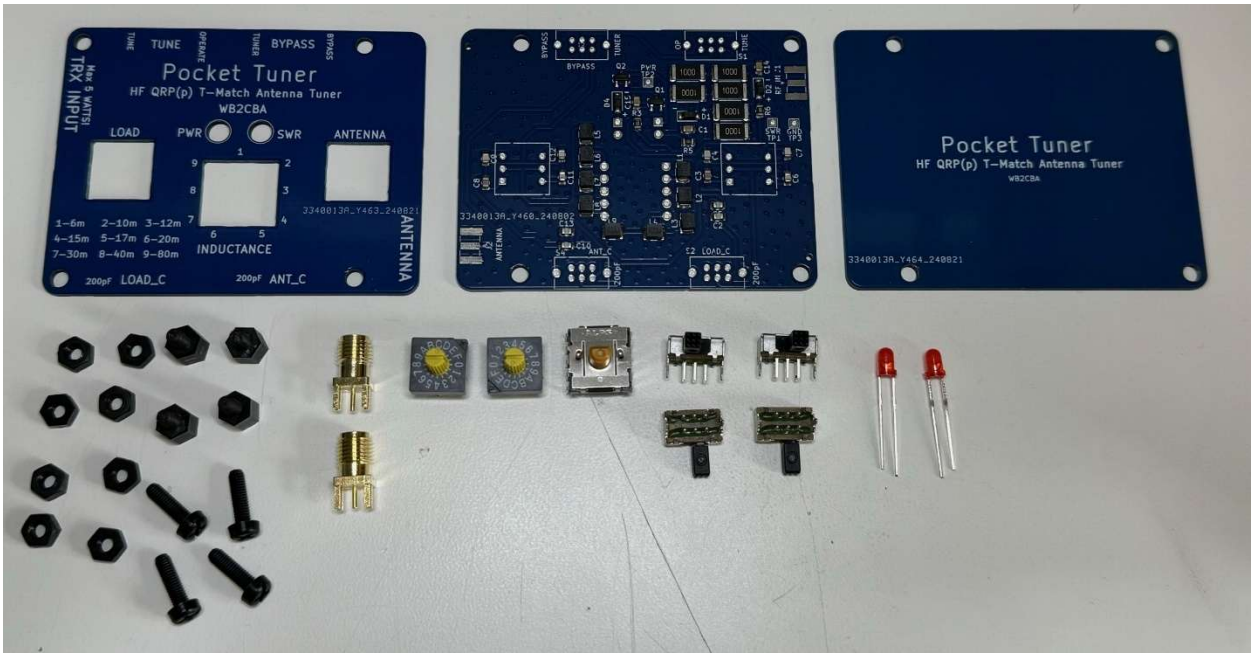
POCKET TUNER

A Credit Card sized HF T-MATCH ANTENNA TUNER KIT for QRPp Portable Operations

1- BUILDING POCKET TUNER KIT:

Start building POCKET TUNER following below steps.

Kit Contents:



POCKET TUNER KIT PARTS:

1 x Main SMD populated POCKET TUNER PCB

1 x PCB TOP PLATE

1 x PCB BOTTOM PLATE

2 x SD1110 Rotary HEX ENCODER

1 X KC1901A 9 position rotary switch

4 x DPDT slide switch

2 x 3mm RED LED

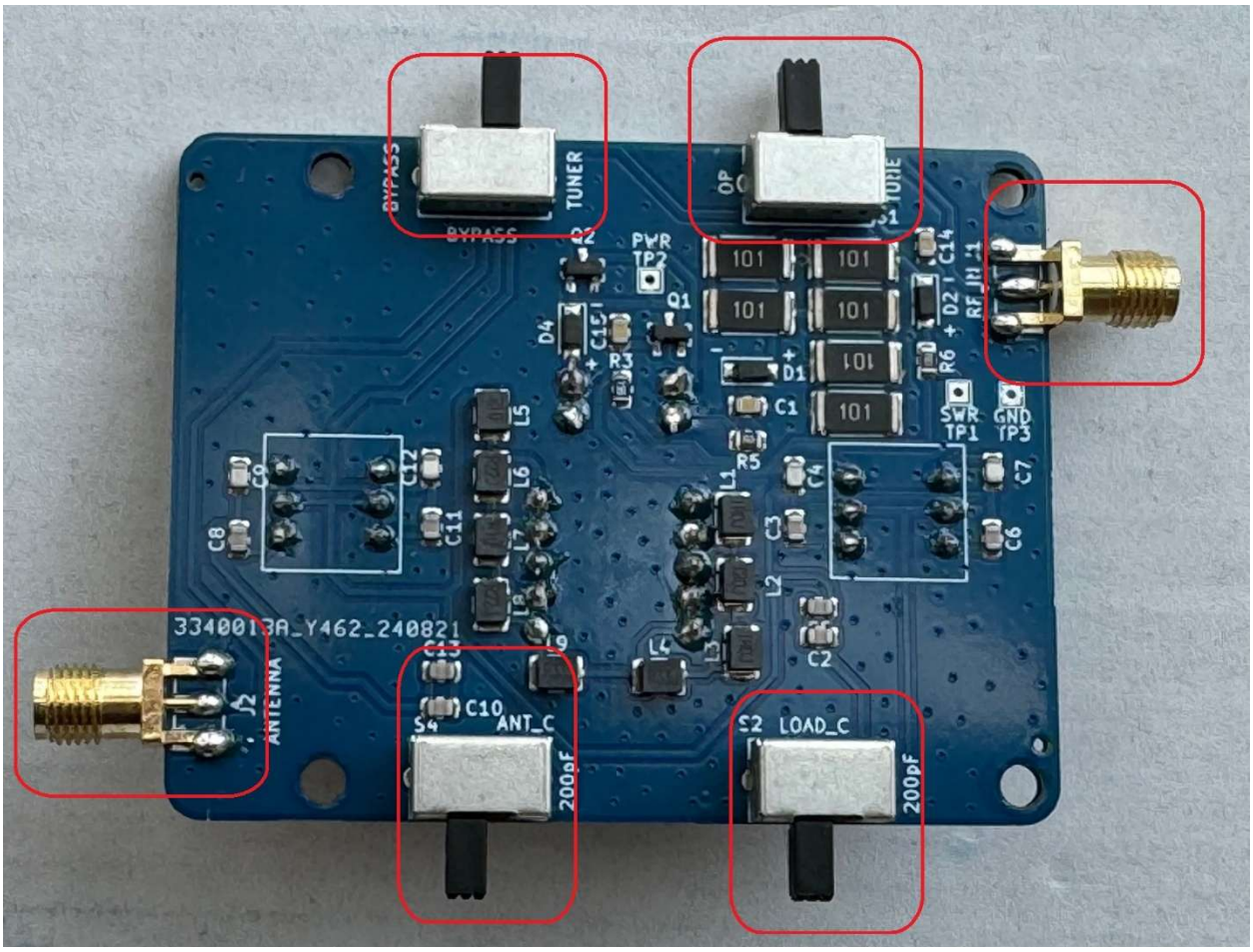
2 x SMA type pcb edge connector

8 x M3 plastic nut

4 x M3 10mm Bolt

4 x 6mm female-male stand off

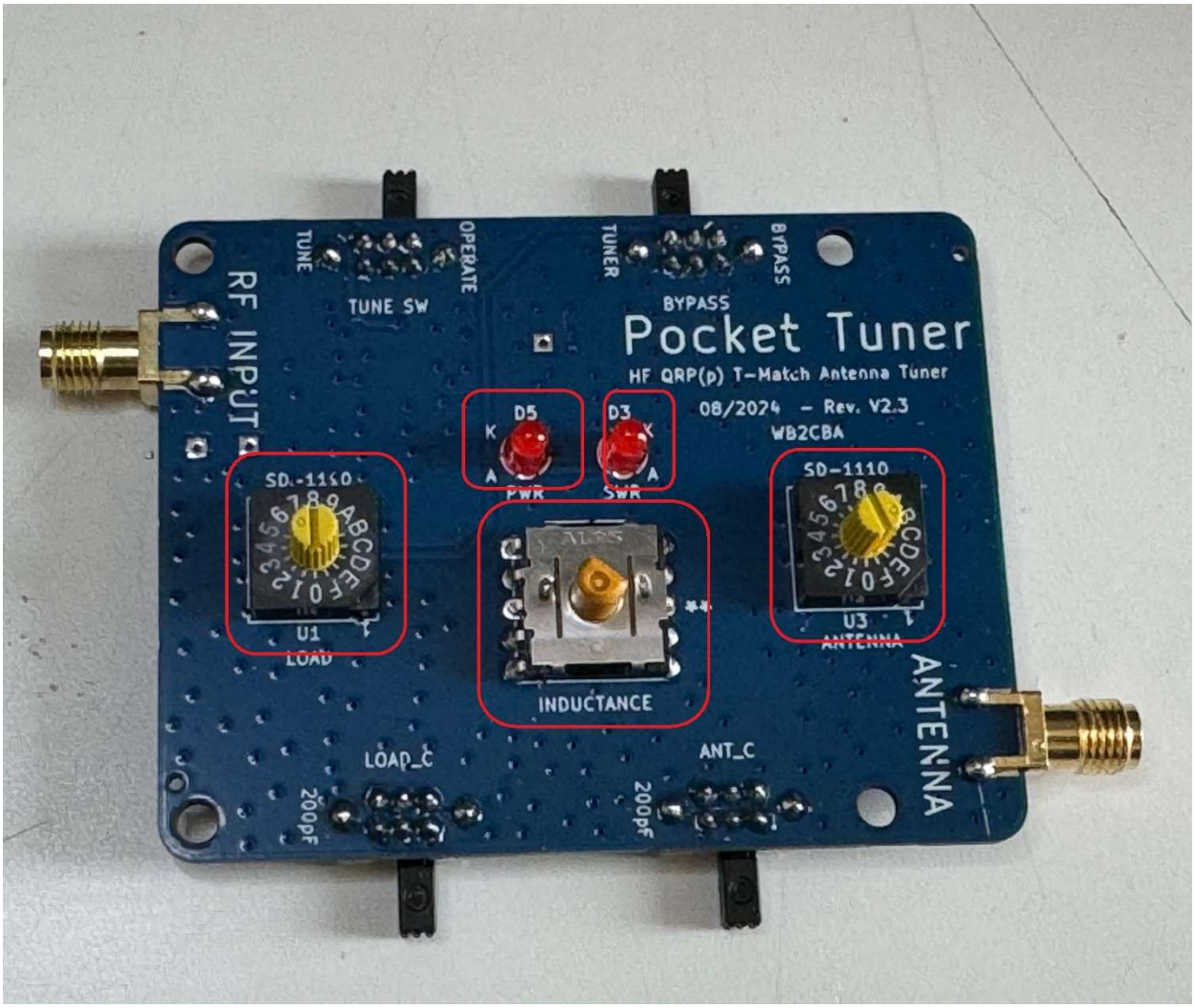
STEP 1:



1- Solder 4 x DPDT slide switches
2- Solder 2 x SMA PCB TYPE Edge connectors

Your soldered Main PCB should look like this in this step photo.

STEP 2:



ALL PARTS IN THIS STEP WILL BE SOLDERED TO BACK OF PCB SMD COMPONENT SIDE!

In this step we will install 5 parts,

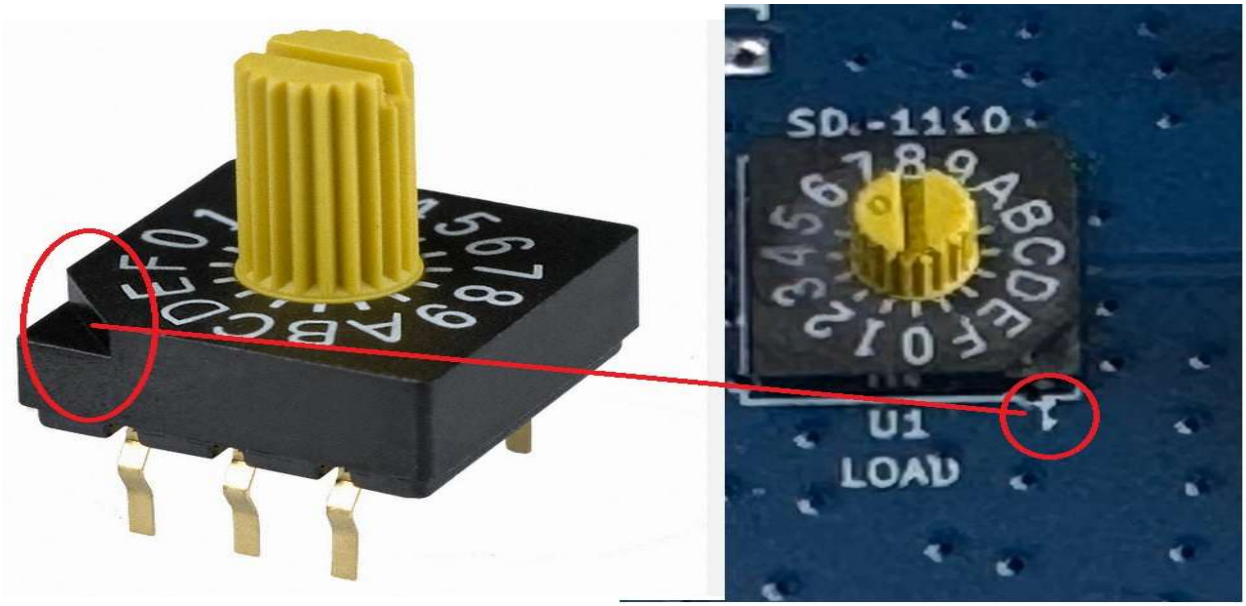
2 x SD1110 ROTARY HEX SWITCH

1 x KC1901A 9-POLE ROTARY SWITCH

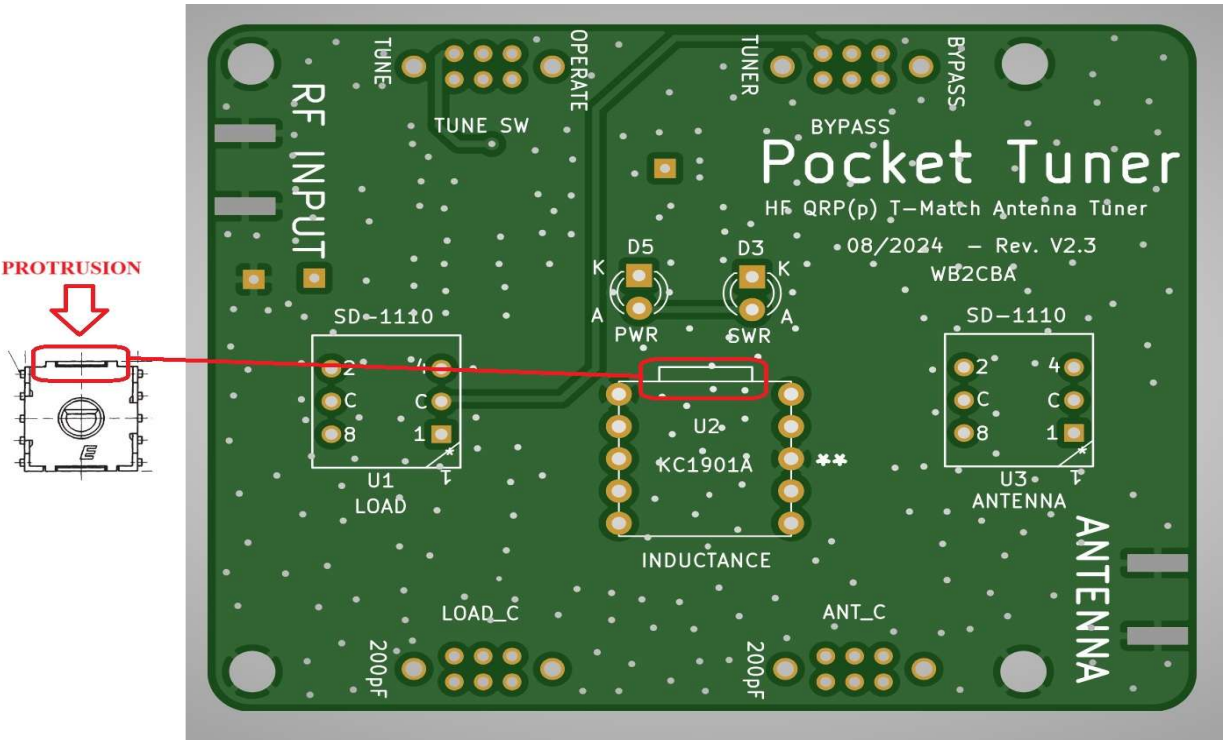
2 x RED LED

IMPORTANT! SOLDER LEDS, SD1110 ROTARY HEX ENCODERS and 9 Pole ROTARY SWITCH flush with the board. Push these parts all the way in so that parts will be touching PCB board and there is no gap between the base of these parts and PCB. This is important to have the top pcb cover fitting perfectly over the main pcb.

Solder 2 x SD-1110 Rotary HEX Switches. Align rotary hex switches as outlined in the photo below. When soldering HEX Rotary switches, SD-1110, match skew angled notch on the switch with the skew notch line on the pcb.



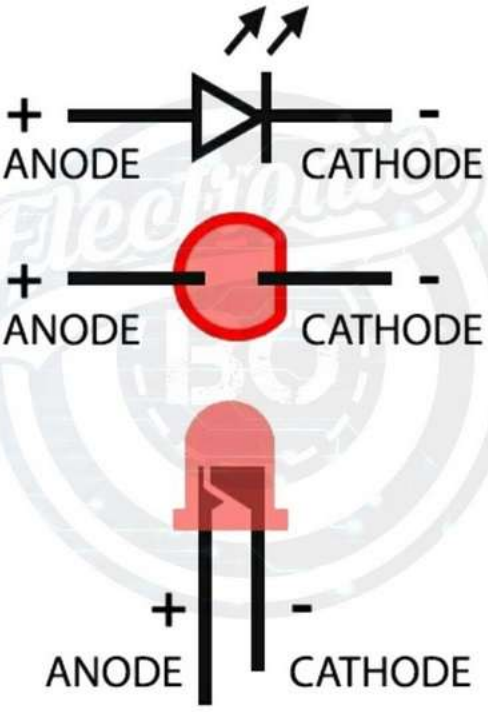
1- Solder 9-Pole Rotary Switch. Align the protrusion of rotary switch with protrusion mark on the PCB silkscreen as in the below photo.



2- Solder 2 x RED 3mm LED:
Align and solder 2 x RED LED as in this photo below:

Cathode of each LED should be aligned with K on PCB. Anode of each LED should be aligned with A on the PCB.

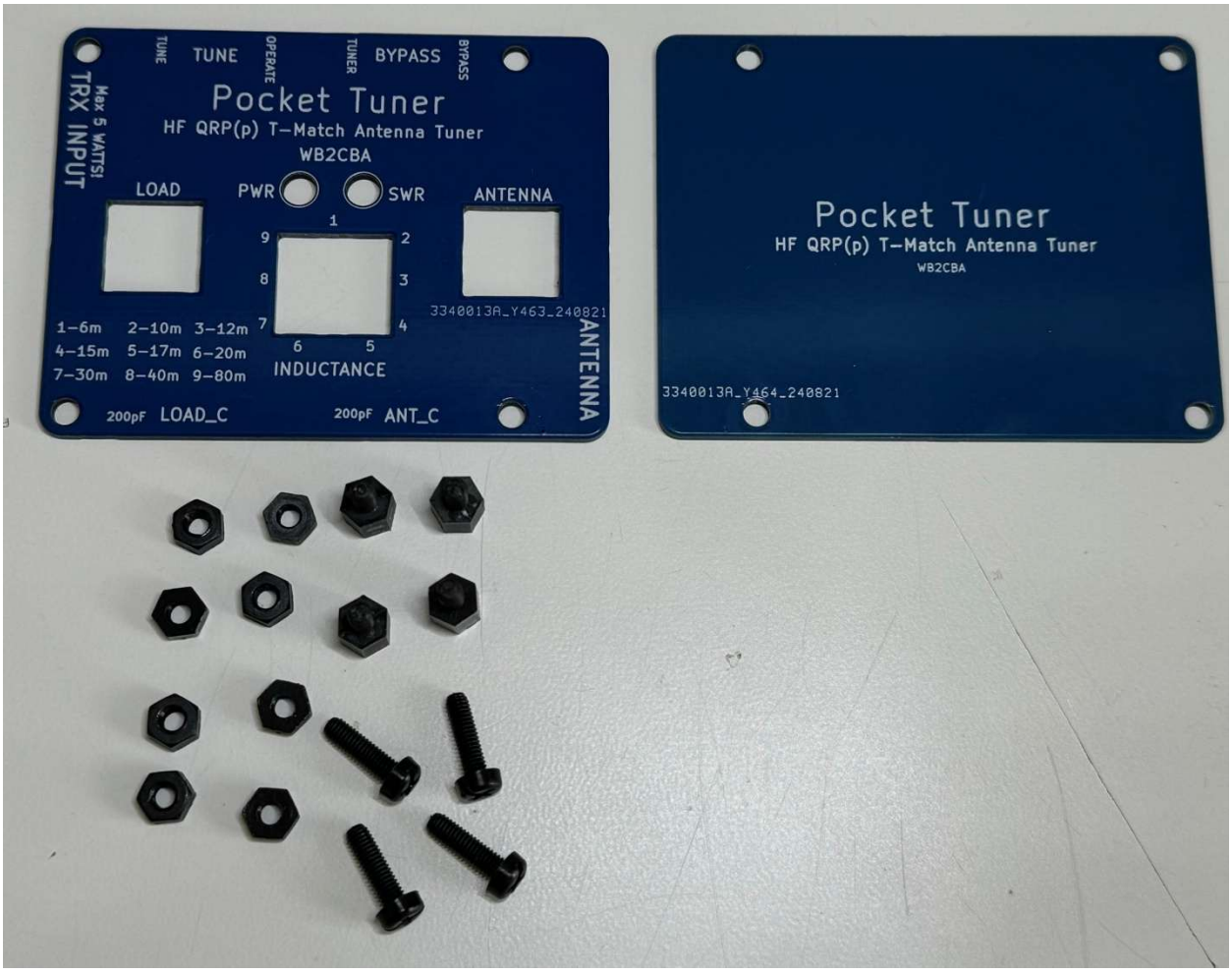
Here is a helpful chart to identify Cathode(K) and Anode(A) of LEDs:



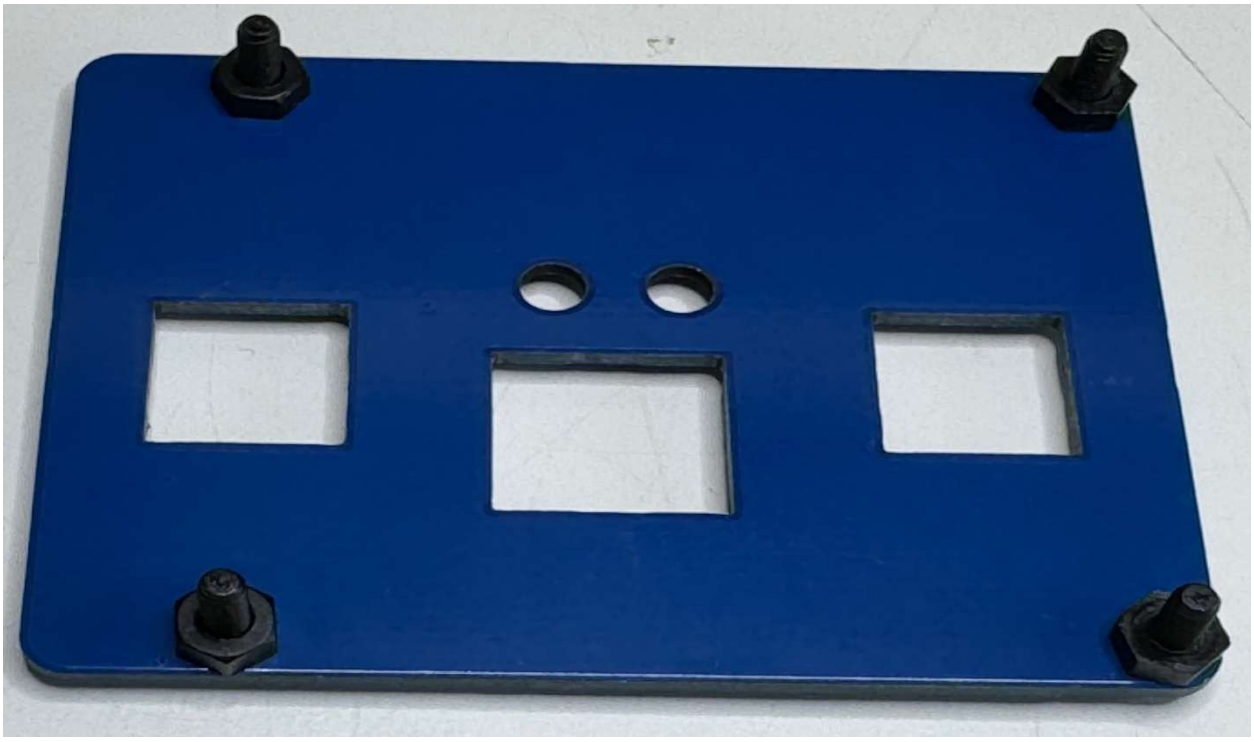
This completes main board soldering.

Installation of Top and BACK Panel Assembly:

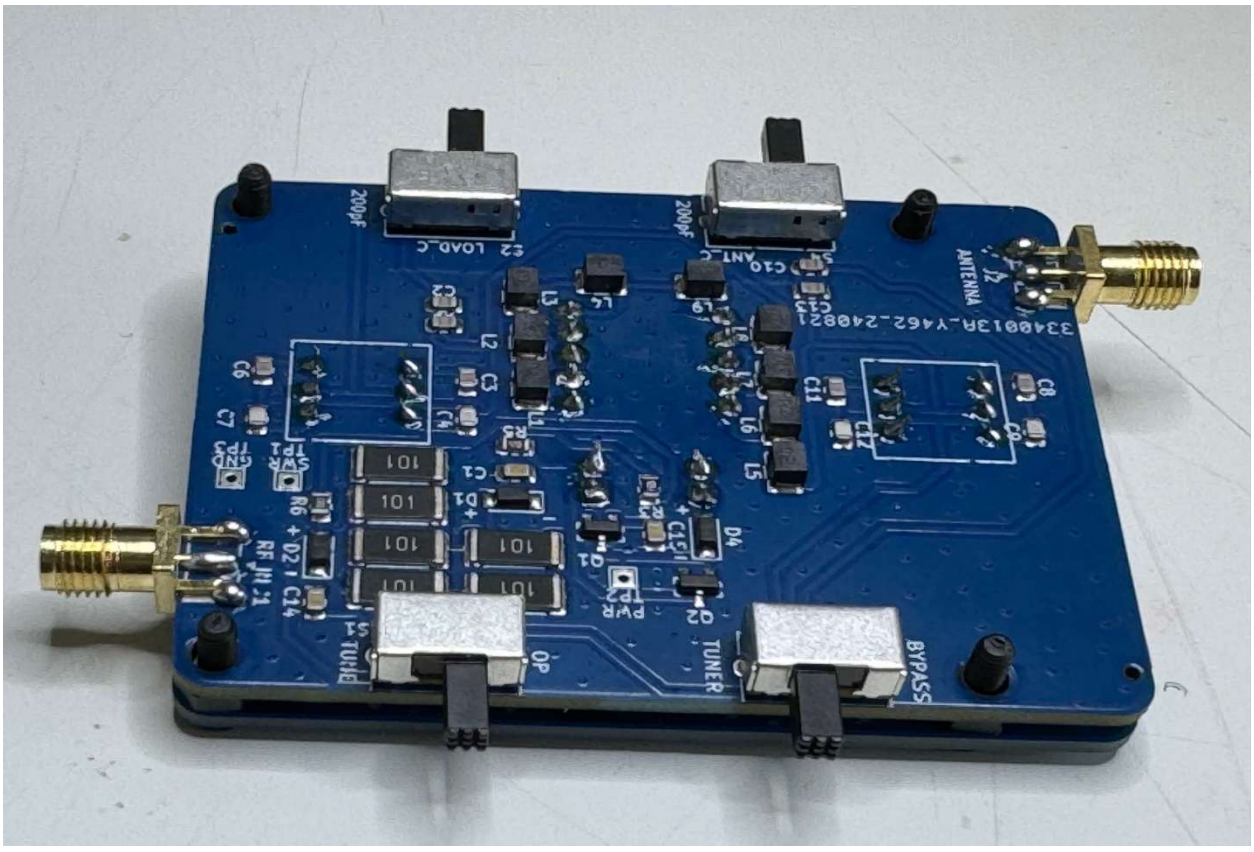
Parts of Top and Back Panel Assembly:



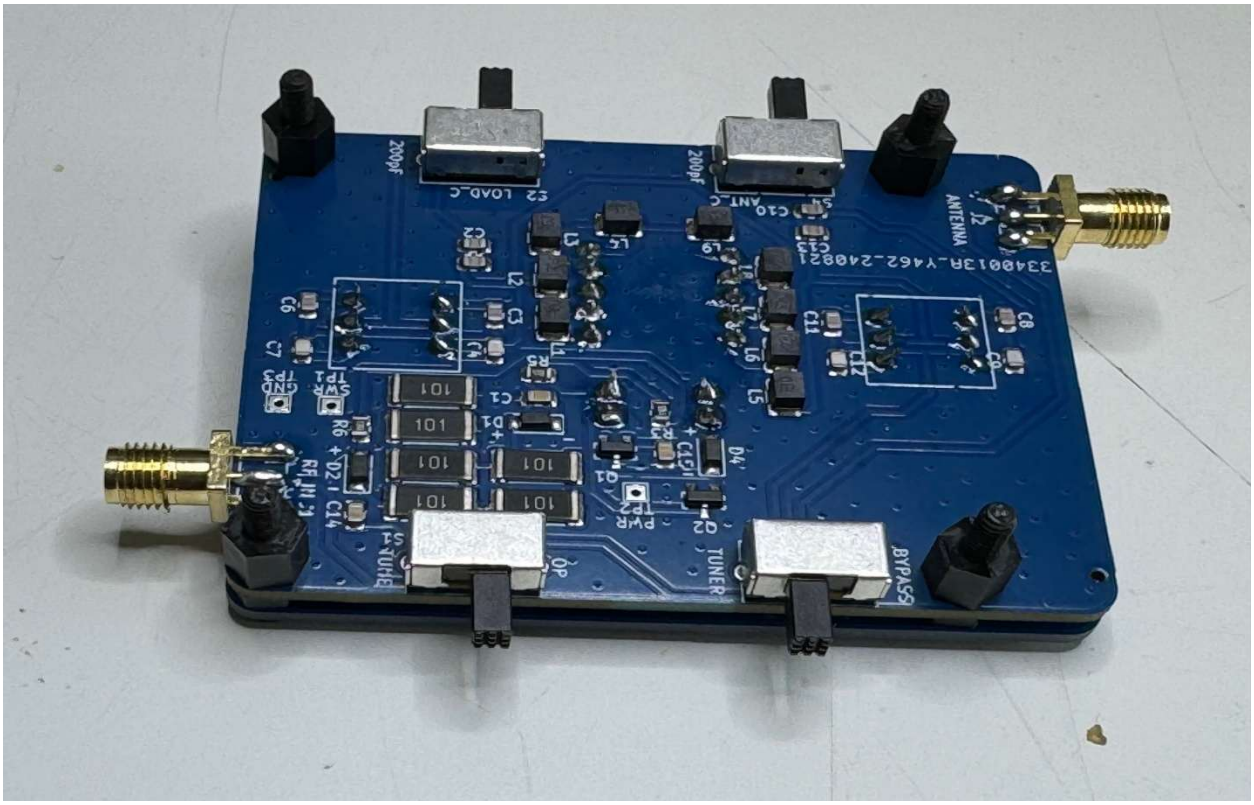
STEP-1: Use 4 x 10mm bolts and 4 x M3 nuts bolting at four corners of top plate as in the photo.



STEP 2: Place main board on top of TOP PLATE gently sliding over plastic bolts.

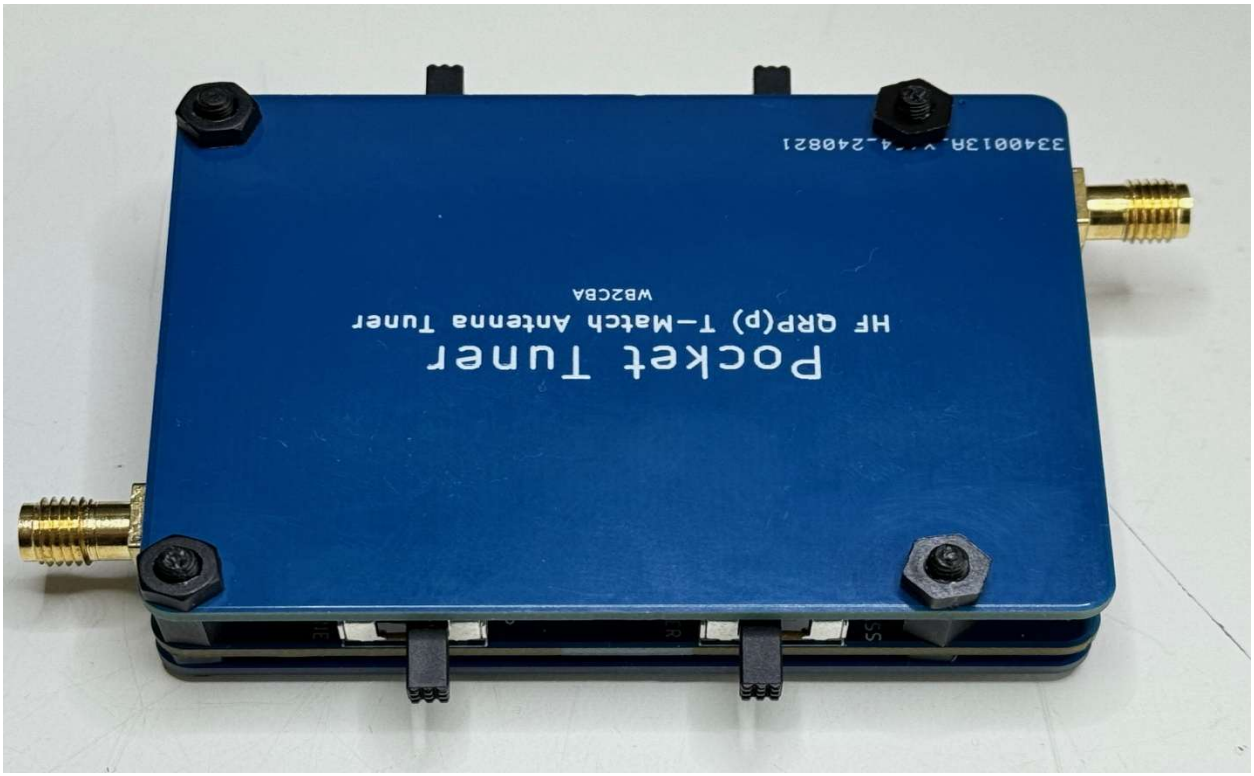


STEP 3: Screw on 4 x 6mm stand offs as in the photo below.



STEP 4: Install bottom cover as in the photo below.

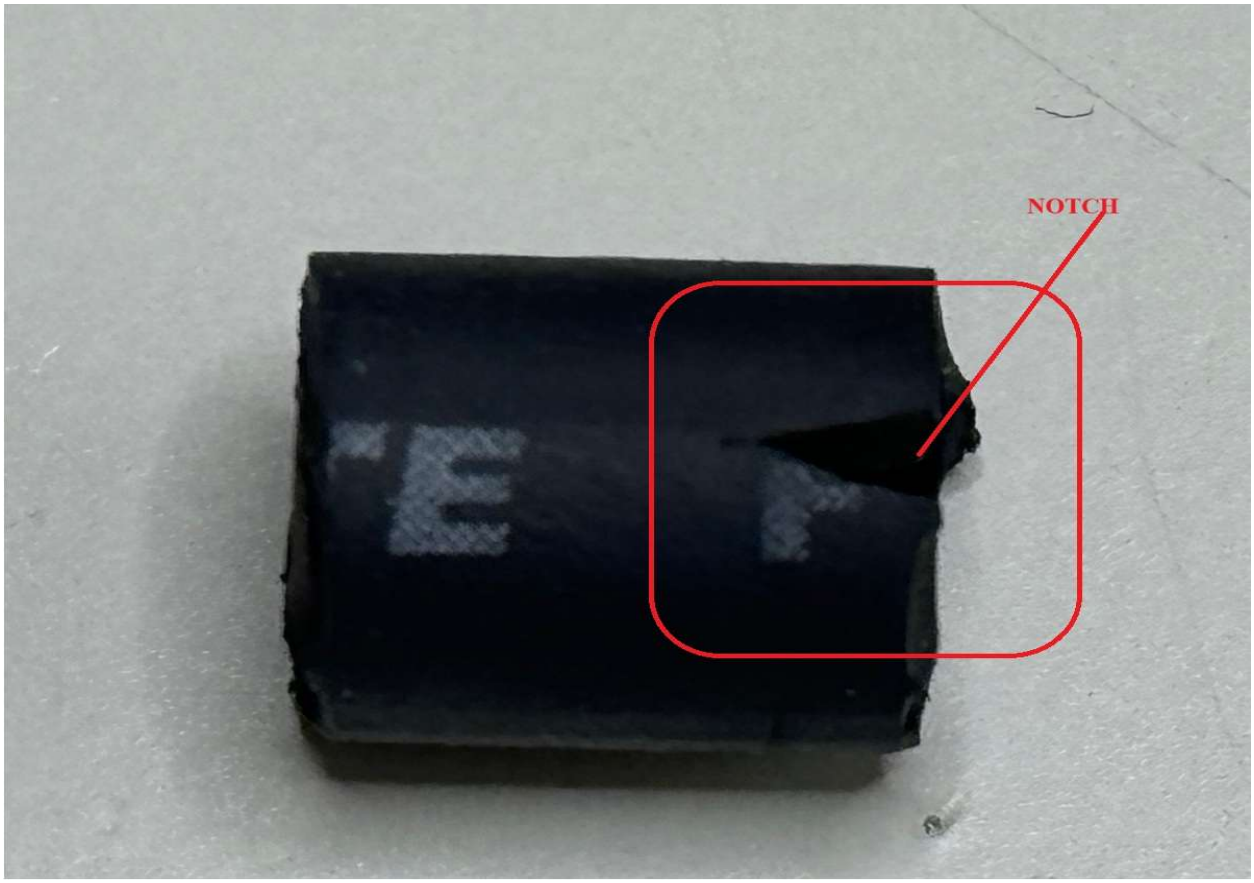
STEP 5: Bolt on 4 x M3 nuts to secure BOTTOM PANEL as in the below photo.



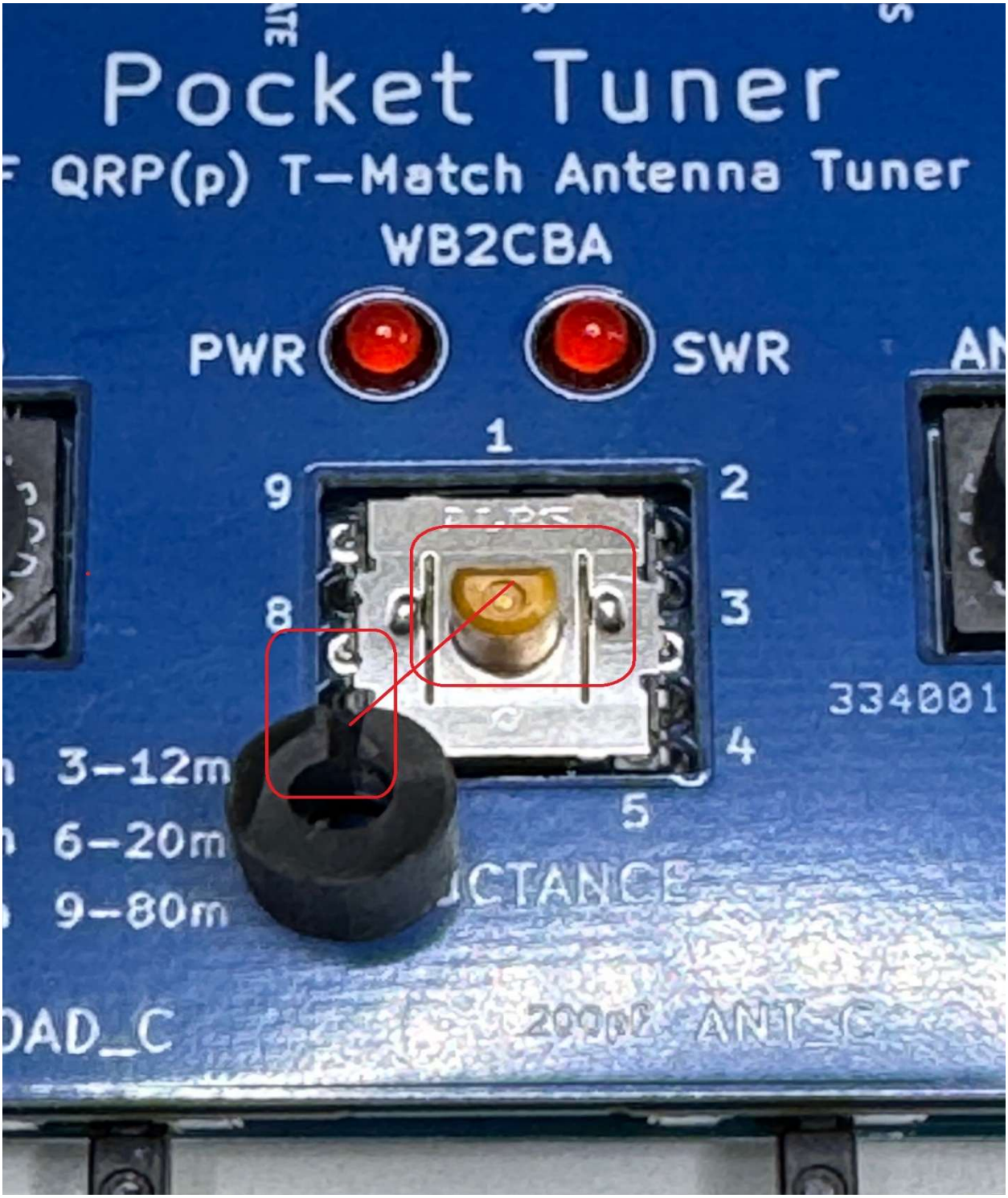
STEP 6: Cutting tuning knobs out of supplied fuel line:

- Cut 3 x 10mm(1/4 inch) pieces like in this photo below:

- Notch one of those cut pieces as in the photo:

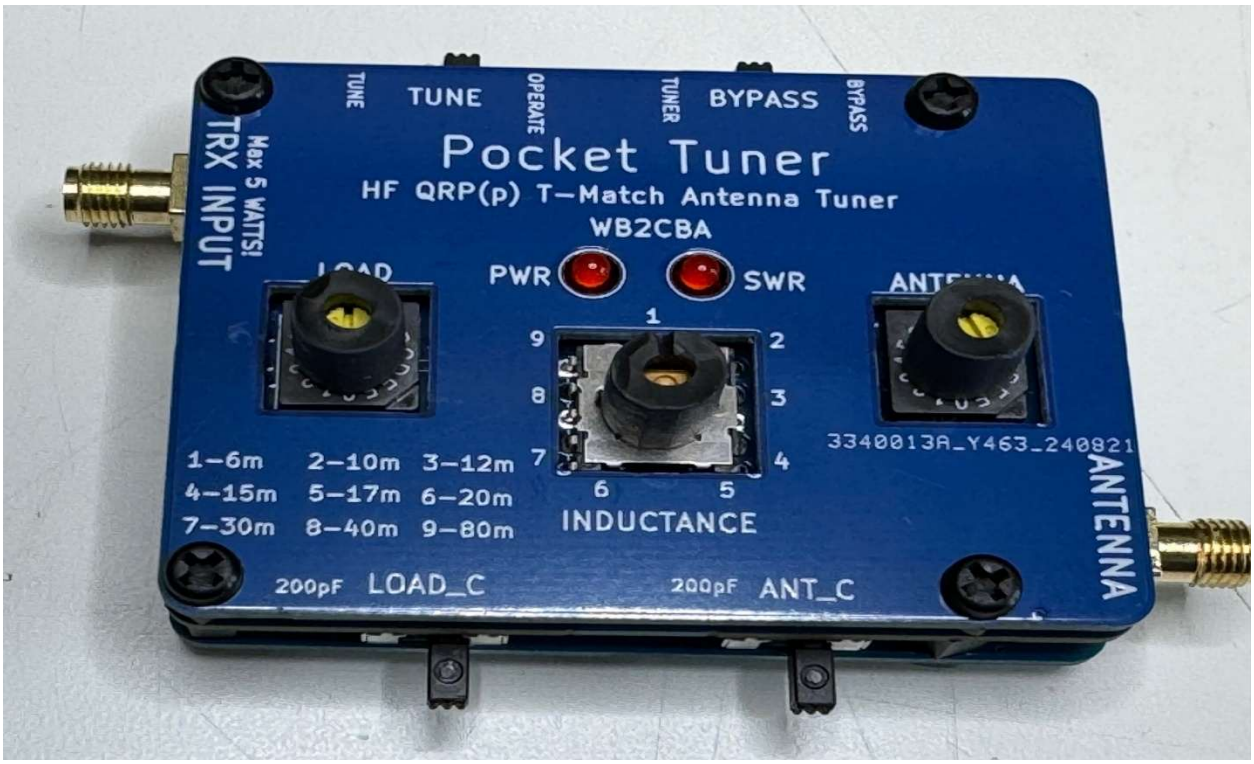


- Align Rotary 9 Pole inductor switch flat shaft cut out with number 1 position on PCB as in the photo.
- Now align notch with that cut out and install on switch. Notch will point to position 1 on switch. When switch is rotated always the notch will be aligned with switch position on PCB.



- Now install leftover two cutout fuel line knobs to HEX rotary encoders.

This will complete soldering and mechanical building of POCKET TUNER. Build complete POCKET TUNER should look like this:



How to use POCKET TUNER:

Using this POCKET antenna tuner is similar to using any manual T-match antenna Tuner.

To start tuning:

- BYPASS Switch should be in **TUNER** mode.
- **TUNE** switch should be set **TUNE**.
- Connect **ANTENNA** connector end to an Antenna and connect **RF IN** connector side to your Transceiver.

- Leave **LOAD_C** and **ANT_C** switches in opposite side of 200pF mark where LOAD_C and ANT_C is written. This means initially we are not adding 200pF to existing capacitance.

- Now transmit and play with **INDUCTANCE selector switch** to observe a dimming in **SWR LED** and/or brightening in **PWR LED**. If there is dimming then leave inductor switch at that position. **Inductor 9 Pole switch** has a table with reference starting recommended positions. These positions are just to give a relative starting position. In real life tuning depending on antenna type these switch inductor positions
  might be slightly different.

- Now advance LOAD Rotary switch clockwise and observe if SWR LED dims and PWR LED gets brighter. Leave the position where you get brightest PWR LED and dimmer SWR LED.

- Now it's time to rotate **ANTENNA rotary switch** while observing if SWR led is further dimming and/or PWR LED is getting brighter.

- You can also add 200pF capacitance and try both switches again to get dimmer SWR LED and brighter PWR LED.

- The aim of tuning is to get SWR LED as dim as possible and get PWR LED as bright as possible while trying different combinations of both LOAD and ANTENNA capacitance rotary switches and trying to add extra capacitance of 200pF to both LOAD and ANTENNA if needed.

- When tuning is satisfactory stop TX and push TUNE switch from Tune to Operate. Now tuner is in operate mod and can TX full power of TRX.

This tuning process is a fine dance of trial and error while playing with different combinations of switches to achieve a dimmer SWR LED and brighter PWR LED. This is the process similar to T-Match antenna tuners. Patience is a virtue in this process!

When Tuning is on, transmit power is lowered with a resistive load and TRX sees a max SWR = 2 so that PA RF stage won't be stressed with high SWR and safe.

Tuning with high power close to 5 watts, it is a good idea to stop TX every 10 seconds or so to avoid stressing Tuner with excess heating.

How This tuner works and Purpose in life of this Tuner!

Lately I am fascinated with miniscule RF power HF rigs and their performance on Digital Modes such as FT-8 and FT4.

Almost a year now I work QRPp on HF Digital Modes with a highly portable QRPp HF Transceiver with Sub 1W RF output from Parks, backpack hikes and from my car. I work mostly on 10m to 17m with my rig. All my QRPp QSOs can be checked on my QRZ log performed with my tiny rig.

All working great except with one minor issue, lacking a highly portable antenna Tuner to accompany my setup in my backpack. ATU type tuners such as ATU-10 or so fail to tune below

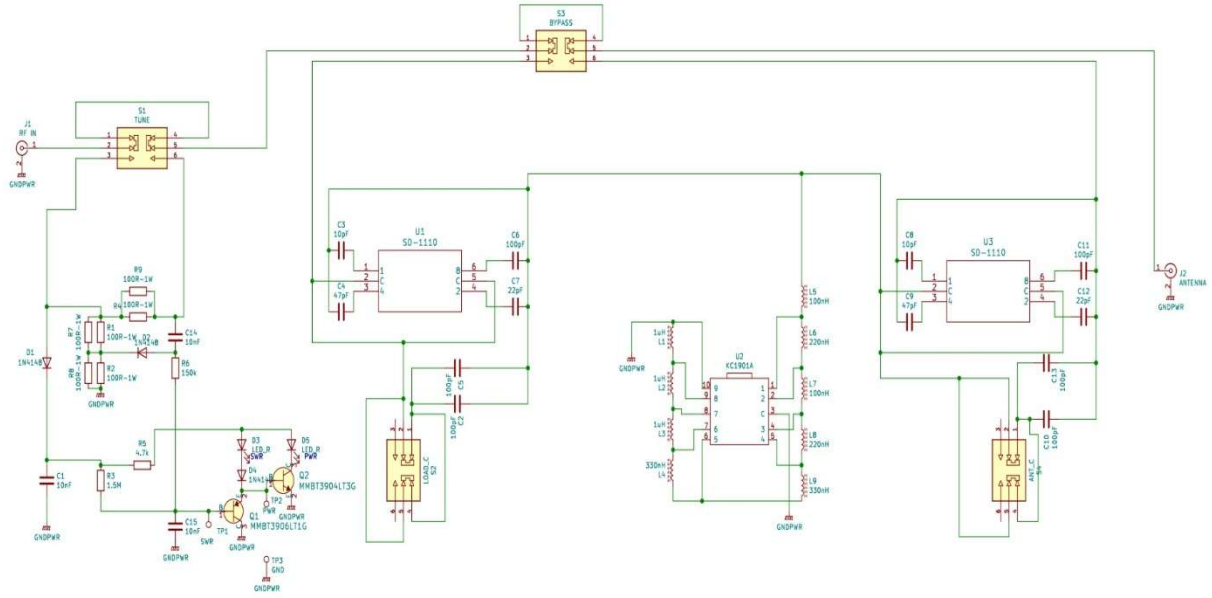
1 Watt!

My go to Tuner is a 4State QRP tuner which I grabbed from a ham fest as a second hand. This tuner designed by David Cripe, NM0S and works like a charm! The only issue I have is its size!

I wanted something the size of a credit card as a Tuner! So, I took this challenge upon me and designed a T-Match tuner similar to David Cripe's excellent 4State QRP Tuner with a twist and way smaller than that.

Before miniaturization process of David Cripe's Tuner I contacted David Cripe to have his blessing on copying his design especially of his excellent SWR led tuning indicator. David was kind enough to grant his approval of using his tuning indicator design. I can't thank him enough for his kind gesture. Thank you, David!

Here is the schematic of POCKET TUNER:



Some specs and aspects of this pocket tuner:

- Works on HF Bands from 6m to 80m.

- I can tune up to 5 watts with this tuner though my aim was more in QRPp zone which is sub 1 watt! Though I successfully used it with my ADX, QDX and QMX without any issues by keeping tuning TX times under 10 seconds at a time not to heat up excessively. Then it works like a champ! 😊

- It has a resistive tuning process indicator which is similar to any resistive tuner meaning does not stress your TRX in tuning mode by lowering SWR in tuning to 2 or lower. This is great not to expose RF PA output stage to excessive SWR conditions while tuning as this is the case in Automatic Antenna Tuners.

Let's talk a bit about limitations of this tiny tuner:

- Aimed for Sub 1 Watt QRPp operation mainly though can be used up to 5 watts by being considerate on Tune TX times.

- **DISCLIAMER: DO NOT attempt to use it over 5 WATTS! Certainly not on 10 WATTS!**

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How this tiny tuner works:

The tuner part of this tuner is a classic T-Match antenna tuner consisting of two series capacitor banks and a switchable inductance bank between two capacitance banks and ground potential.

Nothing special here, parts that are unique to this antenna tuner is how those capacitances are switched and the inductances used.

Let's start with the capacitance banks labeled as LOAD and ANTENNA capacitance. In a classic T-match portable tuner like 4State QRP tuner polyvaricon variable capacitors are used.

In my pocket tuner design I was seeking a different method for the sake of compactness as polyvaricon caps are not as small in size to fit in a credit card footprint.

									Total Cap Value
	BINARY VALUES				8	4	2	1	
DECIMAL VALUE	A	B	C	D	100	47	22	10	
0	0	0	0	0	0	0	0	0	0
1	0	0	0	1	0	0	0	10	10
2	0	0	1	0	0	0	22	0	22
3	0	0	1	1	0	0	22	10	32
4	0	1	0	0	0	47	0	0	47
5	0	1	0	1	0	47	0	10	57
6	0	1	1	0	0	47	22	0	69
7	0	1	1	1	0	47	22	10	79
8	1	0	0	0	100	0	0	0	100
9	1	0	0	1	100	0	0	10	110
10	1	0	1	0	100	0	22	0	122
11	1	0	1	1	100	0	22	10	132
12	1	1	0	0	100	47	0	0	147
13	1	1	0	1	100	47	0	10	157
14	1	1	1	0	100	47	22	0	169
15	1	1	1	1	100	47	22	10	179

Here is my method to walk around that variable capacitor footprint size problem. I used hexadecimal rotary switches which can switch 4 inputs to one common output pin in Hexadecimal 16 possible combinations as outlined in the table above. We have 16 positions coinciding with 16 – 4 bit combinations. If we connect 10pf to LSB digit pin and 22pf following that and 47pf to the next pin and 100 pf to MSB pin then we can switch between 10pf to 179 pf close to 10pf increments.

Now if we add another 200pf in parallel to this HEX switch capacitor bank with another switch now we can go up to 210pf to 379pf. This will give us a range of 10pf to 379pf in approximate 10pf increments.

Those HEX rotary switches are much smaller in size when compared to polyvaricon caps in footprint.

On Inductance side I used high Q, power smd fixed inductors from TDK. Inductance Rotary switch is a 9-position switch that switches from lowest 100nH to highest 4.3uH which gives a decent coverage between 80m to 6m bands in tuning almost all antenna cases.

For tuning indicator as I mentioned above, I used David Cripe, NMOS's design used on 4State QRP Tuner. What I like in this design is that we have two LED indicators for SWR and forward output. The aim in tuning is to have SWR LED as dim as possible and PWR led as bright as possible. When both PWR and SWR LEDs are bright SWR will be less than 2! This is a great indicator, very intuitive to use.

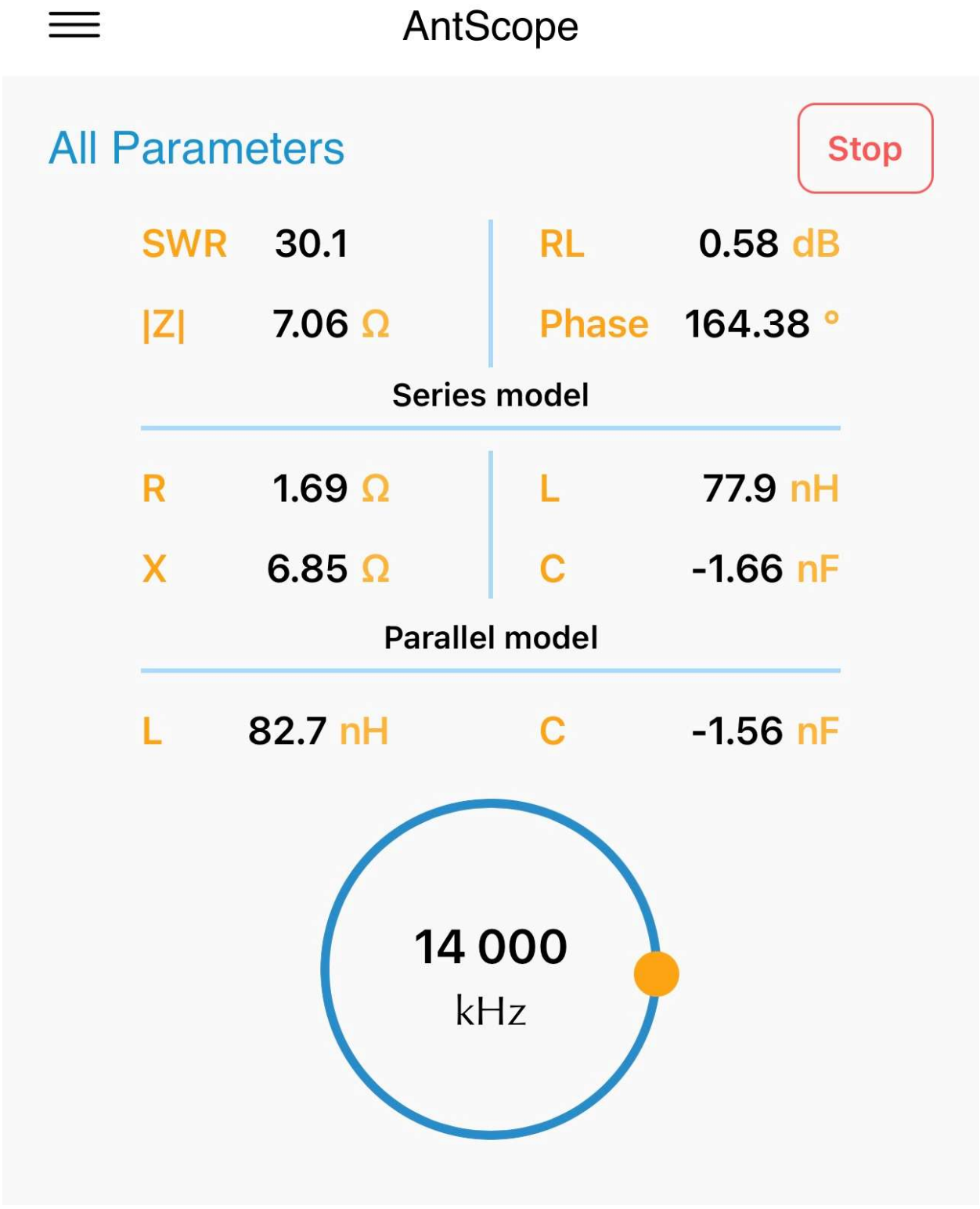
Tuning tests with POCKET TUNER:

I have a 10m MFJ Vertical Antenna which I use in my car setup. This is a 10m/28 Mhz tuned antenna. I carried out a verification test of this tiny tuner to see if it can tune my 10m antenna on different bands .

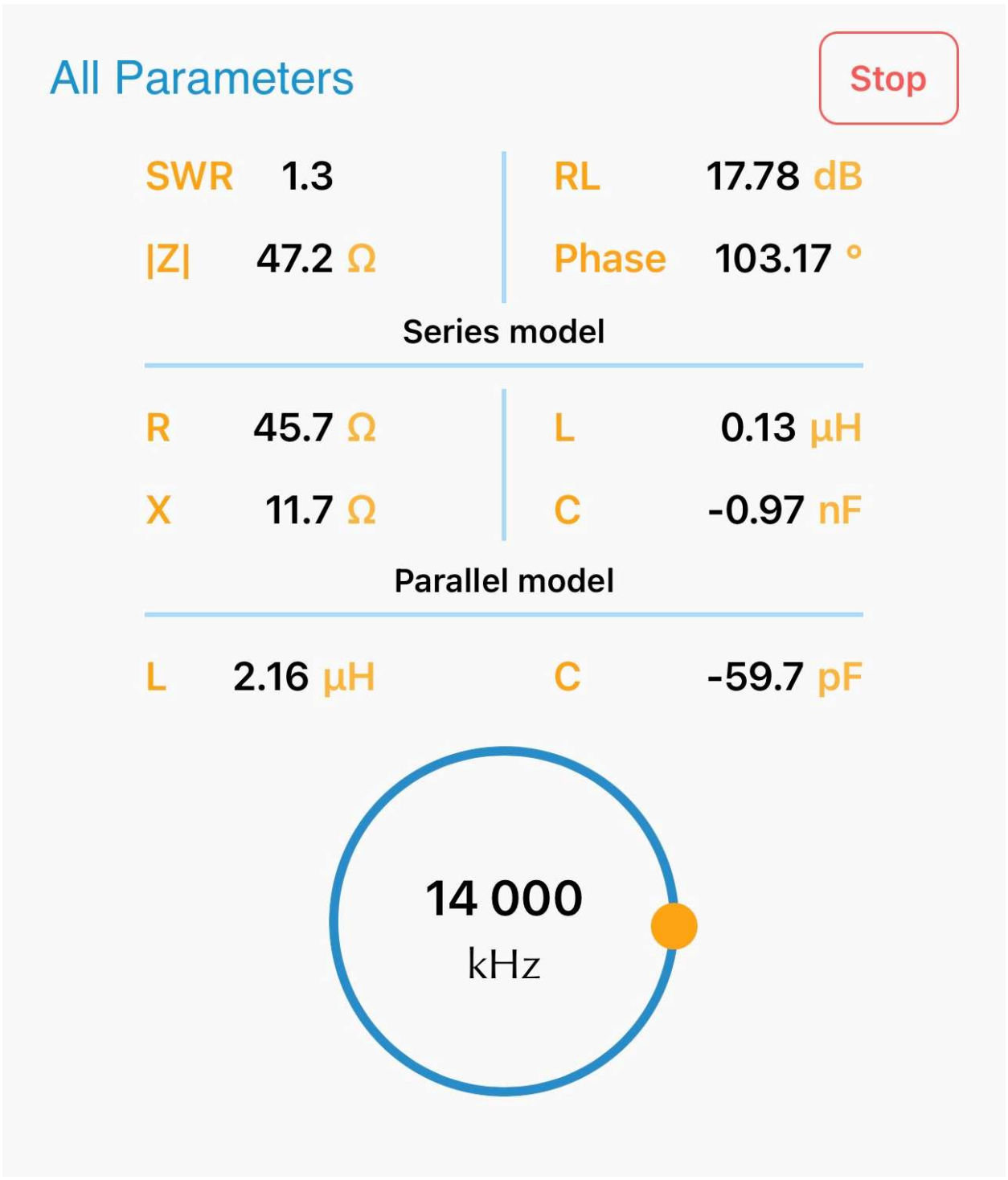
I have a RIGEXPERT A55 Zoom antenna analyzer. I connected this analyzer to ANTSCOPE app which is RIGEXPERTS official phone app where you can view all your antenna values conveniently.

I setup POCKE TUNER between my 10m antenna and RIGEXPERT Antenna analyzer.

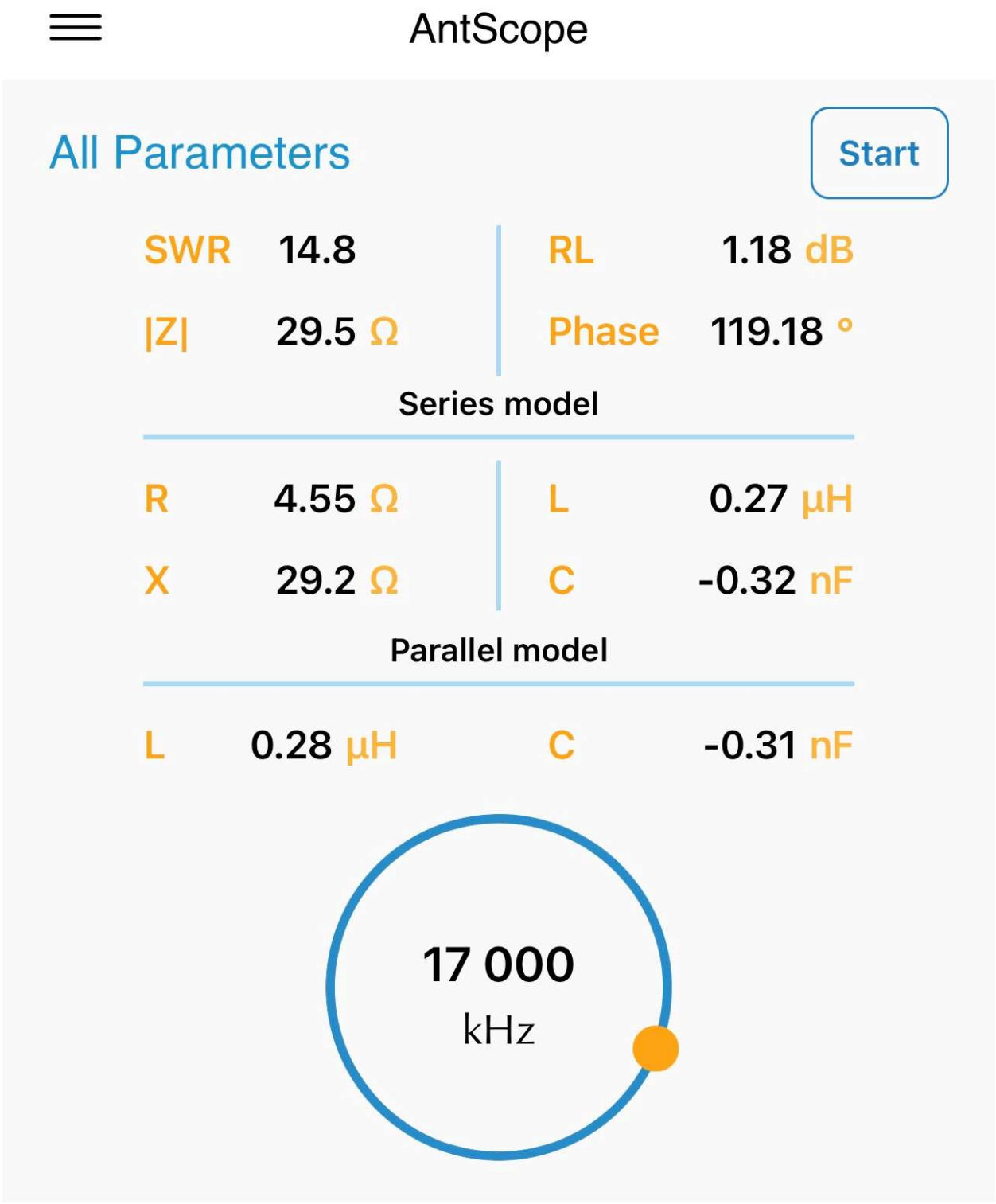
Here are some screenshots of BEFORE tuning and AFTER tuning values of 14MHz, 17MHz and 21 MHz frequencies. This tiny tuner can tune a 10m vertical antenna on these frequencies like a champ! 😊



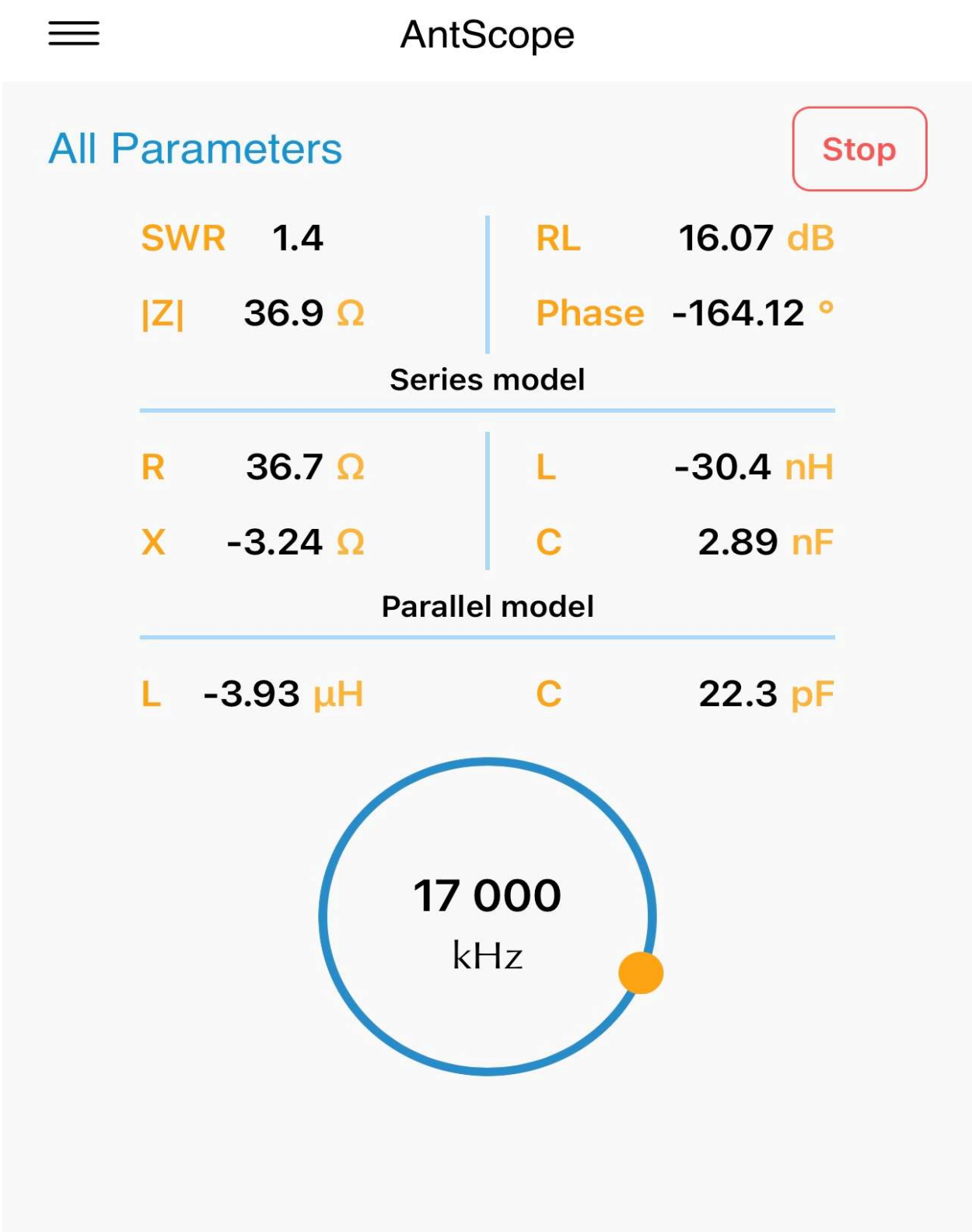
14MHz before tuning



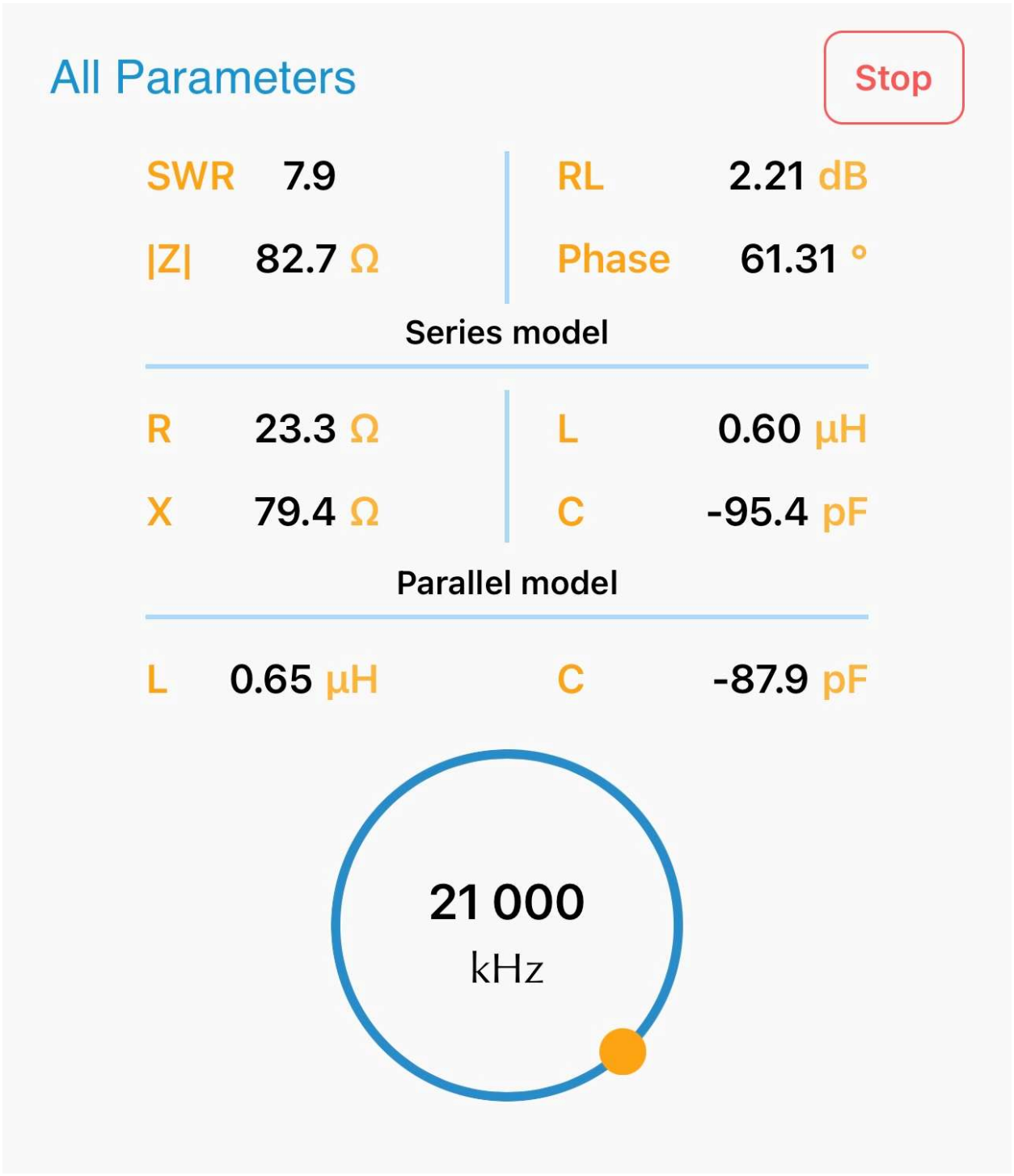
14 MHz after tuning



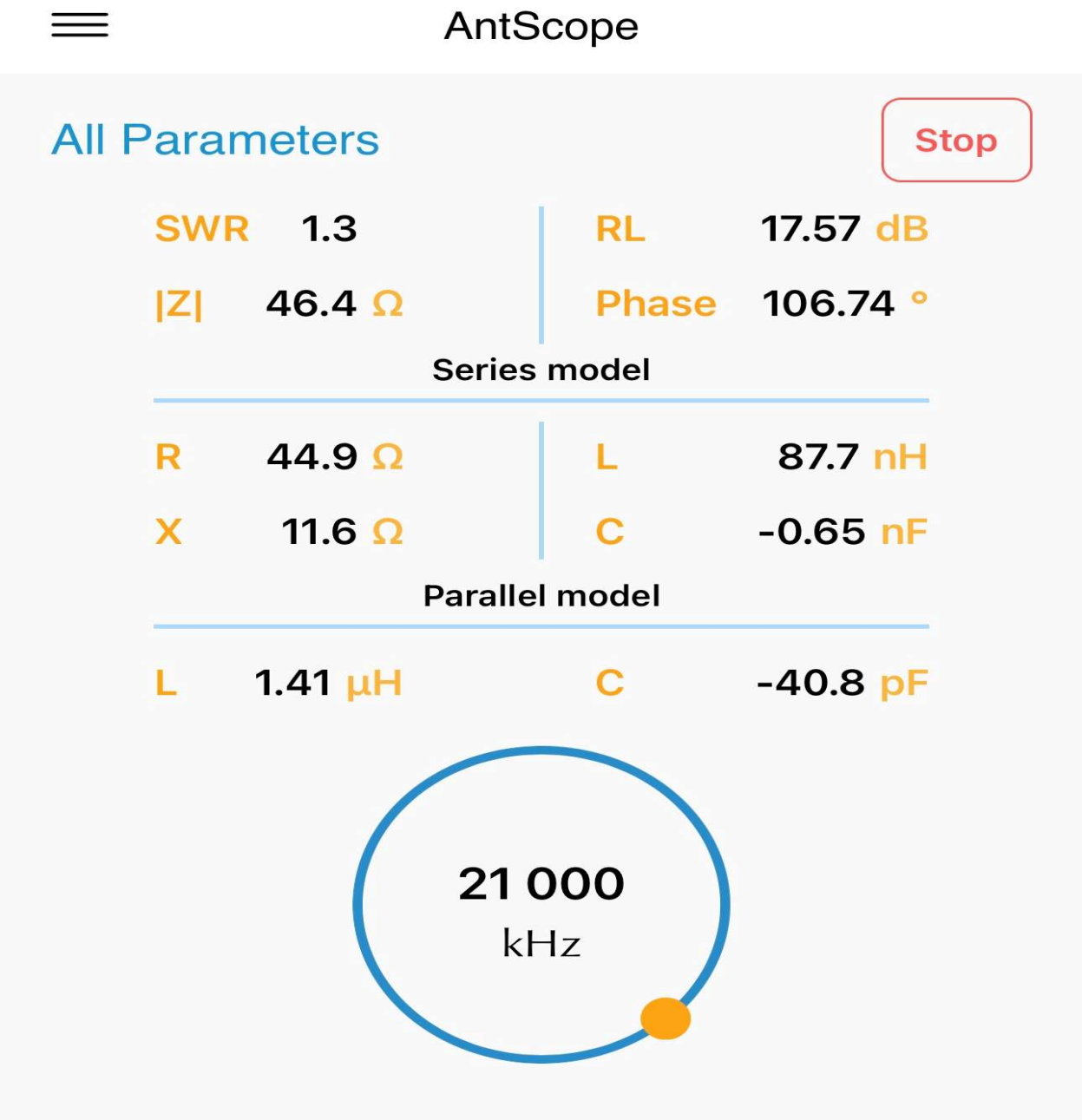
17 MHz before tuning



17 MHz after tuning



21 MHz before tuning



21 MHz after tuning

Please let me know about your user experience and comments are welcome.

Enjoy!

Barb WB2CBA – 02/2025

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