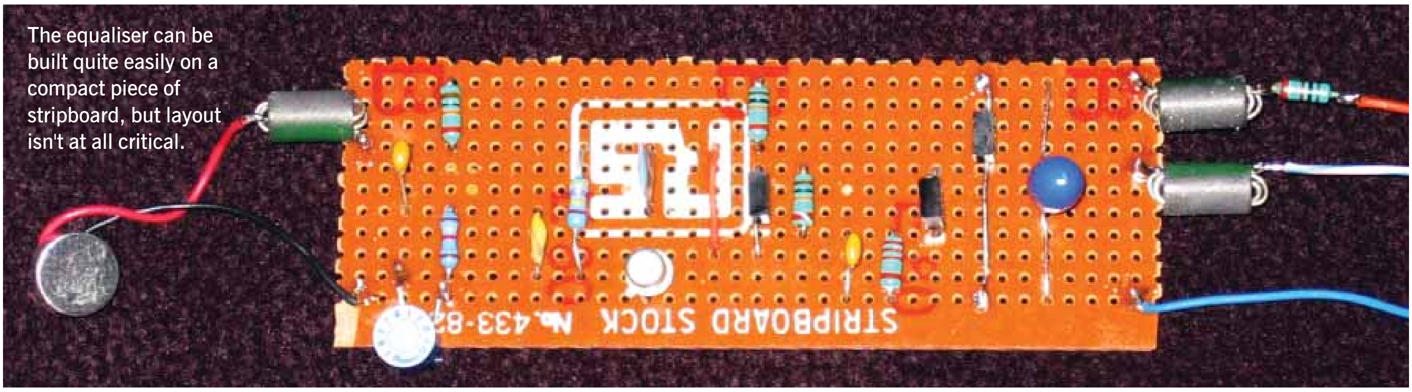
Improving the intelligibility of SSB transmissions

In this concluding part we look at a practical microphone equaliser circuit.



The equaliser can be built quite easily on a compact piece of stripboard, but layout isn't at all critical.

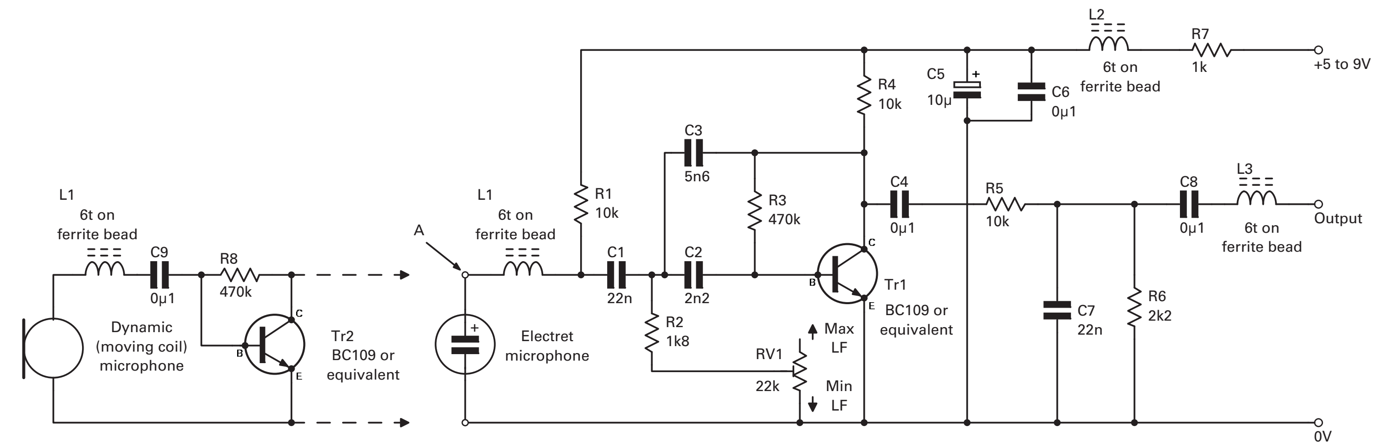


FIGURE 1: Circuit diagram of the equaliser.

RECAP. In part one of this article we looked at the issues involved with generating the most intelligible – though not necessarily the best sounding – SSB signal. As promised, here is a practical circuit I developed to tailor the response of a microphone. The basic circuit is suitable for use with an electret microphone, but I've also included an add-on preamplifier to suit low impedance moving coil microphones.

CIRCUIT DESCRIPTION. The circuit diagram of the equaliser is shown in **Figure 1**. The circuit is based on a fairly conventional single transistor amplifier. R1 provides a DC bias voltage for the electret mic. R3 biases transistor TR1 and R4 provides the collector load. C1, C2, C7 & C8 provide high-pass audio filtering, whilst C3 & C7 provide low-pass audio filtering. RV1 sets the low frequency response of the equalisation curve. R6 can be changed to give a more suitable output level if required (minimum 470Ω, maximum 10K).

RF filtering is provided by L1, L2, L3 & C6, but these can be omitted if they are not required. The inductors can be almost any general-purpose chokes. R7 is wired in line with the DC supply lead and is intended to prevent excessive current being drawn from the supply in the event of a fault or mistake occurring during construction.

If you wish to use a dynamic microphone in place of the electret insert, a small adapter circuit is required. This is the one, shown to the left of the circuit. This is a simple common-emitter amplifier and serves mostly to increase the output from the mic. Join the extra circuit at point A (arrowed) and omit the electret.

CONSTRUCTION. The component layout isn't critical. I've developed a Veroboard layout (**Figure 2**). This view is shown from the component side of the board – note the three track cuts and the wire links. Apart from noting the polarity of C5 there are no particular issues with construction. My original prototype was actually made using surface mount components, which I mounted inside part of a boom headset.

PROVING IT. Whilst developing this circuit I needed to be able to measure the frequency response of various microphone and equaliser combinations. After some searching on the web I came across 'Frequency response plotter' at http://pensa.fr/freqresplot/indexe.htm. This was written by Pascal Pensa to measure the static frequency response of an audio system. By using this software with a PC, soundcard and a good quality headphone as the speaker, it is possible to measure the frequency response of microphones fairly accurately. If you wish you can use a reference microphone to calibrate the software, but I didn't need that level of accuracy during my tests.

The graph of **Figure 3** shows the range of adjustment available with this circuit. Whilst plotting these results, I adjusted the gain slightly in order to ensure that the curves all crossed the 0dB axis at 1000Hz. When using the circuit you may find that you have to change the transmitter microphone gain slightly to compensate for changes in equalisation settings. This is partly due to slight changes in the circuit gain, but the majority of the variation is simply because the level of signal generated by your voice changes significantly as the high energy vowel sounds are filtered and reduced in level. In practice, ALC action usually masks any minor changes once the correct level has been established.

MICROPHONE. I chose to use an electret microphone as these have a very good frequency and transient response at very low cost, especially when compared to dynamic moving coil microphones. However, when I first tried the equaliser circuit with an electret microphone that I'd found in my junk box, I just couldn't get it to sound right. It was far too harsh, with very little low frequency response. So I used the software to measure a few different types and was somewhat surprised to find that they were not all the same. Some had shaped 'telephone' characteristics whilst others had lumps and bumps in the frequency response or a roll-off at 5kHz. So if you find that you can't obtain a good range of adjustment using this circuit, try a different microphone insert.

TESTING. Once you have got the circuit working and connected to a suitable microphone and transmitter, monitor yourself off-air whilst adjusting the equalisation control. You should be able to find a point where the audio is very clear and distinct without sounding too harsh. Although the aim is to improve intelligibility under poor conditions, listening to artificially modified speech for any period of time under good conditions can be very fatiguing. I have a marked a couple of settings that I use for DX and local contacts. The control does not have a linear characteristic and the most significant changes tend to occur when the control is approaching its minimum value of resistance. For guidance purposes, my 'Local' setting is with RV1 set around 3K3 and 'DX' is with RV1 at about 150Ω. Note that this is with the circuit feeding directly in to a PC soundcard. When connected to a transmitter I found that I had to slightly increase the resistance of RV1 to obtain a similar quality sound. Component tolerances will also modify the settings slightly and I have allowed a reasonable margin of adjustment compensate for this. Although I have just included one pre-set control in the circuit, you may prefer to fit a switch and two pre-sets so that you can quickly swap between 'DX' and 'Local' settings.

Perhaps not surprisingly the settings I have chosen seem to have a very similar response curve to that of the renowned Heil HC 4 & 5 inserts. I have measured both the equaliser and electret microphone for comparison purposes, shown in **Figure 4**. It should be noted that the graphs do not represent the absolute frequency response of the Heil microphones or equaliser circuit and electret insert, but they were all measured under the same test conditions.

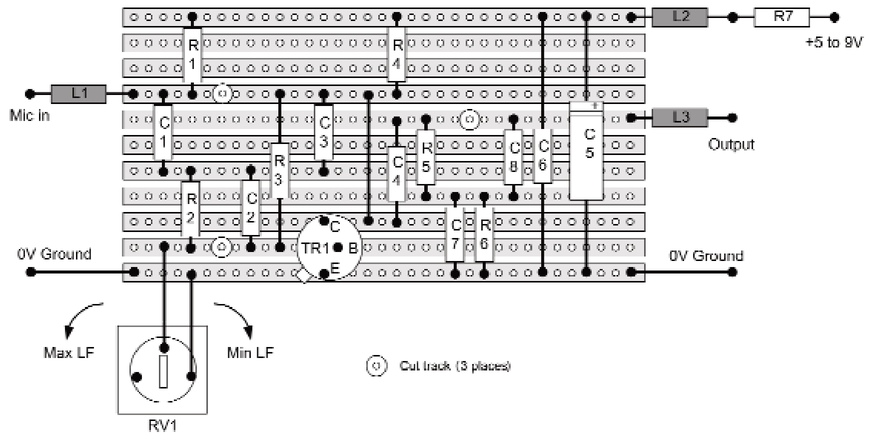


FIGURE 2: Veroboard overlay. Note track cuts.

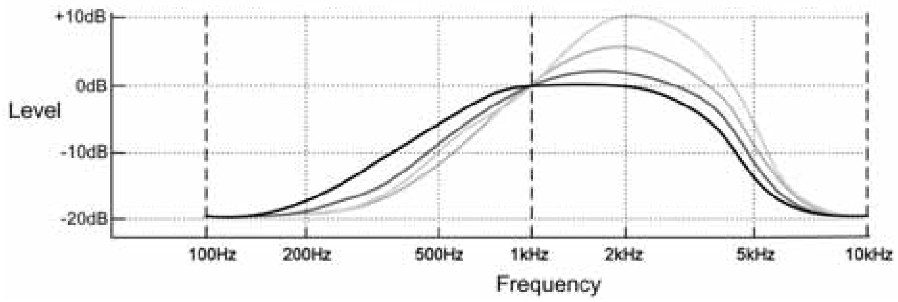


FIGURE 3: Response curve of equaliser showing different settings.

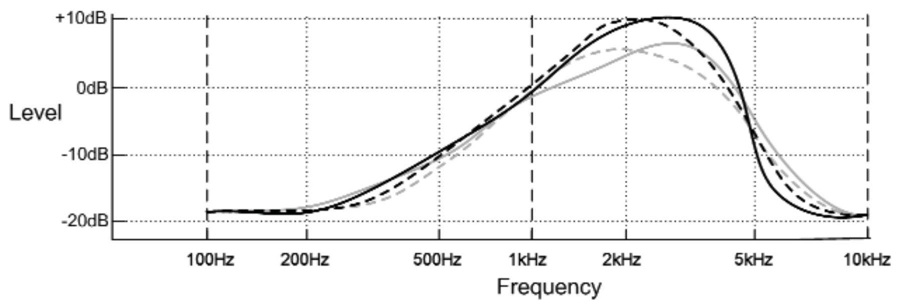


FIGURE 4: Response curve of equaliser and electret mic (dashed), Heil HC4 insert (black) and HC5 (grey).

CONCLUSION. I hope this article has provided an insight into how information is conveyed and what factors can affect intelligibility in a transmission system. As a result of my investigations, I now consider audio equalisation to be just as important as compression in making you heard under weak signal conditions.

I urge you all to experiment by monitoring your transmitted audio and see if you can make any improvements. If your transmitter only offers a limited range of adjustment, the circuit I have described can produce a dramatic improvement in intelligibility for very little outlay.

Further information can be found on my website www.g8jnj.webs.com.