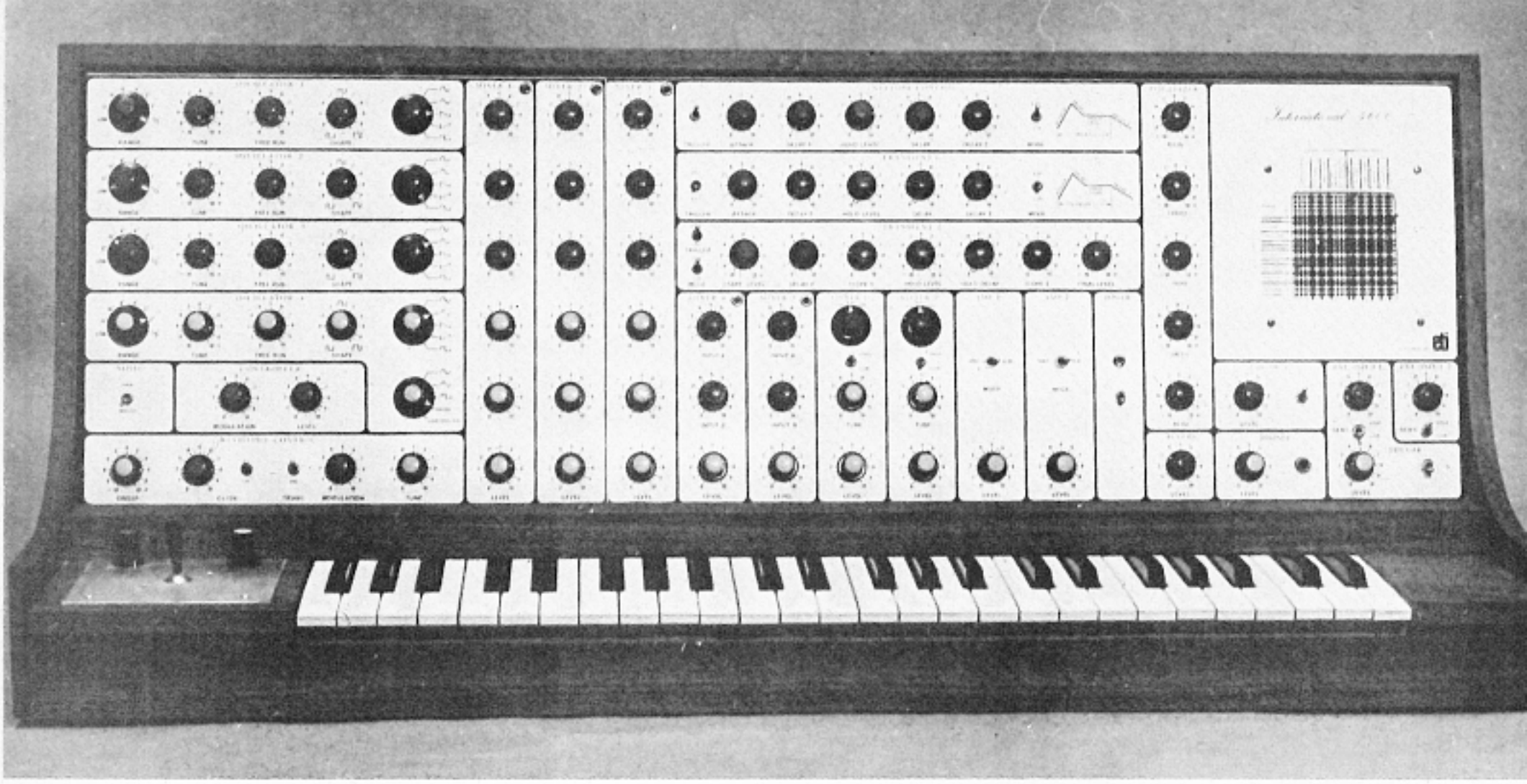


The completed International 4600 synthesizer.

INTERNATIONAL MUSIC SYNTHESIZERS

3600/4600

External input module, keyboard details – and a keyboard controller modification.

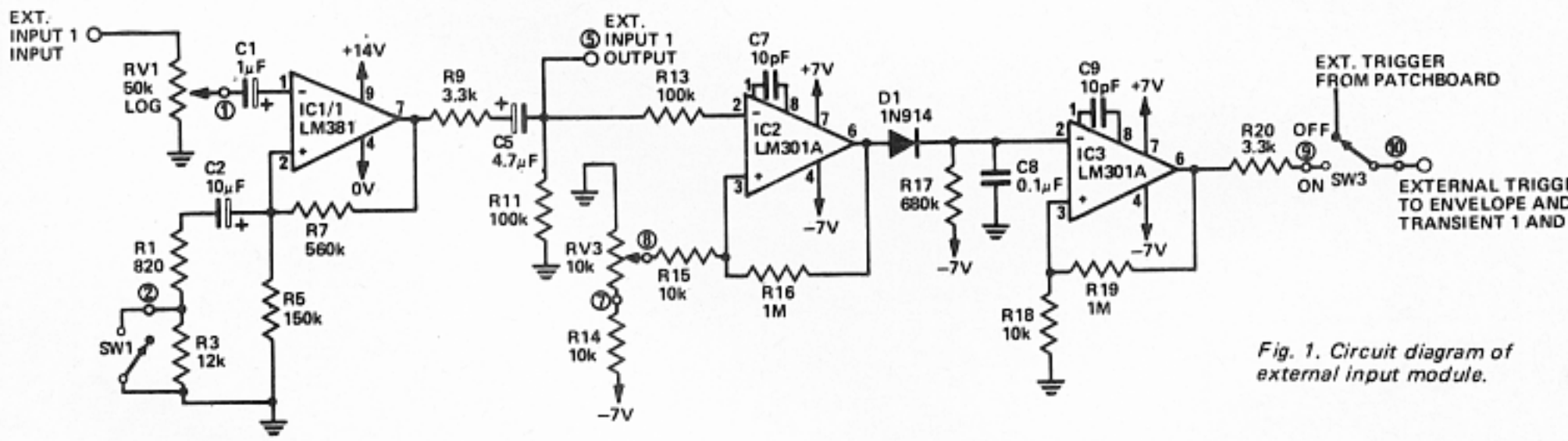
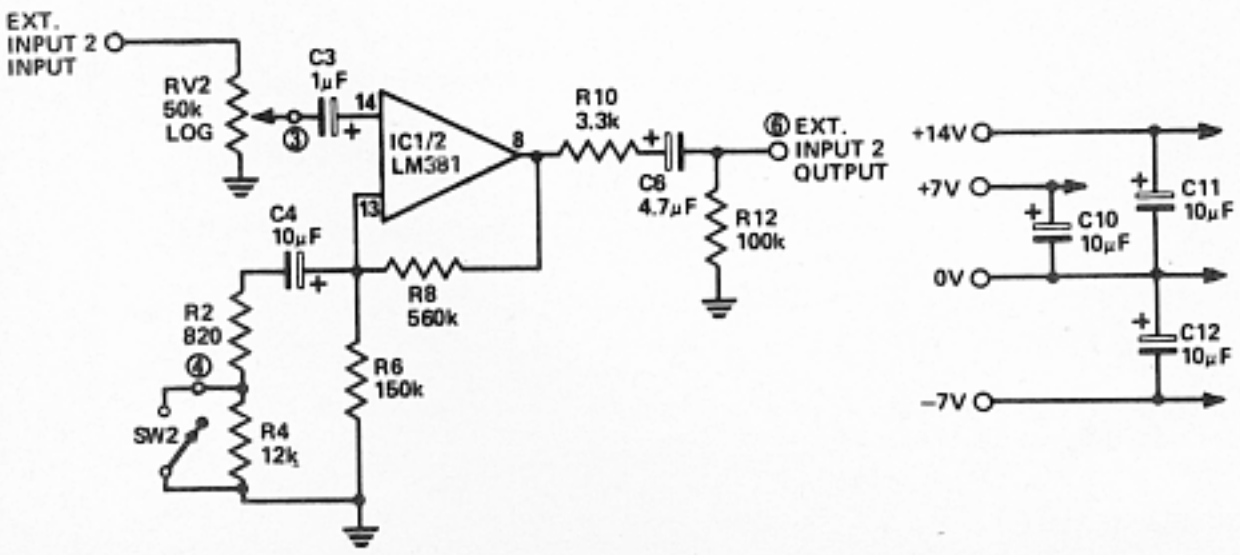


Fig. 1. Circuit diagram of external input module.



HOW IT WORKS – External Inputs

The two preamplifiers for the external inputs are provided by a low-noise dual integrated circuit type LM381. A 50 k potentiometer at the input allows attenuation of the input and sets the input impedance.

The LM381 IC differs from the normal operational amplifier we have been using in that it uses a single power supply of +14 volts and, in that the output has to be biased to

mid-voltage (7 to 8 V) by an external network – in our case R5 and R7. Gain of the amplifier is set by R7/(R1 + R3) and, since R3 may be switched in or out, two gain ranges are available. These are 56 dB and 32 dB (voltage gains of 630 and 40). These, of course, are fully variable by means of the input potentiometer.

The frequency response of the amplifiers is 20 Hz to 50 kHz +0 –3 dB.

Input 1 is provided with a trigger facility. If the peak negative output falls below the voltage selected by RV3, the output of IC2 (acting as a comparator) will go to +6 volts and remain there whilst the RV3 voltage is exceeded. At all other times the output of IC2 will be at –6 volts.

During the positive excursion of IC2, C8 charges rapidly to +6 volts and when IC2 goes negative again C8 discharges slowly via R17 to –7 volts. Another comparator, IC3, will have its output at –6 volts if the voltage on C8 is above 0 volts, and at +6 volts if the voltage on C8 is below '0' volts.

The envelope from a conventional instrument will usually have an initial attack period, a sustain period and then a decay. With this type of envelope the trigger will start high, go low whenever the envelope is greater than the preset level and then go high again. It will not respond to individual cycles due to the slow discharge of C8 by R17. The release time is about 20 milliseconds.

SPECIFICATION
EXTERNAL INPUT MODULE

Input levels	2 mV–5 V rms
Input Impedance	50 k
Frequency response	
20 Hz–50 kHz	+0 –3 dB
Maximum gain	
high sensitivity	56 dB
low sensitivity	34 dB
Trigger level	adjustable 0 to +5V
Trigger release time	approx 20 mS

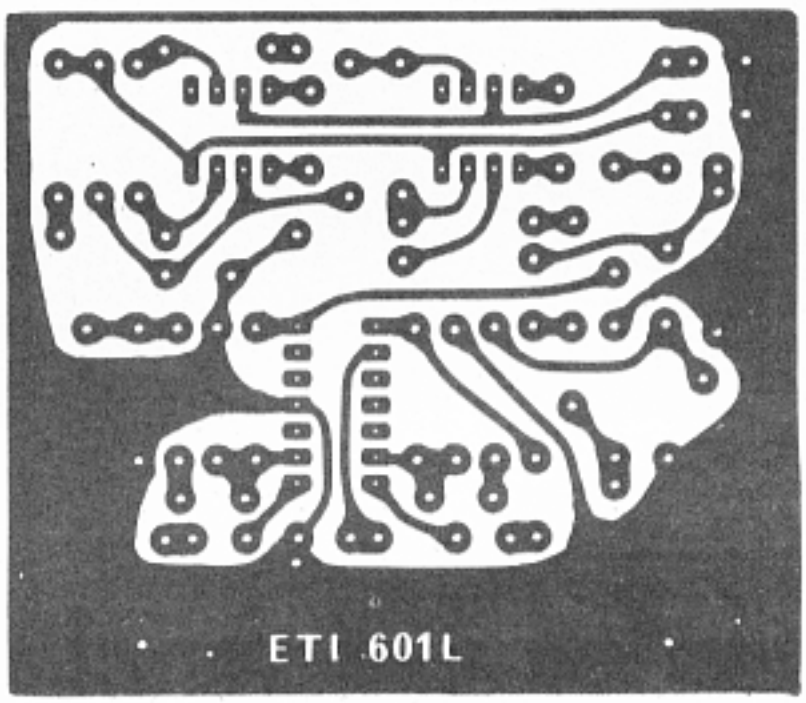


Fig. 2. Printed circuit pattern for the external input module.

THIS month we provide details of the external input amplifier and of a modification to the keyboard controller.

Using the external input circuitry, other electronic instruments (such as an electric guitar) may be fed into the synthesizer modules in order to obtain new and different sounds. One of the two inputs has circuitry which generates trigger pulses from the external instrument's signal, thus allowing the transient generators to be triggered.

CONSTRUCTION

As with all other modules, a small aluminium bracket is used to support the printed circuit board, potentiometers and switches. The components should be mounted onto the printed circuit board in accordance with the component overlay Fig. 3, taking care with the orientation of polarized components.

The switches and potentiometers should then be wired as shown in Fig. 4. The input sockets are best mounted on a panel at the rear of the synthesizer.

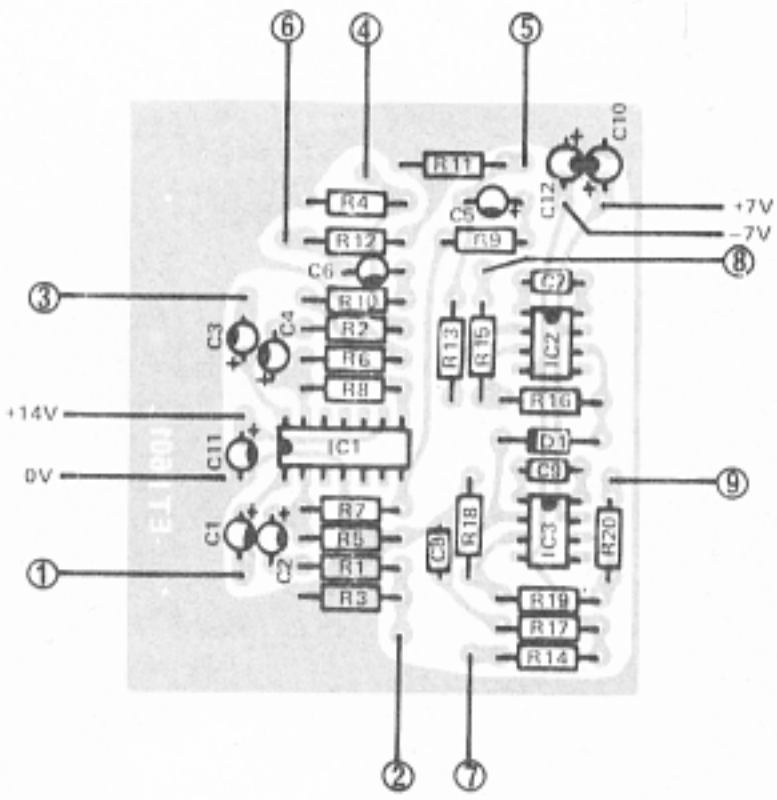


Fig. 3. Component overlay – external input module.

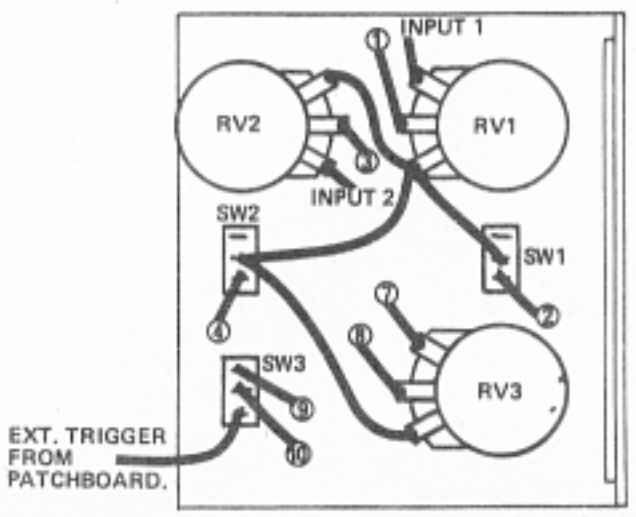
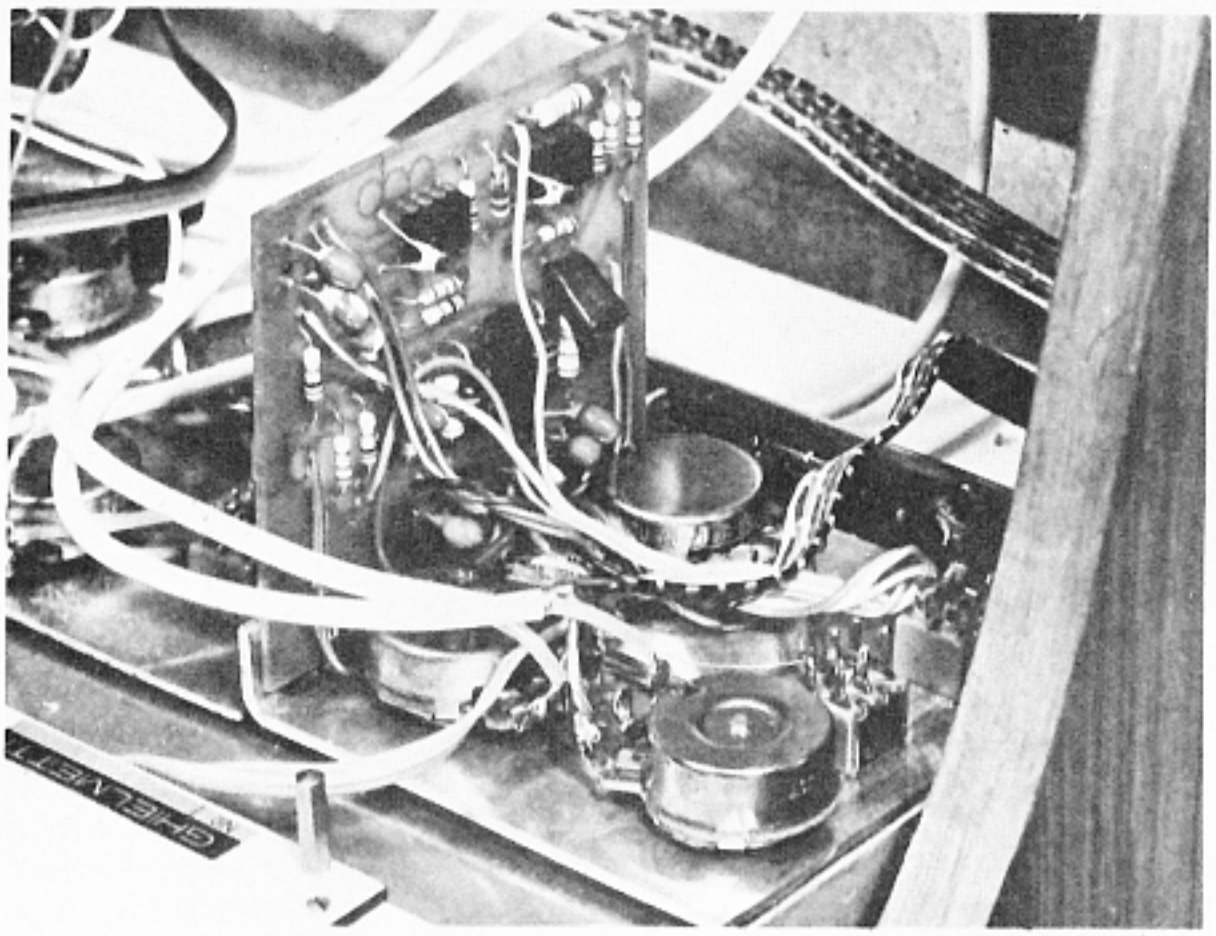
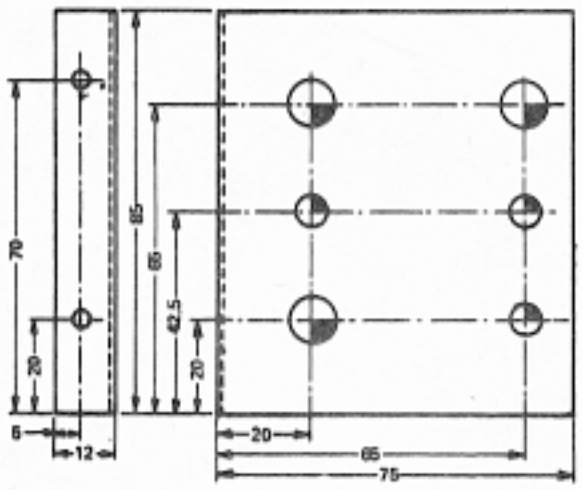


Fig. 4. Wiring to potentiometers and switches – external input module. ▶



The external input module mounted in position.



ALL DIMENSIONS
ARE IN MILLIMETRES
MATERIAL 18 GAUGE
ALUMINIUM OR STEEL

○ 2 HOLES 4 mm. dia.
◔ 3 HOLES 6.4 mm. dia.
◕ 3 HOLES 9.6 mm. dia.

Fig. 5. Drilling details for external input mounting bracket.

PARTS LIST — External Inputs ETI601L

R1,2	Resistor	820	¼ W	5%
R9,10,20	"	3.3k	"	"
R14,15,18	"	10k	"	"
R3,4	"	12k	"	"
R11,12,13	"	100k	"	"
R5,6	"	150k	"	"
R7,8	"	560k	"	"
R17	"	680k	"	"
R16,19	"	1M	"	"

RV1,2 Potentiometer 50k log rotary
RV3 " 10k lin rotary

C7,9 Capacitor 10pF ceramic
C8 " 0.1µF polyester
C1,3 " 1µF 16V electrolytic*
C5,6 " 4.7µF 16V "
C2,4,10,11,12 Capacitor 10µF 16V electrolytic*
* PC mounting or tag tantalum

IC1 Integrated circuit LM381
IC2,3 " " LM301A

D1 Diode IN914

SW1,2,3 Toggle switch SPDT

PC board ETI 601L
Metal bracket to Fig. 5.
Patchboard McMurdo type 673-11-024-01
Patch pins McMurdo type 673-31-100-04.

KEYBOARD

Any 48 note keyboard may be used. We used an F to F organ keyboard but C to C keyboards may be used, if desired, simply by appropriately tuning the oscillators.

Keyboards are quite difficult to obtain in Australia at present, however there are a limited quantity of 49 note (F to F) keyboards available. These should be available through kitset suppliers for around $25. They are not fitted with contacts or springs and these must be added by the constructor.

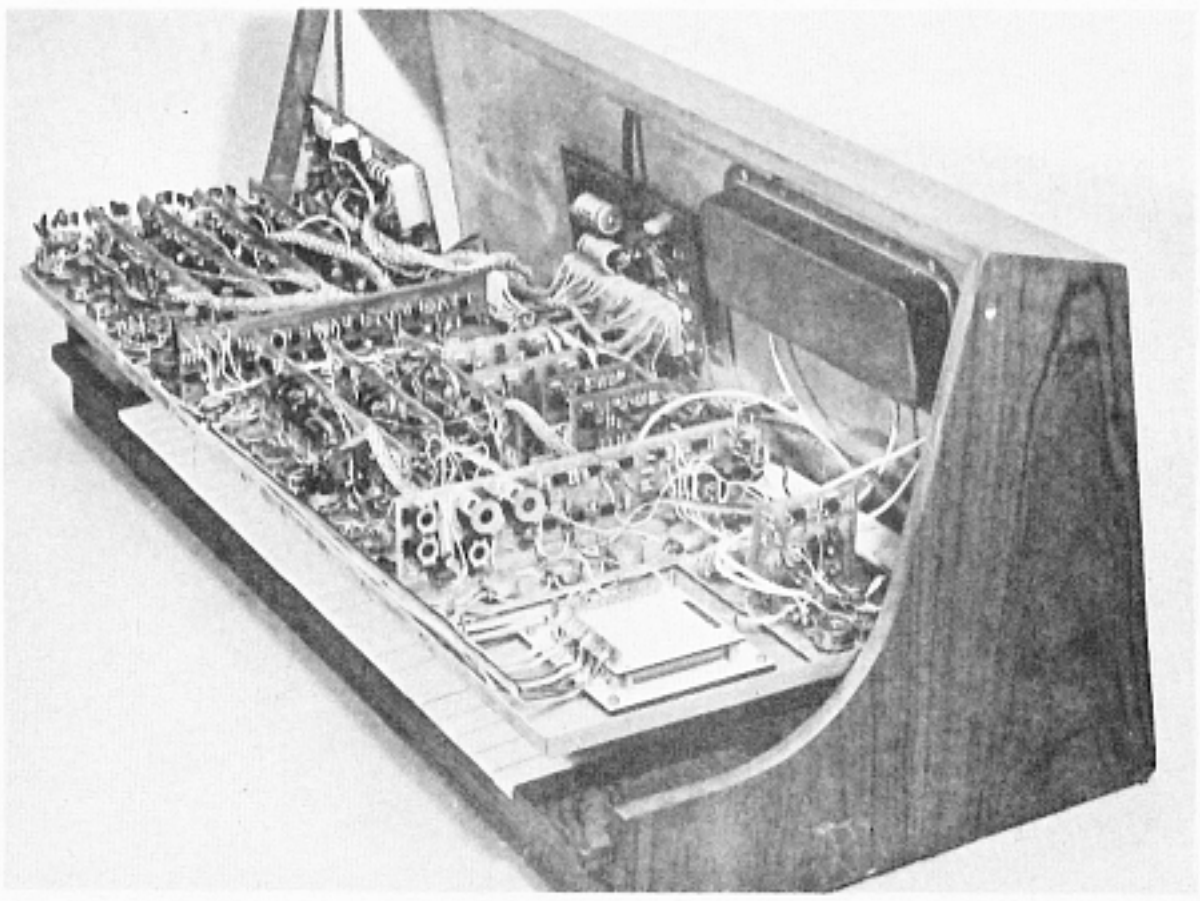
The only other alternative at present, is to import a keyboard from overseas. Those made by Kimber Allen of UK are suitable. These are fitted with contacts and springs, and are available for around £21 plus freight and insurance. Their address is:—

Kimber Allen Ltd
Broomfield Works
London Road, Swanley
Kent BR8 8DF UK
Tel: Swanley 3234-5-6

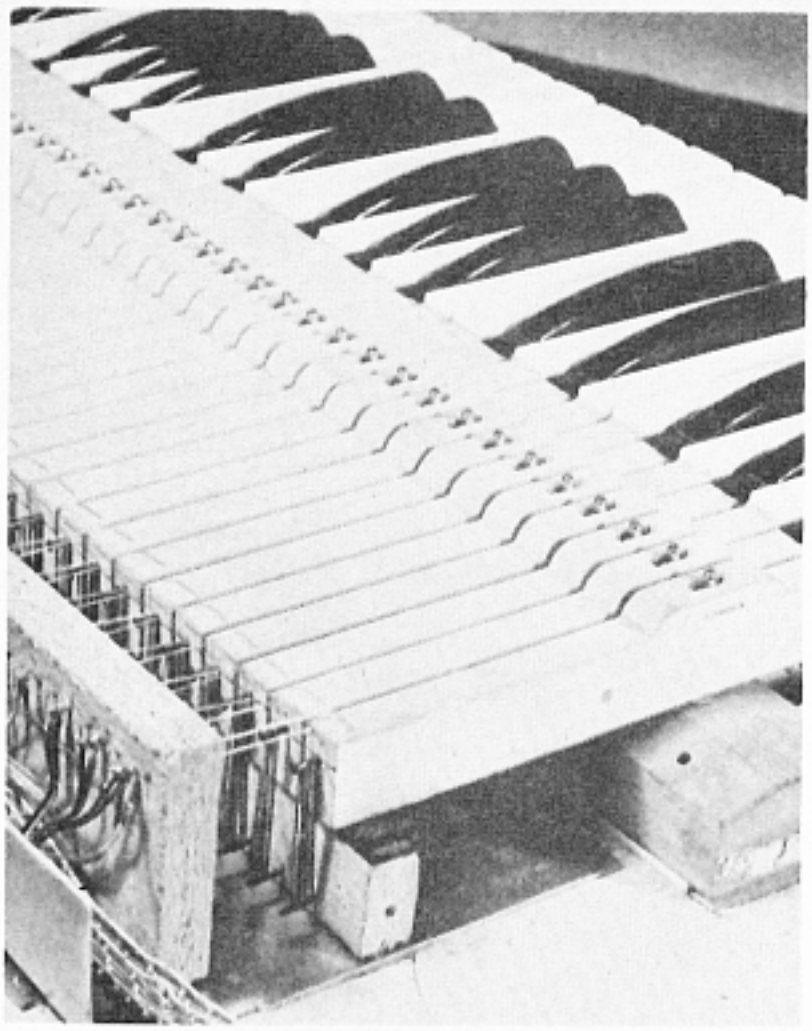
If the local keyboards are used the 49th key (top F) should be discarded and contacts and springs fitted to the remaining keys. The photographs illustrate the methods that we used, but as contacts are not as critical in a synthesizer as in an organ, these may readily be varied to suit individual needs.

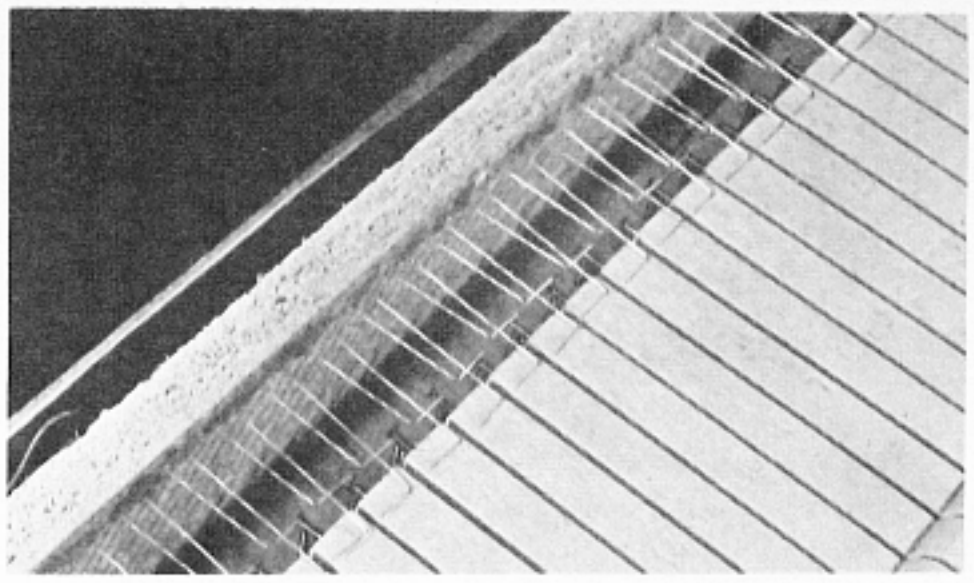
Gold plated wire was used to make our contacts (this also has to be imported) but nichrome wire is readily available, is springy and does not tarnish — it will be just as suitable.

The wire contacts were simply glued



The synthesizer front panel was hinged to allow ease of service.





▲ *Gold or nichrome wire may be used to make the key-contacts.*

◀ *This simple method of springing the keys was found to be entirely adequate.*

into a piece of chipboard. The ends were left protruding from the rear so that wires may be soldered directly to them.

The small key-return springs were purchased from a hardware store and we used two per key. On an earlier prototype we used rubber bands. These were entirely adequate and were still serviceable after 12 months use.

Tension of the springs should be such that a pressure of about 85 gms is required to depress the key. The key should have a total travel of 12 mm and the contact should make at between 6 and 8 mm depression.

KEYBOARD CONTROLLER MODIFICATION

A problem has been found to exist with the sample-and-hold circuitry of the keyboard controller. The problem, which was not apparent on our prototype is that, when a key is released and another quickly pressed, the voltage generating circuitry moves from the previous setting before the sample-and-hold has released. This is due to propagation delays in the detection circuitry.

The solution to the problem is unfortunately a little complex, and a separate PC board is required to contain the new components.

Note that, on the circuit of the keyboard controller modification, the parts in the shaded areas already exist on the main controller board.

HOW IT WORKS – Keyboard controller mod.

Transistors Q1, 2 and 3 form a 5 millisecond time delay for the trigger control signal. When a key is pressed the output of IC1/1 (on existing board) goes to +7 volts. When this occurs, C1 charges via R1, until, at about 0.6V, (set by R2 and R3) transistor Q1 starts to conduct turning on Q2 which by feedback turns on Q1 even harder. The result is that C1 is discharged by Q1 and Q2 to about –6 volts and Q1 and Q2 are held on due to the current through R1.

As Q3 is also turned on, the output voltage falls to –7 volts when the 5 millisecond period has elapsed. Now, when the key is released, the output of IC1/1 goes to –7 volts and, due to D1, transistors Q1, 2 and 3 all turn off. The output transition of Q3 is further delayed by R5 and C2 and then passed back to the CMOS gate IC1/3 where it is squared up and becomes the trigger signal.

The total time lag introduced between pressing the key and the production of the trigger signal is about 20 milliseconds, and the trigger signal continues for about 15 milliseconds after release.

We now have two sample and hold circuits. Transistor Q4 and IC2 form a temporary store which is capable of holding the required analogue voltage for a 10 millisecond period. When a key is pressed the following procedure takes place:–

1. The desired note is selected and appears at the output of IC8 (ETI601e).
2. After 5 milliseconds this voltage is transferred to the temporary store.
3. After a further 5 milliseconds this hold is disconnected and a second hold circuit initiated thus transferring the voltage into the main memory.
4. After a total of 20 milliseconds, the trigger signal appears and activates the transient generators etc.
5. The two sample-and-holds are operated alternately at about 100 times a second. There is a slight gap between them so that it is impossible for them to both be on together.
6. When the key is released both sample and hold circuits are broken.

The result of all this manipulation is that the information going into the second and main memory, is always at least 5 milliseconds old and hence cannot be affected by the propogation delay.

Gates IC1/1 and IC1/2 form a multivibrator which is switched on and off by the output of Q3. The network R6, C3 ensures that the multivibrator always starts in the same sequence. The outputs from IC1/2 and IC1/2 are coupled respectively to IC1/3 and IC1/4 by capacitors C6 and C4. Those gates (IC1/3, IC1/4) form a monostable which produces a pulse having a 4 millisecond period and, since these pulses occur every 5 milliseconds, they have a 1 millisecond period between them. The output of Q3 controls these gates directly (via IC1/3 pin 8 and IC1/4 pin 13) thus over-riding the monostable input. The outputs of IC1/3 and IC1/4 control FETs Q4 and Q7 (ETI 601e).

This sampling technique increases the delay of the glide potentiometer and if this effect is found to be undesirable the value of the glide potentiometer may be reduced to about 2 megohm.

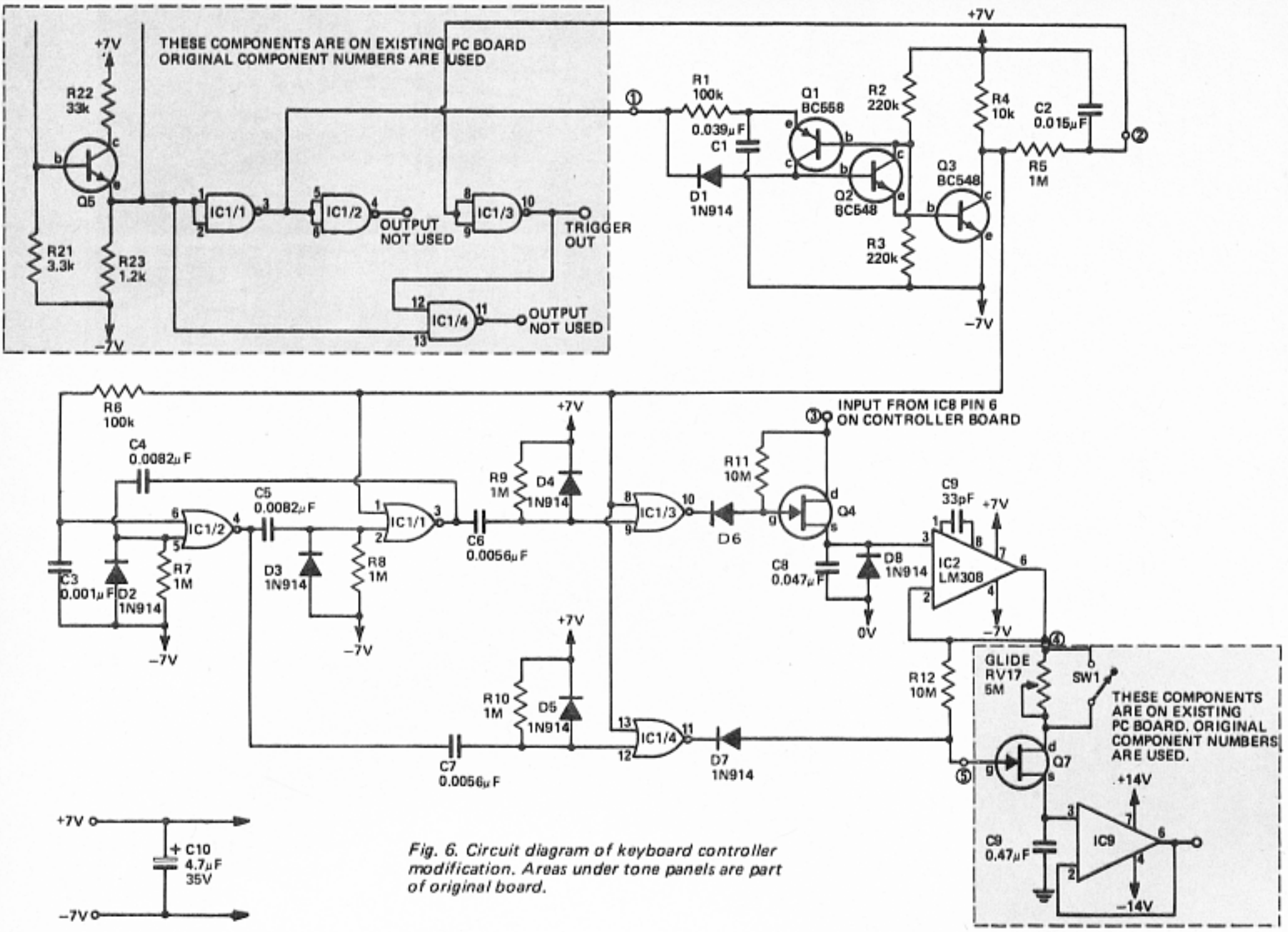
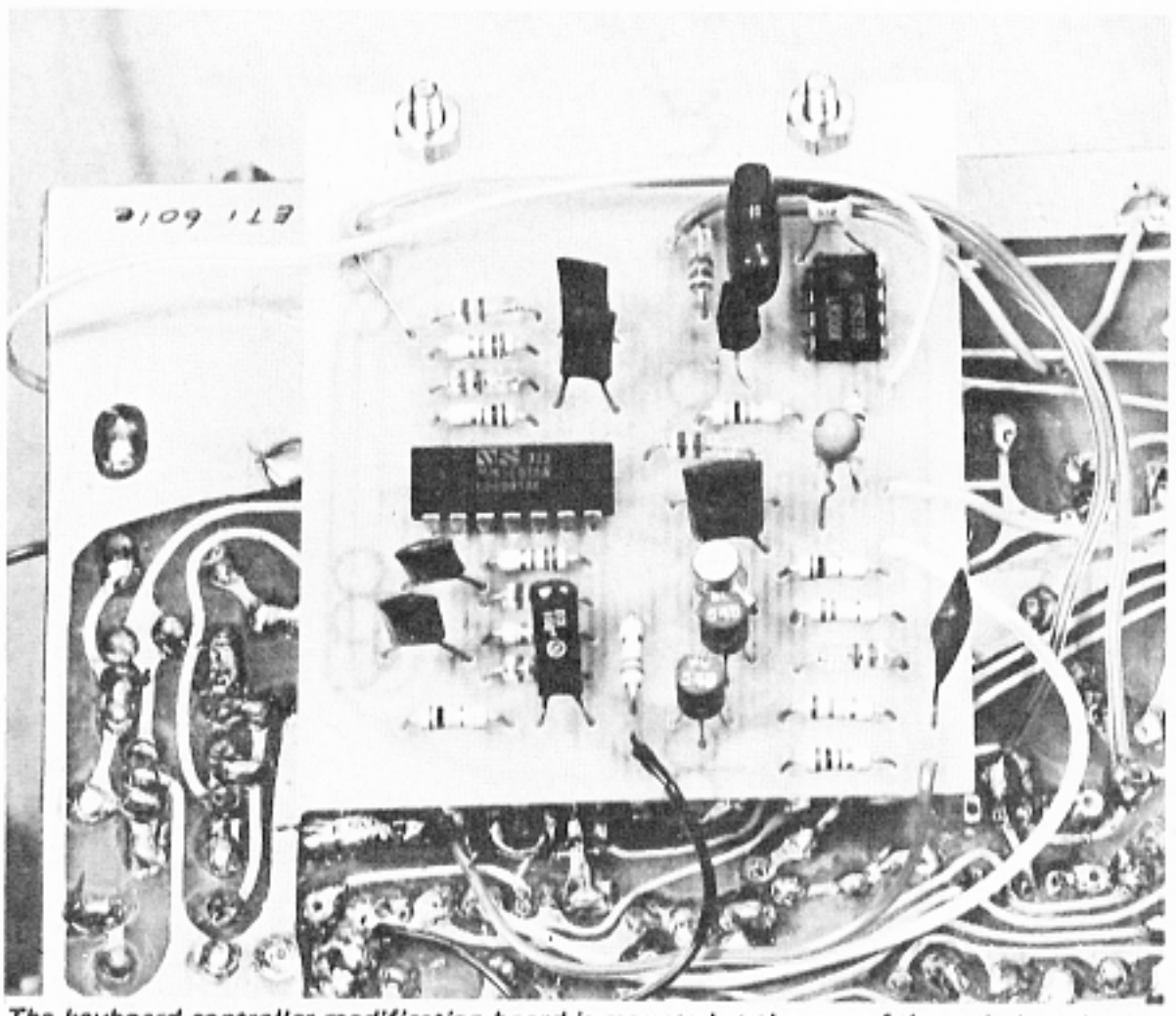


Fig. 6. Circuit diagram of keyboard controller modification. Areas under tone panels are part of original board.



The keyboard controller modification board is mounted at the rear of the main board as shown.

PARTS LIST — Keyboard Controller Modification

R4	Resistor	10k	¼W	5%
R1,6	"	100k	"	"
R2,3	"	220k	"	"
R5,7,8	"	1M	"	"
R9,10	"	1M	"	"
R11,12	"	10M	"	"
C9	Capacitor	33pF ceramic		
C3	"	0.001µF Polyester		
C6,7	"	0.0056µF	"	
C4,5	"	0.0082µF	"	
C2	"	0.015µF	"	
C1	"	0.039µF	"	
C8	"	0.047µF	"	
C10	"	4.7µF 35V electrolytic		
IC1	Integrated circuit 4011 CMOS			
IC2	"	" LM308		
Q1	Transistor	BC558, BC178 or similar		
Q2,3	"	BC548, BC108	"	"
Q4	"	2N5458 *		

* from controller board

D1-D8 Diode IN914

PC board ETI 601M.

2 by 13 mm spacers, 2 nuts, 2 by 20 mm screws.

CONSTRUCTION

Assemble components to the PC board in accordance with the overlay Fig. 8, again taking care with polarization of components. It is recommended that a socket be used for the CMOS ICs.

We mounted the board on the back of the controller via two 13 mm spacers as shown in the photograph.

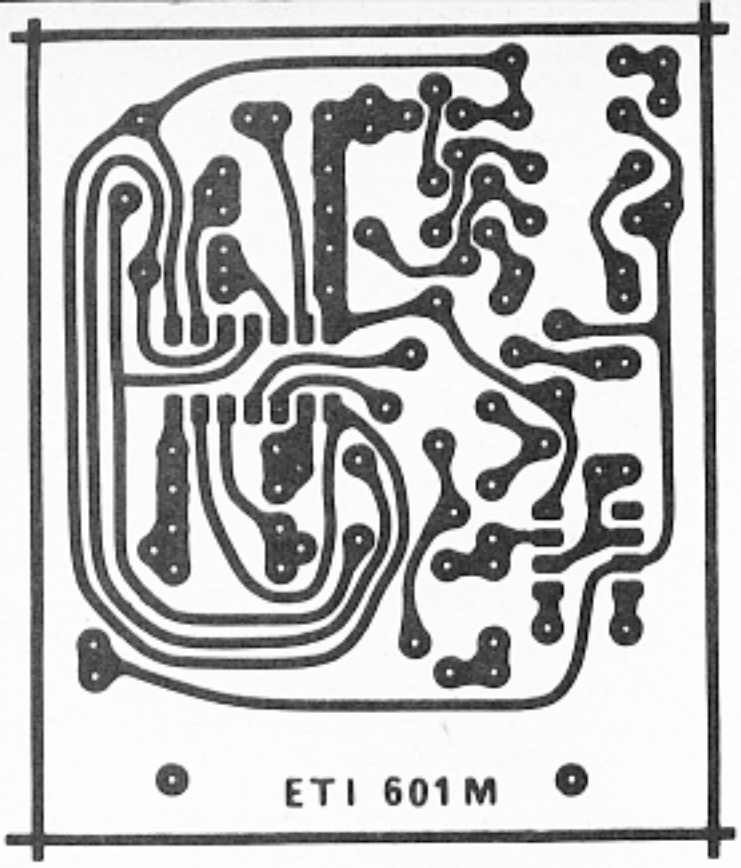


Fig. 7. Printed circuit pattern for keyboard-controller modification.

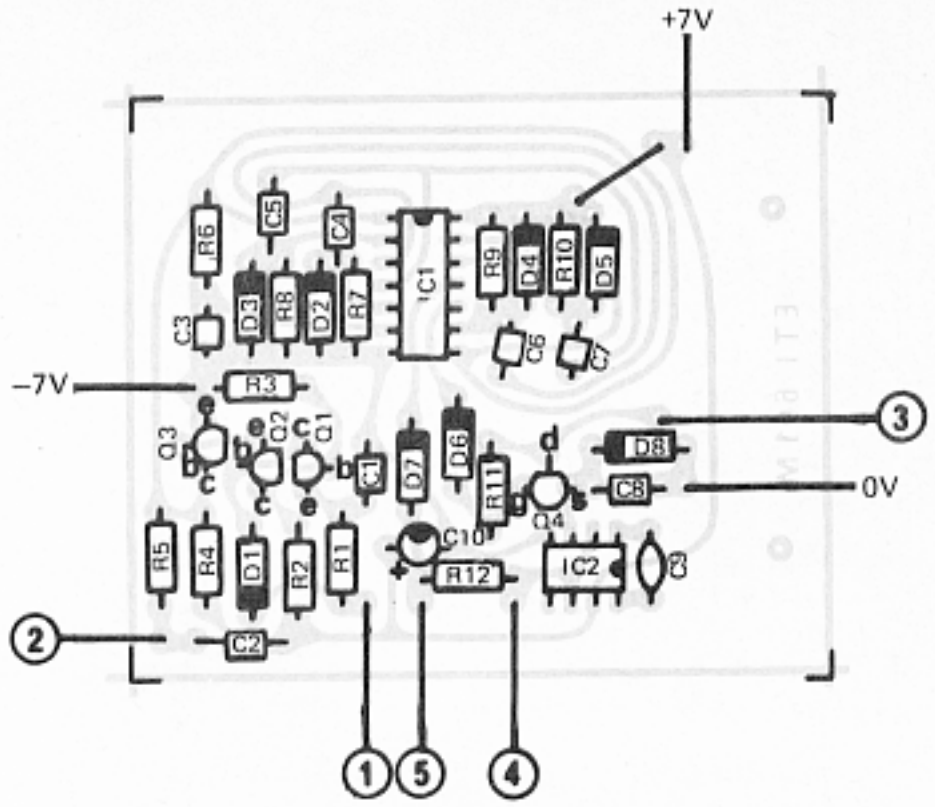


Fig. 8. Component overlay for keyboard controller modification.

Only one additional hole has to be drilled.

The interconnections and modifications necessary are as follows:—

1. Remove Q8 (can be used as new Q4), R48, C1, R26, D2 and the link numbered 40 which goes from IC8 pin 6 to RV17.
2. Connect the +7V, 0V and −7V to the new board from convenient points on the old board. We used pin 14 (+7V) and pin 7 (−7v) of IC1 and a point on the outer copper track for 0V.
3. Link point 1 to pin 3 on IC1/1 (ETI601e).
4. Link point 2 to pin 8/9 on IC1/1 (ETI 601e).
5. Link point 3 to point 40 IC8 (ETI601e).
6. Link point 4 to point 40 on RV17 (ETI601e).
7. Link point 5 to the track joining Q7 and Q8 (ETI601e). ●