A Gain Controlled Microphone Preamp

By JOHN CLARKE

Designed for use with PA systems, this gain controlled microphone preamplifier will provide a constant output level for a wide range of input levels. It ensures that the amplified sound level is always the same, regardless as to how loudly (or softly) a person speaks.

How often have you heard a public address system where the sound level varies all over the place? This problem occurs because different people speak at different sound levels. For example, if the person using the microphone speaks loudly, then the gain control has to be reduced to bring the amplified sound back to the correct level (or to prevent overload). Conversely, if the person speaks quietly, then the gain control has to be advanced to maintain good audibility.

Indeed, a very quiet talker may not provide enough signal to ensure an adequate sound level, even if the amplifier is set to maximum gain.

Level fluctuations can also be caused by people who turn their heads from side to side as they speak, and by people who alternately move closer to and further away from the microphone.

A sound system operator can compensate for some of these problems by riding the gain control on the amplifier. However, there is always a delay in the response because the operator first has to hear the incorrect level before making changes. Another approach is to use a less directional microphone to reduce level variations from people who move around while speaking but this greatly increases the risk of feedback.

A gain controlled microphone preamplifier, such as the unit described here, will help to solve these problems. It automatically varies its gain in response to the microphone signal to ensure that a constant level is fed to the PA amplifier. As the output signal level from the microphone goes down, the gain of the microphone preamplifier goes up, and vice versa.

As a result, the amplified audio level is essentially constant for virtually all people, regardless of their speaking style or how they move about in front of the microphone. In effect, it's just like having a person constantly riding the gain control on the amplifier, except that it's all automatic. And of course, an electronic circuit responds

Main Features

- Suitable for dynamic microphones
- Balanced input
- Constant output over 50dB input range
- Powered by 9VDC plugpack
- Low input impedance
- Low distortion
- Fast response

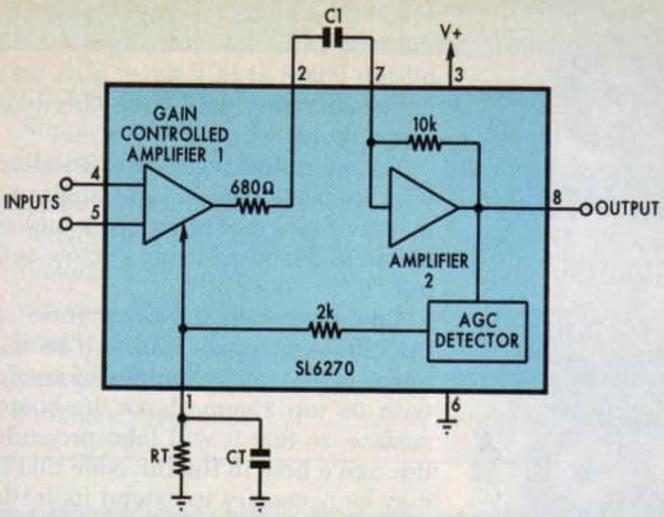


Fig.1: block diagram of the Plessey SL6270DP voice operated gain adjusting device (VOGAD). It contains two amplifier stages & an AGC detector block.

far quicker to any level changes than a human operator, so that the adjustments are imperceptible.

In technical terms the preamplifier has a gain of around 50dB for low input signal levels (ie, 70μV) but limits once the input signal reaches about 1mV. The output signal level remains virtually constant at 100mV for input signals ranging from 1mV to beyond 100mV.

As can be seen from the accompanying photograph, the unit is housed in a small low-cost plastic case. A 3-pin XLR socket fitted to one end of the case accepts a balanced microphone input, while a 6.5mm phono socket on the other end provides the single-ended (or unbalanced) output signal. Power for the circuit comes from a 9V DC plugpack supply.

Block diagram

Refer now to Fig.1 – this shows a block diagram of the Plessey SL-6270DP voice operated gain adjusting device (VOGAD) which forms the heart of the circuit. Let's see how it works.

Inside the SL6270DP IC are two amplifier stages and an AGC detector block. The AGC detector monitors the output level from amplifier 2 and provides a DC control signal which sets the gain of amplifier 1.

In greater detail, amplifier 1 is a DC-controlled balanced input amplifier which accepts signals from the microphone. This stage in turn drives amplifier 2 via a 680Ω resistor and external capacitor C1 which rolls off the low-frequency response.

Amplifier 2 has a gain of about 15, as set by the 10kΩ feedback resistor and the 680Ω input resistor. Its output appears at pin 8 and is also fed to the AGC (automatic gain control) detector block which provides the DC control signal. The 2kΩ resistor and external capacitor C_T set the AGC attack time, while R_T provides a discharge path for C_T.

Finally, the control voltage across C_T is applied to amplifier 1, which adjusts its gain accordingly and thus sets the output level on pin 8.

Circuit details

Refer now to Fig.2 for the final circuit. In addition to the SL6270 (IC1), there's just a 3-terminal regulator, a power indicator LED and a few resistors and capacitors.

As shown, the balanced inputs from the microphone are coupled to pins 4 & 5 of IC1 via 100μF capacitors. These capacitors are necessary to prevent DC current from flowing in the microphone. The 2.2μF capacitor between pins 2 & 7 sets the low frequency roll-off to 300Hz, while the .0033μF capacitor between pins 7 & 8 (ie, in the feedback path of amplifier 2) sets the high frequency roll-off to 5kHz (R1 open circuit).

Resistor R1 has been included to tailor the AGC range. This resistor is in parallel with the internal feedback resistor between pins 7 & 8 of IC1 and so reduces the gain of amplifier 2. Table 1 shows the effect of different values of R1 on the sensitivity and the resulting affect on the signal-to-noise ratio.

Note that as R1 decreases (ie, the gain goes down), progressively higher input signal levels are required to maintain the -3dB output level. It is this reduction in gain that gives the improved signal-to-noise ratio.

The output at pin 8 is AC coupled to the output socket via a 10μF capacitor. Note the associated 47kΩ resistor to ground. This provides a charging path for the 10μF capacitor when no load is connected, to prevent large thumps when the unit is subsequently plugged in.

The 47μF capacitor and the parallel

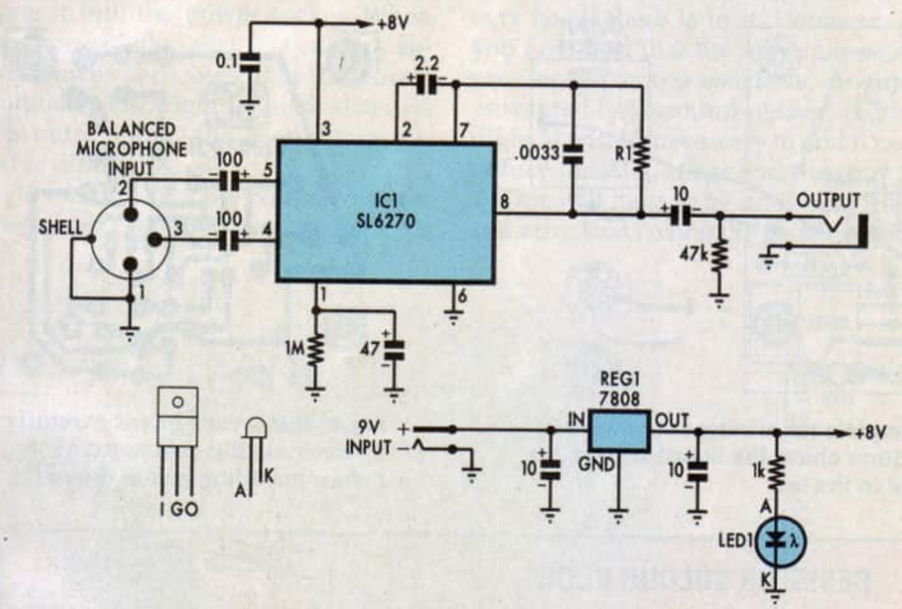
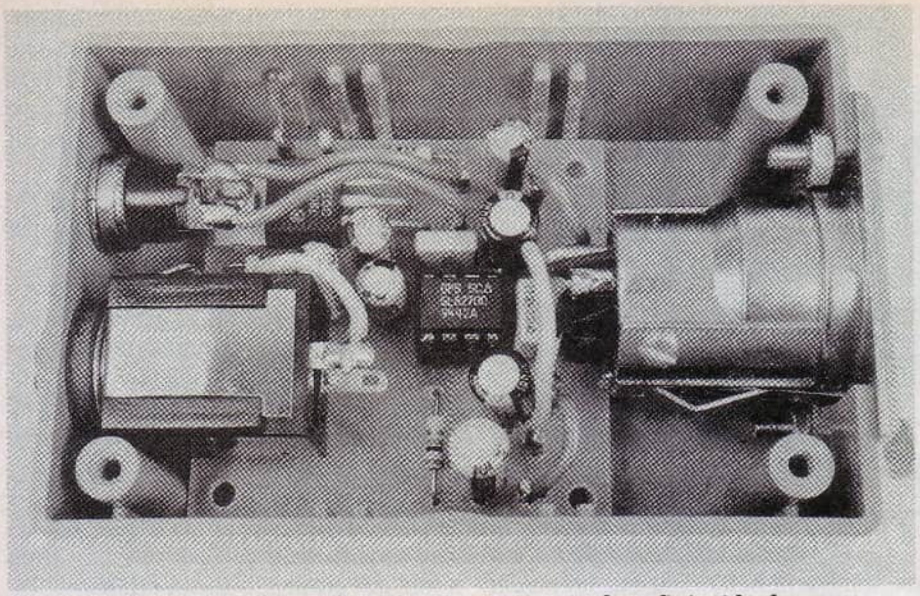


Fig.2: the final circuit of the Gain Controlled Microphone Preamplifier. Resistor R1 allows the gain (& thus the AGC range) to be adjusted – see text & Table 1. Power comes from a 9V DC plugpack & is regulated to 8V by REG1, while LED 1 provides power on/off indication.



This view shows how the PC board & the various sockets fit inside the case. Take care to ensure that the supply polarity is correct before soldering the leads to the DC power socket.

1MΩ resistor on pin 1 of IC1 set the time constant components for the automatic gain control. The 47μF capacitor sets the attack time to 18ms, while the 1MΩ resistor sets the decay rate the 20dB per second.

Power for the circuit is derived from a 9VDC plugpack. This feeds 3-terminal regulator REG1 which delivers an 8V rail to power IC1. The 10μF capacitors at the input and output of REG1 are for stability and supply ripple rejection. LED 1 provides power indication and is driven from the 8V rail via a 1kΩ limiting resistor.

Construction

The Gain Controlled Microphone Preamplifier is built onto a PC board coded 01207951 and measuring 49 x 48mm. Fig.3 shows the wiring details.

Begin the assembly by installing PC stakes at the external wiring points. The remaining parts can be installed in any order but take care with the orientation of the electrolytic capacitors and the IC. Resistor R1 can be left off the board at this stage, as it may not be necessary with your particular microphone.

The 3-terminal regulator is installed with its leads bent at right angles to mate with its mounting holes and is bolted to the board using a screw and nut.

Take care with the orientation of the LED – its anode lead will be the longer of the two. It should be mounted with its top 25mm above the board surface, so that it will later protrude through a hole in the lid. Note that it may be necessary to extend its leads in order to obtain the correct height.

That completes the PC board assembly. It can now be installed inside a plastic zippy case measuring 82 x 54 x 32mm.

First, drill and cut out the holes for the XLR, phono and DC sockets at either end of the case – see Fig.3. You will also need to shave back the ribs in the side of the case so that the PC board can sit directly on the base.

Next, attach the front-panel label to the lid and drill out the four corner mounting holes and the hole for the LED. This done, fit the PC board inside the case and mount the XLR, phono and DC sockets. Finally, complete the wiring as shown in Fig.3. Note the link between pin 1 of the XLR socket and its earth terminal.

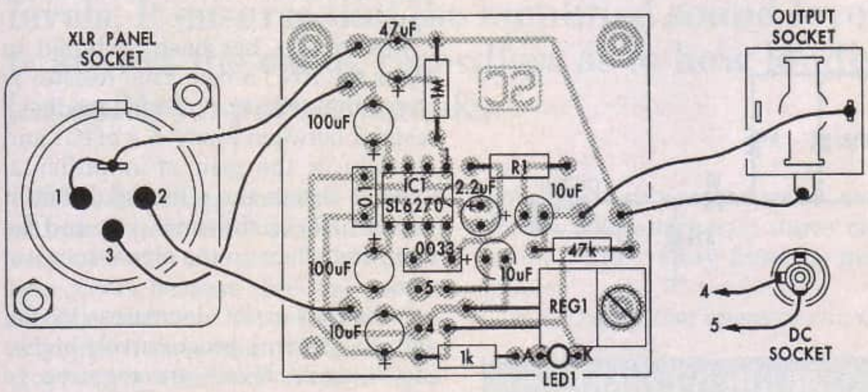


Fig.3: install the parts on the PC board & complete the wiring as shown here. Note that the LED is mounted with its top 25mm above the board surface, so that it will later just protrude through a hole in the lid.

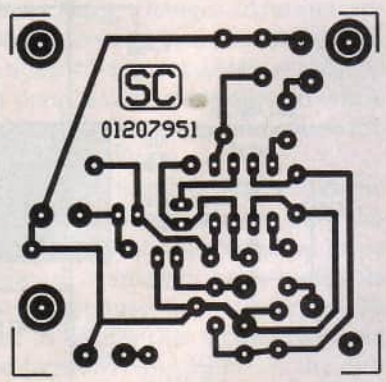


Fig.4: check your board carefully against this full-size pattern before installing any of the parts.

RESISTOR COLOUR CODES

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	1	1kΩ	brown black red brown	brown black black brown brown

Specifications

Input impedance	150Ω unbalanced; 300Ω balanced
Supply current	20mA
Supply voltage	9VDC plugpack
Output level	100mV nominal
Voltage gain	52dB for 72µV input
Distortion	2% @ 90mV input
Signal to noise ratio	see Table 1
Attack time	20ms
Decay time	20dB/second
Frequency response	-3dB at 100Hz & 5kHz

Table 1: The Effect Of Changing R1

R1	Parallel C	-3dB Input Voltage	Signal-To-Noise Ratio
open	.0033uF	120uV	44dB unweighted
3.9k	.0082uF	200uV	52dB unweighted
2.2k	.015uF	540uV	57dB unweighted
1k	.033uF	900uV	63dB unweighted
680	.047uF	1.2mV	66dB unweighted

The wiring connections and the DC sockets should be sufficient to secure the PC board in position. However, if necessary, you can further secure the board to the bottom of the case using machine screws and nuts.

Testing

Carefully check the polarity of the DC plugpack connector before plugging it into the power socket. When you are satisfied that it is correct, apply power and check that the power indicator LED lights. Check also that the output pin of the 3-terminal regulator (REG1) is at 8V.

If you don't get the correct voltage, switch off immediately and check for wiring faults. If the output voltage is correct but the LED fails to light, then it is probably incorrectly oriented.

Assuming that all is OK, you can now test the unit with a microphone and amplifier to verify that it is working correctly.

Adjusting R1

Depending on the microphone, that may be all there is to it. However, if you now find that the microphone is now noisy or too sensitive, or that unwanted background noises are audible, it will be necessary to add R1 to reduce the AGC range and the gain.

This will have to be done on a trial and error basis using the values listed in Table 1 (note that the feedback capacitor in parallel with R1 must be changed as well). For example, if R1 is 1kΩ, the gain and AGC range will be reduced by 17dB, with a corresponding improvement of 19dB in the signal-to-noise ratio.

There is a limit as to how far you can reduce R1 though and this will be determined by the sensitivity of the microphone being used. **SC**

PARTS LIST

1 PC board, code 01207951, 49 x 48mm
1 Dynamark front panel label, 50 x 79mm
1 plastic case, 82 x 54 x 32mm
1 XLR 3-pin panel socket
1 6.5mm mono phono socket
1 2.1mm DC panel socket
3 3mm dia x 6mm long screws & nuts
7 PC stakes
1 9VDC 300mA plugpack

Semiconductors

1 SL6270DP voice operated gain adjusting device (VOGAD) (IC1)
1 7808 8V 3-terminal regulator (REG1)
1 3mm red LED (LED1)

Capacitors

2 100µF 16VW PC electrolytic
1 47µF 16VW PC electrolytic
3 10µF 16VW PC electrolytic
1 2.2µF 16VW PC electrolytic
1 .0033µF MKT polyester

Resistors (0.25W, 1%)

1 1MΩ
1 47kΩ1
1 1kΩ
R1 (see text)

Left: the XLR microphone socket is mounted on one end of the case, while the output & DC power sockets are on the opposite end. Above is the full-size front panel artwork.