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HINTS & KINKS

YAESU FT-920 AUTOMATIC-TUNER TRICKS

◊ About two years ago, I traded for a Yaesu FT-920 that was in excellent condition, except for its automatic antenna tuner. I went to each band and started the matching process by holding the TUNER button in, and the tuner arrived at a good match on all the bands my antenna covered (40 through 6 meters). The next day, the match was gone on some bands.

Trying to tune those bands ended in a match failure, even with a dummy load!

I first suspected a relay or some mechanical failure, so I opened the transceiver and tried to determine the problem. There seemed to be no mechanical problems; everything was secure but to be sure, I went through the Antenna Tuner Adjustment procedure in the Service Manual. Everything seemed to work for a couple of days, and then the problem started again. I dug into it again and tapped on all the relays as it was tuning, hoping to find one that was sticking or making erratic contact—none found!

I decided to watch the tuner as I went through all the bands and noticed that one of the stepper motors had turned its variable capacitor beyond the fully unmeshed position. Normally the home position for these guys is fully meshed; there is a mechanical stop at this position. Looking from the front of the radio, the stepper motors turn the capacitors clockwise, to the fully unmeshed position at most. There is no stop at this unmeshed position and no feedback to the controller indicates whether this position—or any for that matter—has been reached. This time one capacitor was beyond the unmeshed position, and I thought that one of the stepper motors had a problem, so I replaced it. I should have watched it more closely, because that wasn't the case. The problem returned, and with it continued slipping of my sanity. I had about decided that this was a "return to Yaesu" problem and connected a manual tuner. However, the thought that a tuner was there but not working was driving me crazy.

I opened the radio up again, started the tuner on each band and noticed this time that *both* of the stepper motors had gone beyond the unmeshed position! Normally when you first turn the transceiver on, these capacitors go to the home position (fully meshed) and then go to the saved position for the current particular frequency. After one or both of the capacitors have gone beyond the unmeshed position, however, the home-position reference seems to be lost. When you move to another band, the controller takes the stepper-motor positions and relay sequences from memory and acts accordingly. However, the motor-position information is referenced from the home position, which has now changed. Since there is no positional feedback, the capacitor settings are completely wrong. If you try to tune again, the controller thinks the capacitors are somewhere within that 180° arc from meshed to unmeshed, but instead one or both of them is beyond 180°. Therefore, the capacitance increases, rather than decreases with clockwise rotation. That's why no match could be achieved, even with a dummy load. If you turn the radio off and back on, the motors will turn (counterclockwise) for the length of time they are programmed to turn, but will not go fully home if they're beyond 180°. If you do this several times, they eventually get to the home position. Then, the positional information for most bands is correct again. When you go to one of those bands, everything works again.

I eventually discovered that doing a warm reset (pressing GEN and ENT on the keypad while turning the radio on) would clear the problem for a while, but it kept returning—usually every few days. I knew I shouldn't need to reset the radio that often.

Then one afternoon it was doing this wonderful thing again. Everything was fine on all bands until I went to 6 meters. The match was fine there, but when I went back to 10 meters, I heard a dip in the signal level and then it came back up a little. I knew the capacitors were in the wrong place. I opened it and that was indeed the case. I kept it on 10 meters, turned the radio off and on enough times to get to the home position and started the tuner. It did its thing and achieved a match. I went to 6 meters; the capacitors moved to the new location. Then I went back to 10 meters, and both capacitors went beyond 180°. I went through the off-on-tune thing several times, and each time I went to 6 and back to 10 the capacitors went past 180°. The only way to clear it was to do a warm reset and retune on each band.

It then dawned on me what the problem could be. The tuner uses a serial EEPROM to store values. This EEPROM and the microcontroller are powered from 5-V dc from a regulator on the Tuner Control Board. This 5-V line also goes to the Main Tuner Board for the relays, coils, capacitors and so on. Having had some experience with EEPROM devices, I surmised that noise/RF could be getting into them via this 5-V line and causing erroneous values to be written into memory. There are a couple of 1 µF electrolytic and 0.01 µF disc capacitors along this line, but with as much RF as could be running around in there, I thought it needed more. I took the board out, fired up the soldering iron and added a couple of parts. With these additions, I've had *no* problems with the tuner at all over the last two years. In fact, it seems to tune faster and smoother than before. I added two capacitors: a 330-µF 16 V electrolytic. This could probably be much smaller and work as well, but this is what I had on hand: a 0.047-µF ceramic disc. I wanted a 0.1-µF disc, but this is what I had on hand. Here's the modification procedure:

1. Very carefully unplug all cables from the Tuner Control board. Don't jerk them or you might pull a wire out or break it. Gently rock them from side to side until they come loose.

2. There's a white (at least on mine) flat cable that comes up from underneath the transceiver and slides into a connector on the Tuner Control Board. Don't force this one free. Pull up the small clips on each side to release pressure on the cable so it will come out correctly.

3. Remove the four screws that hold the board in place.

4. There is a screened position on the board marked "C5547." There is no part in that position on my board, nor is there a part on the schematic with this designation. This is where I placed the 330-µF capacitor. Please note that the negative connection is marked with a dot on the board—at least on mine—please verify that on yours!

5. The 0.047-µF capacitor should be soldered as close to pin 8 of JP5004 as possible and ground. I traced the 5-V line and found a spot on the board where I was able to get to a ground connection that already had solder on it.

Bob Schetgen, KU7G ♦ Senior Assistant Technical Editor

I also redressed the leads going to this board somewhat. Especially those going to the stepper motors. They seem three times longer than necessary. I bundled them with a wire tie.

That's it! Put the board back in place and replace all the connectors. Be sure to get the right connector to the right socket for each stepper motor.

Several people on the Internet reflectors reported problems similar to mine, even with multiband antennas such as a five-band vertical. At least five of them (the ones who contacted me) tried this modification and it solved the problem. In the real world, there are many variables. Perhaps Yaesu designed the tuner in a lab environment, then problems resulted outside that environment.

Other notes for FT-920 owners

The automatic tuner in the '920 "gives up" quickly if the SWR is high. In addition, if the SWR is more than 1.5:1, the settings will not be saved. A trick I've used is to turn the RF power to minimum and start the tune cycle. When it starts to tune, raise the power a little at a time so a rough match is attained, then turn it up completely near the end of the cycle. I have been able to get a good match on 40 through 6 meters on a half-length G5RV. The only thing I had to do was to increase the length of the feedline a little.

I've also seen that at certain frequencies the tuner will refuse to tune at all and give a "High SWR" indication. I found a way to get around this problem. Like before, turn the RF power all the way down, then start the tuning cycle. Now instead of gradually increasing the power, quickly rock the power control up and down until the tuner starts the sequence. Then like the other instance, increase the power a little at a time until it's at full power. This will take a few tries. You are really tricking the tuner because there's a slight dip that it sees.—*Anthony Bowyer, NT4X, 113 Cliffwood Rd, Bristol, TN 37620;* **adb1x1 @yahoo.com**

◊ Have you read the notes at the end of every Hints and Kinks column? Some Hints are useful, but not necessarily safe in all situations. The important part of Anthony's advice is that stray RF can cause automatic tuners to malfunction. If you experience this problem, first do everything you can to remove the RF: Is the antenna too close to the operating position? Are you using a shield choke at the back of the radio? Is the station properly grounded?

For example, when operated at any SWR greater than 1:1 there are periodic voltage maxima and minima that develop along a feedline. RFI problems sometimes result when a maximum occurs near the affected equipment. Such problems may be reduced or cured when the feedline length is changed by $\pm\lambda/8$ on the problem band, so as to move the voltage maximum away from the equipment. Of course, changing the feedline length may create a problem on another band, so it may take several iterative adjustments to reach a cure.

Once you have exhausted other possible remedies, consider whether you feel comfortable modifying your equipment and with the possible consequences.

In the "Other Notes," Anthony is fooling the tuner into functioning with SWRs beyond its design specifications (greater than 3:1). Although the tuner might be persuaded to match the impedance, there is a concern that the higher RF voltages associated with the higher SWR might exceed tuner-component specifications. (The component specifications presume that the tuner will *not* try to resolve higher impedances.) Perhaps the increased voltages contribute to the need for additional bypassing in the tuner? So, as with all the Hints and Kinks, this technique is definitely "at your own risk."—*Bob Schetgen, KU7G, Hints and Kinks Editor*

ONLINE GRID-SQUARE RESOURCES AND UTM COORDINATES

◊ When I visited the TopoZone site, I found that the coordinates associated with the cursor were given in UTM coordinates, not degrees. UTM stands for "Universal Transverse Mercator," a coordinate system used by the military and others for local navigation. The UTM system divides the world into 60 zones (each 6° of longitude wide, extending from 80°S to 84°N latitude) and superimposes a rectangular grid over each zone. A position is specified by its zone number and Cartesian coordinates (in meters) from a point on the equator 500,000 meters west of the zone center. The first coordinate is an "Easting" and the second a "Northing" (in the Northern Hemisphere, I saw no mention of a "Southing" for the Southern Hemisphere). With the cursor on the ARRL HQ building, UTM 18 688945E 4620367N shows in the status window of the map page. (For an explanation of the UTM system, visit the Map Tools Web page at **www.prusik.com/maptools/UsingUTM/** or the USGS Fact Sheet 157-99 at **mac.usgs.gov/mac/isb/pubs/factsheets/fs15799.html**.) Clicking on the QUAD INFO link at the upper right of the map takes you to a page of information about the USGS map that you are viewing. There, you can read the HQ position as latitude 41.7146°, longitude –72.7288°, where the negative sign indicates west longitude.

Many Web map sources include latitude and longitude information. I often use MapBlast (**www.mapblast.com/myblast/index.mb**). There, you simply enter an address, click the CREATE MAP button and read "Lat: 41.716905, Long: –72.727083" above the map's upper-right corner. MapBlast doesn't give topographic information.—*Bob Schetgen, KU7G, Hints and Kinks Editor*

YOUR GPS UNIT MAY DISPLAY GRID SQUARES

◊ Many VHF/UHF contesters and other hams make use of the Maidenhead system of grid squares. The grid squares are one degree of latitude tall by two degrees of longitude wide. They were agreed upon at a conference held in Maidenhead, England. Many of the populated areas of the world exist in the middle latitudes where the lines of longitude have converged to about half of the separation they have at the equator. This makes the grid squares look approximately square in the middle latitudes.

Over a year ago, I moved to Friendship, Maryland, so I am designing a new QSL card reflecting the new station location. In order to find my grid square for the new card, I took my latitude and longitude readings from a Garmin GPS 12 handheld GPS unit. Then I went out on the Web and found one of the many grid-square lookup pages. The lookup page wanted the latitude and longitude coordinates in degrees, minutes and seconds. The GPS was displaying degrees, minutes and decimal fractions of minutes. Well, it is easy enough to do the math and convert to seconds, but I chose to look in the GPS setup menu and have it display seconds. As I scrolled through the many display formats, I was surprised to find a choice labeled "Maidenhead." What a great deal! Just standing there in my backyard with a GPS and presto! I find that I am in Grid Square FM18QR.

Actually FM18 is the 1°×2° square. The fifth and sixth characters "QR" refine the location to 2.5′ of latitude by 5′ of longitude. For more information go to **www.arrl.org/locate/gridinfo.html**.—*Ric Creager, KK4GV, 24 Scrivner Dr, Friendship, MD 20758-9778;* **creager@erols.com**

◊ A rapid, accurate, interactive and free method to quantify latitude and longitude for locating Maidenhead grid squares, in addition to ordering paper USGS topographic maps or employing a GPS receiver, is to utilize the online USGS