The Radio Hotel – The Standing Wave Ratio Rick – W5RH

SWR – Standing Wave Ratio (always singular – never SWR's) – the ratio of the maximum voltage on the standing wave compared to the minimum voltage on the standing wave (the standing wave being created by the summation of the transmission line's incident or forward wave and the reflected wave. See 'The Radio Hotel' May 2014).

SWR is a snapshot of the quality of the match between the antenna (Load) and the feedline (TL). The ratio is normalized around the TL's characteristic or surge impedance, so a Load with a feed impedance(Z) above the TL Z and a Load with a Z below the TL Z can both have the same SWR For example -- TL is 50 ohms. Ant 1 Feed Z is 100 ohms so SWR = 100/50 or 2:1 Now, Ant 2's Feed Z is 25 ohms and SWR = 50/25 or 2:1. Same SWR. Notice how the ratio is varied in order to keep the result above 1:1 So, from the SWR you can tell 'ONLY' the difference in the impedances of the TL and the Load. It is obviously best to have the TL Z and the Load Z equal, but when they aren't, you need to know that, so you can adjust the antenna or the match. Reducing the SWR to closer to 1:1 reduces the reflected wave amplitude and makes the whole system more efficient with less loss, etc. putting more power into the Load. Lower SWR can also save your transmitter PA transistors, as they are not made to handle much reflected power or the fatal higher voltages generated by 'off resonance' system reactances that can occur. Most transmitters have power output reduction circuits to save the transistors, but that will lower your output power. Something you want to avoid, if at all possible, to maximize radiation.

It is imperative that you remember that **SWR is determined by the Load Z and the TL's characteristic Z**. The antenna feedpoint is the origin of the SWR and the position of the true SWR measurement. SWR can be measured anywhere along the line, but loss in the line has a detrimental effect on the measurement. It causes it to be better. Better? How? SWR can be the ratio of TL Z to Load Z, or Vmax to Vmin or even Power forward versus Power reflected……and that is typically what we use today - Power. We just go for max forward power and minimal reflected power. So, where on the TL do we have the low SWR condition of 'maximum forward power versus minimum reflected power'? At the transmitter! The forward power is at maximum and the reflected power is at minimum, as the reflected wave has occurred loss traveling from the antenna feedpoint back to the transmitter. [Note: ALL transmission lines have loss (some a lot, some very little).] Measuring the SWR at the transmitter gives you a reasonable picture of your situation, as long as you keep the loss of the TL in mind.

Take this next situation as an example of the above -- using the software **TL Details** (Google it)….. for 146.94 MHZ (WA5CYI/R), a 2 meter transceiver with a 100 foot piece of RG-58 coax connected to a ground-plane antenna. This ground-plane is 30 ohms at resonance at 146.94 Mhz. SWR at the antenna is 50/30 or 1.66:1 SWR, but when measured at the transmitter end of the coax the SWR is 1.18:1 due to the loss in the coax. This gives a false impression that all is OK at the antenna. Not so and some situations are much worse than this.

Further, due to a high "matched" RG-58 coax loss of 4.6 dB at VHF, you get only 33 watts delivered to the antenna (with 100 watts out of the transmitter). With that in mind it would be much better to improve your coax quality (lower loss), so that you get more power into the Load. With lower loss, the SWR will increase at the transmitter end. But, by knowing that the SWR is determined by the TL and Load match, you can take steps to improve that match closer to a 1:1 SWR where it really matters -- at the antenna feed point -- and put more of your transmitter power into the antenna.

Next time "SWR Measurements"

*The purpose of **The Radio Hotel** is to give you a practical kickstart into exploring the workings of antenna systems. Do a bit of research – Google the buzz words and find out what they mean. Read up on antenna theory to see how it all works together. You will be glad you did.*

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Donn Washburn, N5XWB, Life Member of BVARC, SK

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