

# *electronics today*

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50p



**STAGE LIGHTING CONTROLLER**

**Cellular Logic \* Analogue To Digital**

**Visual Hi-Fi \* Magnetic Amplifiers**

... NEWS ... PROJECTS ... MICROPROCESSORS

# STAGE DIMMER

**A comprehensive unit designed to handle up to 20A per channel with emphasis upon ease of construction and versatility in operation**

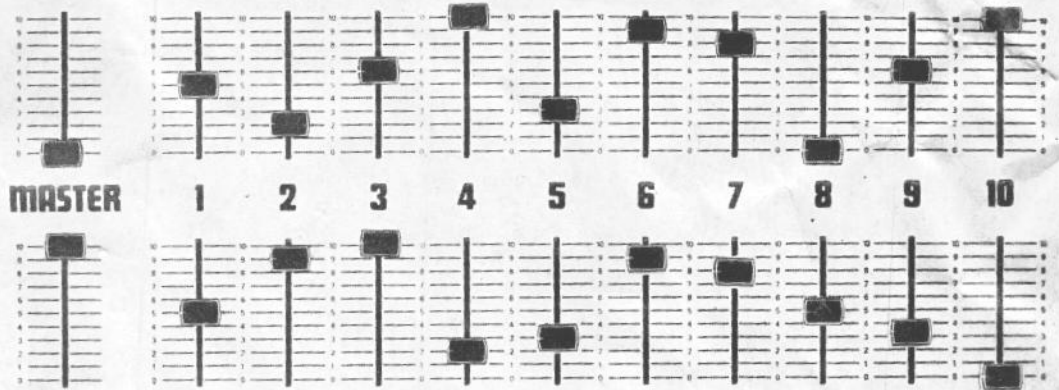
SINCE THE EARLY DAYS of the theatre the need for lighting has been all-important. Just as important has been the need for control of that lighting. This ranges from very crude initially to very sophisticated today, often with a computer doing the controlling in the creation of special moods and effects.

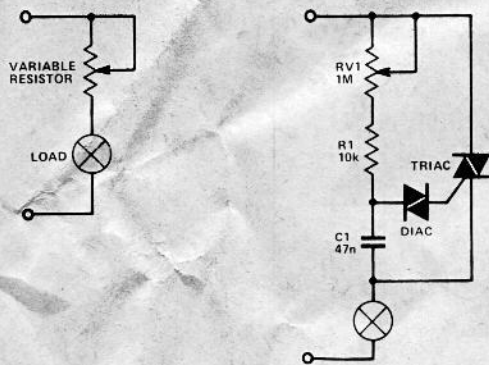
The first types of dimmer used, of which there are still some examples in older theatres, was a variable resistance type which used either a variable or switched power resistor in series with the load. With small loads a wire wound resistor or a carbon pile was used while larger loads used a tank of saline solution with a central

electrode which was raised or lowered in the liquid, effectively changing the resistance. This type of dimming, while reasonably effective, dissipated a lot of power which made life uncomfortably hot for the operator, since to minimise mechanical linkages the dimmers themselves were often in the control room.



### Theatrical Lighting Controller eti 588





## Electronics

With the advent of electronics, life was a little bit easier. The use of phase controlled dimming using thyratrons and later SCRs and Triacs reduced the heat dissipation dramatically (if you'll excuse the pun) and also allows the control to be physically separate from the dimmer. Besides being easier for the operator performances were greatly enhanced by the much better control available.

Today the use of phase control is almost universal as it is simple, reliable and cheap. Another method in use today is by magnetics; this type has the advantage of generating no RFI but unfortunately is expensive.

The problem of RFI is common to all phase control circuits, but can usually be reduced to acceptable levels by the use of a choke and several capacitors. For RFI the choke need not be very large, but one other effect of phase control is the audible rattling of the lamp filament (especially with the larger globes) which is due to the sudden application of power, and the magnetic field so produced, each half cycle. This can be cured by reducing the rate of the rise of current by using a larger choke.

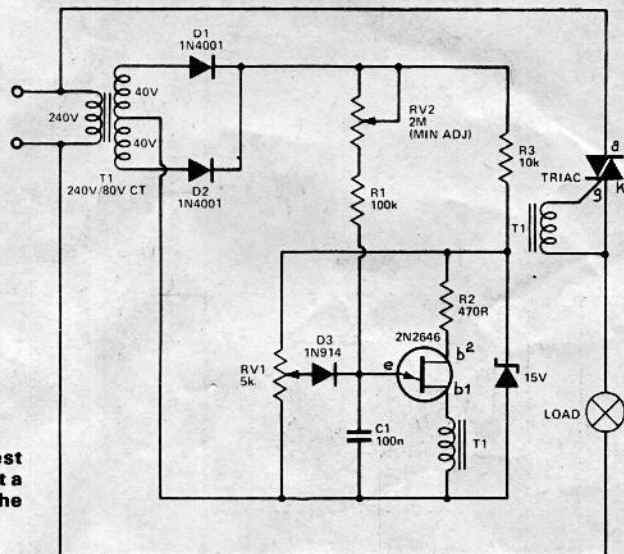
## Type Casting

We have given some schematic diagrams of types of dimmers which have been used previously. Fig. 1 is the oldest type comprising simply a variable resistor in series with the load. The second (Fig. 2), probably the most common type in use today (mainly in homes) is very simple but lacks the versatility needed for theatrical work.

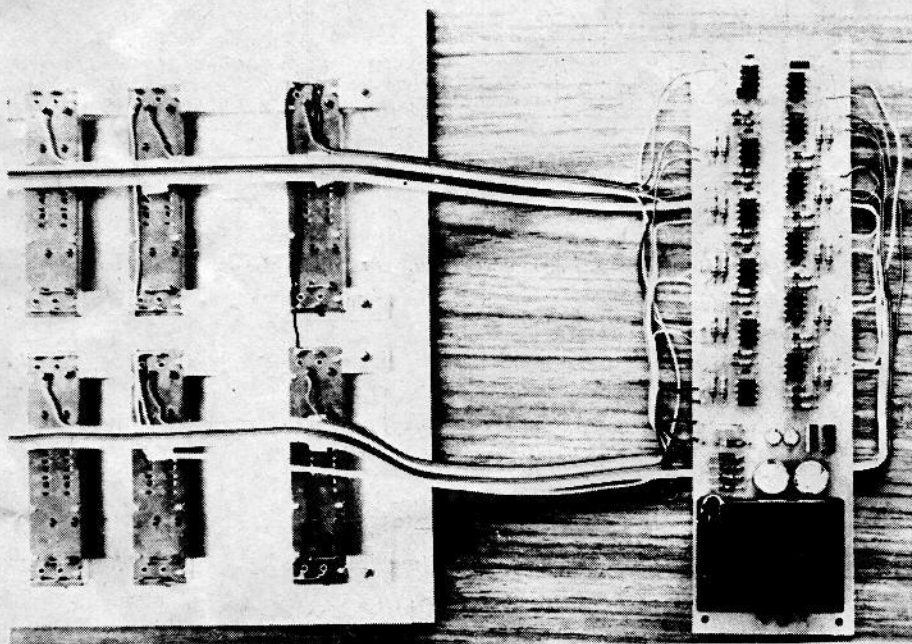
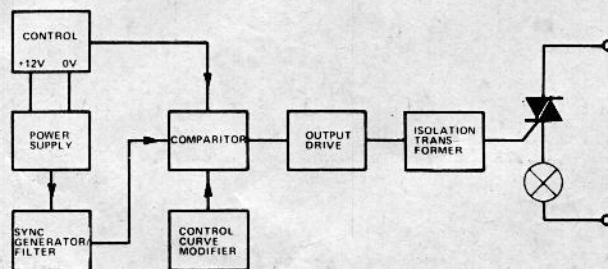
The third type (Fig. 3) is in common use and while still very simple does have many good features. These include having the

**Fig 1. (Far left). The earliest type of dimmer employing just a variable resistor controlling the load.**

**Fig 2. (Left). Common! The most usual kind of light dimmer in use today.**



**Fig 3. (Right). A more refined realisation of the art, which at least has the control isolated!**



control potentiometer isolated from the mains voltage and also a modified control curve to give a better input-output voltage relationship. Synchronization is referred to the zero crossing of the mains voltage, making the unit more suitable for driving inductive

(fluorescent) loads; this also eliminates hysteresis which occurs with the simple dimmers.

The dimmer to be described here is more complex than most but a great deal of effort has been taken to ensure that *all* problems have been solved. A low pass filter, with phase

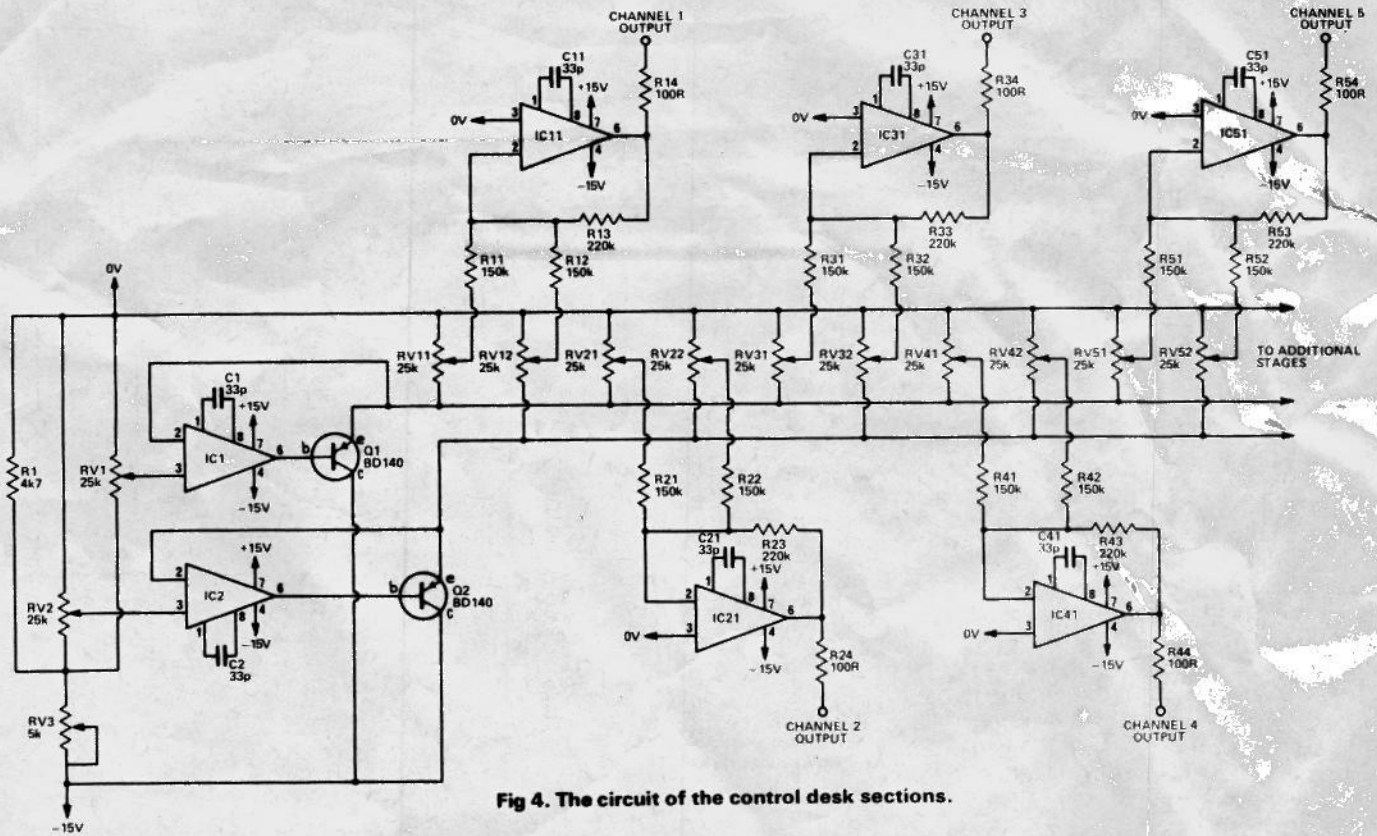


Fig 4. The circuit of the control desk sections.

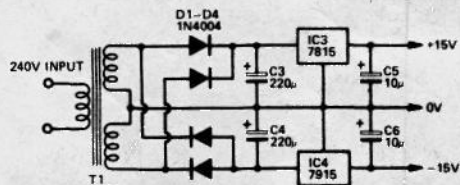


Fig 5. Power supply circuit

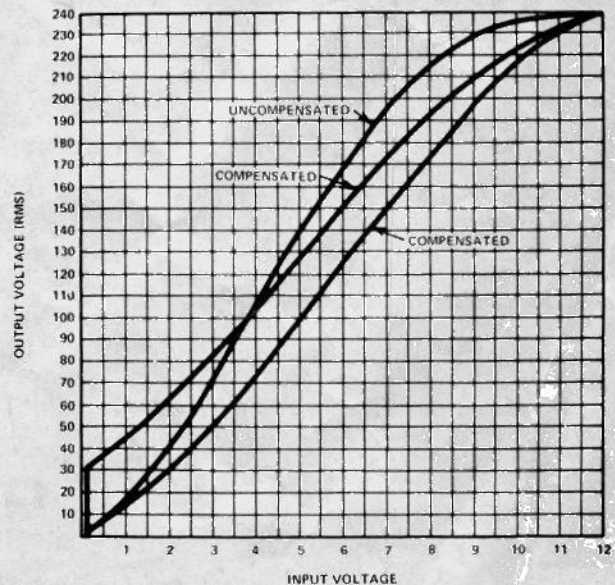
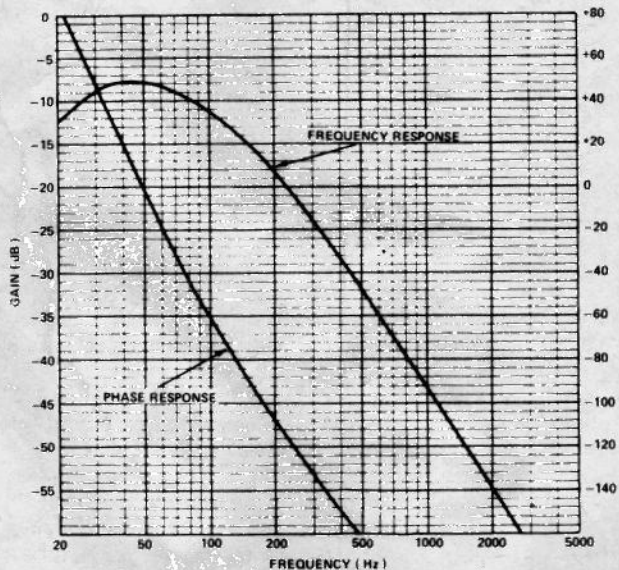
## HOW IT WORKS - CONTROLLER

There are two controls for each dimmer along with two master controls. The master controls vary the voltage on the individual level control potentiometers from 0 V (no light) to -8 volts (full light). Normally one master will be at maximum and the second at zero. The outputs of the two controls for each dimmer are added by an operational amplifier, referred to 0 V. As one set of potentiometers has 0 V on both of its ends it

can be varied without changing the output allowing it to be set for the next scene. By varying the master controls together, but in opposite directions, the complete lighting set up can be smoothly varied from one scene to the next.

As we need +12V out to drive the dimmers the supply voltage of the control desk is  $\pm 15$  volts.

Fig 6. (Below). Showing the phase v frequency responses effect of compensation upon response



# PARTS LIST

<b>Resistors all 1/2 W 5%</b>	
R1	4k7
R11, 12, 21, 22, 31	
32, 41, 42, 51, 52,	
61, 62, 71, 72	
81, 82, 91, 92, 101, 102	150k
R13, 23, 33, 43, 53	
63, 73, 83, 93, 103	220k
R14, 24, 34, 44, 54,	
64, 74, 84, 94, 104	100R

<b>POTENTIOMETERS</b>	
22 off	25k 1in. 60mm slide
RV3	5k trimmer

<b>CAPACITORS</b>	
C1, 2	33p ceramic
C3, 4	220u 50V
C5, 6	10u 25V
C11, 21, 31, 41	33p ceramic
C51, 61, 71, 81	33p ceramic
C91, 101	33p ceramic

<b>SEMICONDUCTORS</b>	
IC1, 2	301A
IC3	7815
IC4	7915
IC11, 21, 31, 41	301A
51, 61, 71, 81	
91, 101	
Q1, 2	BD140
D1-D4	1N4001

<b>MISCELLANEOUS</b>	
Transformer	30V
Box and front panel	5W
Knobs to suit	

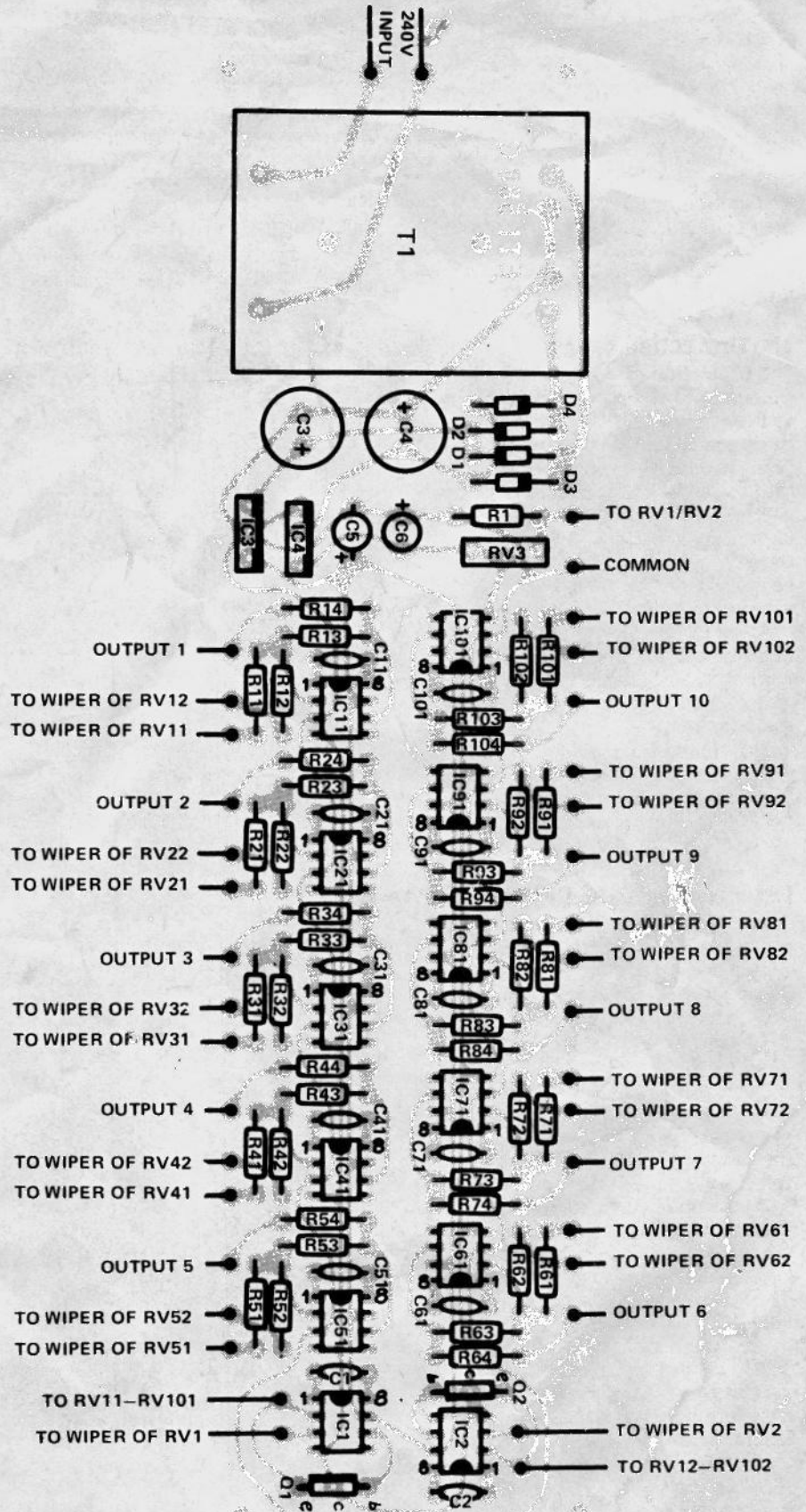


Fig 7. (Right): Component Overlay for the Controller Module.

# BUYLINES

Apart from the pulse transformer T1 — for details of which see Table One — none of the components in this (admittedly huge) project should tax your local supplier overmuch. If you send us an SAE we will send you the foil patterns for the PCBs used here, as they were simply too big to print full size. Any 400V ten or twenty amp triac will probably serve if you can't find the specified type easily.

correction, is used to ensure accurate synchronization. The control curve is also modified to give a subjectively more linear response and it has the ability to drive a fluorescent load without requiring a ballast resistor. Both the maximum and minimum light levels are adjustable without interaction giving reliable and predictable output. This is especially necessary if a dimmer fails for some reason and is replaced by a spare unit.

## The Protection racket

The protection of SCRs and Triacs, especially Triacs, is usually difficult as they tend to fuse faster than the fuse purportedly protecting them. The use of a cheap Triac which requires an expensive fuse to protect it is false economy. We have used a large rugged Triac (40 A device for the 20 A dimmer) which allows economical fuses to be used, especially for the 10 A version.

On the control side we will be describing a panel with two sets of long sliders per dimmer with two master controls which allow the next scene to be set up, then faded in when required. A digital memory which can 'prerecord' scenes and recall them on demand may be published later.

## Dimmer Module — Construction

Assemble the board with the aid of the overlay. The heatsink should be drilled and tapped for the triac to allow easy replacement if ever necessary. Note that the mounting of the fuse is different for the 10 and 20 A dimmers.

The choke is bolted onto the PCB using the long clamping bolts, preferably using rubber grommets in the holes in the board (they may have to be drilled out to do this). The leads from the choke should be bent such that they go into the holes provided without going near the mounting bolts which are at earth potential. The leads can now be soldered (both sides on the 20 A unit).

The pulse transformer can now be added according to Table 1. Be careful when winding this transformer not to damage the insulation on the wire as there is 240 V between windings. We also recommend some epoxy between the transformer and the board.

The printed circuit boards for the two versions of the dimmer board are identical in layout and differ only in that the connector end of the 20 A board is double sided to present a greater area of contact with the connectors.

## Controller-Construction?

The component numbering system used on the controller drawings is designed to indicate which channel a particular component is part of. The printed circuit board drawing for the dimmer board is too large to publish in the magazine at full size; however, the pattern is available from our offices for the cost of an SAE — a large SAE!

If the dimmer modules are not required to be connected through sockets, the total cost can be reduced by connecting directly to the modules and mounting them in a box. In the 20 A unit the heavy wires should be bolted on to the appropriate pads to ensure contact to both sides of the board.

One more modification to the control desk is the addition of a black-out switch which allows all lights to be blacked out without moving the master control. This is simply done by switching the supply voltage on the master potentiometers from the 8 V supply as set by RV3 to 0V. RV3 should be adjusted such that with one master at maximum, the second at minimum and one

individual control at maximum that its output voltage should be +10 volts.

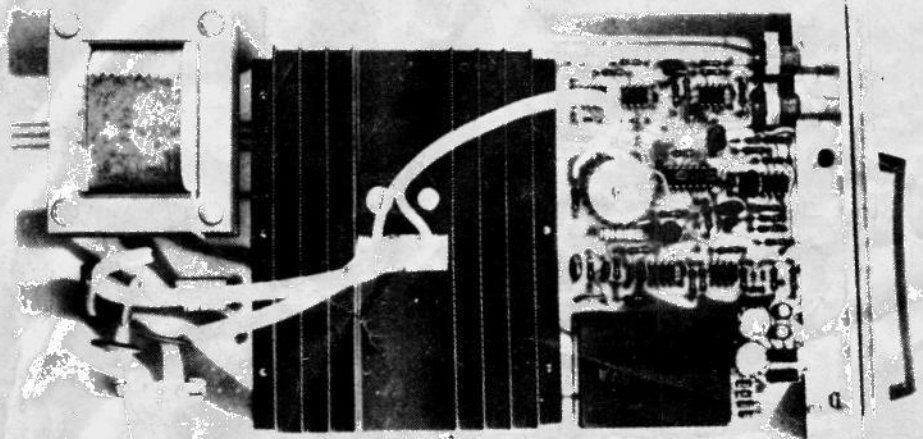
## Setting up

With the dimmer module the trim potentiometer has to be adjusted so that the output pulse from IC7 occurs at the very end of each half cycle. This is easiest set using an oscilloscope although an approximate setting can be made without one.

If the dimmer is connected up to a reasonably heavy load and adjusted for about 1/3 level it will probably be found that with RV3 at one end the light level is not stable and tends to flash. This is caused by the sync pulse occurring after the end of the half cycle and the trigger pulses from the previous half cycle triggering the next. The trim potentiometer RV3 should be turned back about 1/4 turn from the position at which this effect stops.

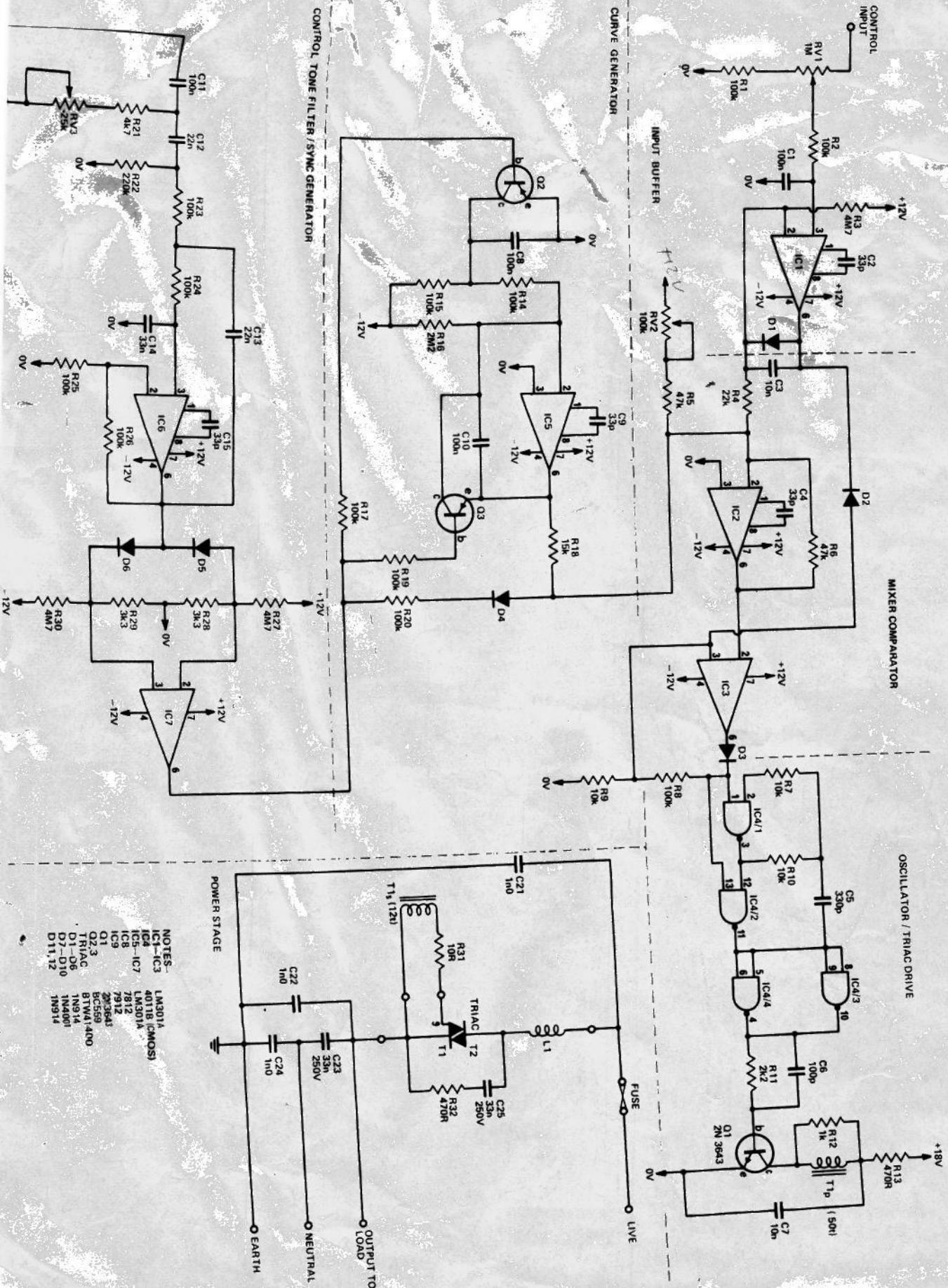
## Max and Min

When adjusting the maximum and minimum levels the minimum should be adjusted first. Note that the control potentiometer must be slightly up off zero to get any light and minimum should be adjusted at this point. The maximum should be adjusted with both the master and individual control at maximum and set to the point where the light level is just starting to drop. ▶



Shown above is a completed dimmer module

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- NOTES-**
- IC1-IC3 LM301A
  - IC4-IC5 4017B (CMOS)
  - IC6-IC7 LM301A
  - IC8 7812
  - IC9 7912
  - O1 2N3643
  - O2,3 2N3643
  - O4,5 2N3643
  - O6,7 2N3643
  - D1-D6 1N914
  - D7-D10 1N4001
  - D11,12 1N5314