2025-03-04 Hamlet Net - SWR Definition

Announcements:

- Test Session Info
    - Next VE session is Saturday, March 22nd in the Clover Building at the Boulder County Fairgrounds, and starts at 9 am. It is a PVET session, so there is no fee to test. For more info, and to pre-register, see the Licensing/Testing page on the club web site, https://w0eno.org/, under the Education menu.
- Please take the latest survey on the web site: https://w0eno.org/larc-general-membership-poll/
- Upcoming Club Volunteer Opportunities:
    - This Saturday, we are finishing up the Yagi antenna kits which are being sold at LARCFest. This will run from 10 to 12 at the Clover Building at the Boulder County Fairgrounds.
    - The club is building a GoBox for the CU Amateur radio club. This will take pace on March 15th from The first is building a GoBox for the CU Boulder amateur radio club. This will take place at the Sawhill Ponds Wildlife Preserve in Boulder from 10am to 2pm.
    - LARCFest (April 5, 2025): https://w0eno.org/other-clubs-and-radio-organizations/?sheet_id=15 or contact Chuck at: k0itp@w0eno.org
    - Summer Field Day (June 28-29) -
    - HAMCON Colorado 2025 for Rocky Mountain Division is October 23-26, 2025 in Grand Junction. For more information and to register, see their web site at: hamconcolorado.com
- Pictures from LARC Winter Field Day.are up on the web site.
- The next RMHAM University presentation is an antenna workshop covering antennas for HF and VHF. Topics include transmission lines, different HF antennas (dipole, OCF, Zepp, bazooka, multi-band, trapped, vertical, beams), building and tuning wire antennas, yagis, traps, etc. Oriented at practical considerations, stealth, size and height. It will be held on March 8th from 8:30 am to noon-ish.

  You can attend live in Greenwood Village at the Cherry Creek Schools ESC. It's also being held on Zoom if you can't make it, and they usually record the sessions for later viewing as well.

To sign up, go to the RMHAM web site at: https://www.rmham.org/ and click on the "Sign Up for RMHAM University" link under the "RMHAM UNIVERSITY" menu item.

- If you are an ARRL member, remember that you have digital access to four magazines - QST, On the Air, QEX, and National Contest Journal.

- We have a new net on the LARC repeaters. It's run by Timothy Moss, KFØLAR, on the 22nd of every month at 6pm - that's this Sunday. The 22nd was chosen to highlight the average of 22 vets who commit suicide each day. While the purpose of the net is to connect veterans, non-vets are welcome to participate as most all of us have friends or family who are or have served.

- The ARRL Colorado Section Net occurs on the second Monday of the month from 7 to 8pm. The net is run by Amanda Alden, K1DDN, our Colorado ARRL section manager, and is open to hams and non-hams alike. This net is a place where Colorado hams can ask questions of ARRL leadership and request help, guidance, club support, and technical support. This net meets on the second Monday of each month at 7:00 pm Mountain time. The net is on the Colorado Connection, Rocky Mountain Ham Radio DMR Talk Group 700, The Fun Machine, WE0FUN, and the NCARC Buckhorn Repeater 447.700 – with 100 Hz tone.

- We have some volunteer opportunities available where you can help out LARC:

    - Photographer / videographer - record team activities and upload to web site / YouTube

    - Newsletter Editor - put together the monthly Splatter newsletter

    - Event Coordinator

- Time's up for this year, but you can earn your 2026 membership or future renewal by acting as NCS for at least 5 nets next year. You can run either this Tuesday night net or the Thursday night net (or both). We have scripts available for both, so all you need is a good connection into the repeater, and somewhere to keep track of names and call signs as people check in. If you're going to be on the net anyway, why not save some dough at the same time!

- Chuck has set a goal for the Club of running at least one activity a month. This can be a hands-on construction activity, an operating activity like Field Day, a fox hunt, or a special event station. The goal is to get people together to have fun with amateur radio! We have multiple locations at our disposal, as well as lots of Club equipment, so if you have an idea for something you think others hams would like to do, please let us know, and if you're willing to run it, even better!

- The Club is also looking for presentation topics for 2025. If you have any ideas, or better yet, would like to present, please let Chuck know and we'll get you on the schedule! We would like to get some presentations from club embers on stuff they've been doing, projects they're working on, or just things that interest them.

- All club activities are open to anyone - members and non-members. If you have questions, ask them on a net or **send email to elmer@w0eno.org**

Presenter: Bryan, AF0W

Topic: SWR

- One thing some hams obsess over is the Standing Wave Ratio, or SWR, of their antenna systems

- Everyone wants that perfect 1:1 SWR, but what does that really represent?

- First of all, what is SWR?

- It is a measure of impedance matching of loads to the characteristic impedance of a transmission line

    a. In the case of a typical amateur radio setup, the load is the antenna and the transmission line is the feedline to the antenna

    b. The most commonly used feedline is coaxial cable with a 50 ohm characteristic impedance

- So what is the characteristic impedance? Does this mean that if I connect an ohmmeter to both ends of a coaxial cable, or across the center conductor and shield at one end, it will read 50 ohms?

- The first thing you may notice is that the term includes the word "impedance." This should be a clue that we're talking about something different from DC resistance, which is what your ohmmeter will read, so no, you won't see 50 ohms with a multimeter.

- Impedance is the opposition to alternating current presented by a combined resistance and reactance - the AC current being the RF signal generated by your transmitter, and the reactance being the opposition to the current by inductance and capacitance

- In your licensing studies, you may have come across the fact that reactance is a function of frequency. You can see this in practice as you will see different SWR values for the same antenna system when tested on different bands.

- The characteristic impedance is based on the distributed capacitance and inductance in a transmission line

    a. It is determined by the geometry and materials of the transmission line (such as the diameter, spacing between conductors, and the type of insulation), and is not dependent on its length (assuming the transmission line is uniform)

- So back to SWR - if the load and transmission line characteristic impedances are equal, then it is said that they are matched, and then the SWR is 1:1
- If there are any impedance mismatches, then reflections will occur, which will cause standing waves along the transmission line
- SWR is defined as the ratio of the standing wave's amplitude at maximum and minimum points
- SWR has an impact on the amount of power that reaches the actual antenna
- For example, if you have a 50 ohm antenna connected to a 50 ohm lossless coax feedline, then there are no reflections, then close to 100% of the power output by the radio reaches the antenna. This system has an SWR of 1:1
- The SWR is always something to 1 - 1:1, 2:1, 10:1 - it's never 1:5, for example
- Now what if you replace the antenna with one that has a 100 ohm impedance?
    a. The SWR for a purely resistive load can be calculated by dividing the load resistance by the characteristic impedance (or vice-versa - whichever calculation results in a value greater than or equal to)
    b. For this system, the SWR would be 100 ohms divided by 50 ohms, or 2:1
    c. For a 2:1 SWR, approximately 33% of the voltage, or 11% of the power is reflected back towards the transmitter
    d. If you could observe the voltage along the transmission line, you would see that instead of a constant AC voltage as is the case for a 1:1 match, it now has standing waves which would appear as peaks and valleys as it interacts with other RF waves from the transmitter
- In the case of a perfect transmission line, which has no losses, this reflected voltage would bounce back and forth in the transmission line until all of it reached the antenna.
- When using a real-world transmission line, there will be losses due resistive heating. The magnitude of these losses will depend on the lossiness of the transmission line used.
- If a very low-loss transmission line is used, then no matter what the SWR, most of the power will eventually reach the antenna.

- On the other hand, if you have a long and very lossy feedline, you may get a low SWR reading, but what you may not be seeing is that the reflected power from the antenna is being lost due to heat.

- Note that these standing waves also mean that your feedline length makes a difference. Your SWR will actually vary based on the length of your feedline.

    a. You may have read antenna information that states a specific length of feedline that needs to be used, or perhaps lengths of feedline to be avoided - usually based on the frequency or wavelength at which the antenna is being used. Note that this is referring to the length of the feedline, not the antenna itself.

- The ARRL Handbook has much more in-depth information, and includes a graph that shows the SWR at the antenna for a given SWR at the transmitter, and a given feedline loss.

- An example of the use of this graph would be a 2 meter station and antenna connected by 120 feet of RG-8X cable.

    a. If the manufacturer's specs for that cable show an expected loss of 4.5 dB and your transmitter's SWR meter reads 2:1, you may think that while this is not optimal, it's not too bad.

    b. Using the chart I mentioned previously, you will find that the actual SWR at the antenna is 20:1, not 2:1. This is due to the mismatch and cable loss.

    c. Your SWR meter is understating the SWR as much of the reflected power is being lost when traveling back to the transmitter and SWR meter.

    d. The 20:1 SWR at the antenna means that less than 1/10 of your transmitter's output power is arriving at the antenna.

- So what can you do about these losses?

    a. One way of addressing them is to use a balanced feedline, such as open wire line, window line, or ladder line

        - The loss for this type of feedline is quite low for HF frequencies

    b. For example, 300 feet of 450 ohm ladder line has a loss of less than 0.5 dB at 30 MHz, while a good quality, expensive coax might have around 1 dB of loss for the same length - and cheap coax will have closer to 2 dB of loss

    c. This means that you can use this type of feedline even if you have a high SWR (mismatched) antenna - the lower losses will result in more power being radiated rather than lost in the feedline

    d. This behavior is utilized in the multi-band doublet antenna, which is a wire dipole that is fed by a balanced feedline. The low losses in the feedline allow most of the transmitted power to actually reach the antenna, whereas a coax feedline to the same antenna would suffer high losses.

- The examples I used are all based around purely resistive impedance values. Again, the real world isn't quite so pretty.
    a. To match the impedance of the feedline and antenna (or transmitter), the impedances must be complex conjugates of each other.
    b. In amateur radio applications, this is done by adding inductance and/or capacitance to the antenna system - frequently via an antenna tuner or match box
- Keep in mind that while a low SWR (i.e. close to 1:1) is generally good, it does not mean that your antenna system is radiating effectively
    a. If you connect a 50 ohm dummy load to your radio with a piece of 50 ohm cable, you will get close to a 1:1 SWR, but your station will not radiate very much signal!
- Also note that if you use an antenna tuner to present a 1:1 impedance to your radio, this does not mean that the rest of your antenna system is 1:1
    a. For example, say you have a 5:1 SWR with your antenna tuner bypassed, which means it is essentially not affecting your antenna system at all. If you then engage the tuner and adjust it to a 1:1 match, your radio will also see a 1:1 SWR, but the SWR on the far end of the antenna tuner will remain 5:1
- Much of the information in this presentation was based on an article in the November 2006 QST (https://www.arrl.org/files/file/Technology/tis/info/pdf/q1106037.pdf)
- I'll have a bit more information on how to measure the SWR in your station in a later presentation.

Questions:

1. **The question for the week is:** Do you use any non-coax feedline in your station, and if not, do you have a tuner that is capable of using balanced feedline directly?
2. **In my case,** I'm currently using coax for all my antenna feedlines. My main HF antenna is a G5RV Jr. which is a dipole antenna that was designed for 20 meters, but which can be operated on other ham bands with the use of an antenna tuner to overcome the impedance mismatches on those bands. The antenna is a wire dipole with a 15.5 foot feedline made of window line, which then connects to coax to run back to the shack. The ladder line is actually part of the impedance match for the antenna.

My antenna tuner does have connectors for a balanced feedline, and I plan to eventually try a multi-band doublet which will consist of a wire dipole fed entirely by window line.

More Info:

- Standing Wave Ratio (Wikipedia): https://en.wikipedia.org/wiki/Standing_wave_ratio

- If you have ideas for net topics or general meeting topics / presenters, please let us know! Tell us on a net, or send email to k0itp@w0eno.org

Email to elmer@w0eno.org

1. KCØCT - Joe Clarke - Broomfield
2. AEØDO - John - N of Longmont
3. KØITP - Chuck - Firestone
4. W7PGF - Philip - Frederick
5. AFØW - Bryan - Longmont

End: 7:38pm

Powerpoles - Mouser