TO COMPLEMENT THE SECURITY VARI-LIGHT

OPTO REPEATER

BY A.R.WINSTANLEY

THE Opto Repeater is designed for use in conjunction with the Security Vari-Light project (last month) and serves to present a more realistic overall illusion to the prospective prowler.

Although the Security Vari-Light will operate a single lamp (or combination of lamps not exceeding 500W), the disadvantage is that only one room can be controlled in this manner.

The Opto Repeater utilises a photo-transistor to detect when the main Security Vari-Light is on and, when illuminated by the main lamp, operates a secondary lamp for a preset period.

OPTICAL COUPLING

Thus a system of optical links are used to enable the "master" lamp to control lights in other rooms, so that a larger section of the household appears to be inhabited at night.

The design has been kept simple, the use of complex logic circuitry having been avoided, since the constructor may well wish to assemble more than one unit for use around the home. The low cost of the Opto Repeater will help him to do this.

CIRCUIT DESCRIPTION

Fig. 1 illustrates the circuit diagram for the Opto Repeater. TR1 is the remotely located photo transistor connected via PL1 and SK1 to the trigger input (pin 2) of IC1. This integrated circuit is a 555 timer wired as a simple monostable, the period of which is determined by R2 and C1. This *RC* network sets the time period to about 8 minutes or so but this may vary in reality, due to quite large manufacturing tolerances on C1.

When TR1 is in darkness, it in effect exhibits a high resistance, such that pin 2 is virtually at the supply potential. However, as light starts to fall upon the photo-transistor the voltage at its collector will fall, bringing down with it the trigger input of IC1 until it triggers.

Thus when the Security Vari-Light illuminates, the position of TR1 will be such that the phototransistor will be illuminated as well, causing IC1 to trigger.

When the i.c. commences timing, its output (pin 3) rises to a little less than the supply rail voltage and this causes a mains-rated relay RLA to activate. Consequently the contacts RLA1 close and complete a circuit between the mains supply and the remote lamp plugged into SK2.

The timer i.c. will then continue with its timing cycle and under normal circumstances the relay will deactivate at the end of the timing period, thereby extinguishing the remote lamp.

In fact, for *normal* operation to occur it is necessary that the triggering period is less than the timing period set by R2 and C1. This means that the Security Vari-Light must illuminate TR1 for a period less than the timing period of IC1.

If the trigger time exceeds the *RC* timing period then the i.c. will re-trigger and commence timing again until the trigger signal diminishes, that is, the master lamp extinguishes. The Opto-Repeater's timer will then reset itself also.

MAINS POWER

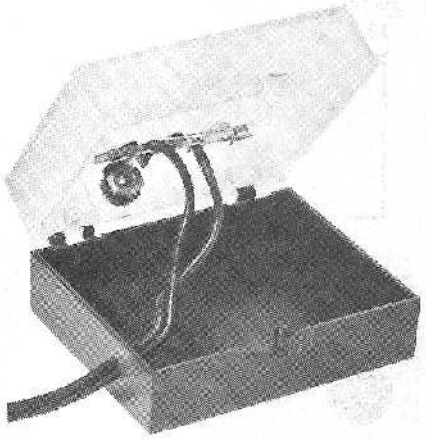
The Opto Repeater is mains powered through T1, a centre-tapped transformer which steps down the mains voltage applied to its primary winding to about 12V a.c. This is full-wave rectified by D3 and D4, and is then smoothed by C4 to produce a d.c. potential of approximately 16V within the maximum rating of the timer i.c.

R3 and C3 form a filter which reduces the ripple present after smoothing, to give an improved supply rail quality.

Mains power is switched by S1. In the SECURITY mode, the Opto Repeater operates as dictated by the light falling upon the phototransistor; in the BYPASS position, power is routed straight through to SK2 via F2 so that the electronic circuit is disconnected and the lamp is continuously illuminated. In the centre OFF position, both lamp and timer are disabled.

However, the presence of an arc suppressor, X1, means that some power may be transmitted through it when S1 is in the BYPASS mode. This means that although the transformer primary may appear to be disconnected, the electronics may in fact be partially operative, but this is nothing to worry about.

Phototransistor mounted in a clear fronted plastic box.



COMPONENTS

Resistors

R1	100kΩ
R2	4·7MΩ
R3	15Ω
All ¼W carbon +5%	

See Shop Talk page 23

Capacitors

C1	100µF, 25V elect, radial lead
C2	0·01µF polyester C280
C3,4	470µF, 25V elect, radial lead (2 off)

COMPONENTS approximate cost £18 excluding p.c.b.s & case

Semiconductors

D1,2	1N4148 silicon (2 off)
D3,4	1N4001 silicon (2 off)
TR1	2N5777 *npn* photo-darlington
IC1	555 timer

Miscellaneous

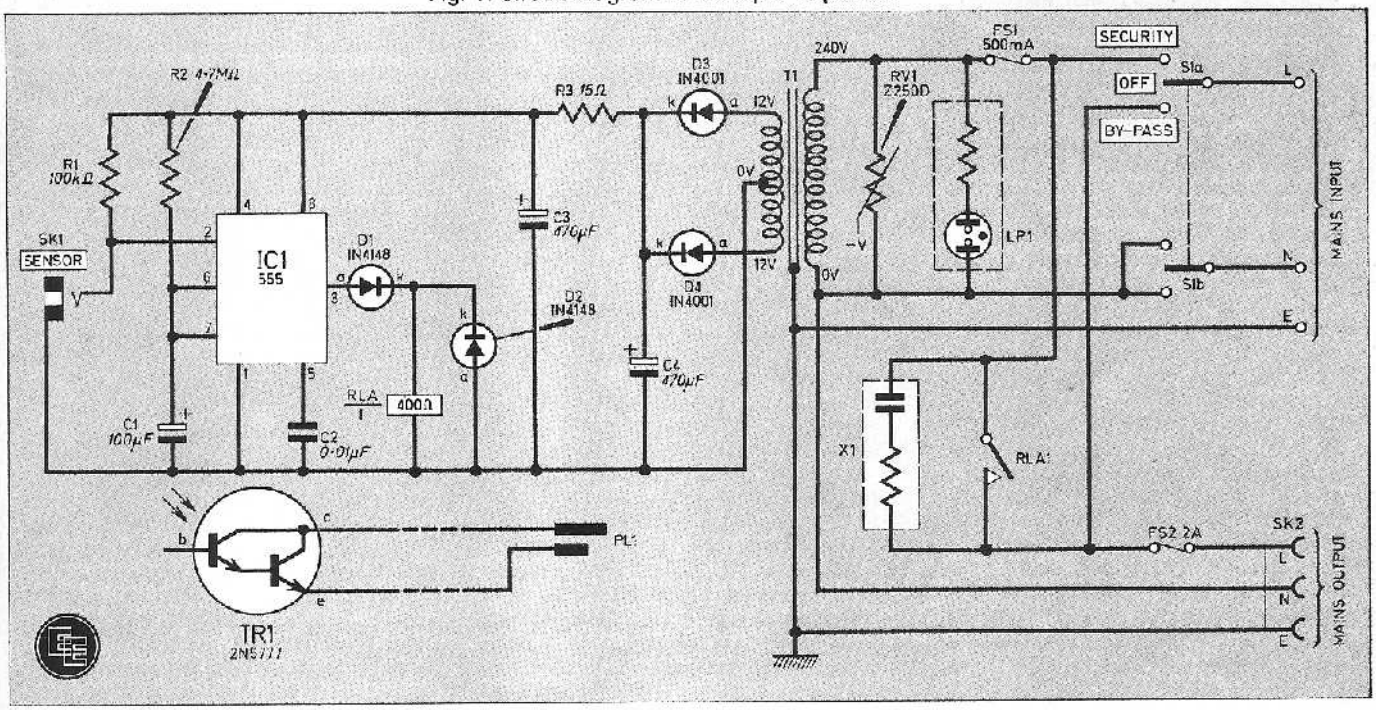
T1	Miniature mains transformer, 12V·0-12V, 100mA secondary
S1	d.p.d.t. centre-off miniature toggle
SK1	3·5mm jack socket
SK2	Mains panel mounting socket
PL1	3·5mm jack plug
PL2	Shrouded pin mains plug (for SK2)
FS1	20mm, 500mA fuse with chassis mounting holder
FS2	20mm, 2A fuse with p.c.b. mounting clips
LP1	240V mains neon indicator with integral limiting resistor
X1	Mains R-C contact suppressor
RV1	Mains transient suppressor Z250D
RLA	Ultra miniature high power mains relay, 12V, 400Ω coil, contacts rated at 240V, 10A

Console type case, 215 × 130 × 78mm (rear) × 47mm (front)—BIM type 1006; clear plastic box, 60 × 45 × 25mm (for phototransistor); single sided glass-fibre p.c.b. 92 × 45mm; 8 pin d.i.l. holder; 24/0·2mm wire (for mains wiring); 7/0·2mm wire; 3-core, 6A mains cable; twin core cable (approx. 4m); 3-way tag strip (2 off); grommet; P-clip; standard 3-pin mains plug with 5A fuse; self-adhesive feet (4 off); Veropins; mounting hardware (nuts, screws, washers and p.c.b. guides).

LP1 is the POWER ON indicator formed by a neon bulb with integral limiting resistor. It may light up when S1 is in the BYPASS setting; this can be attributed to the location of X1, and be disregarded.

RV1 is a mains transient suppressor but this, along with X1, is optional and may not prove entirely essential. Both the transformer and lamp are fuse-protected by FS1 and FS2 respectively.

Fig. 1. Circuit diagram of the Opto Repeater.



CONSTRUCTION starts here

PRINTED CIRCUIT BOARD

Since both mains and low d.c. potentials are intermixed in the circuit, the unit has been constructed on a single printed circuit board, see Fig. 2.

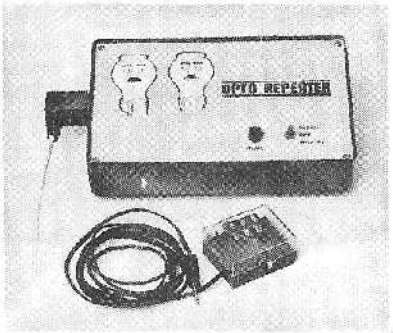
Construction is straightforward with the following possible exceptions. RLA is an "Ultra Miniature High Power Mains Relay", available from Maplin, part number YX97F, and other types may not be pin-for-pin compatible with the holes drilled in the p.c.b.

FS2 is a printed circuit mounting type 20mm fuse clip and four 1·5mm diameter holes are required in the circuit panel, as indicated. It may also be wise to use an 8-pin i.c. holder for the timer.

CASE

The case chosen for the project was a plastic console, type BIM1006 which measures 210 × 125 × 41mm (front) × 62mm (rear), with an aluminium top panel. SK2 was fixed on one side of the box with the jack socket SK1 fitted to the rear. The neon lamp and toggle switch were fitted on the front panel.

Four mounting holes, one in each corner, are shown in the p.c.b. which permit mounting by M2·5 or 6BA screws, nuts



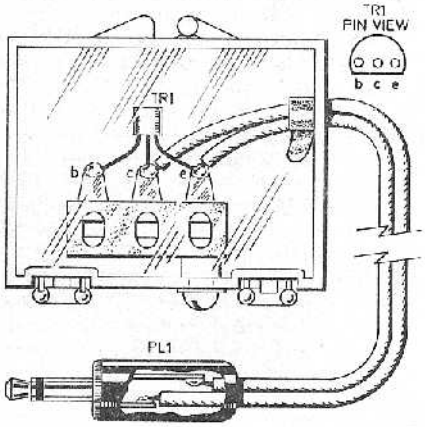
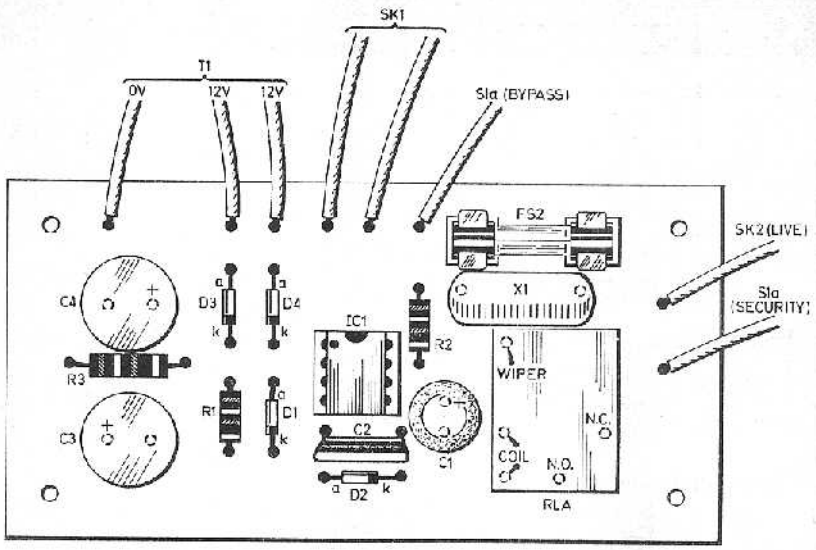


Fig. 4. Assembly of the phototransistor unit. Note that the curved face of TR1 is photosensitive.



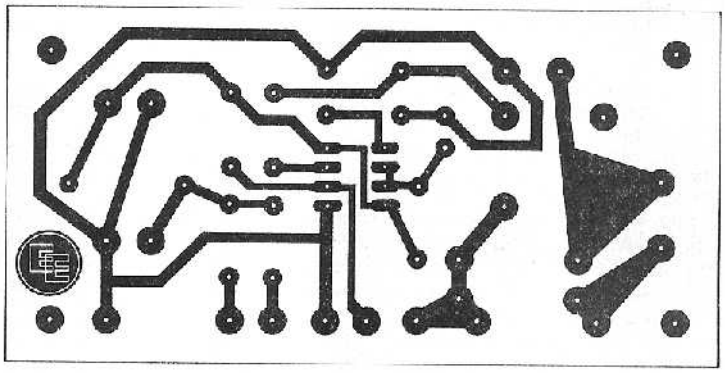
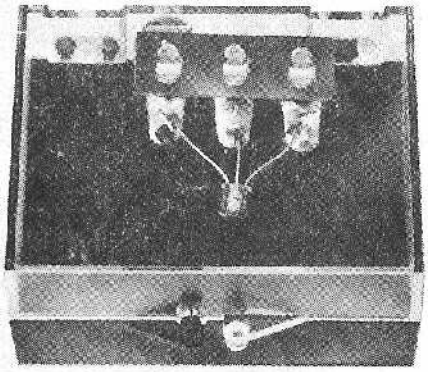
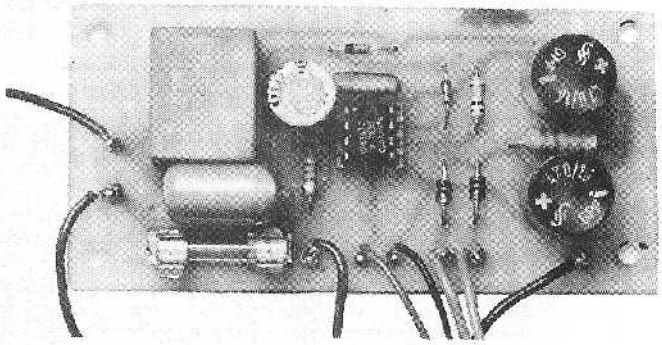


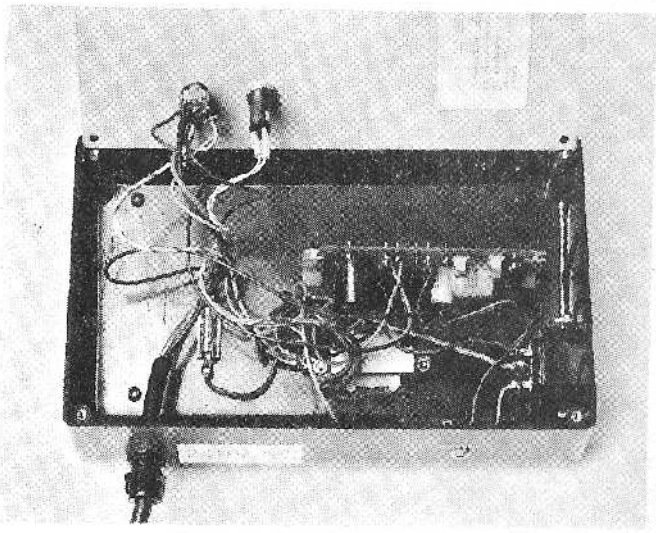
Fig. 2. Full size track pattern and component layout for the Opto Repeater circuit board. Note that the board is designed to accept the Maplin "ultra miniature high power mains relay".



Plastic "stylus" box housing tag strip and TR1.



The completed prototype p.c.b. assembly. Note the use of an i.c. holder for IC1 and Veropins for all wired connections.



View inside the console case showing the relative positions of the main components.

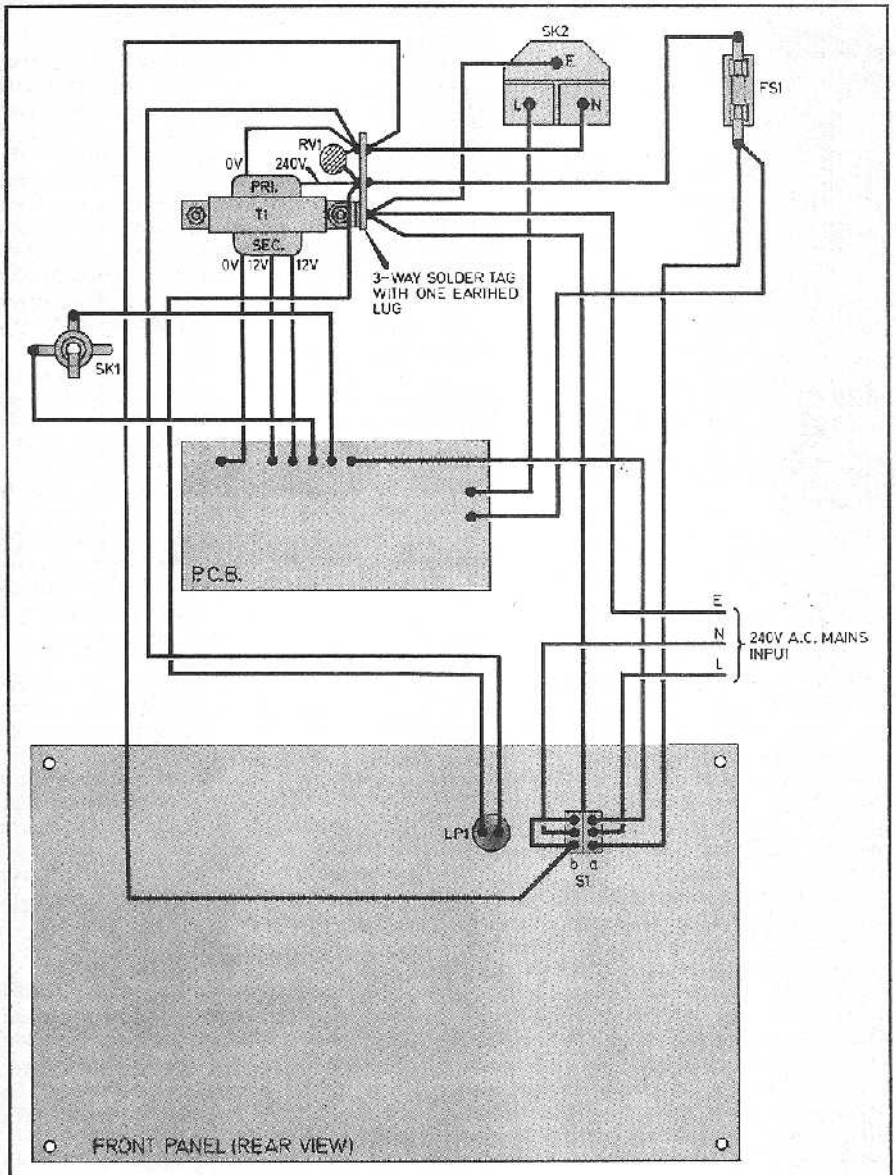


Fig. 3. Interwiring diagram. Mains input cable must be securely clamped with a cable clamp or strain relief gland.

and spacers but the prototype was mounted vertically using special plastic clip-in guides.

It is *essential* to ensure that if the p.c.b. is fitted vertically, there is no possibility whatsoever of the fuseholder FS2 coming into contact with the metal front panel. It is desirable therefore to place the p.c.b. such that FS2 is downwards, against the floor of the non-conductive case.

WIRING

Full interwiring details are given in Fig. 3. Mains wires must have a rating of 4·5A 250V a.c., typically a 24/0·2mm wire. It is a good idea to insulate all mains soldered joints with p.v.c. sleeving to avoid accidental shocks.

Other wiring can be completed with 7/0·2mm general purpose wire. Several flying leads come from the p.c.b., some of which are mains-rated, and the point at which they connect with the board, terminal pins should be used.

A three-way tag strip carries connection for the neon lamp and mains transformer as shown in the construction diagram, and one of the tags is earthed and screwed to one of the transformer mounting screws. Thus it is through the tag strip that the transformer is earthed.

It is necessary to earth the metal front panel of the console and this can be achieved by soldering an earth wire to the metal body of the switch, or by placing a large automotive type tag under S1 mounting nut inside the case.

Furthermore, it is important that precautions are taken to ensure that the three-core mains cable is secured so that it cannot pull out. A grommet should be fitted at the point of entry and some form of retention clip must be used to secure the cable.

PHOTOTRANSISTOR

The phototransistor was soldered to a three-way tag strip and then bolted into an old hi-fi stylus box which had a transparent front. The curved face of the transistor must point outwards since this is the light-sensitive side of the device. See Fig. 4 for details.

Twin-core cable can then be used (maximum length of about 4 metres) to connect TR1 to the console by means of a 3·5mm jack plug and socket.

TESTING

With construction now completed, check the wiring thoroughly, especially those sections of the assembly which are at mains voltage. Connect a suitable mains lamp (500W maximum) to the 6A Euro-type plug and insert this into the console. Also connect the photo transistor unit but place it in complete darkness, for example, in a light-proof box. Plug the Opto Repeater into the mains, with a suitably fused 5A plug.

Set S1 to the SECURITY position and the lamp may illuminate straight away. However, after a delay of up to about 10 minutes it should extinguish. By temporarily exposing the phototransistor to light, the mains lamp should illuminate for a controlled time period.

If this period is too long, in excess of 15 minutes, then the method of correcting this is to reduce the value of R2 on the printed circuit board.

If illumination of TR1 does *not* cause the mains lamp to operate, then check that the wiring of TR1, both at the tag strip *and* the jack plug. Also make sure that TR1 is facing the right way. You should also hear the relay click on and off—this indicates that the phototransistor is triggering the i.c.

INSTALLATION HINTS

It is obvious that the main Security Vari-Light needs to be positioned first and then the location of the phototransistor controlling the Opto Repeater can be determined. The phototransistor must be placed so that when the main lamp is extinguished it is in relative darkness, and when alight it is exposed to that light. Tests carried out on the prototype showed that the distance between the sensor and main lamp can be up to about four metres.

It is important that light from the "remote" lamp does not fall onto the phototransistor controlling it. If this should happen, the Opto Repeater will latch, so that the remote lamp will be continually alight.

If a bedside lamp is used in conjunction with the Opto Repeater, and this is the author's anticipated application, then it is desirable that the console is placed by the bedside with the lamp to enable the user to switch the bedside lamp on and off using the BYPASS facility. Then it is essential that the phototransistor is placed *outside* the bedroom so no optical feedback problems should arise. □