PROJECT OF THE MONTH

Adjustable Threshold Temperature and Light Alarms

By Forrest M. Mims

IF you enjoy gardening as much as I do, you could probably use a circuit that sounds an alarm when the temperature approaches freezing. Figure 1 shows a very simple circuit that signals a distinctive alarm tone when the temperature approaches 0° Centigrade. Since the temperature detection threshold is adjustable, the circuit can sound an alarm at any point over a wide temperature range.

The circuit uses a 741 op amp as a voltage comparator. An adjustable voltage divider, *R2,* provides a reference voltage to the noninverting input (pin 3) of the 741. A temperature-dependent voltage for the inverting input (pin 2) of the 741 is obtained from thermistor *TCR1* and fixed resistor *R1.*

The resistance of *TCR1* is inversely proportional to temperature. In other words, the resistance of *TCR1 increases* as temperature *decreases.* Therefore, the voltage output from the divider formed by *TCR1* and *R1* falls as temperature decreases. When this voltage reaches the reference voltage, the comparator output switches from low to high. This turns on *Q1,* to actuate the piezo alerter.

The output from the 741 can be connected directly to *R3,* but the low-state output voltage will then turn *Q1* partially on and cause the alerter to emit a low-amplitude, but audible, tone. This off-state tone is eliminated by *D1, D2* and *D3.* The total forward voltage drop of these diodes is about 1.8 V, enough to cancel the effect of the low-state output voltage from the 741.

Thermistors can be purchased from Newark Electronics and other electronic parts distributors. For best results, use a thermistor having a room temperature resistance of 25 to 50 kilohms. Glass-bead and bulb thermistors are more expensive than other kinds, but since they can be safely immersed in water they are easily calibrated. Use crushed ice or snow to achieve an exact 0° C calibration point if you plan to use the circuit as a freeze detection alarm.

The circuit in Fig. 1 can drive more powerful alarm devices such as sirens by substituting a relay for the piezo alerter. The following circuit shows how this is accomplished.

An Adjustable Light Detection Switch. Replacing the thermistor in Fig. 1 with a cadmium-sulfide photoresistor allows the circuit to function as an adjustable threshold light/dark detection switch. Figure 2 shows one possible circuit configuration.

In operation, *R2* sets the circuit's threshold. When the light intensity at *PC1*'s surface is decreased, the resistance of *PC1* is increased. This decreases the voltage at the inverting input of the 741. When the reference voltage at the 741's noninverting input is properly adjusted via *R2,* the comparator will switch from low to high when *PC1* is darkened. This turns on *Q1* which, in turn, pulls in relay *K1.*

The low-state output voltage from the 741 does not have sufficient amplitude to pull in the relay. Therefore, this circuit does not require the diodes used in Fig. 1.

Going Further. The sensors used in both these circuits are interchangeable. You can use a cadmium-sulfide photoresistor in place of the thermistor in Fig. 1. And you can use a thermistor in place of the photoresistor in Fig. 2. Furthermore, both circuits are adjustable over a very wide temperature or light-intensity range. Therefore, you should have little difficulty adapting one or both of these useful and versatile circuits to your specific application.

Finally, be aware that the reliability and accuracy of these circuits is determined by both your calibration procedure and the physical location of the finished circuit. For example, when the circuit in Fig. 1 is configured as a freeze detector, it may fail to operate consistently if the battery is exposed to temperature extremes. It may also sound false alarms or fail to operate if water bridges any of the leads from *R1, R2* or the thermistor. Be sure to keep these caveats in mind when you plan your application. ◇

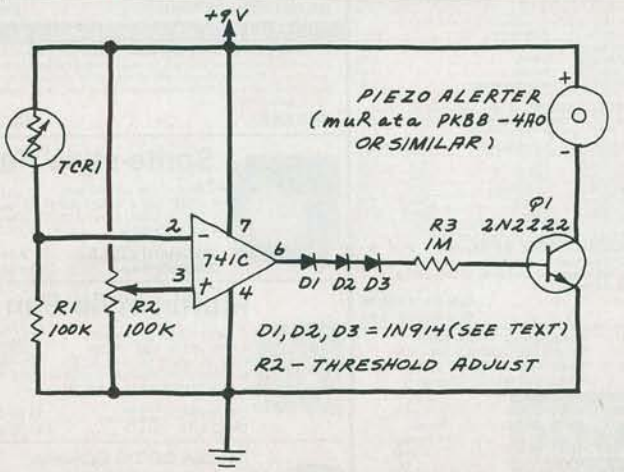

Fig. 1. Adjustable threshold temperature alarm.

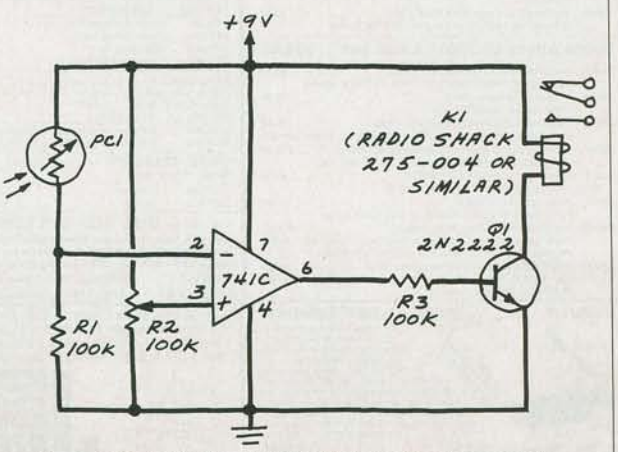

Fig. 2. Adjustable threshold light-dark detection switch.