Newcomers and Elmers Net: Tuners/Matching Networks
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A *Transmatch*, commonly referred to as a Tuner or ATU, is an important piece of amateur radio gear which is often unjustly maligned by purists.
-- As we discussed last week, electrical transmitter circuits are easily overloaded by an excess of power
-- The circuitry is designed to back down power when the match is not 50 Ohms.
-- some radios must have 1.7:1 or less to avoid a cutback.
-- A transmatch can help eliminate or minimize 2^{nd} or 3^{rd} order harmonics which might otherwise be radiated
-- these are unwanted signals occurring on the multiple of a frequency
-- Tuners can also help receivers when there are strong stations nearby with more selectivity
-- this may reduce adjacent channel interference or overload.

What they cannot do is change the impedance between the feedline and the antenna—they only allow a transmitter full output power.

More technically, we are looking for is a match between the antenna and the radio such that the feedline "appears" to the radio to be at the same impedance as the radio
-- In other words, we want characteristic impedance (Z_0) to be 50 Ω, the feedline to be 50 Ω, and the antenna impedance to be 50 Ω.
-- This gives an SWR of 1:1 with no reflected power.
-- In an ideal world we would never need a tuner, but as we often have to do more with less these days
-- we are often forced to work with non-resonant antennas on multiple bands, where a tuner is a must

Selecting a Tuner
There are several considerations when choosing a tuner design, whether commercial or homebrew, starting with the intended use.
-- Some units allow only for one type of feedline, while others may accommodate both coax and ladder line.
-- This is a nice feature especially if ladder line might be used in the future.

Another consideration in choosing a tuner is the degree of match the tuner will be expected to provide.
-- smaller, transistor-driven tuners may have a 10:1 limit.
-- 10:1 sounds good, but it is not uncommon for shortened low-band antennas to have significantly higher SWR at the receiver.

-- Inductor tuners designed for high power applications have much bigger coils, which might be just the thing to avoid arcing problems on the lower bands.

High-Tech or Old School?

Modern automatic tuners (ATUs) typically have a limited amount of manual adjustment
-- they will often tune for flat match or as close as possible
-- A manual tuner and a power meter may actually show an increase of power output when the tuner is set for an SWR of 1.5:1.
-- Some ATUs do come with the ability to manually adjust the computer setting, but many do not.
-- there are varying ideas as to why a 1.5:1 match might out perform a 1:1 match, but just be aware you might see a slight difference in your power meter when things are not 1:1

Auto tuners have fairly limited tuning ranges because of the sensitive electronics involved in their design
-- there is a potential for overloading the relays at an SWR greater than 5:1
-- tuners with actual coils in them tend to be able to handle a greater range of mismatches
-- Unlike manual tuners, automatic tuners will need to be adjusted in steps if working on the 80- or 160-meter bands.
-- Jumping from 1.8 MHz to 1.95 MHz, for example, will likely cause an auto-tuner to overload and not find the proper relay settings. By retuning every 25 or 50 kHz, the tuner will be able to adjust itself properly. A little experimentation will indicate how big of a step can be taken.

Resonant antennas can show enough of an increase as one gets closer to the band edges to require a tuner on the lower bands, 40-160 meters.
-- the flashing green light looks good when tuning a band, but changing frequencies on 40 meters or 80 or 160 meters means impendence levels can change drastically.
-- A wideband antenna on 40 meters may only have a 1.5:1 match over 100 kHz or less.
-- If working the extra phone portion of the band through to the top of the band, there is a change of 175 kHz
-- on 80 meters, the change is 400 kHz with an even smaller acceptable SWR range.
-- get in the habit of re-tuning whenever there is a change of a few kHz: 10% or less on 80 meters or 25% on 40 meters.
-- Retuning only takes a moment or two, whether automatic or manual
-- The 2nd and 3rd harmonics interference I mentioned before is reason enough to re-tune

-- so too strong signal interference is likely to be more noticeable the further away one is from resonant frequency

Tuners should be used with an SWR meter, and having a reflected power indicator is even better.

Dissipation
Assuming good quality components, insertion loss (resistance from connectors, materials, etc.) may only be 1 or 2 percent at 40 meters, hardly an issue at 100 watts.
-- on higher bands, 80 or 160 meters, the percentage of loss can increase a lot because of the differences in the wave factor.
-- Using a common T-network designed tuner, loss goes up as the load impedance decreases, meaning insertion loss can become fairly high on these bands.
-- If the power applied is at the legal limit, components could begin to fail as the heat is not able to dissipate rapidly enough.

When loss levels are high (meaning impedance is well below 50Ω) on the upper bands, arcing (or *flashing*) can occur, damaging the tuner's capacitors.
-- The larger the capacitors the less likely this is to happen, but when losses reach 20% or more most tuners will have some arcing.
-- Always try to use the highest output capacitance for the match to lower the risk of flashing. If that does not work then power will have to be reduced accordingly.

More Purchasing Considerations
Some basics for considering which tuner(s) to buy include the type(s) of antennas being used, the power levels used, the style of tuner (manual or automatic), remote or local operation, and the frequency ranges needed.
-- The most practical option is to buy more tuner than is needed now, based on the assumption that needs will change over time.
-- While an amplifier might not be in the shack right now, it might well be added a year from now.
-- Similarly, all the current antennas might be fed by coax presently, but there are many great antennas which work best with ladder line, so a tuner which can handle both might be a good investment.
-- As for manual or automatic, beyond the personal choice, cost may be a significant factor. Beyond 300-600 watts, most automatic tuners get very costly due to the complex circuitry required to protect the sensitive electronic components.

-- A manual tuner with actual coils will usually be much more cost-effective. In fact, the used market for beefy tuners can yield some very good results, and repairs are quite straightforward if needed.

If purchasing a used tuner that is older, keep in mind that tuners used to be rated based on PEP (peak envelope power) just as many amplifiers and vacuum tube radios were rated; a 1200 watt PEP tuner may only handle 800 watts true power out.
-- Depending on the extremes of the antenna used, an auto-tuner simply may not have enough tuning capacity to handle the loads required.
-- Internal tuners for most radios are far less, so even if more capacity might be needed down the road, an auto-tuner may work just fine for typical use.
-- The bigger the compromise antenna, however, the higher capacity tuner it will require.

Another determining factor between manual or automatic tuning would be if there is a need for remote tuning.
-- Most tuners are operated at the radio location, but some antennas really have to have the matching network near the antenna, and an auto-tuner with sensing circuitry built in or with a remote head, would be a very wise investment.

Obviously the quality of cable being used will have an impact on line losses
-- Make sure the coax used is appropriate to the load and the wavelength, and this will help the tuner to work more efficiently.