★ Complements the Syntom and Synwave projects.
★ Makes a metallic chiming sound, similar to bells, gongs etc.
★ Delay variable from 50ms to 5s.

by Robert Penfold

The popular Maplin "Syntom" and "Synwave" projects are capable of synthesising a wide range of percussive sounds, such as drum and hand-clap sounds. The only obvious gap in their "repertoire" is metallic chiming sounds similar to bells, gongs, etc. The "Synchime" unit has been designed to fill this gap, and it has also been designed to match the "Syntom" and "Synwave" units. It can be triggered by tapping the case (or striking a drum on which the unit is mounted) or using a 5 volt positive trigger signal. The envelope shaper has a fast attack time and a decay time which can be varied from about 50 milliseconds to approximately 5 seconds. The other three controls are a straight forward combined volume and on/off type, plus separate frequency controls for the two oscillators. The latter give a wide operating range of about 100Hz to 7kHz so that a wide range of effects can be obtained. The output signal level is up to about 5 volts peak to peak from a low impedance source, which is more than adequate to drive any normal power amplifier.

Block Diagram

A ring modulator and two audio oscillators are used to generate the basic sound signal, as can be seen from the block diagram of Figure 1. A ring modulator is a form of mixer, but it is more like the mixer circuits used in superhet radio receivers than a normal audio mixer. In other words, it heterodynes the two sets of input frequencies to produce sum and difference frequencies at the output. For example, a 1kHz signal at one input would combine with a 5kHz signal at the other input to give output frequancies of 4kHz (5kHz — 1kHz) and 6kHz (5kHz + 1kHz).

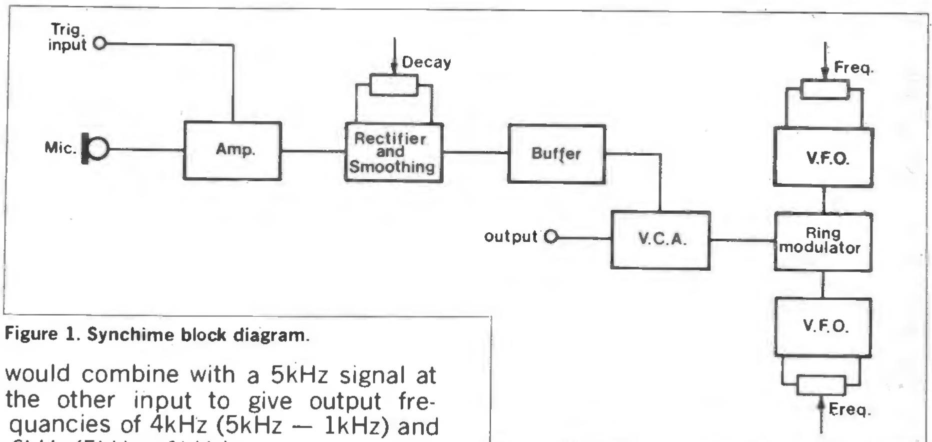


Figure 1. Synchime block diagram.

A ring modulator is a double balanced mixer, which simply means that both of the input signals are balanced or phased out at the output so that only the sum and difference frequencies appear at the output. In practice there is some breakthrough of the input signals at the output, but this is not really of any great significance. The important thing is that the new frequencies generated by the mixing action should be the dominant part of the output signal.

With most instruments the pitch of the sound produced is determined largely by a single dimension, such as the length of a string or a tube. This gives an output spectrum which consists of a fundamental signal plus harmonics of this signal. Instruments which use metal resonators are often two dimensional (plate-like) or three dimensional (bell-like) objects which consequently have more than one fundamental frequency, and mechanically produce a sort of heterodyne effect. A ring modulator fed by two oscillators therefore gives a good electrical analogy of a metallic instrument, and this system generates the desired types of sound.

In order to obtain a realistic percussive sound it is essential to have suitable envelope shaping. A simple fast attack, plus relatively slow decay time is adequate, and this is obtained using an amplifier driving a rectifier and smoothing circuit. When the amplifier receives either a trigger pulse or pulses from the microphone, due to its low output impedance it rapidly charges the capacitor in the smoothing circuit. The discharge rate is controlled by a variable resistor, and this has a value which enables a very long discharge time to be achieved if desired. The output of smoothing circuit is fed to the control input of a V.C.A. which is used to process the output of the ring modulator before it is fed to the output socket.

The Circuit

Figure 2 shows the complete circuit diagram of the "Synchime" unit.

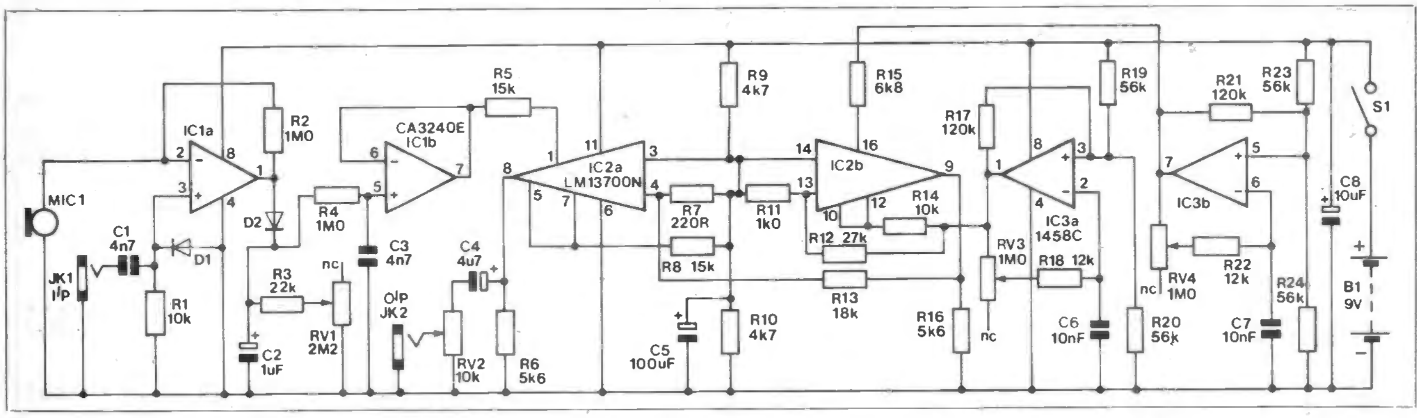
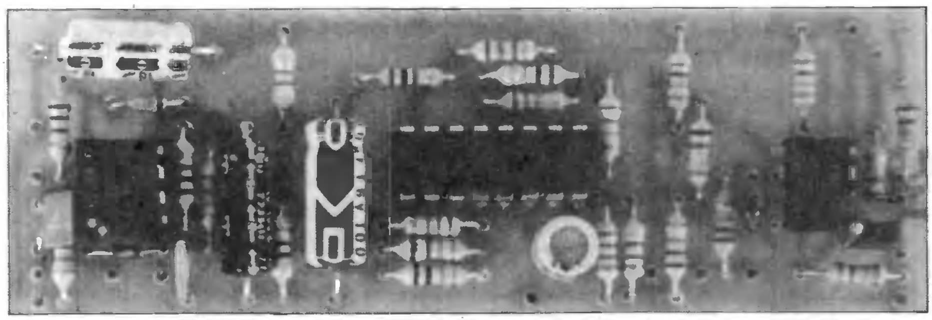


Figure 2. Synchime circuit diagram.



The two audio oscillators are based on the two sections of IC3, and a well known oscillator configuration is used here. The output is a roughly square waveform, and this seems to give good results in the present application due to the strong harmonics which produce a complex signal at the output of the ring modulator.

IC2b is one section of an LM13700N dual transconductance amplifier, and this is the main component of the ring modulator. The output of IC3b is coupled to the amplifier bias input of IC2b via R15. The latter is needed because it is the bias current fed to IC2b that determines its gain, and not the control voltage. Adding R15 in series with the amplifier bias input gives a bias current that is roughly proportional to the applied voltage, and gives the required voltage controlled operation.

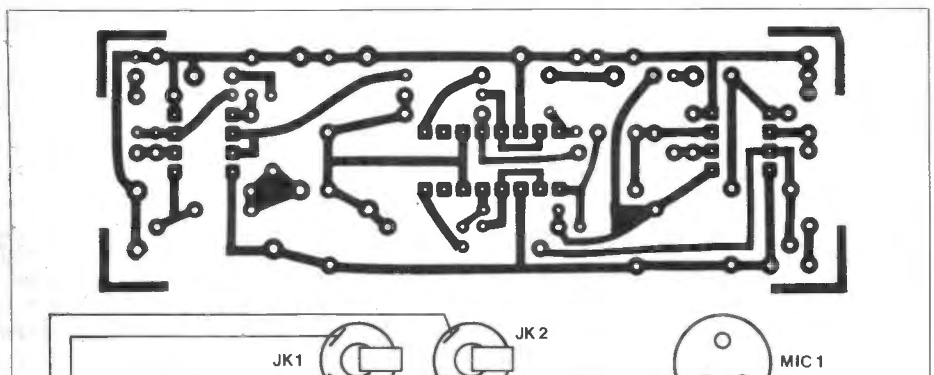


Figure 3. PCB layout.

The output of IC3a is fed to the non-inverting input of IC2b, and it is amplitude modulated by the signal from IC3b to give the heterodyne action and generate the new frequencies at the output. There is little breakthrough of the signal fed to the amplifier bias input and there is no need to add any components to phase out this signal. The same is not true of the signal fed to the inverting input of the modulator, and this does need to be balanced out. This is achieved by including R14 which feeds some of the input signal to the output of the transconductance amplifier. As the signal is inverted through the amplifier this gives the required cancelling, and the value of R14 is chosen to give a high degree of attenuation with the input to R15 at its average level.

Of course, the signal from 1C3a is not totally blocked from the output. When the signal to the amplifier bias input is higher than its average level the gain of the transconductance amplifier increases and its output impedance reduces. This increases the signal from the amplifier and decreases the signal obtained via R14 so that the circuit is unbalanced. Similarly, if the signal to the amplifier bias input falls below its average level, the gain of the amplifier reduces, its output impedance rises and the signal obtained by way of R14 increases so that the circuit is again unbalanced. This provides a proper ring modulator action with a signal applied to just one input producing no significant output, but the mixed signal being produced if both inputs are fed with a signal.

R16 is the discrete load resistor for the emitter follower buffer stage at the output of IC2b. From here the signal is coupled by R13 to the input of the V.C.A. This uses the other section of IC2 as a straight forward V.C.A. which has its

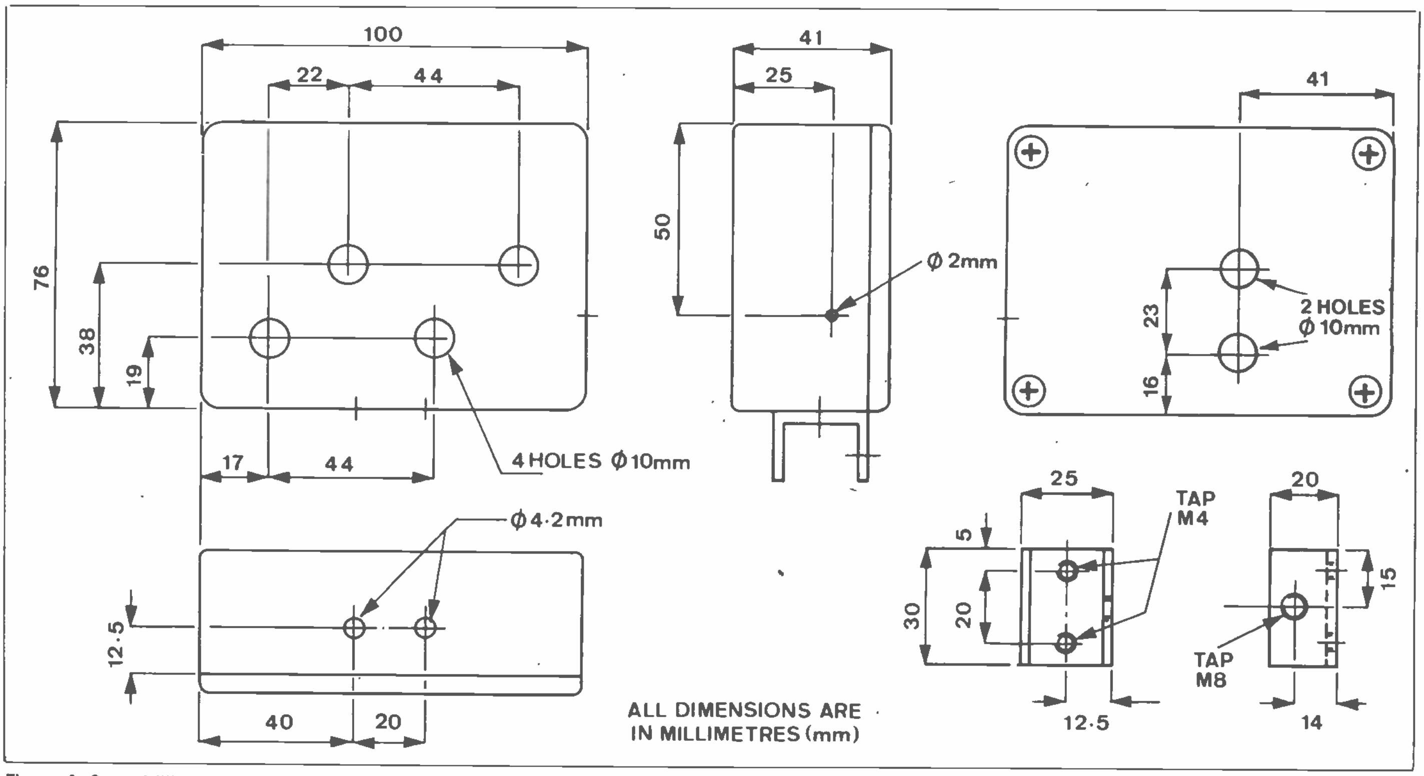


Figure 4. Case drilling details.

output coupled to output socket SK2 through volume control RV2.

IC1a is used as the input amplifier and it has Mic1 directly coupled to its inverting input. This is acceptable as the microphone is a crystal type, and it is actually a crystal earphone which is inexpensive but adequate for this application. R2 has been made quite high in value to give good sensitivity, but if necessary the value of this component could be changed to match the sensitivity of the unit to that of a Syntom or Synwave unit.

R1 biases the non-inverting input of IC1a to the negative supply rail so that the output also assumes this level under quiescent conditions. Negative input half cycles from the microphone drive the output of IC1a positive, but negative half cycles have no effect. The trigger signal is applied to the non-inverting input via C1, and a positive input pulse therefore gives the required positive output from IC1a. C1 is included so that long input pulses are effectively shortened and do not hold the envelope shaper "open".

D2 enables IC1A to charge smoothing capacitor C2, but prevents C2 from discharging into IC1a. It can only discharge through R3 and RV1, and RV1 therefore controls the discharge (decay) time of the circuit. R4 and C3 prevent the circuit from having an excessively fast attack time which would cause a loud "click" each time the unit was triggered. IC1b is the buffer amplifier which ensures that the smoothing circuit feeds into a suitably high input impedance. Note that the CA3240E device used in the IC1 position has a class A output stage which enables its output to go within a few millivolts of the negative supply rail so that the V.C.A. is cut off under quiescent conditions. Other dual operational amplifiers such as the 1458C and LF353 cannot produce a low enough output voltage and will not operate properly in this circuit.

Construction

Details of the printed circuit and wiring are shown in Figure 3. The layout of the board is such that crowding of the components occurs in several places, but this is inevitable given the number of components and the size of the board. However, construction of the board is not difficult provided the specified types of capacitor are used and the small components are fitted into place first. IC1 has a PMOS input stage and it should therefore be fitted in an 8 pin DIL socket. The normal MOS handling precautions should be observed when dealing with this device. Veropins are fitted to the board at points where connections to the microphone, battery, and other off-board components will be made. When the board is installed in the case there is insufficient room to take wires over or under the board, and connections from the off-board components have to be made to the underside of the board. Either double sided pins must be used, or single sided pins inserted from the component side of the board must be fitted.

There is only just enough space for all the components inside the case, and the layout is very critical. Figure 4 shows the correct positions for the controls, sockets, and microphone, and it is advisable to follow this as closely and accurately as possible. The microphone, as explained earlier, is actually a crystal earphone. The transparent section of this is unscrewed from the main section and discarded. The screw at the rear of the unit is removed together with the rear cover which will come away with this screw. This screw is then used

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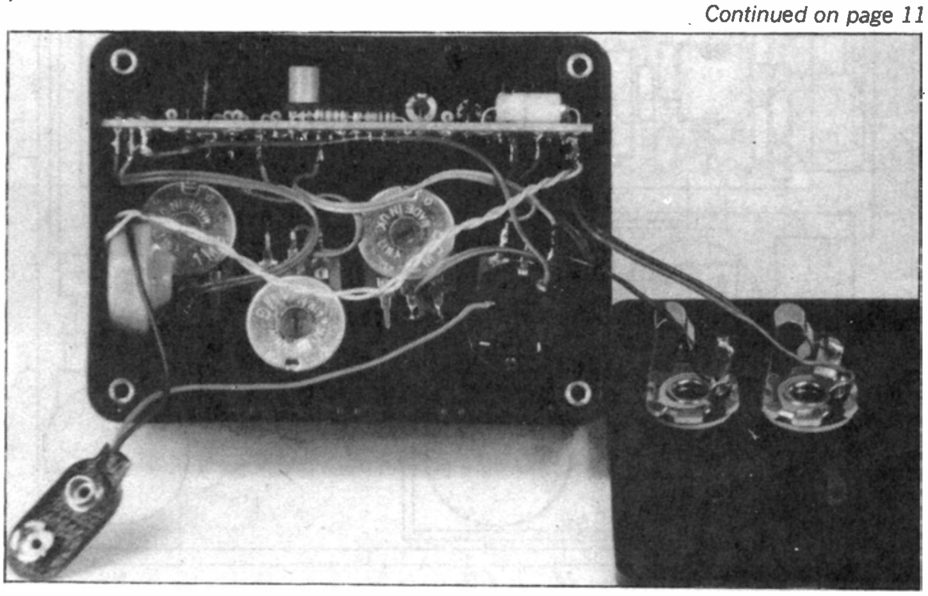

SYNCHIME *Continued from page 4*

to mount the microphone inside the case.

The printed circuit board fits into the top set of horizontal mounting rails in the case with the component side facing upwards. it will probably be necessary to angle C7 slightly inwards so that it fits under one of the corner mounting pillars of the case. Before finally fitting the board in place complete all the point-to-point style wiring. There is space for the PP3 size battery to fit between the sockets and the microphone, and a piece of foam material can be used to wedge this firmly in place.

Testing

With SK2 coupled to an amplifier and the volume control advanced, tapping the unit should give an output, and using RV1 it should be possible to control the duration of each burst of output signal. The two pitch controls can be a little confusing at first, and it has to be remembered that the main output signals are the sum and difference signals produced by the fundamental frequencies of the two oscillators. The fundamental frequencies themselves appear at the output at a very low level, and might not be apparent at all.

In practice this means that quite a low pitch can be obtained if both pitch controls are set for a high output frequency, since the difference frequency might then be just a few tens of Hertz. With a little experimentation you should soon discover the types of sound that are produced at various control settings. At most settings of the pitch controls the output sounds quite discordant, but with the two oscillators set some musical interval apart, normal chime type sounds will be obtained. Good effects can be obtained with the two oscillators just fractionally off-tune, so that a low frequency beat not is obtained. At most settings of the frequency controls the output signal contains a wide range of frequencies, and filtering the output signal can expand the range of effects that can be obtained.

SYNCHIME PARTS LIST

Resistors — All 0.4W 1% Metal Film			
R1,14	10k	2 off	(M10K)
R2,4	1M	2 off	(M1M)
R3	22k		(M22K)
R5,8	15k	2 off	(M15K)
R6,16	5k6	2 off	(M5K6)
R7	220R		(M220R)
R9,10	4k7	2 off	(M4K7)
R11	1k		(M1K)
R12	27k		(M27K)
R13	18k		(M18K)
R15	6k8		(M6K8)
R17,21	120k	2 off	(M120K)
R18,22	12k	2 off	(M12K)
R19,20	56k	2 off	(M56K)
RV1	2M2 lin pot		(FW09K)
RV2	10k switched log pot		(FW63T)
RV3,4	1M lin pot	2 off	(FW08J)
Capacitors			
C1,3	4n7 ceramic	2 off	(WX76H)
C2	1uF 63V axial elect		(FB12N)
C4	4u7 63V P.C. elect		(FF03D)
C5	100uF 10V axial elect		(FB48C)
C6,7	10nF mylar	2 off	(WW18U)
C8	10uF 25V axial elect		(FB22Y)
Semiconductors			
IC1	CA3240E		(WQ21X)
IC2	LM13700N		(YH64U)
IC3	1458C		(QH46A)
D1,2	1N4148	2 off	(QL80B)
Miscellaneous			
JK1,2	Std Open Jacks	2 off	(HF91Y)
S1	Part of RV2		
B1	9 volt PP3 size		
Mic 1	Crystal earpiece		(LB25C)
	Case type MB2		(LH21X)
	Synchime PCB		(GB38R)
	8 pin DIL socket		(BL17T)
	Control knobs	4 off	(YG40T)
	Blue cap		(QY01B)
	Green cap		(QY02C)
	Red cap		(QY04E)
	Yellow cap		(QY06G)
	Battery connector		(HF28F)
	Wire	1 Pkt	(BL00A)
	Synchime Front Panel		(BK77J)

A complete kit of all parts is available.
Order As LK15R (Synchime Kit) **Price £10.90**