Strays – Artificially low SWR

A lossy transmission line, such as coax, can lead you to believe your antenna exhibits lower SWR (standing wave ratio) than it really does. How can that be? Antenna characteristics such as SWR are unique to an antenna without regard to its transmission line, right? Perhaps, but the results from measuring those properties without taking your tools into account can be misleading.

Let's say you have a transceiver that's set to transmit on 2 meters at 100 watts, and it's connected by 67 feet of RG-8X without a tuner to your poorly matched antenna that exhibits a 3.0:1 SWR at the feed point. According to the **coax loss chart**, RG-8X exhibits 4.5 dB loss per 100 feet at 2 meters, or 4.5 dB × (67 ft / 100 ft) = 3.0 dB loss.

After losing 3 dB (half) of its power in the coax, your 100-watt signal reduces to 50 watts by the time it reaches your antenna. Once at your antenna, the 3.0:1 SWR means some of its signal power is reflected back toward your transceiver, as determined by the *reflected power versus forward power ratio*, a derivation of the well-known *reflection coefficient*:

$$\frac{P_{reflected}}{P_{forward}} = \frac{P_r}{P_f} = \left(\frac{SWR - 1}{SWR + 1}\right)^2$$

Then, solving for SWR, you get

$$SWR = \frac{1 + \sqrt{P_r / P_f}}{1 - \sqrt{P_r / P_f}}$$

According to the first equation above, the reflected signal from the 50 watts at the moment it arrives at your 3.0:1 SWR antenna results in a reflected signal strength of

$$P_r = \left(\frac{3-1}{3+1}\right)^2 (50 \text{ watts}) = 12.5 \text{ watts}$$

at that point. This 12.5-watt signal now returns to your transceiver by the same cable and so again loses 3 dB (half), leaving 6.25 watts incident upon your transceiver.

By the second equation, the resulting SWR measured at your transceiver will now be

$$SWR = \frac{1 + \sqrt{\frac{6.25 \text{ W}}{100 \text{ W}}}}{1 - \sqrt{\frac{6.25 \text{ W}}{100 \text{ W}}}} = 1.67 : 1$$

which makes your antenna ***appear*** better-matched than the 3.0:1 you had originally measured for it at the feed point. Just for comparison, if your coax was LMR-400 (1.5 dB loss per 100 feet, much lower loss) instead, the apparent SWR from the same antenna would then have been

$$SWR = \frac{1 + \sqrt{\frac{16 \text{ W}}{100 \text{ W}}}}{1 - \sqrt{\frac{16 \text{ W}}{100 \text{ W}}}} = 2.33 : 1$$

a little closer to reality. Based on what we're seeing here, it seems that SWR is a fairly important property to address when considering antennas and transmission lines. But if that's the case, then why didn't the old timers 60-plus years ago ever worry or even talk much about SWR? It's because *they didn't use coax*.

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