Construction Project:

Remote-controlled Light Dimmer - 2

This month we explain how to construct, test and use the author's remote-controlled light dimmer, whose circuit was described in the first article.

by JEFF MONEGAL

This project has no special construction difficulties, but you'll need a fine-tipped soldering iron as some of the tracks and pads on the PCB are quite small. A magnifying glass to examine your work is also a good idea. When drilling the transmitter case and the dimmer case, we suggest you use the front panel artwork as a template.

Construction

As usual, start by inspecting the PCB for any manufacturing faults. Then fit all resistors. Note that the resistors in the R-2R network are metal-film types and their colour coding is difficult to read. You might check each one with an ohmmeter because if these resistors are not the correct value, the lamp brightness will be 'all over the place'.

Next fit the capacitors and diodes and transistors, taking care with their polarity. Also solder the three trimpots in place.

There are some 25 links on the component side of the PCB and two long links on the track side. Because some of the links are under IC sockets, these should be fitted before you start with the ICs. IC sockets are not essential, but they will make servicing easier and are therefore recommended.

The receiver module solders directly to the PCB, with the components facing out. We used terminal blocks for the transformer and triac gate connections, but these can be directly soldered to the PCB if you wish.

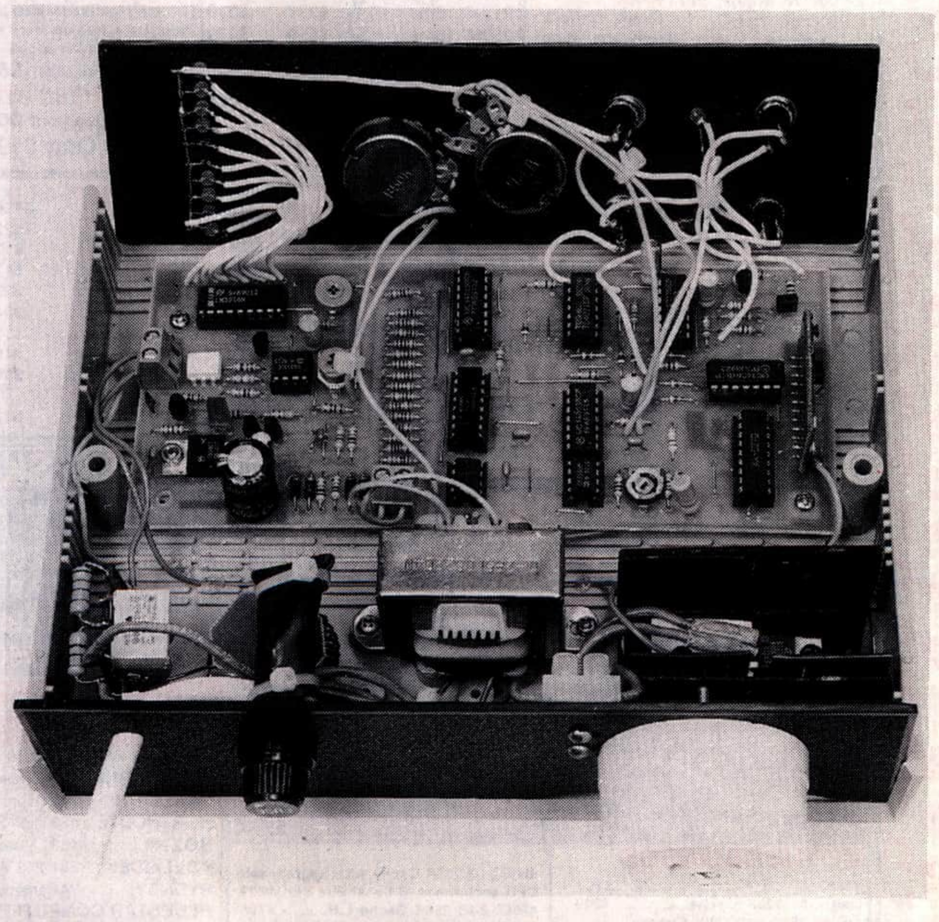
Once you've completed the PCB, check it carefully as it's tightly packed with components. Then go onto the front panel controls and the associated wiring.

The easiest way is to mount all front panel controls, then run wires from the PCB to the pots and switches. The LEDs in the 10-LED bargraph are fitted to the front panel by inserting them into holes drilled in the panel. There are 10 wires, plus the supply to the anode of the LEDs. Make sure you connect the wiring from the LEDs to the PCB correctly as otherwise the display will be meaningless.

An 8V supply is required at each pushbutton, to the UP and DOWN indicator LEDs and to each LED in the bargraph. As the layout diagram shows, the 8V supply is the right-most connection on the PCB.

Preliminary testing

At this stage, you can run some preliminary tests before the mains wiring, triac and associated components are installed — as the LED indicators give enough information to tell if the circuit is working correctly. Set the front panel controls fully clockwise



This photo shows the PCB and front panel wiring from inside the case. There have since been a couple of minor changes to the PCB design, mainly around R45 and R46.

and the internal adjustments to their mid position.

Connect an AC supply of between 10V to 15V to the PCB. When power is applied, LED1 (in the constant current source) should light.

Press either of the manual buttons and check that the direction LEDs for that button come on and go off as the button is pressed or released. You should also see the bargraph rise as the UP button is held down, and fall when the DOWN button is pressed. The rate of change should vary with the 'speed' control and the maximum indication should be adjustable with the 'master level' control.

If the bargraph falls to zero then rises back to maximum while the DOWN button is pressed, adjust VR4 to the point where the bargraph falls to zero and stays there.

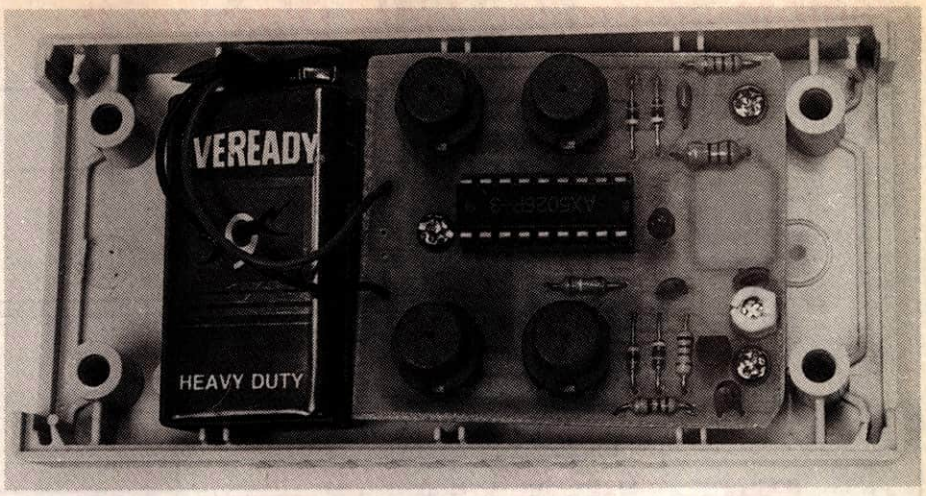
Now press either of the automatic buttons. The associated direction LED should come on and stay on after you release the button. You should also find that pressing these buttons again halts the sequence, providing the speed of the fade is not too fast.

Most problems will be due to faulty wiring, and it's therefore impossible to give more than a few general faultfinding hints. If the unit isn't working, first check that LED1 is on and also measure the 8V supply. If so, check for a high on pin 1 of IC4A when the UP button is pressed and a high on pin 2 of IC4A when the DOWN button is pressed.

Also, the oscillator should run when pin 3 of IC4A is high. However, this can only occur if the counter is between its two limits when pin 11 of IC4D is high or pin 6 of IC10 is high.

If the counters are being clocked, check the top of the R-2R ladder (pin 3 of IC9). You should see a DC voltage that rises and falls at a speed governed by the 'speed' adjustment.

If you can't find the fault, CTOAN Electronics offers a repair service. See the end of the article for details.



The transmitter PCB mounts on 10mm spacers so the switches can extend through the top of the case. Also, fit a 20mm spacer at the rear of the PCB for support.

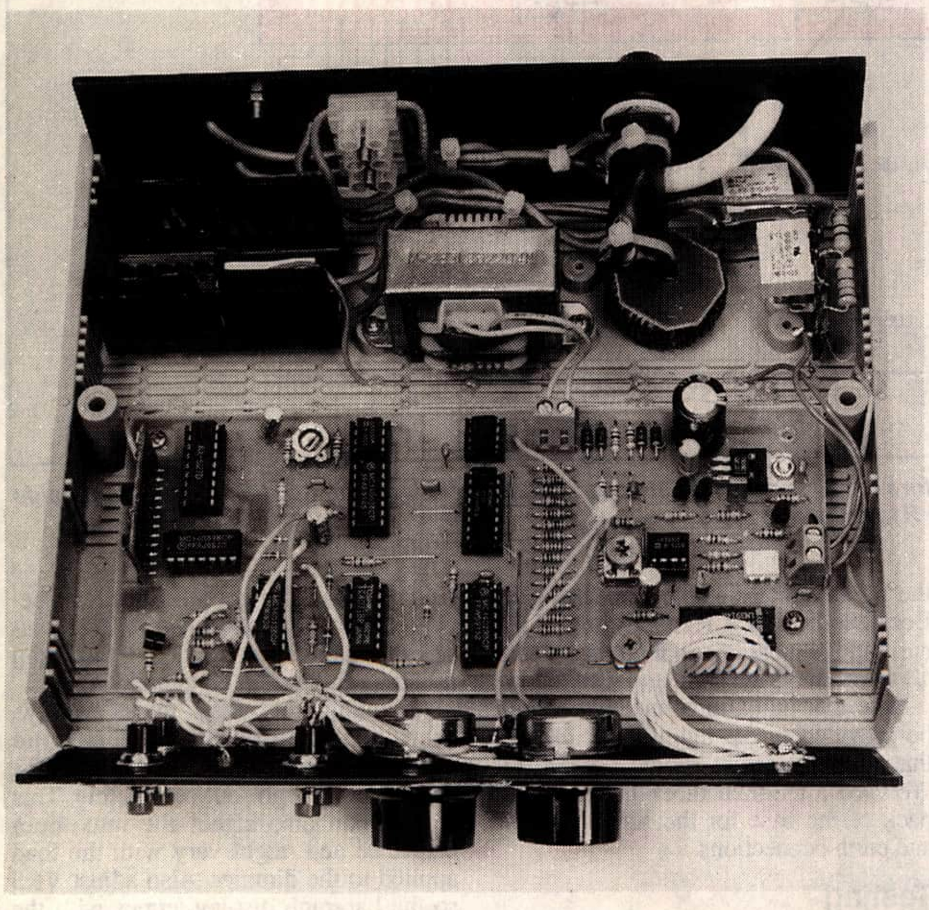
Mains wiring

Next comes the mains wiring. The layout diagram shows where components were placed in the prototype, and all of this wiring should be made with 240V rated cable. As the layout diagram shows, C9 mounts on a two-lug tag strip and C8, R13 and R14 mount on a five-lug tag strip. However, the layout is not critical and can be varied to suit the case.

The inductor (L1) is wound on an iron-powder toroid using a 1.5m length (or so) of 0.8 to 1mm diameter winding wire. Wind about 40 turns on the toroid core, keeping the turns evenly spaced and tightly wound. To hold the toroid in place, we made a washer out of scrap PCB — which was placed on top of the toroid and bolted to one of the case mounting pillars with a 4BA bolt.

The triac is mounted on a heatsink, and because the metal tab of the triac is at mains potential, we recommend using a mica or mylar insulating washer. This will prevent the heatsink also being at mains potential and make the unit safer to work on.

It's a good idea to check with an ohmmeter that the triac is successfully insulated from the heatsink. All connections to the triac should be insulated with sleeving to prevent possible short



The mains wiring is shown here. The toroid is held in place with an insulated washer and a 4BA bolt through its centre. The heatsink is held with two self-tappers, with one also through the tab of the triac.

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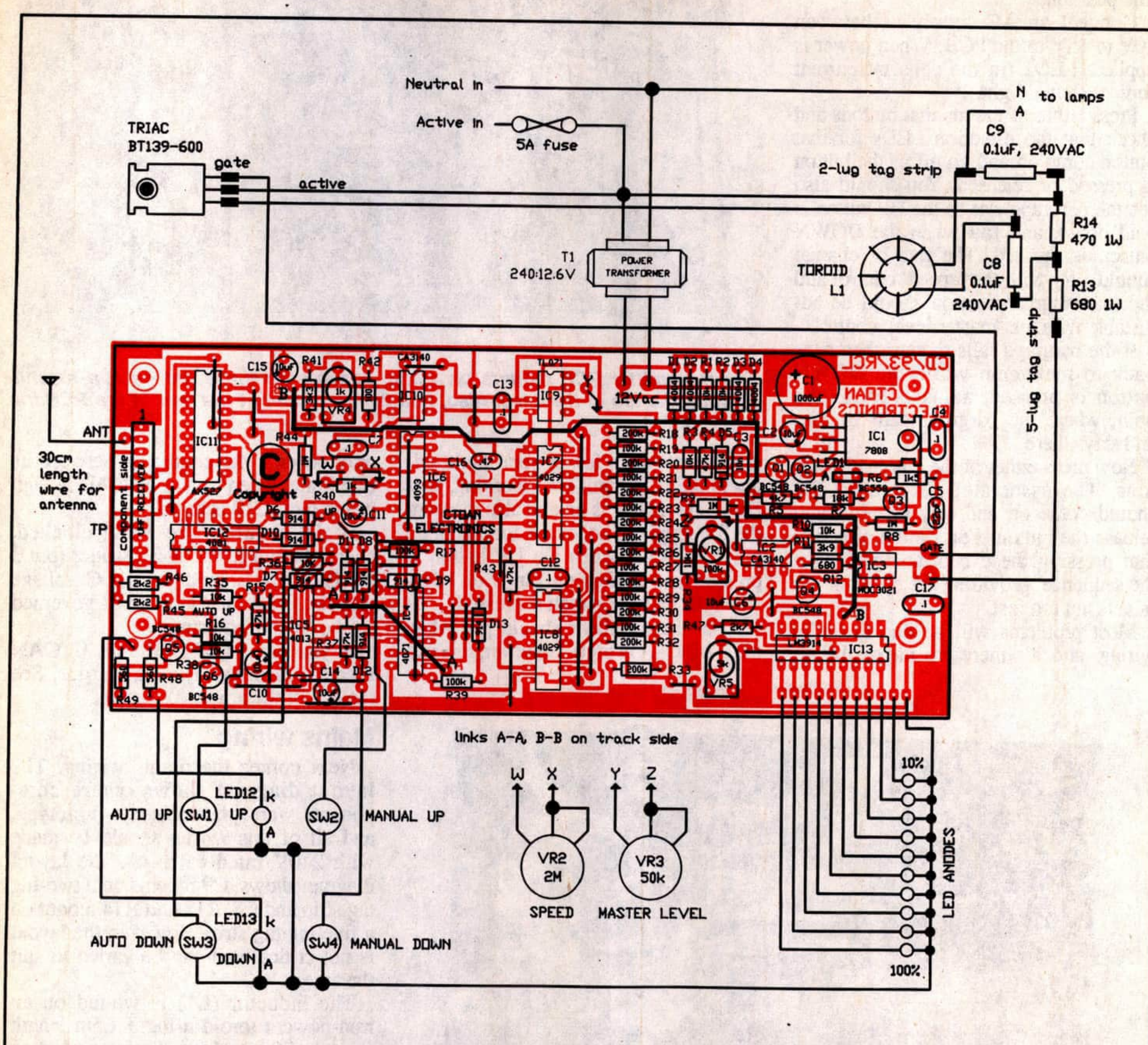


Fit the 25 links on the component side before the IC sockets are installed. Also don't forget the two links on the track side of the PCB. Components C8, C9, R13 and R14 mount on tag strips.

circuits between the triac terminals or to the heatsink.

Note that the heatsink supplied in the kit is suitable for loads up to 1200W. To increase the power rating you'll need a larger heatsink, which will possibly mean a larger case. However, no other modifications are needed except to make sure the mains wiring is rated at 10A or more.

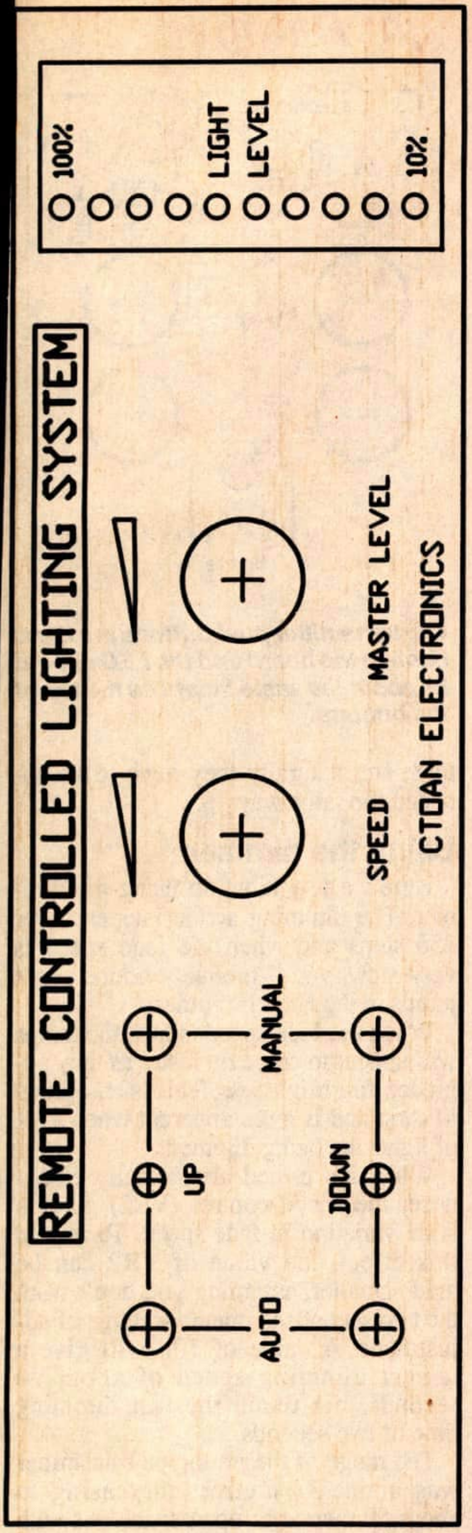
We fitted a three-pin 240V socket to the rear of the case to connect the lamps, but an extension socket could also be used. In a more permanent installation, you would probably connect the lights directly with screw terminals. Because there is a relatively high load current, it's most important to make sure all connections are solid and well made.

Note that an earth connection should be provided to the lighting circuit, and that the transformer should be earthed. We used a terminal block bolted to the back of the case for the active, neutral and earth connections.

Testing

Before you go on to the final testing stage, check the mains wiring once again, confirming for instance that you haven't somehow got a short-circuit between the active and neutral. Then, insert the mains fuse, connect a test lamp as a load and switch on the power.

Assuming the fuse doesn't blow, then go through the test routine described before. You'll need to set VR1 so the lamps go out completely. This setting can also affect the maximum brilliance and might vary with the load applied to the dimmer. Also adjust VR5 so the bargraph display agrees with the light output of the lamp(s) connected to the dimmer. Then, if all is working correctly, it remains to build the transmitter.



The front panel artwork for the dimmer case is reproduced here full size, so you can use it as a template. For an effective front panel, take a photocopy, spray the copy with plastic lacquer, then glue it to the case.

PARTS LIST

DIMMER

Resistors

All 1/4W, 5% unless otherwise stated:

R1-3,10,16 R34-36,38	10k
R4,15,37,43	47k
R5	4.7k
R6	1.5k
R7	18k
R8,9,44	1M
R11	3.9k
R12	680 ohm
R13	680 ohm 1W
R14	470 ohm 1W
R17,39	100k
R18,20,22,24,26,R28,30,32,33	200k 1% metal film
R19,21,23,25,R27,29,31	100K 1% metal film
R40	1k
R41	3.3k
R42	100 ohm
R45,46	2.2k
R47	2.7k
R48,49	560 ohm

Potentiometers

VR1	100k trimpot
VR2	2M linear, panel mount (see text)
VR3	50k linear, panel mount
VR4	1k trimpot
VR5	5k trimpot

Capacitors

C1	1000uF, 16V electrolytic
C2,6,10,11,C14,15	10uF, 16V electrolytic
C3	10nF disk ceramic
C4,7,12,13,17	0.1uF monolithic
C5	22pF ceramic
C8,9	0.1uF, 240V AC polyester
C7	22uF 16V electrolytic
C8	33nF, 240V AC polyester
C16	0.47uF monolithic

Semiconductors

D1-4	1N4004 1A diode
D5-13	1N914 signal diode
LED1	green rectangular LED
LED2-5,12	3mm green LED
LED6,7,13	3mm red LED
LED8-11	3mm orange LED
Q1,2,4-6	BC548 NPN transistor
Q3	BC558 PNP transistor
Triac1	BT139-600 16A triac
IC1	7808 8V regulator
IC2,10	CA3140 CMOS op amp
IC3	MOC3021 opto-coupler
IC4	4071 quad OR gate
IC5	4013 dual D flipflop
IC6	4093 quad Schmitt NAND
IC7,8	4029 counter
IC9	4071 OR gate
IC11	AX527 trinary decoder
IC12	4081 quad AND gate
IC13	LM3914 LED bargraph driver

Miscellaneous

PCB 172mm x 750mm coded CE/93/RLS; 15mm OD, 8mm ID toroid (iron powder core); 240:12.6V 150mA transformer; 4 x pushbutton switches, panel mount; 304MHz UHF receiver module (prebuilt and prealigned); IC sockets as required; 3AG fuse holder and 5A fuse; knobs to suit controls; plastic case to suit (e.g., 200mm x 155mm x 65mm Altronics cat no H0480); 2 x tag strips; heatsink for triac (see text), TO-220 insulator, 10A rated mains lead; 240V plug; 240V socket; mains rated hook-up wire; low voltage hook-up wire; 1.5m length of 0.8-1mm enamel coated winding wire.

TRANSMITTER

Resistors

All 1/4W, 5% unless otherwise stated:

R1	2.2k
R2	18k
R3	1M
R4	100 ohm

Capacitors

C1	47uF, 16V electrolytic
C2	2.2pF disk ceramic
C3	0.1uF monolithic
C4	3.9pF disk ceramic
C5	1nF disk ceramic
C6	2-6pF trimmer

Semiconductors

Q1	BF199 HF NPN transistor
IC1	AX526 trinary encoder
LED1	3mm red LED

Miscellaneous

PCB 51mm x 58mm coded JEN; 10uH choke; four PCB mount pushbuttons; 9V battery and battery clip; plastic case 60mm x 120mm x 30mm (Altronics cat no H0216)

A kit for this project is available from CTOAN Electronics. The cost of a complete kit including all parts, including cases for the transmitter and the dimmer is $159.95, plus $10.00 P&P. A short-form kit is also available that contains the AX526 and AX527 ICs, both PCBs, the UHF receiver module, 2 x CA3140 op amps, the toroid and winding wire and a BF199 transistor. Cost of the short form kit is $68.95 plus $8.00 P&P.

CTOAN Electronics also offers a full backup and repair service for the kit. Maximum cost of any repair is $45.00 including return postage. CTOAN reserves the right to refuse repair on a kit if it has been badly soldered or constructed.

CTOAN also offers ready-built and fully tested PCB assemblies for the dimmer and the transmitter for a cost of $75.00. However the company is not offering completely built versions of the kit.

To order or obtain further information, contact:

CTOAN Electronics
PO Box 211
Jimboomba, Qld 4280
Phone (07) 297 5421

The transmitter

The construction of the transmitter is quite easy, as everything mounts on the PCB. Make sure you don't get the small ceramic capacitors interchanged. Also note that inductor L2 looks like a resistor. At this stage, as with the decoder (IC11) in the dimmer, leave all the address pins of the encoder IC1 open-circuit. The four pushbuttons mount flush onto the PCB, and the LED mounts so its top is about level with the top of the buttons.

You'll need to drill holes in the trans-

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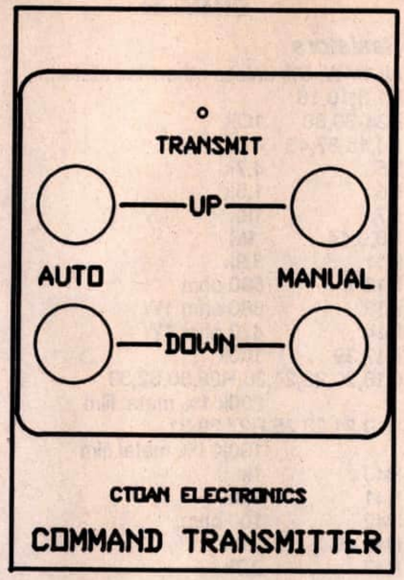
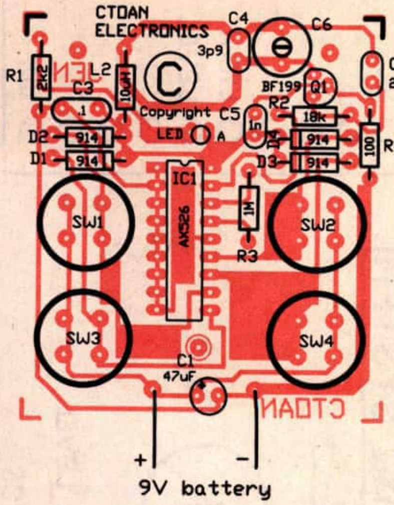


This is the artwork for the transmitter, again shown full size.



The transmitter pushbuttons are fitted flush to the board and the LED should be about the same height as the top of the buttons.

mitter case for the pushbuttons and the LED. The artwork as above will serve as a guide for the size and position of the holes. The PCB mounts on 10mm spacers and is held to the bottom of the case with self-tapping screws.

Now the frequency of the transmitter has to be set. This can be done with an oscilloscope, a multimeter or by trial and error. If you have a 'scope or a multimeter (set to AC millivolts, and connected in series with a 0.1uF capacitor) connect it to the test point of the receiver. The other lead goes to earth, such as the tab of the voltage regulator. Be very careful not to touch the nearby mains wiring!

Press any transmitter button and adjust the trimmer capacitor for a peak in the signal measured at the test point. As an indication that the transmitter is at least working, hold it right up against the receiver PCB.

In this position it doesn't matter whether the transmitter is tuned to the correct frequency or not, as RF energy will burst through and you should get some sort of signal. If you can't get the transmitter aligned, CTOAN will do it free, providing it works properly.

Once you've aligned the transmitter, it remains to code the address pins of IC1 (transmitter) and IC11 (in the dimmer). The transmitter and the dimmer PCBs have tracks for logic 1 and logic 0 placed near the eight address pins of these ICs. Choose an 8-bit code (which can include pins left open-circuit) and connect the address pins accordingly. The address pins for both ICs are pins 1 to 8, and naturally they have to be encoded the same way.

Using the dimmer

Here's a few hints on using the dimmer. The dimming action happens over 256 steps and when the fade speed is very slow, you'll probably notice slight jumps in the lamp brightness.

When the fade speed is fast, the lamps will appear to come on faster as they approach full brightness. This is an optical illusion and is more apparent when a lot of lights are being dimmed.

When it's turned almost fully clockwise, the speed control (VR2) gives a wide variation in fade speed. To reduce this effect, the value of VR2 can be made smaller, assuming you don't want the two seconds to one hour range of adjustment. A value of 50k will give a lowest dimming speed of about 90 seconds, but retain the fast dimming time of two seconds.

The range of the prototype transmitter was about 35 metres, increasing to about 50 metres in open space. As with all radio transmitters, the range is subject to the environment it is working in.

To get a smooth change in brightness with the remote control, set the speed control to give a delay of a few seconds. To prevent a delay when the lamps are being dimmed from maximum brightness, set VR1 so the lamps are just fully on when the DAC output is a maximum.

You'll quickly learn how to get the most out of this versatile dimmer, and certainly you'll enjoy the remote facility. ❖