PROJECT

Light Sentinel

Control up to five house lighting circuits and keep would-be intruders guessing as to whether the home is occupied or not.

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Domestic security systems are taking a much higher priority these days because of the dramatic increase in home break-ins. While an alarm system should of course be the first investment, a device to deter the would-be intruder could well prove its worth. Police also advise leaving a light on to give the impression that the home is occupied.

This is good advice, but the idea can be enhanced with the Light Sentinel described here. The unit provides the means of remotely controlling up to five lighting circuits using the safety of low voltage switching signals that trigger a small interface unit fitted in each wall light switch.

The Light Sentinel monitors the ambient light level and activates at dusk. It then switches on one main light circuit and also sequences through up to four other circuits. The timing of the switching sequence can be adjusted from 10 to 40 minutes. The sequence is performed twice and then the unit goes in to a "rest" state with all light circuits being extinguished.

This state remains until dawn, when the unit is automatically reset. For example, if the timing is set for, say, half hour intervals, the sequence will last for four hours. If the unit is activated at 8pm by the fall in the light level, the Sentinel will continue working until midnight. If the lighting circuits coupled to the unit include the bedroom, bathroom and stairs with the main circuit coupled to the living room, then the impression can be given that there is movement from room to room within the house.

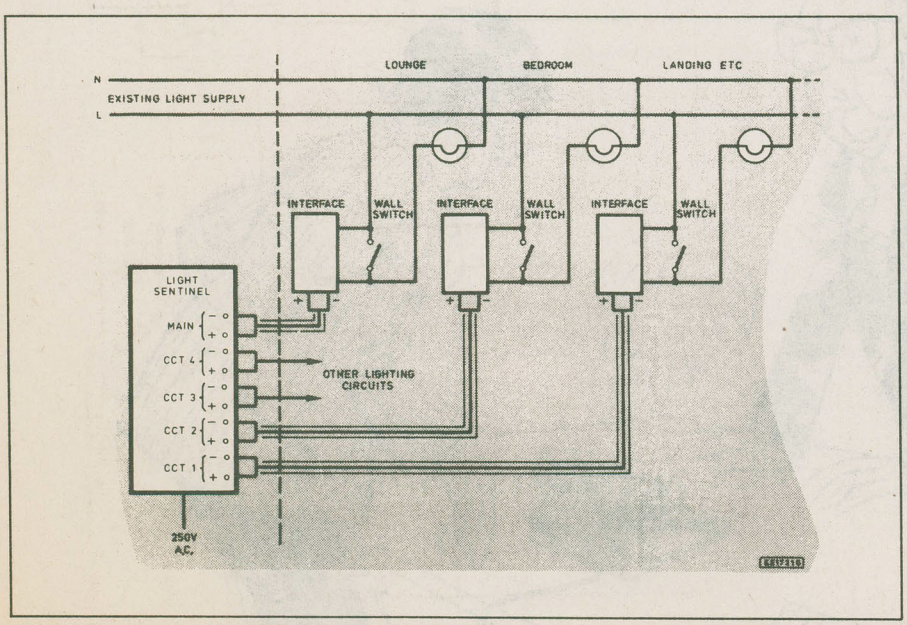


Fig. 1. The system block diagram for the Light Sentinel.

Power Control

Because we are using the lighting as a deterrent we can economize on power if we wish by running the lights at half power using a SCR (thyristor) interface; however, this will then exclude the means of controlling any fluorescent lighting circuits. If normal brightness is preferred, a solid state relay can be used for the interface.

Both these options provide a high degree of safety because only low level signals are sent out of the main unit using two-way cable, and are isolated from the AC supply at the light switch. This ensures that no lethal voltages are present between the unit and the lighting circuits.

The system block diagram in Fig. 1 gives the basic concept and shows how the unit is connected to the lighting circuits. As can be seen, the optical isolator and associated components are mounted on a small printed circuit board within the existing lighting box. If the solid state relay option is used, then this relay is all that is required within the light switch box.

Note that it is not necessary to couple up all circuits for the unit to operate and the switching sequence can be preset using link wires. This will be described later.

An additional facility is built into the unit which will flash all circuits on and off if triggered by a main burglar alarm. This is achieved by shorting out the Test switch

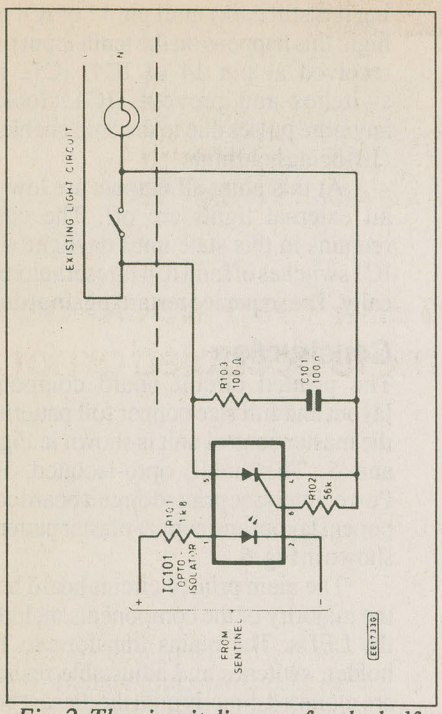


Fig. 2. The circuit diagram for the half-power option.

S1 with a pair of contacts from the main burglar alarm.

Circuit Description

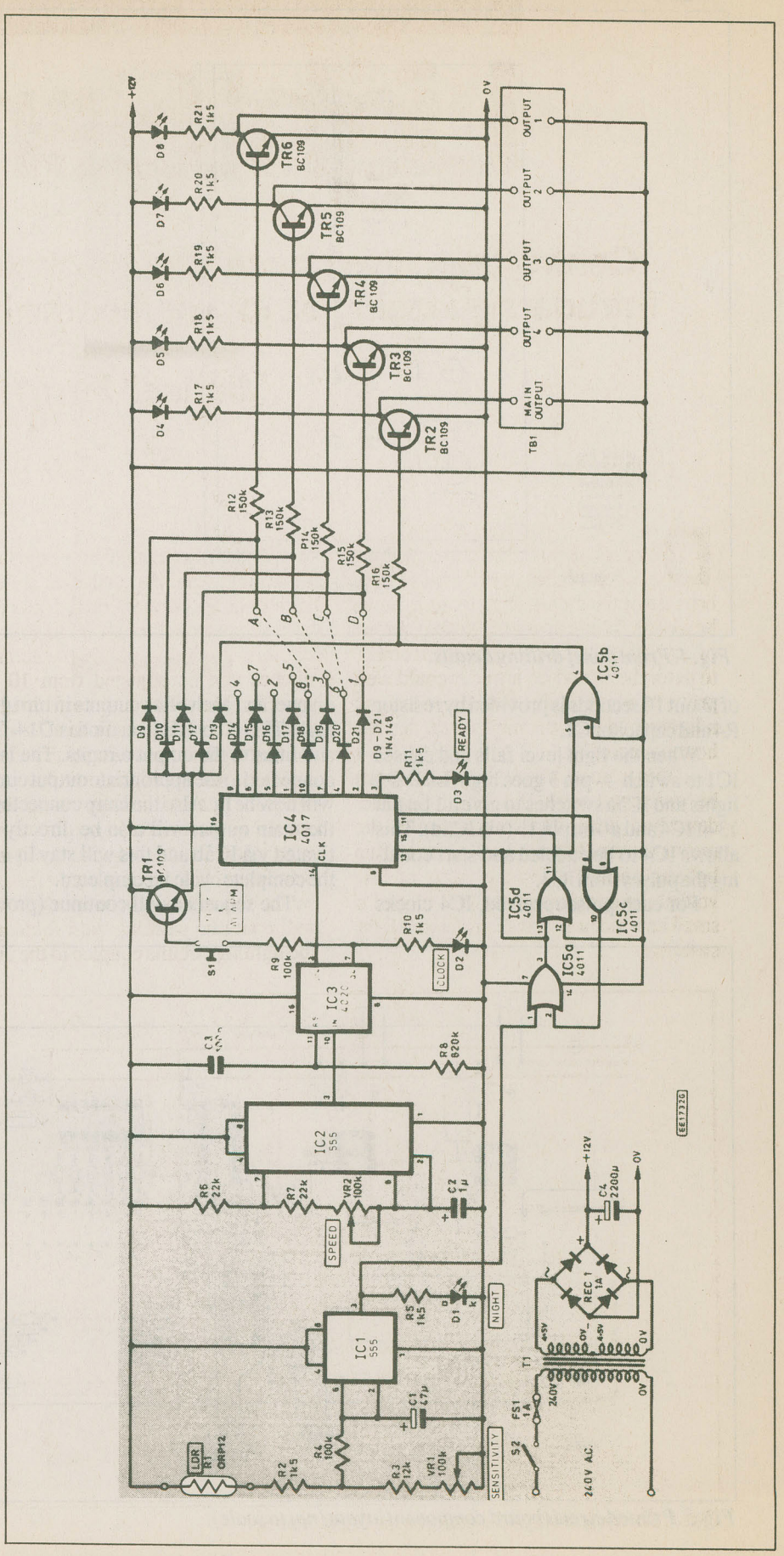
The full circuit diagram of the Light Sentinel is shown in Fig. 2 and the Half Power Interface in Fig. 3. When the unit is first switched on, during daylight conditions, the output from pin 3 of IC1 is low (0). This is coupled via IC5a to give a 1 (high) on pin 13 of IC4 and via IC5a and IC5d to give a 0 on pin 15 of IC4 which as a result is held in its reset state. At this point LED D3 is lit.

The oscillator IC2 is running and clocking pulses into IC3 which is a 14-bit binary counter. IC3, pin 7 is Q4 output and drives LED D2 to indicate that the oscillator is working. This output also has another use. If switch S1 is closed transistor TR1 is switched on and off as Q4 goes high and low. This is coupled via diodes D9 to D13 to the output circuits to enable a lamp test facility.

The unit is activated automatically due to R1, the light dependent resistor (LDR), sensing the change in the light level. As the light level falls, the resistance of R1 increases.

The point at which IC1, the light switching circuit, activates is set by potentiometer VR1. To provide protection from temporary increases and decreases of light, say from car headlights, a time delay

Fig. 3 (right) The complete circuit diagram for the Light Sentinel.



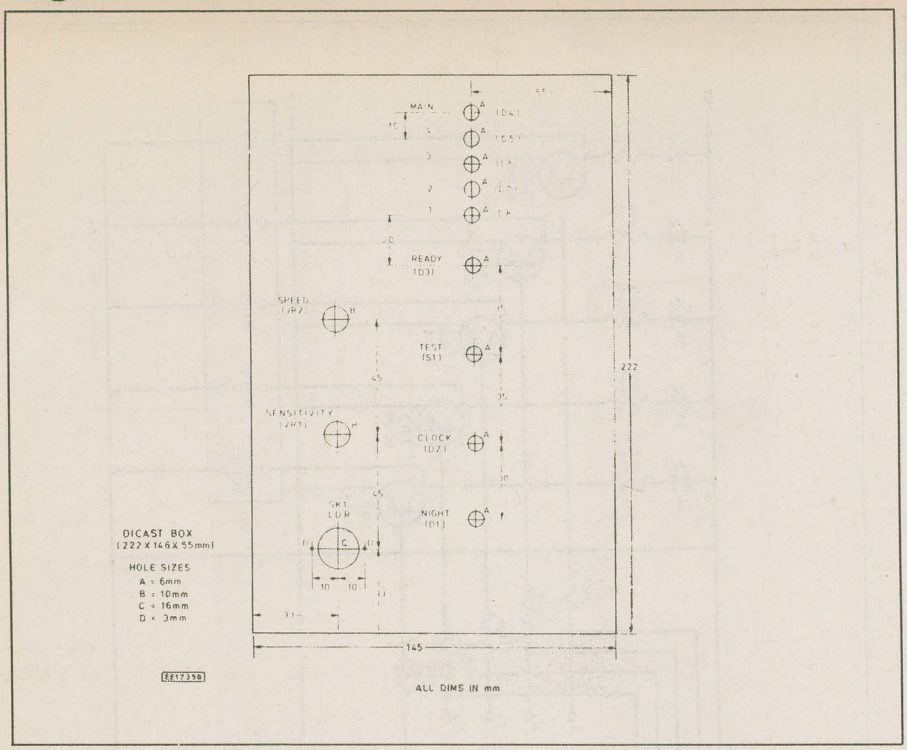


Fig. 4. Front panel drilling details.

of about 10 seconds is provided by resistor R4 and capacitor C1.

When the light level falls and causes IC1 to switch — pin 3 goes high, LED D1 lights and IC5a switches to give a 1 on pin 13 of IC4 and a 0 on pin 15 (via IC5d). This allows IC4 to be enabled and start counting the pulses from IC3.

For each pulse received, IC4 clocks on one, and each of its outputs in turn goes high. This is coupled via diodes D14-D21 and links to the output circuits. The lamp connected to the appropriate output circuit will now be lit. Also the lamp connected to the main output will also be directly activated via IC5b and this will stay lit until the complete cycle is completed.

The sequence will continue (providing it is still dark) until pin 11 of IC4 goes high: this happens on the tenth input pulse received at pin 14 of IC4. IC5a now switches and prevents IC4 clocking anymore pulses due to the chip enable pin (13) being held high.

At this point all outputs are low and all external lights are off. The circuit remains in this state until daylight when IC1 switches off and IC4 is reset automatically. The sequence restarts again at dusk.

Construction

The printed circuit board component layout and full size copper foil pattern for the master control unit is shown in Figs. 4 and 5. The small, opto-isolated, Half Power Interface printed circuit board component layout and copper master pattern is shown in Fig. 6.

The main printed circuit board holds the majority of the components including the LEDs. The mains transformer, fuse holder, switches and adjustable resistors are mounted directly onto the diecast box.

The cost of construction can be reduced if the alarm and test functions are not required. Just omit from the PCB the following items: diodes D9 to D13, transistor TR1, switch S1 and resistor R9.

Start construction by mounting all the components on to the main board, Fig. 4, in the normal order: links, resistors, capacitors and finally diodes, transistors and integrated circuits. The terminal block TB1 is mounted on the reverse side of the board.

If you refer to the component layout,

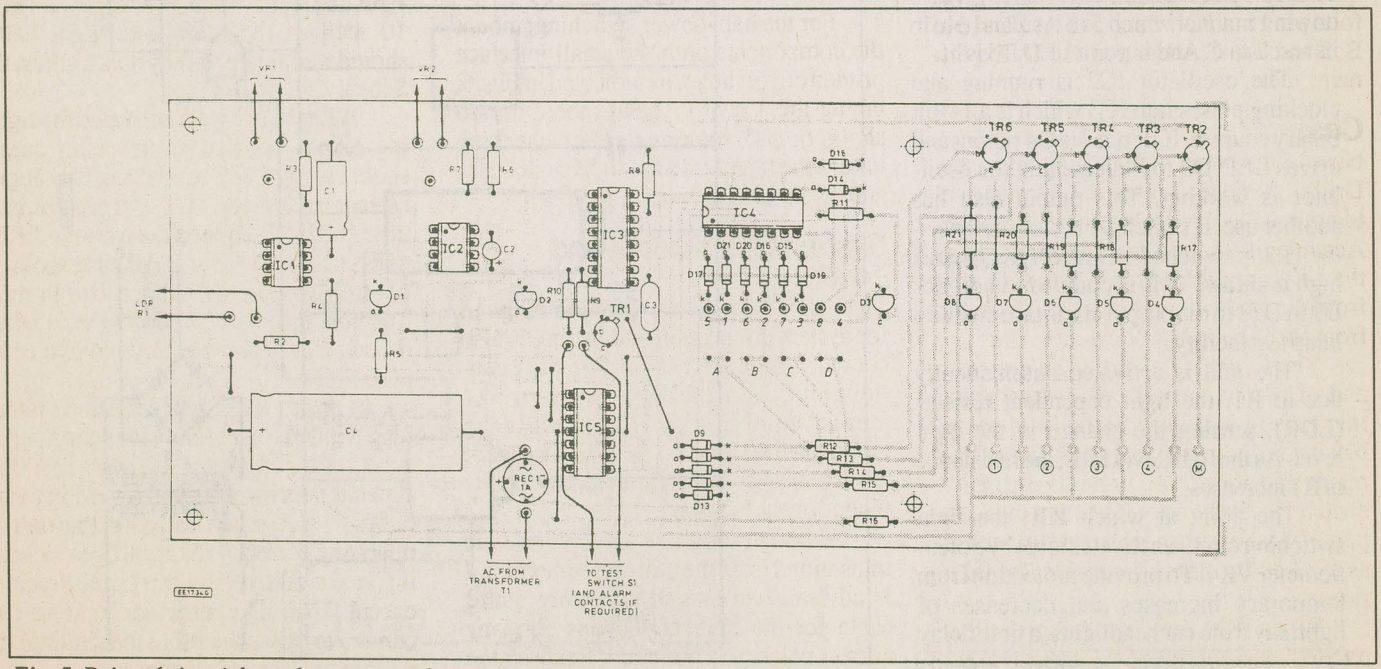


Fig. 5. Printed circuit board component layout (not to scale).

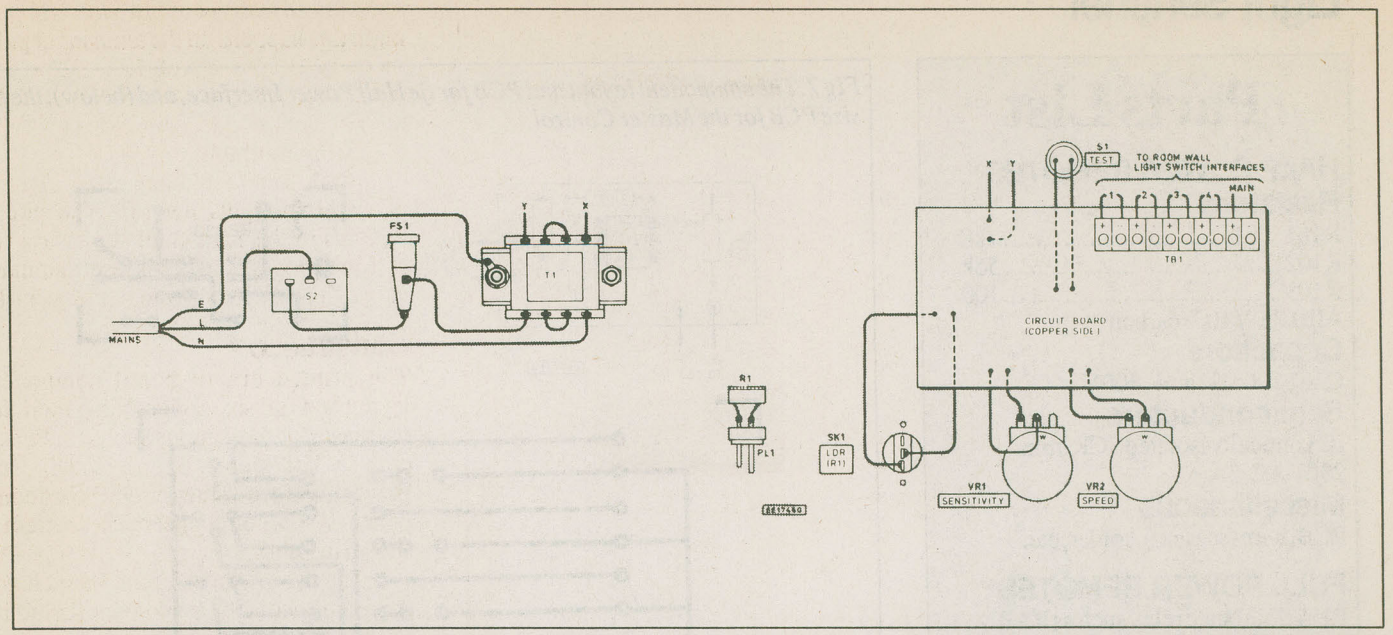


Fig. 6. Interwiring details from the main PCB. The LDR (R1) is mounted directly on PL1 during testing only. It should be wired remotely from the unit.

Fig. 4, you will see just below diodes D15 to D21 there are two sets of pads labelled *1* to *8* and *A* to *D*. These are to enable programming of the switching sequence. Numbers 1 to 8 refer to the outputs from IC4 and one flying link should be connected to each. The letters A to D are the pads connected to the output circuitry and each one can accept up to three inputs from IC4.

For starters try straight forward sequencing by connecting the links in the following manner: 1 and 5 to A; 2 and 6 to B; 3 and 7 to C, and 4 and 8 to D. Experiment later.

Case

Now to the metal work — the bit I hate. Drill all the necessary holes, the front panel template (Fig. 7) should be used as a guide. Accuracy is essential for holes marked *A* as the LEDs are offered into these directly from the PCB which is mounted onto the front panel using four stand-off pillars.

The LDR (R1) is mounted remotely and wired into a speaker plug and plugged into a two-pin socket on the front panel. No layout is given for mounting of the mains transformer T1, fuse FS1 and mains switch S2. These are mounted in the main part of the metal case and are positioned so as to clear the main board when the lid is fitted.

When the box has been drilled, painted and components mounted the remaining wiring to the main PCB should be carried out, see Fig. 8. This completes the construction of the main unit and all that remains are the modifications to the existing lighting switches.

Interface

For the full power interface, there is no construction required as the solid state relay has internal components to ensure correct operation. All that is required is to mount the relay into the switch box and wire it up as shown in Fig. 1.

For the half-power switching, mount the components onto the small interface printed circuit board as indicated in Fig. 6, taking great care to ensure there are no shorts or bad soldering. After checking mount the board into the light switch box and wire it up as shown in Fig. 1.

System Connection And Testing

The majority of the information required for system connection and testing is also contained in Fig. 1. Mount the master control unit in a suitable position near to a mains supply. The LDR should be mounted near a window and should be shielded from any light that may be activated by the Sentinel.

Although only low level signals are transmitted from the unit to the interface it is advisable to use good quality mains cable for the interconnections ensuring correct polarity is observed. Recheck the installation before applying power. Set the Sensitivity control to maximum and the Speed control to minimum (quickest cycling speed).

On powering up the unit during daylight, the following LEDs should light: Ready, Night, Main and Clock. The speed of the Clock LED flash should be adjustable with the Speed control. After about 10 seconds the Night and the Main LEDs will be extinguished.

Cover the LDR (R1) to cut off the light falling on it and after approximately 10 seconds the Main and Night LEDs should illuminate. If they don't, adjust the Sensitivity control.

With the unit now activated the lighting circuit coupled to the main output should be lit. The Sentinel has now begun its sequencing and after a predetermined time (set by the Speed control) the LEDs numbered one to four and their associated lighting circuits should activate in turn. The unit goes back to the rest state when the sequence has been through two complete cycles.

As this testing process can be rather long winded it is possible to speed it up by substituting capacitor C2 with a 100nF capacitor during tests and reverting to the correct value when satisfied the unit is operating correctly. Normal light switching is not affected by the Light Sentinel except when that particular lighting circuit is triggered; therefore the wall switch will have its normal response.

Parts List

HALF POWER REMOTES

Resistors

R101 .....1k8
R102 .....56k
R103 100
All 0.25W 10% carbon

Capacitors

C101 100n ceramic 400V

Semiconductors

IC1 optically isolated SCR, min. 230V AC, 3A

Miscellaneous

PCB, wire (see text), solder, etc.

FULL POWER REMOTES

RLA Solid state relay such as P&B EOTZ-240D15 or Crydom D2W202F.

MASTER CONTROL

Resistors

R1 light dependent resistor such as ORP12, Radio Shack 276-116, or Clairex CL5M7
R2,5 1k5
R3 12k
R4,9 100k
R6,7 22k
R8 820k
R10,11 1k5
R12-16 150k
R17-21 1k5
All 0.25W 10% carbon

Potentiometers

VR1 ..... 100k lin
VR2 .....100k lin

Capacitors

C1 .....47u elec. 25V
C2 ..... 1u tantalum 10V
C3 .....100n
C4 .....2200u elec. 40V

Semiconductors

D1-D8 Red LEDs
D9-D21 ..... 1N4148 diode
REC1 .....1A bridge rectifier
TR1-6 ..... BC109, 2N3904
IC1,IC2 .....555 timer
IC3 .....4020 14-stage binary counter
IC4 .....4017 decade counter
IC5 ...4011 quad 2-input NAND gate

Miscellaneous

S1 .....push-to-make switch
S2 .....power switch
T1 power transformer; 115VAC primary, 4.5V-0-4.5V or 5-0-5 (0.5A) sec., such as Hammond 166G9 or 166G10.

Fig 7. The component layout and PCB for tje Half Power Interface, and (below), the full-size PCB for the Master Control.