

## Which Coax for Wireless Mics?

The choice of Saturday night movies on the satellite wasn't very good, so I put on one of Hellmuth Kolbe's recordings and cranked through the numbers on the loss due to the mismatch of using 75 ohm coax to connect a wireless mic antenna to a 50 ohm load. The results were even more in favor of the 75 ohm cable than I had expected! Using the equations in the Transmission Lines chapter of the ARRL Handbook (Chapter 19 in the later editions), the MAXIMUM loss that you can have due to this mismatch (an SWR of 1.5:1) is 0.18 dB for ANY length of cable! These equations are also displayed in the Handbook as graphs.

Let's put some numbers to practical examples.

Belden 9100, a good RG-59, has 6.7 dB/100 ft of loss at 700 MHz. The mismatch to a 50 ohm receiver would increase that loss to 6.88 dB for 100 feet (6.7 dB + 0.18 dB). It would increase it from 13.4 dB at 200 ft to 13.58 dB (13.4 dB + 0.18 dB). It costs \$94/1000 ft.

Times LMR-240, the best RG-8X I know of, has 8 dB/100 ft of loss at 700 MHz, and 16 dB at 200 ft. It costs \$440 per 1000 ft.

Belden 9310, a good RG-58, has 11.1 dB/100 ft of loss at 700 MHz, and 22.2 dB at 200 ft. It costs \$267/1000 ft.

Wire Type	Loss/100 ft	Price/1000 ft
Belden 9100	6.7 dB	\$94
Times LMR-240	8.0 dB	\$440
Belden 9310	11.1 dB	\$267

So the 75 ohm cable is less than 1/4 the cost of the closest 50 ohm equivalent and works better.

Note that you add the loss due to mismatch to the TOTAL attenuation, not the per/100 ft attenuation. That's because the reflections caused by mismatch (which is what causes the additional loss) are reduced by the loss in the line, so the longer the line the greater the loss. This means that the reflections are weaker as they go down the line, so the excess attenuation is also reduced. The ARRL Antenna Book shows this nicely with some graphs of the standing wave distributions on a line and a discussion of how that increases the loss.

Want to go for the biggest lowest loss coax available (0.400" diameter)? You're talking RG-8 (50 ohms) versus RG-11 (75 ohms). The 75 ohm cable wins there too. It costs \$195/1000 vs. either \$530 for Times or \$774 for Belden. The loss of the best RG-11 is 3.25 dB/100 ft at 700 MHz vs 3.9 dB for the Belden RG-8 and 4 dB for

the Times. Add the loss due to mismatch and you're still ahead with the 75 ohm cable.

The cost/loss advantage is even more in favor of a good RG-6 (75 ohms) if you're going for a good compromise with size (think conduit size/cost, and the cost of handling a heavier cable). A 10% cost premium over the good RG-59 will get you 1.5 dB/100 ft less loss with only 0.27" OD.

Although I've quoted numbers for only Belden and Times, the other good cable companies, Gepco and Commscope, are stuck with the same laws of physics and economics.

By the way, prices quoted are from on-line catalogs of mainline vendors for small quantities of cable. You can obviously do better with careful shopping for any given cable, but the relative costs of one generic type to another aren't going to change. I recently bought 1,000 ft. of quad-shielded RG-6 from Commscope's website to rewire my house for RF. (The last time I bought coax was about 15 years ago, and I just ran out). Cost with shipping was just over \$100.

To be complete, it should also be noted that there can be some mismatch between the antenna and the line, but this could just as easily be in favor of the 75 ohm cable, since wireless mic antennas are generally used over a wide frequency range and rarely very close to ideal at the frequencies of operation.

There's a more thorough discussion of this in the wireless mics applications note on my website. The ARRL publications can be purchased new from [www.arrl.org](http://www.arrl.org) and are widely available used. Although they are published annually with minor revisions (mostly to electronic technology, but also to innovations in antenna design), all of the material referenced here is in the 1949 edition of the Antenna Book. I gave away my older edition of the Handbook, but I suspect it's there too. The bottom line is that a 30 year old edition is just as good as a new one as a way to learn these fundamentals. *jb*

