More on Transmission Lines and SWR – Part I
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I don't know how many times I've heard a fellow ham exclaim "My antenna is really good – SWR less than 1.5 on all bands!" The happy ham is most likely seeing the SWR at the end of the transmission line where it connects to the transceiver, which is usually a substantial distance (30' to 100') from where it is connected to the antenna. A low SWR can be achieved in several ways: (1) with a very lossy transmission line, (2) with a good transmission line of the right length, (3) with a dummy load, (4) with fresh (not dry) cow dung in place of the antenna, (5) with a not-very-good antenna whose radiation resistance plus its losses adds up to the characteristic impedance of the transmission line, and (6) a 'good' antenna whose feedpoint impedance is close to the characteristic impedance of the transmission line. The last case is the optimum condition. My point is, a low SWR at the transmitter doesn't necessarily mean a good (efficient) antenna.

Unless the SWR measurement is made at the feedpoint at the antenna, it doesn't tell one much about the antenna itself. But making SWR/impedance measurements at the antenna feedpoint is often difficult because of physical access – the feedpoint is usually high in the air somewhere. There are equations one can use to back out the effect of the transmission line so that measurements made at the transmitter end of the transmission line can indeed show what the conditions are at the antenna. These equations require that the radio frequency parameters of the transmission line at the frequency of interest are known. Also, some antenna analyzers have the capability to perform this as well, provided that both ends of the transmission line are accessible before final assembly … something to think about before hoisting your next antenna out of reach. Finally, you can also use a length of transmission an electrical half-wavelength long at the frequency of interest (more on this in a later article).

For maximum power transfer into the antenna, the impedance of the antenna at the point where the transmission line is connected needs to match the impedance of the transmission line. I write the words in that order because you can change the impedance of the antenna at the point where the transmission line is connected, but you can't change the impedance of the transmission line – not easily, anyway, unless you make your own. If the two impedances are not matched, some of the transmitted power is not absorbed (and radiated) by the antenna, and is reflected back towards the source. This results in standing waves on the transmission line. The SWR is an indication of the degree of mismatch between the antenna feedpoint impedance and the impedance of the transmission line. A SWR of 1 indicates a perfect match. The higher the SWR, the greater the impedance mismatch and the greater the reflected power.

If you're using a solid-state transmitter, and the SWR is greater than 2, sensors within the transmitter will probably reduce the output power so that the transmitter will not be damaged. An antenna tuner situated between the transmitter output connection and the transmission line can be used to ensure a low SWR at the transmitter.

It should be noted that the “antenna tuner” DOES NOT tune the antenna. It does nothing more than transform (change) the impedance looking toward the antenna from the transmitter to something that the transmitter will tolerate. Some tuners claim to accomplish this over a wide range of load impedances, but they never state that considerable power may be dissipated in the tuner as a result.

We usually think of the transmission line as a pipe where what we see at one end is what we see at the other end. Other times, we deliberately use a transmission line as an impedance transformer where what we see at one end is intentionally NOT what we see at the other end. We can’t have it both ways, so which is correct and why do we care? Next month’s article will explain some of the terms used to describe transmission line characteristics and how the transmission line can affect the SWR.