Microphone Impedance and Amplification

A common dilemma exists when a CBer or amateur radio operator tries to use a modern microphone with an older piece of equipment that was designed for high-impedance microphones. Nearly all of today's mics are designed to interface with a 600-ohm (low impedance) speech amplifier.

Conversely, existing high-impedance mics, such as the ever-popular Astatic D-104, do not allow the production of quality audio when they are used with modern equipment that requires a low-impedance mic. The result from using a D-104 with a 600-ohm-input speech system is tinny sounding audio with no low frequency response. Fortunately, both of the foregoing problems have easy solutions if you are willing to tack together a few inexpensive components.

High Z to Low Z Conversion

A popular brute-force cure for impedance mismatches caused by using high-impedance (high-Z) mics with low-Z speech amplifiers is to simply insert a 100k-Ω, 1/4-watt resistor in series with the audio line from mic. This method prevents the 600-Ω input port of the equipment from loading the high-Z mic (usually about 50k-Ω impedance) and reducing its output level. The series resistor attenuates some of the mic's high-frequency response, but for communications this is often beneficial. It is important to recognize that this technique does not provide an impedance match: It is purely a quick means to an end. This approach, plus a more worthwhile alternative, is illustrated in Figure 1 at B and C.

A miniature matching transformer (T1) can be used between the high-Z mic and the 600-Ω input port. A Mouser Electronics[1] no. 42TL025 audio interstage transformer is suitable for this task, even though its 17k-Ω to 1k-Ω transformation does not allow a perfect match between the mic and the equipment. However, in a practical situation you will observe very little difference between this and a 50k-Ω to 600 Ω transformer's performance. The current price for this little transformer is $1.52.

Figure 1C shows how to use an inexpensive JFET, such as the generic MPF102, as an impedance transformer. The only disadvantage associated with this method is that a dc operating voltage of 9 to 12 is required. This may often be taken from the mic jack of modern transmitting equipment. If it is not available, you can borrow +12 volts from within the gear and route it to an unused pin on the mic jack. A 9-volt transistor radio battery may also be used to power the JFET.

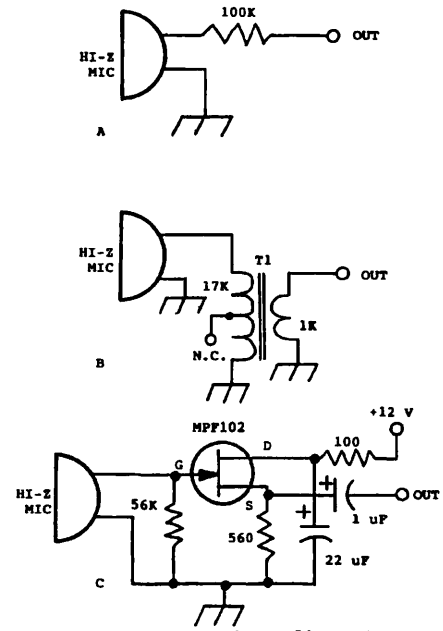

Figure 1 -- Examples of how to use a high impedance mic with equipment that has a low-impedance (600 Ω) audio input port. Circuits A, B and C are discussed in the text. N.C. = no connection.

A More Elegant Matcher

Figure 2 illustrates a circuit that is capable of amplifying the microphone output while providing an impedance match. This circuit is especially helpful if your high-Z mic has low output power. The component values listed are for matching 50k-Ω mics to modern low-Z input circuits. The voltage gain of this amplifier/matcher is 3, which is sufficiently low to avoid having too much audio input power supplied to most speech amplifiers.

C1 and R1 in Figure 2 are used as RF filters. This helps to keep stray RF currents from disrupting the performance of the amplifier/matcher. If you wish to attenuate some of the high-frequency response you may increase the value of C1 to any amount up to 1000 pF. In a like manner, enhancement of the low-frequency response can be realized by increasing the values of C2 and C3. You may use up to 10-uF of capacitance at those points in the circuit. The low-frequency response can be reduced by choosing smaller values of capacitance for C2 and C3.

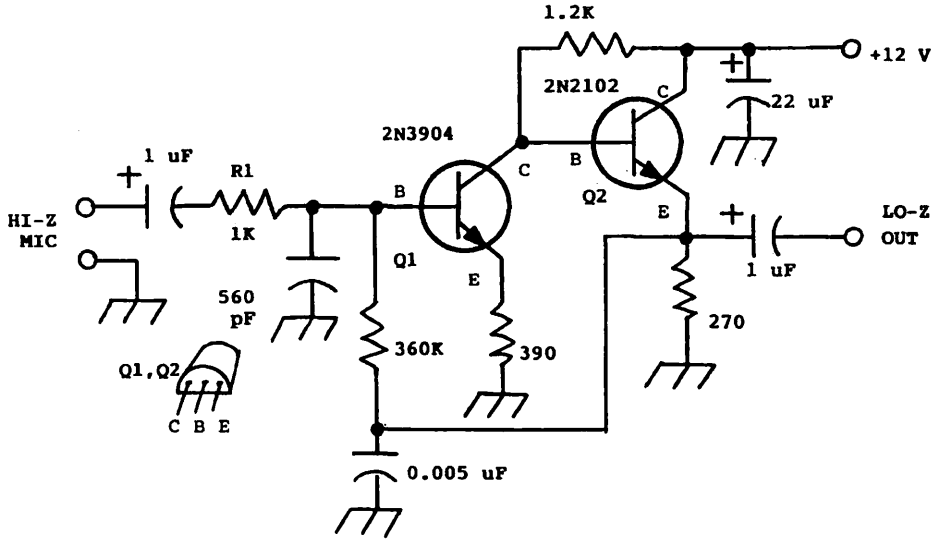

Figure 2 -- Two transistors are used to provide a voltage gain of 3 and to create an impedance match between a 50k-Ω mic and a low impedance audio amplifier in a transmitter or tape recorder. See text.

The Figure 2 circuit should be contained in a metal box to prevent RF energy from entering the amplifier. Shielded audio cable must be used between the mic and the box and between the box and the transmitter audio jack.

Converting Low to High Impedance

The flip side of the foregoing matching problem is encountered when we have a low-Z mic that we want to use with an older piece of equipment that was designed for a high-Z mic. A simple solution for this problem is to add the audio interstage transformer of Figure 1B. It is used in the reverse manner shown in that example. The low-Z (1k-Ω) winding connects to the mic and the 17k-Ω winding interfaces with the mic jack on the transmitter.

A JFET may also be used for matching a low-Z mic to a high-Z speech amplifier. This technique is seen at B of Figure 3. This circuit also requires a dc operating voltage of 9 to 12.

Construction Tips

Any circuit that is external to the mic input jack of the equipment needs to be shielded in order to prevent 60-Hz ac-line pickup and to avoid having stray RF energy enter the outboard circuit. A small Minibox® will suffice. Be sure to connect the mic shield braid and ground wire to the box. Likewise with the ground line from the equipment.

The layout of the circuits that use transistors will provide the best performance if short, direct leads are used between the parts. This will minimize the potential for hum and RF interference to the circuit. You can assemble the circuits on perforated boards, on a small pieces of Formica® or on multilug terminal strips.

Summary Remarks

I want to mention in closing that none of the circuits shown in this article provide a perfect match between the mics and the equipment. But, each method will improve the match between the mic and the transmitter over what would result from having no matching circuit whatsoever. Maximum power transfer (and best audio reproduction) will always be had when unlike impedances are perfectly matched. Although this degree of perfection is often necessary for high-performance or MIL-spec apparatus, it is seldom a criterion for hobby and amateur related applications.

[1] -- All of the parts for the circuits in this article should be available from Mouser Electronics, 2401 Hwy. 287 N., Mansfield, TX 76063-4827. Phone (817) 483-4422 for catalog. MT

Figure 3 -- A low-impedance mic (600 Ω) can be matched to a high-impedance speech amplifier by using T1 at A. A JFET is used for the same purpose at B. N.C. = no connection.