

Figure 8. Circuit board layout for ECC808 (board available from Experience Electronics).

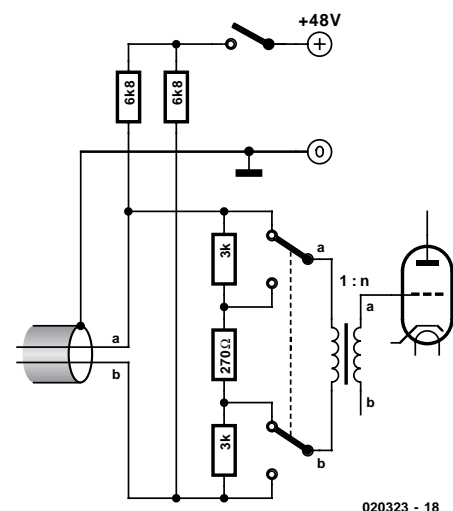


Figure 9. -30 dB input attenuator and connections for a phantom supply.

ments, since the circuit will deliver good results only if it is fitted into a fully screened metallic enclosure. The valves are heated using a 12.6-V dc voltage. The high voltage must be well smoothed. Suitable circuits have already been presented for the Valve Preamplifier (*Elektor Electronics*, June through September 2000 issues). Zener diodes D1–D3 must be used if several preamplifiers are powered from a single supply, or if the power supply has passive RC smoothing. The power supply output voltage must be 350 V. Using a stabilised supply voltage provides the valves with well-defined operating conditions, which is beneficial since the gain of a triode more or less depends on the value of the supply voltage. An important point is that the negative terminal of the filament voltage must be connected to the negative terminal of the high voltage.

When choosing a valve type, you should pay attention to certain details. The measured performance values were achieved using an ECC83S, which is a cross between the ECC83 and the E83CC (military version). The noise figures of ECC83S valves are significantly better than those of standard ECC83 valves, so the ECC83S is clearly preferable. The ECC83 is also available with a variety of American designations, such as 12AX7, which exactly corresponds to the standard ECC83. The 12AX7A and 12AX7WA are versions with tighter tolerances, lower noise and lower microphonics, while the 7025 is the long-life version. An E83CC, or one of the equivalent American military versions with type numbers such as 6681, 6057 and 5751, can also be used if desired. Although these types are significantly more expensive, they have the advantage of being less micro-

phonic and having longer service lives than the standard type.

The term 'microphonic' refers to the fact that mechanical vibrations, particularly in the control grid, can modulate a valve and lead to unpleasant noises or howling in an amplifier installation. This is thus not the place to cut costs in a good-quality microphone preamplifier.

The preamplifier should not be fitted into the same enclosure as the power supply, since otherwise electromagnetic interference and mechanical humming from the mains transformer can manifest themselves in an unpleasant manner. In some cases, it may be necessary to mount the circuit board elastically, for instance using rubber bushings. The circuit is designed such that it is not necessary to use selected valves.

There is yet another interesting option. The ECC808 valve was developed in response to the shortcomings of the standard ECC83 or its direct equivalent the 12AX7. The ECC83 and ECC808 are identical electrically, but the noise characteristics of the ECC808 are better by a factor of three, it is less sensitive to hum and it is significantly less microphonic. Its noise characteristics roughly match those of the ECC83S. In addition, it has a screen between the two triodes, which is of secondary importance in this application. The base arrangement is also different, with the control grid pins being located well away from the anode and heater pins. Consequently, and ECC808 cannot be used as a direct replacement for an ECC83. For this reason, we have also developed a second circuit board layout, as shown in **Figure 8**. The component values remain exactly the same, with the only difference being that the ECC808 requires a filament supply of 6.3 V dc at 0.34 A, instead of the 12.6 V at 0.15 A used for the ECC83. Unfortunately, the ECC808 is not exactly cheap, since it has become scarce. However, it represents an interesting alternative, and its price can be justified in a high-quality microphone preamplifier stage.

Interpreting the measured values

The measured values for the amplifier, which are shown in **Table 1**, require a little bit of interpretation. The open-loop gain, which is the gain when R15 is not fitted, is around 68 dB. If we want to allow a maximum gain of 60 dB, this leaves only 8 dB for negative feedback, which is not very much. Valves do not have high open-loop gains, unlike modern opamps. Consequently, it is recommended to

select a gain in the range of 30 to 50 dB, since the best results with regard to harmonic distortion and frequency response will be obtained in this range.

The harmonic distortion measurements were made at 1 kHz and 80 Hz. As can be seen, the harmonic distortion increases at low frequencies, particularly odd harmonics. The influence of the input transformer can be seen here, since matching transformers generate predominantly this type of harmonic distortion components. The even harmonics can be attributed to the valves. The second-harmonic component has a pleasant sound that is typical of a good 'valve sound'. An increase in harmonic distortion at low frequencies is not especially serious, since the ear is relatively insensitive in this range. Another thing that can be seen from the harmonic distortion values is that the total harmonic distortion at 1 kHz is greater than the average value of the individual harmonic distortion values. At this frequency, amplifier noise predominates. In this case, the measurement equipment cannot distinguish between harmonic distortion and noise, since it makes broadband measurements at frequencies above 1 kHz.

The noise values are to be understood as absolute voltage levels at the output of the amplifier. The input-referenced noise values are obtained by assuming a noise-free amplifier with a noise source at a certain level connected to its input. Three noise values are given: 20 Hz – 20 kHz, A-weighted and CCIR-486. The CCIR-486 filter is used with studio equipment. With this filter, instead of measuring the effective noise value, the rectified peak value is measured using a filter characteristic similar to that of an A-weighted filter, but with the noise components between 1 kHz and 12 kHz being significantly more heavily weighted. That is why it gives the worst noise value.

In order to correctly evaluate the amplifier, it is necessary to correctly interpret the measurements. If a 200-ohm metal-film resistor is connected to the inputs of the instrument, a level of around –118 dBm is measured using the CCIR-486 filter. A

dynamic microphone with a source impedance of 200 Ω generates a noise voltage of –118 dBm. If we assume our amplifier to be noise-free and subtract its gain from the noise level measured at its output, we arrive at a value of –117.9 dBm (weighted using the CCIR-486 filter). This means that the amplifier is only 0.2 dB away from what is physically achievable (0 dBm = 775 mV, the standard studio level).

There is another important point to consider, namely the maximum input voltage. It must be borne in mind that the input transformer boosts the input level by a factor of 16. Thus, if a level of 10 mV is present at the transformer input, the voltage on the grid of the first valve is already 160 mV. Since the grid voltage is only around –1.2 V, the knee of the characteristic curve is reached fairly quickly. The maximum input level for 1 percent harmonic distortion depends on the gain. Several typical values are listed in **Table 2**. A value of 85 mV for a gain of 50 dB may not appear particularly high. However, a dynamic microphone has a nominal level of 2 mV. If the amplifier can handle 85 mV, there is still 18 dB of headroom.

If you want to use this amplifier with a relatively high input signal level, an input attenuator should be used as shown in **Figure 9**. With the indicated component values, the attenuation is approximately 30 dB. If you want to have an exact value, or if you want to modify the attenuation, you can adjust the value of the 270-Ω resistor. **Figure 9** also shows how a 48-V phantom supply can be implemented.

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