

## 2023-10-24 Hamlet Net - SWR - Measuring

### Announcements:

- Test Session Info
  - Next VE session is Saturday, October 28th in the Clover Building at the Boulder County Fairgrounds, and starts at 10 am. It is an ARRL VEC session, so there is a \$15 test fee. For more info, and to pre-register, see the Licensing/Testing page on the club web site, <https://w0eno.org/>, under the Education menu.
- 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
- LARC is running our annual Santa on the Air event again this year, with help from the Northern Colorado Amateur Radio Club. We are planning to have Santa, Mrs. Claus, and Santa's elves operate from Monday, November 27th through Sunday, December 10th.

Our "professional Santa" has retired this year, so we are in need of some help! We currently have one Mrs. Claus and one Elf, so we need some volunteers to round out our team.

The only requirement is that you can get into the LARC repeater or the NCARC 447.700 repeater on Mount Buckhorn - you can also use Echolink to get into the LARC repeater. I suppose you should also like kids as well. 😊

I believe Chuck has some material put together by our old Santa on how to play the part, so if you are available, please help us out!

Contact Chuck, K0ITP, at [k0itp@w0eno.org](mailto:k0itp@w0eno.org) to see how you can assist.

- 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**

**Topic: SWR - Measuring**

- Last week, we talked about the standing wave ratio, or SWR - this week, I'll present on how to measure it. I'm going to mention a number of MFJ products, but this is more for reference rather than an endorsement
- I'm sure you will be very unsurprised to hear that you measure it with an SWR meter, but how does this item work?
- This is typically done by employing a device called a directional coupler
- These devices are used to sample the RF signal power flowing in a single direction - in the case of amateur radio, this would be either from the transmitter to the antenna, called the forward power, or from the antenna back to the transmitter, called the reflected power
- Once you know the forward and reflected power, you can calculate the SWR

**Types of Meters**

- There are a number of different ways that meters indicate the SWR
- The SWR meter in your radio typically displays the value directly on a single-needle analog or digital meter

- One type of external meter used for measuring SWR is the Bird ThruLine wattmeter which is designed to measure power rather than SWR directly. It's also designed more like a piece of test equipment, rather than something you'd permanently install in your station.
  - a. It consists of a directional coupler and a single needle meter with various power scales labeled in watts
  - b. It has a socket into which you install components called elements or slugs. Each element has a frequency range and maximum power rating, as well as an arrow
  - c. The input and output connectors are on the right and left sides of the device's case, and you rotate the element to point in the direction for which you want to measure the power flow
  - d. Once you have the forward and reflected power values, you can either use a graph or calculations to figure the SWR
  - e. These meters can get expensive, as you will likely need to acquire multiple elements to support different bands and power levels
- You can also purchase external meters that measure power and SWR using a single-needle meter for direct reading
  - a. One characteristic of such meters is that they typically require adjustment or calibration every time you change transmitter power output or frequency band
    - This typically involves changing a switch on the meter to a calibrate position, transmitting a signal (ideally using FM or CW mode), and then adjusting a calibration knob until the the meter points to a calibration mark on the meter scale
    - You can now switch the meter back to SWR measurement mode and read the SWR directly
  - b. These meters usually have a switch setting for showing forward or reverse power as well
  - c. An example would be the MFJ-872 wattmeter
- Another type of SWR meter has a power meter with two needles on it. One needle indicates forward power, and the other, reflected power
  - a. Instead of having to perform calculations to find the SWR, you can read it directly on the meter face - there are curves for different SWR values, and you find the curve where the two needles intersect, and the read the SWR from that curve

- b. This type of meter does not require any ongoing calibration when switching bands or power levels
  - c. An example of this type of meter would be the MFJ-815D cross-needle wattmeter
- Finally, there are digital meters that directly show the values for SWR, and both forward and reflected power, such as the MFJ-847 and MFJ-849
- Keep in mind that all meters will have a frequency range over which they are designed to operate, and a maximum power that they can withstand
  - a. If you operate a meter outside of its frequency range, you will most likely receive incorrect readings. There are a lot of cheap SWR meters meant for CB radio use - these will not work for VHF and UHF, for example.
  - b. Some meters will have a switch on the front to set different maximum power levels. Make sure you do not exceed this limit, and also that you take your reading from the appropriate scale on the meter face.

## Accuracy

- One thing to keep in mind is that these meters (including the ones in your radios) are not laboratory instruments
  - a. I'd always thought that the Bird Thruline meters had very high accuracy just because I'd seen them in a lot of Youtube radio repair videos, and they look very heavy-duty.
  - b. I was going to purchase one until I took a look at the specifications. For example, the specifications for CW mode on a Bird meter are +/- 5% of full scale.
  - c. This means that if you are using a 250 watt HF element, your power reading can be off by as much as 12.5 watts.
  - d. The single-needle MFJ-870 is rated at +/- 10% accuracy, while the digital MFJ-849 is rated at the same +/- 5% accuracy as the Bird meter.
  - e. A big step up in price is the TelePost LP-100A digital vector wattmeter, which can reduce the error down to around 3% with NIST calibration, but costs over twice as much as the other meters
  - f. Many meters do have internal calibration adjustments, but unless you have a known good meter to compare them to, you won't know when it's right.
  - g. In reality, most amateur applications do not require a high degree of accuracy - it doesn't really matter if your SWR is 1.5:1 or 1.465:1 or 1.6:1. You're really just

looking to minimize your SWR and make sure it's not something excessive, like 6:1

- h. Note that even though the forward and reverse power readings may not be extremely accurate themselves, SWR is a relative measurement, meaning it will probably be more accurate
- One other option that you might want to look for is the ability of the meter to read peak power.
- When using SSB, remember that there is no carrier present, so your output power will vary based on the signal you are sending out.
- This is something that has tripped up new hams before - you connect an SWR or power meter to your new 100 watt radio, press the push-to-talk, and the meter shows a low or zero reading, leading you to think there is a problem with your radio!
  - a. The ideal way to measure you radio's output is to use CW or FM - both of these modes output a full-power signal at all times
  - b. If you still want to test SSB, then you need to make a loud noise into your microphone - many people do this by whistling.
- Typically, you're not whistling into your mic when you use your radio, so if you want to get a more accurate representation of the power of your output signal, you can use a meter that supports peak output power readings
- Peak-reading meters have active electronics and tend to have slower needle response times as the peak detector attempts to follow the power variations
- This also means that they require a power source to operate.
  - a. Some non-peak-reading meters may also require power, but this is typically just to run the meter backlights
- High SWR will result when there are mismatched impedances in your antenna system.
  - a. While an SWR meter will indicate the SWR, it does not measure the actual impedance. If you need to know that information, you need to use a device such as an antenna analyzer, which will also likely be able to provide SWR information.
- Also keep in mind that many antenna tuners include larger power and SWR meters that are found on radios
- There is a saying that "A man with one watch knows what time it is - a man with two watches is never sure." You will likely run into the same scenario with SWR or power

meters. The meters on your radio, antenna tuner, and an external meter will very likely not agree, but should all be in the same ballpark, and allow you to determine whether there is a matching issue with your antenna system or not.

### Why have one?

- You might be wondering why you would need to add an SWR or power meter to your station. What's wrong with the meter built into your radio?
- One issue is that many radios have a single meter that is used as a signal strength or S meter in receive mode, and can be set to indicate SWR, output power, or other values (such as ALC or compression) when in transmit mode
- This means you cannot simultaneously monitor your SWR and output power
- Internal SWR meters are usually very small, and may be hard to read accurately for those of us with bad eyesight. If you fall into this group, MFJ makes the MFJ-868B Giant Peak-Reading SWR/Wattmeter which features a meter measuring 6.5" diagonally

### Where to Install

- There is also a question of where to install such a meter. In a station with a radio, antenna tuner, feedline and antenna, where do you put it?
- If you install it between your radio and antenna tuner, you will see the power being output by your radio, and also will see how good of a match your antenna tuner is able to make. Ideally, it should be very close to 1:1.
- If you place it after the tuner and before your feedline, then you will be able to see the power sent and reflected by your antenna system, and any SWR mismatch in those components. Note that this mismatch is not corrected by the antenna tuner.
- Finally, if you have an SWR meter with a remote sensing capability, you can install the sensor at your antenna's feed point, which will allow you to see the actual amount of power reaching the antenna (after losses in the antenna tuner and feedline), as well as the SWR based on any impedance mismatch at the antenna itself.

### Summary

- So in summary, you should have the ability to measure the SWR in your radio system especially when you install a new antenna, but it probably doesn't make sense to install a dedicated SWR meter in your vehicle for your VHF/UHF system.

### Questions:

- **The question for the week is:** Do you have any SWR meters other than those in your radio, and if so, which, and how do you like it?

- **In my case**, I have a number of ways of measuring SWR. My HF radio does include a small SWR and power meter, but I also have a meter in my antenna tuner, and an external dual-needle meter from a company called Daiwa installed after it. I usually leave the radio's meter set to monitor output power instead of SWR.

I have an external single-needle SWR meter on one of my VHF / UHF dual-band radios, but I almost never use it for SWR measurements due to the added hassle of having to recalibrate it. Growing up, I always liked all the old monster and sci fi movies with lots of flashing lights and meters, so the additional moving meters are great eye candy for me.

- I also have an old HF digital SWR / power meter from Radio Shack that I installed between my radio and antenna tuner to monitor the SWR and output power.
- I did end up getting a warning that something was wrong with my antenna system with an SWR meter. I noticed that my antenna tuner suddenly started indicating a high SWR whenever I transmitted on HF. I verified that there was something bad going on with my radio's built-in meter, and when I went outside to check my antenna system, I found out what it was. Squirrels had eaten through one of the support lines for my G5RV wire dipole, and half of it was sitting on the ground.

### **Backup Questions:**

1. What hobbies do you have other than ham radio? Do you (or could you) use ham radio in these hobbies?
2. Share an "a-ha" moment you had with amateur radio?

### **More Info:**

- Bird Model 43 RF Wattmeter: [https://birdrf.com/Products/Test%20and%20Measurement/RF-Power-Meters/Wattmeters-Line-Sections/RF-Wattmeters/43\\_General-Purpose-Wattmeter.aspx](https://birdrf.com/Products/Test%20and%20Measurement/RF-Power-Meters/Wattmeters-Line-Sections/RF-Wattmeters/43_General-Purpose-Wattmeter.aspx)
- MFJ-847 Digital Wattmeter: <https://mfjenterprises.com/products/mfj-847>
- MFJ-849 Digital Wattmeter: <https://mfjenterprises.com/products/mfj-849>
- MFJ-872 Single-Needle Wattmeter: <https://mfjenterprises.com/products/mfj-872>
- MFJ-815D Dual Needle Wattmeter: <https://mfjenterprises.com/products/mfj-815d>
- 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. KF0MXH - Art - Longmont -
4. KN6CFI - John - Longmont -
5. WA0JJC - Bob - Boulder -
6. W7PGF - Phil - Frederick -
7. W0PPC - Steve - Lyons -
8. KM6SJA - Steve - Longmont -
9. AF0W - Bryan - El Paso -
10. AI7JW - Ian Wallace -

End: 7:55pm