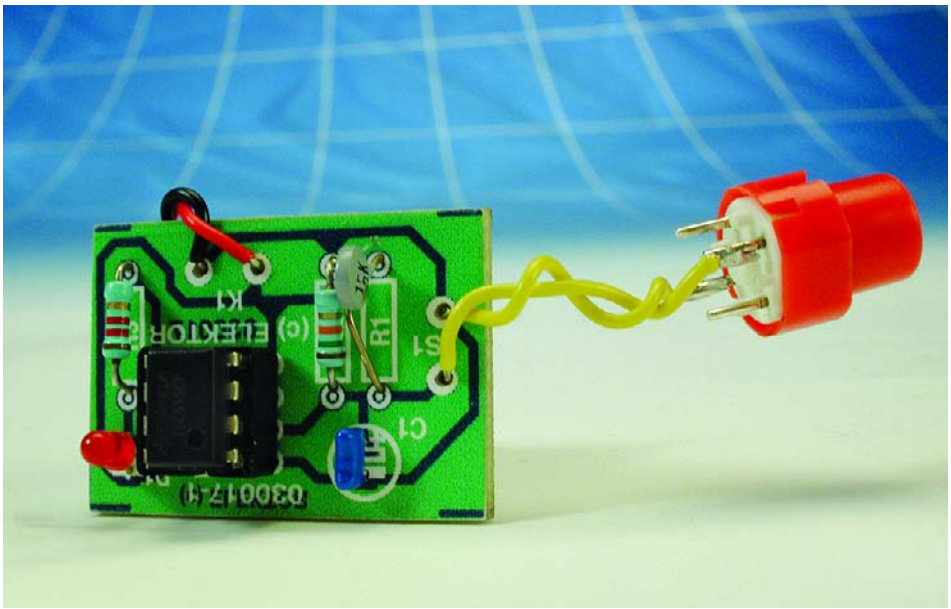
Over-temperature Alert

A universal alarm circuit

Design by B. Kainka

It's probably the worst nightmare for all PC owners: The fan has been quietly doing its job keeping the PC internals nice and cool but over time the bearing lubricant dries out and friction increases until one fateful morning you turn on the PC and the fan sticks. Now it's only a question of time before something expensive pops. This neat circuit gives a warning when things start to get too hot.



The circuit shown in **Figure 1** uses a simple and economical thermistor as a temperature sensor. The sensor should be insulated and positioned on the PC case. When the temperature exceeds 40° C a warning LED lights or a buzzer sounds or a cooling device can be switched on. The alarm will not be reset when the temperature dips below 40°C again so it 'stores' any brief over-heating event. Pressing push-button S1 will reset the circuit.

An alarm temperature of 40°C does not seem to be excessively hot when you consider that silicon semiconductors can withstand temperatures up to around 150 °C but its important to realise that down at component level the chips are running much hotter so 40 °C is a good compromise. The circuit can be easily modified to cater for different temperature switch levels by substituting a different value resistor for R2. Alternatively a pre-set variable resistor can be used in place of R2 to make the alarm temperature adjustable.

The value of R2 is dependant on the thermistor resistance at the desired alarm temperature. The NTC (Negative Temperature Coefficient) thermistor has a resistance of 10 kΩ at 25 °C and its resistance falls as the temperature increases so that at 40 °C its resistance is 5 kΩ. At this value of resistance the alarm will be triggered. The simple rule is that the alarm will be triggered when the thermistor resistance falls to half the value of R2. If you know the resistance of the thermistor at the alarm temperature then it's a simple process to work out the value of R2.

Table 1 will help in selecting the correct value. The circuit can also be used as a 'freezer fail' alarm so negative temperatures are also given. It is also possible to use a different type of NTC thermistor. The relationship between R1 and R2 will remain the same so that if for example you have a 4.7 kΩ NTC then the value of R2 will need to be changed to 4.7 kΩ to give an alarm temperature of 40 °C.

The circuit

The low power CMOS version of the popular 555 timer chip is used in this design. Internally this chip contains two comparators that switch when the input voltage as at 1/3 and 2/3 of the supply voltage and these outputs control an RS-type flip flop (**Figure 2**). When the 555 timer is configured as a monostable or astable multivibrator a timing capacitor is used and the voltage across the capacitor swings between these two thresholds. Capacitor C1 generates a reset to the timer when power to the circuit is first connected. When the sensor temperature reaches 40 °C its resistance has fallen to 5 kΩ and the voltage at the sense input will be at the threshold of 2/3 of the supply voltage so the alarm will sound. The alarm can be turned off by pressing the reset button or will be automatically reset when the sense voltage drops below 1/3 of the supply voltage. With the circuit values shown here giving an alarm temperature of 40 °C this occurs when the temperature has fallen to about +10 °C, corresponding to an increase of the thermistor resistance to 20 kΩ.

The circuit can be built on the PCB shown in **Figure 3.** The artwork files can be downloaded from this month's Free Downloads at www.elektor-electronics.co.uk. Fitting the components to the PCB should present no problems.

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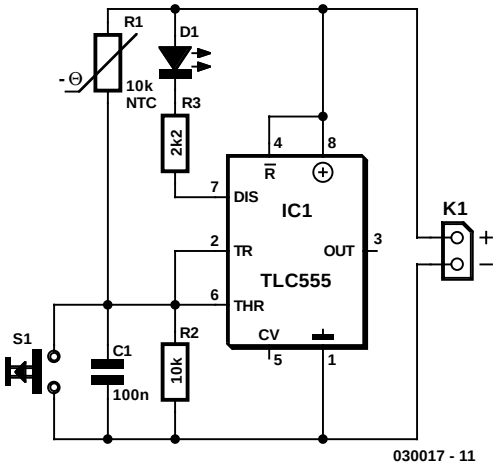

Figure 1. The circuit diagram.

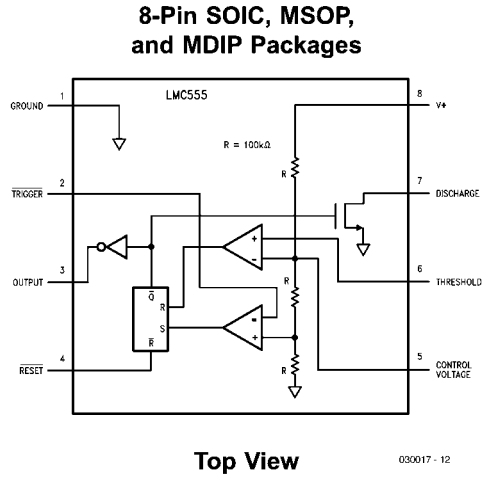

Figure 2. Internals of the 555.

Figure 3. A mini PCB for this mini circuit.

Temperature	Thermistor resistance	Required value for R2
–20 °C	130 kΩ	270 kΩ
–10 °C	68 kΩ	130 kΩ
0 °C	37 kΩ	75 kΩ
+10 °C	21 kΩ	43 kΩ
+20 °C	13 kΩ	27 kΩ
+25 °C	10 kΩ	20 kΩ
+30 °C	7,9 kΩ	16 kΩ
+40 °C	5,0 kΩ	10 kΩ
+50 °C	3,3 kΩ	6,8 kΩ
+60 °C	2,2 kΩ	4,3 kΩ
+70 °C	1,5 kΩ	3 kΩ

COMPONENTS LIST

Resistors:
R1 = NTC 10kΩ *
R2 = 10kΩ *
R3 = 2kΩ2

Capacitors:
C1 = 100nF

Semiconductors:
D1 = LED
IC1 = TLC555

Miscellaneous:
S1 = pushbutton, 1 make contact
K1 = 2 solder pins

* see text