

2022-10-04 Hamlet Net

Announcements:

- Test Session Info
 - Next scheduled test session is October 22nd at 350 Terry Street
 - ARRL session, so \$15 there is a \$15 testing fee.
 - To test before this (or online), go to hamstudy.org -> Find a Session (make sure you search for online sessions!)
- The LARC Christmas Party will be held on December 14. We are planning to hold it at the Niwot Grange. If we can get at least 75 people to attend, we can get the cost per person down to \$11. Members and spouses/family members are welcome! (Dick - KE0VT)
- Doug, KE0SI, has a Super Antenna system for sale (<http://newsuperantenna.com/>) - contact him for more info. - email: dadouga321@gmail.com
- The 2022 ARRL Rocky Mountain Division Convention will be held on October 7th through 9th in Cheyenne Wyoming. 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)
- JOTA - Jamboree on the Air - Coming up on October 15 in LaSalle. Send Chuck email for more info and if you can volunteer to help.
- 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:

- Nevada, Arizona, Pennsylvania, South Dakota state QSO parties this weekend

Presenter: Bryan, AF0W

Topic: Antenna Tuners

- We've been discussing SWR and ways of measuring it, so tonight I'm going to talk about a way of addressing high SWR due to impedance mismatching in antenna systems
- The primary device that handles this situation is called an antenna tuner

- a. This is interesting because it does not actually "tune" the antenna at all!
 - b. Other names for these devices include antenna matching unit (or ATU), impedance matching unit, matchbox, transmatch, antenna tuning unit (or ATU), and antenna coupler
- The purpose of this device is to match the impedance of the antenna system to that of the radio, which for amateur purposes, is 50 ohms
 - Note that this 50 ohms is purely resistive - there is zero reactance present
 - Antenna system impedance is typically corrected by adding capacitance and/or inductance to bring the system impedance closer to that 50 ohms
 - Also remember that antenna system reactance is dependant on frequency - this means that the amount of reactance needed from the antenna tuner will vary based on the transmitting frequency

Tuner Types

- There are many different antenna tuners available, but there are three main groups:
- The first are fixed - they add a specific amount of impedance and are not adjustable.
 - a. These could be a coil with or without a capacitor that corrects the impedance of a single-band HF antenna
 - b. It could be a coax stub of a specific length tied into the feedline
 - c. It might also be a transformer, such as a 49:1 or 9:1 used for end-fed antennas
- The next two types are adjustable
 - a. The first is a manual tuner - this type of tuner requires the operator to manually adjust the impedance as needed when changing frequencies or bands
 - b. The second are automatic tuners - these automatically adjust their impedance in response to the frequency being used
- A typical arrangement for a manual adjustable tuner is a circuit with two variable capacitors and one variable inductor, often connected in an arrangement that looks like a T, with one capacitor on the transmitter side, one on the antenna side, and the inductor connected between them going to ground.
- A popular model of such a tuner is the MFJ-941E, which includes this T matching circuit as well as a dual-needle SWR meter, an open-wire feedline balun, and an antenna selection switch

- If using a manual tuner, you can make your life easier if you figure out the manual adjustments for the bands you plan to operate on and write down the settings of the matching controls
 - a. That way, when you are operating, you can quickly get a "close match" without having to spend as much time fiddling with the knobs
- One caveat of using this tuner is that a multi-position switch is used to select the inductance value. You should never adjust this switch while transmitting as this can cause arcing on the switch and damage it
 - a. It is OK to adjust the variable capacitors while transmitting
- Note that changing one of the three tuning controls may require changes to the other two, as the controls all interact with each other
- Some manual tuners, such as the MFJ-969 tuner feature roller inductors.
 - a. These are constructed as several loops of wire forming a spiral around an insulating core with a rolling contact that touches the coil at a single point, and which is free to slide along the coil
 - b. The tuner has either a knob or a crank on the front that rotates the coil, causing the slider to move along it and varying the inductance
 - c. The tuner will usually have some sort of counter to indicate the number of turns of the coil so that you can note the position as with the knob-based tuners
 - d. Since these tuners provide an inductance at all times while being adjusted, it is safe to change the inductance setting while transmitting
 - e. The downside is that you may have to turn the crank a bunch of times to change settings, whereas with a tapped inductor connected to a switch, it is simple to click over to a new setting
- With any type of tuner, you should first tune up using a minimum power level.
 - a. This is to prevent your transmitter from encountering a high SWR in case the tuner is not providing a good match with the initial settings
 - b. After performing a low-power tune, you can increase the power and make small changes to the settings, if needed
- Automatic tuners perform the process of determining the proper capacitance and inductance settings for you, so you do not have to fiddle with knobs
- An example of such a tuner is the MFJ-929 IntelliTuner.

- a. Instead of a T network, it uses an L network which has inductance along one leg of the L, and capacitance along the other
- b. There are several fixed inductors and capacitors in the tuner which are swapped into and out of the signal path by some sort of microcontroller
- c. The microcontroller monitors the SWR of the match, and has an algorithm that finds the combination with the best match
- d. It also stores a number of these matches (along with the transmit frequency) so that it can immediately jump to settings for a known frequency (much like writing down the values for a manual tuner)
- e. This MFJ tuner "memorizes" more than 20,000 combinations across its two antenna ports - it has 256 values each of inductance and capacitance available to make the match
- f. The components are swapped in and out using mechanical relays, so there is a good deal of "clicking" when it is searching for a match
- g. The tuner will likely have configuration settings such as at what SWR to trigger an automatic tuning cycle, or at what SWR to stop trying to find a "better" match
- h. It may also include integration with your radio, so that when a tuning cycle is initiated, the radio switches to a constant-carrier mode like CW, lowers the power and goes into transmit mode while the tuning process is taking place, and then returns to the previous mode and power setting afterwards
- i. I've also seen a few automatic tuners that actually contain adjustable capacitors and inductors - in fact, I have one factory-installed in my Kenwood HF radio from the 1980s.

"Tuning" Antenna

- I mentioned that the tuner doesn't actually tune your antenna - what does this mean?
- If you recall from your studies for your license, when you construct an antenna, say a half wave dipole, you adjust the length of the antenna based on the frequency you are planning to operate on so that it is at resonance - this is actually "tuning the antenna"
- What the antenna tuner does is attempt to transform the impedance on the antenna side of the tuner to make it appear as a purely resistive 50 ohm load on the radio side
 - a. This makes your radio think it is transmitting into a perfect match, and allows the maximum amount of power to be transferred between it and the antenna tuner

- b. Of course, the mismatch is still there on the antenna system, so there will still be a higher SWR, reflected power, and standing waves on the antenna side of the tuner, resulting in lost power
- c. The tuner hasn't done anything to your antenna system at all - it just shifts the location of the impedance mismatch to the tuner instead of your radio

Installation Location

- As was mentioned with SWR meters, there are different locations where you can install an antenna tuning device
- The two most prevalent locations are at the transmitter and at the antenna
- The best location from a matching perspective is likely to be at the antenna feedpoint, but this is also the most inconvenient location for interacting with the tuner
 - a. A manual antenna tuner would require you to walk outside to your antenna to adjust the controls whenever you changed bands
 - b. Even an automatic tuner will require a power source to operate, necessitating power cables to be run to the antenna feed point
 - c. The reason this is probably the best spot for the matching to take place is that if you are using a feed line with 50 ohm impedance, then when the tuner presents a 50 ohm load, there will be no reflections and associated lost power over the entire length of the feedline.
 - d. If the tuner is instead installed in your shack, then there will be an impedance mismatch on the entire antenna system, resulting in higher loss

Etiquette

- One problem with either type of adjustable tuner is that you must transmit a signal while adjusting the impedance, whether manually or automatically
 - This means that a signal, however weak, will be transmitted from your station
 - If you've ever waited on a frequency to make a contact with another busy station, you may have heard random "beeps" or tones on the frequency - these are very likely people adjusting their tuning
 - In some cases, hams get in a rush and forget to reduce their output power while tuning, so these may be very strong signals!
 - The correct procedure is to move to a nearby quiet portion of the band and perform your tuning there - then go back to the other stations' frequency - it's

likely that the optimal tuner settings won't be very different, so you shouldn't have to make changes to the tuner settings

- Also, since you are technically transmitting when you perform the tuning, you should identify with your call sign as well

What to look for

- So what should you look for when choosing an antenna tuner?
- Tuners are rated in watts - you want to be sure that the tuner you buy will handle the power output of your station.
 - Keep in mind that in a situation with a large impedance mismatch, there may be high power on the antenna side of the tuner, so if you plan to operate at 100 watts into such a system, you need to get a tuner that can handle more than 100 watts
- The type and number of connections on the tuner is another option.
 - For example, the MFJ 949E has two coax antenna outputs, and one balanced line connector that can be used either for open-wire feedline or a random-wire antenna
 - Both manual and automatic antenna tuners with multiple antenna connections will have some means of switching between the two
- Some tuners include a built-in dummy load that can be used to "pre-tune" the tuner without transmitting a signal through your antenna system
- Some tuners do not include any sort of SWR or power meter (especially those for QRP operation) - in this case, you will need to use your radio's meter, or an external SWR meter
- The tuner may include a built-in balun for connecting to balanced feed lines
- If you plan to use your tuner outside, you'll want to choose a model made for that application. Keep in mind that you may need additional power and control wiring
- If you get an automatic tuner and your radio supports it, you may want to choose a model that integrates with the radio - or even purchase a radio with a tuner built into it
 - External tuners generally have a larger range of mismatches that they can handle compared to built-in tuners

- Built-in tuners are certainly more convenient as it's one less box and feedline jumper that you have to keep track of if you are operating portable
 - Automatic tuners are good if you hop around to different bands frequently. If most of your operating is 20 meter FT8, then you can save some money with a manual (or even a fixed) tuner
- Be sure to look at the range of SWR over which the tuner can match - many times, an radio's internal tuner will be more limited than an external one
- Manual tuners aren't that complicated - they are something that a do-it-yourselfer can put together from parts - I saw large variable capacitors and inductors for sale at the BARC hamfest this weekend.
 - There are even kits for automatic tuners that just require some modest soldering and assembly skills
- Of course, if your SWR meter shows an SWR below 2:1 for all the bands you want to operate on, you may not even need a tuner in the first place!
- Also, while there are tuners for VHF and UHF, if you have a large mismatch at those frequencies, especially in a mobile installation, you should try to actually tune your antenna first, as the coax losses at those frequencies will be rather large for coax feedlines

Additional Info

- Some manufacturers: MFJ, LDG, Palstar, SGC, Ameritron (owned by MFJ now)
- <https://www.electronics-notes.com/articles/antennas-propagation/antenna-tuning-tuner-unit/what-is-an-atu-basics.php>
- https://en.wikipedia.org/wiki/Antenna_tuner#Narrow_band_vs._broad_band_matching_methods

Questions:

- **The question for the week is: Do you have an antenna tuner in your shack or vehicle, and if so, what type?**
- **In my case, I have a few tuners.**
 - a. **As I mentioned, the first is in my Kenwood TS-440S/AT radio (the "AT" in the model name refers to the tuner). It is automatic, but a bit slow, and sometimes fails to find a match.**

- b. I also have an external automatic tuner - an LDG AT-1000 Pro tuner. This tuner is rated to 1000 watts, so I can use it with my 500 watt amplifier with no problems.
- c. I have a smaller LDG tuner that interfaces to my Icom IC-706MKIlg radio, although the antenna tuner jack on the radio is not supplying 12 volt power to the tuner, so I have to get that fixed.
- d. I also have an Icom auto tuner that will interface with the IC-706 that I plan to use to match a 43 foot vertical antenna, but I have to get the power output fixed on the Icom first. It does require a 4 wire control/power cable to be run to it.
- e. Finally, I have a very small manual QRP tuner from MFJ that I've not used yet.

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

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

Do you need an antenna tuner after an amplifier (WB4FAW question) - does it matter if amp is solid-state or tube?

WB4FAS - Don - Using an auto tuner (MFJ-993B) and internal radio tuner. Also has a QRP tuner from QRPguys (<https://qrpguys.com/>)

NA0A - John - Using built-in tuner, no power amplifier

AE0D0 - John - Have a 1980's Yaesu with a separate Yaesu antenna tuner

WA7EM - Ed - Using internal tuner on his FTdx10. Also bought a remote tuner at BARCFest that is powered over the coax - no additional power or control lines needed

KC0CT - Joe - Has a couple of auto-tuners - MFJ-929 and MFJ-939, also MFJ-259d analyzer, and has been using that to make resonant antennas

KV0N - Raman - Both IC-705 and IC-9100 have internal SWR meters - using IT-100 auto tuner, and has some MFJ tuners and is experimenting with a few for the 705 (including some auto-tuner kits from ebay)

KM6STA - Steve - Both his IC-7300 and Elecraft KX3 have built-in tuners

KE0VT - Dick - Has 590SG with built-in tuner that will handle up to 10:1, also a remote auto tuner for a flagpole antenna (600W MFJ)

N0ZFV - Using LDG AT-897, also has MFJ-949E which he uses for the SWR meter and dummy load

WB4FAW - Charlie - Has a Dentron 160-10 transmatch connected to an inverted V antenna, also a Kenwood 870S with a built-in tuner

K0ITP - Chuck - Has auto tuners on all his radios