Elliott Sound Products

Project 6

LX-800 POWER CONTROL SECTION

WARNING

Under no circumstances should any reader construct any mains operated equipment unless absolutely sure of his/her abilities in this area. The author (Brian Connell) and ESP take no responsibility for any injury or death resulting, directly or indirectly, from your inability to apprecia the hazards of household mains voltages. The circuit diagrams have been drawn as accurately possible, but are offered with no guarantees whatsoever. There is no guarantee that this design meets any regulations which may be in force in your country.

Introduction to Dimming

Remotely controlled light dimmers in theatrical and show-lighting applications use an industry-standard 0-10V control signal for controlling the lamp brightness.

0V = lamp off and 10V = fully on.

Any voltage level between these two values represents a proportional lighting level voltage betw those values adjusts the average voltage which is applied to the light bulb. The voltage level fro the controller is compared to a ramp signal generated in sync with the mains frequency (50Hz, o 60Hz in US and some other countries).

The lamp circuit is switched on when the levels of the control signal and the ramp are equal. For instance, if the control is set to halfway, that equality will occur when the ramp signal reaches 50 its level, switching the triac on. When the mains cycle falls to zero, the triac will automatically swi off. Consequently, only half the mains cycle is passed to the lamp by the triac, and the lamp is at brightness.

Ramp generator

This circuit is the heart of the system. It is where all the synchronisation takes place and produce the phase controlled switching to the triac output stages. Electrical noise is caused by things switching on and off at random points on the mains cycle. We've all heard the dreadful sounds a refrigerator can make through a radio when it switches on and off. Random switching occurs in theatrical or musical environments, and if all that interference broke through the sound equipme well, the lighting guy would be toast! While the dimmers are inherently reasonably quiet, filter circ has been added to ensure that the system performs correctly under all circumstances.

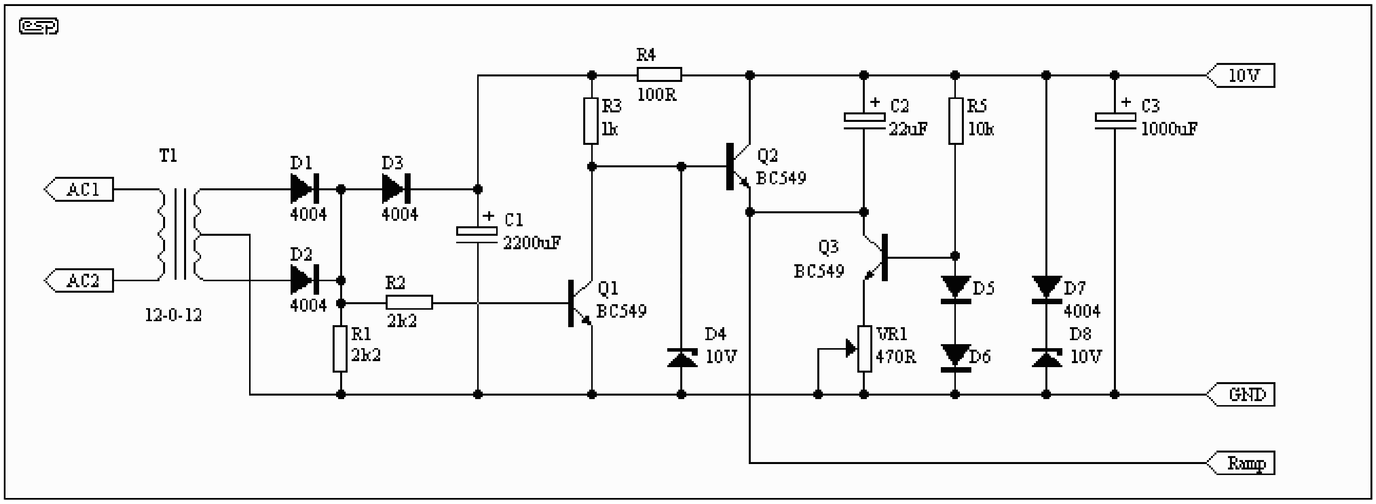

Figure 8 - Ramp Generator

Resistors R1 and R2 should be a minimum of 1/2W, R4 must be 1W, and all others can be 1/4W
Capacitors should be rated at a minimum of 25V. Unmarked diodes are 1N4148 or 1N914.

12 May 2001
The ramp generator is about to be revised, to allow the use of the extra resistors on the faders. Since the load will be over 60mA, the circuit shown will be unable to supply the current needed. hope to have the new version ready in a few days.

09 June 2001
The circuit of Figure 8a shows the new version of the ramp generator and 10V supply. It uses a simple series pass transistor regulator, that will be more than adequate for the current drawn by 10V circuitry. This will easily power the new fader arrangement with current to spare. The BD13 transistor (Q4) will need a small heatsink - a piece of aluminium 50mm square (or a small commercial heatsink) should be quite sufficient.

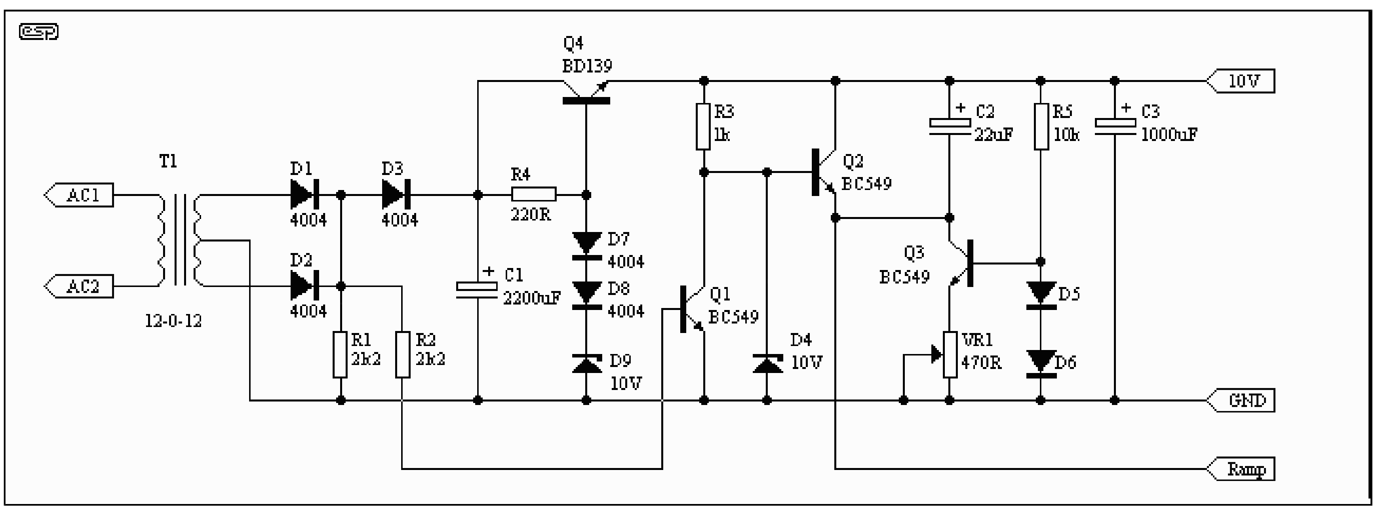

Figure 8a - New Ramp Generator Circuit

Resistors R1, R2 and R4 should be a minimum of 1/2W, and all others can be 1/4W. Capacitors should be rated at a minimum of 25V. Unmarked diodes are 1N4148 or 1N914.

One thing you will notice, especially using high wattage globes is "filament sing". This is not a fau with the dimmer. It occurs when the filament in the globe vibrates in sync with the chopped mains waveform being sent to it from the dimmers.

stages. The circuit generates a 100 Hz (or 120Hz) ramp signal which is synchronised to the incoming mains voltage. The ramp signal starts at 10V and goes linearly down to 0V in 10 milliseconds (8.33 ms for 60 Hz mains), and continues with each mains half-cycle, triggering at th point where the mains voltage has the same level as the ramp signal. The 470 ohm pot is used t adjust the ramp so it is in perfect sync with the mains. It is recommended that an oscilloscope is used to ensure that the ramp is properly synchronised.

In this way, a 10V input signal triggers the TRIAC at the very beginning of the waveform, so full brilliance is achieved. At zero volts, the TRIAC is not triggered at all, so the lamp(s) are off. At intermediate levels, the TRIAC triggers somewhere between the beginning and end of the wavef - thus at 5V input, the TRIAC triggers at exactly half way between the AC zero crossing points, s the normal sinewave is applied giving about 1/2 brightness - this is not strictly true since our eyes have a logarithmic response, but it works well enough in practice. The same principle is used fo dimmers, regardless of size or purpose.

Power Supply

The power supply is quite conventional, and is shown in Figure 9. A standard full wave rectifier a a positive and negative regulator supply power to all parts of the circuit. The supply is mounted i the Dim-Rak cabinet, along with the ramp generator and the eight modular dimmer circuits.

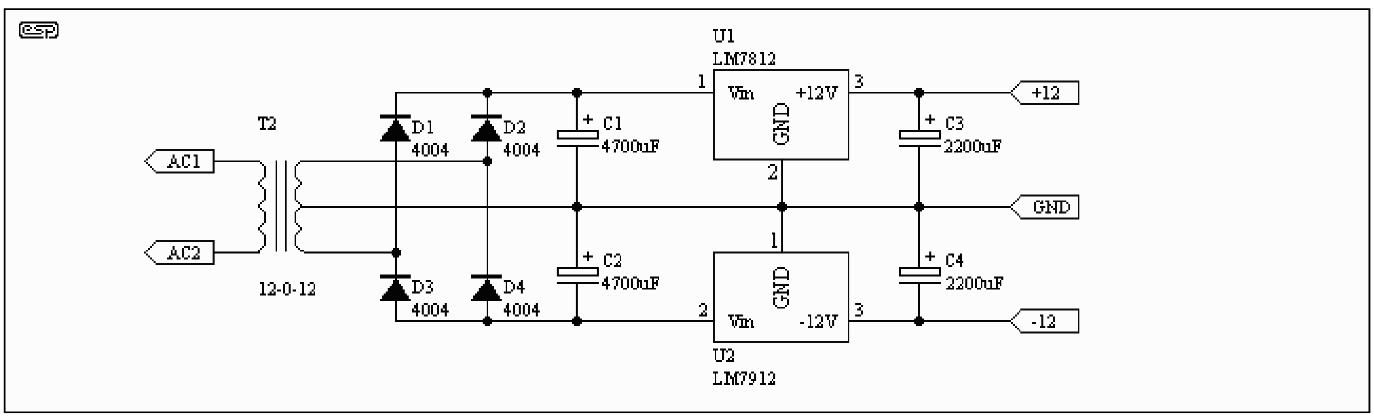

Figure 9 - Power Supply

The transformer must be rated at at least 25VA, and all capacitors should be 25V. Heatsinks are suggested for the regulators, to ensure the coolest running (which translates to longer life). A sin transformer may be used to power the ramp generator and power supply - I suggest that a 50VA be used.

Dimmer Unit

The dimmer unit is shown in Figure 10. Each dimmer has a 741 opamp, and the heart of the circ is really the opto-isolator IC, the MOC3020. This provides the essential isolation between the ma and the control circuit. These devices are rated at 7500V isolation, and it is essential that no trac are run between the pins of the IC, or safety will be seriously compromised.

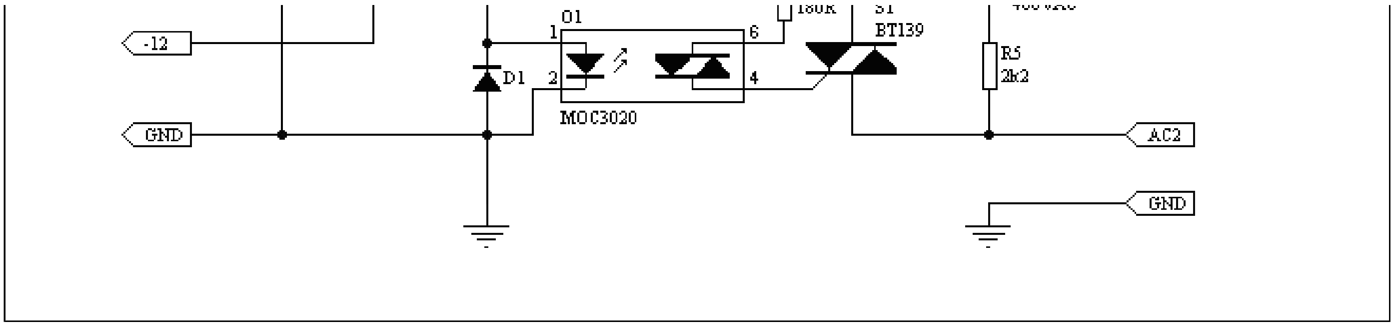

Figure 10 - Dimmer Circuit

D1 is a 1N4148 or 1N914. R4 and R5 should be 1W - not for the power dissipation, but to ensur adequate voltage rating. There may be some advantage in using a 5W wirewound resistor for R a safety measure. I shall leave this to the reader.

NOTE: There was an error in Figure 10, which was pointed out by a reader. The signal inputs to were reversed, so the dimmer would not work as intended. The drawing shown now is correct.

Eight dimmers are needed to make one 8-channel Dim-Rak. The terminal marked "0-10V" is the input from the faders, S2L unit or chaser. With this unit, it is absolutely essential that all mains w is fully protected against accidental contact. The TRIAC (S1) must be on a heatsink, and great c is needed to ensure that the unit is completely safe. If the suggested TRIACs are used, they hav insulated tab, and may be mounted directly to the heatsink without the need for mica washers an such. This make a much safer installation than non insulated devices. The case MUST be earth via a 3-pin mains plug, and all mains voltage tracks and wiring must be kept a minimum of 5mm the low voltage circuits. The inductor (L1) needs to be a mains rated interference suppression ty These may be available from electrical installation suppliers, or you might have to make your ow

The fast turn-on time of the TRIAC will result in the generation of RFI which may interfere with ra reception. This can be reduced by using an RFI filter. An alternate possible filter can be an indu (say 100 µH) in series with the TRIAC as shown, and a capacitor (0.1 µF) in parallel with both the TRIAC and the inductor. The filter causes a ring-wave of current through the TRIAC at turn on ti and the filter inductor is selected for resonance at any frequency above the limit of human hearin but below the start of the AM broadcast band for maximum harmonic attenuation. In addition, it i important that the filter inductor be non-saturating to prevent di/dt * damage to the TRIAC.

To make these inductors, try about 10 turns of insulated wire wound on a powdered iron toroid. not use a high permeability core such as ferrite, as this will saturate and may damage the TRIAC Make sure that the inductors are firmly mounted, and that accidental contact is not possible while system is live.

* di/dt - delta (change) in current versus time.

Circuit Layout

The power control section is modularised: the power supply and ramp generator on one printed circuit board, the eight triacs on individual PCBs. This was done because if anything is going to g wrong, it is usually a triac that blows. I arranged for the boards to plug onto the output connector with spade connectors so that they could be replaced quickly and easily. You are free to build thi section to suit yourself, but my own experience has proved that this methodology works well.