Impedance in the Real World

"The Big Picture" in this issue showed you what impedance is. Here's some insight into how it can affect your operating experiences.

This HF dipole antenna is being fed with traditional 600-ohm ladder line. [Photo by True Ladder Line, trueladderline.com]

Antennas and Feed Lines

Every antenna has an impedance that changes according to the frequency of the energy you're feeding to it. If that impedance happens to be 50 ohms, it is a perfect match to your 50-ohm coaxial feed line and the output circuitry of your radio, which is usually designed for 50 ohms. In this ideal situation, you can feed as much power to the antenna as your radio can generate.

But what if the antenna impedance is different from the impedance of the radio? Now you have an *impedance mismatch*, and you're going to see power being lost in the feed line due to an elevated standing wave ratio (SWR).

This is not a good situation. You may have to adjust your antenna to bring its impedance closer to 50 ohms. You may also need to use a device known as an *antenna tuner* to compensate for the mismatch.

As we've discussed in the January/February 2021 issue of *On the Air*, an antenna tuner is a variable impedance transformer. It adjusts coils and capacitors to effectively convert the impedance that exists at its antenna connector to 50 ohms for your transceiver.

Coaxial Cable and Other Feed Lines

Feed lines have different impedances based on how they are constructed. Most coaxial cables used by amateurs have an impedance of 50 ohms. There are exceptions, though. You may run into coax that has a 75-ohm impedance. This will cause a mismatch at your antenna — assuming its impedance is 50 ohms — and your transceiver.

This isn't to say that 75-ohm coax should be avoided, but it does mean that you're likely to need an antenna tuner or some other device, such as a transformer, to convert the 75-ohm impedance to 50 ohms at your transceiver. You'll probably need to make some tweaks to the antenna as well. This may involve adjusting its length.

There are other feed lines that consist of two wires in parallel. They all offer very low RF loss, even in the presence of a high SWR, but none of them have an impedance of 50 ohms. The three most common types are:

Twinlead – 300 ohms

Windowed Ladder Line – 450 ohms

Traditional Ladder Line – 600 ohms

Using any of these feed lines will require an antenna tuner or other form of impedance matching at your station. Check out "Untangling Feed Lines" in the March/April 2020 issue of *On the Air* for more about the properties and uses of these types of feed line.

Most coaxial cables used by hams have impedances of 50 ohms, but not all. This cable is known as RG-6, and it has an impedance of 75 ohms. When you're shopping for coax, make sure you choose the right one.

A typical 8-ohm speaker commonly used for mobile applications.

Microphones

All microphones exhibit a certain impedance. And just like an antenna system, this impedance must be closely matched to the impedance at your radio's microphone jack. If it isn't, the result will be weak or distorted audio, or both.

Microphone impedances can vary considerably. In amateur radio transceivers it is common to see microphones with impedances between 500 and 600 ohms. You may sometimes encounter microphones with much higher impedances in the range of 10,000 ohms or more.

If you go shopping for a new microphone for your radio, choose carefully. Check your radio's user manual to see if it lists the required microphone impedance, or at least the impedance of the microphone that came with the transceiver. You may also see a specification stating that the microphone is an *electret* or *dynamic* type. Whichever microphone you purchase, it not only has to be the same type as the mic that came with the radio, but the impedance must be the same as well.

Speakers and Headphones

Yes, they have impedance values, too. Typical *loudspeakers* (the traditional name for what we call "speakers") have impedances of just 8 ohms. You may also find speakers with impedances of 4 ohms.

It is critical that the speaker impedance match the impedance at your transceiver's external speaker jack, which is usually 8 ohms. This isn't just a matter of diminished performance. A mismatched impedance can result in damage to your transceiver's audio circuitry.

Just as speakers have impedances, so do headphones. The range generally spans 8 to 600 ohms, with 32 ohms being increasingly common. Fortunately, the consequences of a mismatched headphone impedance aren't as serious as a mismatched speaker impedance. The result of a poor match is usually a reduced audio level. Some amateurs use headphone amplifiers to compensate.

Impedance Does Matter

These are just four reasons why impedance values matter; there are many more.

You'll encounter impedance specifications wherever you have signals running about. The values are important because when there is a mismatch between one device and another, the result can be annoying and sometimes even serious (as in damage to expensive gear).

There is some intense mathematics behind impedance values. Engineers grapple with such strange creatures as *complex numbers, phasors,* and *imaginary numbers* when calculating the impedance of circuits.

Fortunately, you don't need to know any of this. At a practical level, just remember that impedances between two circuits or devices need to match as closely as possible. When this is the case, signals flow properly and all is well. Or to quote Julian of Norwich from the 14th century: "All shall be well, and all shall be well, and all manner of thing shall be well."

This MFJ Enterprises microphone has a 600-ohm impedance to match most transceivers.

Most headphones have impedances of 8 ohms, but there are exceptions. Some headphones for older equipment have impedances of 600 ohms or more.