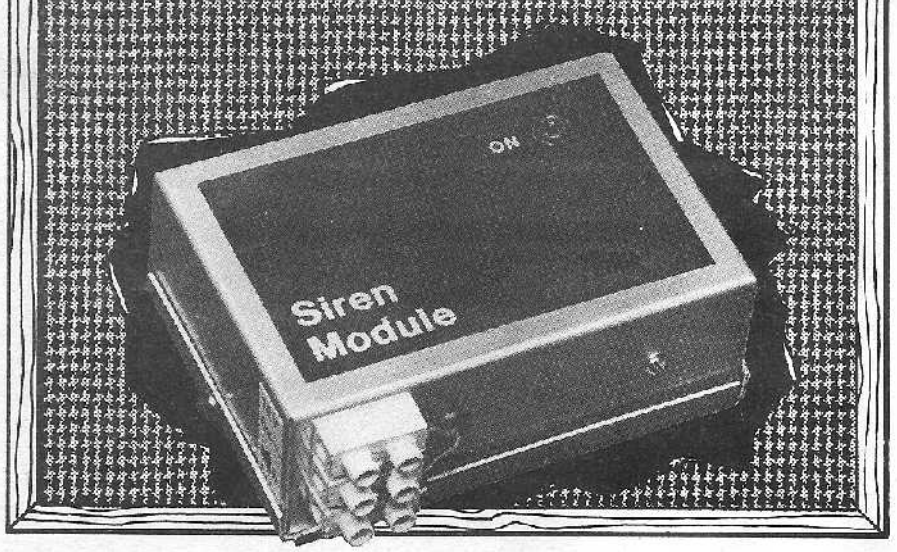
SIREN MODULE

BY A. R. WINSTANLEY



THE device described in this article generates a US police-car type "whooping" tone and is suitable for many medium-power alarm applications. The tone is sounded over a 5 watt loudspeaker and in fact the level of output available is quite startling. The module can be used with burglar alarms, fire alarms or in fact in any unit requiring a distinctive audible alarm and which is capable of supplying 12 volts at about 500mA.

It is possible to incorporate a small modification which permits the module to imitate the familiar two-tone sequence of many British police cars.

THE 555 TIMER I.C.

The circuit employs two 555 timer i.c.s, both of which are operated in the astable mode. This is illustrated in Fig. 1.

An astable multivibrator possesses no stable state, and continues to offer a steady stream of pulses at its output without the need for triggering. In the case of a 555 astable, a constant square wave (Fig. 2) appears at the output terminal. The frequency, or number of pulses per second (measured in hertz), is dependent upon the values of three external timing components, namely R_a, R_b and C. Fig. 2 illustrates how the frequency is controlled by these three components.

The other interesting features depicted in Fig. 1 are the "reset" and "control voltage" facilities. The reset pin, if grounded, will halt the output, that is the output will go low and remain like this until the reset signal is removed. It is customary to connect the reset pin to $+V_{cc}$ (the positive supply rail) if it is not required.

CONTROL VOLTAGE

The "control voltage" pin provides another means of adjusting the frequency of the output. Apart from altering the values of R_a, R_b and C, a control voltage may be applied to pin 5 to vary the output frequency independently of the "RC network".

By applying a voltage to pin 5, it is possible to modulate the frequency of the square wave output in sympathy with the amplitude of the control voltage. This method is employed in the Siren Module where the applied voltage has a sawtooth waveform.

If the control voltage terminal is unused, normally it is connected to 0V via a 0·01μF capacitor, although for a minimum component count it can be left entirely unconnected.

CIRCUIT DESCRIPTION

The circuit diagram of the Siren Module is shown in Fig. 3. It can be seen that two 555 astable circuits are employed, IC1 and IC2 with associated timing components. IC1 produces a square wave operating at a nominal frequency of about 500Hz; this forms the basic "tone" of the system.

IC2 produces another square wave of a much lower frequency, about 3Hz. Note however that a variable resistor VR1 is incorporated so this frequency is adjustable to a certain extent. VR1 was in fact eventually incorporated in the design to compensate for large tolerances which affect the value of C3.

The output of IC2 is coupled through R4 and R5 to the control voltage terminal of IC1. C2 is a large-value electrolytic capacitor whose presence converts the square wave produced by IC2 into a sawtooth waveform.

The square wave from IC2 causes C2 to constantly charge up and discharge, and so the smooth sawtooth waveform produced by this is used to modulate the output of IC1; the frequency of operation of IC1 is altered rhythmically to produce a "whooping" tone instead of a continuous 500Hz note.

As a basis for experimentation, readers may wish to note that by omitting C2, a "two-tone" effect will

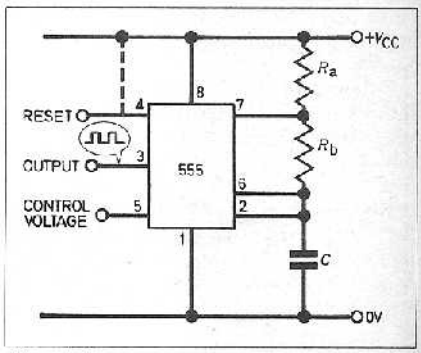


Fig. 1. Basic arrangement of a 555 timer i.c. to function as an astable multivibrator.

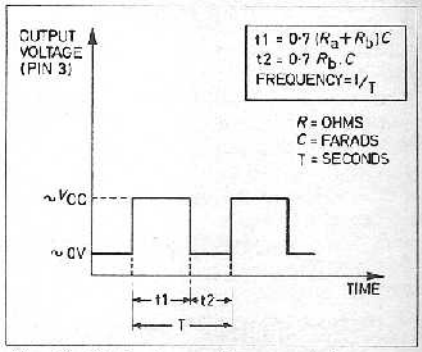


Fig. 2. Output waveform and frequency calculation for 555 astable.

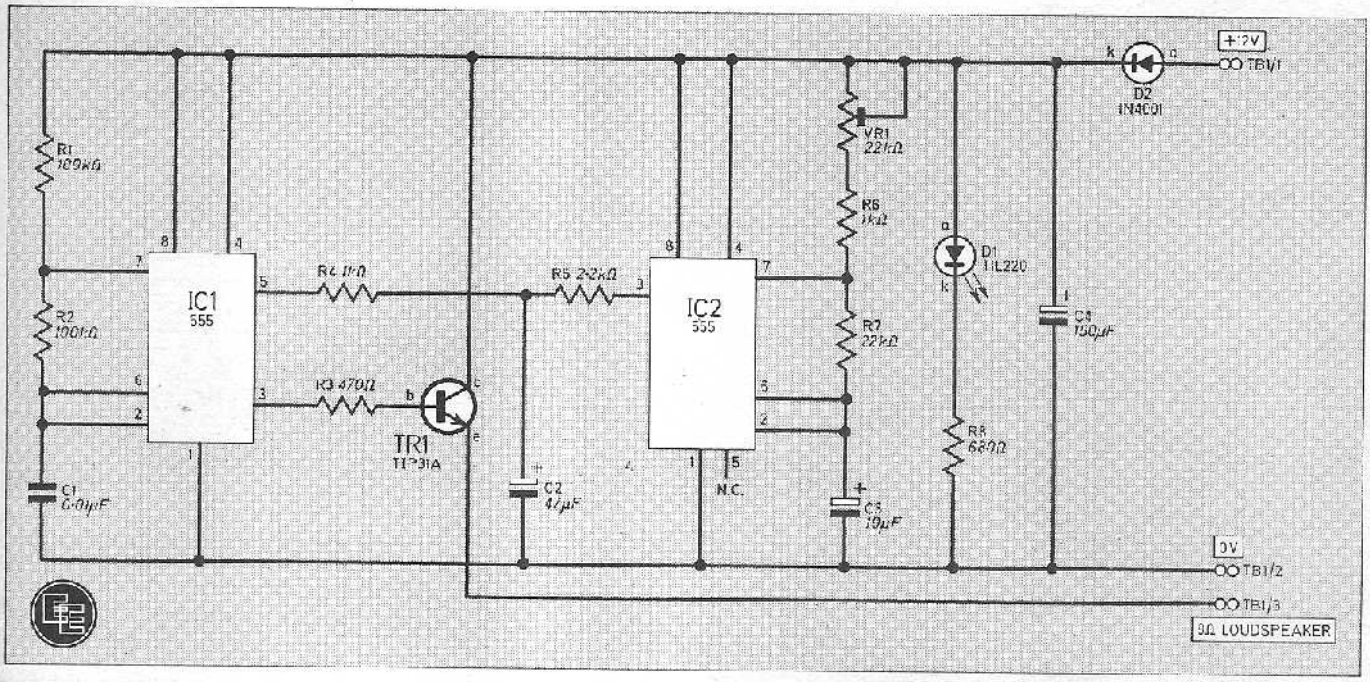


Fig. 3. The complete circuit diagram for the Siren Module.

COMPONENTS

Resistors

R1	100kΩ
R2	100kΩ
R3	470Ω
R4	1kΩ
R5	2·2kΩ
R6	1kΩ
R7	22kΩ
R8	680Ω

All ¼ watt carbon ± 5%

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Capacitors

C1	0·01μF polyester (C280)
C2	47μF 12V elect. radial leads
C3	10μF 12V elec. radial leads
C4	150μF 12V elect.

Semiconductors

IC1, 2	555 timer i.c. 8-pin d.i.l.
TR1	TIP31A *npn* silicon
D1	TIL220 0·2 inch red l.e.d.
D2	1N4001 1A silicon

Miscellaneous

VR1	22kΩ sub-miniature horizontal preset
TB1	3-way 2A screw terminal strip

Stripboard: 0·1 inch matrix 18 strips × 37 holes; 8-pin d.i.l. sockets (2 off); clip/bush for D1; TO-220 insulating kit for TR1; rubber grommet; metal case size 100 × 70 × 40mm; Veropins (5 off); p.v.c. covered stranded wire; 6BA fixing hardware; 2mm diameter sleeving; 22 s.w.g. tinned copper wire; Loudspeaker and enclosure—see text.

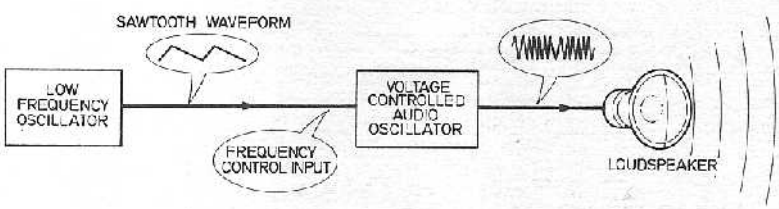
Approx. cost Guidance only £4 excluding speaker

be produced. This is because a square wave is being used directly as a modulating signal for IC1, so that the 500Hz tone is suddenly increased and then decreased again, producing two separate notes.

The final "whooping" tone is available at pin 3 of IC1, but the maximum current that can be supplied is only 200mA. This is insufficient for the required 5 watts power output. TR1 functions as a current amplifier to realise 5 watts into an 8 ohm speaker.

An 8-ohm loudspeaker (minimum) should be used, with a minimum power rating of 5 watts r.m.s. An ex-music-centre loudspeaker mounted in an enclosure has been used with the prototype with very great effect. Note however that the loudspeaker is connected to the Siren Module through a terminal block, but it will be possible to mount an unhoused Siren Module in the loudspeaker enclosure itself.

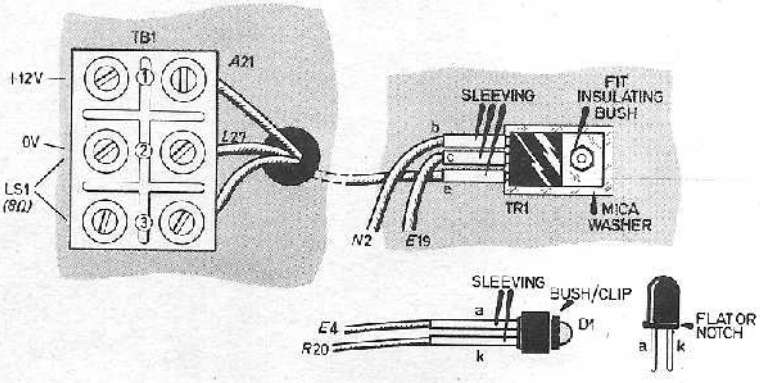
The circuit requires a 12V supply maximum at 500mA maximum, 300mA minimum. D2 protects the circuit from damage which could occur if the power supply happened to be accidentally reversed upon initial switching on. Finally, D1 is a light-emitting diode which glows when the power is on, and C4 serves to decouple the power supply and prevents unwanted interaction between the two oscillators.

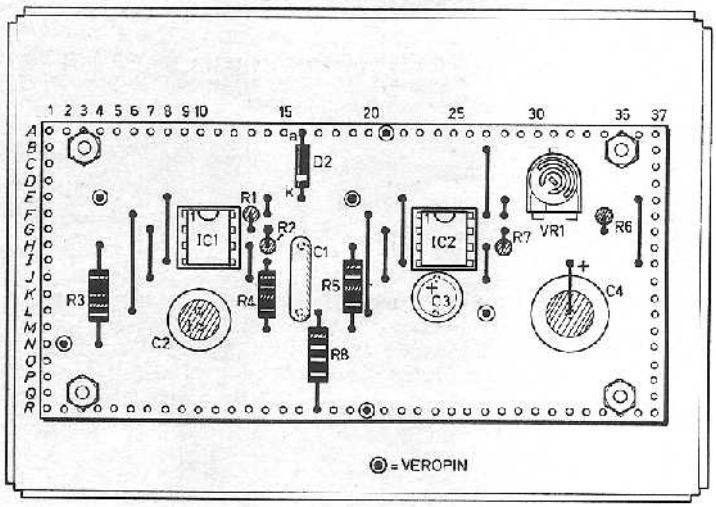


HOW IT WORKS

A low frequency oscillator has its output "shaped" to provide a sawtooth waveform. The second audio frequency oscillator, without any signal fed to its control input produces a tone of about 500Hz. The effect of the sawtooth voltage is to cause this tone to vary in pitch about 500Hz, the shape of the sawtooth producing a "whooping" tone. This is heard in a loudspeaker via a current booster amplifier (not shown).

SIREN MODULE





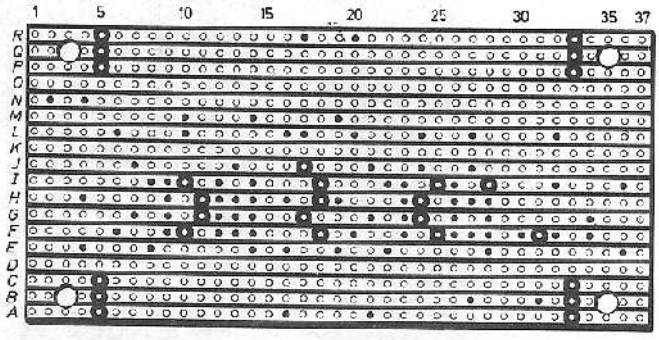
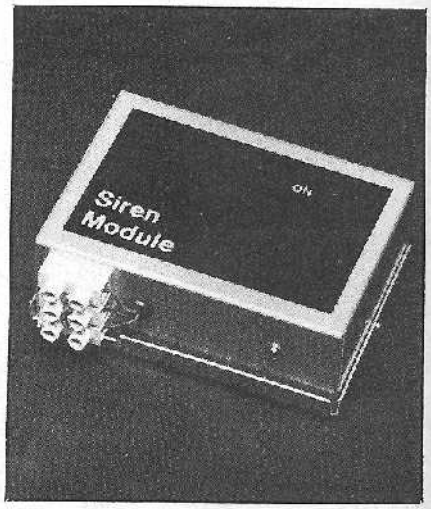


Fig. 4. Layout of the components on the stripboard and breaks to be made in the tracks on the underside. Veropins are used as anchorage points for wiring the remote components to the circuit board. Sockets are advised for both i.c.s.



The completed siren showing the mounting of the supply and loudspeaker connecting terminal block on the side of the case.

CONSTRUCTION starts here

CASE

The Siren Module can be built into a standard aluminium box measuring 100×70×40mm and the circuit itself—with the exception of TR1—can be constructed on 0·1inch stripboard, 18 strips×37 holes.

Any other metal case can be used providing that it is of a size suitable for carrying the completed circuit board.

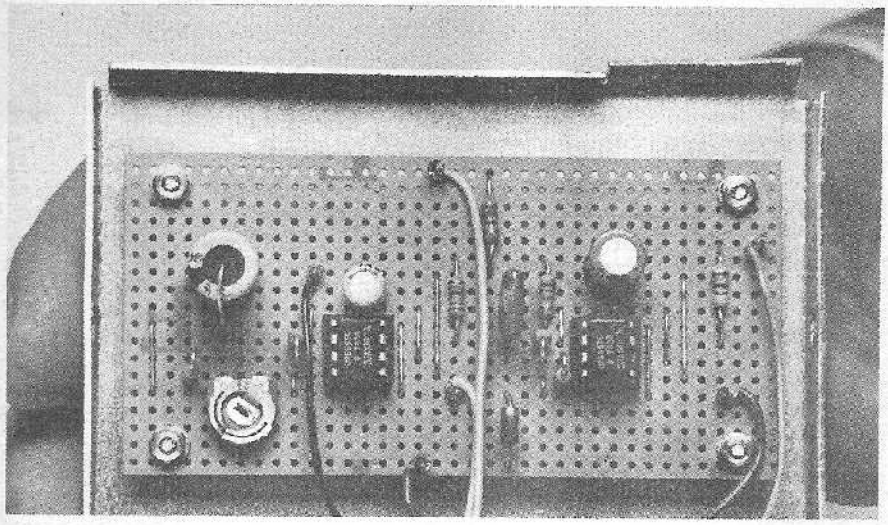
CIRCUIT BOARD

Fig. 4 illustrates the suggested stripboard layout. Having cut the stripboard to size, drill four 6BA clearance holes in each corner as shown to take the necessary mounting hardware. Take care when drilling to make sure that the circuit board is not fractured due to excess pressure.

Then all the breaks in the copper strips are made, using either a hand-held twist drill or the proper spot face cutter. The Veropins may then be inserted and soldered in the positions indicated.

At this stage it may be best to solder in the two 8-pin d.i.l. sockets which carry the i.c.s. These serve as a good reference when locating and soldering the 22 s.w.g. tinned copper link wires.

The recommended order of construction continues with the soldering in of the miniature resistors and the electrolytic capacitors.



The completed circuit board mounted in position on the base of the case. The cutaway in the lip to avoid obstructing the terminal block can be seen top right.

HEATSINK FOR TRANSISTOR

During normal operation, the temperature of TR1 will rise noticeably, and so the aluminium box is used as a heatsink to dissipate some of this heat, the reason for specifying a metal box to house this project.

TR1 is mounted on one wall of the aluminium box with 6BA hardware, using a TO-220 mica washer and insulating bush to isolate the transistor tab (which is internally connected to the collector) from the box. A smear of silicon grease or similar heatsink compound on both sides of the mica washer will assist in heat transfer from the transistor to the heatsink.

Note that it will be easier to solder a flying lead to each of the terminals before fixing in place.

TERMINAL BLOCK

Mounted externally on the case is a 3-way screw terminal block which carries the connections for the positive supply rail and also one terminal of the loudspeaker; the third screw terminal forms a combined connector both the 0V and remaining loudspeaker terminal. Bear in mind that the lip of the lid overlaps about 6mm when positioning the terminal block on the outside of the case.

A small hole must be drilled next to the terminal block and this hole should be fitted with a small grommet. Flying leads are then taken from the appropriate Veropins on the circuit board, through the hole to the terminal block as shown.

The light-emitting diode can be mounted on the front of the box using and l.e.d. bush-clip. The l.e.d. must be positioned such that its leadouts will not interfere with the circuit board inside once the completed module is closed up—in fact the leads will probably need cutting back a little. Cut the anode shorter than the cathode so that you can easily identify the leadouts.

Standard multicored hook-up wire can be used throughout as flying leads, with 2mm diameter p.v.c. sleeving pushed over the leads of the l.e.d. and TR1 to ensure that short-circuiting will not occur.

TESTING AND SETTING UP

Once construction is complete, check out the finished unit carefully. In particular inspect the circuit board closely, and fit the i.c.s correctly into their sockets if you have not already done so. Set VR1 to middle position.

Connect a suitable loudspeaker to the 0v and LS terminals of the module, and then apply 12V (500mA maximum) to the +12v and 0v terminals.

Switch the power on: the l.e.d. should illuminate and the Siren Module should drive the speaker, but the "whooping" tones may not be perfectly formed. By adjusting VR1 it should be possible to produce the desired effect.

The "lid" or base of the siren removed showing clearly how the circuit board is mounted on spacers. The l.e.d. is seen on the right of the case with insulating sleeving over the pins. Take care that the l.e.d. does not foul on the circuit board.