

CHORUS/ FLANGER UNIT

Tim Orr returns to the pages of ETI with a project to make your amplifier see double — a chorus/flanger.

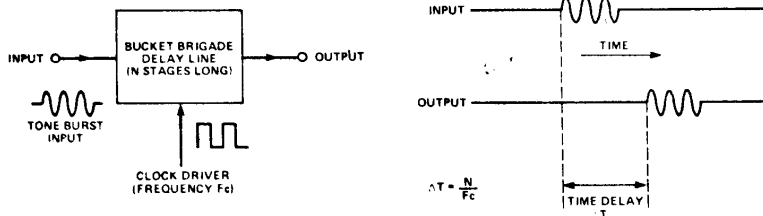
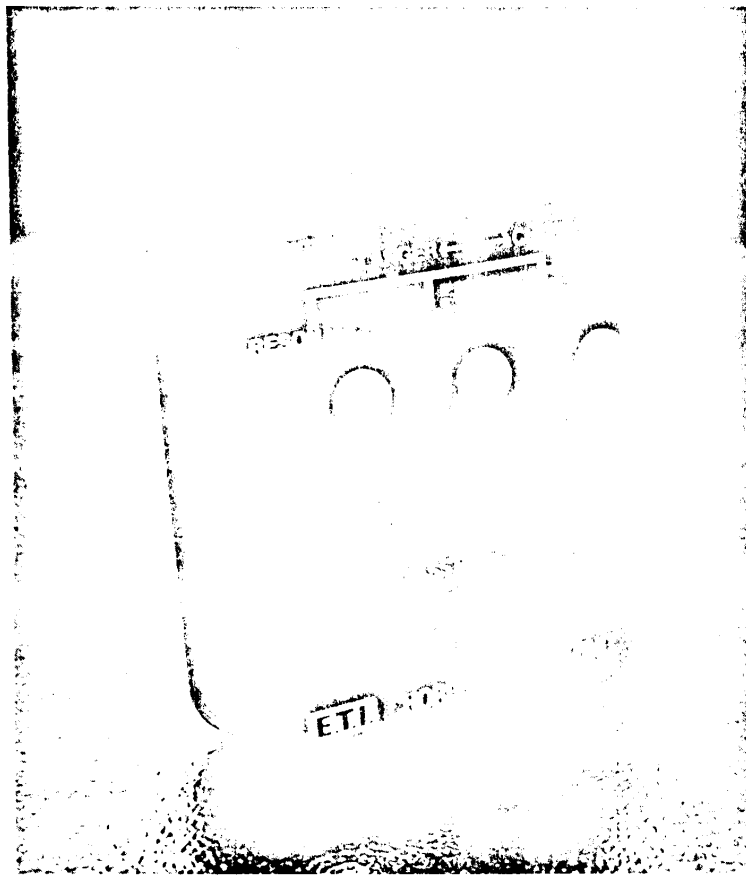


Fig. 1 The basic principle of producing a time delay.

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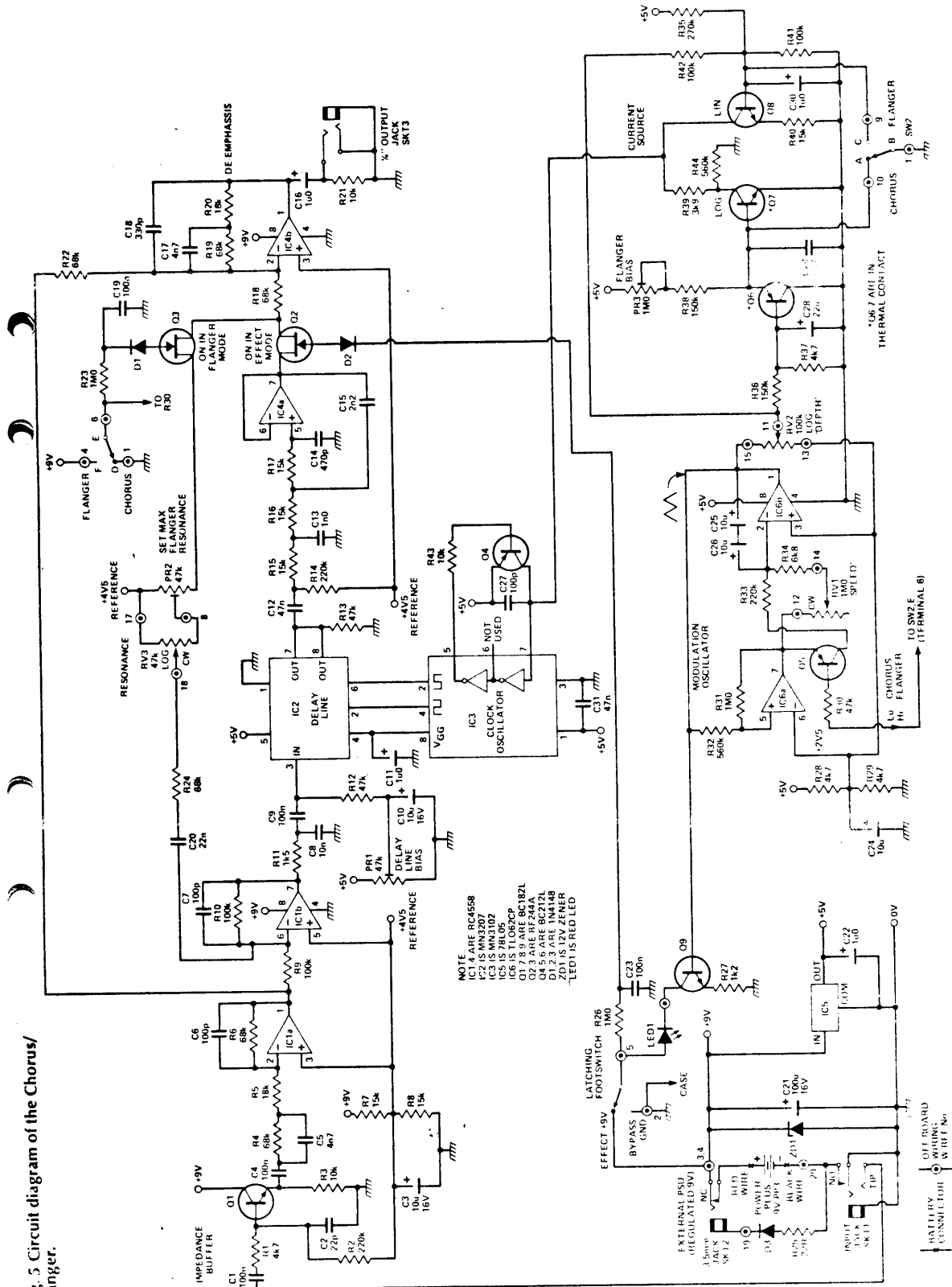
The Chorus/Flanger unit is a device for processing musical and other signals to produce a wide range of effects. The electronics have been optimised for an electric guitar input but the unit can run equally well from line level signals (−6dBm) and high output microphones.

The chorus effect simulates a second instrument, which is producing the same sound as the input signal, but which is slightly delayed in time. This tends to generate the illusion of a second instrument and also enriches the overall sound quality. If a relatively fast (10Hz) time modulation is used, then genuine vibrato is generated. Flanging is a very dramatic colouration of the input sound. An instrument played through a flanger sounds like it is being heard in a drain pipe, the size of which is changed!

Flanging is similar to all time delay effects, and so their implementation is relatively simple if we use a bucket brigade delay line, Fig. 1. Voltages presented to the input of the delay line are sampled and then converted into small quantities of charge. These charges are passed along several hundred electronic 'buckets' until they reach the output, whereupon they are reconverted back into the original voltage. This process takes time, in fact the time delay is equal to the number of buckets divided by the speed at which the charge is passed along the line. The signal recovered at the other end very closely resembles the input signal except for a small amount of noise and distortion (it's an imperfect world).

As this is a sampled information system we must sample the input signal much more frequently than the highest frequency compon-

Fig. 5 Circuit diagram of the Chorus/Flanger.



PROJECT : Chorus/Flanger

HOW IT WORKS

Q1 forms a conventional high-impedance buffer; experience has shown that electronic guitars sound better when presented with a fairly high input impedance.

IC1a performs signal pre-emphasis, lifting all frequencies above about 500 Hz; IC1b performs the low-pass anti-aliasing filtering, as well as mixing the feed-back proportion of the delayed output (which comes in via RV3, R24 and C20).

PR1 sets the DC bias level of signal going to the input of the bucket-brigade device; this is needed to obtain minimum signal distortion. The output from IC2 is recovered by the low-pass filter around IC4a, and passed to the FET signal switch, Q2 (FETs are used rather than mechanical switches to save loudness). Q2 allows the signal to pass except when the unit is in the bypass mode.

Q3 is another FET signal switch, and when the unit is in the flanging mode, this feeds a proportion of the delayed signal back to the input via PR2. The resonance control RV3, R24 and C20. At the same time, the feed-forward signal and the delayed signal are combined by IC4b, which also performs the de-emphasis. From here the signal is passed to the output.

IC6 forms a simple triangle/square-wave oscillator. RV1 controls the oscillation speed. Q5 is used to limit the low

frequency range of the oscillator when in the chorus mode.

Q9 is used to drive the panel LED. When the effect is selected (via the footswitch) the LED will light up and flash at the modulation rate.

IC3 and Q4 form the clock oscillator for the delay line. C27 is charged up by either Q7 or Q8, both of which act as current sources. When pin 7 of IC3 drops below about +2.5V, pin 5 of the same IC goes low, which turns on Q4, which discharges C27 back up to +5V. Thus the circuit oscillates at a rate determined by the size of the current sink from either Q7 or Q8. In the chorus mode Q8 generates a linearly varying current over a maximum two-to-one range. C30 limits this sweep at faster rates. In the flanger mode, Q6 and Q7 generate an exponentially varying current over a seven-to-one range. Again the modulation depth is limited at fast rates by a capacitor, C28.

IC5 provides a stable +5V power supply for the modulation oscillator, clock oscillator and the delay line. Battery voltages drop with time! The battery starts life at about +9.5V and has an end of usefulness at about 6.5V. For maximum battery life, plug in the effect unit only when it is needed and never leave it on over night. The ON/OFF switch is the input jack which has a switched earth pin. For infinite battery life use a mains power supply (a PP3 eliminator)!

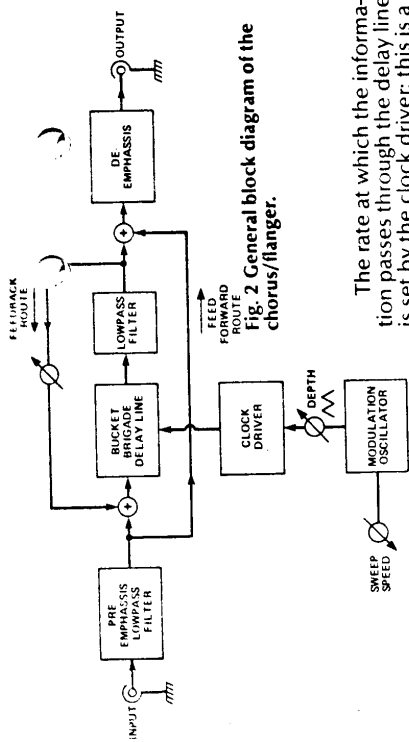


Fig. 2 General block diagram of the chorus/flanger.

The rate at which the information passes through the delay line is set by the clock driver; this is a high frequency oscillator which can be frequency modulated. The delay line (MINI3207) has a delay length of 512 buckets, so a clock frequency of 512 kHz will produce a delay time of 1 millisecond. The modulation oscillator is used to produce slowly-varying time delays of variable speed and depth.

The chorus-flanger unit has been configured to look like a comb filter, Fig. 3. This is a filter

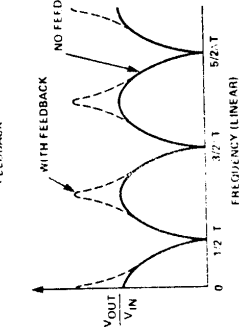
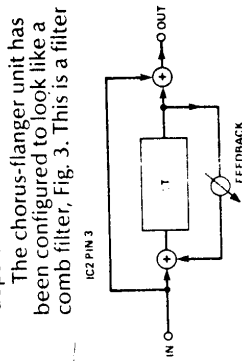


Fig. 3 A basic line delay comb filter.

nents of the input signal. By doing this, we can avoid the dreaded aliasing distortion (which sounds like ring modulation) and hope to recover the input signal with some degree of integrity.

The general block diagram of the chorus-flanger unit is shown in Fig. 2. The low-pass filter at the front end of the unit limits the input bandwidth and so helps to avoid any aliasing problems. The low-pass on the output recovers the delayed signal and rejects unwanted high frequency clock and noise signals.

The audio signal is given a treble lift (pre-emphasis) at the front end of the unit and a treble cut (de-emphasis) at the output. This helps to produce a better signal to noise ratio throughout the unit; most natural sounds have an energy spectrum that drops off very rapidly with increasing frequency, so by giving a frequency lift to these parts of the spectrum, more information can be elevated above the noise floor of the delay line. At the output end of the system, the de-emphasis restores the overall frequency response back to a flat one, but also suppresses high frequency noise from the delay

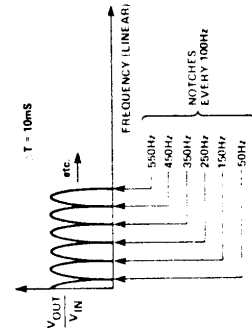
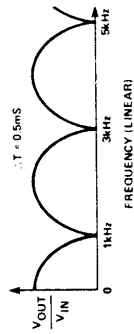


Fig. 4 Comb filter frequency responses for different time delays.

with a frequency response that is full of notches, and which looks like the teeth of a comb! When the delayed signal is 180° out of phase with the direct signal, then cancellation will occur and a notch in the frequency response is generated. These notches are linearly spaced with a separation of $1/T$ (the time delay). Feedback around the delay line (used in flanging) makes the comb response much more peaky when the phase shift around the delay line is zero. Short time delays produce few notches and long time delays produce several. Fig. 4. Note that the frequency separation of the notches is linearly proportional to the clock frequency.

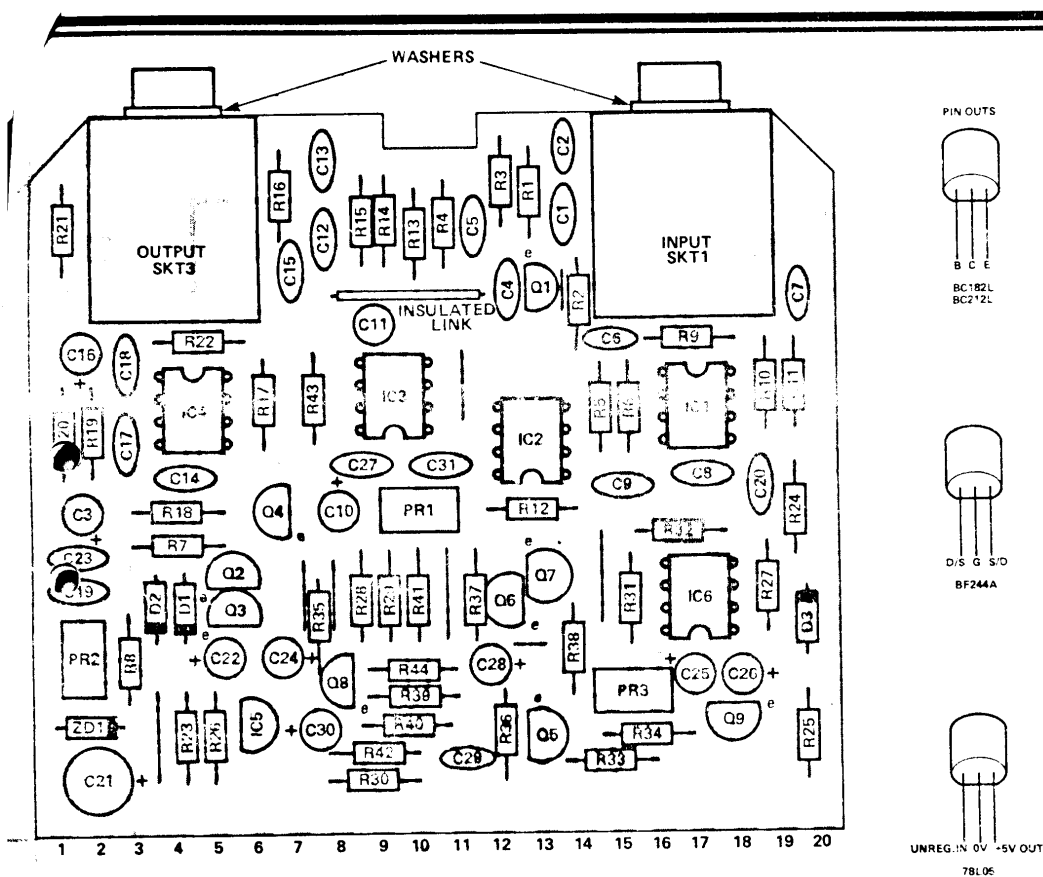


Fig. 6 Overlay diagram of the PCB for the Chorus/Flanger

PARTS LIST

RESISTORS (all 1/4W 5%)		POTENTIOMETERS		SEMICONDUCTORS	
R1	4k7	RV1	1M0 reverse logarithmic	IC1,4	RC4558
R2	220k	RV2	100k logarithmic	IC2	MN3207 <i>DELAY LINE</i>
R3	10k	RV3	47k reverse logarithmic	IC3	MN3102 <i>CLOCK OSCILLATOR</i>
R4,6	68k	PR1,3	47k preset	IC5	78L05
R5	18k	PR2	1M0 preset	IC6	TL062CP
R7,8	15k	CAPACITORS		Q1,7,8,9	BC182L
R9,10	100k	C1,4,9	100n polyester	Q2,3	BF244A
R11	1k5	C2	22p ceramic	Q4,5,6	BC212L
R12,13	47k	C3,10	10µ 16V PCB electrolytic	D1,2,3	1N4148
R14	220k	C5	4n7 polyester	ZD1	BZY88-12V zener
R15,16,17	15k	C6,7	100p ceramic	LED1	0.2" red LED
R18,19,22,24	68k	C8	10n ceramic	MISCELLANEOUS	
R20	18k	C11,16	1µ0 63V PCB electrolytic	SKT1,3	1/4" mono switched jack sockets
R21	10k	C12	47n polyester	SKT2	3.5 mm mono jack socket
R23,26,31	1M0	C13	1n0 polyester	SW1	latching footswitch SPCO plus cap
R25	22R	C14	470p ceramic	SW2	DPDT switch
R27	1k2	C15	2n2 polyester	PCB; knobs; PP3 battery connector; case; self-adhesive foam strip (for securing the PCB); 8-pin IC sockets (5 off); holder for LED; wire, solder, Gibson Les Paul Special etc.	
R28,29,37	4k7	C17	4n7 polyester		
R30	47k	C18	330p ceramic		
R32	560k	C19	100n polyester		
R33	220k	C20	22n polyester		
R34	6k8	C21	100µ 16V PCB electrolytic		
R35	270k	C22,30	1µ0 63V PCB electrolytic		
R36,38	150k	C23	100n polyester		
R39	3k9	C24,25,26	10µ 16V PCB electrolytic		
R40	15k	C27	100p ceramic		
R41,42	100k	C28	22µ 16V PCB electrolytic		
R43	10k				
R44	560k				

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Assembly And Setting Up

Assemble the PCB and connect to the controls as shown in Figs. 6 and 7. When testing is complete, the PCB is mounted in the box, supported by the jack sockets, with the foil side to the case bottom. Put some thin sticky-backed foam rubber on the inside of the case bottom to prevent shorts.

Table 1 shows various DC test voltages around the circuit and Fig. 8 shows some of the waveforms you should find using an oscilloscope. As regards the setting of the pots, you can just plug in, switch on and hope for the best and set the presets by trial and error, but if you do have access to

IC1, PIN 8	+9V (FOR BATT. OPERATION)
IC1, PINS 3,5	+4.5V APPROX
IC1, PINS 1,7	+4.5V APPROX*
Q1 EMITTER	+3.8V APPROX*
IC2, PIN 5	+5V
IC3, PIN 1	+5V
IC3, PIN 8	+4.67V
IC4, PINS 1,7	+4.5V APPROX*
IC5, PIN 8	+5V
IC6, PIN 3,6	+2.5V

* VOLTAGE WITH NO INPUT SIGNAL

Table 1 DC test voltages.

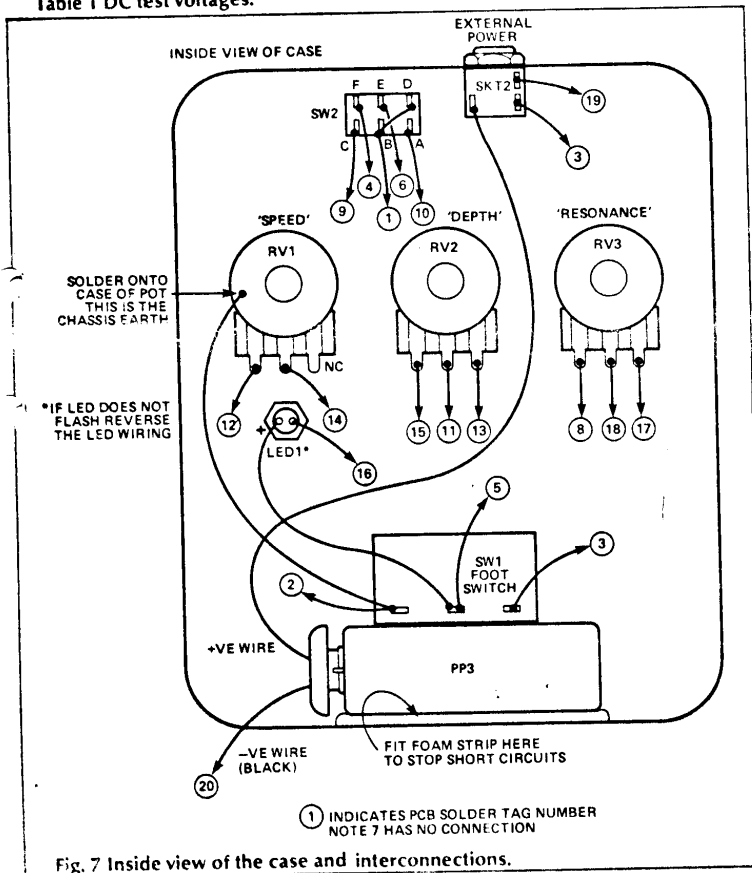


Fig. 7 Inside view of the case and interconnections.

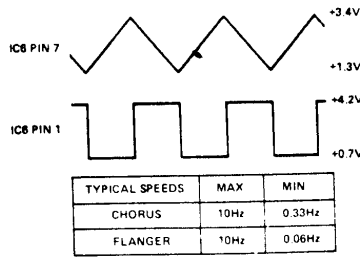


Fig. 8a Waveforms for the modulation oscillator; note that the voltage levels for IC6 are only approximate, as are the oscillator frequencies.

some test gear, here is the proper way to set up the unit.

Inject a 2.0 V peak-to-peak 500 Hz sinewave into the input socket, and select chorus on SW2 with the footswitch, SW1, set to effect. Set the rate control to maximum and the depth control to minimum. Using an oscilloscope, check that the undistorted signal is present at

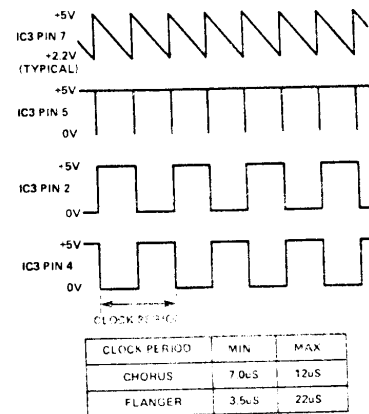


Fig. 8b Waveforms for the clock oscillator; select minimum depth (RV2) for these waveforms. The table shows the limits of the clock period for depth set to maximum and rate set to minimum; the preset PR3 should be adjusted to bring the oscillator into the range given for the flanger mode (with the flanging effect selected).

Q1 emitter, IC1 pins 1 and 7 and IC2 pin 3.

Set PR1 to its mid-way position and look at the signal present on IC2 pin 8; adjust PR1 until the signal is clipping symmetrically (see Fig. 9). Note that this signal will have a lot of high-frequency clock signal breakthrough; this is normal.

Examine the output at IC4 pin 7; this should be the same signal without the HF breakthrough. Reduce the input signal level to remove the clipping on this signal. Turn the depth control to maximum and the rate control to minimum and the signal at IC4 pin 7 will be frequency modulated by the modulation oscillator; a mixture of this signal plus the direct signal should appear at IC4 pin 1.

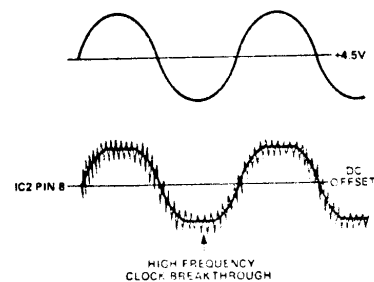


Fig. 9 Waveforms at the input and output of IC2.

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The flanging effect is best tested with a 200 mV P-P square wave oscillating at 2 Hz. This excites the unit with two clicks per second. Set resonance to maximum, speed to minimum and SW2 to the flanger position (foot-switch SW1 should still be set to effect and not bypass). Listen to the output from the unit via a suitable amplifier, and adjust PR2 so that the output is a rich 'drainpipe' sound (you'll hear what we mean). If PR2 is set for too much feedback the unit will oscillate; if this occurs back off the control a little.

For both chorus and flanging effects, the time modulation depth reduces as the modulation speed increases. The modulation depth at 10 Hz should produce a pleasant vibrato effect, caused by small time delay sweep.

Power Supply

The unit consumes about 1mA. Using an Ever Ready PP3PP (power plus) for two hours per day, the expected battery life will be about 20 hours. If you leave the unit turned on over night, you will exhaust the battery. It is possible to use a rechargeable Nickel Cadmium PP3 battery. This has a shorter discharge life time of about 7 hours, but can be reused (charged/discharged) about 600 times! The purchase price of Nickel Cadmium batteries is about six times that of a standard PP3, and also you will need a charger unit. A non rechargeable alkaline PP3 battery (eg Duracell type) gives about four times the energy content of a zinc carbon PP3 but costs about twice as much.

A 9V battery eliminator can be used, the operating power is then derived from the mains. Note that the inner connection is +9V and the outer is 0V; if the polarity is reversed, D3 should prevent any damage to the chorus flanger, but the unit will not work.

BUYLINES

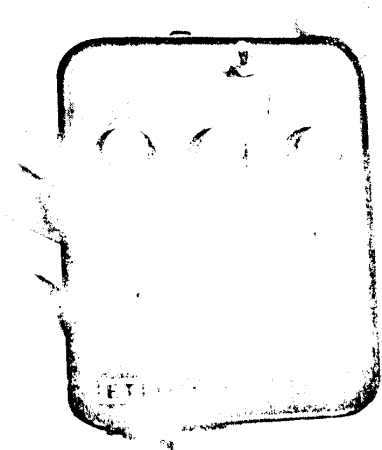
A full kit of parts for this project is available from Sola Sound Ltd, for £49.95 all inclusive. Alternatively, some of the more unusual parts are available as follows: PCB £1.15 inclusive; case (fully screened) £3.75 inclusive; MN3207/MN3102 (IC2 and 3) £13.80 the pair. All these prices include VAT and postage. Sola Sound Ltd may be found at 18 Barton Way, Croxley Green, Rickmansworth, Herts. (Note that the PCB will not be available through the ETI PCB service.)

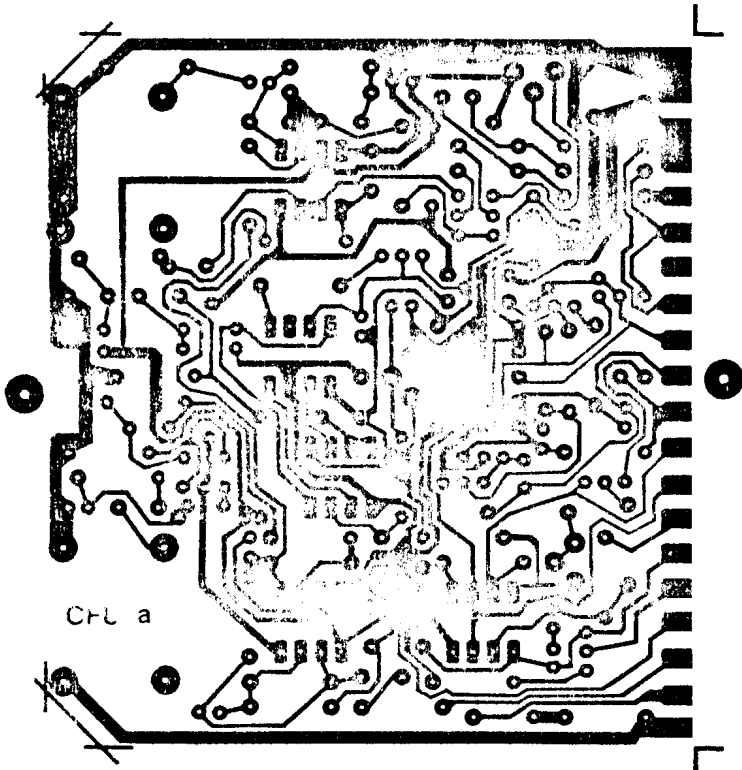
User Guide
Plug in the guitar and the amplifier. Press the footswitch so that the LED is off. Turn up the guitar volume, set up the amplifier level and tune the guitar. This is the BYPASS mode.

Vibrato
Set up the controls as shown, with SPEED and DEPTH at maximum. RESONANCE is inoperative. Press the footswitch so that the LED is flashing. Play the guitar. A fast (10Hz) vibrato will be heard. If necessary alter the guitar and amplifier levels. Adjust both controls for less depth and different vibrato rates.

Chorus
Set up the controls as shown, with the DEPTH set to maximum and a SPEED setting of about 1 flash per second. RESONANCE is inoperative. Play the guitar. A "creamy" sound will be heard. Press the BYPASS footswitch and see how flat the original signal sounds. Go back to the effect and try some different SPEED and DEPTH settings.

Flanging
Set up the controls as shown with DEPTH and RESONANCE to maximum and SPEED to minimum. Tap the guitar strings. A slowly sweeping "drain pipe" resonance will be heard. Try playing a melody with a rhythm that has the same period as the sweep time. Try other control settings.





The Chorus/Flanger Board