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Constructional Project

OPTO-ALARM SYSTEM

STEPHEN SPENCER



Scare the pants off unwanted intruders with this portable, optically balanced, security alarm.

THE Opto-Alarm is an optically balanced light alarm for general purpose security applications. The alarm is triggered by increasing the light level to a light-dependent resistor (l.d.r.), via a focusing lens assembly. This assembly only accepts a narrow field of light to the l.d.r., thus increasing sensitivity, to allow specific object protection and minimise false alarms.

Alarm activation occurs when the light level increases rapidly, varying light levels from cloud movement, 50Hz mains flicker from fluorescent lamps, dusk-to-dawn light changes and total darkness situations, will not cause false alarms.

BASIC SYSTEM

The full system block diagram is shown in Fig.1. The alarm incorporates an Exit delay indicated by a green l.e.d. to allow departure from the protected area, and to allow time to set the system for the required operation. A further red "Test" l.e.d. indicates any triggering whilst setting up. When time-out occurs, the Exit l.e.d. extinguishes and the alarm is now in the "active" mode of operation, further triggering will activate a warning tone, followed by full siren activation for a pre-set period, after which the alarm will fully reset until activated further.

An optional Entry alert facility is also included to give a 30 seconds warning that you must deactivate the system before proceeding any further. A two-tone pulse is produced which sounds for approximately 11 seconds, giving enough time to "cancel" the alarm. If the alarm is not deactivated (reset), the main siren will "sound-off" once every 2-5 seconds for 11 times, after which the system will automatically reset.



CIRCUIT OPERATION

The full circuit diagram for the Opto-Alarm section of the system appears in Fig.2. When power is applied to the circuit, via keyswitch S1, an Exit delay of 1-45 minutes is activated. The NOR gate inputs at IC3a, pin 1 and pin 2 are initially kept high by C4, resulting in the output at pin 3 being kept low preventing IC2 pin 4 (Reset) enabling, thus isolating IC2. This stops the rest of the circuit from operating until capacitor C4 is charged up, through resistor R9 (l.e.d. D3 indicates the Exit delay period is active).

This delay period allows time to exit the protected area, and time to test and set the alarm for the required operation. When IC3a time-out occurs, l.e.d. D3 will extinguish and pin 4 of IC2 will go high, the whole circuit is now in the "Active" mode of operation.

Light-dependent resistor (l.d.r.) R1 and resistor R5 form a potential divider network, biasing the inverting input at IC1 pin 2 through resistor R3 and the non-inverting input (pin 3) through R4.

IC1 is configured as a comparator and when the ambient light level presented to l.d.r. R1 is increased, the voltage present at pin 2 and pin 3 of IC1 will increase due to R1's resistance being lowered. For slow changes in light level, capacitor C1 charges sufficiently fast for the comparator's trip point not to be reached. However, any rapid changes in light level instantly present the voltage change to IC1 pin 3, but capacitor C1 needs to charge up before it can present any changes to pin 2, causing the output at IC1 pin 6 to go high. Resistor R2 helps to prevent any false alarms when the unit is placed in total darkness situations.

The high output at IC1 pin 6 rapidly charges the delay capacitor C3 via diode D1 and the voltage is fed through resistor

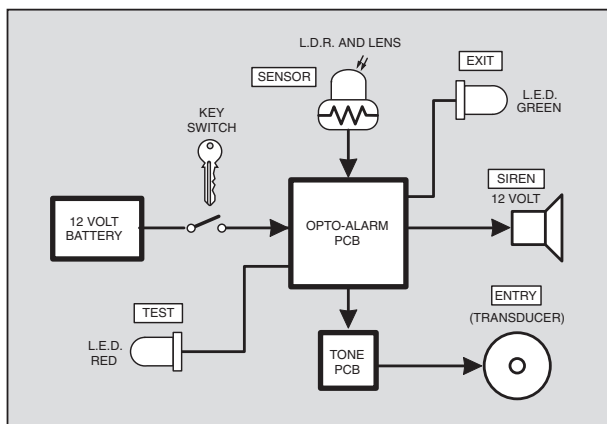


Fig.1. Block diagram for the Opto-Alarm System.

SPECIFICATION . . .

(Subject to component tolerances)

Exit Delay: 1-45 minutes. Entry Delay: 11 seconds.

Siren: Operation 30 seconds. On/Off 11 times. Duration 2-5 seconds.

Current Consumption (12V): 12mA – Strong light. 2mA – Darkness. 3mA to 5mA – Normal use.

R7 to transistor TR1 base (b). The resulting low voltage output from TR1's collector (c) is used to trigger the input of timer IC2, at pin 2. This is indicated by Test I.e.d. D2 via resistor R8.

IC2 is configured as a monostable, whose timing period is determined by capacitor C5 and resistor R10. The positive output at pin 3 is fed to IC3b via resistor R12 and capacitor C6 which cause an 11 seconds delay, after which IC3b's output changes state. The drive to the optional two-tone Entry warning circuit (refer to Fig.3) is also taken from this point.

Input pins 5 and 6 of IC3b go high at "time-out", producing a low output from IC3b pin 4, which in turn triggers an astable oscillator, made up of IC3c/IC3d, at pin 9. Timing components R13, R14 and C7 give an on/off duration of 2.5 seconds, lasting approximately 30 seconds before IC2 time-out occurs.

The astable output is fed, via resistor R15, to the base of Darlington pair TR2/TR3 and finally to a 12V siren WD1. The switching effect enhances the acoustic output from WD1 and conserves battery power. Capacitor C8 helps to prevent any false re-triggering of the circuit, allowing the alarm to fully reset until further activation occurs.

COMPONENTS

Approx. Cost
Guidance Only

£25
excluding batts.

OPTO-ALARM

Resistors

- R1 ORP12, light-dependent resistor (l.d.r.)
 - R2, R9, R10, R12 1M (4 off)
 - R3, R4 470k (2 off)
 - R5, R7, R11, R15 10k (4 off)
 - R6 20M (2 x 10M soldered in series – see text)
 - R8 1k
 - R13, R14 10M (2 off)
- All 0.6W 5% carbon film or better

Capacitors

- C1 100n polyester layer, 5mm pitch
- C2 47p multi-layer ceramic
- C3, C4 100µ radial elect. 16V (2 off)
- C5 47µ radial elect. 16V
- C6 22µ radial elect. 16V
- C7 220n polyester layer, 5mm pitch
- C8 220µ radial elect. 16V

Semiconductors

- D1 1N4001 rectifier diode
- D2 5mm hyper brightness, red l.e.d.
- D3 5mm hyper brightness, green l.e.d.
- TR1, TR2 BC548C npn transistor (2 off)
- TR3 TIP41A npn power transistor
- IC1 CA3140E MOSFET op.amp
- IC2 TS555CN low power timer
- IC3 4001 quad 2-input NOR gate

Miscellaneous

- S1 key-operated On/Off switch
- WD1 12V siren, 115dB
- B1 12V battery pack (8 x AA cells)

Stripboard 0.1-inch matrix, size 21 strips x 20 holes; waterproof plastic box, size 150mm x 110mm x 70mm; 8-pin d.i.l. socket (2 off); 14-pin d.i.l. socket; red Cliplite l.e.d. cover; green Cliplite l.e.d. cover; 10mm clear l.e.d. (for focussing lens – see text); battery clip, PP3 type; multistrand connecting wire; 24 s.w.g. tinned copper wire, for links; 1mm solder pins (12 off); clear epoxy adhesive; solder, etc.

See
SHOP
TALK
page

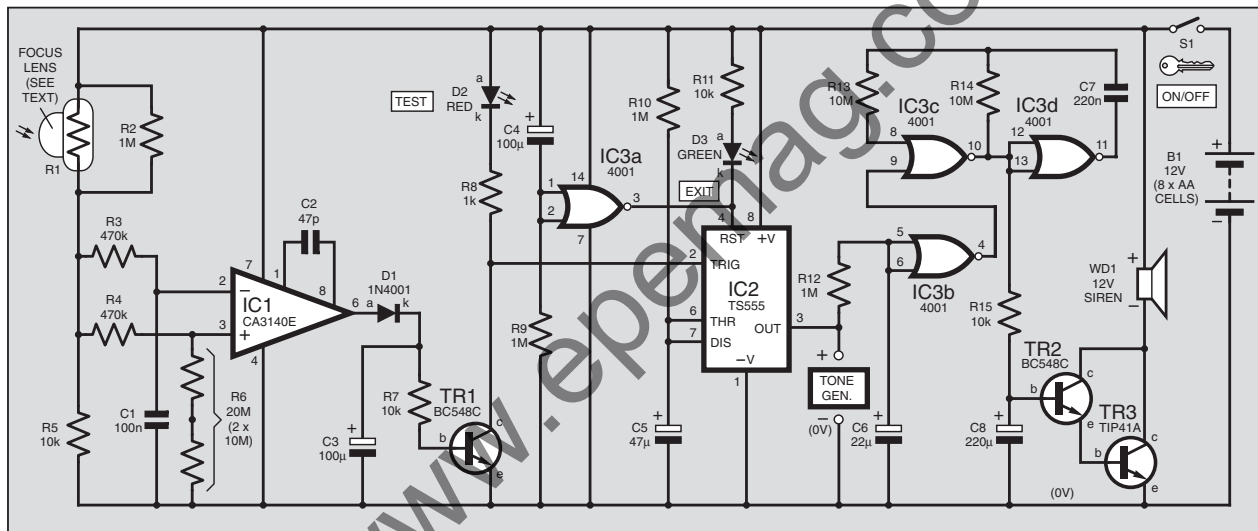


Fig.2. Full circuit diagram for the Opto-Alarm section of the system.

TWO-TONE GENERATOR

The circuit diagram for the optional two-tone warning appears in Fig.3. Operating power is obtained from IC2 pin 3, see Fig.2. The circuit is based around a 556 dual timer, IC4.

The first low frequency oscillator and timing components resistor R16 and capacitor C10 produce an output pulse of about one second duration at pin 5. This output pulse is fed through resistor R17 to the control voltage pin 11 and modulates the second high frequency oscillator. The timing components, resistor R18 and capacitor C11, set the two-tone frequency range. The output at pin 9 is then fed directly to the Entry piezoelectric transducer WD2. This will sound for about 11 seconds before the main siren is triggered. Capacitor C9 is included to decouple the two oscillators,

allowing independent operation to be achieved.

CONSTRUCTION

The stripboard component layout and details of breaks required in the underside copper tracks for the Opto-Alarm appear in Fig.4. Begin construction by making the cuts in the copper tracks, inserting all wire links followed by i.c. sockets and solder pins.

Next fit all passive components observing capacitor polarities. Note that capacitor C2 is soldered across IC1 pin 1 and pin 8 on the copper track side. Carefully insert and solder in position diode D1, transistors TR1, TR2 and TR3, taking care over their pin identities and not to overheat the lead-out wires.

Insert all integrated circuits, handle these devices carefully due to the

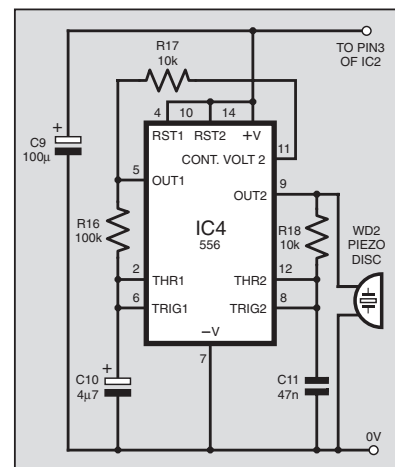


Fig.3. Circuit diagram for the optional Entry "Two-Tone Generator" stage.

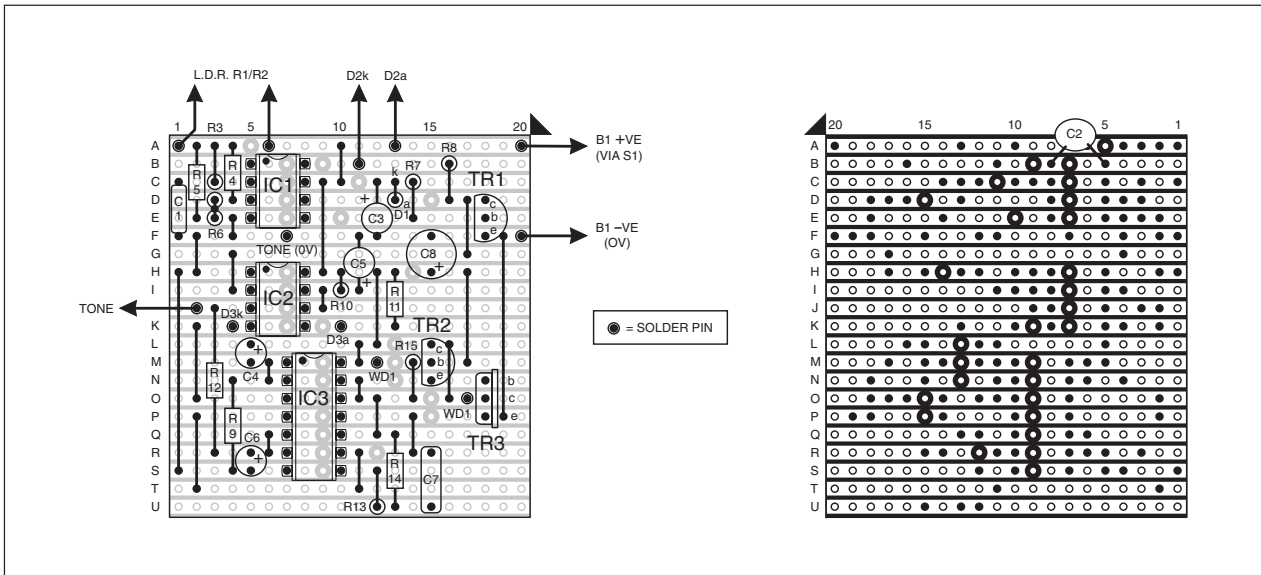
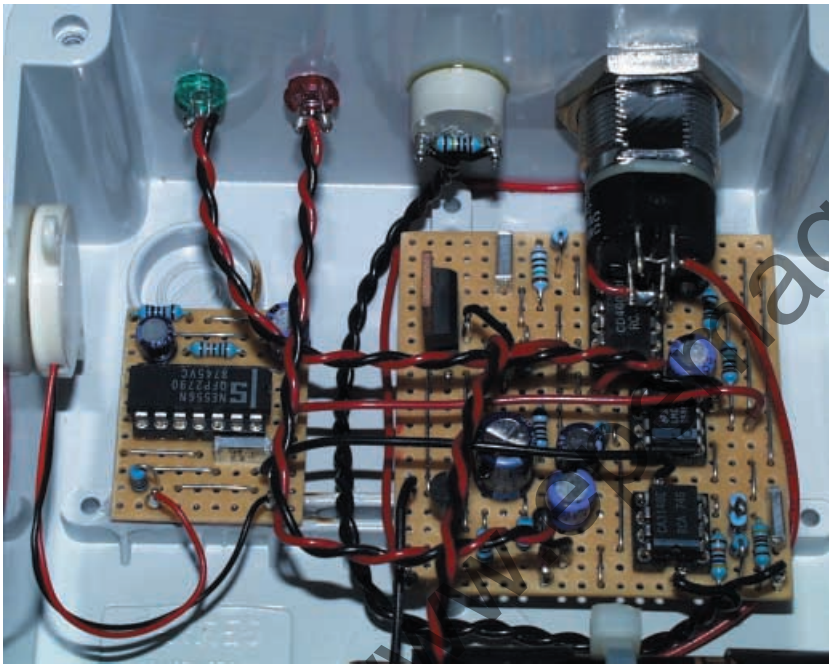


Fig.4. Opto-Alarm stripboard component layout and details of breaks required in the underside copper tracks. Note that capacitor C2 is soldered directly across IC1 pins 1 and 8 on the underside.



Wiring from the off-board components to the two circuit boards.

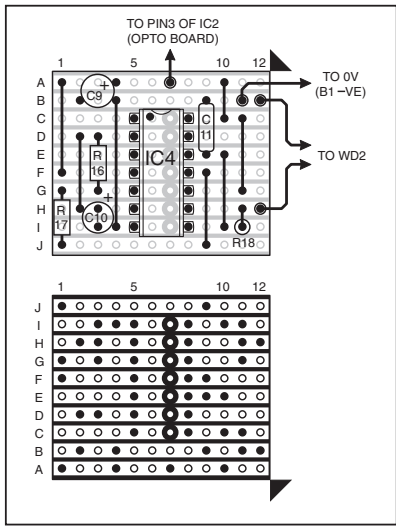
possibility of static discharges that can destroy CMOS i.c.s. Finally, inspect all solder joints for quality and any possible solder bridges.

Follow the same method for the Two-Tone circuit board construction, again observing polarities. The stripboard component layout and details of breaks required in the underside copper tracks are shown in Fig.5.

FOCUSING LENS

Before committing the circuit boards and off-board components to the case, it is necessary to consider the make up of the focusing lens. By using a focusing lens in addition to a light-dependent resistor (l.d.r.), there will be a significant increase in sensitivity, and also a narrower

Fig.5 (right). Component layout for the optional "Two-Tone" entry sounder.



acceptance angle, allowing single object protection whilst minimising false alarms from doors opening etc.

The most effective and easiest method of lens construction is to adapt the lens of a 10mm clear l.e.d. Using this method you can choose the l.e.d.'s most acceptable viewing angle, allowing optimised operating conditions (a six degree viewing angle was used on the prototype).

Referring to Fig.6, begin construction of the l.d.r. lens by taking a 10mm clear l.e.d. and holding it in a vice by the lead-out wires, saw off the lens section just above the actual l.e.d. platform, using a junior hacksaw. You now need to sand this end as

COMPONENTS

TWO-TONE GENERATOR

Resistors
 R16 100k
 R17, R18 10k (2 off)
 All 0.6W 5% carbon film

Capacitors
 C9 100µ radial elect. 16V
 C10 4µ7 radial elect. 16V
 C11 47n polyester layer, 5mm pitch

Semiconductors
 IC4 556 dual timer

Miscellaneous
 WD2 3V-30V piezo transducer

See **SHOP TALK** page

Stripboard 0.1-inch matrix, size 10 strips × 12 holes; 14-pin d.i.l. socket; multistrand connecting wire; 24s.w.g. tinned copper wire, for links; 1mm solder pins (4 off); solder, etc.

Approx. Cost Guidance Only **£3.50**

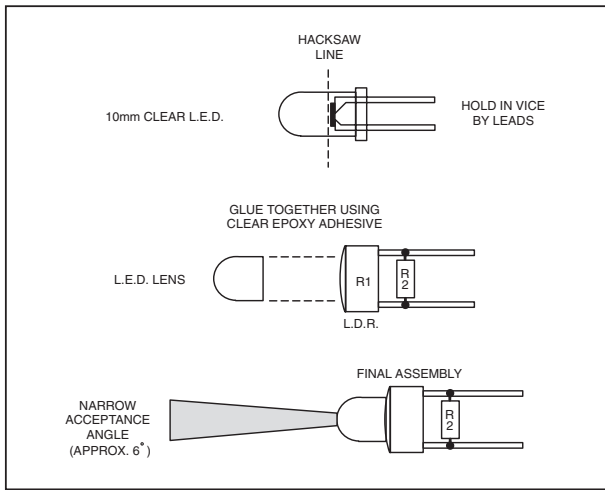


Fig.6. Producing the focussing lens from a 10mm l.e.d. The lens is glued over the "window" of the light dependent resistor (l.d.r.).

flat and smooth as possible using fine grade "wet and dry" paper. The lens will need to be able to transfer collected light as efficiently as possible to the l.d.r., so the face must be finely polished.

Clean the l.d.r. face and use clear epoxy adhesive to glue the l.d.r. and lens together. This completes the focussing lens assembly.

CASING-UP

Attention can now turn to the alarm case and wiring. The author used a plastic waterproof case measuring 150mm x 110mm x 70mm, but the final choice is down to the constructor.

Begin the casing-up process by carefully measuring and marking out where you require the front panel components, and how you wish the interior to be laid out, see Fig.7 and photographs. All the components are mounted in round holes easing construction, and the best way to drill these holes is by first measuring the components against drill bit diameters and choosing a fractionally smaller bit than actual component size.

The holes can be enlarged later using a reamer, or needle files. Using a centre punch or bradawl, mark the holes for drilling, begin by using a 2mm diameter bit as a guide hole for producing a clean and accurate final hole.

FINAL ASSEMBLY

Check the fitting of all components and, once satisfied, proceed with the interwiring between the stripboards and all off-board components.

Wire up l.e.d.s D2 and D3, the battery connector, siren, keyswitch S1 and the focussing lens assembly. Remember to solder resistor R2 across the l.d.r. (R1) lead out wires. Finally, wire up the Two-Tone board to the main Opto-Alarm board, as indicated in Fig.7. If using an unwired piezo transducer, take care not to overheat the discs' delicate "white" area when attaching connecting leads.

The two circuit boards were secured to the case using epoxy adhesive, saving on nuts and bolts, allowing a more compact stripboard design and to give additional protection from corrosion. The 12V battery pack was enclosed in a holder made from plastic off-cuts glued in place.



The keyswitch, light sensor and test and exit l.e.d.s mounted on a side panel of the waterproof case.

TESTING

With the two circuit boards now wired up connect the battery supply. At switch on Exit l.e.d. D3 should light for approximately 1-45 minutes. Placing your hand over the focusing lens and then quickly removing it should illuminate

Test l.e.d. D2 for around one second. Try moving your hand slowly across the sensor, this should not trigger the Test l.e.d. at all.

When the Exit l.e.d. has extinguished, IC2 now becomes "active" and activating the l.d.r. sensor again should

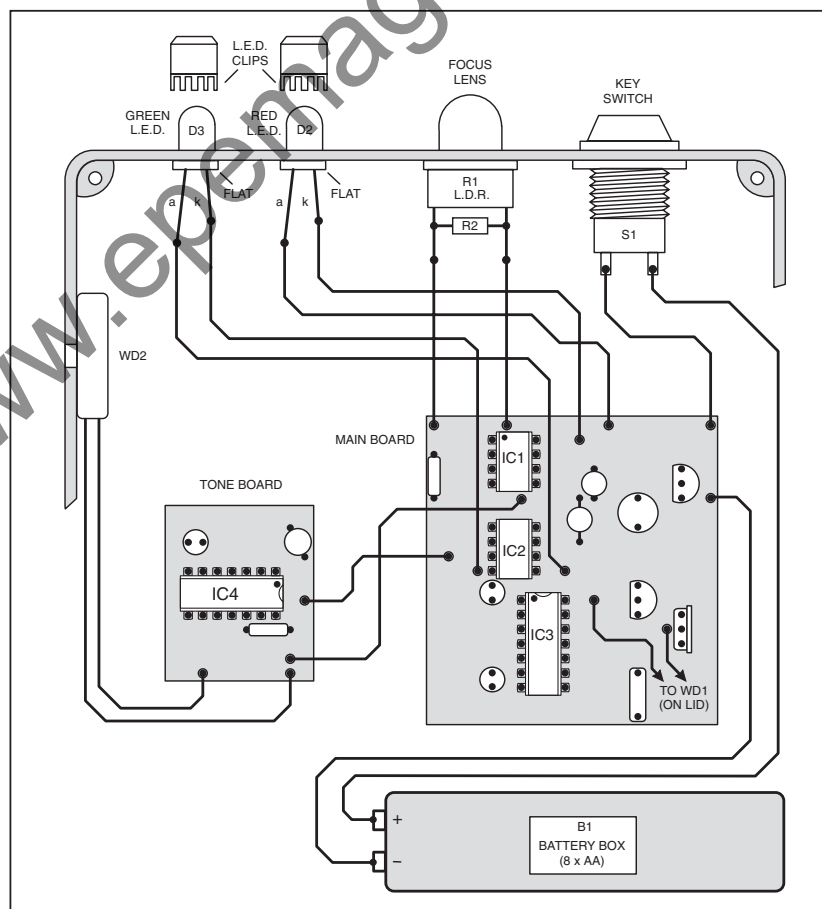


Fig.7. Interwiring from the two circuit boards to all off-board components. The Main siren (WD1) is mounted on the inside rear of the case lid, see photograph on the next page.



Completed Opto-Alarm system showing the main siren in the lid.

produce a two-tone Entry warning for approximately 11 seconds. If the alarm is not reset, via keyswitch S1, within this

period the main siren WD1 will sound on/off once every 2.5 seconds for 11 times, after which the alarm should fully

reset itself, with no l.e.d.s lit, thus saving battery power. This completes Testing and confirms all circuitry is operating correctly.

Should problems be encountered with the unit switching under bright light conditions, due to the low resistance of the l.d.r., experiment with inserting a low value resistor (e.g. $1k\Omega$) between the l.d.r. and its positive supply line.

IN USE

The Opto-Alarm will respond instantly to any rapid changes to the ambient light level in the protected area. If the alarm is placed in a well lit area, it will require a fairly high level of introduced light to trigger the unit. However, if the alarm is placed in total darkness or an area of low light level the required amount of light to trigger the unit will be minimal.

The principle of operation does not solely rely on additional light to activate the alarm. If the sensor was aimed at a specific point, for instance, a wall across a room, any person moving rapidly across that point would firstly dim the available surrounding light, and on departure the light level presented to the sensor would instantly increase triggering the alarm. By experimentation you will discover the best set-up for yourself.

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