IC Sound Generator

A very simple, low cost unit that uses the popular 555 timer IC and a single transistor for audio sound generation.

CHRIS BOWES

This month we introduce a simple IC Sound Generator circuit, which can be used either on its own or incorporated with other circuits in this series to provide an audible addition to a control or alarm circuit. Like all of the circuits in this series it can be operated from a single nine volt battery and may be mounted inside a case if this is desired.

The generator circuit uses a 555 timer in the standard astable mode. The basic circuit for this is shown in Fig. 1a. In this arrangement the IC produces an output at pin 3 (the IC's output connection) which repeatedly switches on and off in a timed sequence as shown in Fig. 1b. The duration of the on and off periods is governed by the values of *Rz*A, *R*B and in *C* in the manner shown in Fig. 1b.

The output current from the 555 timer is not sufficiently high to enable the circuit to directly drive a loudspeaker so a single transistor is used as an emitter follower to provide the necessary current handling capacity.

Circuit Description

The full circuit diagram for the IC Sound Generator is shown in Fig. 2. Basically the circuit consists of the 555 timer astable circuit shown in Fig. 1, with preset VR1 and resistor R1 taking the place of *R*A and resistor R2 taking the place of *R*B. Preset VR1 is included to enable the frequency of the output oscillation of IC1 to be adjusted so as to give the desired output tone and resistor R1 is included to provide a minimum resistance in the circuit and to prevent damage to the IC which would otherwise occur should VR1 be accidentally set to its zero value.

The frequency of the circuit's operation is determined by the values of VR1, R1, R2 and capacitor C1. With the components specified the operating frequency will be at approximately 1kHz. Capacitor C2 is required by the bipolar timer IC to set the control voltage level at pin 5 of IC1. If you use the CMOS version of the 555 timer then C2 may be omitted.

A simple emitter follower amplifier, formed by transistor TR1 and resistors R3, R4, is used to provide the current gain needed to drive the loudspeaker LS1. When a current flows through the base-emitter circuit of the transistor, this allows a much higher current to flow through the collector-emitter circuit.

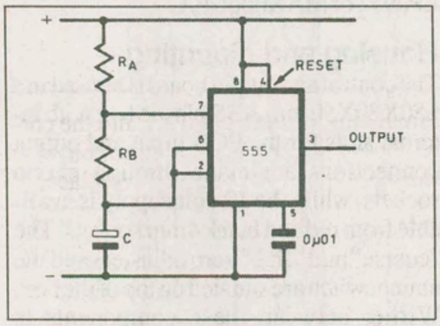


Fig. 1.a. Using the 555 timer in the stable mode.

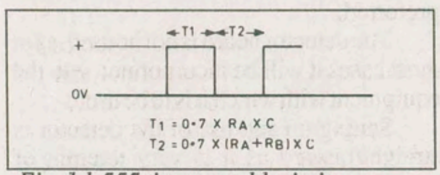


Fig. 1.b 555 timer astable timing diagram.

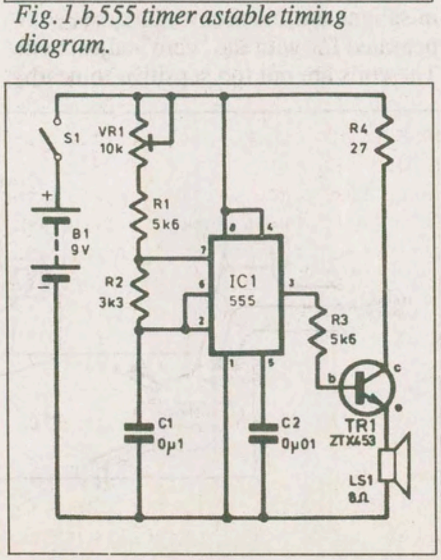


Fig. 2. Complete circuit diagram for the IC Sound Generator.

The emitter follower circuit makes use of the fact that the transistor's construction is such that the voltage between the base and emitter is maintained at 0.7V. When the voltage at the output (pin 3) of IC1 is at the 0V level, then no current flows through TR1. When the voltage at pin 3 rises to the battery voltage, then a current flows through the base-emitter circuit.

In order to maintain the base-emitter voltage at 0.7V the voltage across the loudspeaker consequently rises to approximately 0.7V less than the battery voltage. As the output from IC1 is constantly being switched on and off this causes the voltage across the loudspeaker to be switched on and off at the same frequency.

Resistor R33 is included in the base circuit of TR1 to ensure that the current flowing through the base-emitter of the transistor is kept to a safe level. Similarly, resistor R4 is included in the collector of TR1 to restrict the maximum current flowing through the loudspeaker to a level which will prevent damage occurring.

Construction

The first task when commencing the construction of the IC Sound Generator is to cut a piece of stripboard 13 strips deep and 20 holes wide. If you are going to mount the project into a box by using PCB stand-offs, you will need to allow an extra six holes width (three each side) on the board for case mounting holes using a 4mm drill, make these mounting holes at the four corners of the board before starting to construct the circuit.

The component layout and details of breaks required on the underside copper tracks is shown in Fig. 3. It is important that these track breaks are made completely so that not even the merest sliver of copper remains to bridge across the track break.

Once the board has been prepared you can start the electronic construction. To help with this the strips and holes have been numbered and lettered, see Fig. 3.

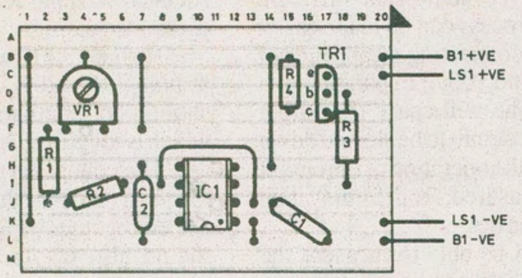
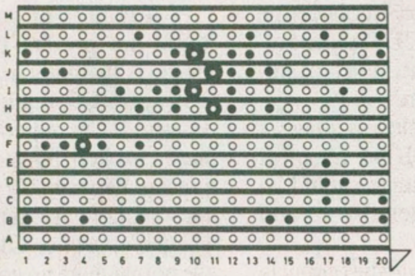


Fig. 3. Stripboard component layout and details of breaks in the underside.



Although it does not make any difference to the operation of the circuit which order you insert the components into the stripboard, you will find it easier to construct the circuit if the components are inserted in ascending order of size. Commence by inserting and soldering the five link wires into place, as shown in Fig. 3. The wire links are made with insulated single-core wire and after soldering in place cut off any excess wire protruding on the underside of the board with your cutters.

The next task is to put the resistors in their correct places by first bending the wires of the resistor at right angles to the body of the component so that they will fit through the holes, as shown in Fig. 3. Counting across and down the board, using the numbers and letters as a guide, put all of the remaining resistors into their correct positions and solder them into place. Also fit and solder preset VR1 into place.

The next item to be inserted into position is the IC holder. Although it is possible to solder the IC directly into place, using a socket will both make the construction simpler and make for easier replacement if a fault should occur. It is important that you take care to make sure that the notch on the IC holder is facing towards the bottom of the stripboard as this will help you when inserting the 555 timer into place.

Next come the capacitors, which are both non-polarized types so it does not matter which way round they are inserted. Finally insert transistor TR1 into the correct holes, making sure that it is oriented as shown in Fig. 3, and soldered into place.

Interwiring

The connecting wires to the battery can now be soldered into place on the board. The black wire from the battery connector goes to the point on the stripboard shown as B1-V and the red wire of the battery connector goes to one tag of the on/off switch S1. Another red wire is then connected between the other switch terminal and the B1+V connection on the stripboard.

Two wires should also be soldered to the loudspeaker and connected to the LS1+ and LS1- connection points on the stripboard.

The final step, prior to connecting the battery, is to insert IC1 into its holder making sure that the notch on the IC corresponds with the notch on the IC holder. Some versions of the 555 timer do not have a notch in one end but have a slight, circular dent near pin one. In this case the end with the indentation goes nearest to the edge of the IC holder which has the notch.

Case

Although the project can be easily used as it stands or be incorporated into another project, you may wish to mount it into its own case. The easiest way to do this is to use self-adhesive PCB mounting strips as shown in the photographs. Alternatively, you may use stand-offs in the position of the mounting holes previously drilled in the stripboard before making the circuit up. The requisite holes should be carefully marked on the body of the case and the appropriate stand-offs mounted in suitable positions to support the stripboard. Similarly suitable mounting holes must be drilled to accommodate the switch S1 and loudspeaker LS1.

In the version of this project shown in the photographs the loudspeaker is not provided with mounting holes so it was necessary to hold the loudspeaker against the case lid by means of a strip of material which spans the width of the loudspeaker and is held in place with two bolts which are accommodated in suitable holes drilled in the case. It will also be necessary to drill a matrix of holes in the lid to allow the sound from the loudspeaker to be transmitted.

In order to provide remote switching the case can be fitted with a small switched jack socket, which is mounted in the side of the case and wired in series with the battery and switch S1. If desired the switched socket can be wired in such a way that when the jack plug is removed the socket is shorted out — thus allowing the circuit to be controlled solely by S1 until the jack plug is inserted, when the circuit can then be controlled from the end of the cable

PARTS LIST

Resistors

R1	5k.6
R2	3k.3
R3	1k
R4	27

All 0.25W 5% carbon.

Potentiometer

VR1	250k min. preset, horiz.

Capacitors

C1	0u1 Mylar 16V
C2	0u01 Mylar 16V

Semiconductors

TR1	ZTX453, 2N2219 NPN
IC1	555 timer

Miscellaneous

LS1	8 ohm loudspeaker
S1	optional switch
SK1	3.5mm switched socket (opt.)
B1	9V battery

Stripboard, 0.1" matrix 13 strips X 20 holes (see text); plastic case to suit (optional); 8-pin IC socket; battery connector; connecting wire; solder, etc.

connected to the jack plug.

When preparing the case all of the holes required should be drilled before installing the circuitry. Similarly if the case is to be painted or lettered this should be completed before the circuitry is installed.

Testing

Before connecting the battery and testing the circuit you should carefully examine the stripboard to make sure that all of the components are inserted into their correct places, are the correct way round and that there are no blobs of solder shorting out the tracks.

If the circuit does not operate correctly it will be necessary to check for faults. In this project the only components which will cause problems if they are connected the wrong way round are IC1 and TR1.

If no mechanical problems are found then it will be necessary to check the circuitry to see whether there is a faulty component or not. You will probably find that you will need to use a test meter to perform this stage of the process.

Because of the high frequency of operation of the circuit fault finding with a test meter can be somewhat difficult. However, the process can be made easier by temporarily connecting a capacitor of between 22uF and 100uF in parallel with capacitor C1. The will cause the output frequency of the circuit to be slowed down to a level where the operation of the circuit can be easily measured. Fault finding then becomes much easier.

You should be able to measure the battery voltage between any 0 volt connection and both pins 8 and 4 of IC1 as well as between the Battery+ connection to the board and pin 1 of IC1. If these voltages are not present this will indicate faulty wiring up of the stripboard.

The next step is to check the voltage at the output (pin 3) of IC1. If the circuit is working correctly this voltage should be regularly switching between 0 volts and the battery voltage.

If this does not occur and the output is locked permanently at a fixed voltage then you should remove the IC from its socket and check the voltage at the pin 3 connection again. If the voltage persists with IC1 removed then the fault does not lie with IC1 but most possibly with the wiring associated with the IC and the output or its associated wiring.

Replace the IC and check the voltages at pins 2, 6 and 7. The voltage at pin 7 should be fluctuating around a value which is roughly 2/3rds of the battery voltage. The voltages at pins 2 and 6 should be identical (because these two pins are connected together by a wire link) and these should also be fluctuating in a similar manner, but at a voltage slightly less than that found at pin 7.

If neither or only one of these voltages are present then the most likely cause is that the circuit from the positive voltage rail, through preset VR1, resistors R1 and R2 is not correctly made. This is best checked by measuring the voltage present between 0V and each junction in the component chain through VR1, R1, R2 and capacitor C1 and investigating at the point where no voltage is measured.

If a voltage is present between 0V and pin 7 but no voltage, or only a very small voltage, is measured between the 0V rail and pins 2 or 6 of IC1 then you should check that the resistance between pins 7 and 6 of IC1 is roughly equal that of resistor R2. If this is correct then check the resistance of capacitor C1 with the resistance range of your meter.

If the resistance is very low (less than about 500 ohms) then you should replace capacitor C1. If there is no voltage measurable between pins 6 and 2 of IC1 then this could be caused by a short circuit between the connections of C1 or by a short circuit within C1.

Output Stage

If the voltage switching described above is taking place then the IC and its associated components are working correctly and the fault will most probably lie in the area of transistor TR1 and its associated components. The first point to check is the junction of resistor R3 and the base of TR1.

The voltage at this point should fluctuate between 0 volts and almost full battery voltage, in time with the fluctuations in the output of IC1. If this is happening then you should be able to measure a similar voltage change at the junction of the emitter of TR1 and the loudspeaker LS1.

The voltages between 0V and the emitter and collector of TR1 should both be measured. The voltage at the emitter should rise and fall, following the fluctuations of the output from IC1. If the voltage at the emitter does not rise and fall but stays at 0V then the connections to the loudspeaker should be checked out.

If the voltage remains locked at a level approaching the battery voltage, then the transistor should be checked for correct function by removing it from the circuit and measuring the resistance between the base and emitter and the base and collector. It is important to measure these resistances with *both* polarities of the meter current.

Because of the construction of the transistor a high resistance should be measurable between the base and te other connections, with the base connected to one of the meter leads, and a low resistance should be measurable between the base and the emitter or collector, with the base of the transistor connected to the other lead of the meter. If the resistances measured do not match the expected results then the transistor should be substituted for a new one.

Setting Up

Once construction and testing are complete the circuit can be very easily set up by installing the battery, switching the circuit on and adjusting preset VR1 until a sound at the desired pitch is heard.