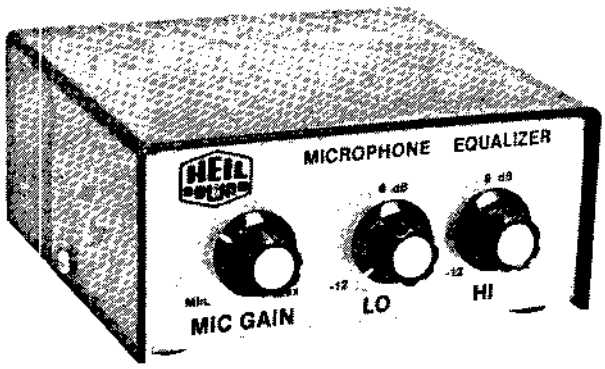

Equalize Your Microphone and Be Heard!

How does the audio sound at the other end when you are talking? How does your repeater sound? Build this equalizer and be surprised at the improvement!

By Bob Heil,* K9EID

Hams place emphasis on high-power transmitters, large antenna systems and accessories that are aimed at making Amateur Radio signals louder. Few take note of articulation (clear and effective utterance). Good articulation gives the listener the ability to clearly understand each syllable.

Manufacturers say very little about audio-frequency response and distortion levels. The audio section (of a transmitter) should be fairly flat in response — meaning that there are no big peaks or nulls in the overall response pattern — and have less than 0.2% distortion.

Choose the Correct Microphone

Microphones are designed for specific purposes. In the sound-reinforcement and recording-studio industry, a microphone is purchased only after evaluations are made to ensure that a particular one will produce the desired results.

Amateur Radio operators do not usually select a microphone on this basis. Few hams bother to listen to the output of a microphone before purchasing it. Microphones look "sharp," match the color of your transmitter or appeal to your spouse's sense of decor! One fellow recently commented on 40 meters that he purchased a particular microphone because it had a long cable.

A Proper Test

Recording studios have racks of expensive test instruments to help conduct a proper test. But what about you? You only need a good-quality tape recorder and one of your fellow amateur friends. Have him record directly from the speaker of his hf receiver into the line input of the tape recorder while you transmit a signal. Take the tape home and "digest" it. You will hear your station almost as others hear it. It is a simple method for finding out what your station sounds like.

To make the test properly, use three or four microphones that you think will do the job for you. Then select several that you don't think you will like. Using a 2-meter direct-frequency link for coordination, have your friend tape directly from his receiver, making sure to avoid input-overload conditions. If your signal is strong, have him disconnect his receiving antenna, or listen with his dummy load connected.

During the test, try each microphone with your transmitter. Be very careful to document each move, by mentioning each microphone by model, and note the level setting on the tape recording. You then have an accurate reference when listening to the playback.

After the test transmissions, you will want to listen to the results under conditions similar to those of others who will hear your signal. Don't listen to the tape while using a high-quality speaker system. Play the results back through the speaker of your Amateur Radio receiver. When listening, be ready for some surprises! Remember those three microphones you didn't think much of? Chances are, one of them might be the best of the lot! You will be listening for good articulation in the midrange and sibilance (the high frequency presence of "s" and "t") sounds with low or no distortion. Once you find a microphone that suits you, it's time to start equalizing your system for optimum audio characteristics.

Passive Equalization

Most modern ssb transmitters contain filter networks that limit the response from 300 to 3000 Hz. If you use a microphone that has a wider frequency response, the transmitter may produce a wider signal than is necessary. The lower-frequency audio (under 300 Hz) does nothing to help the receiving-station operator understand the information better. In fact, better articulation is achieved by passively rolling off the microphone response under 300 Hz. This can be accomplished easily by installing a disc-ceramic capacitor, such as a 0.01-μF unit. The impedance of the microphone and the capacitor value will determine the roll-off frequency.

This capacitor should be installed in series with the "hot" microphone lead. Placing the capacitor across the hot lead to ground will roll off the high frequencies, should you desire to do this. In most cases you will not want to roll off the high-frequency response.

Your end goal is to achieve good articulation without killing any of the natural midrange and low-frequency responses. You will want to roll off the low end, keeping your signal as narrow as

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possible. Most modern receivers have filters that pass only 300 to 3000 Hz audio. Transmitting any frequencies outside of this range causes the transmitter and final amplifier to work harder to produce suitable signals. Anyway, the receiver should filter out the responses outside the passband.

Active Equalization

To get the full advantages of proper audio equalization, active filter circuits should be used instead of passive ones. Active elements are capable of giving you ±15 to 30 dB ("cut" and "boost") at precise frequencies. These can be selected easily or made completely variable by using parametric filters with variable passband slopes and adjustable filter Qs.

Using a dual 741 (LM1458), you can build a simple but effective active filter, providing the flexibility needed to equalize a microphone. You can add other functions, such as tape recorder, phone patch or inter-tie audio patches.

The circuit can be built with several bands of filtering, so you can control the spectrum from 300 to 3000 Hz. For communication-quality speech, two active filters are sufficient. For maximum utility, drive the filters from a high-quality microphone preamplifier that has been designed carefully so it will not overload the active filters, even at maximum gain.

W1AW/R Equalized

Like many other homemade repeaters, the W1AW/R 2-meter repeater had poor audio characteristics. Some operators' voices were virtually unrecognizable when operating through the machine. As suggested by author Heil, we installed an equalizer circuit in the repeater, thereby replacing the old coupling system.

The results have been better than expected. Based on experience with our old system, we classified two voices as our worst cases. We then equalized the audio to make these voices sound natural while coming through the "machine." It took a few visits to the repeater site, but it was worth it. Everyone agrees that the audio has improved dramatically. If you are having trouble with the audio on your repeater, we suggest you try an equalizer. *— Peter O'Dell, KB1N and Gerald Hull, AK4L*

Circuit Description

Two dual op amps are used in the circuit (Fig. 1). One half of the first IC is used as the microphone preamplifier. It has a transformer input to provide proper impedance matching, as well as protection from RFI. Using transformer-coupled input circuits (where high levels of rf are present) is a good practice. The ac audio signal passes through the windings, but rf will not pass; therefore, you have a good rf shield at the input. It would also be advisable to use ferrite beads on leads that enter the chassis, thus keeping stray rf from entering.

This preamplifier is coupled to the two active filters by means of C4. The filters are set at 500 and 2200 Hz. Filter slopes are fixed at 12 dB per octave, while the filter gain is set to the range of +12 dB to −12 dB. The Q of each filter is 1.7. Output of the Equalizer is variable from 0 to 0.9 volt. Be aware that it may overload your transmitter microphone preamplifier. The proper level will have to be set as a preventive measure.

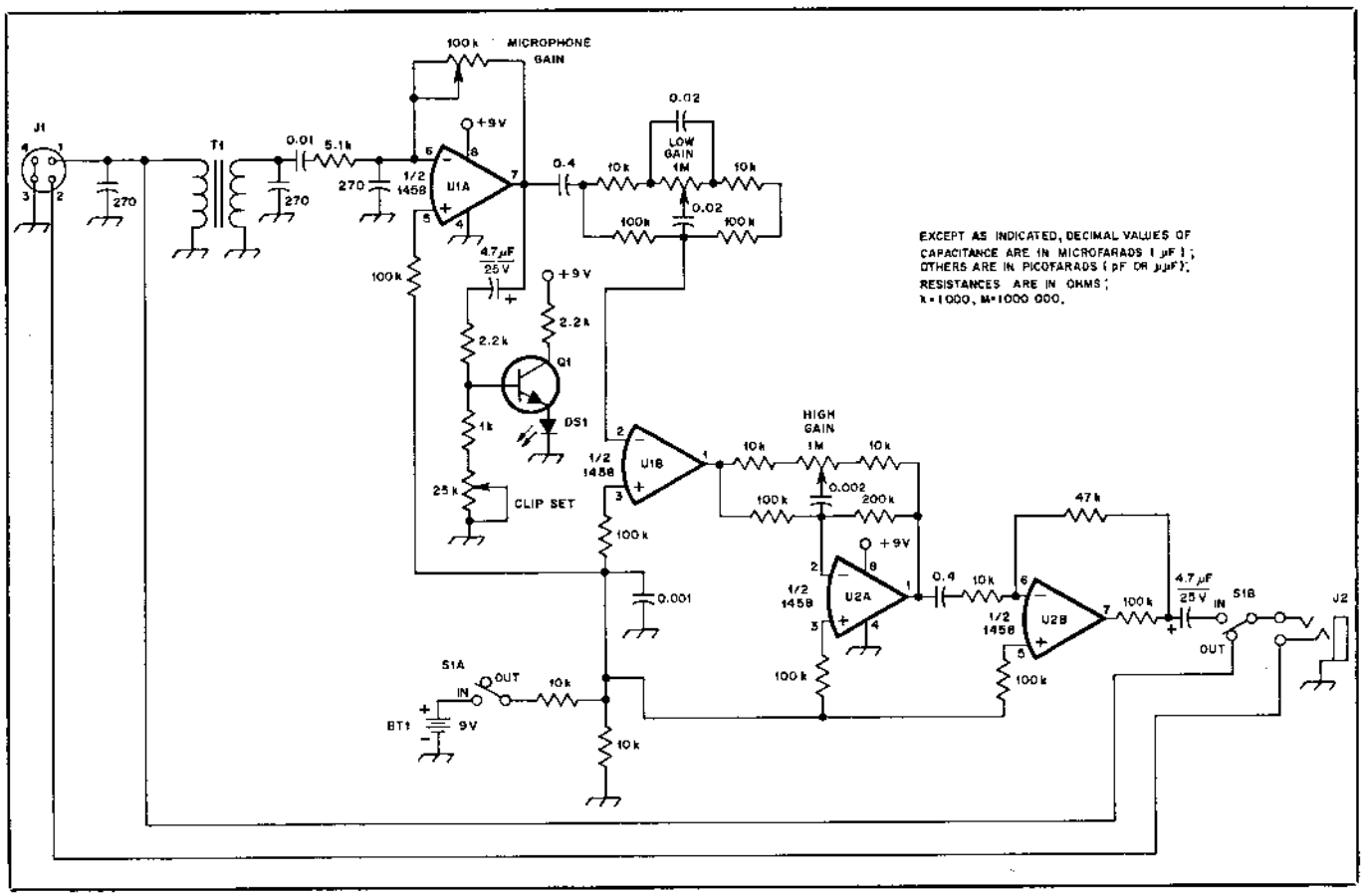


Fig. 1 — Schematic diagram of the Equalizer. All resistors are 1/4-watt carbon-composition or film types. Part numbers in parentheses are Radio Shack.

DS1 — LED, size and color not critical.
Q1 — Silicon, npn small-signal bipolar transistor, 500 mW, 2N2222 or equiv. (276-2009).
S1 — Dpdt toggle or slide switch (275-666, 275-403, etc.).
T1 — 2 K to 10 K audio-interstage transformer, RS273-1378 or equiv.
U1, U2 — Dual operational amplifier IC, type 1458 or equiv. (276-038).

The power supply can be a 9-volt battery or a well-filtered ac supply. If care is taken to avoid ground loops and magnetic fields affecting the high level microphone preamplifier, you can build a supply inside the housing.

Construction

The circuit is assembled on a small pc board (Fig. 2).[1] Mount the board, with either the battery or power supply, in a small metal enclosure. Take care to shield every connection to the outside. Use ferrite beads or feedthrough capacitors for each lead that enters the chassis. Subjecting any audio circuit to high levels of rf may cause problems.

An LED connects to the "clip" light circuit of the preamplifier. This circuit has a control, R1, to adjust the light threshold. Overloading the preamplifier will turn on the overload indicator. The light is best set to come on at 6 dB, before hard clipping is observed on an oscilloscope. If you don't have a scope, you may be able to set it by listening to the output of the preamplifier through a small audio amplifier and adjusting it so the light comes on just before distortion occurs.

Adjustment of the two filters is accomplished best by listening to another receiver, or by having a friend record your testing (as discussed earlier). Once the equalizer is set, it shouldn't have to be changed. Many of these units are tucked away behind the rig so that the controls aren't bumped and changed by mistake.

Equalization for Repeater Service

Many repeater systems can be improved by using an audio-filtering system similar to the one described here. A typical repeater system loses some articulation and sibilance because of losses encountered with improper coupling between the receiver and transmitter audio sections. Impedances between the two are often mismatched, further complicating matters. A simple group of variable filters set at 400 and 2500 Hz will aid audio articulation. Of course, once the filter is installed and set for maximum intelligence, it should not have to be adjusted again.

Don't Forget the Microphone

You can play a few "tricks" to enhance the response of some microphones. Again, you will have to rely on the tape recorder test to determine optimum performance, but it will be worth the effort.

One microphone that can be improved is the Kenwood MC-50. If you have one, make a transmission and have it tape recorded by a fellow operator. Then, wrap electrical or masking tape around the microphone to cover the long slots in the sides near the cartridge. About three turns will usually cover them sufficiently.

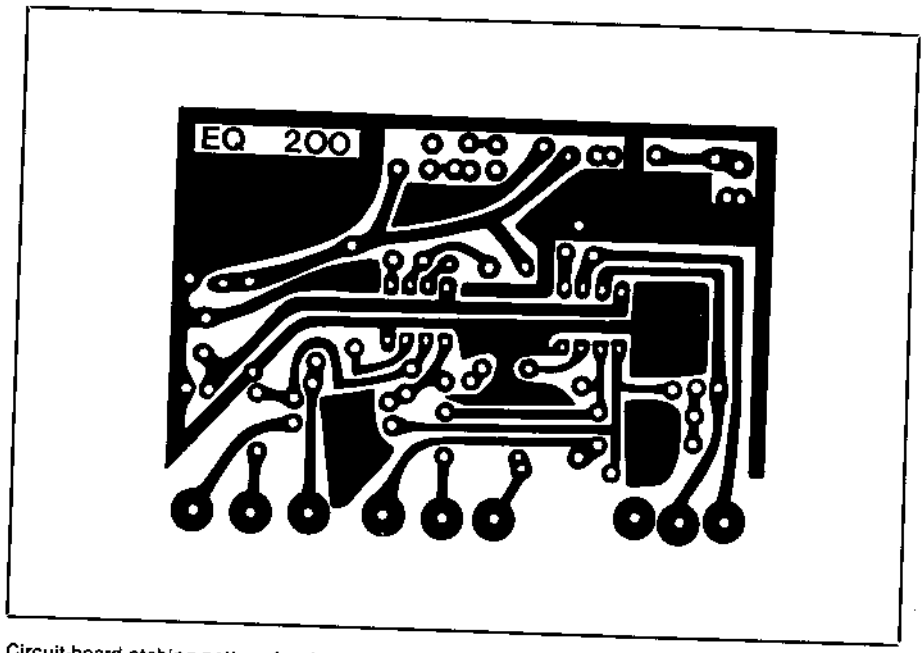
Record the signal again. The difference is remarkable! All low-end rumble should be gone. The midrange will be enhanced. You have equalized the microphone by dampening the back of the cartridge, and not allowing the element to travel as far in the basket by closing the air chamber. The cardboard tube inside a toilet-tissue roll fits perfectly over the end of the MC-50, providing a permanent, simple, but effective, modification. Many other microphones can be dampened in similar ways.

Be Aware of Excess Room Resonance

One of the worst things done to Amateur Radio audio today is placing the microphone in a hard-surfaced room with lots of echo. Some operators crank the gain of the preamplifier up so that they can lie back 3 to 4 feet away, controlling the PTT with their toes! I think this "murders" a good signal. Most communication microphones are designed to be close-talked, using low microphone gain, and thus produce better presence and articulation. The room echo becomes practically nonexistent, while the speech audio comes out on top.

Even in recording studios, where acoustics are nearly perfect, microphones are "worked" very close. Many microphones exhibit a proximity effect: The closer you talk into the microphone, the more low and mid frequencies it produces, in relationship to the high-frequency response. When you back off from the microphone, the result is a "thin" sound, as the body of the voice characteristics is lost.

Little things make stations sound big. Proper use of microphones, correct placement, small amounts of equalization and suitable gain settings are some of the most important "little" things. Are you aware of what you sound like, and do you want to make it better? Our bands are becoming more populated. Perhaps crowded bands can be tolerated, all things being *equalized.* QST



Circuit-board etching pattern for the Equalizer. Black represents copper. The pattern is shown at actual size from the foil side of the circuit board. The parts placement diagram for the equalizer was unavailable at the time of publication.

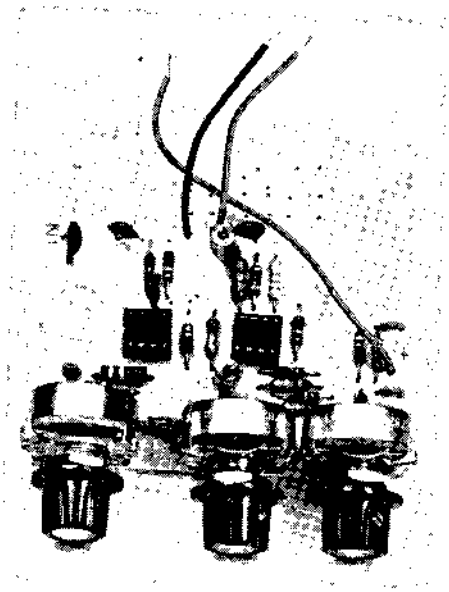


Fig. 2 — Equalizer board before mounting it in the W1AW/R 2-meter repeater.

[1]Parts, partial kits and completed units are available from Hell Sound, Box 26, Marissa, IL 62257, tel. 618-295-3000. The ARRL and *QST* in no way warrant this offer.