

## 2024-09-17 Hamlet Net - Coax Cable

### Announcements:

- Test Session Info
  - Next VE session is September 28th 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.
- Tomorrow is the September Annual Meeting, which includes voting on Club Bylaw amendments as well as Club officers. We do have a minimum quorum requirement, so if you are a club member, please plan on participating, either in person, via Zoom, or by submitting a proxy on the Club web site. The meeting starts at 6:30pm with socialization, with the meeting starting at 7pm.
- Chuck is running a fox hunt this month on 9/28 from noon to 2pm. This one is different from normal in that you will have to find the operating frequency of the Fox by monitoring its APRS position reports (which will be sent out approx. once every 15 minutes). The fox will also move approximately every 7-10 minutes to keep things interesting. Once you have the fox's frequency and general location, you can hunt it using RF as you normally would. For more information, see the club website at: <https://w0eno.org/another-larc-fox-hunt-2/>
- Volunteer monitors who have automated programs that match up license classes with traffic on the bands to see if they are operating within their license class.

Technicians have CW only privileges on 80, 40, and 15 meters. While there may be some band plans or information out there stating that Techs can use digital modes as well, this is not the case. One small loophole is that Techs are not prevented from using hardware-based CW transmitters and receivers.

I learned this by watching a summary of a club meeting that had a panel of 6 individuals from the ARRL and FCC answering questions. You can find this video on Youtube by searching for "HRM 534" ( <https://www.youtube.com/watch?v=SwD0aKa9SGY>). You can also watch the full 2 hour recording by searching for "21 Group FCC ARRL Luncheon" ( [https://www.youtube.com/watch?v=86FLGI\\_e5nw](https://www.youtube.com/watch?v=86FLGI_e5nw)).

- We are still looking for volunteers for Santa on the Air - we can use elves who act as net control, as well as Santas. We've got a script for the elf, and a list of questions for Santa to keep the net going when Santa doesn't have anyone to talk to. No experience is necessary. You can even participate over Echolink as well.
- 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
- Social media manager
- You can start earning your 2024 membership or future renewal by acting as NCS for at least 5 nets this 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! There are four free memberships available for 2023, so don't wait to get started!
- 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 2024. If you have any ideas, or better yet, would like to present, please let Chuck know and we'll get you on the schedule!
- 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](mailto:elmer@w0eno.org)**

**Presenter: Bryan, AF0W**

**Topic: Coax Cable**

- After radios and antennas, coax cable is probably the next most-used item in amateur radio
- "Coax" is short for "coaxial" and refers to the design of the cable itself
  - a. In the case of amateur radio, coax cable typically consists of a center conductor surrounded by a tubular dielectric insulator, which itself is surrounded by a tubular, metallic shield and finally a plastic jacket
  - b. The term "coaxial" refers to the fact that each of these "layers" share the same geometric axis
- Normally, the outside of the shield is kept at ground potential and the signal-carrying voltage is applied to the center conductor

- Coaxial cable is a type of transmission line which is designed to carry high-frequency electrical signals with low losses
- If you've not had experience with coax cable in amateur radio, you may have used it when connecting an antenna or cable system to your TV
- It is typically a round, black or white cable with some sort of connector installed at each end
- Let's look at each of these pieces in detail

### **Center Conductor**

- The center conductor is typically made of copper for amateur radio uses
- It can be either solid or made up of multiple strands of small wire
- Cables with solid center conductors are less flexible than those with stranded conductors

### **Dielectric Insulator**

- To maintain the proper physical properties of the cable, the center and shield conductors must be separated electrically by a certain distance along the entire cable
- The dielectric insulator is responsible for this task
- Unlike metal, dielectrics have no loosely bound, or free, electrons that may drift through the material and carry electrical current - they are instead electric insulators
- Different materials may be used, such as solid plastic, foam plastic, or air
- Solid polyethylene, or PE, is used in some lower-loss cables, but does not have much flexibility
- In some larger cables, the dielectric is air. There is a spiral-wrapped plastic spreader that is used to maintain the correct physical separation along the cable
- Pressurized air or nitrogen is sometimes used in cables where there is a need to monitor cable integrity (against damage or attempts to surreptitiously tap into the cable)
- There are also cables designed to use a vacuum instead of air
- A typical dielectric used in amateur radio coaxial cables is polyethylene foam, sometimes listed as "PF," which is more flexible than the solid polyethylene insulators
  - a. As a foam, it also contains air or some other gas, further improving its dielectric properties

## Shield

- Frequently referred to in amateur radio as the "braid," the shield of a coax cable is the second conductor
- It is typically constructed of braided copper wire to allow the cable to flex
- This does result in gaps in the shield layer
  - a. Many coax suppliers actually list the percent of coverage as part of their cable specifications
  - b. For example, DX Engineering sells RG-8X coax with a shield coverage of 96-97%
  - c. Cheaper coax such as from Radio Shack has a reputation of having a thin shield with a loose weave which results in low coverage, and while it may be acceptable for HF, it's not good for VHF and above
- Interestingly enough, there is actually a real-world use for "lossy" coaxial cables
  - a. They are used in underground mines to enable the use of radios to communicate throughout the underground tunnels as well as to the surface
  - b. They are called "leaky feeder cables"

## Cable Jacket

- The outer shield serves multiple purposes
- One is to physically protect the shield (and other cable components) from abrasion
- It also protects against moisture, which can severely compromise the cable
- Some jackets also protect against ultraviolet light, which is important for cables used outdoors, such as for feedlines to antennas
- Some cables are also rated for direct burial in the ground - again, the jacket is the primary protection for the cable in these cases
- The jacketing can also affect the flexibility of the cable
- A common jacket material is PVC, but this is not UV-resistant

## Transmission Lines

- One other important property of a coax is the characteristic impedance of the cable

- In electrical engineering, a "transmission line" is a specialized cable designed to conduct electromagnetic waves in a contained manner
- This happens when the conductors are long enough that the wave nature of the transmission line must be taken into account
- In coaxial cables, nearly all the electromagnetic wave is confined to the area inside the cable
- This is one of the major benefits of using coaxial cable as a feedline in an amateur station
  - A big one is that the cable can be bent without negative effects
  - It can also be mounted to or run near conductive materials, such as metal antenna masts, rain gutters, and metal-framed windows
- Coaxial cables are not the only types of transmission lines - in amateur radio, we also have open-wire, window line and twin lead, to name a few
- Transmission lines can be modeled as having series inductance and parallel capacitance distributed along their entire length
- As 50 ohms is used for amateur radio, a cable with a characteristic impedance of 50 ohms will "match" this impedance - using a cable with a different characteristic impedance can result in reflections when connected to a 50 ohm radio or antenna
- The coax used for cable TV and video applications typically has a 75 ohm characteristic impedance
  - This does not mean that it cannot be used for amateur applications - only that you must take this impedance mismatch into account

### **Choosing the Right Cable**

- So with all the different combinations of components that can be used in a coax cable, how do you go about selecting one?
- When selecting a coax cable, there are a number of things you should take into account:
  - a. The characteristic impedance of the cable - typically 50 ohms for amateur use
  - b. The signal loss at the frequency at which you are operating
  - c. The power handling capability of the cable
  - d. The diameter and weight of the cable

- e. The flexibility of the cable
  - f. Any required environmental resistance of the cable
- As with many things in amateur radio, the cable you select may end up being a compromise between features, requirements, and cost
- Signal loss at operating frequencies becomes a concern at higher frequencies
  - a. Cable that has acceptable losses for HF may be too lossy for UHF use, for example
  - b. The loss per length (frequently either 100 meters or 100 feet) is typically specified
  - c. Cables used for short runs, such as between components in your shack, will experience less overall loss than long cables, such as feedlines to an outdoor antenna
  - d. There are also many online references and calculators to help you make an informed choice - I've included some in the notes for this presentation
  - e. A common coax, RG-8X has a loss at HF frequencies of around 1 dB per foot and 8 dB per foot at VHF frequencies.
- There isn't really a naming convention for all the different varieties of coaxial cable
  - a. The "RG" nomenclature, as in "RG-58" stands for "Radio Guide" and is the original military specification for coaxial cables that dates back to World War II and is now referred to by the Mil-C-17 standard (<https://nepp.nasa.gov/docuploads/96D38FB4-6F63-45A5-8CB5ABCA633430EB/MIL-C-17.pdf>). Here is a web site with a table to characteristics: <https://www.rfcafe.com/references/electrical/coax-chart.htm>
  - b. The numbers in the designation are somewhat arbitrary and are not always indicative of the specific form and function of the cable itself, so make sure you examine the specifications of any major coax purchases
- Different coax cables have different power-handling capabilities
  - a. A cable that works for connecting your HT to a tape measure Yagi may not be able to handle connecting your 1500 watt amplifier to your antenna tuner!
  - b. For receive-only or low-power QRP use, coax power rating is not an issue
- Coax cable comes in many different diameters - obviously, larger-diameter cable is going to weigh more

- a. This may matter if you are putting together a GoBox or QRP setup for a backpack
- b. Larger diameter cable is also likely to be less flexible - a larger-diameter, lower-loss cable may look good on paper, but not practical to use with an HT
- c. Some commonly-used coax cables are RG-8X which has a diameter of .242 inches, and LMR-400, which has an outer diameter of 0.405 inches.
- Cable flexibility is important - you don't want an inflexible cable if you need to make short jumpers between devices, if you frequently rearrange your operating position, or for use with antenna rotators
  - a. One thing to keep in mind is that solid core conductors are easier to terminate if you plan on installing the cable connectors yourself
- Environmental resistance was mentioned briefly when discussing cable jackets
  - a. Probably the biggest concern is to make sure you have UV-resistant cable if you plan to use it for permanent outdoor runs
  - b. Another consideration may be crush resistance for a cable that is run across the ground where it may be walked on or even driven over
    - If the cable becomes deformed, it will not maintain the expected characteristic impedance

### **Coax Cable Info**

- Here are some typical coax cable types used in amateur radio:
- RG-58 (and LMR-200) is a lightweight cable with an outside diameter of 0.194 inches and is a standard cable for mobile installations.
  - a. RG-58 is good for 1000 watts at 10 MHz, around 200 watts for VHF, and 135 watts for UHF
- RG-8X (and LMR-240) is a larger cable with a diameter of 0.242 inches, with lower loss than RG-58
  - a. A rule of thumb is that it is good for runs up to 50 feet at 50 MHz and below
  - b. Up to 146 MHz, it is good for runs up to 25 feet
  - c. RG-8X is good for 1500 watts at 10 MHz, but only around 550 watts for VHF and 250 watts for UHF

- RG-8U (and LMR-400) is larger yet, with a diameter of 0.405 inches, and is a good general-purpose cable, especially for long cable runs
  - a. It is good for up to 3500 watts at 10 MHz, 975 watts at VHF and 450 watts at UHF
- The "RG" in the name comes from when these cables were made to military standards
  - a. Nowadays, these terms are used rather loosely, and refer primarily to the size of the cable
- Another thing to keep in mind when you are sourcing cables is whether you want to buy unterminated bulk cable and cut it and install your own connectors, or whether you want pre-terminated cables

### Where to Buy

- So where do you buy coax cable?
- If you typically order online from places like Amazon or eBay, you need to be very careful and make sure you are ordering from a reputable vendor and are actually getting what you are ordering
  - a. As with everything nowadays, there are many knockoffs with dubious quality
  - b. These sites also have a lot of "no-name" cable
    - Sticking to a known good manufacturer such as Times Microwave, Belden, Davis RF, ABR Industries, Cable Experts and Messi & Paoloni will help ensure you have a good experience
  - c. Your antenna system is a major component of your amateur station - you don't want to unknowingly buy inadequate cable as it can affect your station performance significantly
- Amateur radio related businesses are a much better place to look - some examples are:
  - a. Ham Radio Outlet, or HRO (<https://www.hamradio.com/>), is a great choice as you can drive down to Denver and actually look over the product before purchasing (as well as getting assistance and opinions from other hams on what to buy)
    - If you would rather order online, you can do that as well
  - b. DX Engineering (<https://www.dxengineering.com/>) sells many brands of coax cable, including their own





- c. I also terminated a few pieces of coax myself.
- d. I have two eggbeater antennas in my attic for satellite use - one for VHF and one for UHF. I have 50 foot runs of Times Microwave LMR-400 for these antennas
- e. I also have an Ed Fong dual-band antenna connected to 50 feet of RG-8X coax that I ordered from Ed along with the antenna

**More Info:**

- Coaxial Cable (Wikipedia): [https://en.wikipedia.org/wiki/Coaxial\\_cable](https://en.wikipedia.org/wiki/Coaxial_cable)
- Coaxial Cable Characteristics and Data Used in Amateur Radio Stations: <https://www.hamuniverse.com/coaxdata.html>
- Leaky Feeder Cable (Wikipedia): [https://en.wikipedia.org/wiki/Leaky\\_feeder](https://en.wikipedia.org/wiki/Leaky_feeder)
- Transmission Line (Wikipedia): [https://en.wikipedia.org/wiki/Transmission\\_line](https://en.wikipedia.org/wiki/Transmission_line)
- Cable Attenuation and Power Calculator: <https://timesmicrowave.com/calculator/?productId=121#form>
- Times Microwave Systems LMR-400 Coax Specifications: <https://timesmicrowave.com/wp-content/uploads/2022/06/lmr-400-datasheet-1.pdf>
- RG-58 (Wikipedia): <https://en.wikipedia.org/wiki/RG-58>
- eHam Feedline Reviews: <https://eham.net/reviews/view-category?id=7>

**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](mailto:k0itp@w0eno.org)

**Email to [elmer@w0eno.org](mailto:elmer@w0eno.org)**

1. K0ITP - Chuck - Firestone
2. AE0DO - John - N of Longmont
3. W7PGF - Philip - Frederick
4. AF0W - Bryan - Longmont

End: 7:50pm