2022-09-20 Hamlet Net

Announcements:

- Test Session Info
    - At the Sunday test session, we had two candidates pass their Technician exam and two upgrade from Tech to General. One of whom is David, KF0CFD
    - Next scheduled test session is October 22nd at 350 Terry Street
        - ARRL session, so $15 there is a $15 testing fee.
    - BARC is running a Patriot VE exam during BARCFest on October 2. Pre-registration is encouraged
    - To test before this (or online), go to hamstudy.org -> Find a Session (make sure you search for online sessions!

- Our club president, Chuck, KE0ITP, has opened a challenge - if you run Net Control for five nets (either this Tuesday night net, or the general club net on Thursday nights), you will get a free one year of club membership.

- The monthly LARC meeting is tomorrow night on Zoom.

- Steve will be on FT8 from Alaska as WL7CYQ on 20 meters tonight.

- The Boulder Amateur Radio Club has announced that they will be putting on their BARCFest ham fest on Sunday, October 2 at the Boulder County Fairgrounds. For more information, see their web site at www.qsl.net/w0dk/ that's w-w-w-dot-quebec-sierra-lima-dot-net-slash-whiskey-zero-delta-kilo and click on the BARCFest button on the left

    - LARC will have three tables for selling SK and Club stuff - if you're available to help, please get in touch with Chuck

- The 2022 ARRL Rocky Mountain Division Convention will be held on October 7th through 9th in Cheyenne Wyoming. Rick Roderick, ARRL President is the featured speaker this year. The main convention day will be Saturday, October 8th with vendors, a swap meet, forums, activities, a VE test session, banquet and special event station W7Y. For more information, see wyhamcon.org (whiskey-yankee-hotel-alpha-mike-charlie-oscar-november.org)

    - If you have gear you want to get rid of, they are running a "country store" where you drop off your stuff along with pricing info, and they will sell it for you. They do charge 10% for this service, but you don't have to sit at a table for the entire swapfest.

- I saw some free items that might make good antenna mast supports. They were posts embedded in concrete inside tires. I was considering grabbing one or two, but they're pretty heavy. If you want to check them out, they're on the south-west corner of Sunset

and Boston in Longmont at 1801 Boston Avenue. There's a "free" sign next to them and some other used wood and PVC pieces.

- 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**
- Club breakfast Saturday mornings at 8am at the Hidden Cafe in Longmont
    - Come meet other Club members and discuss amateur radio

Misc:

- Maine state QSO party this weekend

Presenter: Bryan, AF0W

Net Notes

- I've started archiving the notes from the weekly Hamlet Nets, so if you miss a URL, or miss a net, you can catch up
- To access, go to the club web site at w0eno.org and mouse over the "Repeaters/Nets" menu item, mouse over the "Tuesday Hamlet Net" item, and finally click on the "Hamlet Net Topics" link. The URL is: https://w0eno.org/hamlet-net-topics/

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 system 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 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, and 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 1)
    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
- 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:

- **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?**
- **In my case, I'm currently using coax to feed my G5RV Jr. antenna for use on multiple bands and my single-band end fed antenna. My antenna tuner has balanced feedline connectors on the back, and I plan to set up a multi-band doublet at some time in the future.**

Notes:

- 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

K0ITP - Chuck - Strictly using coax (RG-213 or RG-8), and have tuners on his HF system

KF0CFD - David - (not responding)

AE0DO - John - Had wave table in physics class also.

KC0CT - Joe - Run coax on most everything. Haven't used balanced line, but has MFJ-929 that will handle it.

WA7EM - Ed - Has 2 tuners that can do balanced feedline, but no antennas. Good demo in physics class on a water table

KN6CFI - John - Interesting topic. Waves add together when they encounter . Use coax for everything. How does this affect data quality?

KF0IKI - Pam (Frederick) - Don't have too many thoughts. Brand-new.

KE0EE - Don - (no response)

KM6SJA - Steve - No balanced feed line.

AF0W - Bryan -

W0DPC - Donald - New to this as well. Just plugged in first HF antenna to Yaesu 991 about 3 hours ago. RigExpert AA55 Zoom in his hand. Tuned through HF bands, but didn't hear anything. Is normal not to hear anything on HF bands?

KF0EAJ - Steve (Alaska) - Two rigs - one at home with couple of dipoles in attic (3 bands), and fan dipole in Alaska. Use RigExpert and lengthening/shortening wires on antenna for resonance. Both fed by LMR-400 coax. Running pretty close to 1:1 on 20m in Alaska.

Not hearing anything - WWV on 5, 10, 15, and 20 MHz

Balanced antenna - needs to be in the open - not around metal - has to remain balanced

Great wave presentation: Youtube, search for AT&T archives waves (https://www.youtube.com/watch?v=DovunOxlY1k)

What effect does high SWR (standing waves) have on digital? (KN6CFI question)