MARTIN - G8JNJ

ECLECTIC AETHER - ADVENTURES WITH AMATEUR RADIO

USING AUTO-TUNERS

When using an autotuner you don't necessarily have to use a resonant length of wire. In fact if you wish to use one for multiband operation it may be best to pick a length of wire which isn't resonant on any of the required frequencies. Let me explain.

Auto tuners tend to fall into three categories. The first type is often referred to as auto coupler and is usually built into the transceiver. They have a limited impedance matching range, and can only cope with VSWR's of 3:1 or less. The main purpose is really just to increase the bandwidth of resonant antennas to provide full band operation.

The second types are those which can match a wider range of impedances, and are able to cope with VSWR of up to 10:1. These are more versatile and can be used to match a variety of coax fed antennas or random wires when used with a 4:1 transformer. A good example of this is the LDG Z-11 (6 ohms to 1000 ohms) or the MFJ-991 (6 ohms to 3200 ohms)

The final types are genuine random wire tuners which should be able to cope with almost any impedance, although in practise they have a finite matching range. Examples include the SGC range such as the SG-237 or MAC-200 or the cheaper CG Antenna CG-3000 (which uses a T network to improve its matching range)

Some test results can be found at :-

http://ham.srsab.se/pdf/test_aut_tuners.pdf (http://ham.srsab.se/pdf/test_aut_tuners.pdf) (Sorry this link now seems dead - I will try and find another)

Most auto-tuners use a set of Capacitors and Inductors in a relay switched binary sequence to form either a switched L or T network. The exact configuration is automatically selected to provide the best match to between the 50 ohm nominal output impedance of the transceiver, and the complex impedance presented by the antenna and feeder. In order to reduce the size and complexity of the design most auto-tuners are a compromise in the maximum values of capacitance and inductance which can be switched into circuit. Unfortunately unlike manual tuners, which use variable capacitors and inductors it is not always obvious when the tuner is close to the limit of its ability to match to a particular load. You can't look inside the box and see if the capacitor or inductor is at the end of its range of travel. So you may occasionally find that if it is presented with a load which changes slightly from one day to the next, some days it's just within the matching range and other days its not. Likewise if you use an auto-tuner with an antenna that moves around a lot, you may have to either reduce the VSWR sensitivity or switch it out of auto mode once a match has been found. This will prevent it from continually trying to find a slightly better match. If you are using a particularly narrow bandwidth antenna (usually on 160m) you may also find that high frequency components in speech sometimes trigger a tuning cycle, once again reduce the VSWR sensitivity of the auto-tuner or put it in manual once a match has been found.

Some manufacturers give a range of frequencies and impedances the auto-tuner will handle. Others simply give limited frequency ranges, maximum and minimum wire length, or say avoid using ½ wavelengths of wire. Care is required when interpreting these descriptions.

http://www.k0bg.com/couplers.html (http://www.k0bg.com/couplers.html)

As there is a harmonic relationship between the amateur bands, if an antenna is resonant at 3.5MHz it will be presented with a high impedance on frequencies which are even harmonics of the fundamental such as 7, 14, 28MHz etc. In these cases the impedance can become as high as 5000 ohms which is well beyond the matching range of most autotuners. Alternatively if a very short antenna is used, such as a mobile whip, the impedance is likely to be much less than 50 ohms. Typically it can be 15ohms or less, which is also outside the matching range of many auto tuners.

One solution is to select a length which has a natural resonance outside the Amateur bands.

For example, good lengths of wire to use for vertical antennas, permitting operation from 80m to 6m are around 7.2m (tune for resonance on 10.4MHz) or 9.2m (tune for resonance on 8.2MHz). Note that the shorter length gives better results on the higher frequency bands. This is because the radiated energy tends to tilt up towards the horizon, when the length of the antenna becomes greater than 5/8 wavelength long. This results in poor performance for long distance contacts.

Using these wire lengths the impedance rises to a maximum value of around 1000 ohms on 14 and 18MHz and to a minimum of approximately 78ohms at 7MHz, all of which are fairly manageable. Even my own LDG Z-11 Pro, which is not a true random wire autotuner, can work with this length of wire without an additional 4:1 transformer.

If you are using a longer length of wire, perhaps as a Sloper or inverted 'L' good lengths to choose are either 19.4, 22.8 or 34.3m long, as these avoid high impedances on most of the Amateur bands from 160 to 6m.

Even if you are using a true random wire tuner, it may still be advantageous to use a length of wire which does not exhibit either a very high or very low impedance at the required frequencies, as this can result in very high voltages or currents being present in the tuner and at the feed point. This can place additional stress on the matching components such as coils and PCB track inside the tuner and external components such as insulators on the antenna.

In order to emphasise the point here are some thermal images of the inside of two auto-tuners.

Both have been set up to run into a very low impedance load which results in very high currents flowing through the tuner circuits.

First an LDG Z11 Pro being fed with 100w on 3.8MHz into a 0.1 -J12 load.

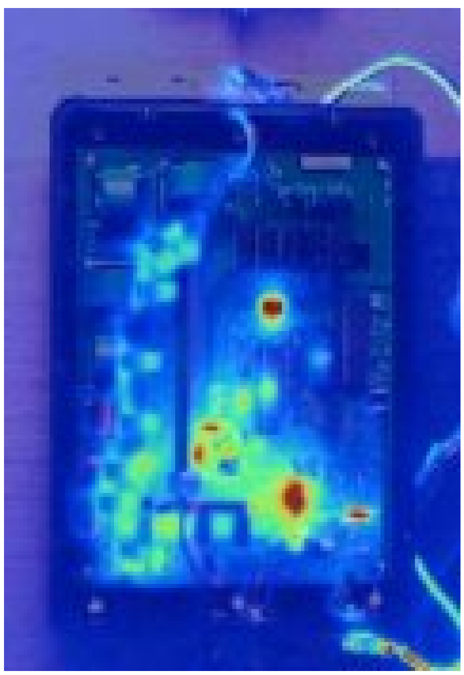
Notice how the small inductors wound on T80-2 iron powder cores are heating significantly.

This is to be expected as I specially selected a difficult load impedance to highlight this problem.

Note that the relays do not show any signs of heating as this particular tuner uses latching relays in order to conserve power.

The PCB track and cables to the rear panel are short keeping connecting losses to a minimum.

Next a CG-3000 set up under the same conditions.



This time the main hotspots are the relay coils which are energised with DC (to the left) and RF sensing circuit and relay driver circuits (to the right).

If you look carefully you can see the long PCB track carrying the RF current heating slightly, but no sign of the air spaced coils becoming warm.

Also note the cables and crock clips connecting the auto-atu to the test load heating as they carry the high RF current.

Comparing the two images you may think that the smaller LDG tuner has a much higher through loss than the much larger CG-3000.

This did not seem to be the case as both tuners measured about 6dB loss when feeding a low impedance load.

However the temperature rise through the CG-3000 was distributed over a much larger area and not concentrated into a small iron powder cored inductors.

I would not reccomend running this power level into such a low impedance load for more than a few minutes.

A tuner with a much higher power handling capacity would be required.

When feeding a balanced antenna with an unbalanced tuner a number of factors have to be taken into account. See my notes on baluns and tuners (http://g8jnj.w ebs.com/baluns.htm)which cover this subject in much more detail.

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