Versatile moisture & light detector

Build this multi-purpose alarm unit

You can use this easy-to-build little gadget as either a moisture alarm or a light level sensor. Completely self-contained and battery powered, it provides an easily heard 1kHz warning tone.

by GERALD COHN

The fact that this alarm system is designed to operate from two quite different types of sensing devices may appear a little strange at first, but it is a very interesting concept which has a lot to offer. In particular, it offers the opportunity to experiment with other types of sensors, or variations on the sensor circuits described.

But even as it stands, it can be a very versatile device, with applications ranging from simply amusing, or instructive, to some of real practical value. For example, as a moisture sensor it can serve a real purpose as a rain alarm; something which any housewife will consider is worth its weight in gold when she has a load of washing on the line.

Another application is as a water level detector. If it is necessary to monitor the level of water in an inaccessible tank, or remote dam, this simple device may well be all that is needed, and could save a lot of unnecessary walking or climbing.

In the light sensing mode it can be equally useful. An obvious application is monitoring shop doorways, particularly where a lone staff member has to divide his time between the shop and a workroom or store at the rear. Used with a suitable light beam across the doorway, it can eliminate the strain of listening for a customer — or shoplifter!

Another application, which we suggested in a previous article, (Low Cost Alarm, February 1976, File No. 3/MS/62) also provides a form of property protection. In this case the light sensor (but not the alarm) is placed in a cupboard or drawer which may contain anything valuable. When opened, the admitted light will activate the alarm, making a very simple but very effective protection system. (This application calls for a circuit change, discussed later.)

A third application involves the physically handicapped. Any person confined to bed needs a means to summon assistance, and a simple pressbutton and buzzer is customarily used. However, some patients may be so handicapped that the normally simple action of pressing a button may be beyond them.

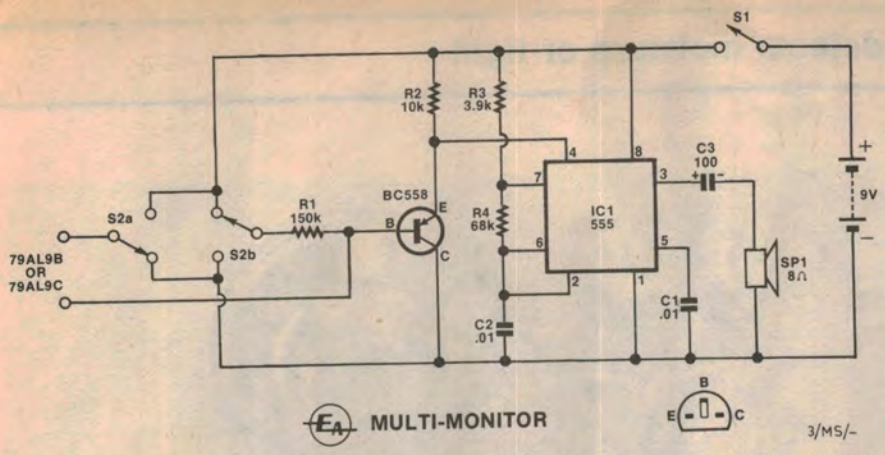
In this case the light sensor can do the same job, if the patient simply places his hand over it, at least while the room is illuminated. For use in darkness a small torch globe could be mounted about 15cm above the sensor, suitably shaded, but still providing a pool of light which would pinpoint the sensor in the dark.

The circuit is built around what I consider to be one of the most versatile devices ever manufactured, the 555 (timer) IC. The IC is used as an astable free running 1kHz oscillator, held in the normally reset (off) state until the unit is triggered by one of two sensors that form part of this project. The "front end" consists of a PNP transistor wired as an emitter follower; a configuration which gives it a very high input impedance and, therefore, a high sensitivity.

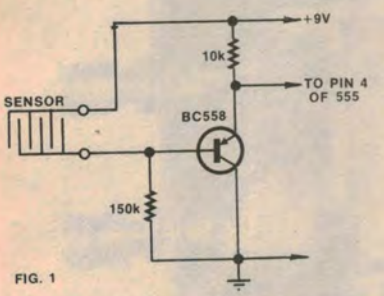
To understand "how it works" take a close look at the switching arrangement at the input to the circuit, and how this provides the two modes. Consider first the moisture sensing mode. To make this easier to follow, we have provided the equivalent circuit for the "front end" when switched into the moisture sensing mode (Fig. 1). The text that follows should be read together with this circuit diagram.

The transistor, Q1, is biased on by the 150k resistor, allowing collector current to flow, and thereby holding the voltage at pin 4 at ground potential. This switches the 555 to its reset, or

This photograph shows the complete unit with the two sensor boards.



Above is the circuit diagram of the unit. Take particular note of the switching arrangement at the input.



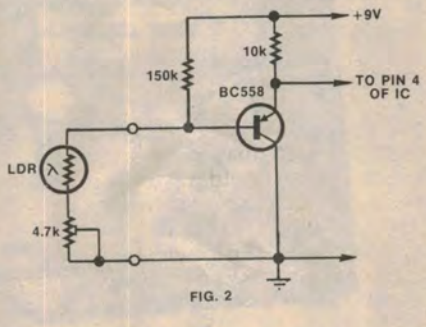


Fig. 1 shows the equivalent circuit of the input stage when switched into the moisture sensing mode, while Fig. 2 shows it in the light sensing mode.

PARTS LIST

Printed circuit boards; 79AL9A, 79AL9B, and 79AL9C.
Plastic case, 130mm x 68mm x 41mm, UB-3 or similar
1 BC558 PNP transistor
1 NE555 timer IC
1 ORP-12 (or similar) light dependent resistor
1 3.9k ¼W resistor
2 68k ¼W resistors
1 150k ¼W resistor
1 4.7k horizontal mount miniature trimpot
2 .01uF capacitors LV polyester types
1 100uF electrolytic capacitor
1 single pole miniature toggle switch
1 double pole double throw miniature toggle switch
No. 216 battery and clip to suit
Spring loaded terminals (1 red and 1 black)

Miscellaneous:
Solder, screws, nuts, hookup wire, etc.

NOTE: Resistor wattage ratings and capacitor voltage ratings are those used for our prototype. Components with higher ratings may be generally used provided they are physically compatible.

"off", state. The sensor board, 79AL9B, attached to the input is an open circuit, and therefore has an infinite resistance.

If a drop of water falls on this board its resistance falls, the bias on the transistor base is reduced, and the collector current is reduced. When this happens the voltage at the emitter (which is applied to pin 4 of the 555) rises towards the 9V supply. This takes the 555 out of the reset state (or into an "on" state), and allows the oscillator to start, giving a 1kHz tone at the output.

If we assume that the switch is changed to the light sensing mode, Fig. 2 shows the basic circuit. Here, the sensing device is a light dependent resistor (LDR), the resistance of which will vary from about 300 ohms under bright light conditions, to several hundred thousand ohms in darkness.

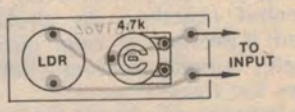
Note that there is a basic difference between this circuit and that of Fig. 1. In Fig. 1 the sensor starts out with a high (infinite) resistance and the alarm is sounded when the resistance falls. In Fig. 2 the sensor starts out with a low resistance and the alarm sounds when the resistance increases.

Compare the two circuits and you will see why. The sensor and the 150k resistor have changed places in Fig. 2, relative to Fig. 1. In Fig. 1 lowering the sensor resistance reduces the bias on the transistor base, whereas in Fig. 2 increasing the sensor resistance reduces the bias.

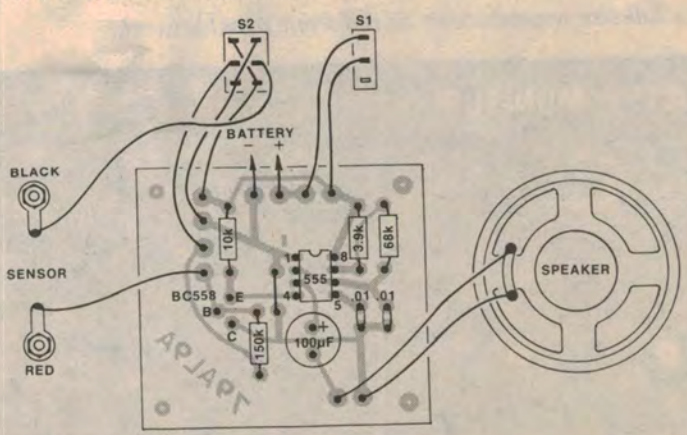
Thus, when the light on the LDR is high, and its resistance is low, the transistor is biased on and, as previously explained, this switches the 555 to its reset, or "off" state. When the light is removed from the LDR its resistance increases, the bias on the transistor is reduced, the 555 is switched out of its reset state, and the alarm sounds.

Instead of this arrangement, it is sometimes desirable to have the alarm sound when the light on the sensor increases, as for the cupboard application which we mentioned earlier. This can be done, and we will have more to say about it later.

The light sensor is in its most sensitive condition when the 4.7k pot is at its minimum setting. In these circumstances a minimum of light is need-



There are only two components on the light sensor board, the LDR and the pot.



Use the above diagram as a guide to the placement of the components. Check that the transistor, IC and electrolytic capacitor have been inserted with correct polarity.

ed to hold the alarm off, typical examples being a LED (light emitting diode) at a distance of about 2.5cm, or a 6V, 50mA torch globe at about 15cm.

If you find the ambient light level to be a bit too high, then it may be necessary to increase the resistance of the pot. This is done by trial and error, until you have the right setting to trigger the unit.

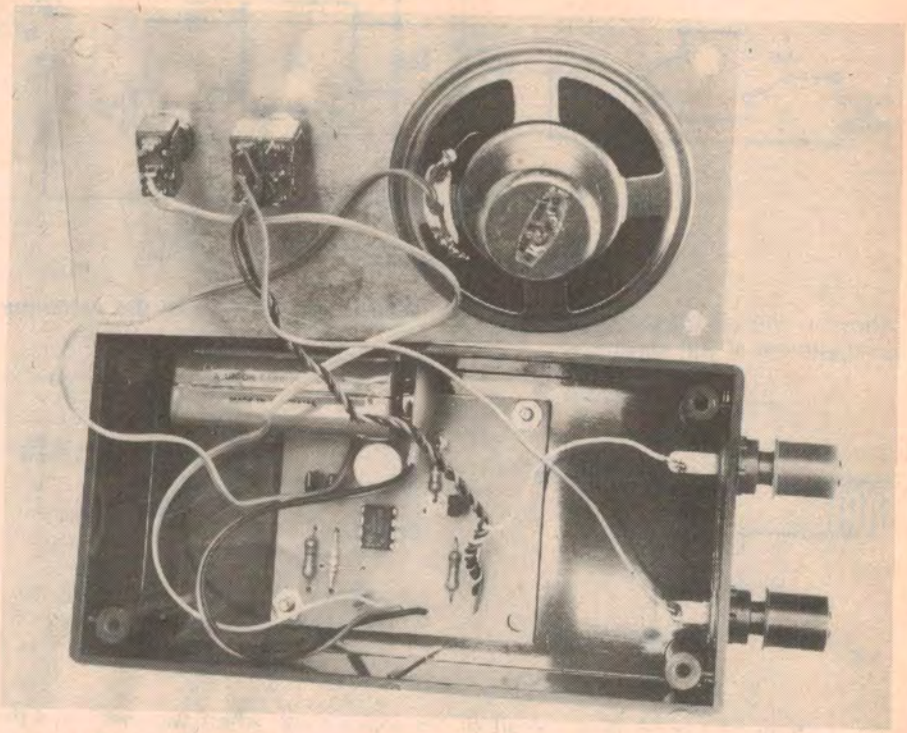
Construction of the unit is simple and should take only a couple of hours. All the components are accommodated on printed boards, which makes assembly simple and reduces the risk of errors. The unit, complete with the sensing devices, consists of three printed boards. The main board is housed in a plastic "Zippy box" together with the battery and the loudspeaker.

Either sensor board is connected to the master unit via a pair of spring terminals and any convenient length of cable. This makes the system quite flexible, allowing the sensor and the alarm to be well separated, if necessary.

We estimate that the current cost of parts for this project is approximately

$18

This includes sales tax.



Here is a view of the works. The speaker is attached with contact adhesive.

The moisture sensing board (79AL9B) has no components on it. It is simply two copper tracks, interwoven, but not connected together. As already explained, it presents an open circuit in a dry state, but will conduct when water bridges the tracks.

The light sensing board (79AL9C) has two components on it; the LDR and the 4.7k trimpot in series with it. This is used to set the minimum light level at which the system will trigger.

When assembling the main board mount the passive components first, checking that they are placed in their correct positions, and also the polarity of the 100uF electrolytic capacitor. Then fit the transistor and integrated circuit, being particularly careful regarding the lead identification and the orientation of these devices. (Mistakes of this kind are by far the most common among home constructors — even experienced ones.) Then add the battery clip, speaker, power switch, and changeover switch.

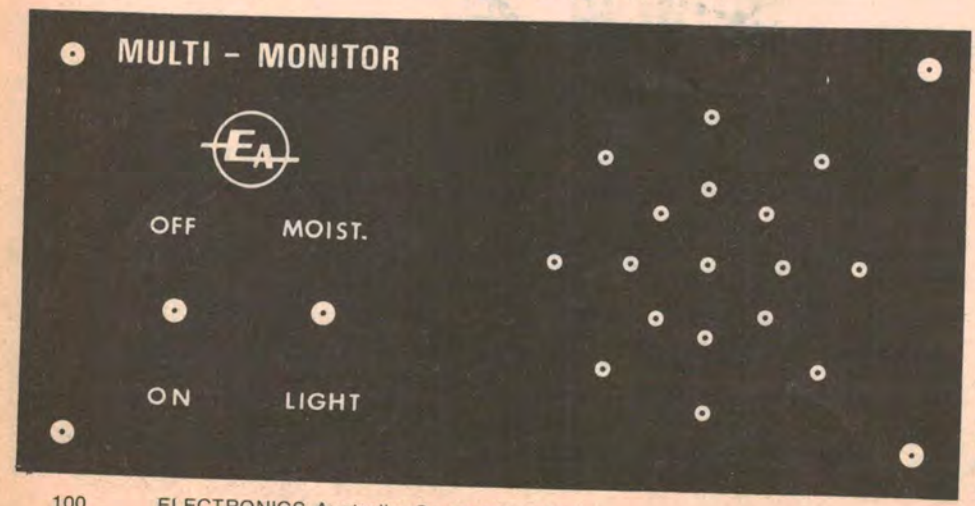
We used a plastic box for the prototype, one of the range of "Zippy Boxes". The one we used was type UB-3, and was purchased from Radio Despatch Service, in Sydney, but this type is also available from Dick Smith Electronics, as well as other component suppliers. The overall dimensions are 130mm x 68mm x 41mm.

We made a front panel for the unit using artwork and aluminium "Scotchcal" material. Copies of this artwork will be distributed to those firms which have requested them, or readers may purchase a dyeline copy for $2.00. We have also reproduced the artwork full size and readers may use this as a template for the panel, or as a temporary label, protected by a piece of transparent plastic.

If a "Scotchcal" panel is used it should be stuck to the front panel of the box, then drilled. The holes in front of the speaker may be about 4mm and the switch holes are 6.35mm. The terminals for the sensor cable mount on one end of the case, as shown in the photograph. The speaker is attached to the front panel by contact adhesive.

The printed board has been provided with four mounting holes so that it can be screwed to the base of the box, but this is not the only method that can be used to mount it. Another mounting

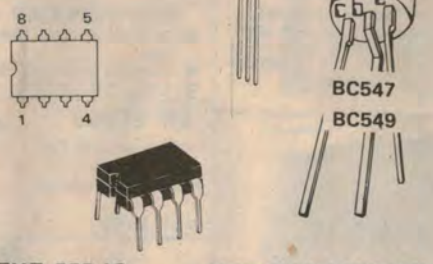
Here is a full size reproduction of the front panel artwork.



IDENTIFYING TRANSISTOR & IC LEADS

THE TRANSISTOR is a polarity sensitive device and must be connected the right way round. The collector, base and emitter leads are arranged according to the diagram at far right.

Pin 1 of the 555 timer IC is located adjacent to the notch (or dimple) at one end of the plastic package, as shown in the diagram at right. Note that the diagram shows the device as viewed from the top of the package.



suggestion is to use double sided foam tape, available from most hardware stores off the "Selleys" product racks. This same method can be used to provide a fixed mounting for the battery.

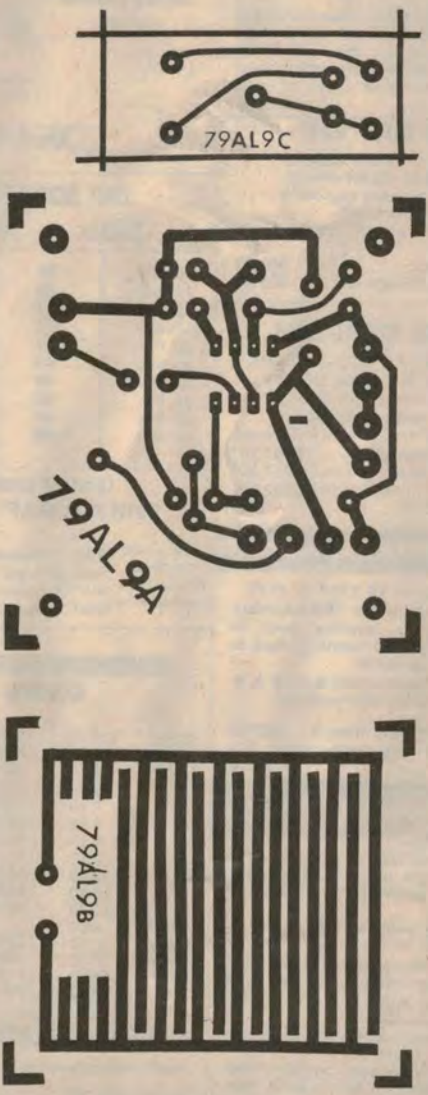
Once the unit has been fully assembled, place the mode switch in the light sense position and switch on the power. A high pitched sound should be heard from the speaker. Switch off, and connect the LDR module. Turn the trimpot on the LDR board fully anticlockwise, and place the board under a table lamp or other source of bright light. Turn on the unit and no sound should be heard from the speaker. Turn off the light and there should be a tone from the speaker. If there is no tone the light level is not low enough. Place your hand over the LDR and this should start the oscillator. If necessary, adjust the 4.7k trimpot to suit the light levels.

Connect the moisture sensor to the unit and place the mode switch in the moisture sensing position. Turn on the power and no sound should be heard at the speaker. Now place a drop or two of water onto the board and the 1kHz tone should be heard.

Earlier, we suggested that the light sensing function might be inverted, so that the alarm sounds when the light increases. To do this we use an arrangement similar to Fig. 1. The LDR connects in place of the moisture sensor and, because the LDR never becomes an open circuit, we must reduce the bias resistor from 150k to about 18k.

We also hinted that the system is not necessarily confined to sensing light or moisture. The basic unit can be used with any sensor which exhibits variable resistance over a sufficient range. For example, temperature dependent resistors may be tried, and could result in a simple temperature sensitive alarm.

But we leave these ideas to the reader to investigate for himself. Now that you have built the unit you will no doubt find dozens of applications for it. Apart from being an enjoyable and satisfying project, it should also help you understand more about circuit theory and practical construction. And, on top of that, it may well find a useful application around the home.



A full size reproduction of the three artworks for the PCBs.