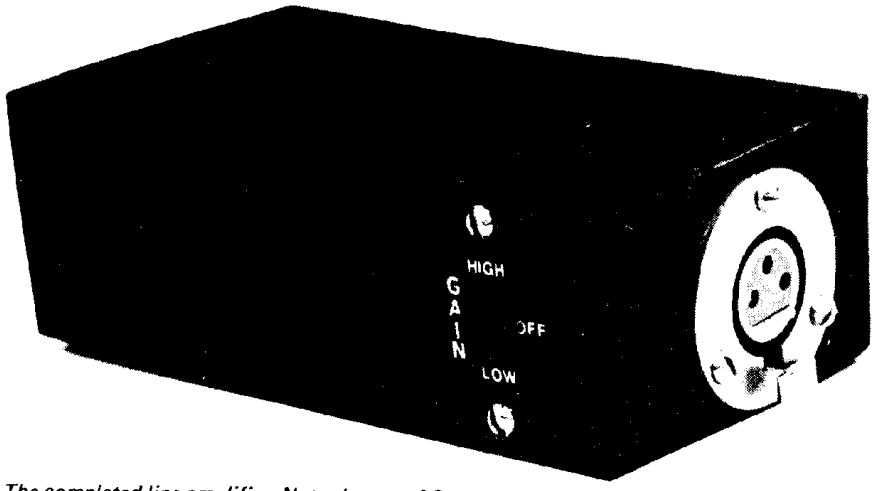
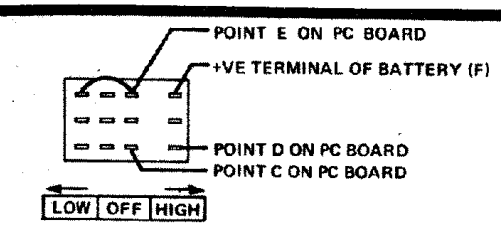
LINE AMPLIFIER

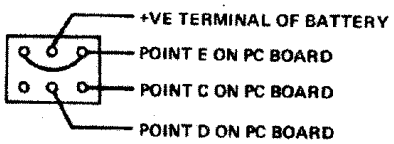
Boost microphone output with this low noise amplifier.



The completed line amplifier. Note the use of Cannon plugs and the gain switch on the side.

Wiring of DPDT toggle switch with centre off position.





PROJECT 430

MODERN high quality microphones are low impedance units having a very low output voltage. To minimize noise, picked up on long leads, it is usually necessary to use special balanced and screened leads together with balancing transformers. An alternative approach is to use a low noise amplifier to boost the signal *before* passing it down the cable. The ETI 430 line amplifier, described here, is intended for this purpose.

Such a unit, when used with the ETI Master Mixer (described in April, May, June and July 1973) provides either 20 or 40 dB of gain prior to the mixer. This allows the mixer to be used on the low-sensitivity range. Thus the larger signal now available, effectively over-rides the inherent noise of the first amplifier in the mixer.

The overall effect of using such an amplifier is to vastly improve the signal-to-noise ratio of the particular microphone channel and to eliminate the need for an expensive balanced and screened cable and balancing transformer.

To reduce the possibility of mains hum pickup we have used a small nine volt battery to power the unit. Since the current drawn is a mere 0.5 mA, the battery should last about three to

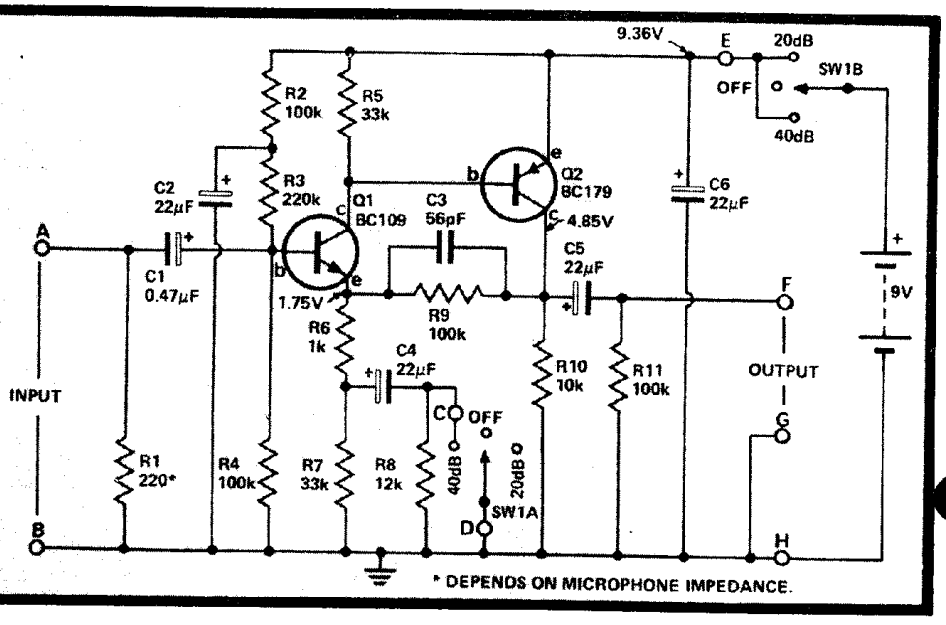
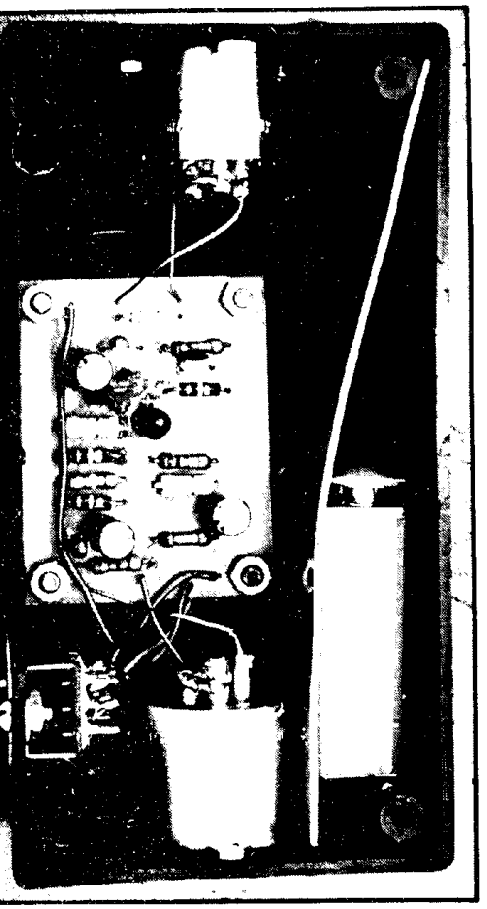


Fig. 1. Circuit diagram of the microphone line amplifier. Voltages shown are typical and as measured on our prototype.



Internal layout of the line amplifier.

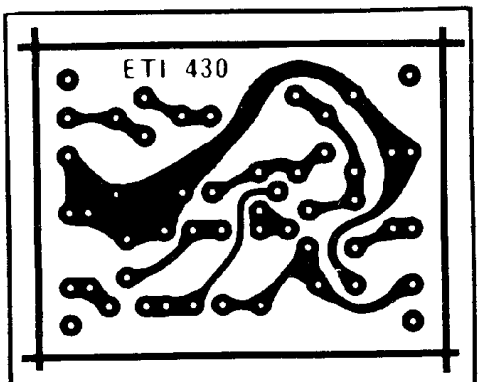


Fig.2. Printed circuit board layout for the amplifier. Full size 55 x 42 mm.

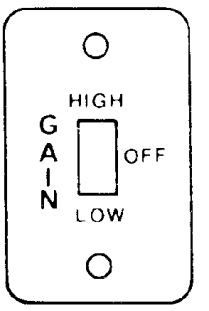


Fig.3. Artwork for the gain switch label. (Shown full size).

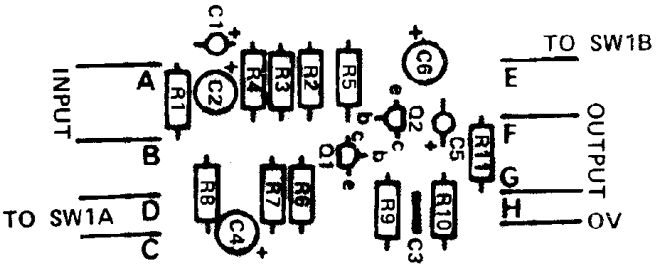


Fig.3. Component overlay. Note particularly the orientation of the transistors and electrolytic capacitors.

four hundred hours before replacement is required.

The ETI line amplifier can of course be used to great advantage with any recording equipment where low noise operation is necessary. When used with the Master Mixer the low impedance input should be used but the terminating resistor (fitted across the mixer input socket) should be removed so that a 4.7 k input impedance is obtained.

CONSTRUCTION

The circuit is not critical in any way hence, practically any construction method may be used. However, the use of the printed circuit board specified will considerably simplify construction.

We used an unbreakable plastic box (polycarbonate) to house our unit but if the unit is to be used in the proximity of power cables etc it would be advisable to mount the unit in a metal box (diecast or similar). This is especially so if an input impedance above 1 k is to be used as the higher the impedance the more likely is hum pickup.

If Cannon plugs are used, as in our prototype, pins 1 and 2 should be linked and used as the earth line. Pin 3 is then used as the active line.

MEASURED PERFORMANCE

IMPEDANCE			
Input			selectable up to 68k max
Output			≈ 1.5k
GAIN			
High			40 dB
Low			20 dB
OUTPUT VOLTAGE			
Maximum			3 volts
INPUT VOLTAGE			
Maximum (high range)			30 mV
Maximum (low range)			300 mV
FREQUENCY RESPONSE			
10 Hz – 30 kHz			+0 – 3 dB
EQUIVALENT INPUT NOISE			
(referred to 1 mW into 600Ω)			
High Range			–110 dBm
Low Range			– 102 dBm
DISTORTION			
Output Voltage	100 Hz	1 kHz	6.3 kHz
300 mV	<0.1%	<0.1%	<0.1%
1 V	0.17%	0.2%	0.17%
2 V	0.5%	0.5%	0.5%
3 V	1.75%	1.8%	1.7%

LINE AMPLIFIER

HOW IT WORKS – ETI 430

The line amplifier is basically a two transistor amplifier having a selectable gain of either 20 dB (x10) or 40 dB (x 100).

The input impedance of the amplifier (referring to Fig. 1) is determined by the combined values of R1, R3 and R4 – all in parallel. The parallel impedance of R3 and R4 is 68 k and this is therefore the upper limit of input impedance (R = ∞).

For impedances less than 5 k the values of R3 and R4 may be ignored and R1 is set to the same value as the desired input impedance. Hence the circuit as shown matches microphones having 200 ohm output impedance.

Resistor R2, in conjunction with R3 and R4 determines the dc bias for transistor Q3 whilst capacitor C2 decouples the input bias network from any supply rail noise. The output of Q2 is fed back to the emitter of Q1 thus providing negative feedback which as well as supplying a dc bias, sets the ac gain of the stage.

The gain of the amplifier may be calculated using the following formula (assuming ideal transistors).

$$\text{Gain} = \frac{R9 + R6 + (R7//R8)}{R6 + (R7//R8)}$$

Thus for R8 = 12 k the gain is 11.2 or 21 dB. For R8 = 0 the gain is 101 or 40 dB. The actual gain obtained is slightly lower than this due to the finite betas of the transistors used.

The value of capacitor C3 determines the upper 3 dB point of 30 kHz whilst capacitors C1, C4 and C5 all give individual break points at the low end of 5 Hz, 7 Hz and 1.5 Hz respectively.

PARTS LIST – ETI 430

R1	resistor	selected to suit input impedance
R2,4, 9,11	"	100 k ¼W 5%
R3	"	220 k " "
R5,R7	"	33 k " "
R6	"	1 k " "
R8	"	12 k " "
R10	"	10 k " "
C1	Capacitor	0.47µF 25V TAG
C2,4,5,6	"	22µF 16V electrolytic
C3	"	56pF ceramic
Q1	Transistor	BC109 etc.
Q2	"	BC179 etc.
SW1	Switch 2 pole 3 position slide or 2 pole centre off toggle	
PC board ETI-430		
Cannon sockets (male and female)		
Cord plugs =		
Box to suit (preferable metal), 9 V battery and clip input and output sockets etc.		