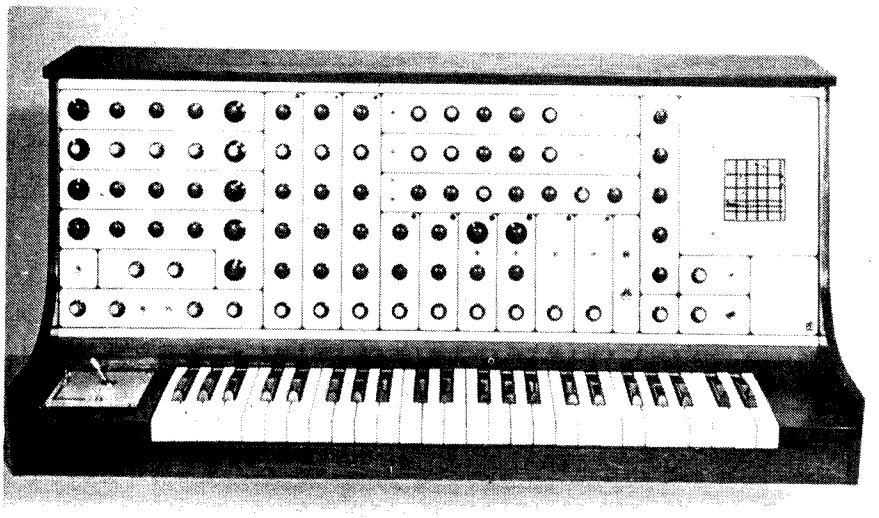
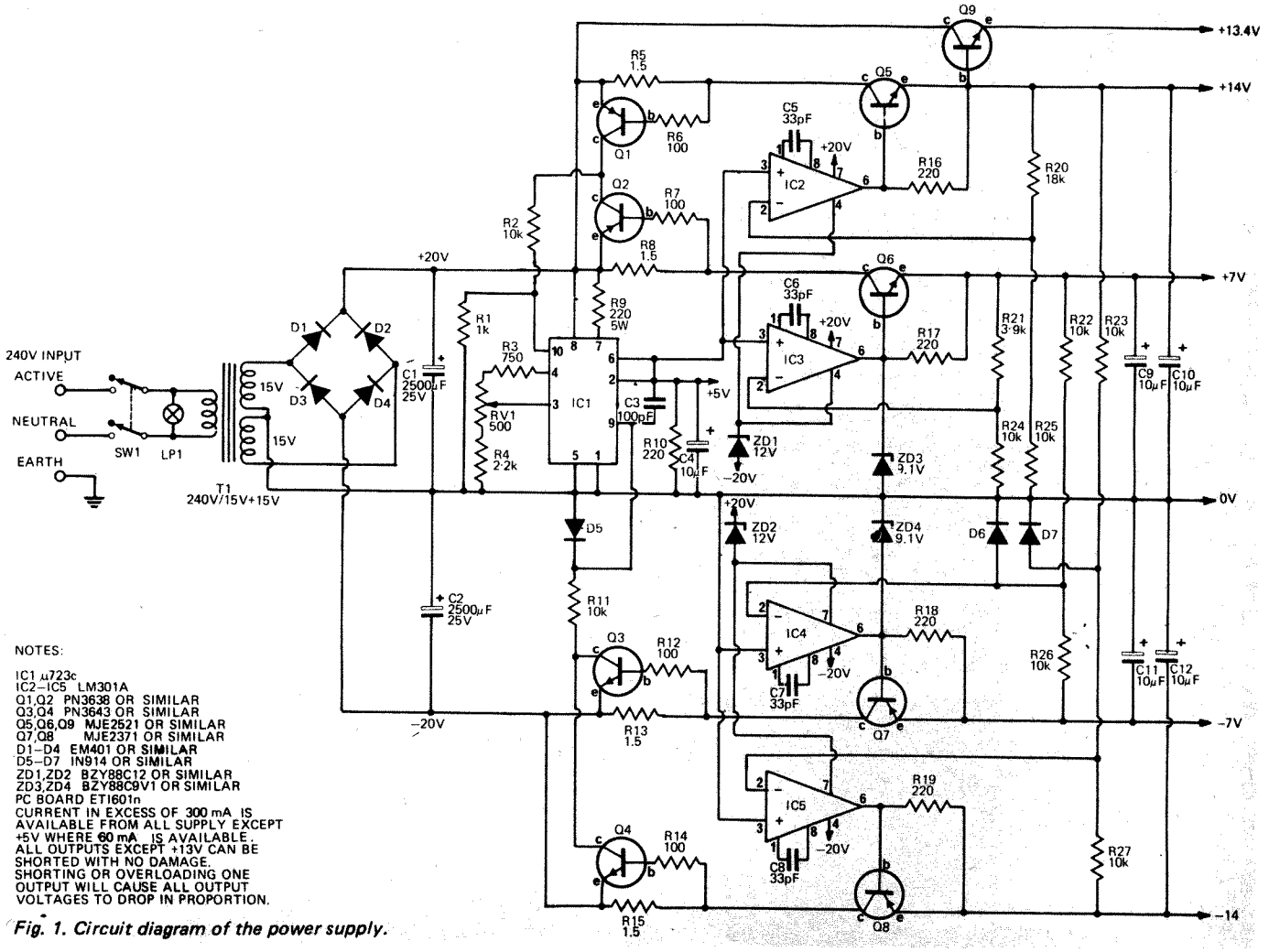
INTERNATIONAL MUSIC SYNTHESIZERS



eti 3600/4600

Constructional details of the mixer, noise generator/controller and main power supply are provided in this, the third article in the series.



NOTES:

IC1 μ723c
IC2–IC5 LM301A
Q1,Q2 PN3638 OR SIMILAR
Q3,Q4 PN3643 OR SIMILAR
Q5,Q6,Q9 MJE2521 OR SIMILAR
Q7,Q8 MJE2371 OR SIMILAR
D1–D4 EM401 OR SIMILAR
D5–D7 IN914 OR SIMILAR
ZD1,ZD2 BZY88C12 OR SIMILAR
ZD3,ZD4 BZY88C9V1 OR SIMILAR
PC BOARD ETI601n
CURRENT IN EXCESS OF 300 mA IS AVAILABLE FROM ALL SUPPLY EXCEPT +5V WHERE 60 mA IS AVAILABLE. ALL OUTPUTS EXCEPT +13V CAN BE SHORTED WITH NO DAMAGE. SHORTING OR OVERLOADING ONE OUTPUT WILL CAUSE ALL OUTPUT VOLTAGES TO DROP IN PROPORTION.

Fig. 1. Circuit diagram of the power supply.

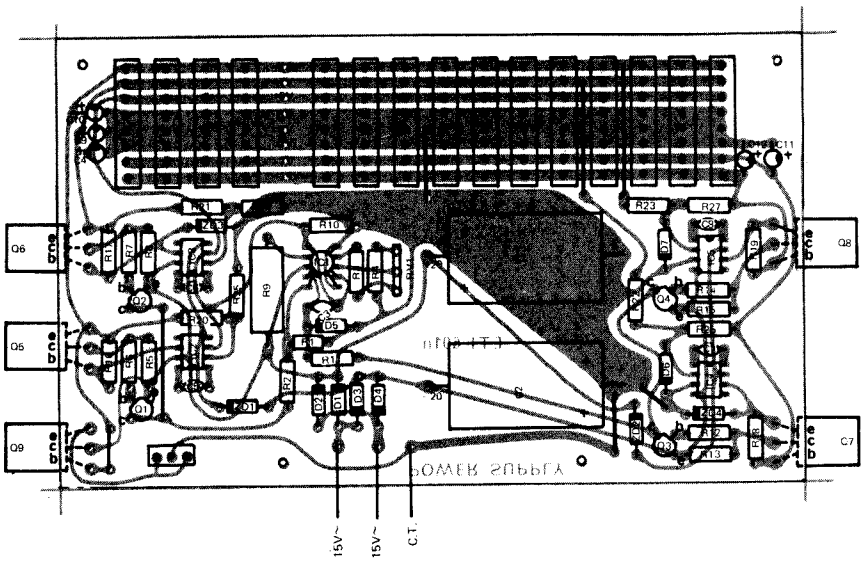
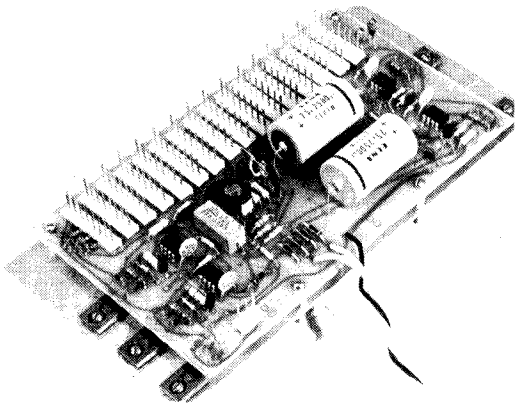


Fig. 2. Component overlay for power supply.



The method of construction of the power supply particularly mounting of the power transistors is shown in this photograph.

MODULES to be described this month are, the mixer, noise generator and controller, and main power supply.

These three modules, together with those described last month enable the partly completed unit to be used to generate quite complex waveforms — and hence, sounds.

CONSTRUCTION

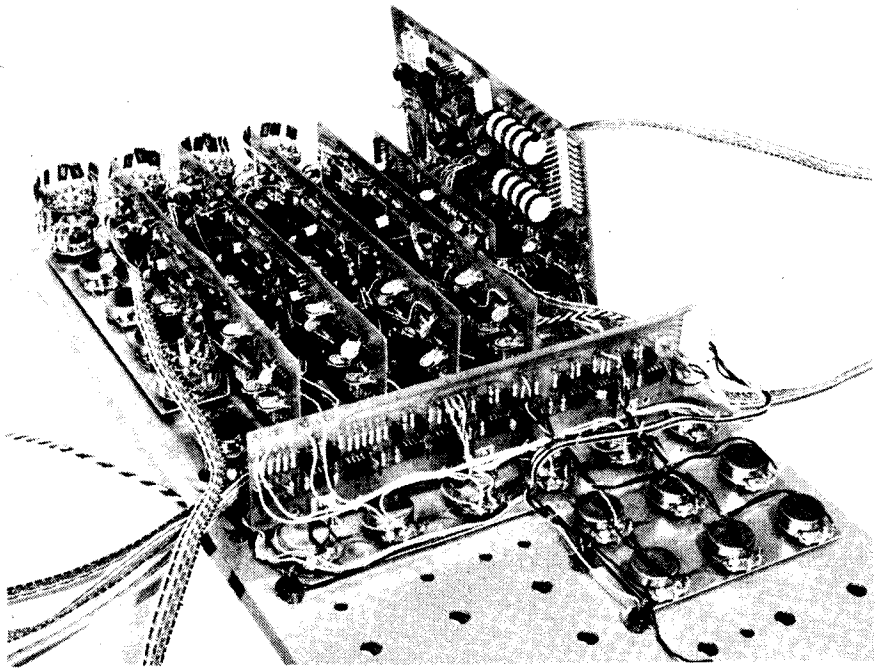
Power Supply

Assemble the PC board with the aid of the component overlay Fig. 2. The power transistors should not be mounted at this time. Check the orientation of all the components especially checking the 723 regulator, the tag on the IC being next to pin 10.

The PC board is mounted by ¼ inch spacers onto an aluminium panel Fig. 9 which is also the heatsink for the power transistors. The power transistor leads must be bent apart and up at right angles to pass through the PC board from the underside.

The heatsink should be used as a guide to determine the bending points. Since the transistors are on the under side of the PC board there must be no strain on the joints, otherwise the PC board track may be broken. Mount the transistors, using mica insulators, in position on the heatsink. The transistors may then be soldered to the PC board through the access holes provided. If required the heatsink may then be removed for other work to be carried out.

All assemblies and modules described in this, and last month's, article are used in the larger (4600) model synthesizer. Some of the components are used also in our smaller (3600) unit, but interconnections etc, are changed. Full details of this will be provided later.



The mixer and noise generator modules shown mounted in position.

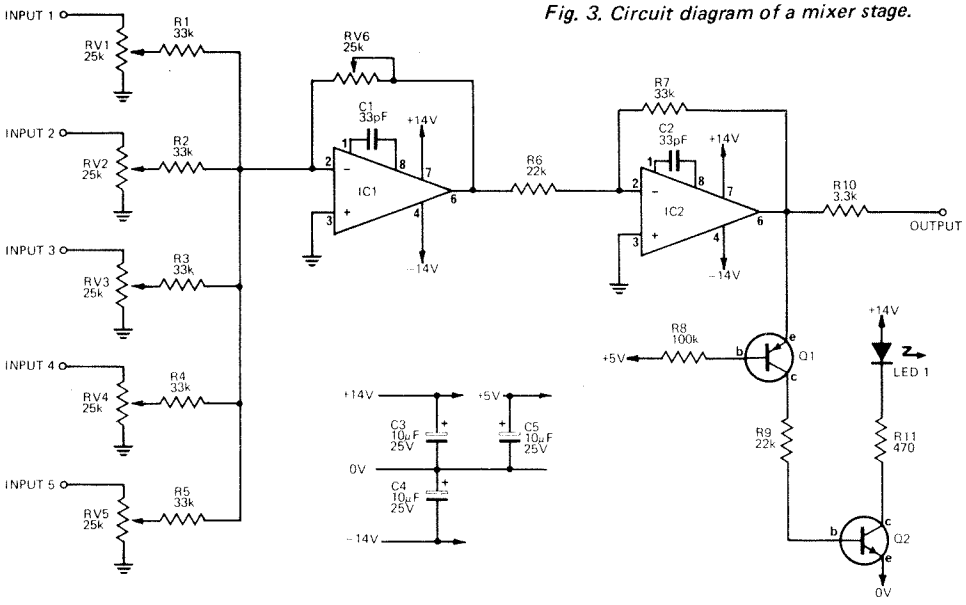
Mixer

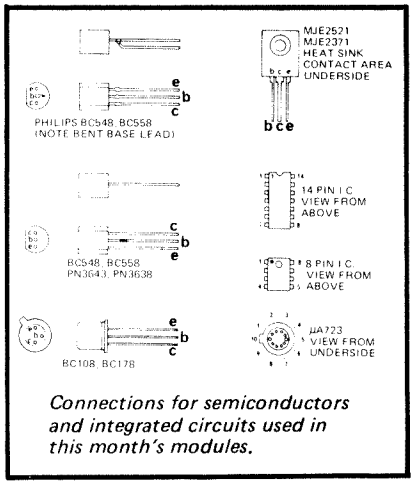
Assemble the PC board with the aid of the component overlay Fig. 4. Check the orientation of ICs and transistors. With the BC548-558 transistors there are two different pin connections used, depending on the manufacturer. National and Fairchild versions are the same and as shown on the overlay, whereas the Philips type is the reverse. The Philips type can be identified by the base (centre) lead, which is bent off centre, away from the flat. To use the National type bend the centre lead towards the flat.

The mechanical assembly is slightly different on this module than that for the oscillators. A metal plate is used to hold all the potentiometers (24) and three small brackets hold the PC board. The LED indicators are mounted on the front panel itself and are connected to the PC board either by soldering, or as recommended, by a plug and socket.

Each oscillator output is fed to three potentiometers on the mixer board. Five pads are provided on the PC board for connecting the common connection of each set of three potentiometers. A pin may also be fitted to each pad so that the oscillator connection may be disconnected if required.

Fig. 3. Circuit diagram of a mixer stage.





Connections for semiconductors and integrated circuits used in this month's modules.

NOTES:

MIXER 1 ONLY SHOWN, MIXERS 2-5 ARE SIMILAR
EXCEPT MIXERS 4 AND 5 HAVE ONLY 2 INPUTS
IC1 AND IC2 LM301A OR SIMILAR
Q1 BC558 OR SIMILAR
Q2 BC548 OR SIMILAR
LEDs NSL 5023 OR SIMILAR
COMPONENT NUMBERS FOR MIXERS 2-5
ARE AS FOLLOWS :-
MIXER 2, ADD 20 TO ALL NUMBERS i.e. R5 BECOMES R25
MIXER 3, ADD 40 TO ALL NUMBERS i.e. R5 BECOMES R45
MIXER 4, ADD 60 TO ALL NUMBERS i.e. R5 BECOMES R65
MIXER 5, ADD 80 TO ALL NUMBERS i.e. R5 BECOMES R

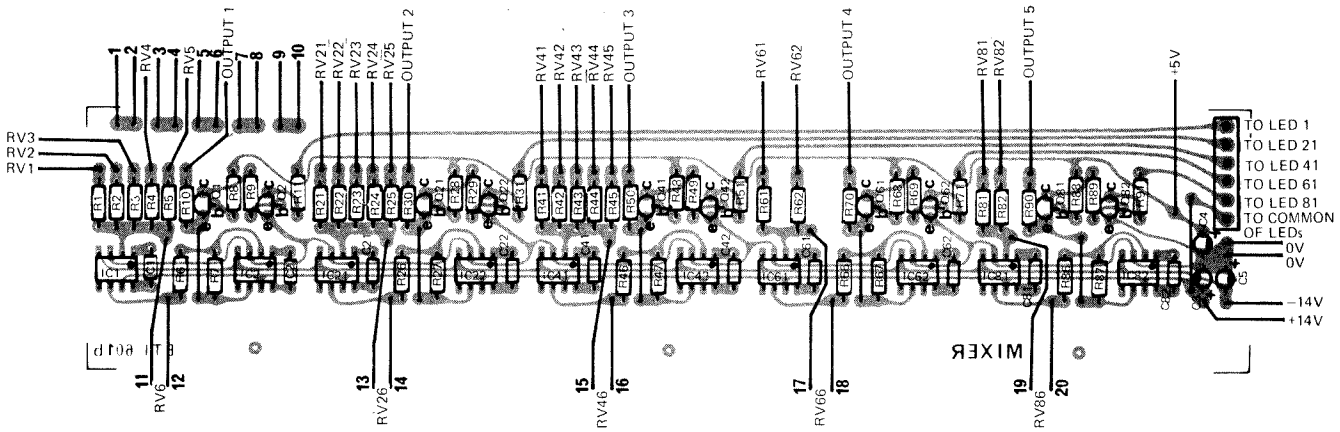


Fig. 4. Component overlay for mixer board.

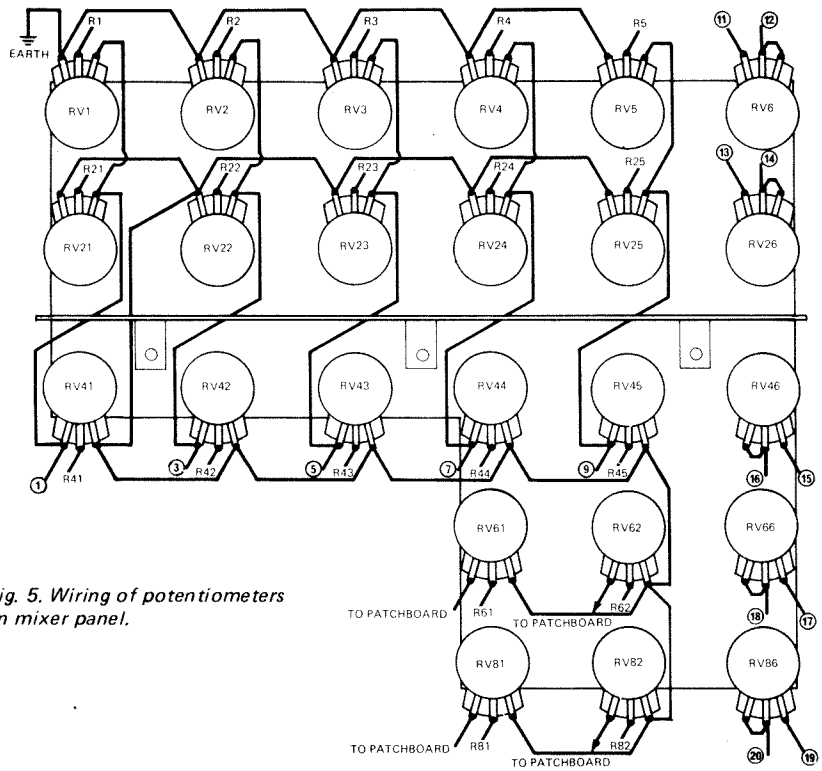


Fig. 5. Wiring of potentiometers on mixer panel.

Noise generator and controller

The construction of the module is very similar to that of the oscillator described last month.

Assemble the PC board with the aid of the component overlay, Fig. 7. It is recommended, that IC sockets are used for the CMOS. Make sure the integrated circuits and electrolytic capacitors are orientated correctly before soldering in place.

The PC board is then mounted on the metal bracket shown in Fig. 12. The bracket goes on the component side of the PC board to prevent any possibility of shorting the copper tracks. The two potentiometers and the switch may now be mounted and wired up. This bracket also holds the additional switch related to oscillator 4 which is wired up as shown in Fig. 8 The interconnection between this switch and that in oscillator 4 can be either by soldered leads or, a plug and socket can be used.

Soldering with power connected should be avoided along with accidental shorting of the outputs. The output can be shorted for a brief

POWER SUPPLY – How it works

The power supply provides regulated outputs of +14V, +7V, +5V, −7V and −14V. The 5V supply can deliver 60 mA and all other outputs 300 mA. An additional output of +13.4V is provided to supply the high current requirement of the headphone output amplifier.

The rectifier and filter is a conventional system supplying ± 20V. The 5V output is derived from a μA723C, voltage regulator (IC1) which has very good temperature and load regulation. The +5 volts is used as the main reference for the other supplies. Current limitation is provided for by R9 which limits the current to about 85 mA. The output is adjustable by RV1 such that exactly 5V can be obtained.

The output of IC1 can be shutdown in either of two modes. A positive current into pin 10 or a negative current out of pin 9 will cause the output voltage to drop to zero. Use of this is made in the overload network of the other supply outputs.

The +7V output is via a series pass transistor, Q6, which is controlled by IC3, a high gain differential amplifier which is used as a comparator. The non-inverting input (positive) of IC3 is connected to the +5V output where, in addition, the inverting (negative) input, is connected via a 5/7 divider R21/24. The result of this connection is that the output will stabilize at +7V. The high gain of IC3 will keep this voltage constant with nominal load and supply voltage changes.

A current sensing resistor, R8, is in series with the collector of Q6. If the voltage across this resistor exceeds 0.6V, the base emitter of Q2 will become forward biased, turning it on. This causes a positive current to flow into pin 10 of IC1 shutting it down. Since the output of the +7V regulator is referred to the +5V output, the +7V supply will also shut down and the output current will be limited to about 400 mA. To prevent over voltage from the +7V supply on switch on, the output is limited by ZD3 to about 8.5 volts.

The −7V supply is similar to the +7V supply, except that the reference voltage is now zero volts, (pin 3) and this is compared to a voltage at the junction of R26 and R22. The voltage will be zero when the output of the −7V is identical to the +7V but of opposite polarity. Diode D6 is used to protect the input of IC4. Overload on this output turns on Q3 which removes current from pin 9 of IC1 shutting it down. This shuts down the +7V supply and since the −7V "tracks" the +7V output, it also will shut down.

The ± 14V supplies are identical to the ±7V supplies except for the sensing resistors R20/25 on the +14V supply.

The +13.4V output is simply an emitter follower on the +14V rail. This supply should not however be shorted since no protection is provided.

MIXER – How it works

The mixer used is quite conventional, using an IC (IC1) to sum the input currents. Individual gain control is provided by RV1-5 and overall gain by RV6. Since the output of this type of mixer is inverted an additional IC is used to reinvert the signal.

Overload indication is provided by Q1, Q2 and LED1. If the output voltage exceeds 5.6V, Q1 becomes forward biased and Q1 and Q2 turn on, illuminating the LED indicator. The base resistor R8 prevents damage to Q1 should the output swing negative. The overload point as indicated by the LED is chosen to protect the inputs of following stages from being overloaded. The mixer itself has an overload point of about 12V.

Mixers 1,2, and 3 are identical whereas mixers 4 and 5, although otherwise identical, have only 2 inputs. The inputs of mixers 1,2, and 3 are wired directly to the outputs of the individual oscillators.

NOISE GENERATOR AND CONTROLLER – How it works

White noise is generated digitally by an 18 bit shift register which is clocked at about 35 kHz. Several feed-back loops around the shift register cause it to generate a psuedo-random bit pattern which closely approximates white noise.

The oscillator uses a quad, dual-input NOR CMOS gate (IC3), and although a NAND or inverter could be used in the circuit, it would not necessarily be a pin for pin replacement. Feedback is taken from the 5th, 9th and 18th stage in the shift register and these outputs are "mixed" by IC2 which is an exclusive OR gate, (see table) the output of which controls the 'D' input of the shift registor. Resistor R1 and capacitor C1 are used to ensure that the system will start.

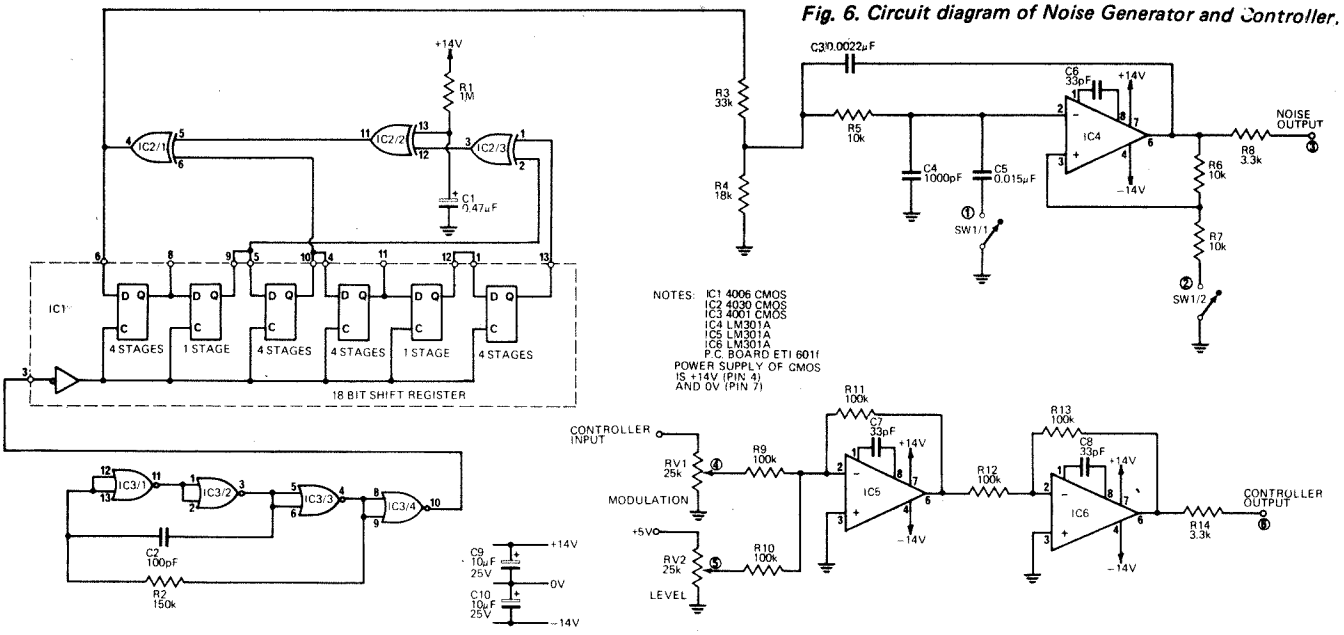
INPUTS		OUTPUTS
A	B	
0	0	0
0	1	1
1	0	1
1	1	0

1 = HIGH LEVEL
0 = LOW LEVEL

The output of IC2/1, as well as being the control for the shift register, is the white noise we require. However, due to some unwanted components above 15 kHz, a low pass filter is used with a 15 kHz cutoff. To give an alternate "PINK" noise output, the filter is changed to cut frequencies above 500Hz with a 6 dB/octave slope. Since the output voltage will fall if some of the spectrum is removed, additional gain is also provided when 'PINK' noise is selected.

The controller is a completely separate function which is used to add a dc component to another signal or control voltage. This is done by mixing, in IC5, a percentage of the input signal and a percentage of a dc voltage. The output of IC5 is negative however, and must be inverted by IC6.

Fig. 6. Circuit diagram of Noise Generator and Controller.



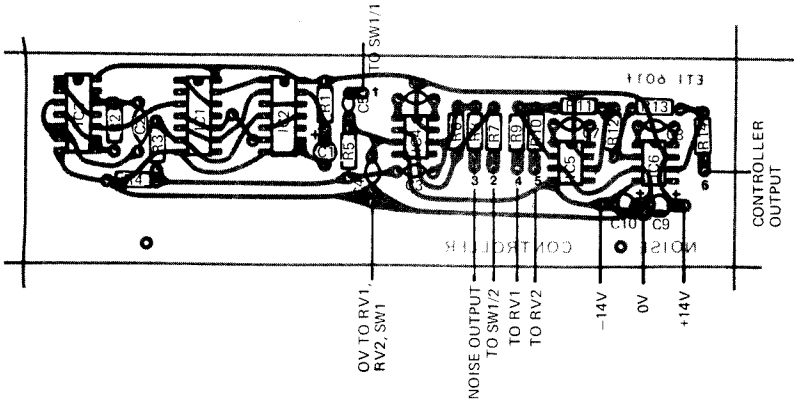


Fig. 7. Component overlay of Noise Generator and Controller.

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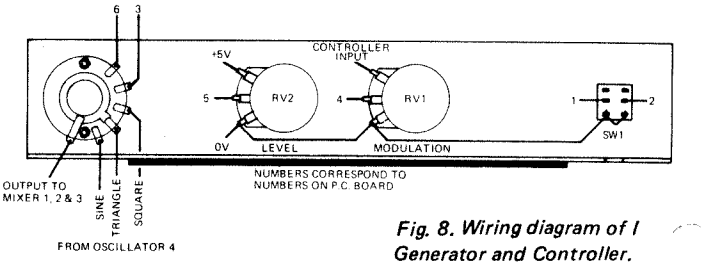
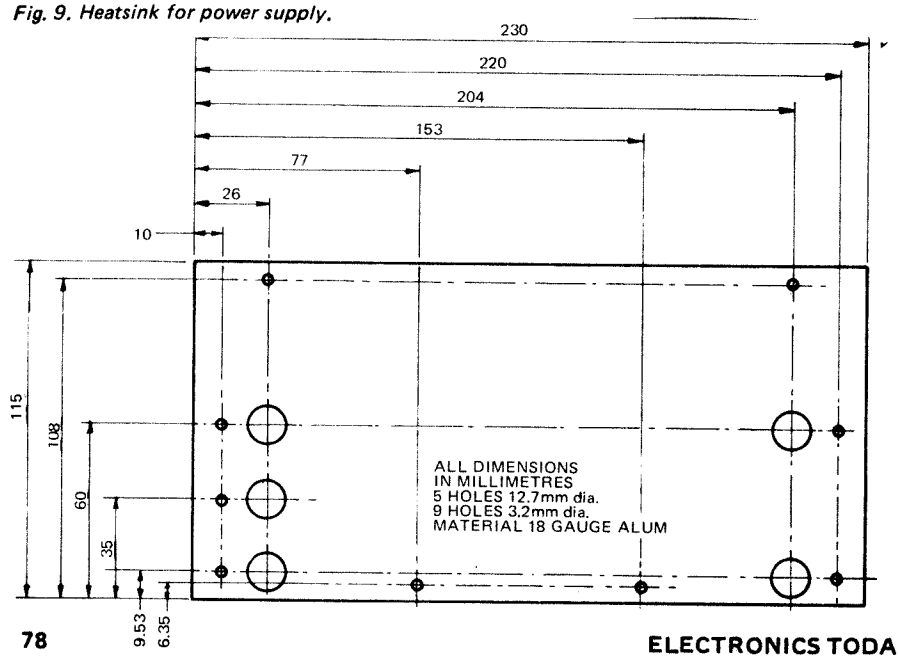


Fig. 8. Wiring diagram of I Generator and Controller.

Fig. 9. Heatsink for power supply.



period without damage however this is not recommended.

The supply voltage to CMOS must never be reversed. This could cause the devices to destroy themselves.

Although the inputs of CMOS are internally protected against static charges, some care is still required in their handling. They should be stored in their aluminium carrier or in conductive plastic. They should be the last components added to the PC boards, preferably using IC sockets.

NEXT MONTH

Next month we will describe the Envelope Control, Transient 1 and Transient 2 modules. It is emphasised again that we are at present describing the larger synthesizer. The changes required for the smaller unit will be detailed later.

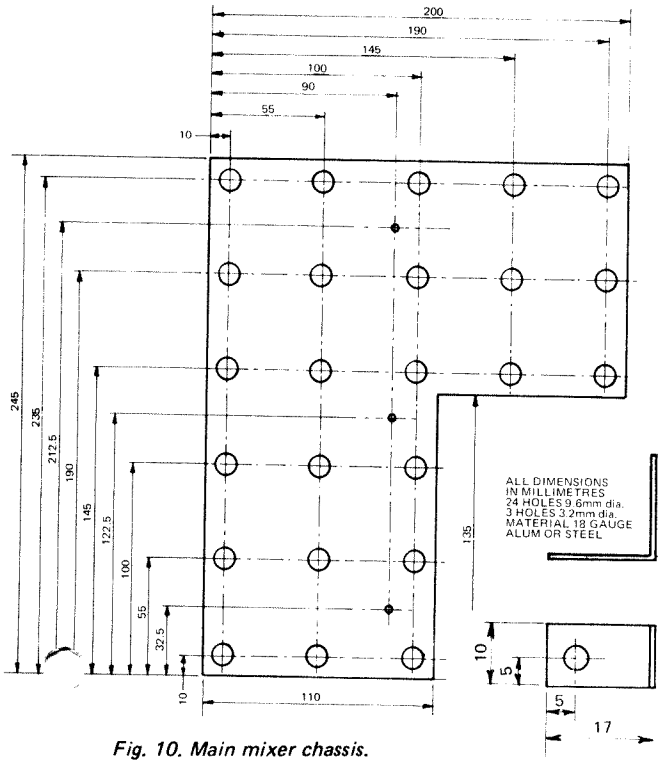


Fig. 10. Main mixer chassis.

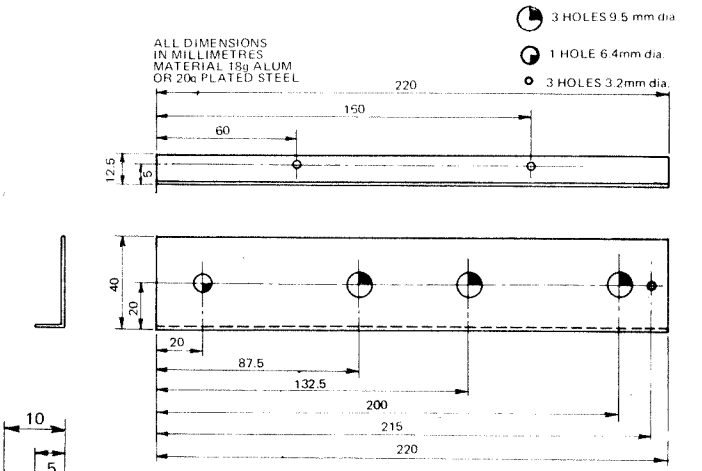
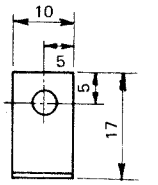


Fig. 12. Noise generator and controller support bracket.



ALL DIMENSIONS
IN MILLIMETRES
2 HOLES 3.2 mm dia.
MATERIAL 18 GAUGE
STTEL OR ALUM.

Fig. 11. Mixer board support bracket (three required).

PARTS LIST POWER SUPPLY

R1	Resistor	1k	¼ W	5%
R2,11,22,23, 24,25,26,27	"	10k	"	"
R3	"	750Ω	"	"
R4	"	2.2k	"	"
R5,8,13,15	"	1.5Ω	½ W	"
R6,7,12,14	"	100Ω	¼ W	"
R9	"	220Ω	5 W	"
R10,16,17,18,19	"	220Ω	¼ W	
R20	"	18k		
R21	"	3.9k		
RV1	Potentiometer	500Ω large trim type		
C1,2	Capacitor	2500μF 25 V electrolytic		
C3	"	100pF ceramic		
C9,10, 11,12	"	10μF 20V electrolytic P.C. mounting		
C5,6,7,8	"	33pF ceramic		
IC1	Integrated Circuit	μA723C metal can type		
IC2,3,4,5	" "	LM301A minidip		
Q1,Q2	Transistor	PN3638 or similar		
Q3,4	"	PN3643 " "		
Q5,6,9	"	MJE2521 "		
Q7,8	"	MJE2371 "		
D1-D4	Diode	EM401 or similar		
D5,6,7	"	IN914 " "		
ZD1,2	Zener Diode	BZY88C12 "		
ZD3,4	" "	BZY88C9V1 "		

T1 Transformer 240V primary 15 V-0-15 V sec @ .75A or more.
SW1 Toggle Switch DPDT 240 V rated
LP1 240V Neon Indicator
PC board ETI 601 n
Heatsink as per Fig. 9.
T05 heatsink for IC1
4 ¼" spacers
Recommended extras

16	8 pin Utilux plugs type A2402-8
1	3 pin Utilux plug type A2402-3

PARTS LIST MIXER

R1,2,3,4,5,7	Resistor	33k	¼ W	5%
R21,22,23,24, 25,27	"	33k	"	"
R41,42,43,44, 45,47	"	33k	"	"
R61,62,67	"	33k	"	"
R81,82,87	"	33k	"	"
R6,9,26,29,46	"	22k	"	"
R49,66,69,86,89	"	22k	"	"
R8,28,48,68,88	"	100k	"	"
R10,30,50,70,90	"	3.3 k	"	"
R11,31,51,71,91	"	470	"	"
RV1-6	Potentiometer	25k	lin rotary	
RV21-26	"	25k	"	"
RV41-46	"	25k	"	"
RV61,62,66	"	25k	"	"
RV81,82,86	"	25k	"	"
C1,2,21,22,41	Capacitor	33pF ceramic		
C42,61,62,81,82	"	33pF	"	
C3,4,5	"	10μF 20 V elect. PC mounting		
IC!, 2,21, 22,41	Integrated Circuit	LM301A minidip		
IC42,61,62, 81,82	" "	"	"	
Q1,21,41,61,81	Transistor	BC548, BC108 or similar		
Q2,22,42,62,82	"	BC558, BC178 or similar		

LED 1,21,41,61,81 light emitting diode NSL5023 or similar
PC board ETI 601 b
Metal chassis as per Fig. 10
3 brackets as per Fig. 11
Recommended extras

1	6 pin plug Utilux type A2402-6
1	6 pin socket Utilux type M2139-6
1	8 pin socket Utilux type M2139-8
14	pins Utilux type M2138

PARTS LIST NOISE CONTROLLER

R1	Resistor	1M	¼ W	5%
R2	"	150k		
R3	"	33k		
R4	"	18k		
R5,6,7	"	10k		
R8,14	"	3.3 k		
R9,10,11,12,13	"	100k		
RV1,2	Potentiometer	25k lin rotary		
C1	Capacitor	0.47μF 25V elect. PC mounting		
C2	"	100pF ceramic		
C3	"	0.0022 polyester		
C4	"	0.001 "		
C5	"	0.015 "		
C6,7,8	"	33pF ceramic		
C9.10	"	10μF 20V elect. PC mounting		
IC1	Integrated Circuit	SCL4006AE*CMOS		
IC2	" "	SCL4030AE*CMOS		
IC3	" "	SCL4001AE*CMOS		
IC4,5,6,	" "	LM301A minidip		

*The prefix and suffix of CMOS varies from manufacturer to manufacturer.
SW1 Toggle switch DPDT C & K 7201 or similar

PC board ETI 601 f
Metal bracket as per Fig. 12.
Recommended extras

3	14 pin IC sockets Utilux type M1938-4 or similar
1	8 pin molex socket Utilux type M2139-8
8	pins for above socket Utilux type M2138