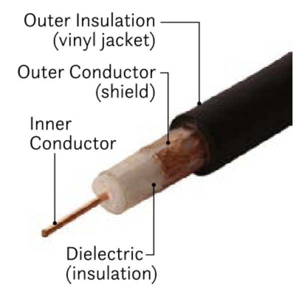
Untangling Feed Lines

Without a feed line, no radio station — amateur or otherwise — can function. You need it to get your transmitted signal from your radio to your antenna, and to get the signals your antenna receives to your radio. Here are some feed line basics.



Coaxial Cable

Coaxial cable, or simply "coax," consists of one wire — the *center conductor* — surrounded by another — the *shield* — and separated by some sort of material — called a *dielectric* — that provides electrical insulation between them. In the types of coax hams most often encounter, the dielectric material is either solid or foam plastic, or it may be an open space filled with air. The exterior of coaxial cable is covered by a plastic *jacket*.

Ladder Line

This type of feed line has its roots in the early days of amateur radio. Back then, hams often fed their antennas simply by running two wires in parallel, using insulators to keep the wires separated. The result was a feed line that resembled a rope ladder hanging from the antenna, hence its name — ladder line.

We use the term *ladder line* today to mean any type of feed line comprised of two parallel wires. Traditional "true" ladder line is still available from a few vendors, but you rarely see it in use. These days, the most popular variety is *windowed line*. In windowed line the parallel conductors are separated by a plastic insulating material that features open sections every inch or so.

Pros and Cons

The advantage of ladder line over coax is its relative lack of loss. Ladder line has extraordinarily low RF loss, even at very high frequencies (VHF). Considering this fact, you're probably wondering why ladder line isn't used everywhere. The truth is, there are a couple of issues with ladder line that greatly diminish its utility.

Impedance

Ladder line impedance is typically several hundred ohms. For instance, most windowed line has an impedance 450 Ω, but your radio is designed for a 50 Ω feed line. This means you'd need an antenna tuner at your station to convert the impedance to 50 Ω.

Ease of Installation

Unlike coax, ladder line must be kept reasonably straight and well away from metal objects. The parallel conductors generate fields that effectively balance each other (which is why ladder line is referred to as a *balanced line*). A sizable hunk of metal a few inches away would be enough to disrupt the fields, changing the impedance of the feed line at that point. The impedance of ladder line will also change if the line becomes encased in ice or snow.

Let's Talk Loss

Every type of feed line has loss. No matter what type of feed line you choose, it will convert some of the power from your transceiver into heat, and it will do the same to the signals coming from your antenna.

Choosing a feed line that offers the lowest amount of loss isn't a straightforward process. It's a balancing act between three loss factors.

Loss and Frequency

Here is an inviolate rule of feed lines: Loss increases with frequency. The higher the frequency, the greater the loss.

Let's say you have 100 feet of RG-58 coax connected to your antenna and you're transmitting at 14 MHz. That much cable at that frequency results in a loss of 1.33 decibels, abbreviated dB. We won't go into detail about decibels and how they work mathematically, but suffice it to say that 1.33 dB is an acceptable amount of loss. Anything beyond about 2 dB is excessive.

Now let's ramp the frequency up to 146 MHz and leave everything else the same. This is the frequency you'd encounter with your VHF radio. Now the loss jumps to 4.6 dB. That may not seem like much of an increase, but because of the way decibels work, it's a lot. It means that about 65% of your transmitted power will do nothing more than heat the cable!

Loss and Length

Another factor in feed line loss is the length of the line. The longer the line, the greater the loss. This is true of any sort of wire that is used to carry electrical energy.

SWR and Loss

Whenever your transceiver sends power to the antenna, a certain amount of the energy bounces back. That returning energy runs into the energy your radio is still generating. They combine in the feed line, adding and subtracting from each other. The results in what are known as *standing waves*. We call this interaction the *standing wave ratio*, or SWR, and measure it with meters in the feed line or within the radio.

When it comes to feed line loss, the higher the SWR, the greater the loss because more RF is "tied up," so to speak, in the standing waves along the feed line. That RF energy will be lost as heat. Like all RF losses in feed lines, the loss caused by SWR increases with frequency, the type of feed line, and the length of the feed line.

Putting it All Together

Amateur radio equipment dealers usually advertise feed line loss in dB per 100 feet at a given frequency. Some may use other lengths or show several different lengths. They always assume that you'll adjust your antenna to keep the SWR as low as possible, so they don't include SWR in the loss figures.

Table 1 will give you an idea of the losses in 100-foot lengths of several popular types of feed line at several frequencies. Notice how the losses increase with frequency. Remember that the shorter the lengths, the lower the loss. For example, if a feed line has a 4 dB loss over 100 feet at 146 MHz, you'd be right to reject that cable, but if the distance to your antenna is only 50 feet, the loss would be a 2 dB loss, which is acceptable in most applications.

Table 1
Comparing 100-Foot Feed Lines

Feed Line	Loss in dB at... 7 MHz	28 MHz	146 MHz	440 MHz
RG-58	0.9	1.9	4.7	9.0
RG-8	0.8	1.6	4.0	8.0
Belden 9913	0.3	0.7	1.6	2.8
LMR-400	0.3	0.6	1.5	2.7
Windowed Ladder Line	0.07	0.2	0.4	0.7