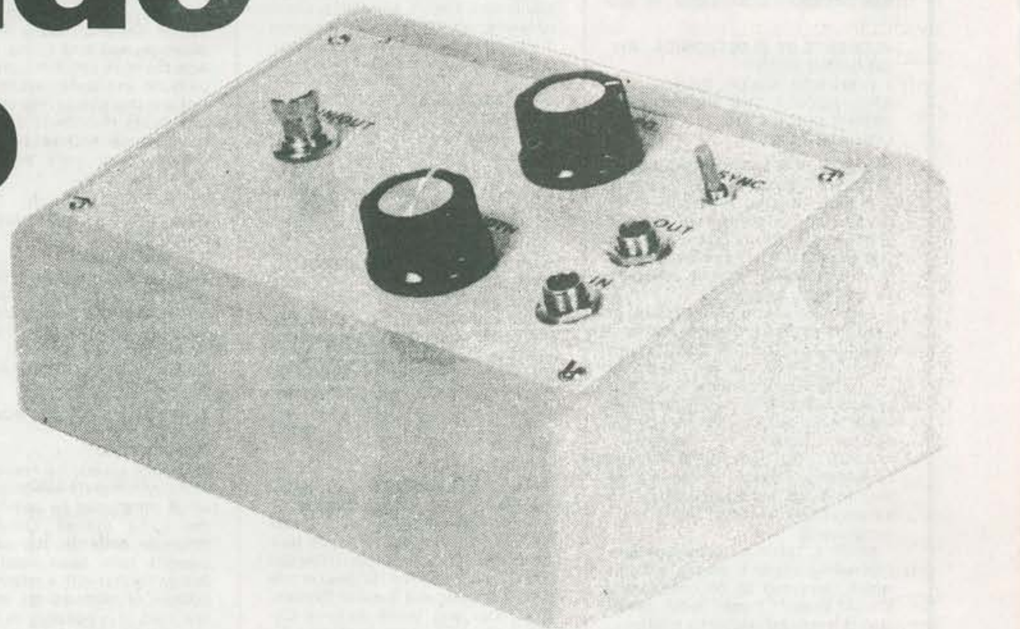
Pseudo Echo Unit



Produce realistic echo effects at a realistic price.

By Robert Penfold

This device is really a form of tremolo unit, but when used with an instrument (such as a guitar) which has a fast attack and slow decay, it provides an effect which is much more like an echo effect than a conventional tremolo type. The unit differs from a standard tremolo rather than the more usual sinewave or triangular signal.

The effect of a normal tremolo unit is much the same as manually varying the volume up and down at a rate of (typically) a couple of times per second, and this effect can be generated manually via a swell pedal. The effect of this unit is to switch the signal on and off with no in-between state. This can be used as a rather harsh and extreme form of tremolo, but it is probably most effective when used on a suitable signal to give a pseudo echo effect.

The waveform of **Fig. 1** shows how this effect is obtained. The input signal must be a type having a fast attack with a much slower decay time if the right effect is to be produced. The output from an electric guitar is in this category, and synthesizers and most other electronic instruments can provide a suitable signal.

The effect of the unit is to chop up the signal into short bursts, and the output from the unit is therefore a series of signal bursts that start at a high level and gradually decay. The sound this gives is very much the same as if a short burst of signal were to be fed into an echo effects unit.

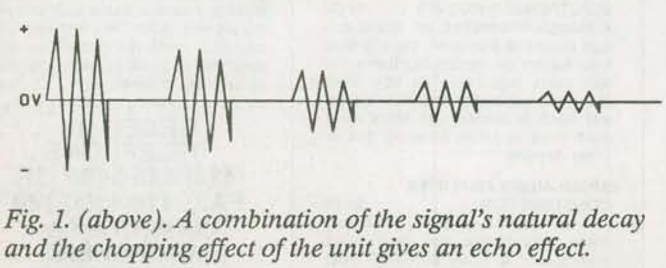


Fig. 1. (above). A combination of the signal's natural decay and the chopping effect of the unit gives an echo effect.

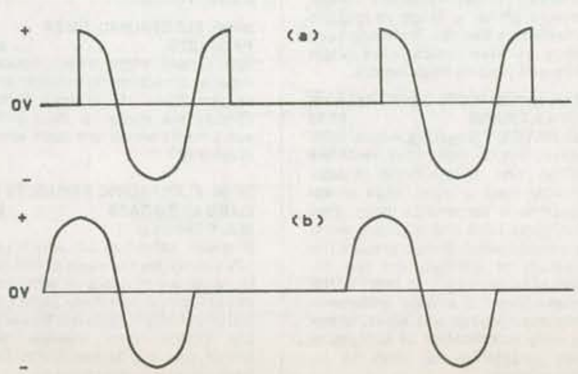


Fig. 2. (right). The waveform of (a) is the result of a simple chopping process; (b) is the result of incorporating zero switching in the process.

There are limitations to this way of doing things, and the main one is that it only works properly with a signal that has a suitable envelope shape, and which remains essentially the same throughout its duration. With most instruments there is no problem in either case, but the obvious exception is a voice signal which is unsuitable in both cases.

Another problem, and one which is most troublesome when using a low modulation frequency, is that of the start of a note occurring during an "off" period. This can seriously effect the timing of the music, and by eliminating the important attack period of the signal it can drastically alter its sound.

The Pseudo Echo Unit described here has a simple synchronization facility which can be switched in when using low modulation frequencies, so that the unit is forced to commence an "on" phase at the start of each new note. This seems to totally eliminate the "of" period problem.

Zero Switching

A third problem with this very harsh form of amplitude modulation is that it tends to produce "click" sounds as the signal is gated on and off. This happens because the unit will usually switch the signal on or off when it is not at zero volts. This gives a sudden change from whatever level the signals happens to have at instant of switching, to the zero volts level. Under worse case conditions a waveform of the type shown in **Fig. 2a** is obtained, where the signal switches from its peak level to zero volts of each transition of the signal gate.

There are ways of reducing or eliminating the problem, and in this circuit zero point switching is used. This is very effective indeed and it permits quite high switching frequencies to be used without any significant switching glitches being generated at all.

The method used is very simple in essence, and it avoids the switching glitches by synchronizing the modulation signal with the input signal in such a way that the signal gate only switches state as the input signal passes through 0V. This gives an output signal of the type shown in **Fig 2b**, with only sets of complete half cycles present.

System Operation

The block diagram of **Fig. 3** shows the general arrangement used in Pseudo Echo Unit. A buffer stage is used at the input of the unit, and the main signal path is through the sample and hold circuit to the output socket.

The sample and hold circuit is a form of signal gate, and it allows the input signal to pass straight through to the output when it is supplied with a "high" control signal. Switching the control input "low" blocks the signal

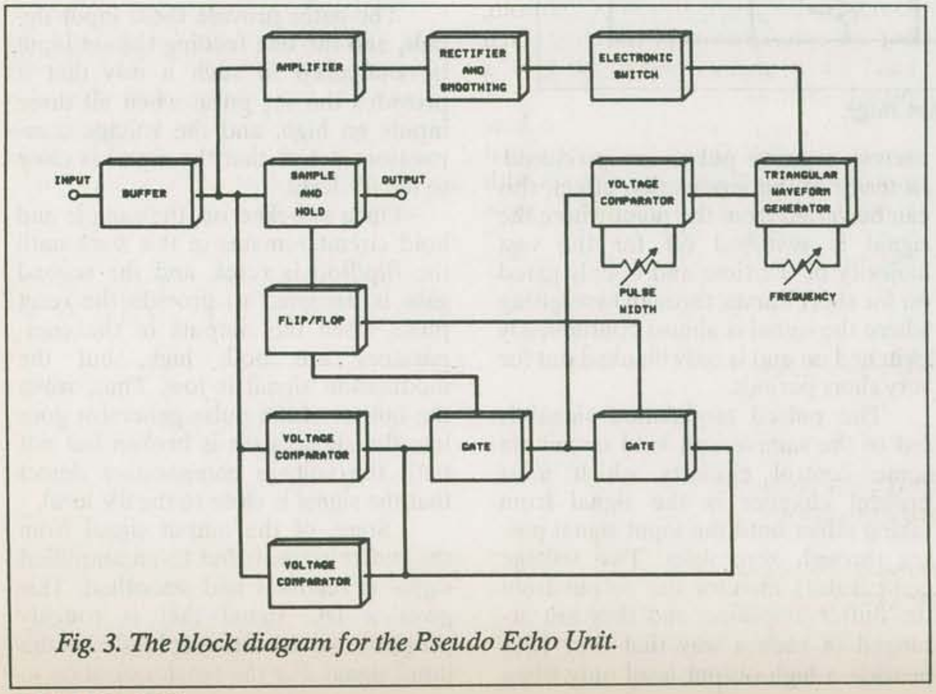


Fig. 3. The block diagram for the Pseudo Echo Unit.

PARTS LIST

Resistors

R1 R2, R15.................. 100k
R3, R10, R16,
R17, R18, R22
R23.................................. 10k
R4, R5, R11, R12 .... 4k7
R6, R9............................ 1M
R7, R8, R21 .... 2k2
R13................................ 220k
R14................................. 47k
R19, R20......................... 15k
All 1/4 W 5% carbon

Potentiometer

VR1............................47k lin
VR2............................1M lin
VR3 100k sub-min hor. preset

Capacitors

C1, C5 100u radial elect. 10V
C2, C6 .... 470n polyester
C3 .... 10n polyester
C4 ....10u radial elect. 25V
C7, C9 ....2u2 radial elect.
C8 ....1u radial elect. 63V

Semiconductors

D1 to D8.....................IN4148
silicon signal diode
TR1 .... 2N5818 npn silicon
IC1 LF351 .... bifet op amp
IC2 .... 4016BE
CMOS analogue switch
IC3 CA3140E MOS op amp
IC4 .... 4001BE CMOS
quad 2-input NOR gate
IC5,7 ....1458 dual op amp
IC6,8 .... 741C op amp

Miscellaneous

SK1................ Standard jack
with DPDT switch contacts
SK2 ..... Standard jack socket
S1 locking pushbutton switch
S2 .... Part of SK1
S3 .... Miniature SPST
toggle switch

Case, sloping front type about 165 x 70 x 125mm; printed circuit board; two controls knobs; B1, 9V; six 1.5V size cells in plastic holder; battery connector (9V type); 8-pin DIP socket (6); 14-pin DIP sockets (2); pins, wire, solder, etc.

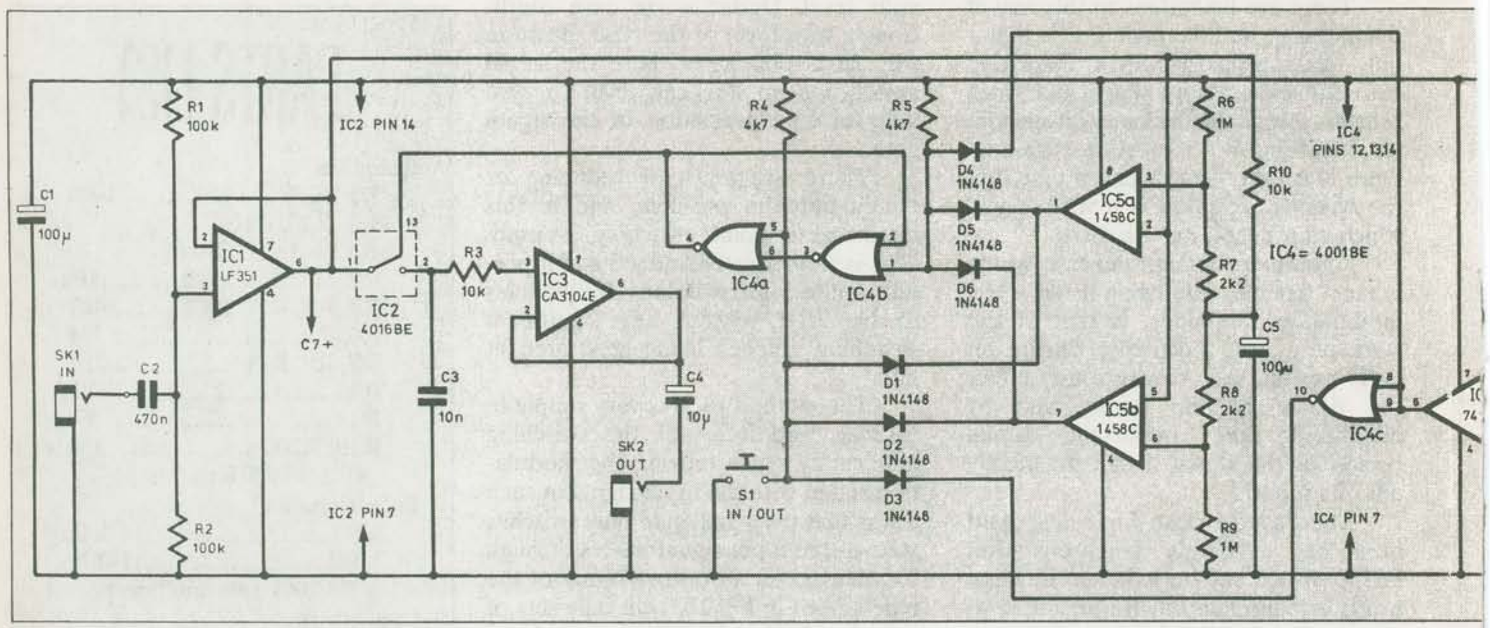


Fig. 4. The main circuit diagram for the Pseudo Echo Unit.

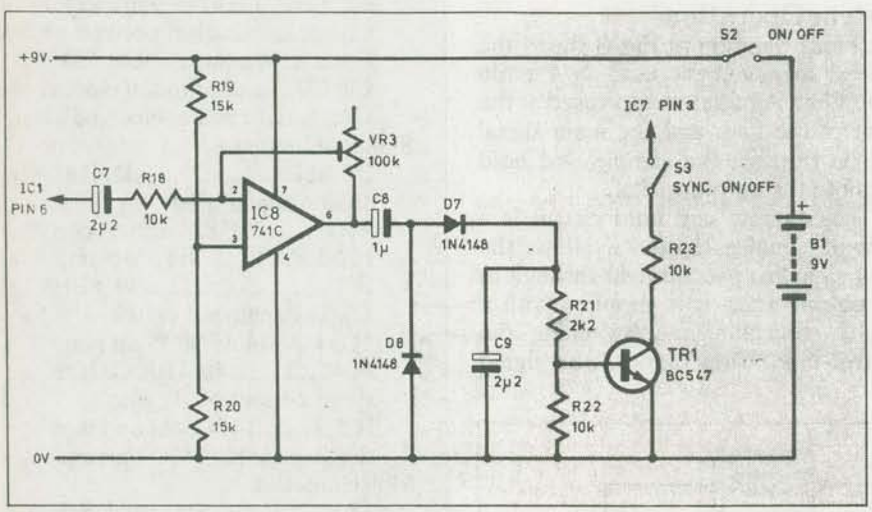


Fig. 5. Circuit diagram for the synchronization stage.

path, and the output is maintained at whatever level it happened to have at the instant when the signal was cut off. It is important that the output is not simply allowed to drift as this could result in unwanted "clicks" and other noises on the output signal.

The modulation signal is generated by a triangular waveform generator which feeds into a voltage comparator. The other input of the comparator is fed from a variable reference voltage, and this combination constitutes a conventional variable pulse generator.

The output signal can be continuously varied from narrow positive "needle" pulses through a 1 to 1 squarewave and on to the point where narrow negative pulses are produced. In terms of the modulation effect, this can be varied from the point where the signal is switched off for the vast majority of the time and is only gated on for short bursts, through to a setting where the signal is almost continuously switched on and is only blanked out for very short periods.

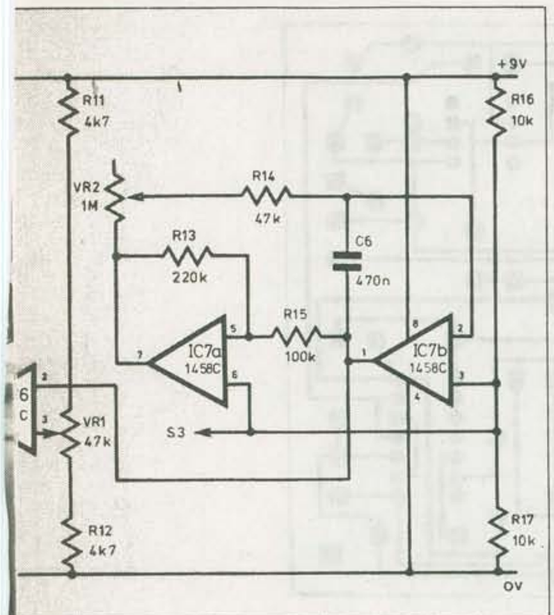
The pulsed modulation signal is fed to the sample and hold circuit via some control circuitry which must prevent changes in the signal from taking effect until the input signal passes through zero volts. Two voltage comparators monitor the output from the buffer amplifier, and they are arranged in such a way that they both provide a high output level only when the signal is very close to the 0V level. The voltage comparator outputs, together with the modulation signal, are fed to the inputs of two logic gate circuits.

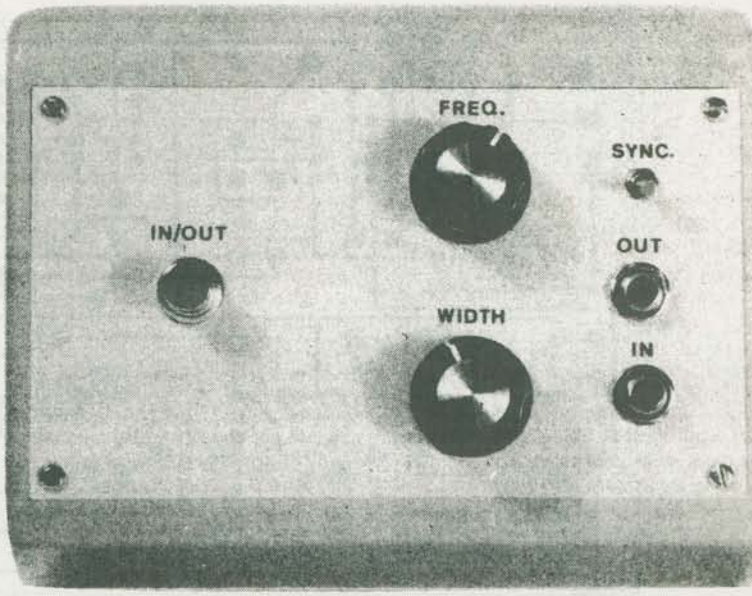
A simple S/R (set/reset) flip/flop provides the control signal for the sample and hold circuit. The flip/flop must be supplied with a high input signal to its "set" input in order to switch on the sample and hold circuit, and a high input level is then needed at the "reset" input in order to take the sample and hold circuit back to the "hold" mode.

The gates provide these input signals, and the one feeding the set input is configured in such a way that it provides the set pulse when all three inputs go high, and the voltage comparators detect that the signal is close to the 0V level.

Once switched on, the sample and hold circuit remains in this state until the flip/flop is reset, and the second gate is designed to provide the reset pulse when the outputs of the comparators are both high, but the modulation signal is low. Thus, when the output of the pulse generator goes low the signal path is broken but not until the voltage comparators detect that the signal is close to the 0V level.

Some of the output signal from the buffer stage is fed to an amplified signal is rectified and smoothed. This gives a DC signal that is roughly proportional to the amplitude of the input signal. For the synchronization to





The finished echo unit, showing the footswitch mounted on the far left of the front panel.

work properly the input signal must be a type which has a fast attack time with a reasonably rapid initial decay characteristic. Guitars and signals with form, and the electronic switch is turned on briefly each time a note is played. The switch is connected to the biasing circuit of the triangular waveform generator, and it is has the effect of forcing the start of a new cycle each time the switch is closed, thus giving the required synchronization effect.

Circuit Operation

The main circuit diagram for the Pseudo Echo Unit appears in Fig. 4, but the synchronization circuit is shown separately in **Fig. 5**.

The buffer amplifier (IC3) at the output ensures that there is no significant discharging of capacitor C3 during the "hold" periods. The CA3140E specified for the IC3 posi-

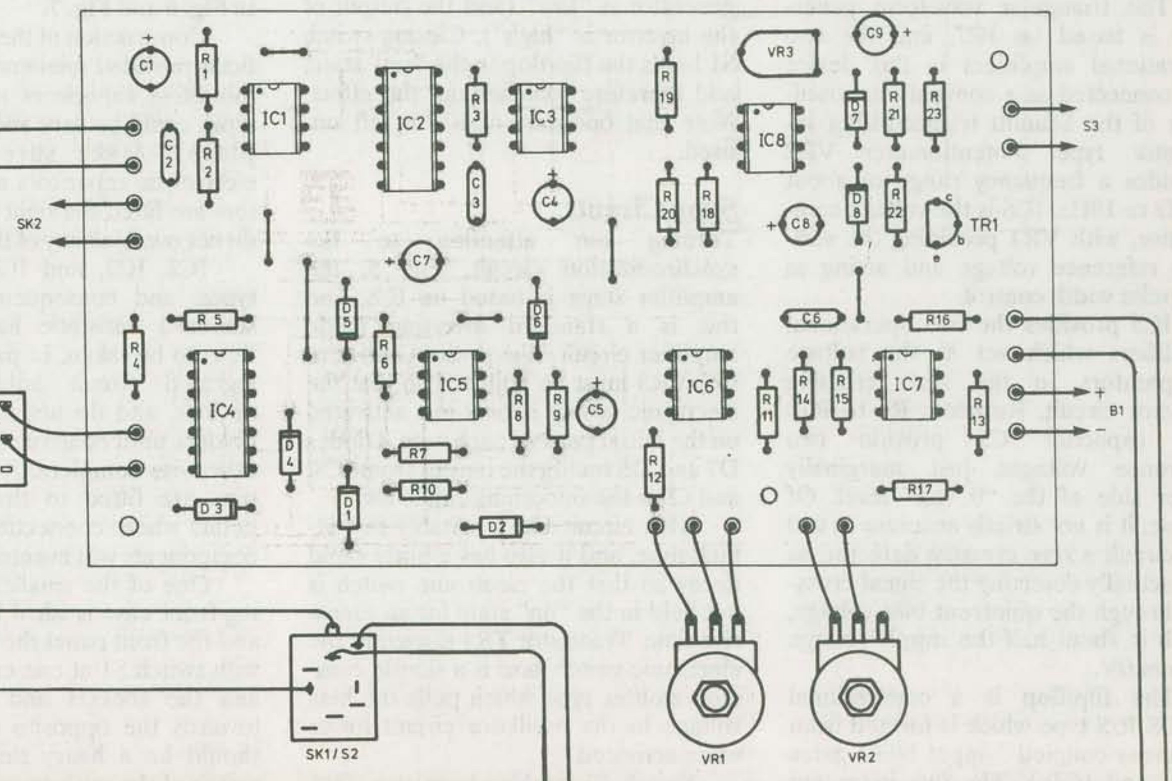


Fig. 6. The printed circuit board component layout and interwiring details for the case-mounted components.

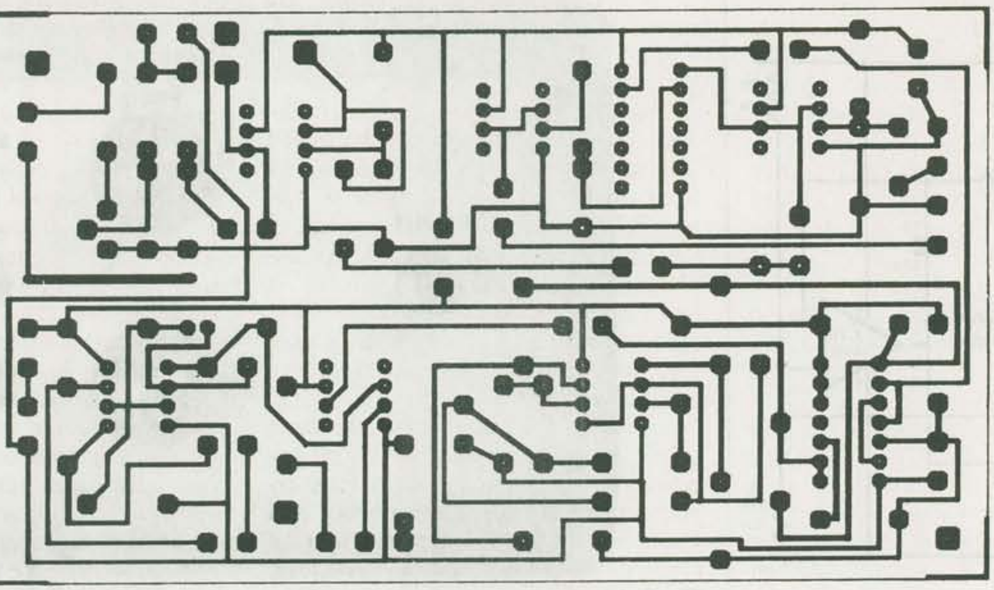


Fig. 7. Full size printed circuit board foil pattern.

tion is a MOS input type which gives an input impedance of over one million megohms. Note that there are actually four switches in IC2, but in this circuit only one is used and there are no connections to the other three.

The triangular waveform generator is based on IC7, and the two operational amplifiers in this device are connected as a conventional oscillator of the Schmitt trigger/Miller integrator type. Potentiometer VR2 provides a frequency range of about 0.5Hz to 10Hz. IC6 is the voltage comparator, with VR1 providing the variable reference voltage and acting as the pulse width control.

IC5 provides the two operational amplifiers which act as the voltage comparators in the zero crossing detector circuit. Resistors R6 to R10 and capacitor C5 provide two reference voltages just marginally either side of the "0 volt" level. Of course, it is not strictly accurate to call this circuit a zero crossing detector, as it is actually detecting the signal crossing through the quiescent bias voltage, which is about half the supply voltage and not 0V.

The flip/flop is a conventional CMOS R/S type which is formed from two cross coupled 2-input NOR gates (IC4a and IC4b). The two gates are simple 3-input AND types, each formed from a pullup resistor and three diodes. However, the one which drives the reset input of the flip/flop is driven from the pulse generator by way of IC4c which is connected to operate as an inverter. This gives the desired action with the reset pulse being produced when the output of the pulse generator is "low" (and the output of the inverter is "high"). Closing switch S1 holds the flip/flop in the "set" state, and therefore switches out the effect. Note that one gate of IC4 is left unused.

Sync Circuit

Turning our attention to the synchronization circuit, Fig. 5, the amplifier stage is based on IC8, and this is a standard inverting mode amplifier circuit. The preset Gain control VR3 must be adjusted so that the electronic switch is only just activated on the initial peak of each note. Diodes D7 and D8 rectify the output from IC8, and C9 is the smoothing capacitor.

This circuit has a suitably fast attack time, and it also has a fairly rapid decay so that the electronic switch is not held in the "on" state for an excessive time. Transistor TR1 is used as the electronic switch, and is a simple common emitter type which pulls the bias voltage in the oscillator circuit lower when activated.

Switch S3 enables transistor TR1 to be switched out of circuit so that the synchronization can be disabled (which can be beneficial when using high modulation frequencies).

Construction

The component layout and full size printed circuit board foil master pattern for the Pseudo Echo Unit is shown in **Fig. 6** and **Fig. 7.**

Construction of the board is not difficult provided miniature printed circuit mounting capacitors are used (larger types could be very awkward to fit into place). Make sure that all the electrolytic capacitors and semiconductors are fitted the right way around and do not overlook any of the six link wires.

IC2, IC3, and IC4 are all MOS types, and consequently require the standard antistatic handling precautions to be taken. In particular, use integrated circuit holders for these devices, and do not fit them into the holders until construction of the unit is otherwise complete. At this stage only pins are fitted to the board at the points where connections to off-board components will eventually be made.

One of the smaller types of sloping-front case is ideal for this project, and the front panel should be arranged with switch S1 at one end of the panel, and the sockets and other controls towards the opposite end. Switch S1 should be a heavy duty push button switch of the push-to-make – push-to-break type, so that it can be operated by foot. It is for this reason that it should be mounted well clear of the other front panel mounted components (so that they do not impede operation of this "foot switch").

The completed printed circuit board is mounted on the base panel of the case using the normal mounting pillars or screws plus spacers. It is then wired up to the front panel mounted components, see Fig. 6, and there is no need for any of this wiring to be screened, but it should be kept reasonably short and direct. In Fig. 6 it has been assumed that on/off switch S2 will be a set of make contacts on the input socket SK1. A socket with a single set of make contacts is unlikely to be obtainable, and it is therefore necessary to use two contacts of a socket having DPDT types.

With this method of switching the unit is automatically switched on when a plug is inserted into SK1, and switched off again when the plug is removed. This is common practice with musical effects units, but obviously an ordinary socket and a separate on/off switch can be fitted if preferred.

In Use

If the synchronization feature is ignored initially, the unit can be tested without setting up VR3. The output from socket SK2 is coupled to the amplifier, mixer, or whatever via a standard screened jack lead. As explained previously, the unit is automatically switched on when a signal source is connected to input-socket SK1, and switched off again when the plug is removed.

The effect is not one of the most subtle ones and it should be very apparent on any input signal. A little experimentation with the Frequency and Pulse Width controls will soon reveal the range of sounds that can be produced. The unit will work satisfactorily with a wide range of input levels, but it is not suitable for use with very low level sources such as microphones and some guitar pickups unless a suitable preamplifier is added ahead of the unit. Inputs of up to about 6 volts peak to peak can be accommodated before clipping and serious distortion occurs.

It is really only worthwhile using the synchronization facility when the Frequency control is set for quite low modulation frequencies. At high modulation frequencies it is likely to have no noticeable effect, and could be counterproductive by elongating the initial modulation cycle (although you may prefer things this way).

In order to give the preset gain control VR3 the correct setting, start with this component fully backed off (set fully counterclockwise) and then advance it very gradually while playing notes into the unit. Adjust it just far enough to produce the synchronization effect. Remember, the synchronization will only work on signals that have an envelope with an initial transient to switch on transistor TR1.■