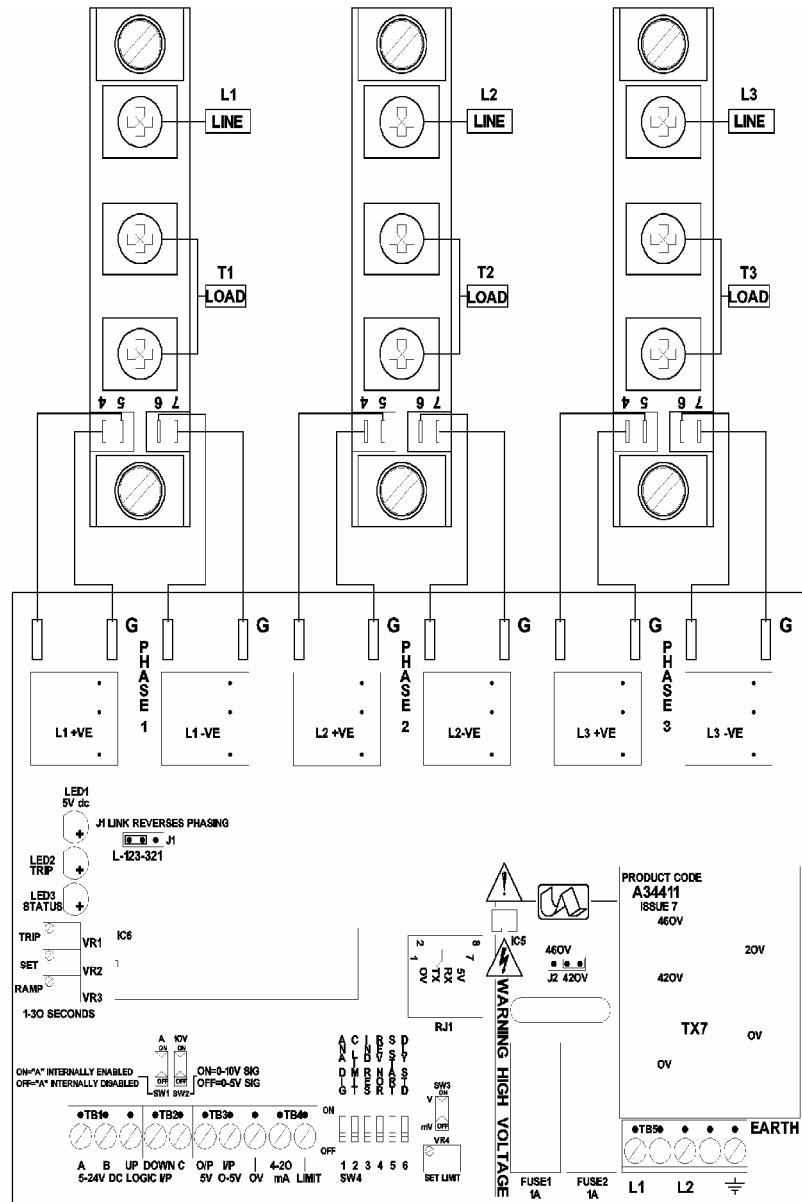


# Thyristor Connections



## LOGIC CONTROL INPUT

The logic control inputs are optically isolated and are ideally utilised for remote control in electrically noisy environments. The logic inputs A, B, UP and DOWN are activated by a 5 to 24 V dc signal with respect to terminal C which is 0 V. The logic input can also be activated by the 5V dc output from the FC36M via relay switching.

For the following logic control options, position No.1 on the 6 way DIL switch (SW4) should be switched to the OFF position. For additional control options see table A.

### Logic control

Maximum power output levels are set by the input voltage at the terminal marked SIG I/P. With, for example, 4V on this input, the output will be limited to a maximum of 80%. Link the SIG I/P terminal to the 5V output terminal for 0-100% control range.

### Phase Angle control

Option 1 – the switch marked SW1 can be switched to the ON position, which utilises the internal 5V supply. This ON position simply connects terminals A with 5V.

Option 2 – the switch marked SW1 can be switched to the OFF position. The position isolates the inputs and disconnects terminals A from 5V. Inputs A and C then require an external supply between 5 and 24V dc.

### To Increase output power

The terminal marked UP requires a 5 to 24 V dc supply. Terminal C is 0V. The output power will increase at a rate determined by the ramp setting on VR3 (0-30 seconds). The output will reach its maximum when the ramp time has elapsed. If the UP signal is terminated during the ramp time the output will remain at that level, for example, if ramp time is 10 seconds. UP signal is on for 5 seconds, power output will ramp up to 50%.

### To decrease output power

The terminal marked DOWN requires a 5 to 24V dc supply. Terminal C is 0V. The output power will decrease at a rate determined by the ramp setting of VR3. The output will decrease to zero should the DOWN signal be maintained. If the DOWN signal is interrupted before the ramp down time has elapsed, the output will stay at that level. Proportional control can be achieved with an on/off signal. This arrangement is particularly useful for temperature controllers, relay switching and PC based process controllers.

### Burst Fire control

The switch marked SW1 should be switched to the OFF position and the terminal marked B should be linked to 5V. Link terminals marked 5V and SIG I/P. For remote Burst Firing control, a 5 to 24V dc signal should be connected between B and C. C is 0V.

### Inductive or Resistive loads

With switch position 3 on DIL switch No.4 in the OFF position, the firing circuit is configured to control resistive and some slightly inductive loads. When the switch is in the ON position, the firing circuit should be used on inductive (transformer and coil) type loads.

### Current Limit

The current limit input is designed to operate from either a 0-100mV (SW3-OFF) or 0-25V (SW3-ON) dc input connected between terminals marked LIMIT input and 0V. With maximum current limit feedback signal, adjust VR4 so that approximately 3.5V dc appears on pin 1 of IC8. This voltage is fed into the microprocessor IC5 and compared with the voltage set by VR2 (I SET), which can be measured on pin 5 (IC6). When the voltage on pin 1 (IC8) is greater than the voltage on pin 5 (IC6), the controller will start to ramp down until the current reaches the I SET level.

### Current Trip

The current trip is designed to operate from either a 0-100mV (SW3-OFF) or 0-25V (SW3-ON) dc input connected between terminals marked LIMIT input and 0V. With maximum current limit feedback signal, adjust VR4 so that approximately 3.5V dc appears on pin 1 of IC8. This voltage is fed into the microprocessor IC6 and compared with the voltage set by VR1 (I TRIP), which can be measured on pin 7 (IC6). [continued]

When the voltage on pin 1 (IC8) is greater than the voltage on pin 7 (IC6) the controller will shut down immediately and will stay latched in this state until the microprocessor is powered down or reset. The voltage on pin 7 (IC6) is normally set to 4.2V to allow for a 120% maximum current level.

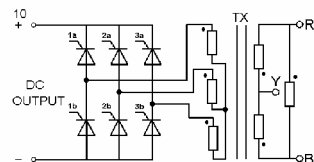
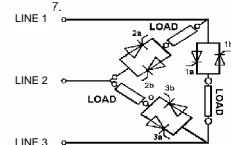
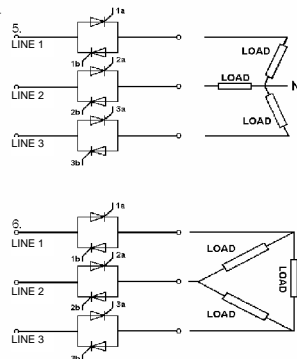
Table A

Switch No.1	Function Selected		
Position 1	Up	On	"A" internally enabled
	Down	Off	"A" internally disabled
Switch No.2	Function Selected		
Position 1	Up	On	0-10V Signal
	Down	Off	0-5V Signal
Switch No.3	Function Selected		
Position 1	Up	On	0-5V limit signal input
	Up	On	0-100mV limit signal input
Switch No.4	Function Selected		
Brown Position 1	Up	On	Analogue input, 0-5Vdc, 0-10Vdc and 4-20 mA and SW1 in On position
	Down	Off	Logic inputs A: Phase Angle, B: Burst Fire, U: Up, D: Down
Red Position 2	Up	On	Limit input 0-100 mV (SW3-off) or 0-25 (SW3-ON), Current Limit Set by VR2
	Down	Off	Limit input off
Orange Position 3	Up	On	Inductive load timing
	Down	Off	Resistive load timing
Yellow Position 4	Up	On	Reverse pulse transformer outputs
	Down	Off	Standard pulse transformer outputs
Green Position 5	Up	On	Soft Start/Slew rate ENABLED (1 second factory preset)
	Down	Off	Soft Start/Slew rate DISABLED
Blue Position 6	Up	On	Timing for 12 pulse operation using additional FC36M
	Down	Off	Standard timing position

## Power connections

AS SHOWN ON STACK DATA SHEET

- 5. 4 WIRE 3 PHASE WITH STAR POINT TO NEUTRAL  
NOTE: FLOATING STAR LOAD WHEN NEUTRAL NOT USED
- 6. 3 WIRE 3 PHASE CLOSED DELTA LOAD
- 7. 6 WIRE 3 PHASE OPEN DELTA LOAD
- 10. 3 PHASE CONTROLLED DC



6

## TECHNICAL SPECIFICATION

### SUPPLY

FC36M (400V)  
FC36M (230V)  
FC36M (110V)

360/440V ac @ 50/60 Hz  
205/255V ac @ 50/60 Hz  
95/125V ac @ 50/60 Hz

### ISOLATION

Isolation voltage

3500Vrms

### CURRENT CONSUMPTION

Full conduction – TX secondary

350mA

### GATE PULSES

Initial short circuit gate current  
Sustaining short circuit gate current  
Initial pulse voltage (open circuit)  
Sustaining pulse voltage (open circuit)  
Initial gate pulse rate of rise  
Pulse width 50/60 Hz  
Pulse train frequency

500mA  
250mA  
9V  
5V  
1A/us  
22us  
25 kHz

### OPERATION MODES

Selection by input enable or auto

Burst Fire and Phase Angle

### CONTROL SIGNAL ANALOGUE

Voltage signal into 10K ohms / 20K ohms  
Current signal into 240 ohms

0 – 5 V dc / 0-10V dc  
4 – 20 mA

### CONTROL SIGNAL LOGIC

Opto-isolated inputs

5 – 25 V dc

### SOFT START

Adjustable range from power up

0 – 30 seconds

### CURRENT LIMIT

Controlled limit or over-current trip  
Selection by SW3

0 – 100mV or 0-25V dc

### LOAD OPTIONS

Selection by switch (SW4)

Resistive or Inductive

### TEMPERATURE LIMITS

Operating range (°C)  
Storage (°C)

0 - 65°C  
0 to 85°C

### MECHANICAL DIMENSIONS

Length (mm) x Width (mm) x Height (mm)  
Holes and fixing centres (mm)

162 x 108 x 40  
150 x 62

### FUSING

It is recommended that semiconductor fast acting type fuses or circuit breakers (Semiconductors – MCB) be used for device protection. On initial operation, some loads may need an increased Factor of Safety (F of S) for unit and/or device protection. See SRA Data sheet X10255 for further information.

### Manual Control

The FC36M firing circuit has a 5Vdc output that can be used to supply the clockwise end of a 5K ohm potentiometer. The wiper is connected to the terminal marked SIG I/P and the counterclockwise end to 0V.

### Voltage control

For control using a remote dc signal the positive input should be connected to the terminal marked SIG I/P and the negative input to be connected to 0V. The input impedance is 10K ohms for 0-5V input and 20K ohms for 0-10V input.

### Current control

For current control connect a 4-20mA dc signal between terminals marked 4-20mA and 0V. This input can also be used as 1-5V dc input. The input impedance is 240 ohms.

### Phase Angle control

Option 1 - the switch marked SW1 should be switched to the on position. This position connects terminals A with 5V.

Option 2 - (see Soft Starting) the switch marked SW1 can be switched to the OFF position. The OFF position isolates the inputs and disconnects terminals A from 5V. Inputs (A and C) then require an external supply between 5 and 24V dc.

### Burst Firing control

The switch marked SW1 should be switched to the OFF position and the terminal marked B should be linked to 5V.

### Phase Angle to Burst Firing control

The switch marked SW1 should be switched to the ON position and terminals A and B should be linked together. The firing circuit will start in phase angle mode and switch to burst mode when the control signal ramps up to the set point. It will stay in the burst mode even if the signal drops below the set point. It will restart in phase angle mode when the unit is switched off or reset.

### Soft Start

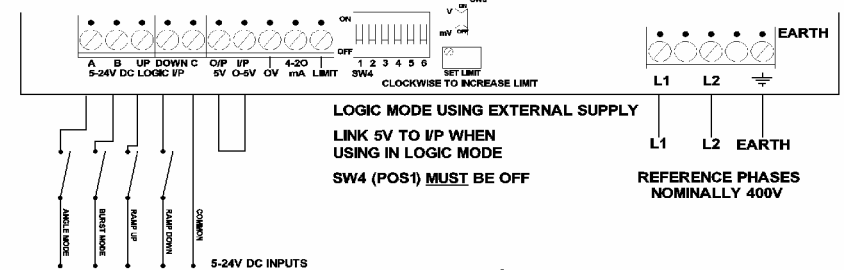
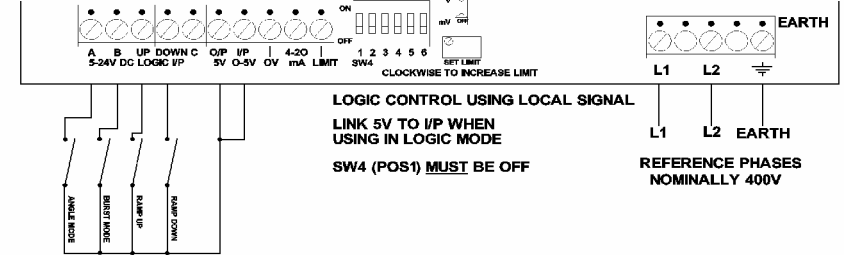
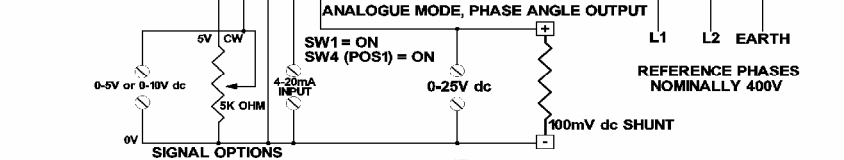
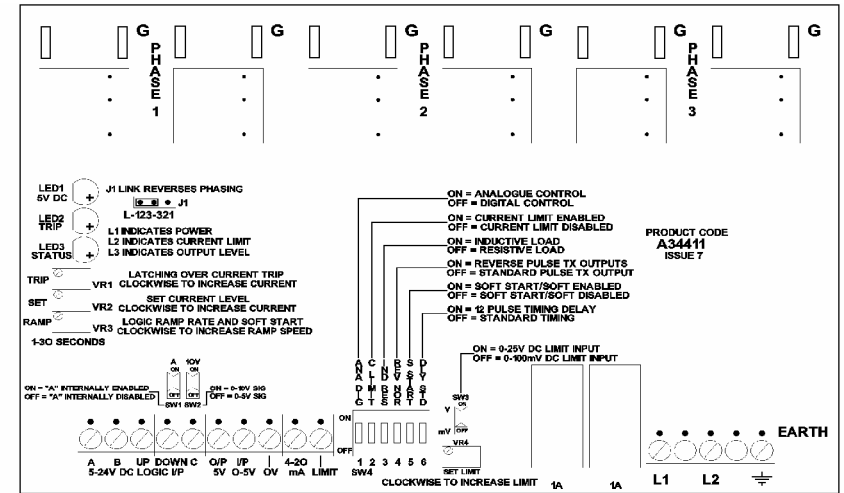
When the FC36M is initially powered up the output is inhibited for 0.5 seconds, then the soft start is automatically enabled and the firing circuit will ramp up at a rate determined by VR3 (0-30 seconds). The ramp time relates to full conduction, for example, if the ramp time is set to maximum (30 seconds) and the set point is 50% the controller will ramp to the set point in 15 seconds.

### Soft Stop and Soft Start after power up

Soft Stop after power up can be achieved by disconnecting the I/P signal. SW4 position No.5 should be switched ON, thus bringing in a preset "slew" rate of 1 second. Other rates of up to 5 seconds can be programmed via a Commander Module. Refer to the Commander Module manual for more information. Whilst the signal is present it will remain in the on state until the signal is removed. Another option is to Enable/Disable the ramp down input. Enabling it will ramp down the output at a rate determined by VR3. Disabling it will ramp up the output up to the level on the SIG I/P terminal, again at a rate determined by VR3.

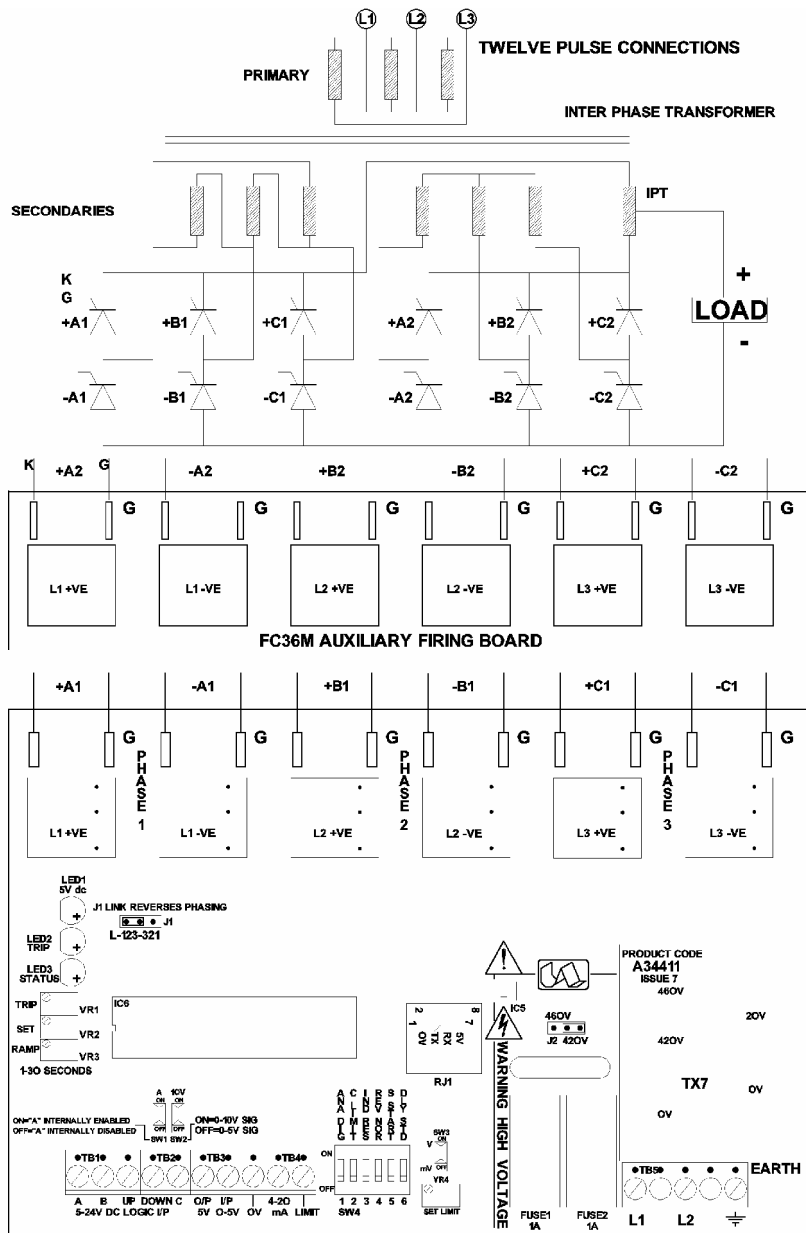
### Hard Stop and Hard Start after power up

Hard Start and Hard Stop after power up can be achieved with the switch marked SW1 in the OFF position and the ramp preset (VR3) turned to the fully clockwise position. When A or B inputs are enabled or disabled and SW4 position No.5 is in the OFF state, the firing circuit will immediately turn on and off.



**WARNING**  
 ENSURE SUPPLY IS OFF WHEN MAKING CONNECTIONS AND ADJUSTING ON BOARD SWITCHES

# Twelve Pulse Connections



## Application

- Power Supplies
- Half and Fully controlled Rectifiers
- AC Motor Control
- DC Motor Control
- Soft Starters
- Heater Controllers
- Induction Generator
- AC Voltage Regulation
- Three Phase Transformer Control

Additional Firing boards can be configured to trigger paralleled SCR's for very high current applications or to provide a twelve pulse driver for smooth DC control

### Key Features

Thyristors require a high initial gate current pulse and comparatively wide sustaining pulses to ensure reliable firing, particularly at small phase control angles. The FC36M provides the following firing specifications

- Gate Drive: Picket Fence with a PRF of 25Khz an initial firing pulse of; 8 volts open circuit. 500 mA into 1 Ohm, and sustaining pulses 250mA into 1 Ohm per output. The sustaining pulses are 20 uS Wide.
- High output initial triggering pulses
- Gate isolation to 3500 V rms.
- Adjustable Soft start and soft start times
- Selectable hard start and hard stop
- 50/60 Hz operation auto selection
- Remote Logic input for control in noisy environment 5-24 V dc
- 3 analogue control inputs 0-5 V 0-10V dc and 4-20mA
- Current control input 0-100 mV
- Over-current limit trip (Latching)
- Adjustable ramp control 0-30 seconds
- Pre-selectable or automatic Phase Angle to Burst Fire control
- Switchable Phase reversal
- Selectable Inductive or Resistive load setting
- Selectable timing delay for use as a twelve pulse driver
- High immunity to mains voltage distortions
- Complete with integral phasing and supply transformer.

## OPERATING INSTRUCTIONS

### APPLICATIONS

The firing circuit responds to voltage or milliamp current signals to produce six, 60°spaced high current thyristor gate pulses. Additional boards can be configured for high current parallel gating of additional thyristors and for twelve pulse converters (rectifiers).

### CONNECTIONS

The Gate and Cathode outputs have 6.3mm blade terminals. All other connections are made with captive screw and leaf terminal blocks. 0.25mm header connections are provided to connect firing boards for paralleled thyristor drive or 12 pulse configuration.

Note: - J1 Jumper reverses phasing.

### LED INDICATION

Three LED's are used for status and fault indication. LED1 (green) illuminates when the 5 volts dc supply is present.

When SW4 position No 2 is ON, LED 2 (red) will illuminate when the LIMIT input has reached the level set by (I SET)

LED 2 and LED 3 (orange) will alternately flash on a 1 second timebase when the LIMIT input exceeded the value set by VR1 (I TRIP). The FC36M will shut down and will stay latched in this statue until the FC36M is powered down or reset.

Under normal conditions LED 3 is used to indicate the output status. In phase Angle mode, when the control signal is increased, so does the brightness of LED 3. In Burst Fire mode LED 3 will pulse on a one second timebase with a variable mark space (on-off) ratio determined by the control signal.

### ANALOGUE CONTROL INPUTS

For the following analogue control options the 6 way DIL switch (SW4) should have position No.1 switched to the ON position. For additional control options see table A on page 6 of this manual.

### Three Phase Firing Board Model – FC36M

This manual should familiarise the user with the relevant features and specifications of the FC36M firing board and incorporates a simple checkout procedure with typical connection diagrams.

#### FC36M General information

The FC36M is a microprocessor version of the industry standard FC36A originally developed in the 1980s. It is smaller in size than its predecessor with a reduced component count, which increases its reliability. It also has more options available with the selections on a six way DIL switch making it much more versatile and economical. It has an integral supply and timing transformer, which is used as a Phase reference.

The FC36M is a general purpose Phase Angle and Burst Firing circuit designed to be used in a variety of two or three, phase 50/60 Hz applications. It can also be used as a Three single phases to Neutral controller. It is easily configured by the user, to optimise its performance, which is achieved primarily by the use of DIL, switches.

To make a complete three/ phase controller, the FC36M requires power devices, protection fuses and a suitable heatsink. It can be used for driving three phase transformer primaries in either star, delta or phase to neutral configurations and can also be configured to control either three phase, half or fully controlled, thyristor bridges.

It may be used on resistive loads (phase to phase or phase to neutral), using burst fire or phase angle, or a combination of both firing modes. Its analogue signal inputs can be used in conjunction with each other, to set two different output levels. The logic opto-coupled inputs allow for remote control in electrically noisy environments. There are two current set points – the lower one is used for current control and the upper limit, when tripped, will cause the unit to latch in the off state.

The firing circuit is based around the PIC18F458 Microprocessor running at a clock frequency of 20MHz, generating six controlled thyristor gate pulses nominally displaced by 60°. It can be controlled by either 0 to 5v, 0 to 10v or 4 to 20mA analogue signal or remote 5 to 24V dc logic signal. The logic inputs also provide remote soft start, soft stop and switching from Phase Angle to Burst Fire either manually or automatically.

This model is available in various supply voltages – see technical specifications for more details.

#### Remote Programmer

A Commander Module (CM-FC36M/MV) has been introduced to complement this Firing Board. The Commander Module is a Human machine Interface (HMI) control unit, which incorporates a simple keypad to input data and a console that displays all the functional information relating to the firing circuit settings. This includes current control switch settings, the conditions of the inputs and many other features such as timing calibration, slew rate setting.

Its compact size and simple connection by means of a RJ45 lead allows OEMs to easily incorporate the FC36M into their product design and end users can update existing equipment very quickly with little development costs. It can also be supplied with a DIN rail mounting enclosure.

Please refer to the Commander Module manual for further information.

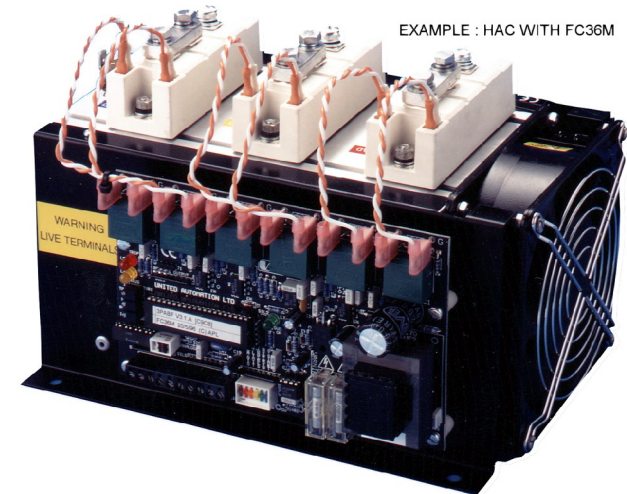
### RECOMMENDATION & SAFETY REQUIREMENTS

Other documents, which may be appropriate for your applications, are available on request.

#### **CODE IDENTITY DESCRIPTION**

X10229	RFI	Filter recommendation: Addressing the EMC directive.
X10213	ITA	Interaction: Uses for phase angle and for burst fire control.
X10255	SRA	Safety requirements: Addressing the Low Voltage Directive (LVD) including, Thermal data/cooling, Live parts warning Earth requirements and Fusing recommendations.
X10378	ILR	Inductive loads remedy sheet for use with Phase angle controllers.
X10652	CM-(FC36M/MV)	Commander module (remote programmer)
AP02/4	COS	UAL Conditions of sale

**NOTE:** It is recommended that installation and maintenance of this equipment should be carried out by suitably qualified personnel, with reference to the current edition of the I.E.E. Wiring Regulations BS7671. The regulations contain important requirements regarding the safety of electrical equipment. For International Standards refer to I.E.C. Directive I.E.C. 950.



## UNITED AUTOMATION LTD – Putting you in control

The FC36M is one of a range of quality, reliable and cost effective power control products that we offer. For further details see our website [www.united-automation.com](http://www.united-automation.com)

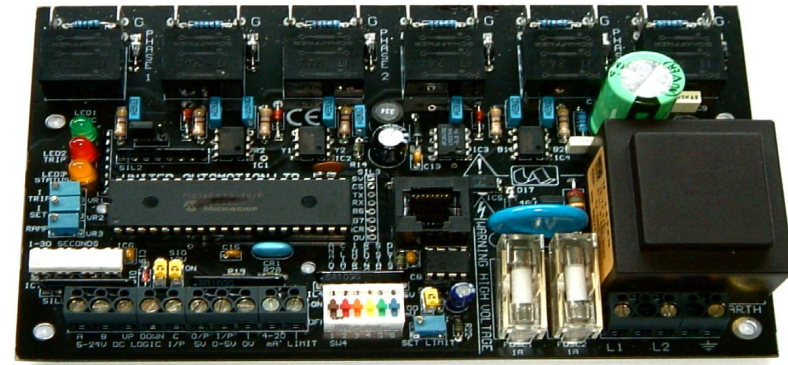
### Product Portfolio

Power Supplies to Specification  
Heating, Ventilation and Air Conditioning (HVAC) systems  
Automatic Control Systems  
Thyristor or Operated Systems  
Electronic Controls for Heating Systems  
Thyristor Phase Control Products  
Microprocessor based Water Heating Controllers  
Command & Control Systems  
Modular High Voltage Power Supplies  
Electronic Temperature Controllers  
Automatic Control Systems for Controlled Atmosphere Furnaces  
Automation Control Systems for Glass and Ceramics Manufacturing  
Solid State Power Supplies for Electroplating  
Triacs  
Semiconductor Controlled Rectifier Stacks  
Thyristor Trigger Modules  
Electronic Assemblies  
Solar Heating Automatic Control Systems  
Solid State Relays  
Digital Energy Modules  
Fuses  
Filters (Single and 3 Phase)

### Product Applications

Heaters  
Ovens  
Stress Relieving  
Lighting Equipment  
Power Supplies  
Furnaces  
Vats  
Trace Heating  
Annealing  
Vibrators  
Dryers  
Extruders  
Smelting  
Plating  
Electromagnets  
Voltage Controlled Motors  
Pipe Heating  
Process Heating  
Vending Machines  
Space Heating  
Lamp Loads  
Blenders  
Mixers  
Pumps  
Quartz Lamps  
Fans

## Three Phase Firing Board Model – FC36M



## User Manual



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