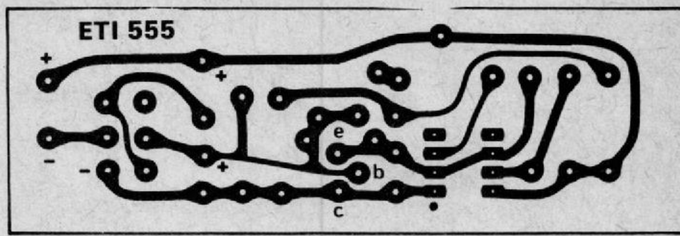
TEMPERATURE ALARM



Find out if it's cold outside or inside with the last, but not least, of our straightforward project series.

THIS IS A SIMPLE BUT VERY versatile temperature monitor which can be used in two different ways:

1. To warn if temperature exceeds a preset level.

2. To warn if temperature falls below a preset level.

The unit may be used to monitor temperature in fish tanks, laboratory ovens and/or water baths, incubators, cooking vessels, etc.

The temperature at which an alarm is given is adjustable over a range predetermined by the combined values of the components RV1 and R1. RV1 is a potentiometer which is used to adjust the final 'set point' (the temperature at which the alarm is given).

Actual temperature sensing is done by a device called a 'thermistor'. This is basically a resistor in which the resistance value varies with changes in temperature. Thermistors are obtainable in innumerable shapes, sizes and temperature ranges.

The unit may be built so that a small loudspeaker provides an audible warning when the set limit is reached.

The unit may be constructed so that the warning takes place as temperature exceeds the set limit – or so that the warning takes place as temperature falls *below* the preset level.

All that is required to convert either unit from one mode of operation to the other is as follows: both the printed circuit board and Veroboard layouts show alternative positions for R1 and the thermistor leads. Each alternative is marked appropriately. Thus to use the circuit in the 'over-temperature' mode just insert R1 into the position marked 'over-alarm' and connect the thermistor to the 'over-alarm' positions. Naturally only one R1 is required.

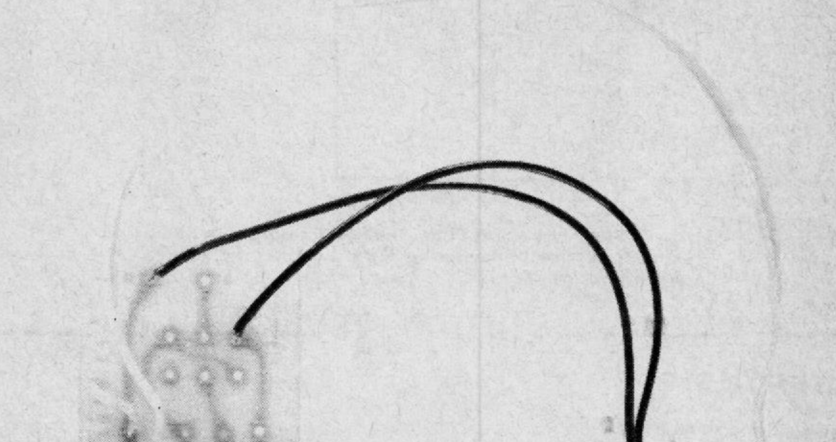


Figure 1 shows the unit with loudspeaker set up to warm if the temperature exceeds the limit preset by RV1.

Building the unit

Constructional method is not at all critical – we show the unit made up on Veroboard and also on a printed circuit board for those who wish to use this simpler and more elegant method.

The thermistor should be mounted in the end of a short length of thin-walled glass tube and sealed with epoxy resin. Thermistors can actually be ▷

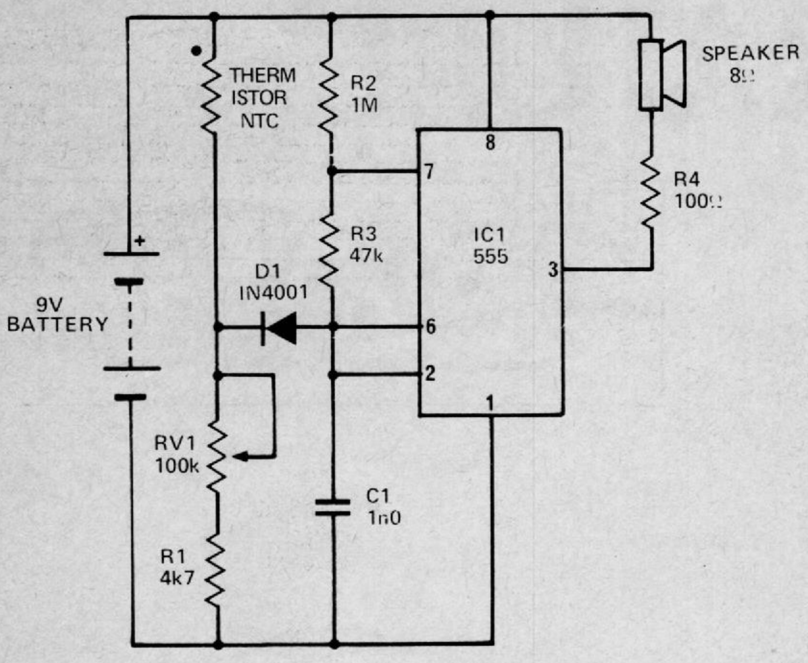


Fig. 1. Basic circuit provides audible warning if temperature exceeds set point adjusted by RV1. See text if opposite operation is required.

PARTS LIST

ETI 555/4

Resistors all ½ W 5%

R1	4k7
R2	1 M
R3	47 k
R4	100 ohms
RV1	100 k Preset

Capacitor

C1	1n0 polyester

Semiconductors

D1	1N4001
IC1	NE555

Miscellaneous

Speaker 8 ohms
PC Board ETI 555 or Veroboard 3.3 x 1.1"
9 V battery
Thermistor 47 k (25°C) Philips type 642 11473 (available from A. Marshall (London) Ltd.)

bought commercially already mounted in this way — but they're expensive.

There are two reasons for sealing the thermistor in the manner described above. Firstly, if the thermistor is not sealed electrolytic action will very quickly dissolve the thermistor leads — our first one lasted just one day! Secondly, if the thermistor is used to monitor the temperature of an open element such as a heating jug there is a very real danger of the thermistor or its leads contacting mains voltage. If the thermistor is used solely for monitoring air temperatures then no sealing is of course required.

As outlined above, the combined values of R1 and RV1 determine the temperature at which the unit triggers. Table 1 shows roughly what the combined resistance should be for various triggering temperatures. Thus for the unit to operate at high temperatures the 100 k potentiometer and the 4k7 resistor specified will enable the set point to be adjusted from about 20° C to about 82°C.

If finer control is required then the 100 k potentiometer could be replaced by a 25 k potentiometer and R1 increased from 4k7 to 75 k. □

HOW IT WORKS

ETI 555/4

Temperature is sensed via a thermistor. This is a resistor which varies its resistance as temperature changes. The one chosen for this application is a NTC (negative temperature coefficient) type in which resistance falls as temperature rises. The resistance at 25 °C is about 47 k falling to about 3 k at 100 °C. This thermistor forms a voltage divider with RV1 and R1.

The familiar 555 IC is the basis of the unit. The IC will oscillate if pins 2 and 6 are allowed to exceed approximately 2/3rds of the supply voltage, however the voltage divider along with diode D1 can prevent this and while it does so the alarm will be off.

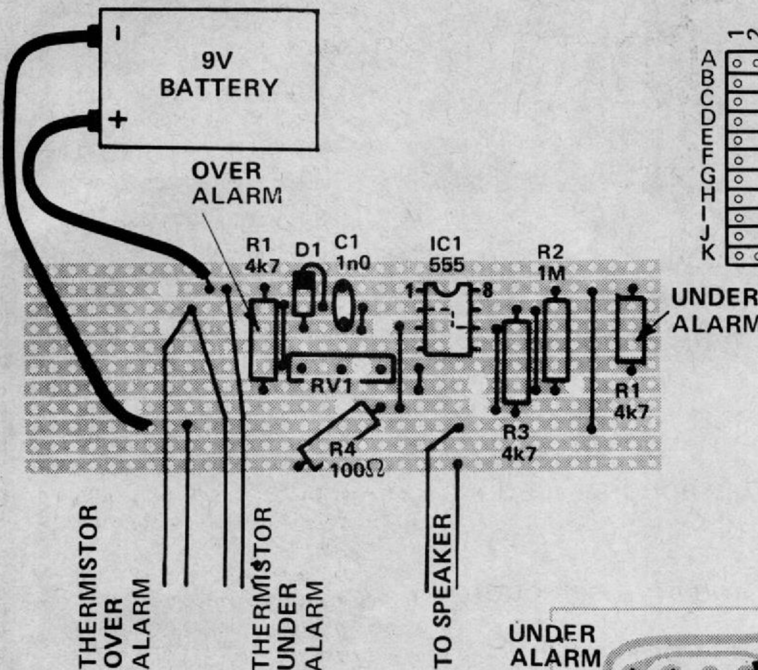
As temperature increases thermistor resistance falls and the voltage begins to rise at the junction of D1, the thermistor and R1. When the voltage reaches $2/3\ V_S - 0.6$ V the 555 begins to oscillate and causes the loudspeaker to sound (at about 1.2 kHz). If an 8 ohm speaker is available then R4 must be included. However if an 80 ohm speaker is available then R4 may be left out — the sound will then be much louder.

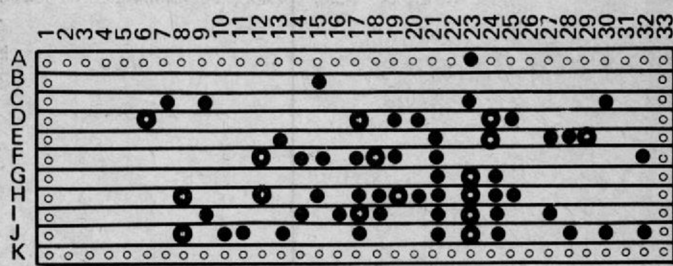
Figure 1 shows the unit set up to sound an alarm as temperature exceeds the set point. If an alarm is required as temperature falls below the set point then the position of the thermistor, and the combination of RV1 and R1 should be reversed — i.e., so that the thermistor is connected to the negative supply rail.

TABLE 1

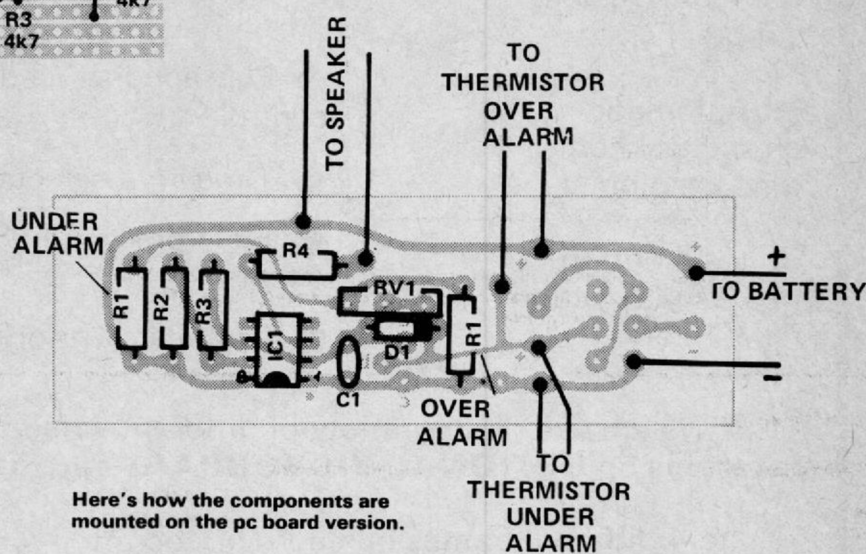
APPROXIMATE VALUES FOR R1 + RV1 FOR VARIOUS TEMPERATURES

Temp °C	Over Alarm	Under Alarm
25	75 k	22 k
35	50 k	15 k
45	30 k	10 k
55	18 k	7k5
65	10 k	5k2
75	6k5	3k8
85	4 k	2k7
95	2k5	2k





This is how the components are mounted on the Veroboard version. Note particularly that two alternative positions are shown for resistor R1 — the position chosen depends upon whether 'under alarm' or 'over alarm' operation is required. Similar comments apply to the pc board version shown on the right.



Here's how the components are mounted on the pc board version.

PROBLEMS?

SUFFIXES 'k', 'm', 'M' etc after component values indicate a numerical multiplier or divider — thus

Multipliers

k = X 1000
M = X 1000 000
G = X 1000 000 000

Dividers

u = ÷ 1000 000
n = ÷ 1000 000 000
p = ÷ 1000 000 000 000

Where the numerical value includes a decimal point the traditional way of showing it was, for example, 4.7k. Experience showed that printing errors occurred due to accidental marks being mistaken for decimal points. The Standard now calls for the ex-suffix to be used in place of the decimal point. Thus a 4.7 k resistor is now shown as 4k7. A 2.2 uF capacitor is now shown as 2u2 etc.

Some confusion still exists with capacitor markings. Capacitors used to be marked with multiples or sub-multiples of microfarads — thus 0.001 uF, 470 uF etc. Markings are now generally in sub-multiples of a Farad. Thus —

1 microfarad (1u) = 1×10^{-6} F
1 nanofarad (1n) = 1×10^{-9} F
1 picofarad (1p) = 1×10^{-12} F

OV on our circuits in this series means the same as —ve (an abbreviation for 'negative'.

Unless otherwise specified all components in our drawings are shown as seen from above — note however that component manufacturers often show them as seen looking *into* the pins.

Pin numbering of ICs — with the IC held so that the pins are facing away from you and with the small cut-out downwards pins are numbered anti-clockwise starting with pin number 1 at bottom right.

The thin line on a battery schematic drawing is positive (+ve or just +).

If a circuit won't work the most probable causes of trouble in the most probable order of occurrence are:—

(a) Components inserted the wrong way round or in the wrong places.
(b) Faulty soldering.
(c) Bridges of solder between tracks (particularly with Veroboard) — breaks in Veroboard omitted — and/or whiskers of material bridging across Veroboard breaks.
(d) Faulty components.