DATA FILE

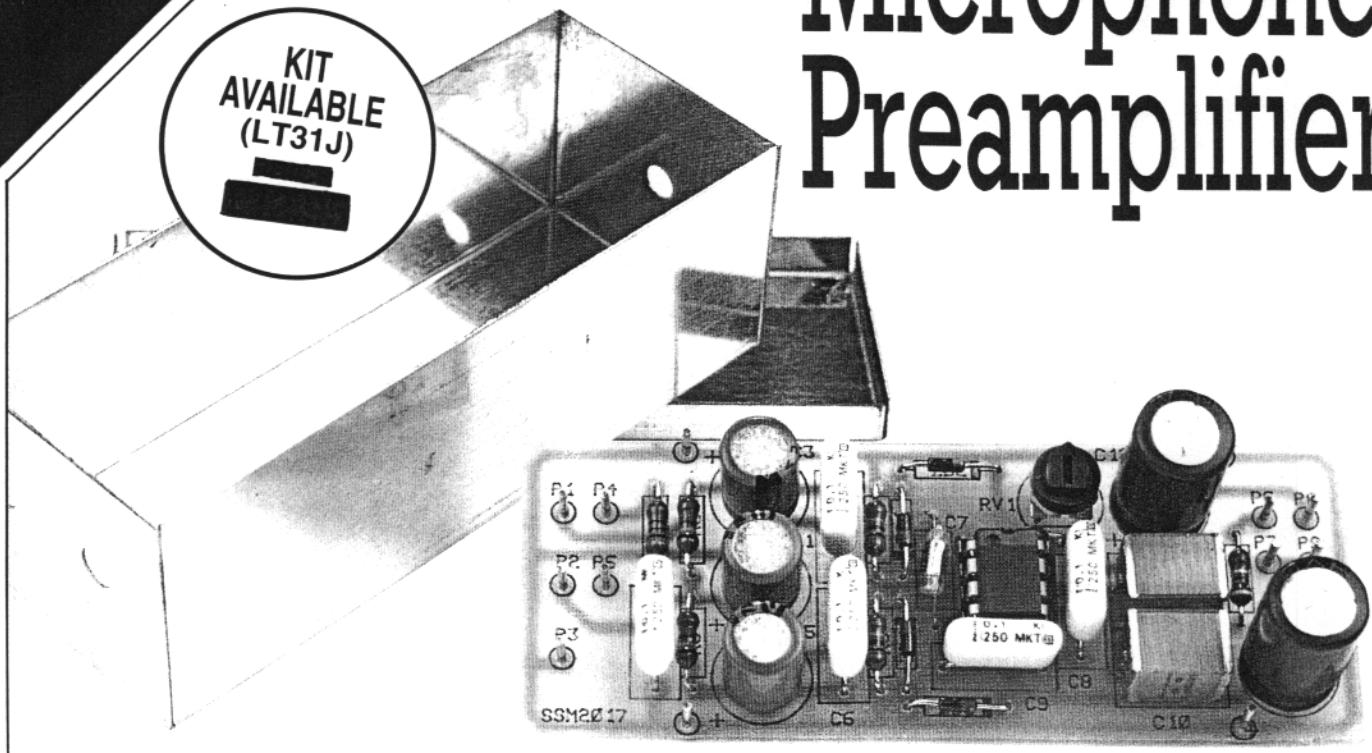
'Data Files' are intended as 'building blocks' for constructors to experiment with and the components suggested, provide a good starting point for further development.

XU33L

2 PROJECT RATING

SSM2017 Microphone Preamplifier

KIT AVAILABLE (LT31J)



Design by Max Horsey and Philip Clayton (Radley College) Text by Max Horsey and Martin Pipe

FEATURES

★ Low noise ★ Low distortion ★ Configurable for use with both balanced and unbalanced microphones ★ High slew rate ★ Wide bandwidth ★ Phantom powering for capacitor-type microphones ★ High gain (over 70dB) obtainable

APPLICATIONS

★ Mixers ★ Tape recorders ★ Uprating existing equipment

The SSM2017 IC, at the heart of this project, is a latest-generation audio preamplifier which is particularly suitable for use as a balanced microphone amplifier. It features an ultra-low noise level (around $2nV/\sqrt{Hz}$), wide bandwidth and high slew rate. It requires a dual rail supply of between $\pm 6V$ and $\pm 22V$, and is available in an 8-pin DIL package. Whilst aimed at balanced applications, it can also be used with unbalanced microphones.

Pin Connections

Figure 1 shows the pin connections of the IC. The reference terminal (pin 5) is normally connected to ground, it can also be used for offset correction or level shifting.

Figures 2a and 2b show the various ways in which connections may be made to the IC. Figure 2a is for 'single-ended' devices (e.g., unbalanced microphones), where the screen or ground is connected to 0V in the circuit, and the signal is connected to the non-inverting input. Note that the unused input must also be connected to 0V. The capacitor removes any unwanted ultrasonic frequencies that may appear at the input.

Figure 2b shows the usual way of connecting a balanced microphone. The two resistors provide DC bias to keep the DC input voltages to within an

SPECIFICATION

THD:	<0·01dB (gain = 40dB)
Noise:	2nV/√Hz (typ.)
Bandwidth:	1MHz (gain = 40dB)
Slew Rate:	17V/μS (typ.)
Power Supply:	±6V to ±22V DC @ 14mA (max) per rail; 48V DC for phantom supply
Common-Mode Rejection Ratio (CMRR):	92dB (typ.)
Gain Adjustment (RV1 = 5kΩ, R6 = 10Ω):	10dB (x3·2) to 60dB (x1000)

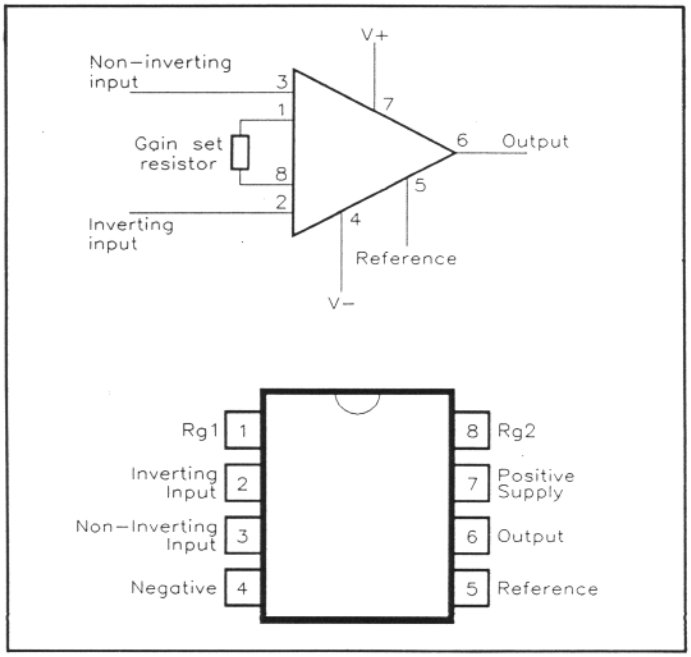


Figure 1. SSM2017 pinout.

acceptable range. The microphone screen is connected to 0V, the 'in-phase' signal is connected to the non-inverting input (pin 3), and the 'out-of-phase' signal is connected to the inverting input (pin 2).

Phantom Powered Microphone

When using an *electret* microphone *without* its own internal power supply, phantom powering may be supplied, using the circuit shown in Figure 3. ZD1 to ZD4 are present to provide transient over-voltage protection for the SSM2017, in those instances when microphones are connected to, or disconnected from, the circuit.

Gain

Pins 1 and 8 are for the connection of a gain-setting resistor, R_g. The gain of the

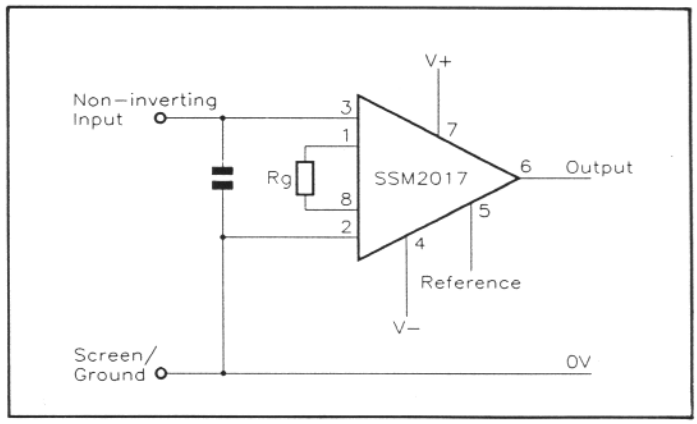


Figure 2a. Single-ended input.

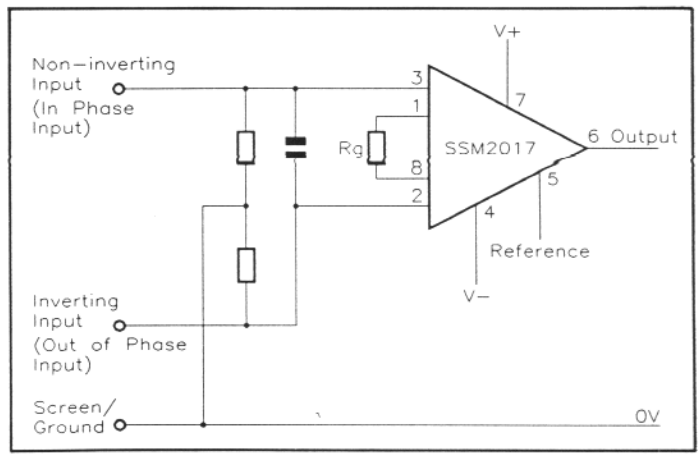


Figure 2b. Differential/balanced input.

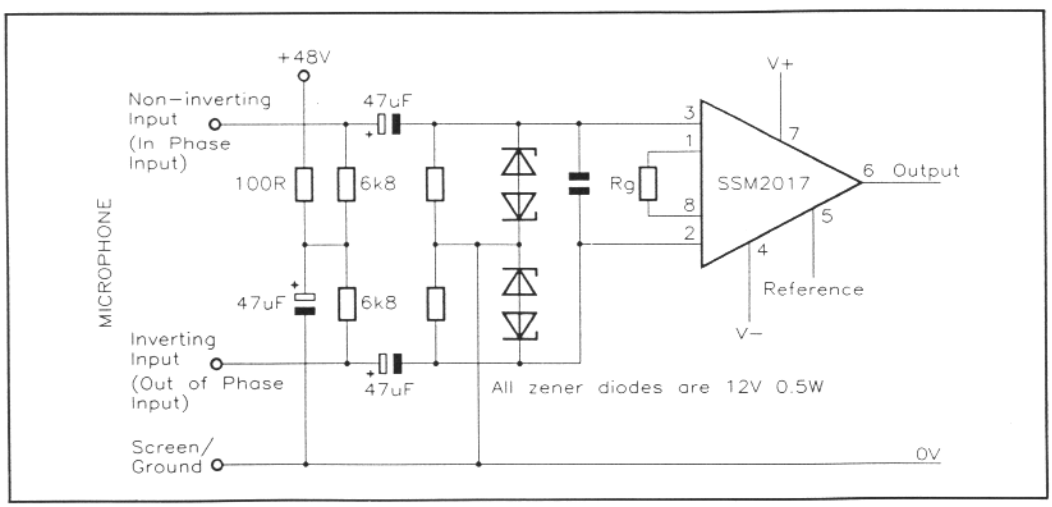


Figure 3. Phantom powering of capacitor-type microphones.

circuit is determined by the formula:

$$\text{Voltage Gain} = \frac{10k\Omega}{R_g} + 1$$

where R_g is the value of the gain set resistor.

The following table provides some typical values:

Voltage Gain	dB	$R_g(\Omega)$
1	0	open
3·2	10	4,700
10	20	1,100
31·3	30	330
100	40	100
314	50	32
1,000	60	10

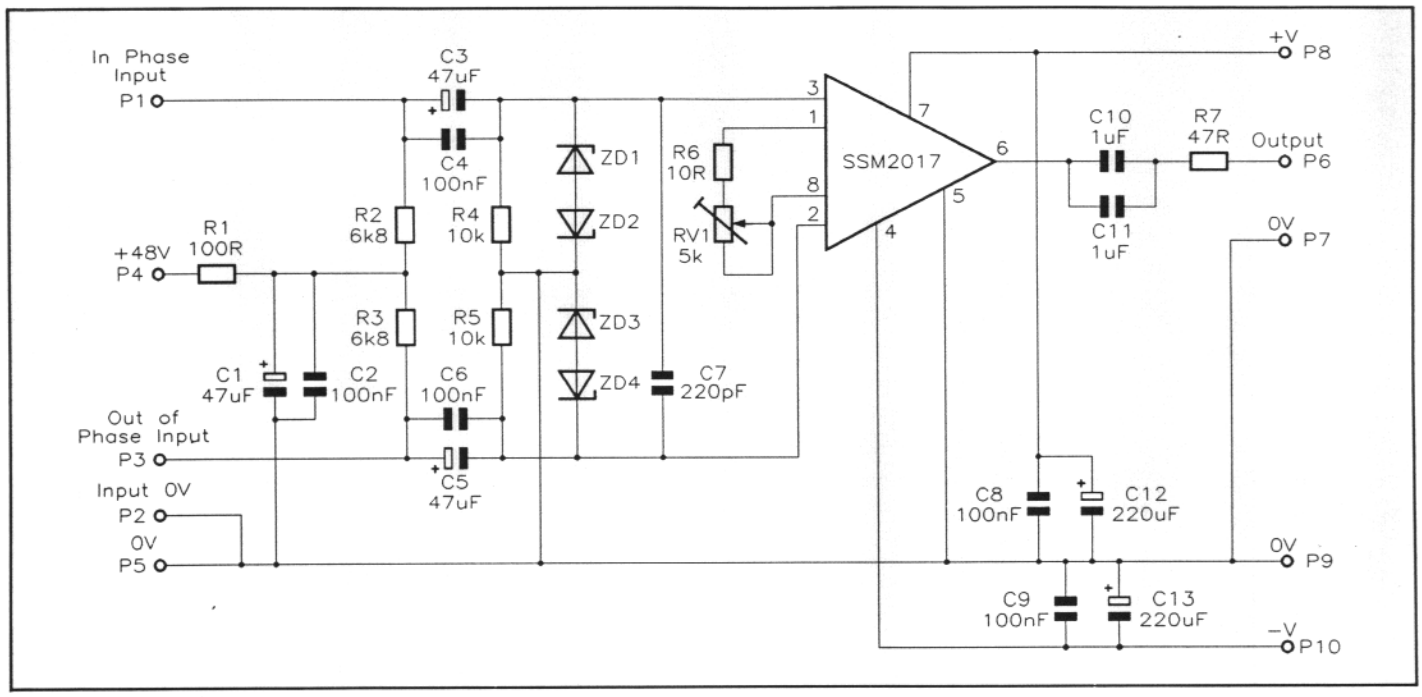


Figure 4. Circuit diagram of SSM2017 Microphone Preamplifier.

If the gain set resistor is removed, the gain will be unity (i.e. 0dB). If the resistor value is reduced to zero, the gain will – theoretically at least – be infinite. In reality, the maximum gain permitted is 3,500 (approximately 71dB).

The gain may be controlled by a fixed resistor or a variable type – there is preset provision on the PCB.

The SSM2017 Microphone Preamplifier Circuit

In the fully-fledged circuit of Figure 4, resistors R4 and R5 provide the DC bias as described earlier, and C7 removes unwanted high-frequencies. C1 and C2 decouple the phantom power supply, forming a simple RC filter with R1 that rejects any noise that would otherwise be introduced.

Gain Control

RV1, the gain set resistor, has a value of 2k2. This could be a fixed resistor if you know in advance the gain required and desire maximum reliability, or a preset (a space is available on the PCB). Coupling capacitors C3 & C4 and C5 & C6 prevent the flow of DC (i.e. the phantom power), but allow the passage of the AC audio signal. The reason for using 47μF and 100nF capacitors in parallel for each input is to maintain an even frequency response across the audio band – paradoxically, the 100nF capacitor has a lower reactance at higher frequencies than the 47μF capacitor! (this is due to the higher Equivalent Series Resistance – ESR – of electrolytic capacitors).

Resistor R6 ensures that the total resistance cannot fall below 10Ω, otherwise the gain would be too high.

Provision has been made on the PCB for a preset to set the gain. This could be replaced by a fixed resistor soldered between the original wiper connection on the PCB, and the pad that is electrically connected to the 'free' end of R6.

Output

The output from the IC is delivered via a 2μF capacitor (two 1μF capacitors – C10 and C11 – in parallel). This allows the AC audio signal to flow, but prevents the flow of any DC that may be present. Resistor R4 greatly reduces the chance of HF ringing on the output, which could otherwise occur. The value of R4 is too low to significantly attenuate the output signal. The final components are the power supply decoupling capacitors (C8 & C12 for the positive rail, and C9 & C13 for the negative rail).

Using Unbalanced Microphones

An unbalanced microphone may be used by connecting the amplifier's *out of phase* input (leading to pin 2) to 0V, as shown in Figure 2a. The microphone signal must be connected to the in phase input, and the microphone screen to 0V.

PCB Construction

Making up the PCB should be a fairly straightforward job – those inexperienced in such matters should refer to the *Constructors' Guide* supplied with the kit. For your assistance, the PCB legend

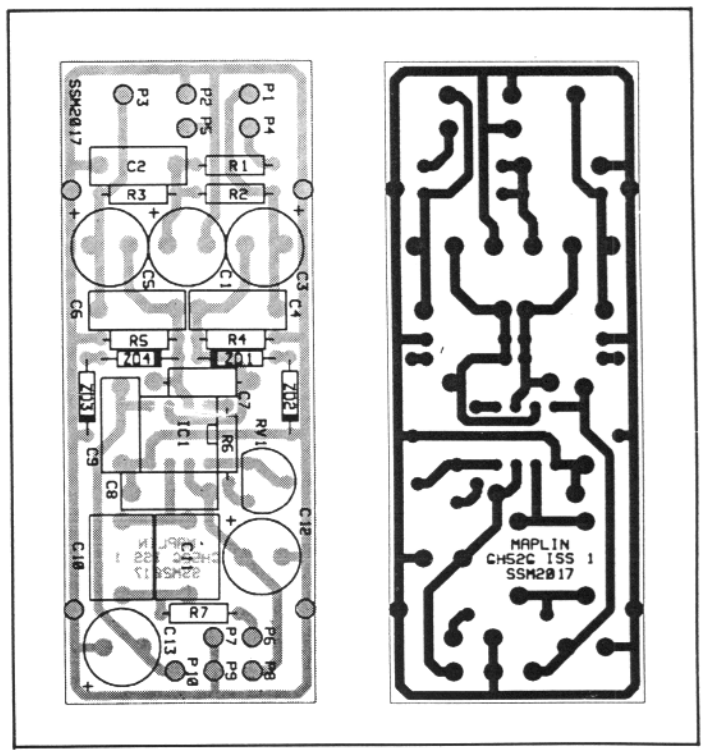


Figure 5. PCB legend and track.

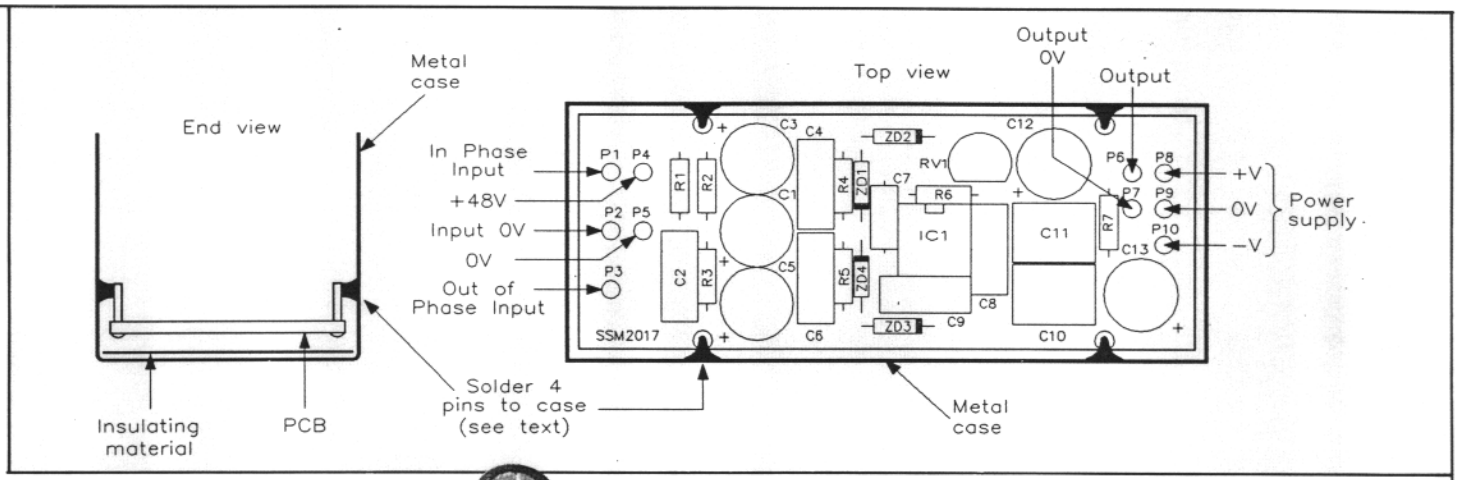
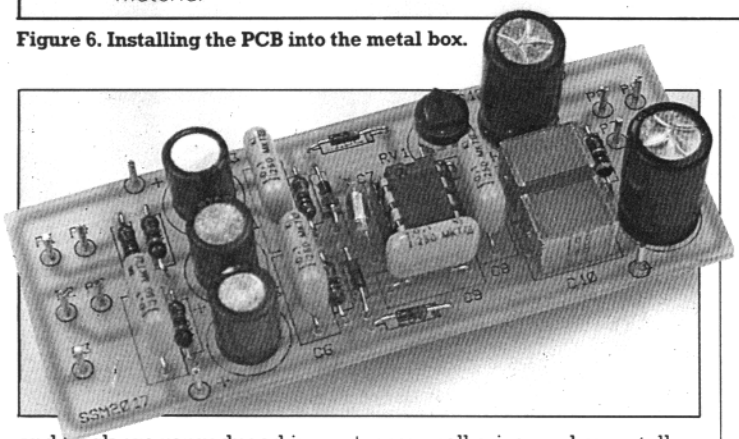


Figure 6. Installing the PCB into the metal box.



and track are reproduced in Figure 5. First fit the resistors, noting the arrangements for the gain-setting resistor (R6 & RV1), as discussed earlier. The capacitors should follow next; note that the electrolytic capacitors must be fitted the correct way round (the '−' symbol embossed on the side of the capacitor must face away from the '+' symbol of the PCB legend). The Zener diodes (ZD1 to ZD4) can now be fitted to the PCB; note that the band on the body of each diode should line up with the band on the PCB legend. Next, fit the PCB pins (these are fitted from the track side of the board), followed by the 8-pin DIL IC socket. This should be aligned, prior to soldering, so that the notch on its body should line up with the notch printed on the legend. The PCB is now complete, and should be checked for silly mistakes and solder bridges, etc., before final assembly and testing of the circuit.

Final Assembly

It is important that the SSM2017 Microphone Preamplifier is built into a metal case. Such screening is important, bearing in mind the high gains. If not included, hum problems may well arise, and crosstalk from other channels may be noticed. If several SSM2017 Microphone Preamplifiers are to be used, it is important, therefore, that each has its own screening; for this reason, a metal box of suitable dimensions (FD20W) is included in the kit.

For the purpose of this article, we will assume that you are installing this project inside a mixer. The SSM2017 Microphone Preamplifier is a versatile unit, though, and can be installed according to your particular requirements, provided that the same logic is applied.

Once you are satisfied with the constructional standard of your preamplifier, the PCB can be installed into the metal box as shown in Figure 6. It is advisable to place a piece of card at the bottom of the box, to prevent the possibility of the PCB shorting out against the metal. Note that the PCB is suspended in the box at four points (i.e. the four solder pins that are soldered to the walls) – these also provide a ground connection to the box.

Make up leads of sufficient length to go to the microphone socket (XLR and jack connections are shown in Figure 7), and to the unbalanced input terminals of your mixer. A cable suitable for all balanced-line connections within a piece of equipment is XS23A. For all external work, a more robust cable (e.g., XR08J) should be used. For the unbalanced audio connections, XR18U is a good low-noise screened cable, and would be ideal for use within a mixer or similar piece of equipment for this application. Again, for exterior use something more robust is required – a cable such as XS24B would be a good choice here. The final wiring consideration is that of the power supply; a split-rail DC supply (±6V to ±22V), capable of yielding 20mA or so on each rail, must be used. Standard 7/0·2 'hook-up' wire should be used here, red should be used for the +V lead, black for the −V, and green for 0V. **At this stage, prepare the leads (tin their ends, etc.), but do not solder them yet.**

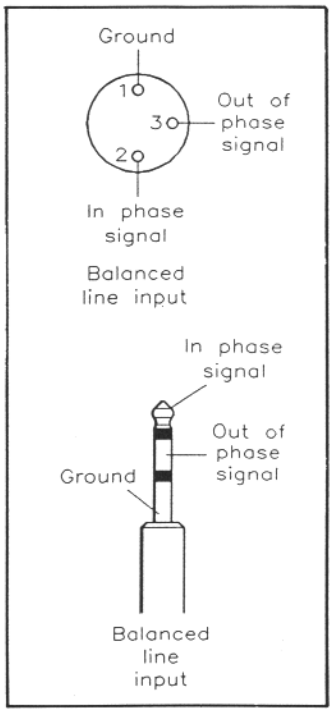


Figure 7. XLR and ¼in. jack plug connections.

To provide a neater finish, and to prevent the wires from chafing against the holes (note that the end-faces of the box have been pre-drilled), grommets should be used; note that these items are not supplied in the kit. If desired, a hole could be drilled in the top of the lid so that you have access to RV1, the gain control. Pass the wires through the holes, and then solder them to the appropriate pins on the PCB, as shown in Figure 6. Route the other end of each cable to its relevant destination, and solder it in place. IC1 may be fitted now.

Testing

The best way of testing the SSM2017 Microphone Preamplifier is to use it in its intended application – i.e., in the example given in this article one would plug in a microphone, power up the mixer and monitor the output through a pair of headphones. The mixer's internal VU meter will provide a rough guide when adjusting gain control RV1, assuming that this is fitted. Once tested, the upper case can be mated with the lower case; the two halves can then be held together with a blob of solder. Don't go too overboard, though – you might need to get back inside the unit again!

SSM2017 PARTS LIST

RESISTORS: All 0·6W 1% Metal Film (unless stated)			
R1	100Ω	1	(M100K)
R2,3	6k8	2	(M6K8)
R4,5	10kΩ	2	(M10K)
R6	10Ω	1	(M10R)
R7	47Ω	1	(M47R)
RV1	5kΩ Cermet Preset	1	(WR41U)
CAPACITORS			
C1,3,5	47μF 63V PC Electrolytic	3	(FF09K)
C2,4,6,8,9	100nF Polyester	5	(BX76H)
C7	220pF 1% Polystyrene	1	(BX49D)
C10,11	1μF Poly Layer	2	(WW53H)
C12,13	220μF 35V PC Electrolytic	2	(JL22Y)
SEMICONDUCTORS			
ZD1,2,3,4	BZY88C 12V 500mW	4	(QH16S)
IC1	SSM2017	1	(CP89W)
MISCELLANEOUS			
	Pin 2145	10	(FL24B)★
	8-pin DIL IC Socket	1	(BL17T)
	Metal Box	1	(FD20W)
	PCB	1	(GH52G)
	Instruction Leaflet	1	(XU33L)
	Constructors' Guide	1	(XH79L)
OPTIONAL (Not in Kit)			
Twin-core Screened Cable		(e.g. XS23A or XR08J) As required	
Single-core Screened Cable		(e.g., XR18U or XS14B) As required	
	Wire 7/0·2 10m Black	1	(BL00A)
	Wire 7/0·2 10m Red	1	(BL07H)
	Wire 7/0·2 10m Green	1	(BL03D)

The Maplin 'Get-You-Working' Service is not available for this project.

The above items (excluding Optional) are available as a kit.

Order as LT31J (SSM2017 Microphone Preamp).

Please Note: Items in the Parts List marked with a ★ are supplied in 'package' quantities (e.g., packet, strip, reel, etc.), see current Maplin Catalogue for full ordering information.

The following new item (which is included in the kit) is also available separately.

SSM2017 Mic Preamp PCB **Order As GH52G.**

MAPLIN

MAPLIN ELECTRONICS PLC
P.O. Box 777, Rayleigh, Essex, SS6 8LU,
United Kingdom
Telephone: +44 (0) 1702 554000
Fax: +44 (0) 1702 554001
Email: Sales@maplin.co.uk
World Wide Web: http://www.maplin.co.uk