The Radio Hotel -- SWR – The Coax Z to Antenna Z Disparity

by Rick Hiller W5RH

A cardinal rule is defined as a fundamental rule upon which other matters hinge. The cardinal rules of the Standing Wave Ratio are:

1 – The Standing Wave Ratio, or SWR, is determined **only** at the physical point where the feedline meets the antenna. SWR is generated by the mismatch of the feedline's impedance (Z) to the antenna's feed impedance (Z). The forward power and reflected power generated at the feed point are also used to calculate SWR. SWR remains constant thru out the feed system, with minor changes due to resistive losses. The SWR is stated, i.e. 1:1.5, or spoken as "one point 5 to one".

2 -- The system's lowest SWR is always found at the antenna's resonant frequency, even in the case of the antenna's resonant feed impedance not being equal to the feedline's characteristic impedance.

3 -- The antenna system's SWR is always lowest at the shack end of the coax due to transmission line losses. The shack end of the coax has 1) the maximum forward power from the transmitter and 2) the minimum measured reflected power coming back from the antenna (due to resistive losses). This means that the SWR at the antenna feedpoint can be higher than what you see in the shack.

Antenna system SWR is one of the most important factors that must be measured to ensure efficient operation of our stations. For the typical coaxial transmission line, the characteristic impedance is nominally 50 ohms. Most of the commonly used antennas have a resonant feed impedance of close to 50 ohms also. The closer to 50 ohms that each impedance is, the lower the SWR, meaning minimum reflected power and maximum forward power to the antenna..

Common ways to obtain the system's SWR is to measure it by using the appropriate SWR meter, antenna analyzer, OIB – Operating Impedance Bridge or simply a power/watt meter. These devices will measure the forward power and internally compare it, or allow us to manually compare it, to the measured reflected power. Since the SWR is fairly constant in the system, we can place the measuring device anywhere within the feedline. (Note: the newer VNA/ microcomputer based analyzers measure the impedance R and +/- j seen at their insertion point and arithmetically calculate the SWR value.

Transmission lines and SWR have a deep technological history. They are based on solid, practical physics and can be defined by absolute, mathematical equations. To learn more about SWR, have a look at the series of **The Radio Hotel** columns in the **BVARC newsletters 2014 May to December**. These can be found online, on the BVARC website home page, left side, under "All Club Newsletters". http://www.bvarc.org/newsletters.php

I hope this helps kickoff your venture into the sometimes confusing world of RF transmission lines, impedances and SWR. Being the ham radio enthusiast that you are, it is well worth the trip, I promise.

Enjoy your hobby. 73…Rick W5RH