NorCal Tuner Upper Manual
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NorCal Tuner Upper is visual SWR meter with self-contained oscillator for single band. It has a crystal oscillator, 50 ohm resistive bridge, and detector which uses super bright LED as an indicator. It's compact, does not require transmitter, highly visible LED for easy reading, and low power minimizes QRM. The kit is available for 40, 30 and 20 meters.

The Tuner Upper components are mostly surface mount components, but the component count is low and layout is spaced for easy assembly. This is follow up to successful 'Dummy load' kit. The NorCal team decided to continue providing easy surface mount kits to encourage use of surface mount devices. Both PCB layouts were created by Bob Okas, W3CD.

Circuit Description:
The idea came from visiting Steve Weber's website (KD1JV). He has a description of fixed frequency 'Tuner Dipper'. I concluded that this would be easier to tune antenna and tuners than using FT817 and external SWR meter.

Steve's circuit works well, but I decided to make few changes. 1) Change 12V battery to more common 9V, 2) Change the circuit bias to operate at 9V, and 3) Change the oscillator.
The detector circuit consists of T2, darlington pair, Q2 and Q3, and super bright LED. It has enough sensitivity to respond to –13dBm. There is slight drop off in sensitivity at upper HF range. The super bright LED enables the user to differentiate the SWR much easier than normal LED. I have used resistive bridge with LED detectors before, but it was difficult to differentiate SWR of 2:1 from 1.5:1.

The resistive bridge is simple to build and used in many projects. A good description can be found on Steve's website as well as others.

A FET oscillator is used for its simplicity and consistency. It will readily oscillate from 3.5MHz to 20MHz and only requires the tank circuit change. I have always had good success with the FET crystal oscillators. The second harmonic level is about 15dBc and about 35dBc for third harmonic. The power level is relatively high, about +10dBm. The second harmonic is about –5dBm, well within the sensitivity of the detector. It's conceivable the detector may respond to the second harmonic and remain on, giving false reading. An elliptical low pass filter was added to the output and 6dB pad provides good match to the resistive bridge. The power level after the pad is about +3dBm and second harmonic is about 35dB down.

The layout will accommodate other bands. The crystal, tank circuit (T1 and C1), and low pass filter values will need change. The kit is available for popular QRP bands but it will work on other bands.

Assembly Instruction:
There are various methods to solder surface mount devices (SMD). I usually melt small amount of solder on one pad, place the component with a stainless steel tweezers, re-melt the solder, and solder the rest of the pads. Alternate methods can be found on the web. An inspection with magnifier is highly recommended after soldering. The smallest part should be soldered first, as tall components obstruct access sometimes.

The unit has been designed to fit into an Altoid can. If you decide to use it, you should mark the mounting holes to drill before soldering any components. Review the pictures of assembled unit shown few pages down.

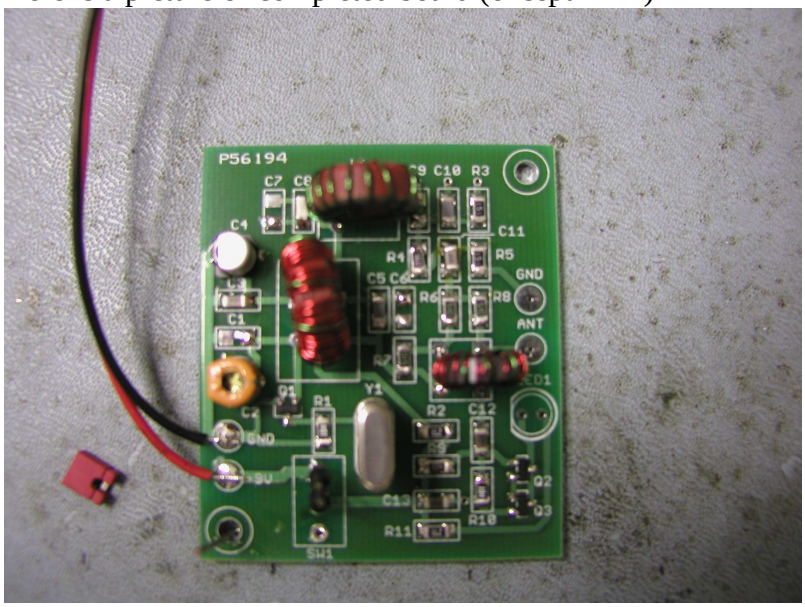
Install oscillator parts – R2, C3, C4 (band is negative), R1 and C1 (C1 for 40m only).
Install Q1 first, then C2. Wind T1 according to the table on the schematic.
Install T1 and Y1.

Low pass filter and pad – Install R3, R4, R5 and C11.
Install C5, C6, C7, C8, C9 and C10 according to the table.
Wind L1 according to the table and install.

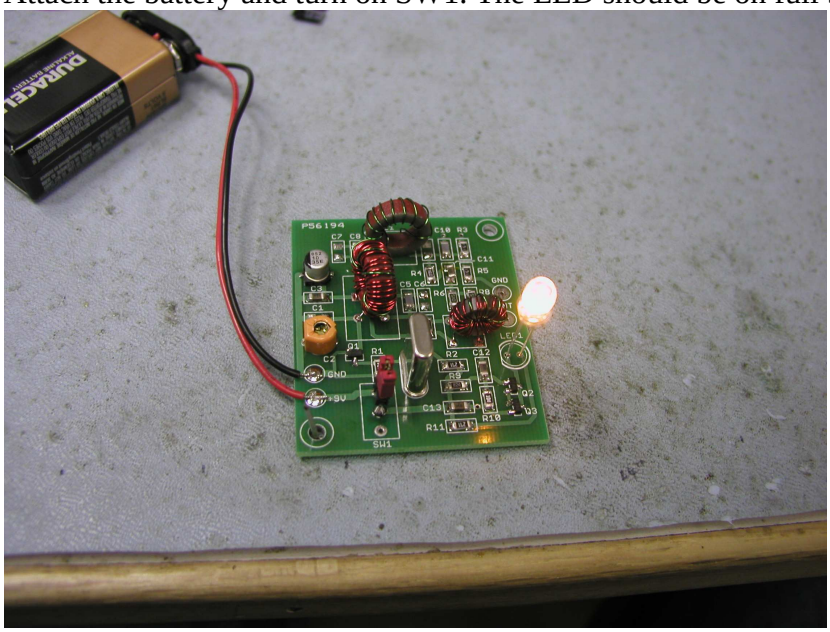
Install C13, 9V battery clip, and SW1.
Connect a 9V battery and turn on SW1.
Use an O-scope (at C11), RF detector or receiver (near by), and peak C2 for maximum signal.
Turn off SW1 and on again. Ensure that oscillation starts easily.
Remove the battery.

Bridge and detector – Install R6, R7, R8, C12, R9, R10 and R11.
Install Q2 and Q3. Wind T2 and install. Do not install LED yet.

Here is a picture of completed board (except LED)



Insert the LED in the holes but do not solder.
Attach the battery and turn on SW1. The LED should be on full brightness.

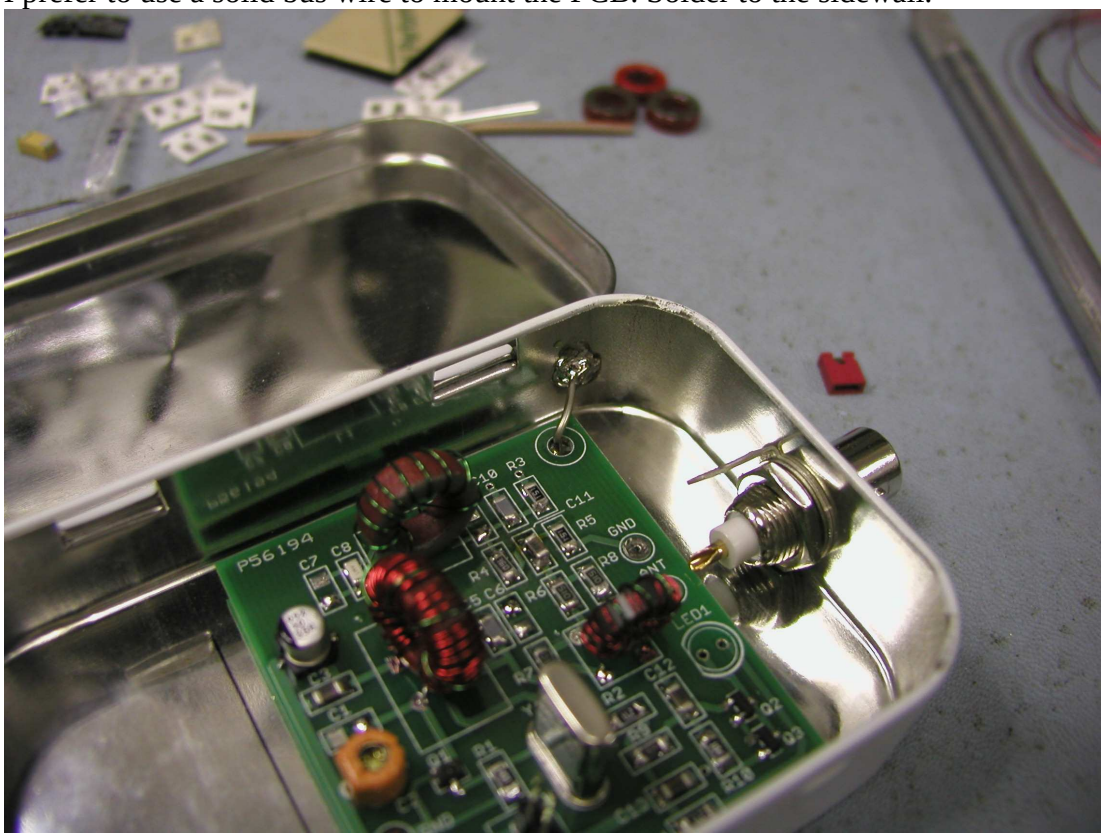


Remove the battery and LED.

Drill a hole for BNC connector and PCB. The step drill bit does a great job on tin.

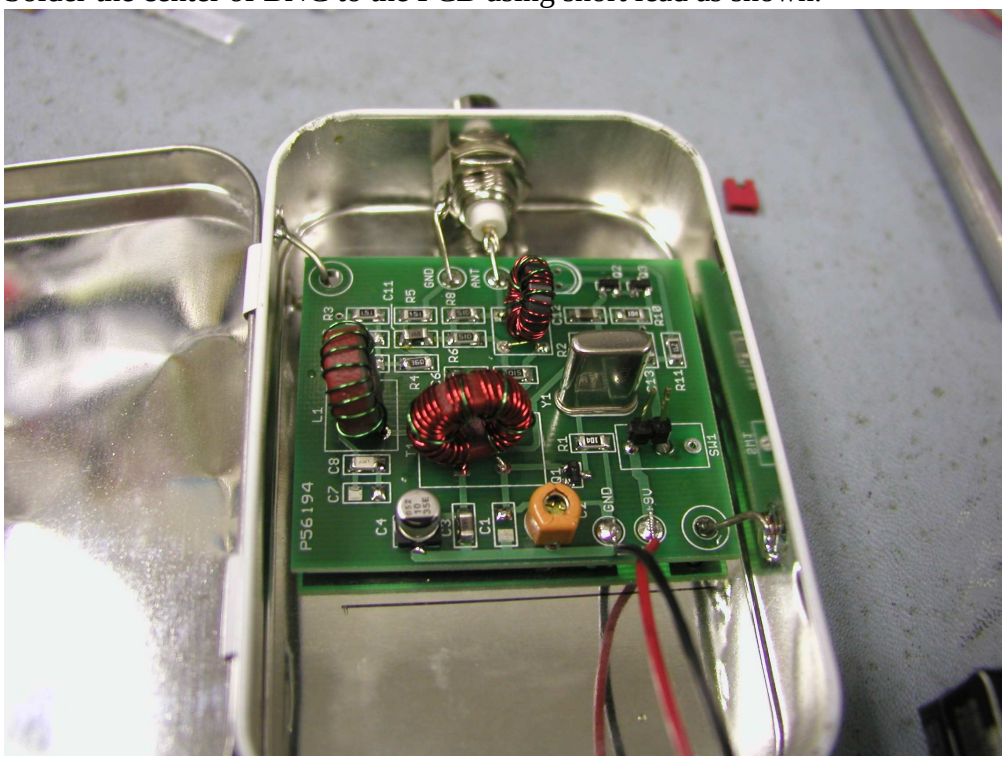
Note that I did not drill the mounting holes for the PCB. I used a bus wire, which is shown below. It’s up to the builder. Install the BNC tight.

I prefer to use a solid bus wire to mount the PCB. Solder to the sidewall.

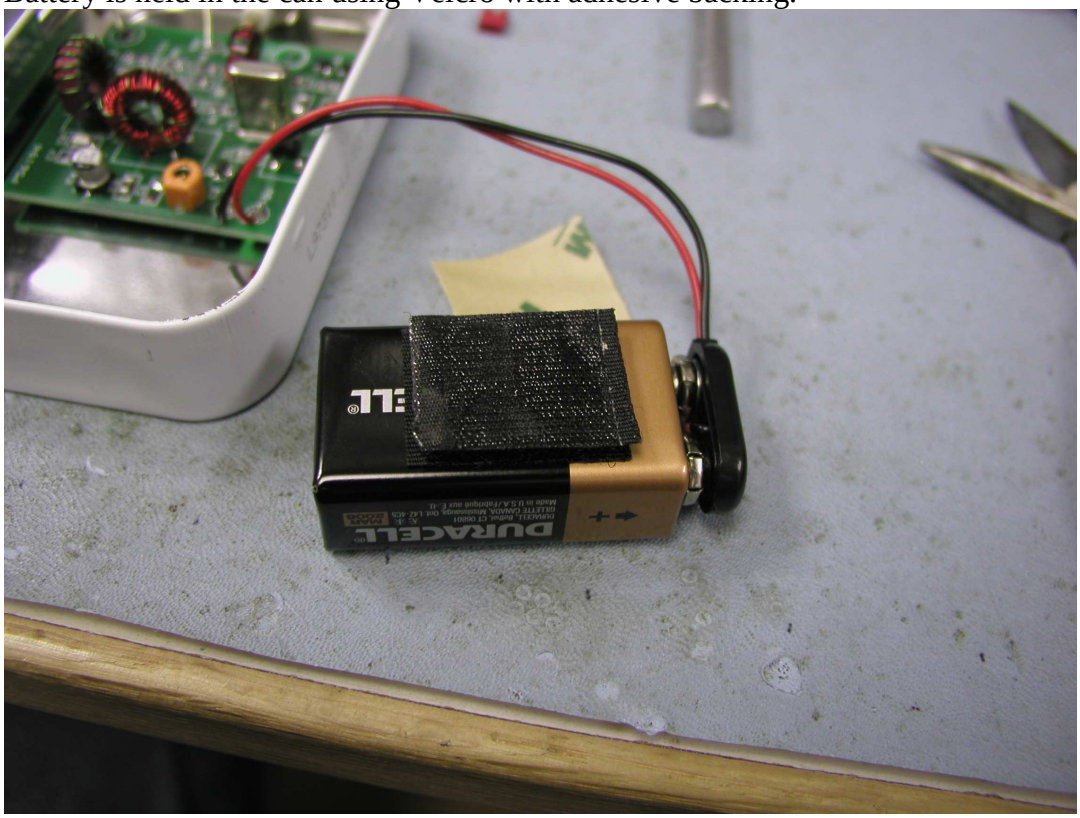


Be sure the bottom is not touching. A layer of tape can be applied to the can.

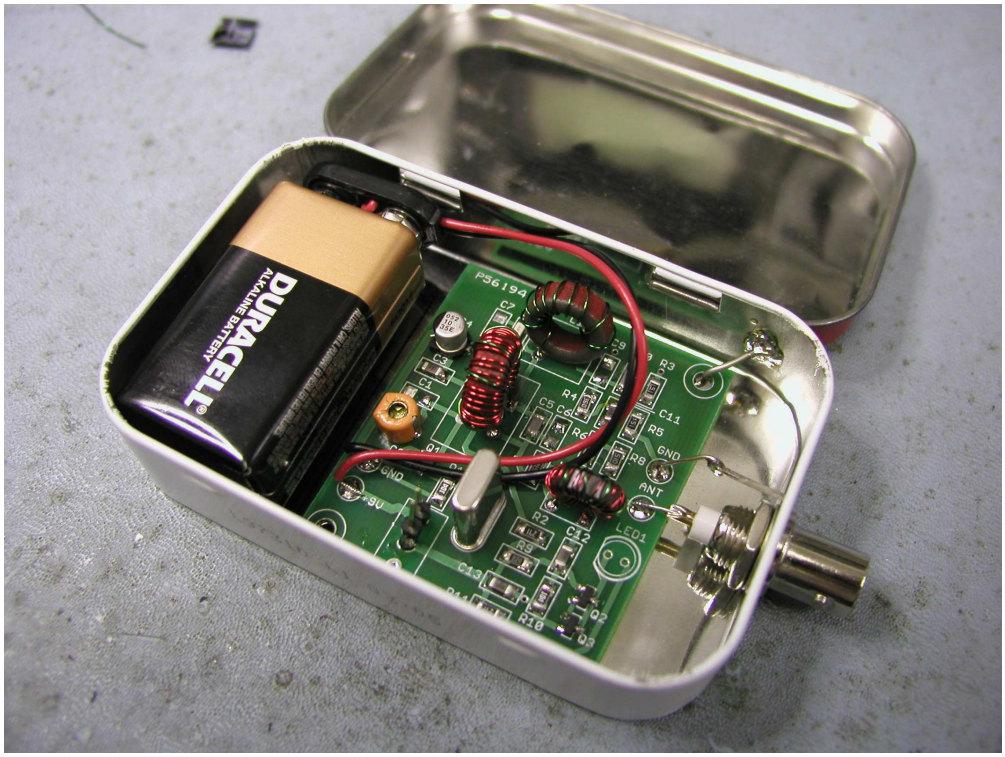
Solder the center of BNC to the PCB using short lead as shown.



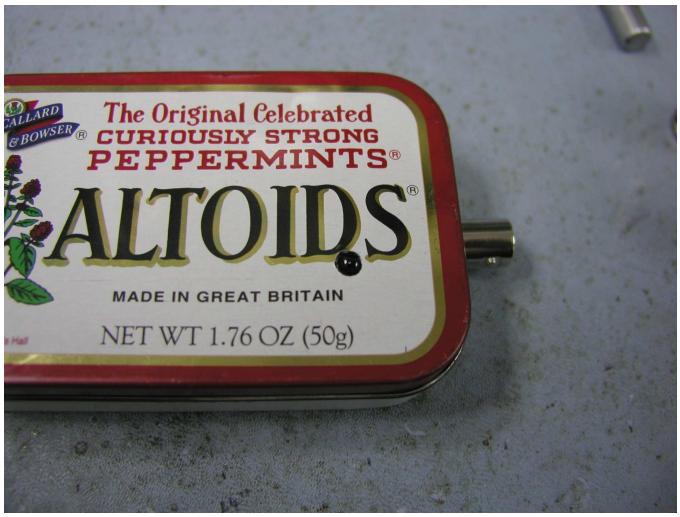
Battery is held in the can using Velcro with adhesive backing.



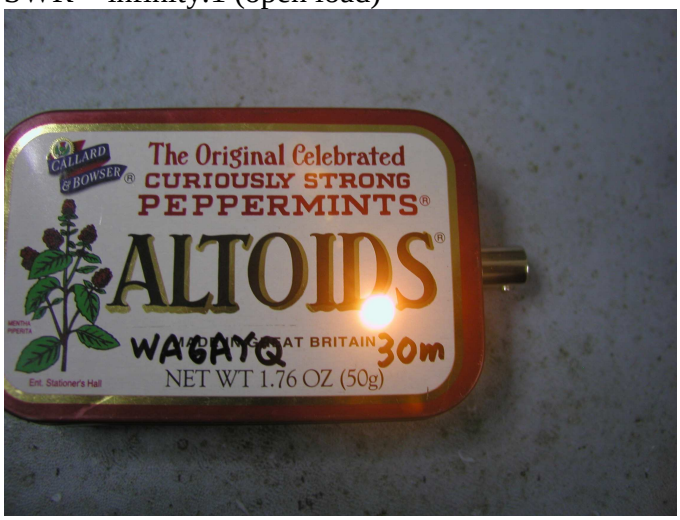
Here is almost finished unit.



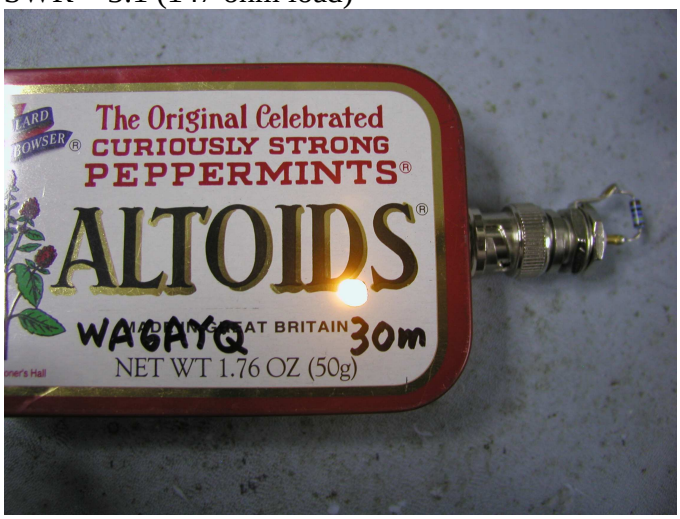
Place the LED. Trim the leads so that the top dome of the LED just sticks above the lid and the bottom of the lead doesn't short. Take your time and trim 1/16" at a time. Solder the leads after checking the polarity – flat side to flat side. Measure the LED location and drill a hole. I used 1/8" drill bit.



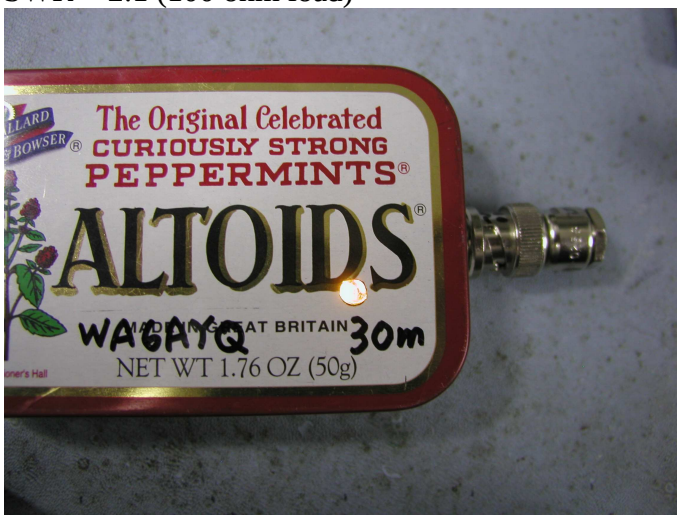
The photos below show LED brightness for various SWR.
SWR = infinity:1 (open load)



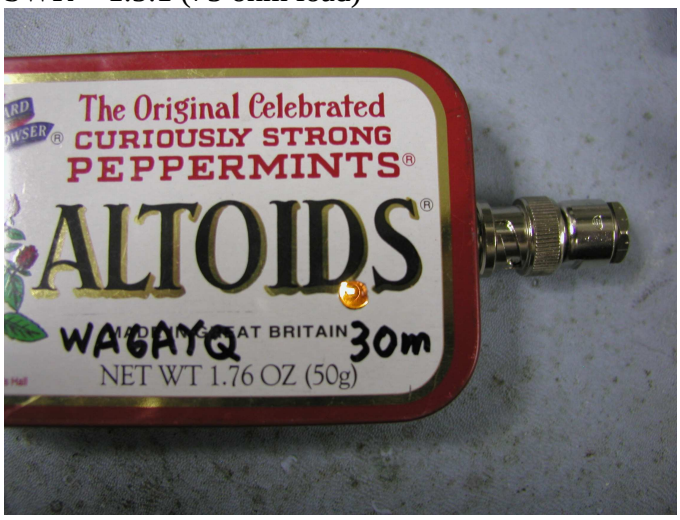
SWR = 3:1 (147 ohm load)



SWR = 2:1 (100 ohm load)

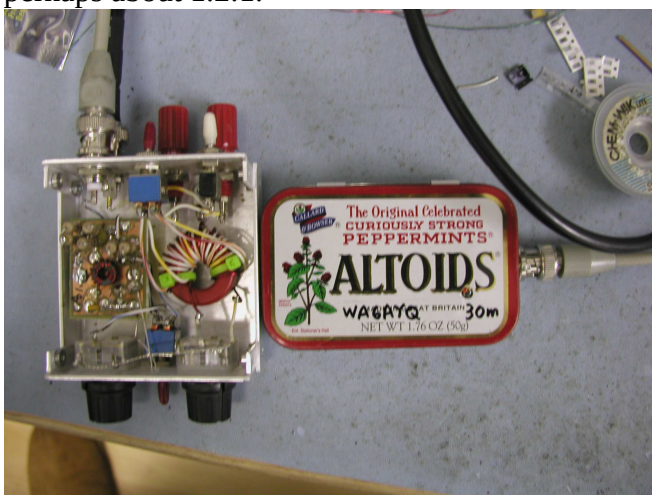


SWR = 1.5:1 (75 ohm load)



SWR = 1:1 (50 ohm load)

BLT tuner and Tuner Upper used to tune 40m loop to 30m. The LED is fairly dim, perhaps about 1.2:1.



Conclusion:
The output level at BNC is about –3dBm. The current draw is about 20mA at full brightness. I change the smoke detector battery every year and use the old ones.
For those who need visual reference, a SPDT switch can be added, with a 75 ohm or 100 ohm resistor at the output. Now at a flip of switch, 1.5 or 2:1 visual reference is available.

The super bright LED is very bright and you should avoid looking directly. It can, however, function as an emergency flashlight ☺.

My thanks to NorCal team for their support. I continue to be amazed at their hard work and dedication. My thanks also to Bob Okas, W3CD, and Bob Miller, KB6KWT, for building the prototype.