simple sound effects

We have, somewhere in the Elektor laboratories, a sound effects department, although the exact location has yet to be discovered. There was a widely held opinion that it was found during the last Christmas office party but this was eventually discounted because a) the noises were too lifelike and b) it was not possible to simulate them electronically! We usually associate their normal products with the dying shrieks of tortured cats, horrifying howls and a whole assortment of plops, bangs, whistles etc. However on the odd occasion they do produce sounds suitable for publication and, to prove that this department really does exist, here is their latest circuit design.

The original design for this rather clever sound effects unit was built into a 19inch rack mounting cabinet which unfortunately tended to overheat to an alarming degree (see 'workshop heater' in Elektor number 184) and lacked a little on portability. Further research resulted in the following circuit which uses only two CMOS ICs and is very cheap to build. Despite its modest dimensions it will produce a range of sounds from that of an American police siren to one closely resembling the 'twittering' of birds.

Sounds simple?

As is apparent from the block diagram of the circuit (figure 1), the basic principle is extremely straightforward. The output of a twelve-bit binary counter is converted into an analogue voltage which is used to control a VCO. As the binary output of the counter increases, the control voltage ramps positive, until the counter resets and the voltage falls to zero, whereupon the count resumes and the control voltage once again starts to ramp positive, and so on. The waveform of the control voltage is thus a periodic sawtooth. The VCO produces the actual output signal of the circuit, whose pitch is determined by the instantaneous amplitude of the sawtooth control voltage. An output buffer amplifier ensures that the signal is sufficiently large to produce an audible tone when fed to a loudspeaker.

The highly individual nature of the resultant sound is due to an unusual feedback configuration. The output signal of the VCO is not only used as the output of the circuit, but as the clock input of the binary counter. Thus the rate at which the counter steps through each count cycle depends upon the pitch of the output signal. In other words, the higher the sound, the faster it varies in pitch. The result is a repetitive *beuip-beuip* sound which starts each phrase at a low frequency and rises exponentially to a maximum pitch.

Circuit diagram

The circuit diagram of the sound effects generator is shown in figure 2, and as can be seen, it consists of only a couple of readily-available CMOS ICs and a few assorted resistors and diodes.

IC2 forms the 12-bit binary counter. The binary value of the 8 lowest order bits (i.e. those bits which change state most frequently) is converted into an analogue voltage by means of resistors R1 . . . R8. The VCO consists of a simple CMOS oscillator (built round N1 and N2) the RC time constant of which is varied by using transistor T1 and a diode bridge as a voltage-controlled resistor. As the control voltage fed to the base of T1 increases, more current is passed through the diodes, with the result that their dynamic resistance falls. The initial frequency of the oscillator is set with the aid of preset potentiometer P1, which is connected in parallel with the diode network.

The squarewave output of the VCO is fed both to the clock input of IC2 and to an output buffer. The latter is formed by four of the remaining inverters of IC1 connected in parallel.

Construction

A printed circuit board has been provided for the circuit (see figure 3). As can be seen, due to the low component count, the board can be kept very small. The loudspeaker can be any inexpensive 8 Ω type capable of handling 500 mW. The supply voltage of the circuit can lie between 4.5 and 10 V; at the lowest supply voltage the current consumption of the circuit is only 5 mA, which means that a 4.5 V battery could be used, thereby rendering the circuit portable. Note that the volume of the output signal is determined by the supply voltage level: the higher the supply voltage the louder the sound.

The pitch of the output signal can be adjusted by means of P1. Since the pitch directly determines the rate at which the pitch changes, reducing the resistance setting of P1 not only increases the pitch of the output signal but also causes it to increase more quickly. At the minimum resistance settings of P1 the resultant sound somewhat resembles that of a chirping bird.

The value shown for P1 in the diagram (1 MΩ) is chosen to give the maximum adjustment range. However, if desired any value from 10 k to 1 M may be used, with or without fixed series resistors.

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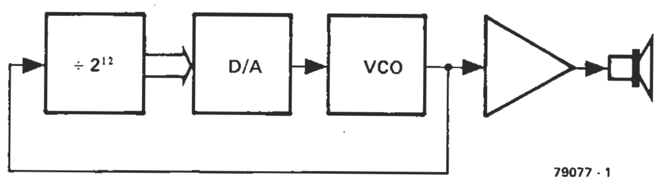

Figure 1. Block diagram of the simple sound effects generator. The output of a binary counter is converted into an analogue voltage which is used to control a VCO. The output of the VCO forms both the output signal of the circuit proper and the clock signal of the counter.

Figure 2. Complete circuit diagram. Two CMOS ICs and a handful of discrete components are all that is required to produce an interesting range of sound effects.

Figure 3. Printed circuit board for the sound effects generator, on which all the components, with the exception of the loudspeaker, can be mounted. The circuit can be battery-powered if so desired (EPS 79077).

Parts list

Resistors:
R1,R9 = 820 k
R2 = 470 k
R3 = 220 k
R4 = 100 k
R5 = 47 k
R6 = 22 k
R7 = 12 k
R8 = 5k6
P1 = preset potentiometer, 1 M (see text)

Capacitors:
C1 = 120 n
C2 = 100 µ/16 V

Semiconductors:
IC1 = 4049
IC2 = 4040
T1 = BC 547B, BC 107B or equ.
D1 . . . D4 = DUS

Miscellaneous:
LS = loudspeaker, 8 Ω/500 mW
S1 = pushbutton

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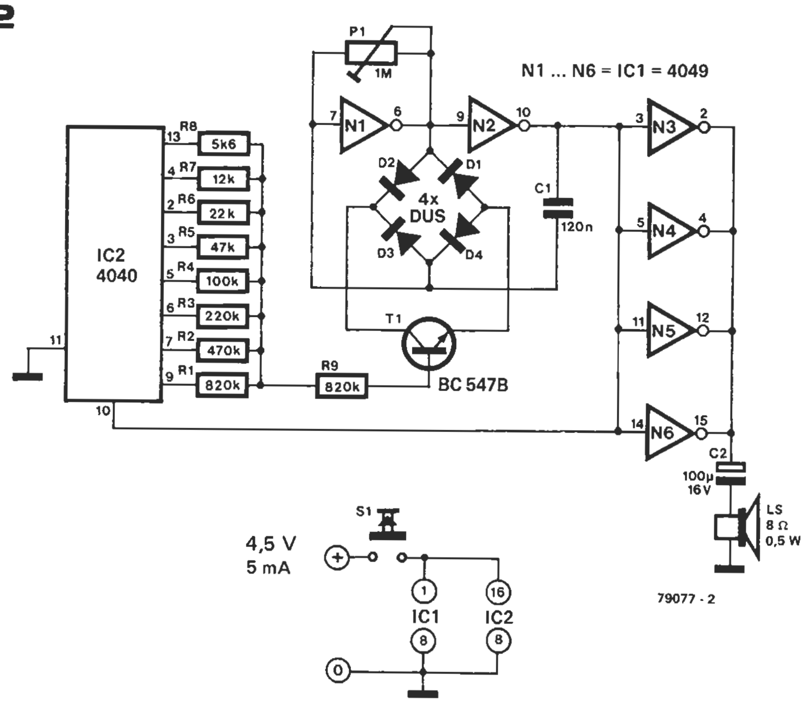

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