MUSIC

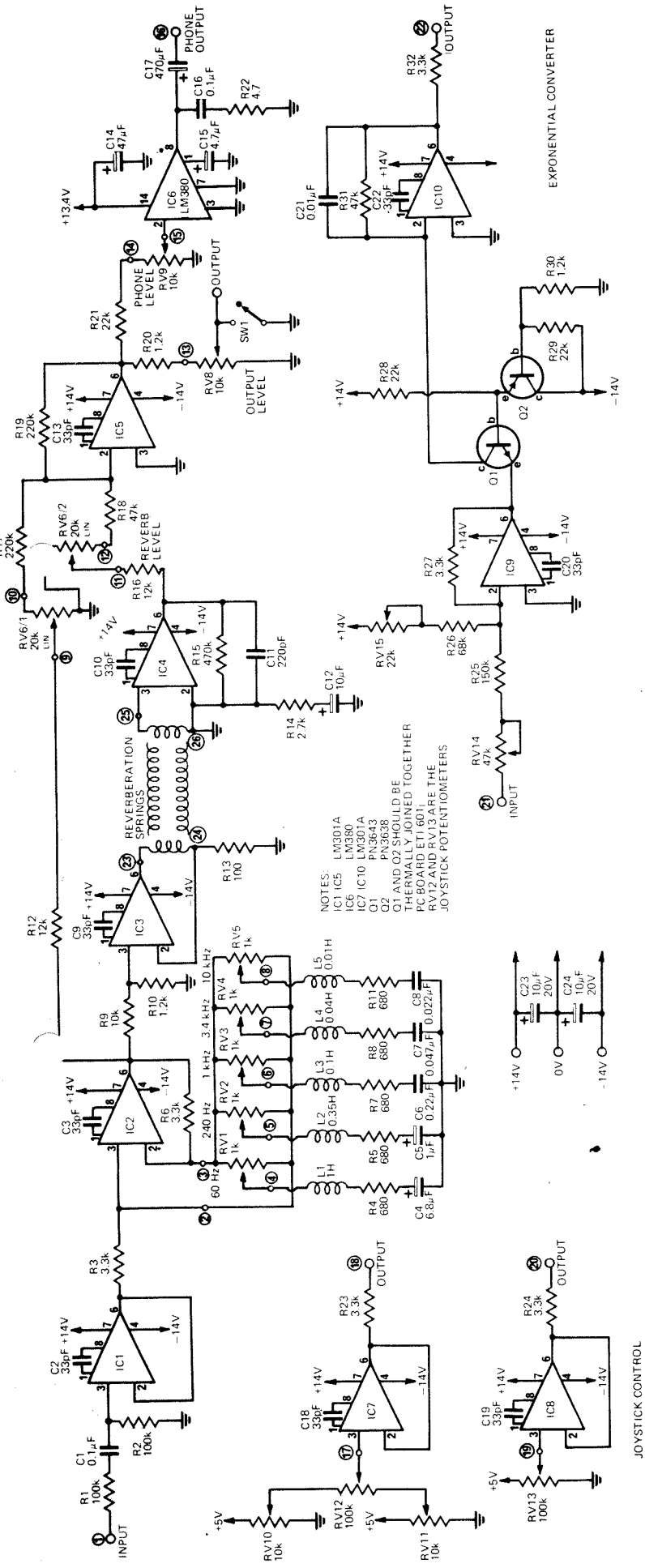

Fig. 1. Circuit diagram of the complete output stage, equalizer and exponential converter etc.

IN THIS issue we describe the output module which contains the equalizer, reverberation and output amplifiers as well as the joystick control buffers and an exponential converter.

CONSTRUCTION

The same procedure should be followed as previously described for other modules. Assemble the printed circuit board in accordance with the component overlay, Fig. 2., taking care with the orientation of polarized components. Wire the potentiometers and switches in accordance with Fig. 3.

CALIBRATION

The exponential converter is the only section of the circuitry that requires calibration. This should be carried out by applying 0 V to the input and adjusting RV15 to obtain 0.156 V, and then by applying 5 volts to the input and adjusting RV14 to obtain 5 volts output. The 0 V input should then be rechecked and the input/output relationship detailed in Table 1 should then exist. This characteristic ensures that a 1 volt change in input voltage will produce an output that, when applied to an oscillator or filter, will change its frequency by one octave. Thus a 5 volt input range provides a five octave frequency range.

The control range may be extended by reducing the 0.15V volt output at 0 volt input (R26 may need to be increased to obtain required range) however the 1 volt/octave relationship will no longer apply.

HOW IT WORKS

OUTPUT MODULE

This section can be broken into sections as follows.

INPUT BUFFER
EQUALIZER
REVERBERATION
OUTPUT AMPLIFIER
HEAD PHONE AMPLIFIER
JOYSTICK BUFFERS
EXPONENTIAL CONVERTER

The input buffer (IC1) has a 200 kΩ input impedance and gives an attenuation of 6 dB (½). The attenuation is required to prevent clipping in the equalizer output stage.

The output from the buffer is directly coupled to the input of the equalizer stage. This stage is a little unusual, since the equalizing networks are arranged to vary the negative feedback. If we consider one

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section with the others disconnected, at the resonant frequency of the series LCR combination the impedance of the entire network will be equal to 680 ohms. Either side of resonance the impedance of the network will increase (with a slope dependent on the Q of the network), due to uncancelled inductive reactance above resonance and uncancelled capacitive reactance below resonance. We can therefore represent the equalizer stage with equivalent circuits as reproduced below. These circuits consider only one network is in circuit, the input signal frequency is the resonant frequency of the network, and the resistance of the inductor is negligible.

With the slider of the potentiometer at the top end (Fig. A) we have 680 ohms to the zero volt line from pin 2 of IC2, and a 1 k ohm between pin 3 and pin 2. The IC will act due to the feedback to keep the potential between pins 2 and 3 virtually zero, thus there is zero current through RV1. The voltage on pin 3 (IC2) is therefore equal to the output of the mixer since there is virtually no current through and no voltage drop across R3.

The output of IC2 in this case is approximately the input signal times (R6 + 680)/680 ohms, indicating a gain of about 15 dB. If the slider is at the other end of the potentiometer (Fig. B) the signal appearing at pin 3 and thus also at pin 2 is about 0.2 of the output of the previous stage due to the voltage division of R3 and the 680Ω. There is still zero current through RV1 and also zero current through R6 since there is no path. The output voltage is therefore the same as that at pin 2, which happens to be about 0.2 times the ouput of the previous stage. The gain is therefore 0.2 – or –13 dB.

With all networks in circuit, the maximum boost and cut will be reduced, but a range of ± 10 dB is still available. With the wiper of the potentiometers set midway – Fig. C, the gain will be unity regardless of frequency, due to the symmetry of the entire network.

The equalizer output is attenuated by about 20 dB (0.1) and fed into the reverb driver IC3. The reverb is connected in the feedback of the IC in such a way that the drive is a constant current and not a constant voltage. This drive method provides a more uniform frequency response. Note that both sides of the input drive coil must be isolated from earth. This is achieved by removing the existing RCA socket and replacing it with an *insulated* socket making sure that it is completely isolated from the frame.

The output of the reverb unit is a very low amplitude signal which is amplified by IC4. The output of IC4 and the output of the equalizer (IC2) both go to RV6 which selects the percentage of each required.

The final amplifier, IC5, amplifies the output of RV6 and applies it to RV8 which adjusts the output level to the main amplifier. The output of IC5 also goes to the headphone amplifier IC6 (LM380). This IC will supply up to 1.5 watts into either headphones or a small loudspeaker.

The joystick simply supplies two voltages which vary between 0 and +5 V. The horizontal axis has both ends of the control potentiometer adjustable between 0 V and +5 V so that the range can be reduced or even reversed. Buffer amplifiers IC7 and IC8 prevent loading of the control potentiometers.

The exponential converter consists of IC9, Q1, Q2 and IC10. The input signal is inverted and attenuated by IC9. Potentiometer RV14 adjusts the gain and RV15 provides the required offset. The exponential relationship between the base-emitter voltage and collector current of a transistor (Q1) is used to provide the required law. Transistor Q2 provides temperature compensation. Note that Q1 and Q2 must be glued together to provide intimate thermal contact (see photograph). The collector current of Q1 is converted into a proportional voltage thus providing the input/output relationship detailed in Table 1.

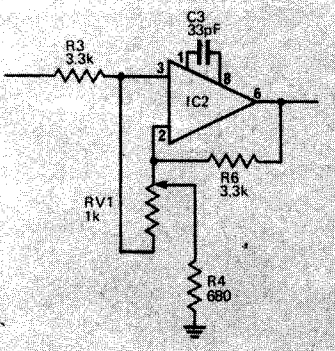


Fig.A. Equivalent circuit of the equalizer with potentiometer set for maximum boost at the resonant frequency of the network.

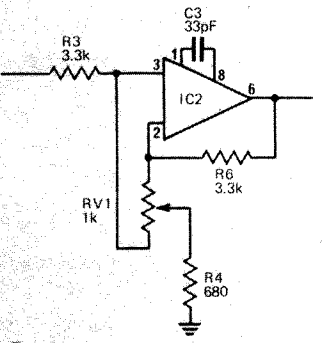


Fig.B. Equivalent circuit of the equalizer with the potentiometer set for maximum cut at the resonant frequency of the network.

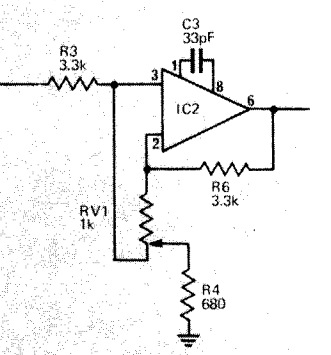
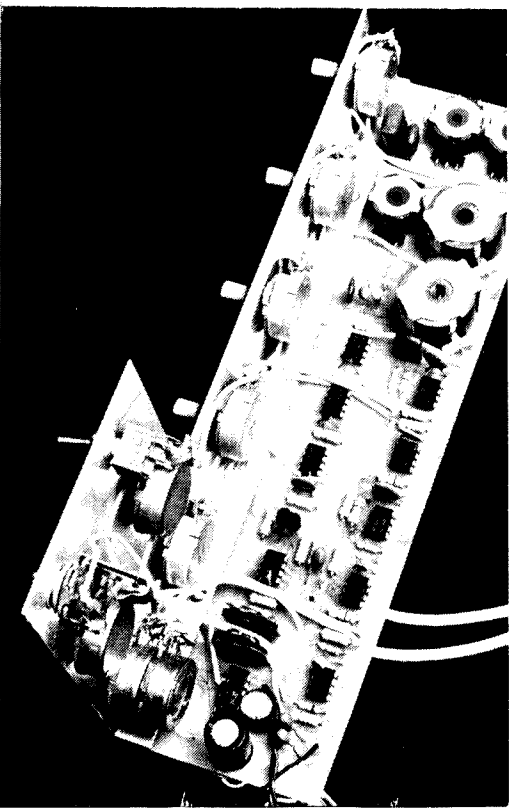


Fig.C. Equivalent circuit of the equalizer with the potentiometer set for unity gain regardless of frequency.

The output module.



PARTS LIST

OUTPUT STAGE

R22,	Resistor	4.7Ω	¼W	5%
R13	"	100Ω	"	"
R4,5,7,8,11	"	680Ω	"	"
R10,20,30	"	1.2k	"	"
R14	"	2.7k	"	"
R3,6,23	"	3.3k	"	"
R24,27,32	"	3.3k	"	"
R9	"	10k	"	"
R12,16	"	12k	"	"
R21,28,29	"	22k	"	"
R18,31	"	47k	"	"
R26	"	68k	"	"
R1,2	"	100k	"	"
R25	"	150k	"	"
R17,19	"	220k	"	"
R15	"	470k	"	"
RV1-5	Potentiometer	1k	lin rotary	
RV6	"	20k	dual lin rotary	
RV8,9	"	10k	log rotary	
RV10,11	"	10k	lin rotary	
RV12,13	"	special 100k joystick		
RV14	"	47k	trim	
RV15	"	22k	trim	
C2,3,9	Capacitor	33F	Ceramic	
C10,13,18	"	33F	"	
C19,20,22	"	33F	"	
C11	"	220µF	"	
C21	"	0.01µF	Polyester	
C8	"	0.022µF	"	
C7	"	0.047µF	"	
C1,16	"	0.1µF	"	
C6	"	0.22µF	"	
C5	"	1µF	35V PC electrolytic	
C15	"	4.7µF	25V "	
C4,	"	6.8µF	20V "	
C12,23,24	"	10µF	20V "	
C14	"	47µF	20V "	
C17	"	470µF	10V "	
IC1-5	Integrated circuit	LM301A	miniclip	
IC7-10	"	LM301A	"	
IC6	"	LM380	14 pin DIL	
Q1	Transistor	PN3643		
Q2	"	PN3638		
L1	Choke	1H		
L2	"	0.35H		
L3	"	100mH		
L4	"	40mH		
L5	"	10mH		

Reverb spring Plessey type 51 or equivalent
Metal bracket to Fig
SW1 toggle switch SPST
6.5 mm phone socket.

TABLE 1. CALIBRATION EXPONENTIAL CONVERTER

INPUT	OUTPUT	
0V	0.15625V	*
1V	0.3125V	
2V	0.625V	
3V	1.25V	
4V	2.5V	
5V	5V	**
6V	10V	

* adjust RV15 with 0V input to obtain 0.156V output.
** adjust RV14 with 5V input to obtain 5V output
(note that these adjustments must be done in the above sequence).

TABLE 2. WINDING DATA EQUALIZER CHOKES

L1 1000 turns 34 B&S

Ferrite Core	Philips	4322-022-29310
Former	Philips	4302-021-20030
Clip	Philips	4302-021-20020

L2 585 turns 32 B&S
Core, former clip same as L1

L3 460 turns 34 B&S

Ferrite Core	Philips	4322-020-24280
Former	Philips	4302-021-20010
Clip	Philips	4302-021-20000

L4 300 turns 34 B&S
Core, former and clip same as L3

L5 150 turns 32 B&S
Core, former and clip same as L3

ERRATA

Music Synthesizer. March 1974, page 76 Parts List – Voltage Controlled Filter. 7th line should read R12, 13, 16 **not** R7, 8, 14 as shown.

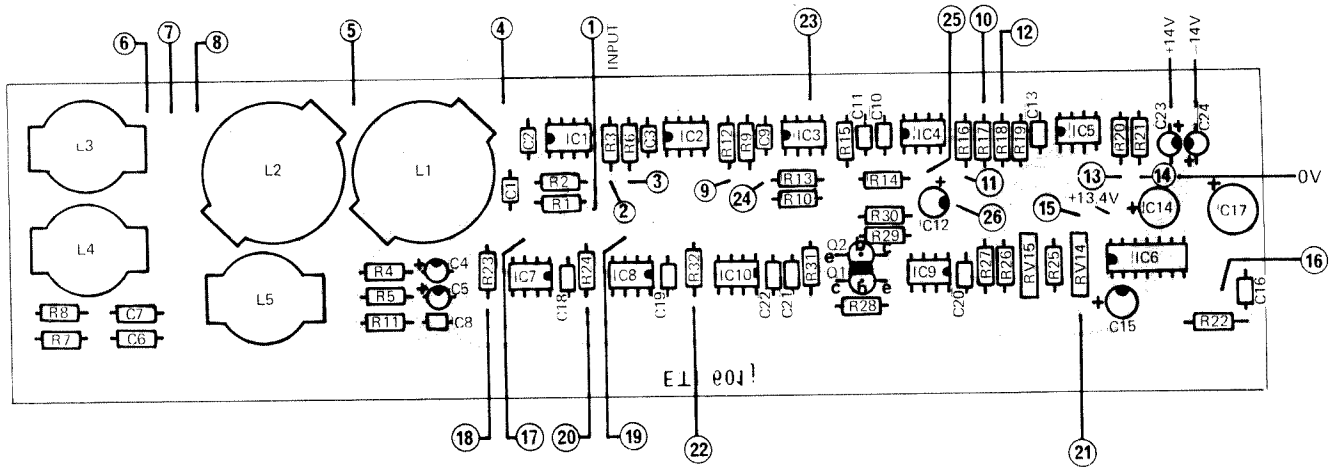


Fig.2. Component overlay for the output module.

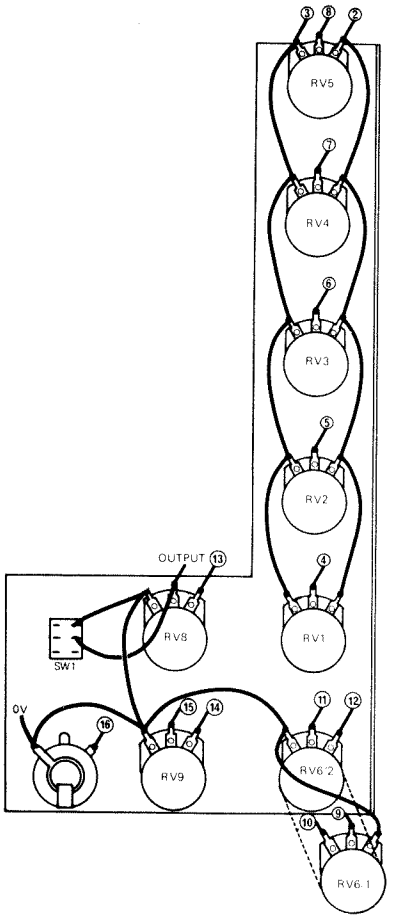


Fig.3. Wiring to output module potentiometers.

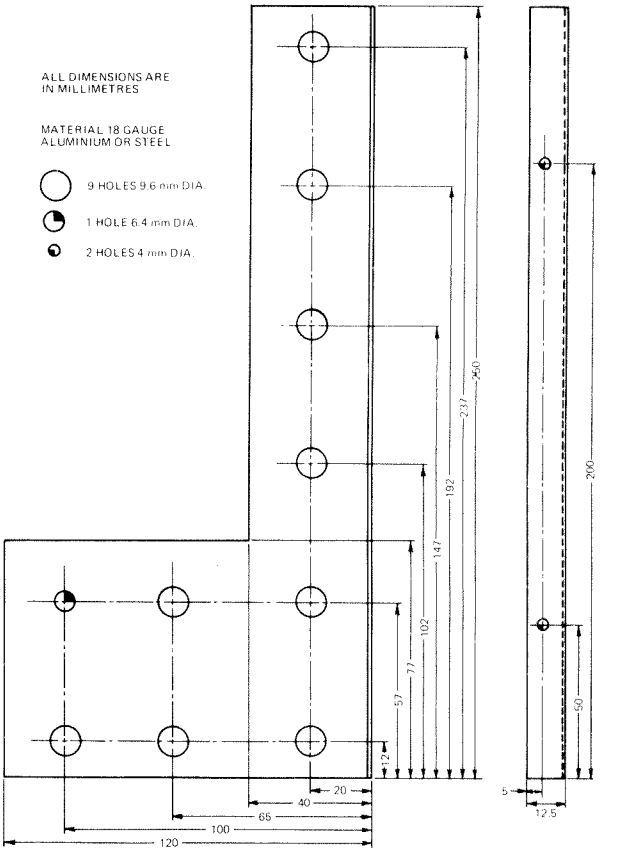
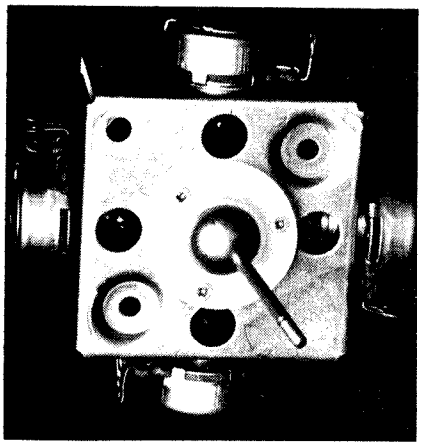
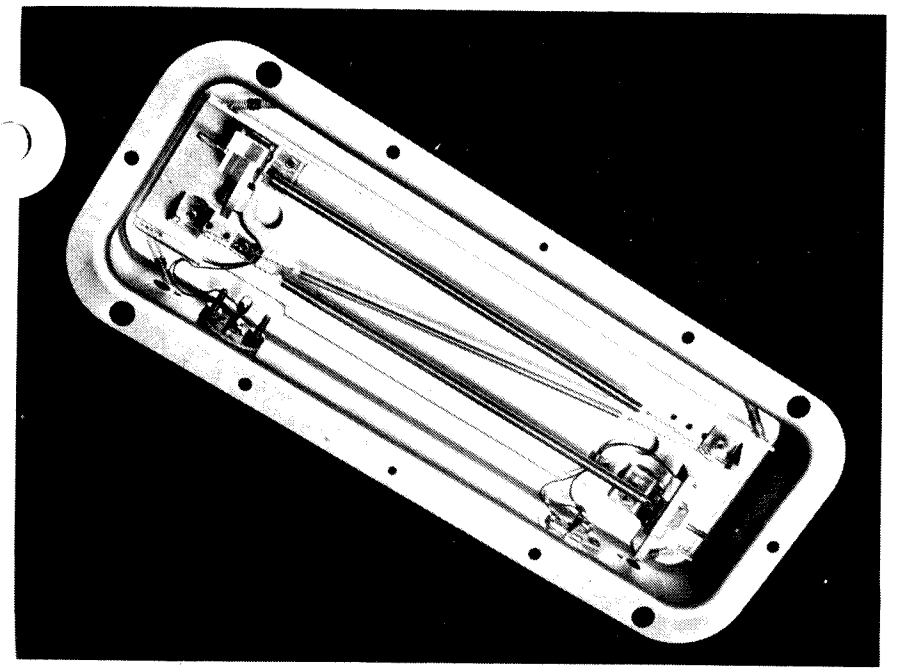


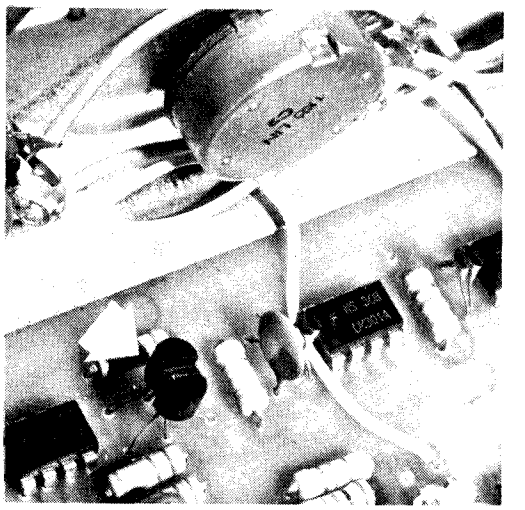
Fig.4. Drilling details of output module sub-panel.



The joystick control potentiometer (available shortly from John Carr Pty Ltd).



Interior of the spring-reverberation unit. The insulated RCA socket may be seen on the left.



The exponential converter transistors Q1 and Q2 (arrowed) are glued together to ensure thermal balance.