FOUR CHANNELS OF INDEPENDENT CONTROL . . .

STAGE LIGHTING

THIS Stage Lighting Dimmer was built to the specific requirements of an amateur revue company. It consists of four independent channels each capable of dimming 13 amps (3250 watts) of incandescent (not fluorescent) lighting. The number of channels may be increased as necessary providing the current capability of the input is uprated.

SYSTEM DESCRIPTION

Each of the four dimmable channels is controlled by a linear slider fader. Any channel can be switched to a Master Fader which is a double unit made up of two stereo slider potentiometers. The Master has control over all channels simultaneously when required.

Each channel has a mimic light next to the fader control which gives a visible representation of the relative brilliance of the lights plugged into that channel.

A preset potentiometer in each channel allows the cutoff point of each channel to be adjusted for different wattage lamps with differing thermal capacities.

Interference suppression is included and the dimmers are mounted in an earthed box to reduce radiation.

The output to each channel is fed *via* a 13 amp switched socket and input from the mains is taken *via* a 60 amp fused switch which can act as a "Master Blackout" control when it is necessary to cut out all the lamps in the fastest possible time.

CIRCUIT OPERATION

Each of the four channels uses an identical circuit which uses a triac to control the current through the lamps. The basis of this circuit is shown in Fig. 1.

A triac is a four layer semiconductor device with three terminals. It will only conduct when a voltage is applied to the gate (g) terminal and will then continue conducting in either direction even when the gate voltage is removed. It will cease to conduct when the current through it drops below a threshold level known as the holding current.

The circuit shown in Fig. 1 varies the average current through the lamps by controlling the point in the mains cycle at which the triac is triggered into conduction. This method of control is known as phase control.

EACH CAPABLE OF DIMMING 3¼ kW OF LIGHTING

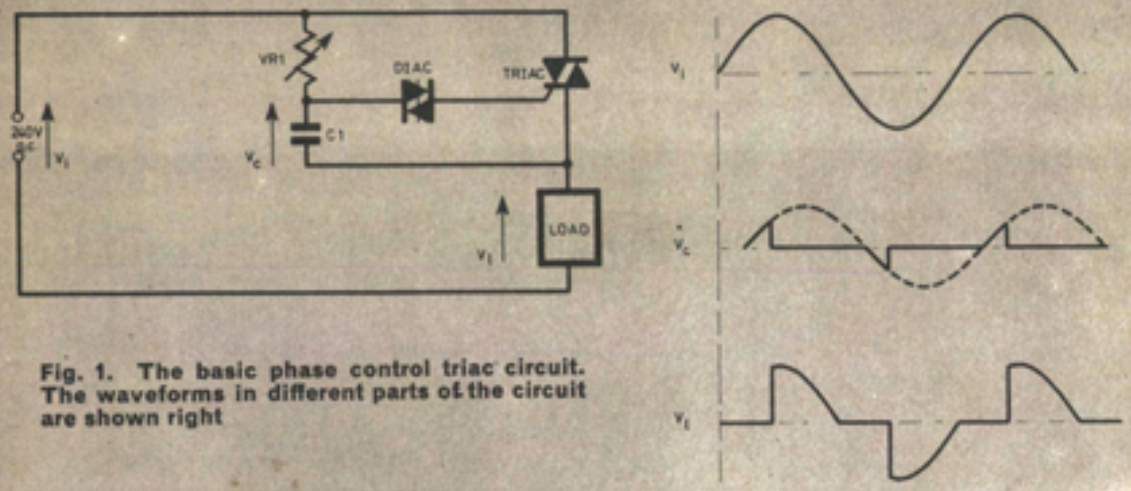


Fig. 1. The basic phase control triac circuit. The waveforms in different parts of the circuit are shown right

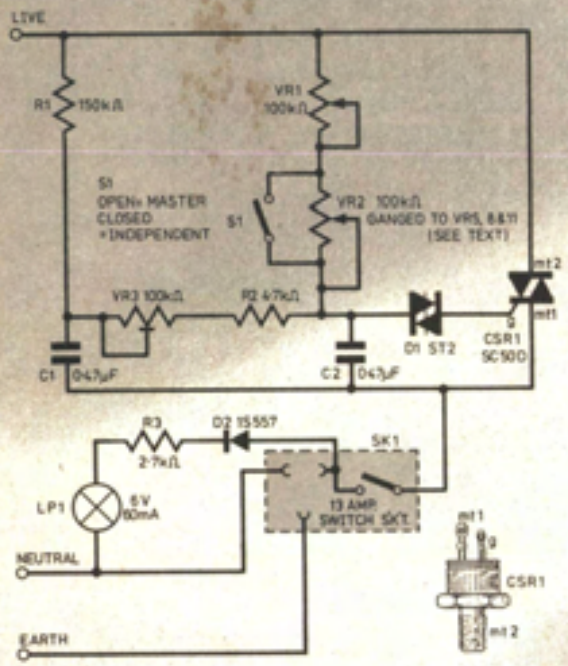


Fig. 2. The circuit of one of the control channels of the Stage Lighting Dimmer. Four identical channels are used in the unit

Referring to Fig. 1, capacitor C1 and variable resistor VR1 form a phase shift circuit which alters the phase of the signal at their junction with respect to the applied mains voltage.

The diac in series with the triac gate is a four-layer device which presents a high impedance until the voltage across it exceeds a value known as the breakdown voltage (about 30 volts) when it presents a low impedance. When the breakdown voltage is reached the capacitor C1 discharges into the gate of the triac causing it to conduct. Typical waveforms are also shown in Fig. 1.

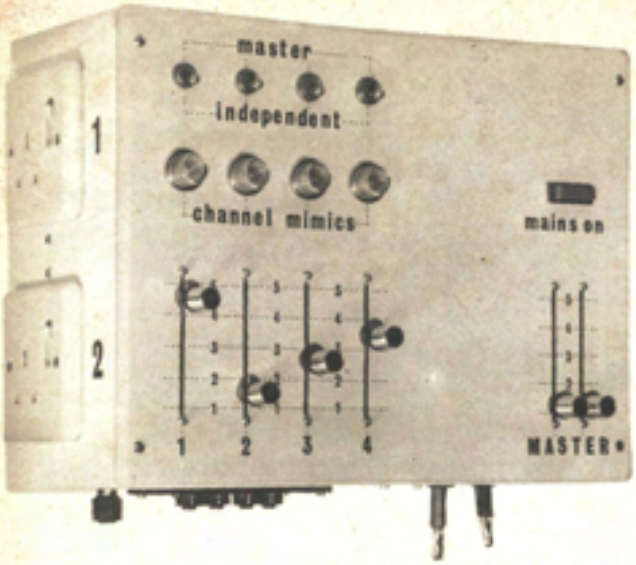
COMPLETE CIRCUIT

In the actual circuit used, shown in Fig. 2, VR1 is the Channel Fader and VR2 is one section of the Master Fader which can be over-ridden by S1 to give independent control. VR1 and C2 form the phase control network and R1 and C1 are additions to provide smooth control at low light levels.

The current supplied by R1 and C1 is determined by VR3 in series with R2. VR3 can be used to

DIMMER

By R. Liffen



Photograph showing the layout of the components on the front panel and the output sockets mounted on the side of the case. Another two sockets are similarly fixed the other side

preset the extinguishing point of the lamp when the Channel Fader is fully down. There are two modes of use for VR3: it may be used to fully extinguish a lamp which would otherwise "sing" (due to the filament vibrating in the presence of small residual spiky current; alternatively it may be set so that the filament glows dull red, which enables a big lamp to be taken to full brightness quickly.

MIMIC CIRCUIT

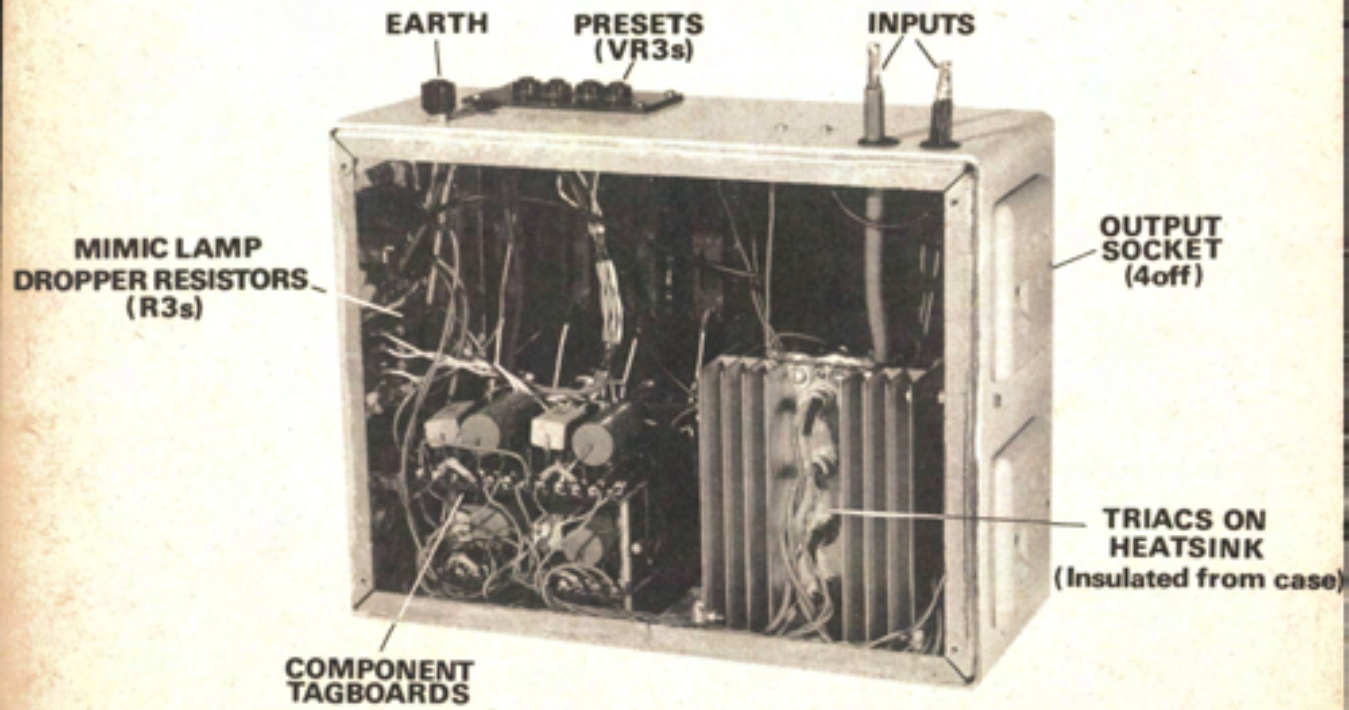
Components D2, R3 and LP1 form a "mimic" circuit to give a visual indication of the lamp brightness. D2 and R3 simply reduce the mains voltage down to six volts. The four resistors (R3 and its counterparts) dissipate nearly 10 watts each and must be placed in a well ventilated position.

Note the special connection between the switchboard 13 amp socket and D2. This is necessary because with no lighting load plugged in, the leakage through the triac will give a glow in the mimic lamp which can be disturbing to the lighting operator. With no lamp plugged in, the channel should be switched off at the socket.

The point to connect D2 will be found as a copper rivet head on the rear of the socket and should be verified with an ohmmeter.

LOAD CONNECTION

The load is connected on the neutral side of the triac. This reduces the risk of electric shock from



Photograph showing the arrangement of the triac heatsink, the presets, the tagboards and the input connections within the case. ***The heatsink must not touch the earthed case***

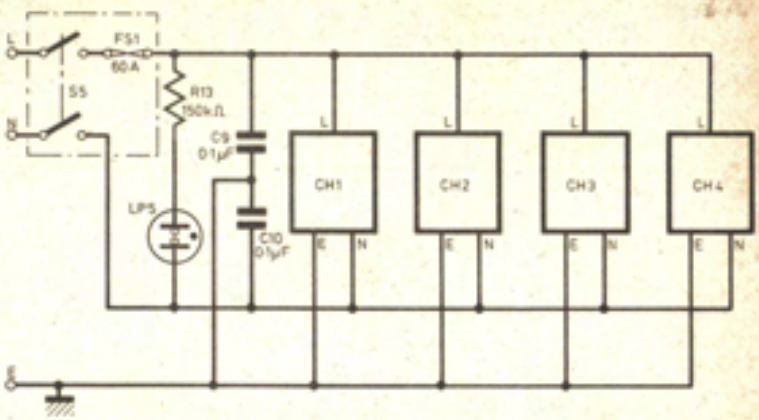


Fig. 3. Block diagram showing the four circuits of Fig. 2 interconnected and the extra components needed to complete the unit

defective lamps, since the lamp is at neutral rather than live when faded down. It also enables all the triacs to be mounted on a heatsink without insulating washers although this has the disadvantage that the heatsink is live and must therefore be insulated from the case.

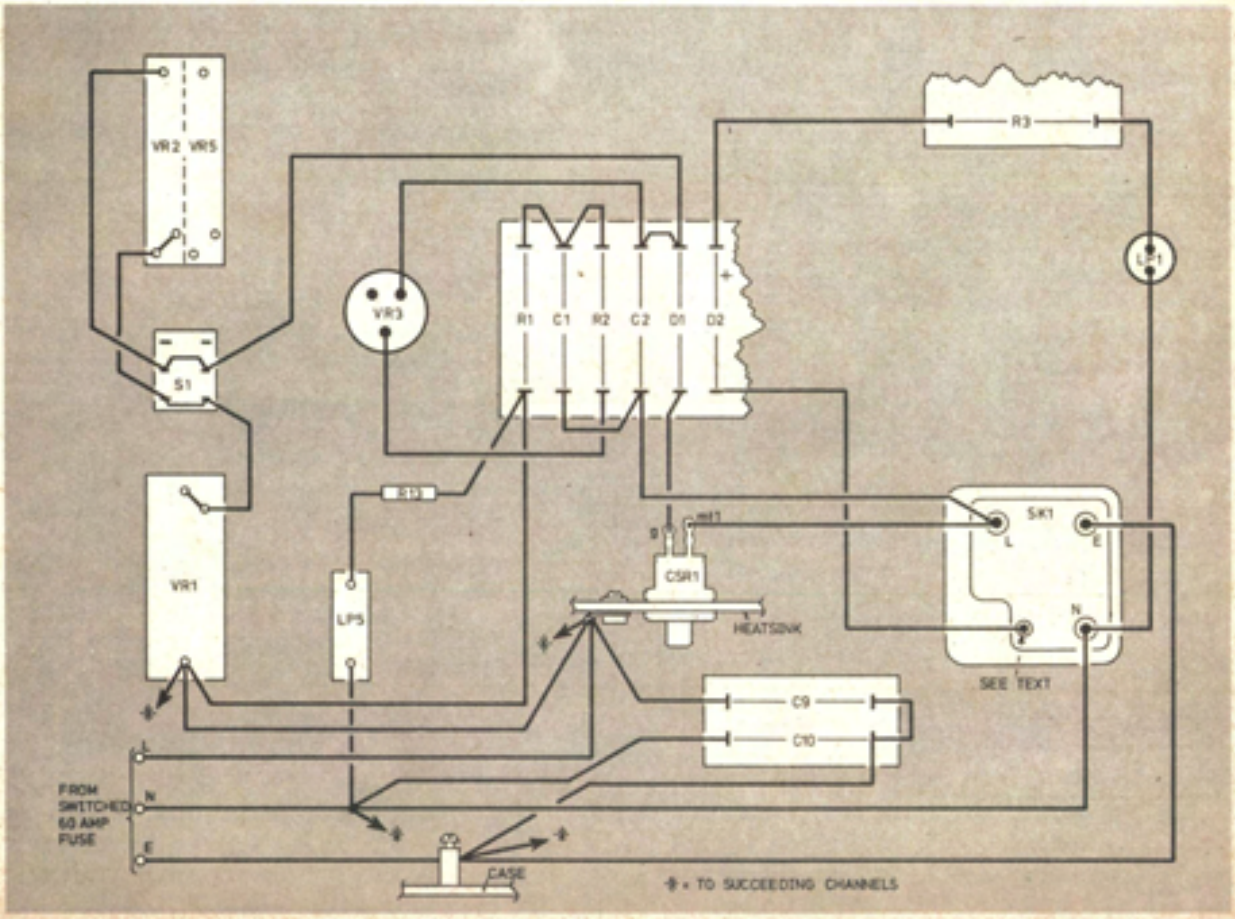
The triac, though a bi-directional device, operates best with the main terminal 2 (mt2) live with respect to mtl. For the SC50D mt2 is the threaded stud.

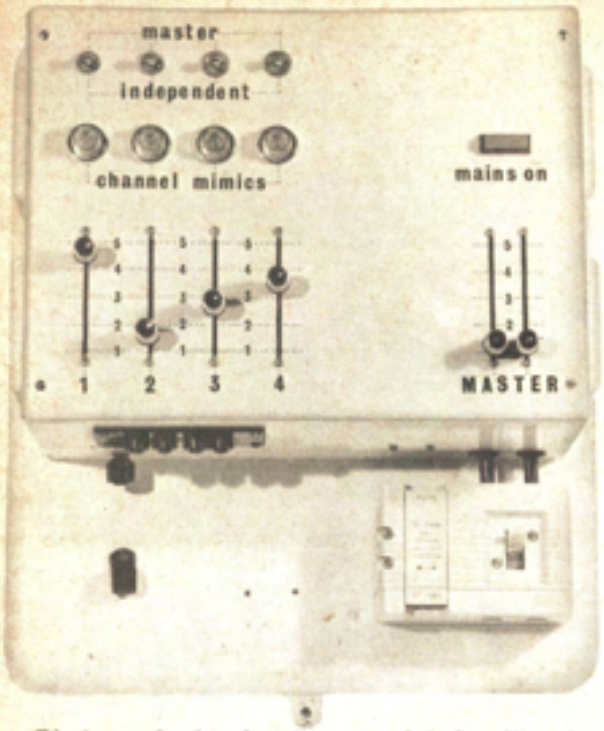
Interference suppression is obtained using two capacitors (C9 and C10) connected between the supply lines as shown in Fig. 3. Also seen on Fig. 3 is the mains indicator neon and the 60 amp fused switch.

CONSTRUCTION

The dimmer was designed to be mounted on a wall so the control box and the switched fuse were

Fig. 4. Layout of the components on the tagboard and interwiring for one of the four channels. Components should be mounted on the front panel, the case and the tagboards, and then interwiring should be done using this diagram and Fig. 3 as a guide. Wires which carry the current to the lamps should be heavy duty to reduce heating effects.





Photograph showing the completed unit and 60 amp switched fuse mounted on the backing board

fitted on a wooden panel fitted with mounting brackets (see photograph). The metal box used for the prototype is not generally available but any aluminium or steel box of sufficient size (13in × 10in × 5in) can be used.

The four triacs are mounted on a large heatsink which is connected to the live input via the switched fuse. A smear of heat-conducting grease should be applied before the triacs are bolted in position.

All the small components are mounted on two tagboards as shown in Fig. 4. The only exceptions are the four mimic lamp resistors (R3 etc.) which are mounted on a separate tagboard in a ventilated position.

The m.e.s. lampholders must be of the type which have both lamp terminals insulated from the case as neither must touch the case which is earthed.

The four preset potentiometers (VR3 etc.) are mounted on the outside of the case so that they are easily adjusted.

The output sockets are mounted two on either side of the case. The tagboards are mounted on pillars.

Plastic brackets are used to support the heatsink without it touching the case. Make sure that the lid of the case does not touch it when fitted.

Vents must be cut in the case to allow air to circulate if none are present.

Front panel layout is not critical, the photographs showing the prototype layout. Note that the two stereo sliders which form the Master Fader should be mounted as close as possible to each other so that they may be moved together. They may be physically joined with a metal bracket if this is desired.

Cables capable of carrying the 60 amp input current must be used for connection to the unit. A heavy duty earth cable should be connected to the case using a screw terminal.

COMPONENTS . . .

Resistors
R1 150kΩ } ½ watt carbon
R2 4·7kΩ }
R3 2·7kΩ 10W wirewound

Potentiometers
VR1 100kΩ linear slider
VR2 100kΩ + 100kΩ linear stereo slider (each channel uses half of one)

Capacitors
C1, C2 0·47μF 400V (2 off)

Semiconductors
D1 Diac type ST2 (Henry's Radio)
D2 1S557, BY100 or any 400V 1A diode
CSR1 SC50D 400V 15A Triac (Henry's)

Miscellaneous
LP1 6V 60mA m.e.s. lamp and holder
SK1 13A switched mains socket (MK2957) + mounting plate MK2200 21L
S1 Mains on/off switch
The components above are required for each of the four channels, i.e. four of each (except VR2) are required. The components below are required to complete the unit

Resistor
R13 150kΩ (not needed if included with neon)

Capacitors
C9, C10 0·1μF 1000V (2 off)

Miscellaneous
LP5 Mains neon indicator
S5 M.E.M. 60A switch/fuse
12 way tagboards (2 off)
4 way tagboard
Screw terminal, 6in × 6in × 2in finned heatsink, plastic brackets, 16mm copper double insulated (p.v.c./p.v.c.)

PRACTICAL POINTS

To reduce the interference effects of the unit it should be used on a supply separate from that being used by any microphone or musical instrument amplifiers, i.e. the 60 amp cables to the input should be taken to the nearest low impedance mains supply, the local "main feeder."

Ordinary household ring main circuits will not handle the unit on full load. In the case of a house or small hall the connections should be made direct to the fuse box, having first checked that the incoming mains can supply 13kW.

Footlights present a special problem since they are often close to stage microphone cables. If possible use footlight feeder cable which has an earth screen totally enclosing the conductors.

The slots in the box for the faders was made using a Monodex metal cutter.

A heavy duty soldering iron is necessary for soldering the 60 amp cables.

Total cost of the unit was approximately £35. ★