VSWR…
Nothing to SWR About..

By Dave Turnmire
N7TZK

Transmission Lines… More Than Meets the Eye

- Transmission line is more complex than a simple pair of wires or one wire inside another conductor.
- For tonight, we'll focus on:
  - It's Characteristic Impedance
  - Incident and Reflected waves… which lead to…
  - Voltage Standing Wave Ratio

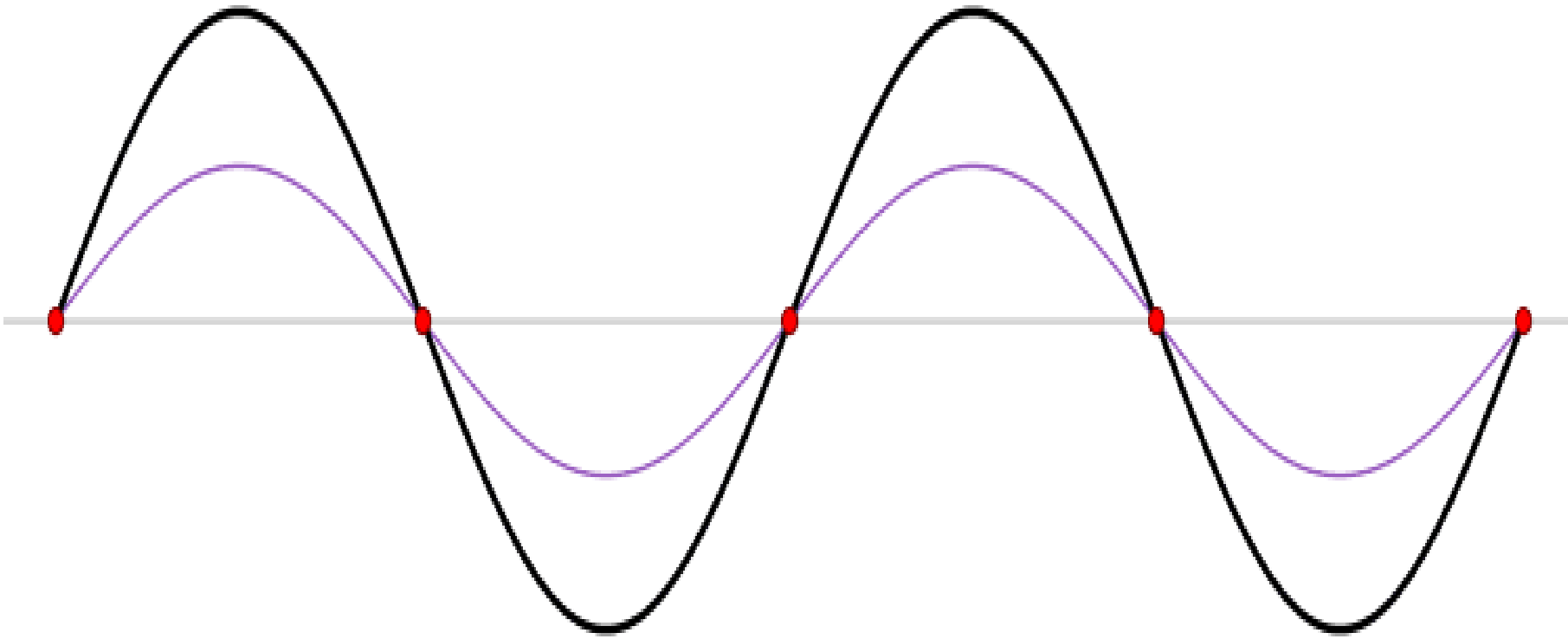
Characteristic Impedance

- Not the same as DC resistance… but still measured in ohms (Ω)
- It can be calculated from: conductor diameter, conductor spacing, and insulation type
- Most common for hams: 50 ohm coax. Occasionally 450 ohm window-line (as in G5RVs). TV receivers use 75 ohm coax.

Bouncing RF

- In only ONE circumstance will an RF signal passing through a *lossless* transmission line all end up in the load…
- The rest of the time… a portion of this *incident* power gets reflected by the load… as *reflected* power.
- The interaction of these two signals results in a *Voltage Standing Wave*.

Follow the Bouncing Wave…



VSWR

- The portion of the incident wave that gets reflected depends on the ratio of the load impedance to the line's characteristic impedance.
- That same ratio determines the Voltage Standing Wave Ratio… VSWR… or more commonly… just SWR.

VSWR… Too Much is Not Good..

- That reflected power ends up adding to the heat generated by your transmitter's output transistors.
- It also can lead to abnormally high voltages that can stress components.
- None of that is good… but like chocolate… a little bit doesn't hurt
  - <1.5:1 Don't care
  - >2.0:1 Time to worry…

VSWR… Too Much is Not Good..

- Heat and excess voltage is what hams normally worry about w/VSWR. But there is other possibilities…
- TV Broadcasters have long kept VSWR under 1.1
  - In analog days, the reflected signal could cause ghosts in the picture.
  - With digital, the reflected signal could confuse a receiver's recognition of bits.
- With some digital radio… same trouble?

Cool Stuff For Geeks…

- Not only does impedance mismatch matter… so does the length of line in terms of wavelength… even for *lossless* lines.
- That length of line can magically *transform* the impedance at the load end so it looks different to the transmitter.

Cool Stuff For Geeks…

- For instance:
  - If the line is ¼ λ long… an open (high Z) load will look like a short (low Z) to the transmitter. And vice versa
  - But if the line is ½ λ long… the transmitter will see the same impedance as the load.
  - All kinds of cool stuff can be done as a consequence. But… we'll KISS

About That *Lossless* Line…

- In the *real world*… we don't have *lossless* lines. It has resistance and some of our signal ends up warming the coax instead of radiating the neighbor's TV… or reaching the other hams receiver.
- Which is bad for signal strength but is good for VSWR at the transmitter.
  - Why?

Causes of Mismatch

- We *might* have bad connections, shorted cables, water in the cable, etc. But perhaps more likely…
- Non-resonant antennas *generally* are something other than 50 ohms
- Some antennas by nature aren't 50 ohms and need matching techniques
- Nearby objects… like Mother Earth… affects impedance.

A Brief Detour to EZNEC

- EZNEC is “free” software with your ARRL Antenna Handbook… not so free… but valuable…
- It lets you “model” an antenna design without the time/expense/hassle to build it.
- Let’s take a brief peek…

Measuring VSWR

- In the Beginning there was… watt meters.
  - Some measured forward and reflected power and to get VSWR, you need to do the math. Or remember:
    - 1.5:1 SWR 4% reflected
    - 2.0:1 SWR 11% reflected
    - 3.0:1 SWR 25% reflected
  - Others measure SWR directly.

Measuring VSWR

- But power meters *only* tell you there is a mismatch… not which type or direction… trial and error to resolve
- Antenna analyzers… like the popular MFJ-259, etc. tell you how much resistance and how much reactance. If the reactance is zero… antenna is resonant and no use worrying about that.

For More Info on VSWR

- www.wikipedia.com for quick research
- https://youtu.be/s2H3u-OPSIE Another old but cool video
- And of course… the ARRL Handbook.
-
- And reach out to your Elmer for a borrowed antenna analyzer to test your antenna.