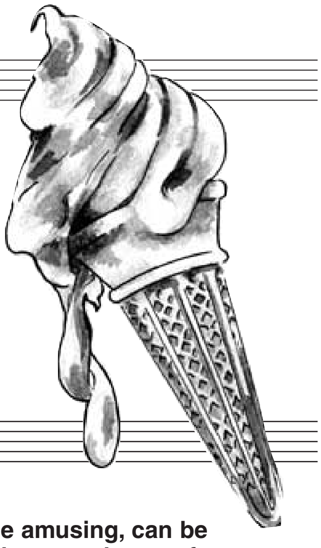
Top Tenners

FRIDGE/FREEZER ALARM



OWEN BISHOP

Project 3

This short collection of projects, some useful, some instructive and some amusing, can be made for around the ten pounds mark. The estimated cost does not include an enclosure, for many of them work just as well as an open board.
All of the projects are built on stripboard, and have been designed to fit on to boards of standard dimensions. All of the projects are battery-powered, so are safe to build. In a few cases in which, by its nature, the project is to be run for long periods, power may be provided by an inexpensive mains adaptor. Again, the cost of such a unit is not included because most spares boxes contain a few of these, possibly pensioned off from obsolete electronic gadgets.

MANY people have a sizeable amount of capital tied up in their deep-freeze. A long power cut or a failure of the freezer itself can lead to significant financial loss, not to mention the prospect of losing the delicious smoked trout from last summer's fishing holiday.

There are also accidents. If the lead on the freezer is a little too short, someone catching their foot in it by chance may drag the plug from the socket without noticing.

Usually, the disaster is not discovered until later, when it's too late to do anything about it. Similar remarks apply to the contents of a refrigerator, though it may be more a matter of disappointment than loss when somebody (who was it?) leaves the door ajar and the chilled lemonade warms up on a summer's day.

This simple alarm project circuit sits in the freezer and simply waits for the temperature to rise above a preset limit. Then it turns on a loud buzzer, one that is loud enough to be heard with the freezer door shut.

It runs from a 9V battery pack and, since the circuit takes only 200μA when not sounding, the battery should last about 100 days. However, there is no "flat battery" warning on this project, so test the battery once a month and replace it when the voltage starts to drop.

CIRCUIT DETAILS

The full circuit diagram for the Fridge/Freezer Alarm is shown in Fig.1. The circuit is based on a useful semiconductor device known as a single trip point temperature sensor, IC1.

This is the TC622 integrated circuit, which comes in two versions. The TC622VAT has a temperature range of –40°C to +125°C, with a precision of ±1°C. The slightly cheaper TC622EAT has a more limited range of –40°C to +85°C with the same precision. Either type is suitable for this project.

TRIP POINT

The principle of the TC622 is that its output at pin 1 is high when the temperature is below the trip point and falls sharply as the temperature rises above this. The i.c. has a built-in hysteresis of 2°C. This means that, if it is set for a trip point at say –18°C, its output does not rise again until the temperature has fallen below –20°C. This hysteresis is very important because, if the temperatures at which it falls and rises were both close to –18°C, the alarm would chatter like a magpie for as long as the temperature stayed near that level.

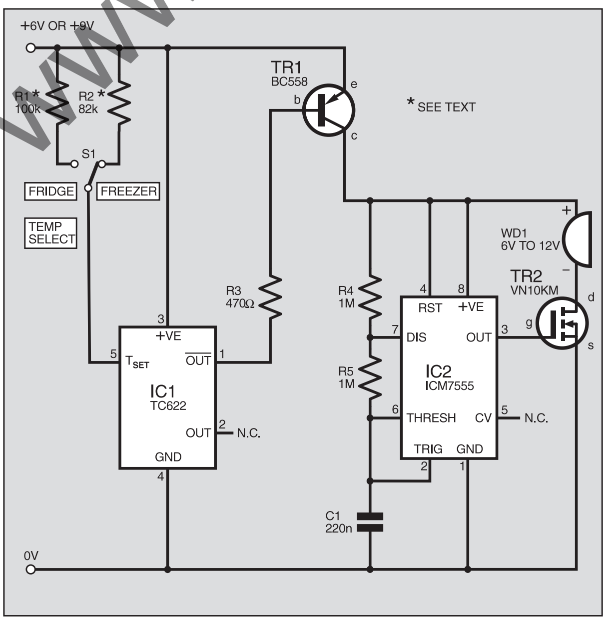


Fig.1. Complete circuit diagram for the Fridge/Freezer Alarm.

The trip point is set by connecting a resistor between the positive supply rail and pin 5 (T_{SET}). The equation for calculating the value of the resistor is:

$$R_{SET} = 0{\cdot}6 \times t^{2{\cdot}1312}$$

In this equation, t is the absolute temperature in Kelvin. For example, to set the trip point to 6°C, add 273 to the temperature in degrees Celsius to obtain the equivalent in Kelvin:

$$t = 6 + 273 = 279\text{K}$$

$$R_{SET} = 0{\cdot}6 \times 279^{2{\cdot}1312} = 97774\Omega$$

A 97k6 0·1% resistor from the E96 series would be ideal. The nearest "standard" resistor from the E24 series is 100k, which would give a temperature trip point of around 9°C. Connecting a 4M7 resistor in parallel with 100k would produce 97k9 and a trip temperature just above 6°C.

TWO LEVELS

In this project, we have made the temperature switchable to two levels, 9°C for the refrigerator and –16°C for the freezer.

These are practicable levels that should not cause a false alarm every time some fresh unchilled food is put in the fridge or freezer. Incidentally, if you want to make a device that sounds the alarm when the temperature falls, use the output at pin 2. This works in the opposite sense to pin 1.

The next point to consider is the alarm. This is to be switched on when the output from pin 1 of IC1 falls to almost zero. A *pnp* transistor, TR1, can be switched by a low-going input so we have used a BC558 and powered the sounder circuit with the current flowing from its collector (c).

An intermittent tone is always much more noticeable than a continuous tone so the next stage in the circuit is an astable based on a 7555 timer (IC2). The values of the resistors R4 and R5 and the capacitor C1 are chosen to give a frequency of just over 2Hz. This produces an "urgent" rate of beeping that is easily heard from outside the freezer.

The output at pin 3 of the timer IC2 goes to a MOSFET, TR2. This type of transistor was used for switching instead of a bipolar transistor in order to maximise the voltage drop across the warning device WD1. There is already a voltage drop of 0·6V across TR1, and a further drop of 0·6V across a bipolar TR2 would mean that there was only 7·8V across WD1. It would be only 4·8V if we used a 6V supply. Under-running WD1 reduces its loudness, an important consideration when it is inside a thick-walled enclosure.

COMPONENTS

Resistors

R1	100k (see text)
R2	82k (see text)
R3	470Ω
R4, R5	1M (2 off)

All 0·25W, 1% metal film

See SHOP TALK page

Capacitor

C1	220n polyester film, p.c.b. mounting

Semiconductors

TR1	BC558 *pnp* transistor
TR2	VN10KM n-channel power MOSFET
IC1	TC622 single trip-point temperature sensor
IC2	7555 CMOS timer

Miscellaneous

S1	2-way s.p.d.t. d.i.l. switch
WD1	6V to 12V solid-state round buzzer

Stripboard 0·1 inch matrix, size 10 copper strips by 39 holes; 8-pin d.i.l. socket; AA size cells with holder – see text; battery clips, double-sided adhesive pad; multistrand connecting wire; 1mm solder pins (2 off); solder, etc.

Approx. Cost Guidance Only £9.50 *excluding batts.*

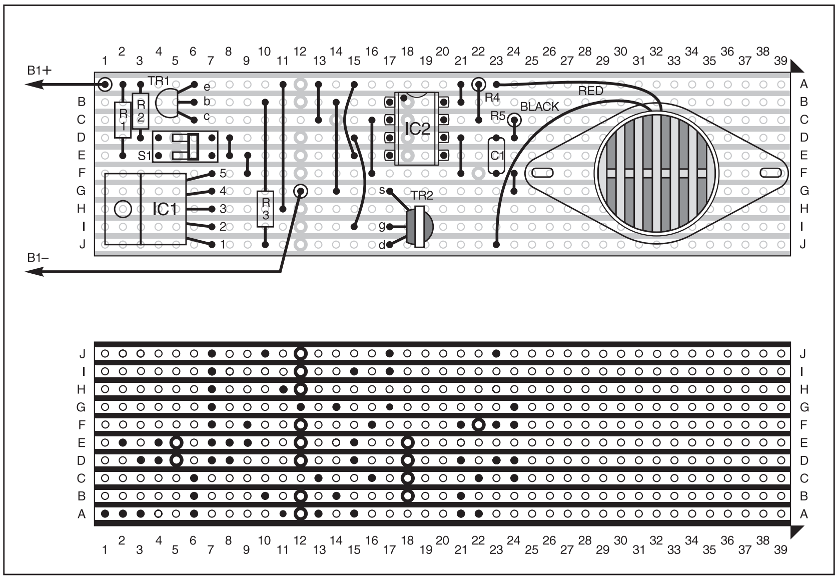


Fig.2. Fridge/Freezer Alarm stripboard component layout and details of breaks required in the underside copper tracks.

CONSTRUCTION

The Fridge/Freezer Alarm can conveniently be run on a 9V supply, but you can run it on 6V or 12V if you prefer. Using a battery holder with four AA type cells or larger will mean that the battery needs renewing less often.

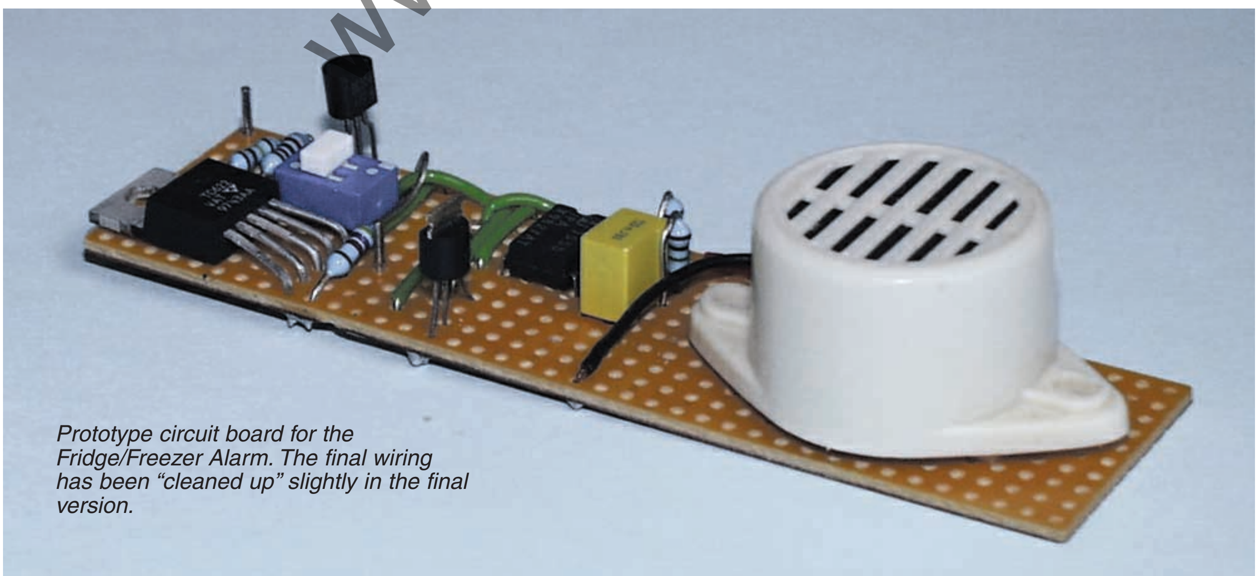
Once completed, the circuit board should be enclosed in a container but, if you are trying to keep costs down, this need not be a regular "enclosure". A used plastic food container with a snap-on lid will do almost as well. It is just a matter of keeping the integrated circuits away from the frozen chops!

The circuit is built up on a small piece of stripboard, size 10 strips × 39 holes. The component layout and details of breaks required in the underside copper tracks are shown in Fig.2. Construction should commence by making the track cuts (15 off) and inserting the wire links (11 off) and the two solder pins.

Next, assemble the alarm circuit section, which is everything to the right of column 13 in Fig.2. The warning buzzer WD1 has two lugs for bolting it to the board, but it is easier to fix it in place using a double-sided adhesive pad. Temporarily connect its power-input point (A13) to the positive power supply. The buzzer should produce its note as a series of bleeps, about two per second.

Now assemble the remainder of the circuit. If you prefer at first to test it outside the freezer, temporarily wire a 10 kilohms (10k) resistor in series with R1 and switch to the Fridge setting. The total resistance of 110 kilohms gives a trip point of about 22°C, a more comfortable temperature for trials.

Finally, place the completed unit in the fridge or freezer with switch S1 switched to the appropriate resistor and no battery connected. Leave it for 15 minutes or more to cool. When you connect the battery, the warning buzzer should stay silent. Remove it from the fridge or freezer and very soon the bleeping should begin. □



Prototype circuit board for the Fridge/Freezer Alarm. The final wiring has been "cleaned up" slightly in the final version.