

## 2023-09-05 Hamlet Net - RFI Filters and Ferrite Chokes

### Announcements:

- Test Session Info
  - Next VE session is Saturday, September 23rd in the Clover Building at the Boulder County Fairgrounds, and starts at 9 am. It is a PVET VEC session, so no fee to take the 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.
- September 16th, noon to 3 - LARC is invited to the NCARC club picnic. Will be monitoring the Horsetooth repeater for talkins.
- See [hamsci.org/contest-info](https://hamsci.org/contest-info) for info on Solar Eclipse QSO party and the Gladstone Signal Spotting Challenge. Both events are on October 14, 2023.
- Chuck is putting together a special event to celebrate the 105th anniversary of the Peak-to-Peak highway involving multiple area radio clubs on September 30th. They're currently looking for volunteers to work this special event. They will be operating HF SSB voice, CW, and FT8 stations from 8am to 4pm with three operators at each station. There is a signup link on the club web page at <https://w0eno.org/>, or contact him for more information!
- We have some volunteer opportunities available where you can help out LARC:
  - Photographer / videographer - record team activities and upload to web site / YouTube
  - LARC Fest Coordinator -
  - Newsletter Editor - put together the monthly Splatter newsletter
  - Activities Chairperson - member of the Board of Directors
- Our sister club up in Nederland is looking for some help with events they are running. They have a weekly Monday night net with no predetermined agenda, so you can lead it however you want. They are also planning a Field Day site at Golden Gate State Park and are welcoming anyone who wants to participate. Finally, they are looking for operators for the Ned Gravel run on July 8th. They have signup links for all these events, so head over to their web site <https://w0ned.org/> for more information!
- You can start earning your 2023 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 2023. 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**

**Questions from Last Net:**

- 1. How far from Betasso Trailhead to Boulder County Fairgrounds (sites for the Boulder Amateur Radio Club and Longmont Amateur Radio Club Field Day Sites)**
  - a. Straight line distance is 14.81 miles
- 2. Would a contact between these two stations be groundwave or NVIS?**
  - a. Most widely used instrument for ionospheric measurement is the ionosonde, which is essentially a high frequency radar which sends short pulses of radio frequency energy into the ionosphere and monitors for reflections
  - b. The highest frequency which the ionosphere will reflect vertically is called f<sub>o</sub>F<sub>2</sub>
  - c. Looked at plot of f<sub>o</sub>F<sub>2</sub> which is produced using ionogram profiles from around the world at: [https://www.sws.bom.gov.au/HF\\_Systems/6/5](https://www.sws.bom.gov.au/HF_Systems/6/5)
  - d. Currently, it appears that Colorado would fall in the 9 MHz range, meaning that anything over 9 MHz will not be vertically reflected, which is necessary for NVIS communication
  - e. This means that if the conditions were the same when the Field Day communication took place, then if the frequency was in the amateur 40, 60, 80, or 160 meter band, then it may have been via NVIS
  - f. Ground wave propagation distance is affected by many factors, such as terrain conductivity and permittivity as well as other factors such as antenna height, distance and frequency

- g. One reference I found (<https://vu2nsb.com/radio-propagation/ground-wave-propagation/surface-wave-propagation/>) mentions that "Over non-homogeneous paths, the use of vertical polarization is the only practical way of leveraging this propagation mode because the ground quickly absorbs horizontal polarization. Even vertical polarization suffers high attenuation if the soil conductivity is poor."
- h. The wire antennas used at LARC's site were all horizontally polarized - I'm not sure about those at the Boulder site - but would assume horizontal polarization as well
- i. While inconclusive, it appears that NVIS may have been the mode of propagation for that Field Day contact

#### **Topic: RFI Filters and Ferrite Chokes**

- One potential issue I mentioned when discussing solar system controllers a few nets ago is radio frequency interference, or RFI - another term used for this is electromagnetic interference, or EMI
- RFI can range from noise heard on your radio receiver all the way up to interference with the operation of electronic devices such as computers, which may even crash or reboot
- RFI can be caused by non-amateur devices such as arcing power line insulators, neon signs, lamp dimmers, LED lamp drivers, and switching power supplies
- RFI is most common on the HF bands, but can also impact VHF and upwards

#### **Filtering**

- One way of dealing with RFI is using some form of RF filtering
- Filters either reject or attenuate signals over some range of frequencies, or they accept or pass them
- For example, filters are available to attenuate signals in the FM broadcast band which spans 87.5 to 108 MHz in the US. These filters can be useful if your station is within range of strong broadcast stations.
- Filters can be characterized by their interaction with signals passing through them.
- The descriptions may involve one or more frequencies of interest
  - a. For example, a low-pass filter will pass frequencies below its cutoff frequency, and attenuate those of higher frequencies

- b. A high-pass filter is just the opposite - it filters frequencies below its cutoff frequency, and passes higher frequencies
- One example of a low-pass filter is the MFJ-704 1.5 kW low pass filter. It can be used if your transmitter or amplifier is outputting undesired harmonics outside of the ham bands. It passes signals from 1.8 to 30 MHz, and attenuates signals above 40 MHz.
- Another complementary pair of filter types are band-pass and band-stop or band-reject filters.
  - a. As the names imply, band-pass filters will pass frequencies within a range, while band-stop filters will attenuate signals within a range of frequencies
- The club owns a set of three band-pass filters that are used in conjunction with our tri-band SpiderBeam antenna.
  - a. This antenna supports 20, 15, and 10 meters, all connected to a common feed point. The feedline runs to a triplexer box that is essentially a low pass, band-pass, and high-pass filter all in one box. It breaks out the single feed line into three outputs, one for each band, which can then be connected to three different radios.
  - b. The triplexer does not have enough isolation between the bands to allow the connected radios to operate at 100 watts without damaging the other radios. This is where the three band-pass filters come into play. They are installed between the three radios and the triplexer to provide additional signal isolation.
- The filters can also be used independent of the Spiderbeam antenna and triplexer in situations where multiple radios are operating on different bands using different antennas, such as on Field Day, to reduce interference between 10 meter and 20 meter radios.
- As with anything, including feedline and connectors, filters will introduce some overall signal loss, called the insertion loss
  - a. The previously-mentioned MFJ-704 low pass filter has an insertion loss of not more than 0.5 dB across the HF bands
- Many newer HF radios have extensive filtering capability built into their receive sections
  - a. Many older radios had used replaceable filters that allowed the operator to configure the radio for the type of operation they preferred
    - For example, a CW operator could install narrow bandwidth filters to help pick out other CW stations, while a voice operator would install much

wider filters which were appropriate for single sideband voice transmissions

- b. Many newer radios now come with adjustable digital filters, allowing the operator to make changes without having to open the radio or purchase new parts
- RFI doesn't only consist of interference into your radio equipment - it can also impact external devices
  - In many of these cases, a low-pass filter can be used to filter HF, VHF, and UHF communications from lower-frequency signals such as AC power lines (60 Hz), audio devices (25 Hz - 25 kHz), and lower-frequency AM broadcast signals.
  - Filters can be constructed using combinations of simple passive components, such as capacitors, inductors, and resistors.
  - For example, the simplest low-pass filter is a capacitor across a signal or an inductor in-line with the signal, or both in combination.
  - But a filter doesn't need electrical components - a ferrite bead can function as a passive low-pass filter by dissipating RF energy into heat
  - If you've ever worked with computer equipment, you may have encountered a video signal cable or a USB cable with a tube-like "bump" near one or both of the cable connectors. This is a ferrite bead, and is there to suppress high-frequency signals or noise.
  - Also called a choke, these ferrites consist of a ceramic with high iron content and high permeability, which results in the ferrite coupling with the high-frequency components of the signals passing through the cable, and dissipating them as heat. Lower frequencies are passed through with minimal attenuation.
  - I have personally had a situation where a Windows computer would signal a USB device disconnection and reconnection when I'd transmit on 2 meters. The device was an Arduino-based Morse code keyer I'd built. When I replaced the USB cable with one that had the ferrite beads on both ends, the problem went away.
  - Now you can't just grab any ferrite and expect it to work in any situation. There are different compositions that have varying frequency and power handling specifications, so you have to have an idea of what frequencies you are trying to attenuate to be able to choose the right ferrite.
  - The composition of the ferrite is frequently referred to as a mix.
  - For example, mix 75 covers 150 KHz to 10 MHz, mix 31 covers 1 - 300 MHz, and mix 61 covers 200 to 2000 MHz.

- Note that you may also need more than one ferrite to provide enough impedance to effectively filter out the RFI. Looping the cable through the same ferrite additional times will also increase the effect, but you may run into limitations with the physical size of the cable and ferrite before you reach a level of filtering high enough to address the RFI.
- When a conductor passes through the center of a ferrite bead, the impedance goes up with the square of the number of passes through the center. This means that to achieve the same amount of choking impedance of a toroid with a few turns through the center, you may need a "string of beads" consisting of 30, 40, 50 or more individual toroids.
  - a. An example of this is the MFJ-915 RF Isolator, which is rated at 1500 Watts and is made up of 50 ferrite core beads placed onto a 13 inch piece of RG-303 coax
  - b. I'd never heard of RG-303, so I looked it up - it has a diameter of 0.17 inches (RG-8X cable has a diameter of 0.242 inches)
- There is no requirement that all ferrites installed on a cable be of the same type. For example, one ferrite may be used to address HF issues, and a second may be used for VHF.
- Since the ferrite dissipates RF energy as heat, the mix used must be able to tolerate the expected amount of heat generated for the level of RF power through the ferrite.
  - a. The MFJ-704 low-pass filter I mentioned is rated for 1.5 KW, but they also sell the MFJ-702B for half the price, but it will only handle 200 Watts of power.
- In addition to the small tube-shaped ferrites, there are also larger tube- or ring-shaped designs that allow you to pass larger-diameter cables through them
- Some ferrites are split so they can be opened to allow a cable to be passed through, and then closed to hold it in place. This makes them easy to add to household equipment such as AC power cords, audio and video signal lines, and speaker wires.
- I've used one such ferrite filter from Radio Shack to handle RFI on a set of powered computer speakers in my ham shack. When I would transmit on certain HF bands, the speakers would output static, but once I wrapped the signal wire multiple times through the ferrite, the problem went away.
- Some things to keep in mind when buying ferrites are that they are fairly fragile and can easily be physically damaged in shipping, and they are usually unlabeled as to the mix they contain. Make sure you label or mark the toroids when you receive them so they don't get mixed up!
- DX Engineering has a wide assortment of ferrites, but you may be able to save money by purchasing from other sources as many ferrites are made by a company called Fair-Rite - you can find product lists and other information on their web site at

<https://fair-rite.com/>, thats foxtrot-alpha-india-romeo-DASH-romeo-india-tango-echo-DOT com

- Palomar Engineers have a lot of ferrites and other devices for use in addressing RFI.
  - a. They even have kits of ferrites to be used for noise reduction on various radios
  - b. For example, they have a kit for the ICOM 7300 that includes 2 ring ferrites for antenna and DC power cables, and 3 snap-on ferrites for I/O cables such as the ALC jack, accessory socket, and USB connection. This five-filter kit runs \$40.
  - c. While the mix is not mentioned directly, the ad does say the filters cover 1 to 300 MHz, which means they are likely mix 31.
- There are many other tools and techniques that can be used to address RFI - ferrites are just one of them.
- Taming RFI is not the only use for ferrites in amateur radio. They are also used for impedance matching for wire antennas.
- Where they excel is in their ease of installation
  - a. For example, if a neighbor complains about interference to their surround sound system, and you track it down to HF transmissions, it is pretty simple to try running their audio cables through a mix 31 ferrite to see if that solves the problem.

#### Questions:

- **The question for the week is:** Do you have any RFI issues in your shack, and have you tried using ferrites to fix them?
- **In my case,** I've already mentioned a couple of cases I ran into in my own shack, but one that also sticks in my mind is that the inverter we have for the LARC GoBox seems to generate some RFI on the HF bands when in operation. The inverter is used to charge the Go Box laptop, so it doesn't have to run continuously, but it definitely causes interference when it is in use. This would likely be a good place to attempt to use ferrites to filter out the noise.

#### More Info:

- Radio Waves and Communications Distance:  
<http://www.arrl.org/files/file/Technology/tis/info/pdf/8501031.pdf>

- ARRL EMI / RFI Products and Other Resources:  
<http://www.arrl.org/products-and-other-resources>
- Understanding and Eliminating RF Interference:  
<http://audiosystemsgroup.com/Ferrites-Ham.pdf>
- How do Ferrite Beads Work and How Do You Choose the Right One? :  
<https://resources.altium.com/p/how-do-ferrite-beads-work-and-how-do-you-choose-right-one>
- MFJ-704 Low Pass Filter - 1500 W: <https://mfjenterprises.com/products/mfj-704>
- MFJ-702B Low Pass Filter - 200 W: <https://mfjenterprises.com/products/mfj-702b>
- MFJ-915 RF Isolator - 1500 W: <https://mfjenterprises.com/products/mfj-915>
- Palomar Engineers - RFI Solution Kits:  
<https://palomar-engineers.com/rfemi-solutions/RFI-Solution-Kits-c21312661>
- DX Engineering Ferrites:  
<https://www.dxengineering.com/search/part-type/ferrite/product-line/dx-engineering-ferrite>
- 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)

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1. K0ITP - Chuck - Firestone
2. W7PGF - Philip - Frederick
3. AF0W - Bryan - Longmont
4. KV0N - Raman
5. AE0DO - John - N of Longmont
6. KF0FEC - Will - Boulder (mobile)
7. KF0MXH - Art - Longmont
8. KM6SJA - Steve - Longmont

AE0DO - One LARC member was having trouble with smoke alarms - a couple would beep when he would transmit. Went over with ferrites and stuff, but instead just replaced with new ones, and problem went away.

Was helping another member troubleshoot some issues getting into the repeaters with his handheld, and noticed that when we transmitted with 5 watts on UHF, his amplified speakers would make noise.



Don't run different cables through a single ferrite