the chorosynth

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the Chorosynth is . . .

an inexpensive keyboard instrument that anyone can play, a mini synthesiser for use as a second keyboard by the working musician, or anything in between.

The Chorosynth is a real instrument with an amazing variety of sound possibilities at its disposal. The winning design of our competition, it is, as the name suggests, a synthesiser with chorus effect. Although the prototype was designed with a keyboard, we have made it possible to 'play now and buy your keyboard later'.

The dynamic range of the instrument needs to be between 150 and 3000 Hz at least, before it can be played. This corresponds to the length of organ pipes ranging from 16' to 2' (feet). Furthermore, the bass notes must be rich in harmonic tones which can be filtered as required. Now a tune played on only a few notes, however rich in harmony, sounds as though something is missing. However, when the same melody is played with fifths a much richer and therefore more musical sound is produced. If the tune is played using several sound sources in unison (tuned to virtually the same frequency), it sounds quite different and this in fact produces the chorus effect. A low frequency modulation (vibrato) is also particularly useful when simulating the sound of stringed instruments.

What does the Chorosynth sound like? As always the description of any specific sound is extremely difficult, however we are sure that the reader will be more than satisfied with the overall sound quality of the Chorosynth. It is significant that the prototype has been used at live performances with great success.

1

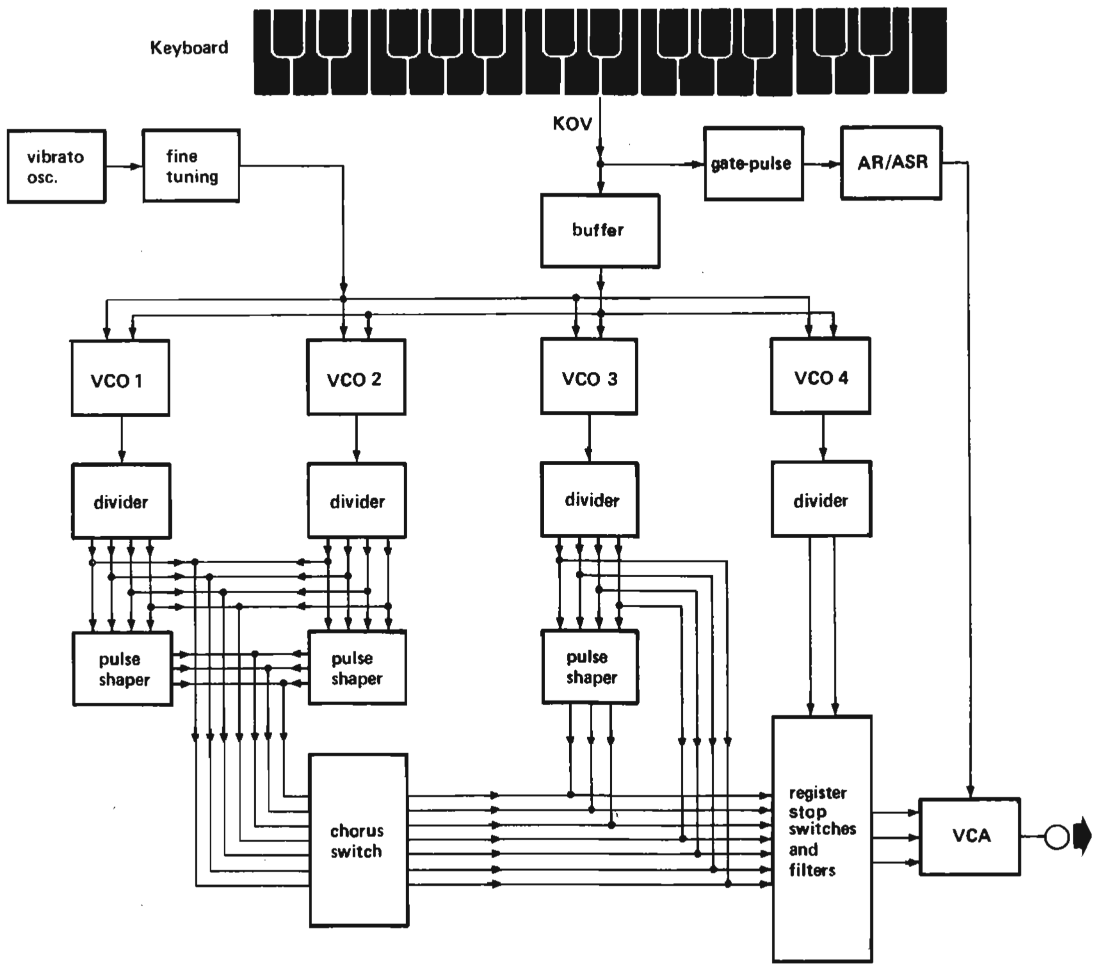


Figure 1. The block diagram of the Chorosynth.

2

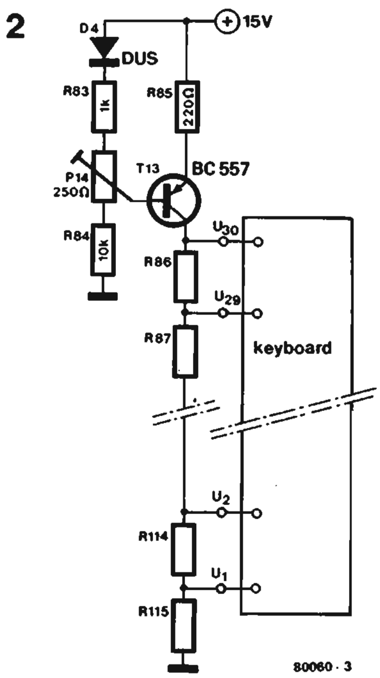


Figure 2. The current source and voltage divider chain for the keyboard of the Chorosynth.

The Chorosynth uses a 2½ octave keyboard and has a dynamic range of 6 octaves. Because of this broad frequency range, instruments ranging from violin to cello and flute to clarinet can be imitated. It is also possible to adapt the dynamics of the output signal with an envelope generator that can be switched to AR (attack-release) or ASR (attack-sustain-release) envelopes.

Block diagram

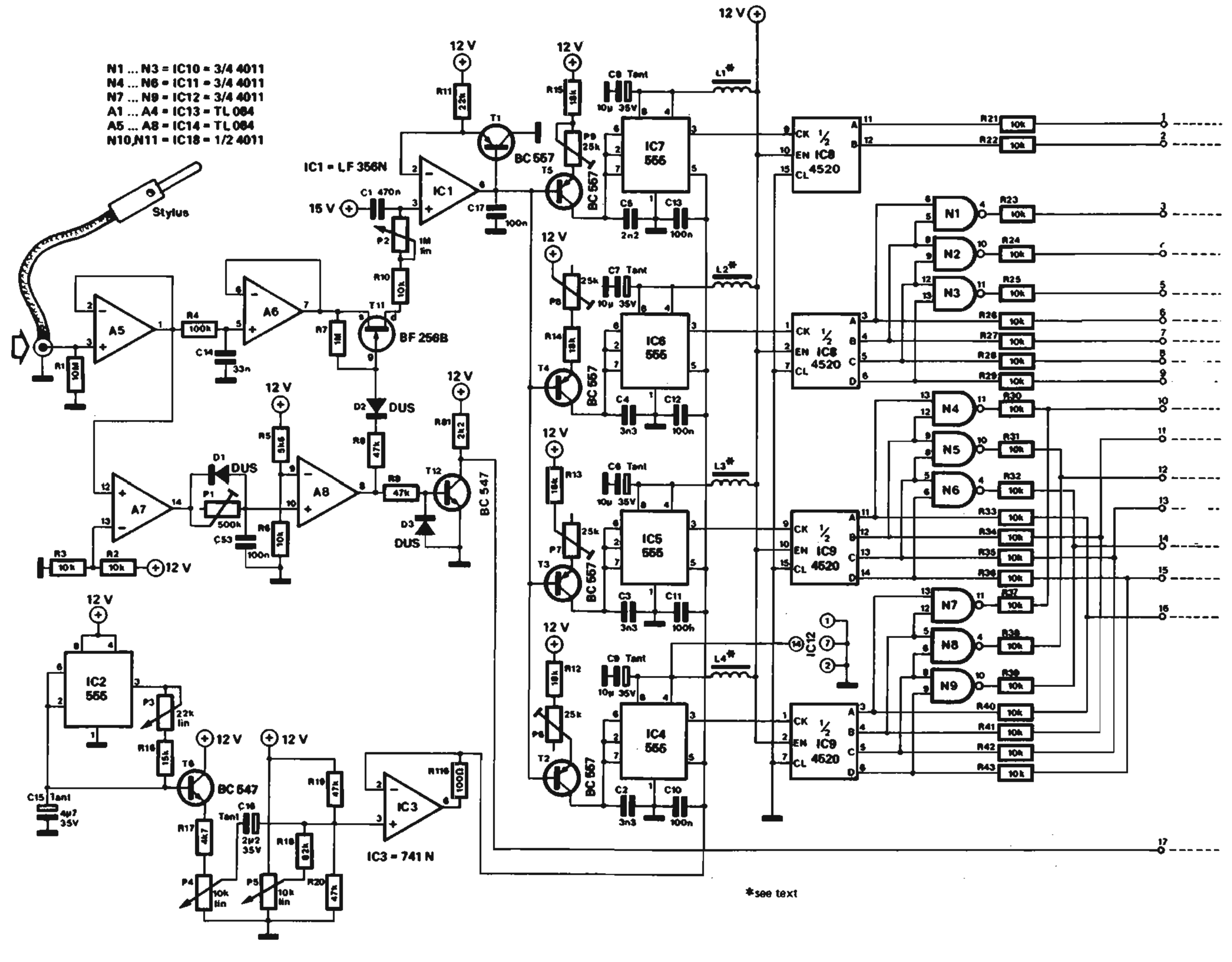
The block diagram of the Chorosynth is shown in figure 1. The 2½ octave keyboard produces a KOV (keyboard output voltage) which controls four VCOs (voltage controlled oscillators). VCOs 1 . . . 3 have the same voltage to frequency characteristics and are tuned to the same pitch. The fourth oscillator (VCO 4) is tuned to a frequency 1½ times higher, in other words it produces a note which is a fifth higher than that of the other VCOs. A fifth oscillator (marked vibrato in the block diagram) produces a relatively low frequency signal which is fed to the modulation inputs of the VCOs. The VCO output signals will then be slightly frequency modulated to produce a vibrato effect. The frequency as well as the modulation depth can be varied.

The output of the VCOs are divided by 2, 4, 8 and 16. The dividers' outputs are exactly one octave apart and can be selected with the aid of 'stops' (or switches if you are not into organs!).

The output signals of the dividers and pulse shapers of VCOs 1 and 2 are added together and mixed with those of VCO 3 via the chorus switch. In this way the chorus effect can be switched on or off as required. The pulse shapers are simply a set of NAND gates which produce a square-wave with a duty-cycle of 25% from the divider outputs. It is this type of waveform that is particularly suitable for simulating the sound of stringed instruments. Of course, some filtering of the signal is required before it is acceptable to the human ear. The Chorosynth has two filters, one for strings and one for woodwinds.

A gate-pulse is derived from the KOV which is used to trigger the envelope generator. This can provide one of two envelope patterns – attack-release or attack-sustain-release. This envelope controls the VCA (voltage controlled

3a



Figures 3a and 3b. The main circuit diagram of the Chorosynth, drawn in two sections for clarity.

amplifier) before being fed to an external amplifier.

Circuit diagram

The current source and voltage divider chain for the keyboard (shown in figure 2) provide each key with a specific voltage level. This keyboard output voltage (KOV) is then passed to the non inverting input of op-amp A5 in the main circuit diagram (figures 3a and 3b).

This can be done by means of the 'printed circuit keyboard' (figure 4) and a stylus; alternatively, a conventional keyboard can be used.

The FET T11 functions as a switch to 'sample-and-hold' the keyboard voltage (in C1). The rate of change of the voltage level at the non-inverting input of IC1 is controlled by P2 and C1 allowing a glissando effect between not(

The four VCOs in the block diagram are the circuits around IC4 to IC7. They are 555 timers which have been wired as astable multivibrators. ICs 4, 5 and 6 (VCOs 1, 2 and 3 in figure 1) are tuned to [illegible] same frequency and therefore have similar component values. IC7

3c

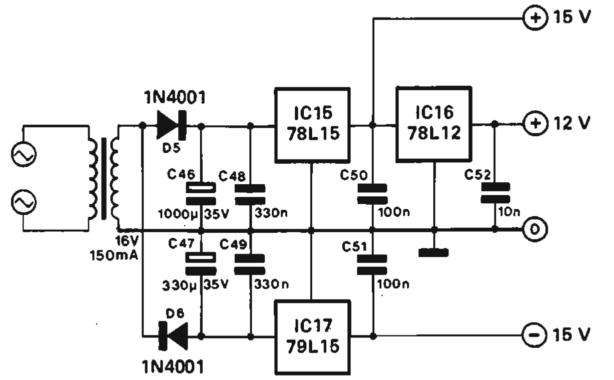
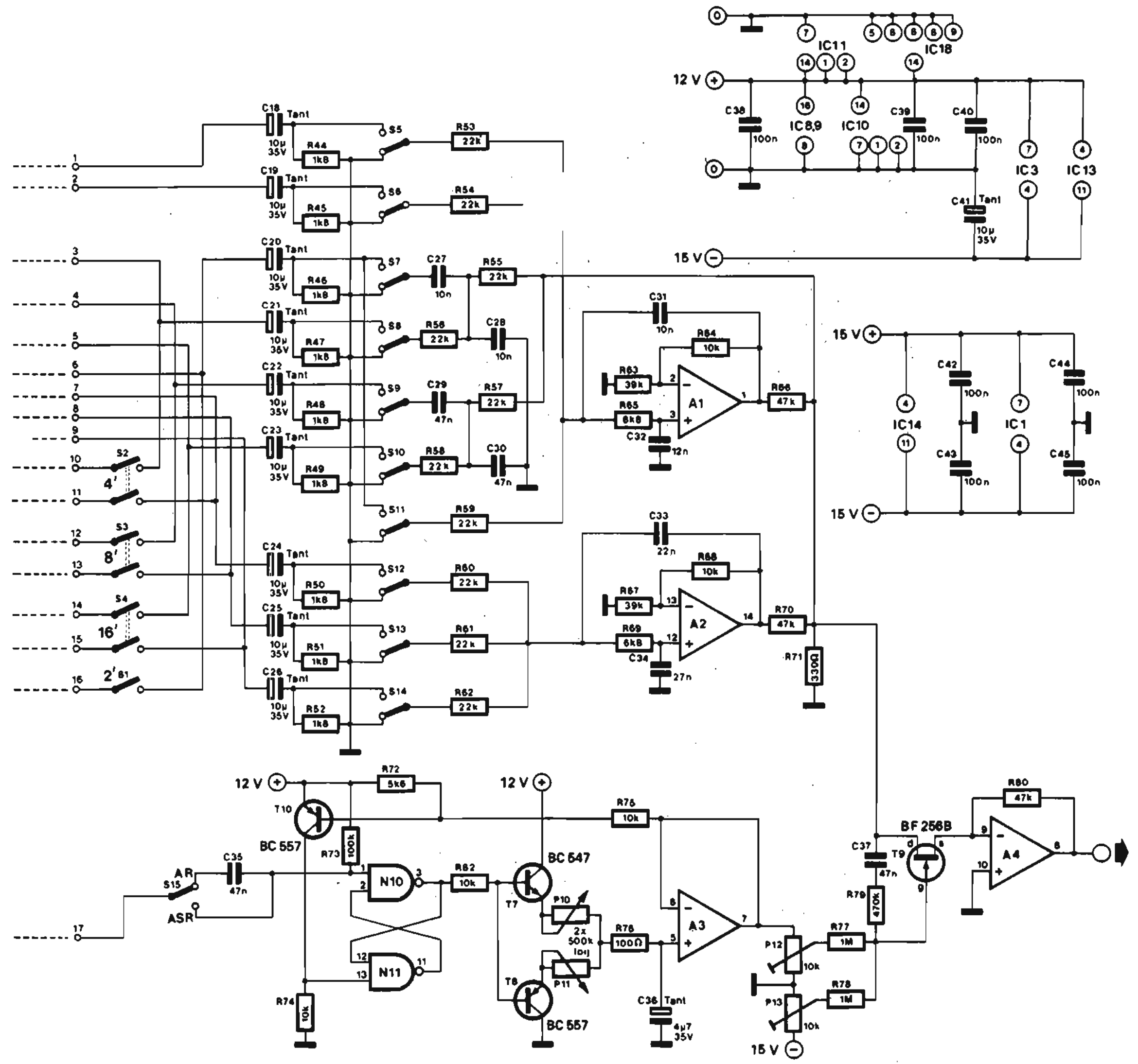


Figure 3c. The regulated power supply for the Chorosynth is included on the printed circuit board.

3b



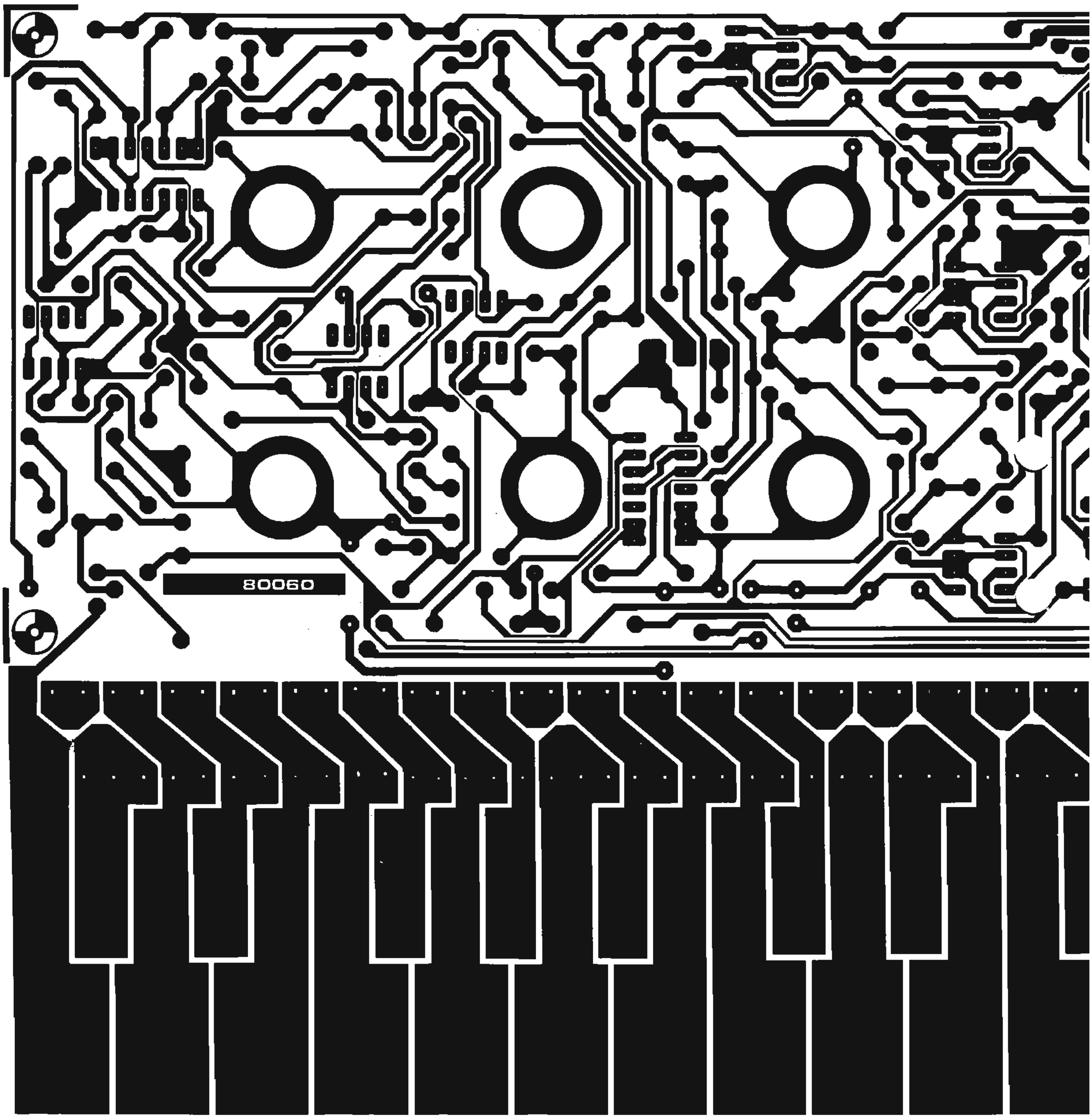
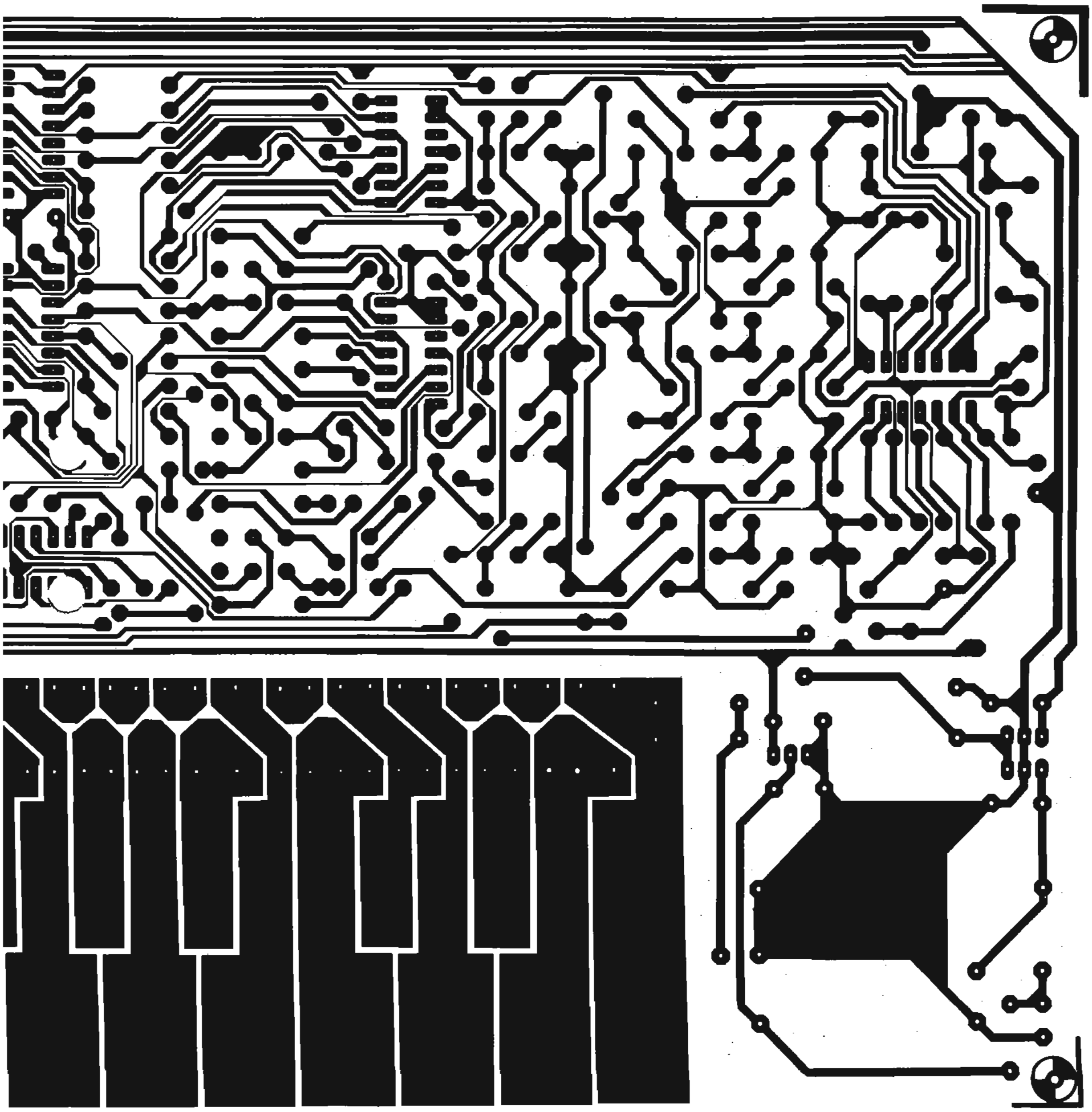


Figure 4. The printed circuit board for the Chorosynth. The component layout is given in figure 5.

(VCO 4) is tuned to a frequency 1½ times greater (that is a fifth higher) which accounts for C5 having a lower value. Each VCO has a modulation input (pin 5) controlled by the vibrato oscillator circuit – ICs 2 and 3. The frequency of the vibrato is varied by P3 and the modulation depth is controlled by P4. The potentiometer P5 introduces an offset to all the VCOs which in practice allows the pitch of the Chorosynth to be fine tuned.
The output of VCOs 1, 2 and 3 are each divided by a 4520 producing frequencies which are 2, 4, 8 and 16 times lower than the VCO frequencies. As far as VCO 4 is concerned, only two outputs of the 4520 have been used. Thus it is only divided by 2 or 4; in other words, only a 1′ or 2′ organpipe can be obtained. The outputs of the two dividers in IC9 are coupled and then mixed with the outputs of the divider for VCO 3 (IC6) via the 'chorus' switches S1 to S4. This provides a seperate chorus effect for each register.
Switches S5 to S14 serve as stops. Depending on which of the stops is closed, the signal reaches either a woodwind or a strings filter. The filter circuits are comparatively simple. Passive highpass filters whose top-end response is slightly rolled off by capacitors C28 and C30 provide the voicing for strings. The woodwind filters are active lowpass elements with a turnover frequency of 2 kHz (for 16′, 8′ and 4′) and 4.5 kHz (for the top three registers, 2′, 2 2/3′, and 1 1/3′). The lower registers thus have a greater proportion of higher harmonics, which improves the musical tone.

Gate pulse

The gate pulse is derived from the KOV via A5, A7 and A8 and its purpose is to trigger the envelope (AR/ASR) circuit. The type of envelope contour is selected by switch S15. With this switch in the AR position, the positive going edge of



the gate signal triggers the flip-flop formed by NAND gates N10/N11, turning on T7 and charging capacitor C36 via the attack control, P10. As soon as the voltage on C36 reaches approximately 13.5 V, T10 turns off and the flip-flop is reset. The capacitor then starts to discharge via the release control, P11, and transistor T8.

With the ASR envelope selected, the flip-flop remains set as long as the gate signal is present, that is as long as a note is held (sustained) on the keyboard. Only when the key is released can T10 reset the flip-flop and C36 discharge (release).

The output of the envelope shaper circuit controls a simple VCA (voltage controlled amplifier), which in turn determines the dynamic amplitude characteristics of the output signal. The VCA consists of an op-amp (A4), with a FET (voltage controlled resistor) connected in the feedback loop.

Construction and setting up

The printed circuit board for the Chorosynth (figure 4) includes all the components and a keyboard layout. The keyboard has been included for those readers who wish to keep the cost down to a minimum. It is a simple matter to connect a conventional keyboard, one set of make contacts per key is all that is required.

It should be noted that since the oscillators have a linear voltage-frequency characteristic, the keyboard tuning resistors must form a logarithmic potential divider. The appropriate values (for example R86a and R86b) are all made up using resistors from the E24 series. With 1% tolerance resistors, a tuning accuracy of 1% of a semitone is obtained, however (with the exception of R115a and R115b where 1% must be used) 5% resistors will also prove suitable, since the chorus effect by and large obscures any slight mistuning. Inductors L1 to L4 are ferrite beads

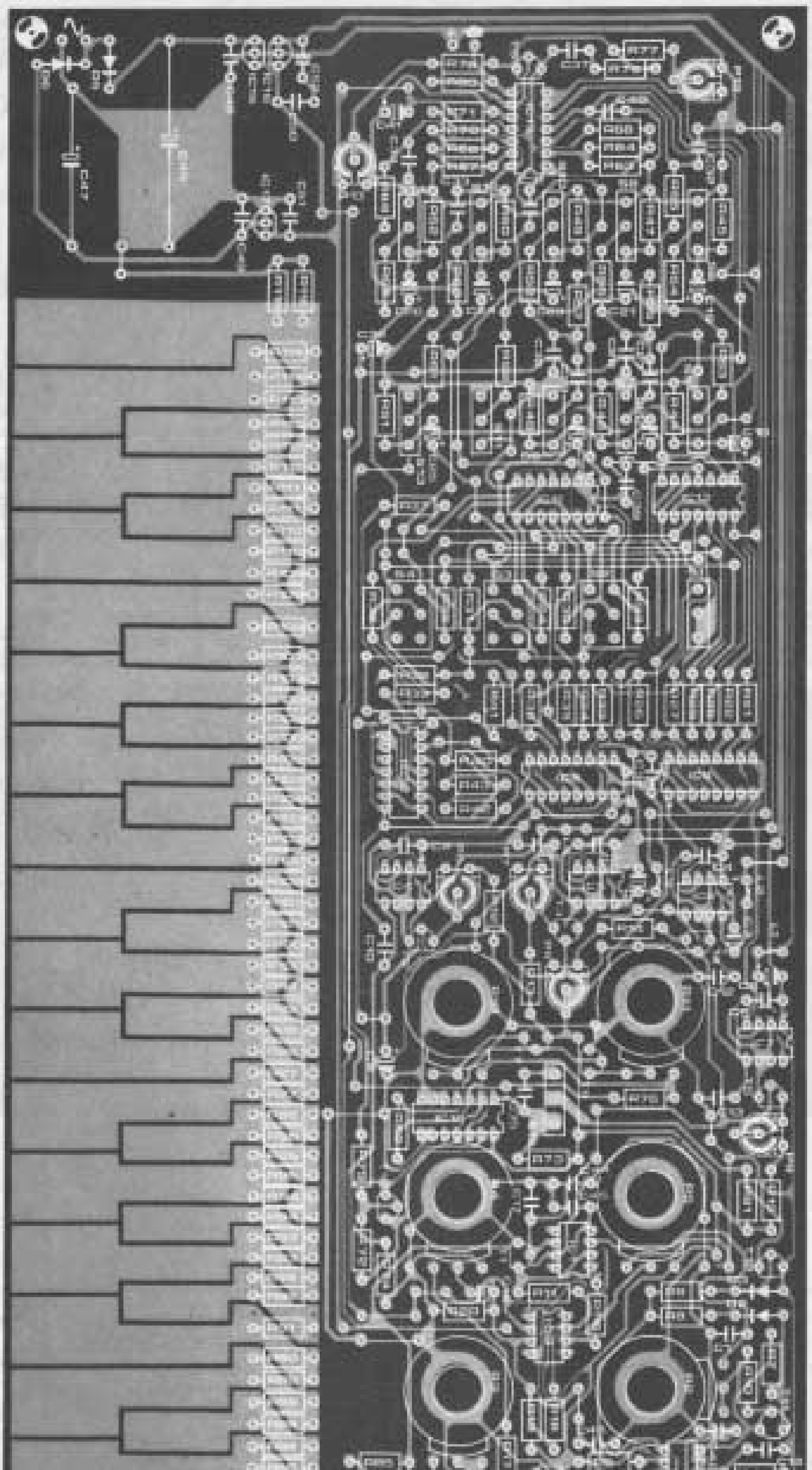


Figure 5. Component layout. In order to fit it on this page, this layout is reduced in size.

with five turns of 0.2 mm enamelled copper wire. All other components are readily obtainable.

Since the Chorosynth has a large number of potentiometers, controlling it may at first be a little difficult. It is advisable to set all the controls to the following positions at the beginning of the setting up procedure:

P1	minimum resistance, fully clockwise.
P2	minimum resistance, fully anti-clockwise.
P3	not important
P4	wiper to earth, fully anti-clockwise.
P5	mid-position
P6	minimum resistance, fully anti-clockwise.
P7 . . . P10	mid-position
P11	minimum resistance, fully anti-clockwise.
P12 . . . P13	wiper to earth, fully clockwise.
S1 . . . S4	open
S5, S6	switched to ground
S7	switched to C20
S8 . . . S14	switched to ground
S15	ASR position

The VCA has two adjustment points, P12 and P13. P13 determines the minimum gain and is adjusted such that no output signal is audible. A note is then 'struck' and held, whilst P12 is adjusted until a slowly rising signal appears at the output of A4. P1 is then adjusted so that no change in frequency occurs when a key is struck.

In order to trim the keyboard, P14 is adjusted to give 8.43 V across R115. This should be measured with a universal meter of at least 10 kΩ/V. With the aid of P8, the third VCO (IC6) is adjusted, so that when the key to the far left of the keyboard is operated, a C2 note can be heard at the output. The pitch can be compared with that of another instrument, or the frequency can be measured (523.2 Hz).

S2 is then closed and, by using P7, the frequency of IC5 is trimmed to a value which should correspond as much as possible with that of IC6 – minimum beat note in the output signal. At the same time P6 must be trimmed so that there is very little vibrato at the output. It should now sound like a chorus.

Finally, P9 is adjusted so that the output frequency of IC7 (VCO 4) is 1½ times that of the other VCOs. The Chorosynth should now be ready to play. Under 'technical details' the stops and their values are indicated.

Although this may be the end of the Chorosynth article it certainly is not the end of the possibilities for this instrument. It will be apparent to many readers that the Chorosynth offers considerable scope for many modifications. If you find one that you would like to share, we would like to know about it. ■

Technical details:

Tonal Range:	C to c^5		65.41 Hz to 4184 Hz
Keyboard:	2½ octaves		
Registers:	Cello	(16')	S10
	Bassoon	(16')	S14
	Viola	(8')	S9
	Clarinet	(8')	S13
	Violin	(4')	S8
	Clarinet	(4')	S12
	Violina	(2')	S7
	Flute	(2')	S11
	Twelfth	(2 2/3')	S6
	Larigot	(1 1/3')	S5
Effects:	Chorus	(16')	S4
	Chorus	(8')	S3
	Chorus	(4')	S2
	Chorus	(2')	S1

Additional controls:

Glissando:	(Portamento)	P2
Vibrato:	Depth and rate	P8 and P9
Envelope shaper:	Attack-release or attack-sustain release selectable by S15; attack and release times independantly variable between 1 mS and 10 S (P10 and P11)	

Chorosynth

Elektor no. 59, March 1980 issue p. 17-23.
The parts list for our Chorosynth proto-type was inadvertently substituted for the revised, updated one. We apologise for the error, and include a complete and corrected parts list below.
One last note, the regulator IC17 should be rotated 180° on the parts layout in figure 5.

Resistors:

R1 = 10 M
R2,R3,R6,R10,
R21 . . . R43,R64,R68,
R74,R75,R82,R84 = 10 k
R4,R73 = 100 k
R5 = 1 k
R72 = 5k6
R7,R77,R78 = 1 M
R8,R9,R19,R20,
R66,R70,R80 = 47 k
R11,R53 . . . R62 = 22 k
R12 . . . R15 = 18 k
R16 = 15 k
R17 = 4k7
R18 = 82 k
R44 . . . R52 = 1k8
R63,R67 = 39k
R65,R69 = 6k8
R71,R97B = 330 Ω
R76 = 100 Ω
R79 = 470 k
R81 = 2k2
R83 = 1 k
R85 = 220 Ω
R86A,R112B = 5.6 Ω
R86B,R102B = 0.56 Ω
R87A = 6.8 Ω
R87B,R90B = 150 Ω
R88A,R89A,R92A = 10 Ω
R88B,R108,R112A = 22 Ω
R89B,R110A,
R111A,R113A = 27 Ω
R90A,R91,R94A,R109B = 8.2 Ω
R92B,R98B = 68 Ω
R93A,R96A,R97A,
R99A,R100A = 12 Ω
R93B = 39 Ω
R94B,R106B = 1.5 Ω
R95A,R98A,R101A,R102A,
R105A,R109A = 15 Ω
R95B,R114A = 33 Ω
R96B = 120 Ω
R99B = 1 Ω
R100B = 1.8 Ω
R101B = 560 Ω
R103A,R104A,
R106A,R107A = 18 Ω
R103B = 180 Ω
R104B,R114B = 470 Ω
R105B = 3.3 Ω
R107B = 2.7 Ω
R110B = 270 Ω
R111B = 680 Ω
R113B = 2.2 Ω
R115B = 120 k
R116 = 100 Ω
R115A = 1k24 1%

Potentiometers:

P1 = 1 M preset
P2 = 1 M lin
P3 = 22 k lin
P4,P5 = 10 k lin
P6,P7,P8,P9 = 25 k preset
P10,P11 = 500 k log
P12,P13 = 10 k preset
P14 = 250 Ω preset

Capacitors:

C1 = 470 n
C2,C3,C4 = 3n3
C5 = 2n2
C6,C7,C8,C9,C18 . . . C26,
C41 = 10 μF/35 V tantalum
C10 . . . C14,C17,C38,C39,
C40,C42 . . . C45
C50,C51 = 100 n
C53 = 47 n
C15,C36 = 4μ7/35 V tantalum
C16 = 2μ2/35 V tantalum
C27,C28,C31,C52 = 10 n
C29,C30,C35,C37 = 47 n
C32 = 12 n
C33 = 22 n
C34 = 27 n
C46 = 1000 μ/35 V
C47 = 330 μ/35 V
C48,C49 = 330 n

Semiconductors:

D1 . . . D4 = DUS
D5,D6 = 1N4001
T1 . . . T5,T8,T10,T13 = BC 557
T6,T7,T12 = BC 547
T9,T11 = BF 256B (or BF 245B)
IC1 = LF 356
IC2,IC4 . . . IC7 = 555
IC3 = 741
IC8,IC9 = 4520
IC10,IC11,IC12,IC18 = 4011
IC13,IC14 = TL 084
IC15 = 78L15
IC16 = 78L12
IC17 = 79L15

Miscellaneous:

Tr1 = 16 V/150 mA transformer
S1,S5 . . . S15 = SPDT
S2,S3,S4 = DPDT
L1 . . . L4 = 5 turns of 0.2 mm
dia. enamelled copper wire on
a ferrite bead