CK1602 LDR LIGHT/DARK ACTIVATED RELAY SWITCH

We wanted to do a light/dark switch as a kit. But we found there were several types of basic circuit. This is one type of circuit. Two other types may be found in Kits 79B and 79C. You may read the documentation on our website at http://kitsrus.com/soft.html

By reading about all three Light/Dark Kits you will be able to decide which circuit is the best for your particular application. If your application is in very bright or very dark conditions then you can easily experiment with different resistor values to get better control over the switching range you need.

There is nothing original in these circuits. We have taken them from published material (see end of this paper for References.) But we have redesigned them each onto similar PCB's to allow easy comparison. And in addition a light/dark option has been incorporated into each.
We say 'light/dark' because each circuit has a PCB-mounted switch on-board. In one switch position a light-to-dark transition will activate the relay. In the other position a dark-to-light transition is required.

So you can use the light falling on the detector to switch on a normally off circuit, or switch off a normally on circuit.

Each kit has a 12V relay rated to switch 240VAC/5A mounted on-board. Using a relay allows the light/dark switch to form a module separate from the circuit which is to be switched. The Common, Normally Open, and Normally Closed contacts are brought out to terminal blocks. Power is also brought to the kit through terminal blocks.

These kits are constructed on a single-sided printed circuit board (PCB) with a printed overlay and bottom solder mask. Protel Autotrax and Schematic were used to produce them.

ASSEMBLY INSTRUCTIONS

Before you do any construction we suggest that you connect a resistance meter to the LDR's - the component with the transparent face and a spiral pattern inside it - and note how the resistance depends inversely on the amount of light falling on it. Note the wide range of resistance. Play with the LDR in very bright and very dark conditions. A feel for what is happening in the LDR will help you understand the circuit you are about to build. In the dark, the resistance is very high, typically around 1M ohm. In bright light it is low, typically 1K ohm. The peak spectral response of the LDR (VT936G from EG&G) is at 550nm. The continuous power dissipation is 80mW and the maximum voltage which can be applied to it is 100V.

Check off the components in the bag against the Component listing. It is generally easiest to solder the lowest height components first - the resistors and links. Make sure you get the diode around the correct way according to the overlay. (If you get it the wrong way around you will blow up the transistors.)
The two terminal blocks on each board slide fit together in a tongue & groove arrangement. On the LED's the cathode or the bar on the overlay corresponds to the short lead of the LED. The LDR has a long lead. We suggest you leave it long to start with. You can always shorten it later. The LDR can go in either way.

There are two links to add to the PCB on either side of the DPDT switch. Use some of the leads cut off from the resistors and LED to make these links. Finally connect 12V DC power to the terminal blocks. The relay should click on or off when the potentiometer is adjusted, the switch is moved or the light falling on the LDR varies.

What to do if they do not work. Poor soldering is the most likely reason that the kit does not work. Check all solder joints carefully under a good light. Next check that all components are in their correct position on the PCB especially the diodes. Did you put in the links next to the DPDT switch.

CIRCUIT DESCRIPTION

The circuit depends on a light sensitive device called a LDR, light dependent resistor, as already described above. The resistance of the LDR depends on the amount of light falling on it. The snake-like track on the face of the LDR is a cadmium sulphide (CdS) film. On each side is a metal film which is connected to the terminal leads. If you played with an LDR & resistance meter as suggested above then you will know what it does. The CdS LDR used in these kits are relative slow response devices. This one has a time constant of about 100msec. So it is quite fast enough to switch on/off when people pass or run through it. But if you wanted to use a LDR for fast light-activated photography then other LDR materials, or a different circuit would have to be used.

The LDR and a trimpot form a voltage divider which is used to apply bias to a transistor. The more dark it is, the higher the LDR resistance. As the LDR changes resistance the change in potential is detected by the circuit and the relay is activated.

The PCB-mounted switch just interchanges the trimpot & the LDR as far as the detection circuit is concerned. So a dark activated switch becomes a light activated switch or vice versa. A protection diode is fitted across the relay. This is to short circuit the 'back-emf' generated by the collapsing magnetic field when the relay is turned off. Otherwise a high-voltage spike transient would enter the circuit and quickly damage the other components. In all three circuits an LED with current limiting resistor is in parallel to the relay to give a visual indication of when the relay is turned on.

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This kit is the most basic, practical circuit to build using an LDR to turn on a relay. The two transistors connected as a Darlington pair give the circuit enough sensitivity, while the trimpot give sensitivity adjustment. The switching point of the relay is dependent on the supply voltage and temperature.

This circuit is satisfactory if the changes in light level to be detected are large and the transition is quick - for example, a person walking past a doorway. But an inherent problem of the circuit is chattering of the relay for slowly changing light levels just at the transistion point between turning on/odd and vice versa.

Look what happens when the relay turns on: the input voltage drops slightly (say around 20 mV) when the relay turns on and loads the circuit. If the voltage applied to the base-emitter junction of Q1 is only just sufficient to turn it on then this slight drop will immediately start to turn Q1 off. But then with the relay load reducing the supply voltage will start to rise & Q1 will start to turn on etc. This leads to the relay chattering as it rapidly turns on/off. (This problem is overcome in K79B by the built-in hysteresis of the op-amp, and the Schmidt Trigger arrangment of the circuit in K79C.)

References: Similar circuits to those presented here are common in most modern electronic test books. One particularly good reference we used is:

Optoelectronics Circuits Manual, by R. M. Marston, published by Heimann Newnes, 1988, Chapter 5.

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Components

1K resistor R1	1
1N4004 diode	1
100K trimpot (104)	1
BC338 transistor	2
5mm red LED	1
3mm LDR	1
Relay	1
DPDT PCB-mounted switch	1
3 pole terminal block	1
2 pole terminal block	1
Kit 79A PCB	1