UNIBOARDS

SIMPLE TRANSISTOR DESIGNS

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DUSK–DAWN RELAY

THIS article describes the construction of a device which illuminates a lamp automatically as the night approaches. This three-transistor design operates a changeover relay when the amount of light falling onto a photocell has reached a defined level.

The circuit is powered from a 9 volt rail and whilst this could be derived from dry batteries, the unit described here has been designed to operate from the *9 Volt Power Supply* which appeared in Part 3 of this series.

CIRCUIT DESCRIPTION

The circuit diagram of the Dusk-to-Dawn Relay is shown in Fig. 1. Light-dependent resistor PCC1 is remotely-located and detects the ambient light level. Together with R1 and VR1 (the SENSITIVITY control), the l.d.r. forms a potential divider, so that the voltage at the base of TR1 is dependent upon the amount of light falling onto PCC1.

During the daytime the resistance of the l.d.r. is low—in the order of 20 ohms—and so the voltage at TR1 base is high; conversely as night-time approaches, the resistance of the ORP12 increases, so lowering the voltage at TR1 base.

TR1 and TR2, together with associated resistors, form a circuit configuration called a Schmitt Trigger. This circuit is designed to suddenly switch over at a predetermined setting even though the input signal (i.e. the voltage at the base of TR1) may change over only very slowly.

This snap-over action makes the circuit ideal for operating a lamp when the ambient light level is slowly reducing. The Schmitt Trigger functions as follows.

Consider a night-time situation where the resistance of PCC1 is high —say 500 kilohms or so (although it could be considerably higher). Assuming that VR1 is set to midway, the voltage at the base of TR1 works out at only 150mV. This means that TR1 must be off since the base needs to be 650mV more positive than its emitter for the device to switch on. TR2 is therefore permitted to switch on as base current is able to flow through R2. A voltage then develops across R3 (and also R4); this effectively reverse-biases the base-emitter junction of TR1 and this component remains firmly biased off.

INCREASING LIGHT LEVEL

As the resistance of PCC1 falls (the ambient light level increasing) the voltage at TR1 base will rise until TR1 starts to switch on.

At this point, the collector of TR1 falls, taking TR2 base with it. The effect of this is that TR2 starts to turn off. In so doing, the emitter of TR2 is sent to 0V, as is TR1 emitter. This increases the forward bias on the base-emitter junction of TR1, so enabling TR1 to switch on harder.

As it does this TR2 is forced to switch off even further, thereby causing TR1 to conduct more. This regenerative action, once started, causes TR1 to switch on hard very rapidly, with a consequent switching out of circuit of TR2.

This is the action of the Schmitt Trigger: a very gradual change in the resistance of the l.d.r. results in the circuit "snapping over" very quickly.

As night-time approaches once more, a reverse avalanche takes place resulting in TR1 switching off and TR2 conducting.

TR3 is a *pnp* transistor coupled to the collector of TR2 by R5. When TR2 is on, TR3 is also conducting. This operates RLA, the contacts of which complete the mains circuit to the lamp. Diode D1 also illuminates, signifying that the relay is operating. TR3 serves as a power output stage which prevents loading of the basic Schmitt circuit.

The ratings of the relay contacts must be carefully observed: the specified relay will switch mains loads of up to 3A (750 watts), and this should satisfy most domestic applications.

CONSTRUCTION starts here

CIRCUIT BOARD

The circuit is built onto a standard-sized piece of 0·1in matrix stripboard measuring 10 strips by 24 holes. The l.d.r. and power supply are connected by means of two 3·5mm jack sockets. The Dusk-to-Dawn Relay unit itself was housed in a plastic box which measured 150×80×50mm.

If desired, there is no reason why the power supply cannot be housed in the same case. A larger case than specified may then be required.

Component layout on the circuit board and complete wiring details are shown in Fig. 2. Two 6BA clearance holes are drilled to take the supporting hardware, and then the circuit board is assembled in the normal manner. Take care regarding the orientation of the transistor leads: do not overheat them and ensure that D2 is soldered in the right way round.

Complete the low-voltage wiring using stranded connecting wire as shown. The l.e.d. is mounted on the front panel using the special mounting clip normally provided with it; the relay can be secured in place with a piece of double-sided adhesive foam.

Basic interwiring is also shown for the mains circuitry. In this respect it is important that the soldering to the relay tags is of a high quality. Also mains connecting wire of the appropriate specification (3 amps at 250V) must be employed.

The photocell was soldered to a small piece of tagstrip and twin core flex terminated in a 3·5mm jack plug was used to connect this to the main unit, see Fig. 2.

Setting up comprises simply adjusting the preset, VR1 to about midway and then repositioning it if necessary until the desired switching point is achieved with the l.d.r. sited in its operating position. ⌑

COMPONENTS

See **Shop Talk** page 635

Resistors
R1 5·6kΩ
R2 15kΩ
R3 68Ω
R4 680Ω
R5 3·3kΩ
R6 680Ω
All ¼W 5% carbon

Semiconductors
TR1, 2 BC108 *npn* silicon (2 off)
TR3 BFX88, BFX30 or 2N2905A *pnp* silicon
D1 TIL220 light emitting diode
D2 1N4148 silicon
PCC1 ORP12 light dependent resistor

Miscellaneous
VR1 22 kilohm miniature horizontal preset
RLA 12V relay, coil resistance 185 ohm Continental with 3A 250V c.o. contacts
SK1, 2 3·5mm jack sockets, (2 off)
PL1 3·5mm jack plug
0·1 inch stripboard, 10 strips × 24 holes; case—BIM2005/15; l.e.d. clip; twin-core flex; tagstrip; mains wire; stranded hook-up wire; 6BA hardware.

Approx cost **Guidance only**
£4.00 excluding case

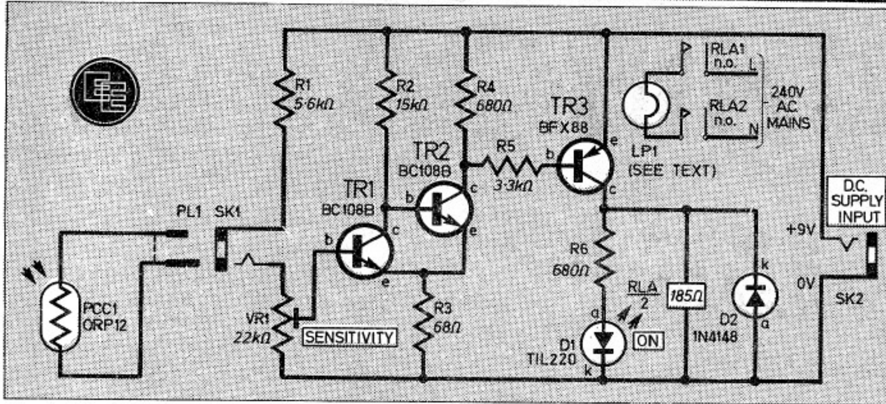
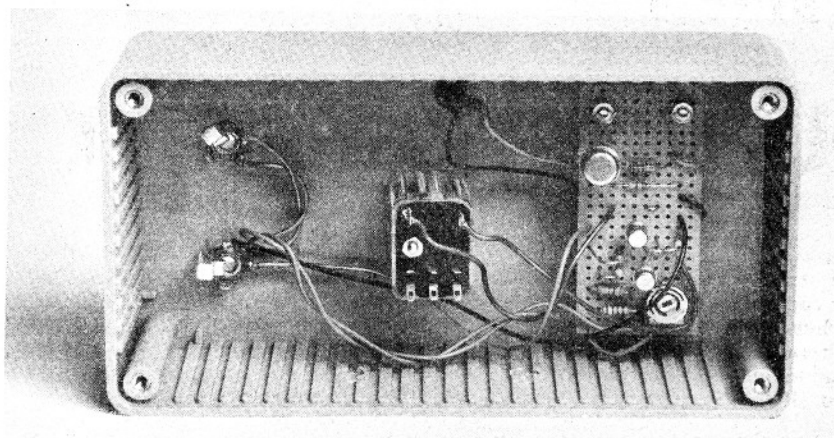


Fig. 1. The circuit diagram of the Dusk-Dawn Relay unit. The power supply may be from battery or the 9V Power Supply Unit featured earlier in this series.



The partially assembled prototype requiring connections from the relay contacts to the lamp and 240V a.c. mains.

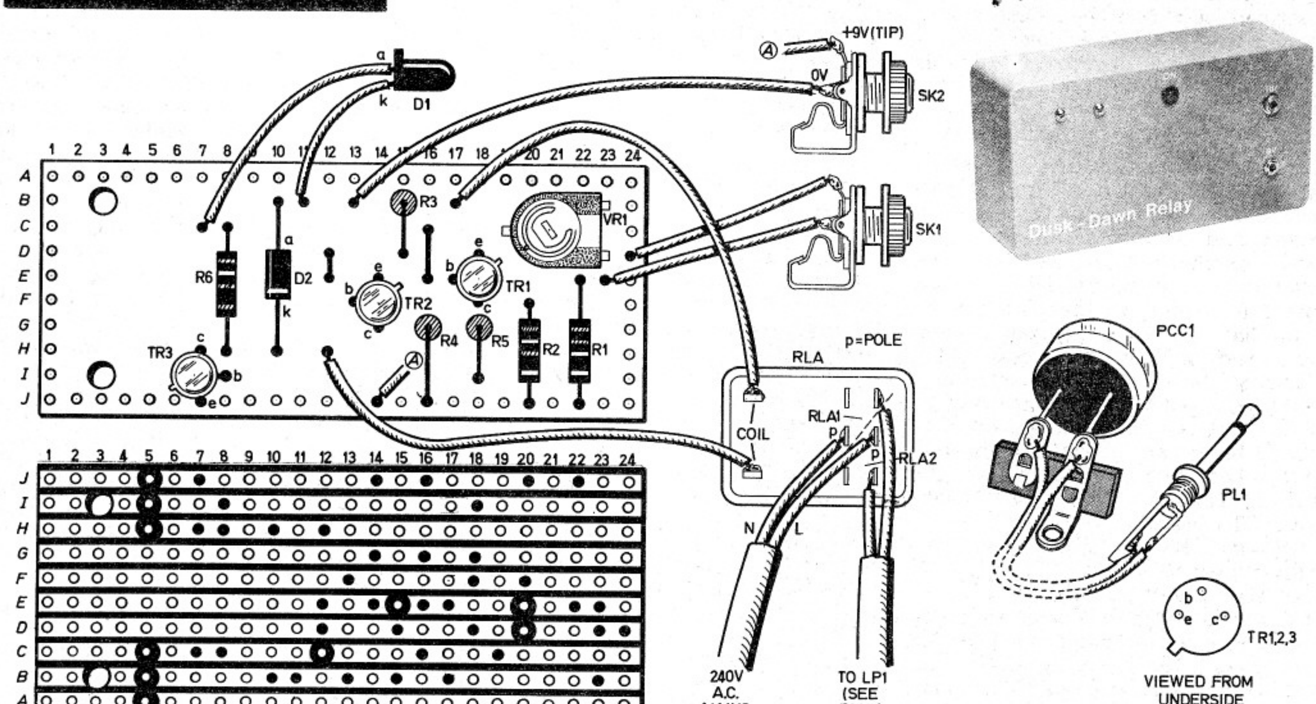


Fig. 2. The layout of the components on the topside of the stripboard, breaks to be made along the copper strips on the underside and wiring up to the off-board components. Also shows 240V a.c. mains connections to the controlled lamp via the relay contacts. The contact arrangement will vary between relay types and should be verified before connection. Seen right is the method used for mounting the light dependent resistor.