

## **An Audible Antenna Tuner for Blind Hams**

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For several years I've been supporting blind hams by providing equipment such as transceivers with features suited to their special needs. Blind and low-vision operators can in fact do nearly anything that we sighted people can, but they may do it a different way. Critical to their success is technology that provides audible feedback and tactile information. Radios that talk, such as the modern transceivers from Kenwood, or models that report settings via CW messages, are invaluable. Inclusion of these accessibility features is to be applauded and hopefully spreads to other manufacturers.

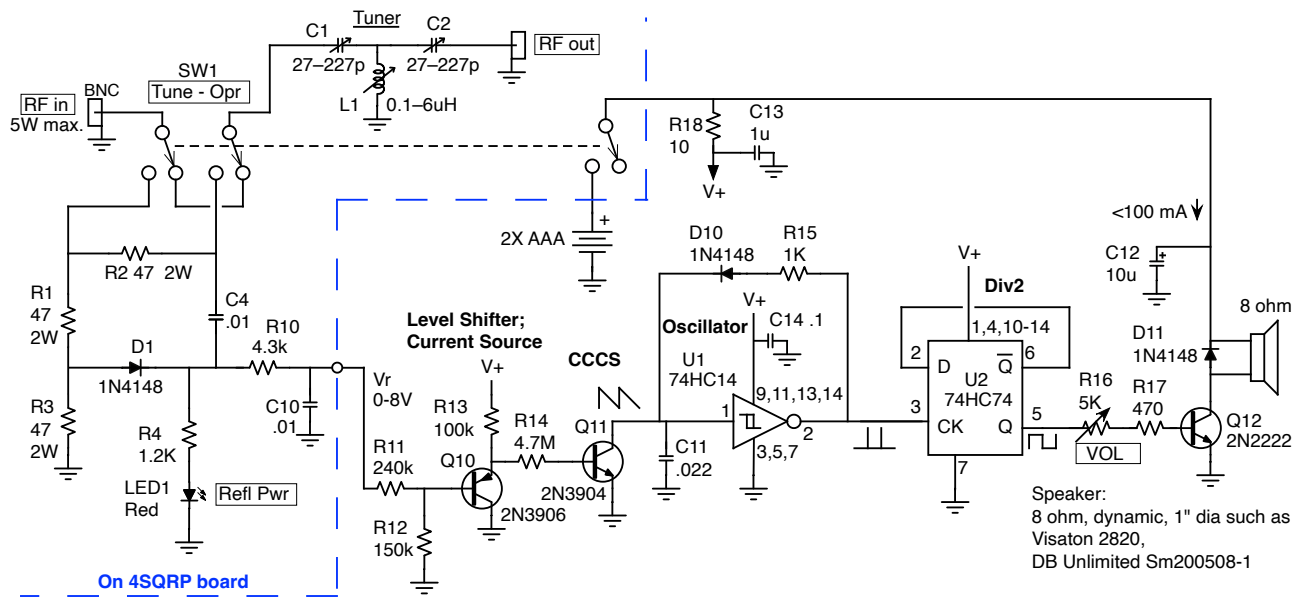
When it's time to tune a non-resonant antenna, talking SWR meters are in short supply. There currently is one: The TW-1 from LDG Electronics, and it is popular among blind hams. It speaks power in watts and SWR, and also plays a continuous tone with pitch proportional to forward or reverse power. Perfect! But what if you want to go on a SOTA outing with your lightweight QRP rig? The TW-1 weighs in at 2 lb, requires a 12V supply, and is possibly as big as your entire QRP kit. But they have the right idea, and that's where I started on this project.

My blind friend Derek Flint, KC1QXL, was starting SOTA and had acquired a Mountain Topper MTR3B-V4. It's a simple and respected mini transceiver and most importantly, reports its settings via CW. But an external tuner is needed in some cases. Enter the *Audible ATU* project. I based this work on the 4States QRP Group 4S-Tuner designed by Dave Cripe, NM0S. It's very compact, handles a wide impedance range, is inexpensive, and since it's a kit, is easy to modify.

### **Circuit Design**

For simplicity, I chose to add a voltage-controlled oscillator driven by the voltage derived from the reflected power side of the SWR bridge in the 4S-Tuner. Driving a tiny speaker, the pitch rises in proportion to reflected power (and of course forward power as well). Adjusting the T-match controls via sound is intuitive and quick, and you can do it with your eyes closed. Or with no eyes at all!

The main design decision was VCO topology, for which there are countless clever circuits. After trying a couple of dead-ends and a dual-opamp circuit (actually a very good candidate), I ended up with the schematic in Fig. 1. The VCO itself starts with a current-controlled current source, Q1, which discharges C11. Inverter U1 has a Schmitt trigger input. When it's low threshold is crossed, it quickly charges C11 via R15 and D10. This produces an output pulse train with frequency proportional to input current. U2 divides the pulsed output of U1 by two, resulting in a square wave that drives Q12 as a brute-force, high-efficiency "digital amplifier" for the speaker.



**Figure 1. Schematic of the audible tuner.**

Interfacing to the SWR bridge required that the voltage from the bridge (0-8 V) be converted to a proportional current to drive Q11. This is accomplished with Q10, which acts as a level shifter, followed by high-value resistor R14 that effectively makes the output a simple current source. This arrangement also sets a minimum current so that the oscillator idles at a low frequency instead of stopping. This circuit could be adapted to almost any SWR bridge by adjusting the scaling.

Is it temperature-compensated? No.  $V_{be}$  and beta of transistors are functions of temperature and no attempt was made at canceling or controlling drift. Simulation in LTSpice shows that the current (and pitch) will increase by about 27% over the range of 0-50 degC. Since this is just a relative indication device, that's not a big concern.

Current consumption would be sub-milliamp if it weren't for the 8-ohm speaker. At full volume, it draws nearly 100 mA and is certainly loud enough. I investigated other transducers. Piezo "speakers" are fairly efficient but are actually resonant buzzers, incapable of producing a wide frequency range. Perhaps one could be driven by a pulsed signal, producing faster beeps as SWR changes. Another option might be an old-school crystal earphone, which is high impedance, but I didn't try one.

Speaking of current consumption, I tried running the circuit from rectified input RF rather than 3 V battery power. This actually works, as long as the input power is above about 4 W. But I wanted it to operate at QRPP levels, so batteries it is.

### Construction

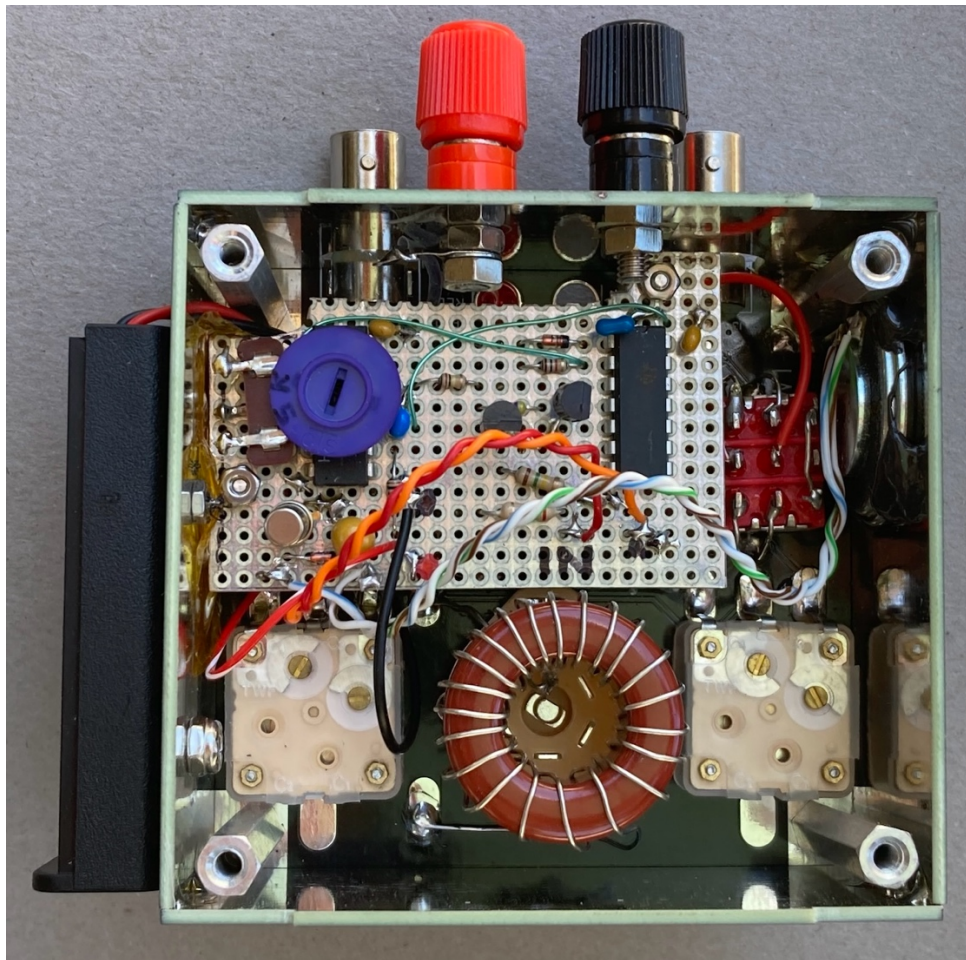
Besides the enclosure, major components of the 4S-Tuner are retained, specifically the LC tuner and the resistive SWR bridge. Transistors and resistors associated with the two LEDs are not installed, other than the Refl Power LED itself. This was done to maximize available output

voltage swing for reflected power. The In/Out switch is replaced by a 3PDT mini toggle so that power can be switched on along with insertion of the SWR bridge/load.

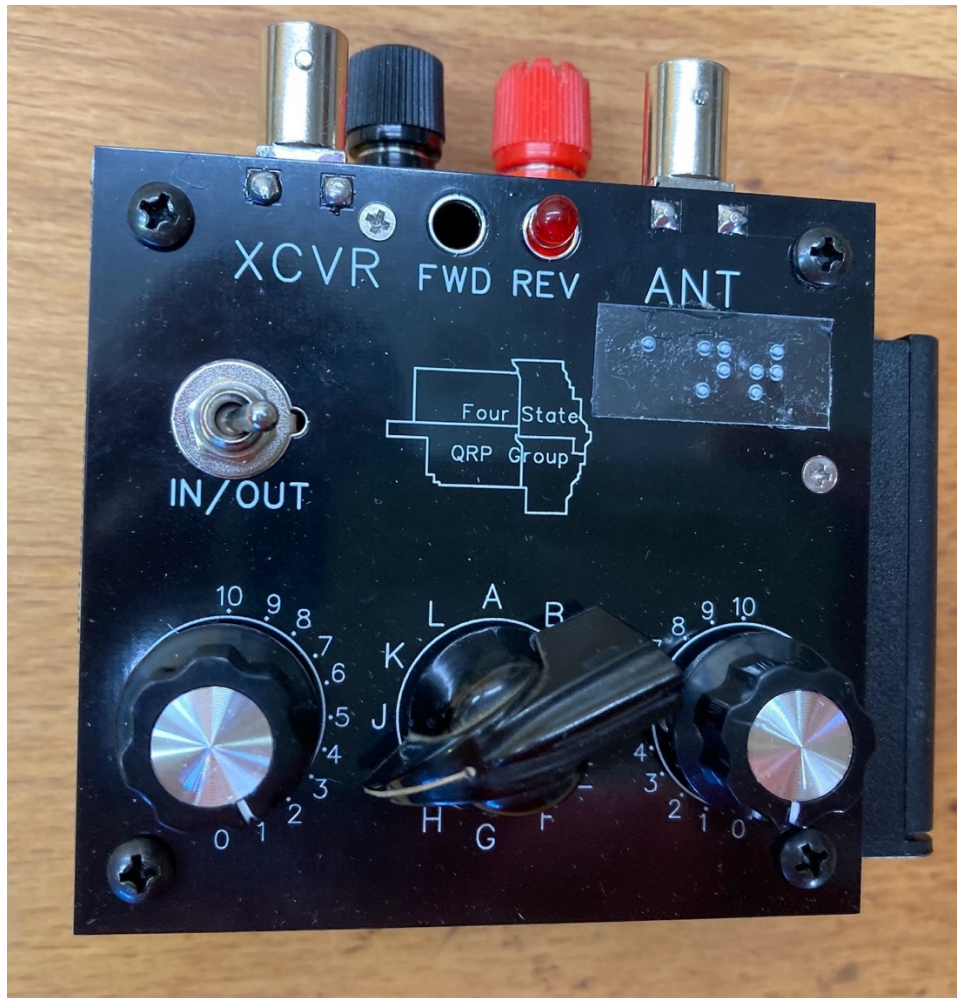
I assembled the circuit on a pre-etched prototyping board (Vector 8007). Depending upon what parts you choose, it's a tight fit. I managed to find locations for a pair of standoffs affixed by flathead screws through the front panel. Figures 2 and 3 show the completed tuner.

An array of holes were drilled in one side for the speaker, and it's glued to the inside. A small battery holder for two AAA cells is screwed to the other side.

Be sure to test the circuit before integration into the tuner. Apply a variable DC source to the input at  $V_r$  and verify that the VCO is operating. You might have to experiment with the volume range for your particular speaker.



**Figure 2. Inside view of the tuner.**



**Figure 3. Front view of the tuner. Note the Braille label for the antenna port and the “chicken head” knob for the inductor, which makes it easier for the blind user to orient.**

## **Operation**

Operation is no different than the standard tuner, but with the addition of the tone. Throwing the switch to the TUNE position starts the VCO and connects the SWR bridge/load which presents the radio with a decent SWR no matter what antenna load is connected. When the match is perfect (or there is no input power), you should hear a very low pitch, and it will increase rapidly with applied power and any mismatch. Adjust the three tuning knobs for the lowest possible pitch. The red LED will also dim. I have made a short demonstration video available at this link: <https://youtu.be/U5ByCdx2YCo>

Lab testing showed that audible tuning is extremely sensitive, way beyond what is achievable with the LED alone, and in fact beyond what is practically required. It's almost a game to tweak it in to perfection. Also, I proved that the system will work effectively with as little as 150 mW input. Of course you won't want to exceed 5 W to avoid damaging the bridge resistors.

## **Conclusion**

This was a one-off build and you can adapt or build it any way you like. A tiny PC board with SMT parts would be a nice fit and more reproducible. At the very least it might give you some ideas for related projects. For instance, any QRP rig with an SWR meter could have something like this embedded in it. Also it could easily be implemented digitally with any microcontroller that has an analog input. What's important is that Derek is now able to tune his endfed wire on SOTA outings with no difficulty. Mission accomplished.

## **About the Author**

Gary Johnson, NA6O, has been licensed since he was 13 years old and is an avid CW operator, DXer, and contester, and especially enjoys station building. He has a degree in EE/bioengineering from the University of Illinois and spent his entire career at the Lawrence Livermore National Laboratory where he focused primarily on instrumentation, measurement, and control systems. Along the way he wrote two books and was awarded ten patents. Now retired, he enjoys many hobbies including woodworking, metalworking, electronics and of course ham radio. He and his wife live in the vineyards of Livermore, CA.