TT2+ 50th Anniversary Transmitter Kit

from QRPme

Preliminary construction manual VER.3A

For close to 25 years, I've been designing QRP kits, tools and building aids. I've really identified with the original TT2 design because of its novelty and SIMPLICITY. In a previous life, I was a professional electronic toy designer so I have always looked at design work on the 'lighter' more FUN-er side. I've been creating versions of the Tuna Tin 2 for 20+ years and have added all kinds of FUN to the basic TT2 concept and lots of tuna can accessories to make complete tuna can stations. In 2011, I created a 35th anniversary kit and I made another one in 2016 for the 40th anniversary. Both kits were close to the original TT2 design with no major deviations. I started the 50th anniversary kit design with a totally different objective. In all the previous TT2 designs of the transmitter was pretty much 'stock' and quite similar to each other with only minor improvements. For the 50th anniversary kit I decided to go completely in a different direction. I wanted to include many 'accessory' circuits in the can to make it as versatile as possible: Band modules from the SUPER Tuna][+, Keyer circuit from the Beaconator][, buffer/driver configuration for more power also from the SUPER Tuna][+ and simple EFHW antenna coupler from the Sea Sprite+. These accessories make this the most powerful and versatile TT2 transmitter design that ever sat on top of a tuna can!

7/05/2026

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BOM VER.3
(JULY 5 changes)

RESISTORS
33 OHM
120 OHM QTY=2
470 OHM QTY=2
1K OHM QTY3
2.2K OHM QTY=2
10K OHM
47K OHM
100K OHM
10K rt angle pcb mt POT
50K rt angle pcb mt POT

CAPACITORS
47pf QTY=3
100pf
150pf QTY=2
330pf QTY=2
680pf
.1u QTY=10
10uf
22uf

SEMICONDUCTORS
1N5231B 5.1V ZENER QTY=2
33V ZENER
1N4148
1N5818
LED
PN2222A QTY=2
2N3866 / 2N2219A or equiv. TO5 pkg.
2N3906
2N7000 QTY=2
BB910 & MVAM109 VARACTOR DIODES
12F1840 KEYER CHIP

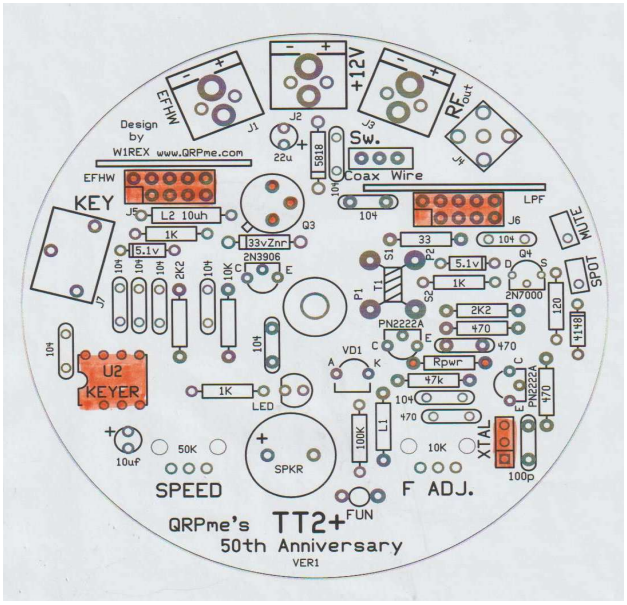
INDUCTORS
2.2uh AXIAL CHOKE
10uh AXIAL CHOKE QTY=2
FT37-43
T50-2 TOROID QTY=2
T50-43 TOROID

MISCELLANEOUS
1x2x.1" dual SCREW TERMINAL QTY=2
1x3x.1" male straight HEADER
1x2x.1" female shorting JUMPER
1x20x.1" SIP SOCKET STRIP
2x5x.1" female HEADER QTY=2
2X5X.1" male rt. ang. HEADER QTY=2
1x2x.1" MEMBRANE SWITCH
8 pin IC SOCKET
RCA JACK rt angle pcb mt RED
RCA JACK rt angle pcb mt WHITE QTY=3
STEREO JACK pcb mt
SMA JACK pcb mt
TO-5 HEATSINK
40m CRYSTAL
PIEZO SPEAKER
#6-32x2" BOLT & NUT
MAIN PCB
LPF MODULE PCB
EFHW MODULE PCB
50" 24-26ga RED MAGNET WIRE
12" 24-26ga GREEN MAGNET WIRE

When I start building a kit, I have to decide which method of building I want to pursue: sub-sections which can be tested as they are built, low to high parts elevation, left to right soldering or parts by category (all resistors, then caps then on to semiconductors etc.) For the TT2+ 50th Anniversary build, I thought I would try sub-sections that can be built and tested as they are built. But I also put a little low to high building in the mix just for ease of building. I like to solder in all the IC sockets, SIP sockets and header sockets before I get to the main build. I do this because they are all similar in height so putting them in first makes sure all the other parts don't get in the way and the pcb lays pretty flat when it is upside down for soldering.

STEP 1: Sockets & headers.
Two header sockets, the IC socket, the SIP sockets for the crystal (3), Rpwr (5), TO-5 transistor (3) are shown in the location figure on the right. I decided that the Rpwr resistor and L1 (5) should also have SIP sockets so they can be changed easily for enabling experimentation with various power outputs and crystal loading. After playing around with the prototype, I decided that the varactor diode VD1 should also have socket pins for easy changes. So there are several more components that need to have IC socket pins installed for experimenting.

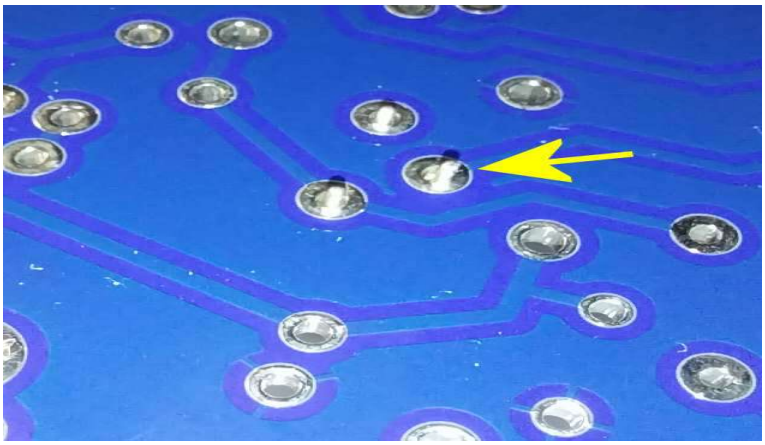
NOTE the orientation of the IC socket. Match the little half round indicator on the socket to the half round on the silk screen.



Install the SIP socket pins onto the transistor leads, which are shortened and dry-fit to fit into the pads properly. This allows you to insert them into the pads and have the weight of the pcb keep them in place. Solder **ONE and only** one pin/pad on the pcb to keep the transistor in place. Turn the pcb over and see how the transistor sits. You can touch the iron to the single pin/pad you just soldered while holding the transistor nice and vertical with your finger. Once you have the transistor sitting upright and where you want it, you can then solder the other 2 pins. Finally, you can touch up the 1st pin to make sure it also has a nice solder job.

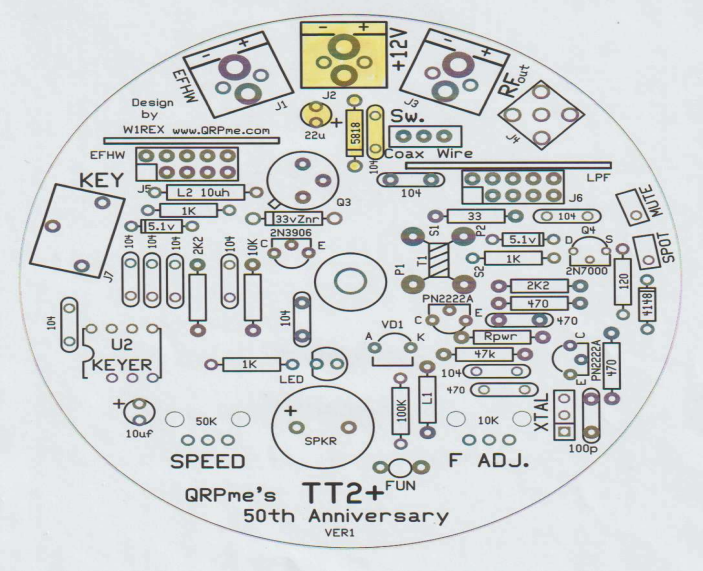
The same principle holds for header connectors and SIP strips. You solder only 1 pin and then inspect the part to make sure it stands up OK and tweak it if necessary. THEN solder the other pads.

Remove the transistor and reinstall it later in the build....



Now that all the low flat multi-pin connectors are soldered in and sitting upright, you can proceed to...

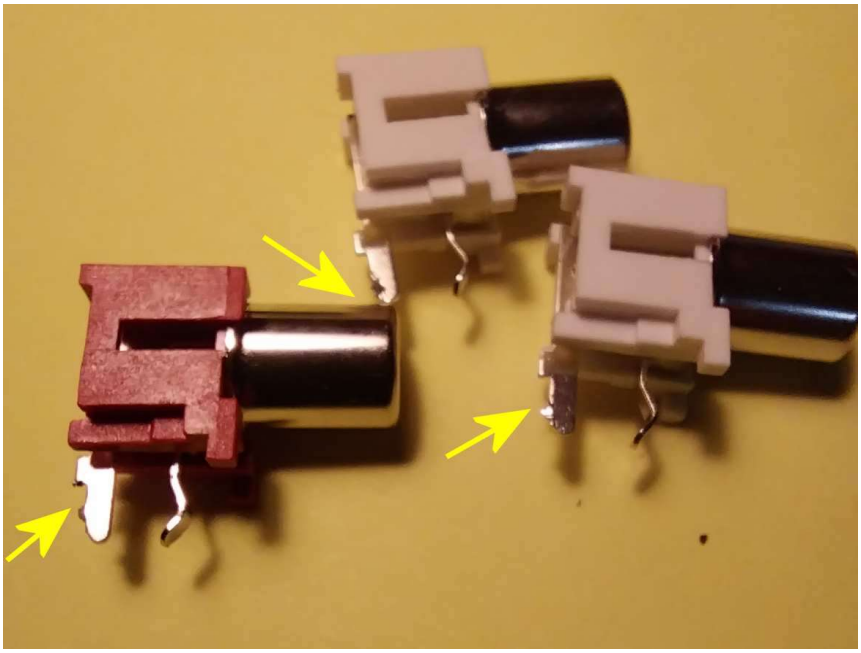
STEP 2: The 12V power entry section. This step is real quick and easy to test.



A 1N5818 polarity protection diode and 2 capacitors stabilize the 12 volt power input and perform RF bypass decoupling. Pay attention to the bar on the diode and the + sign on the 22uf cap as these items are polarity sensitive.

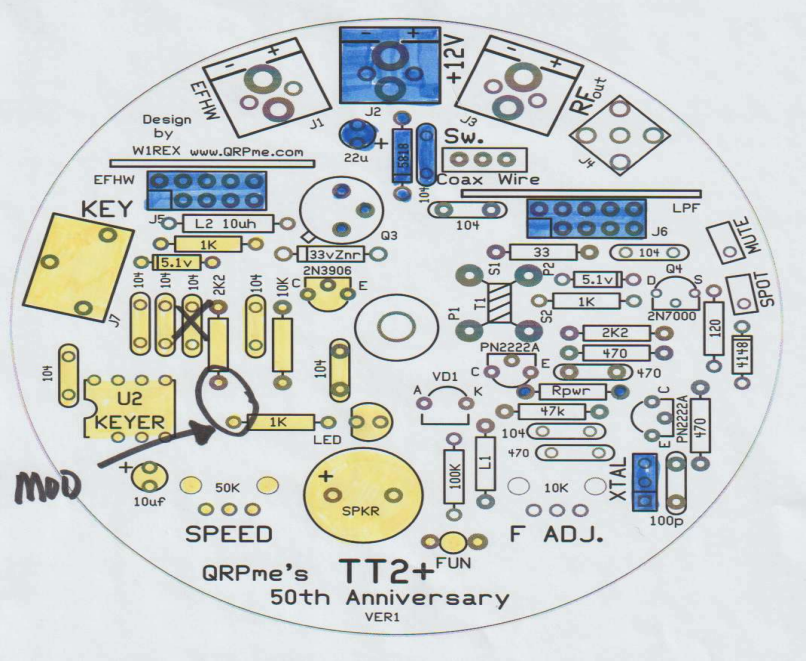
Once you have the parts in place, you should solder up a power input cable with you connector of choice to the battery or power supply and an RCA, preferably RED, male connector for powering your TT2+.

One small goof is that the holes in the pads for the rear lead of the RCA jacks is a couple of 1/1000s too small. You need to clip off a tiny bit of the little pointy hook on the rear lead on the RCA jacks. **DON'T** use your best cutters for doing this cut. I have a former #1 flush cutter that has a little ding in the jaws that I use for these tasks.



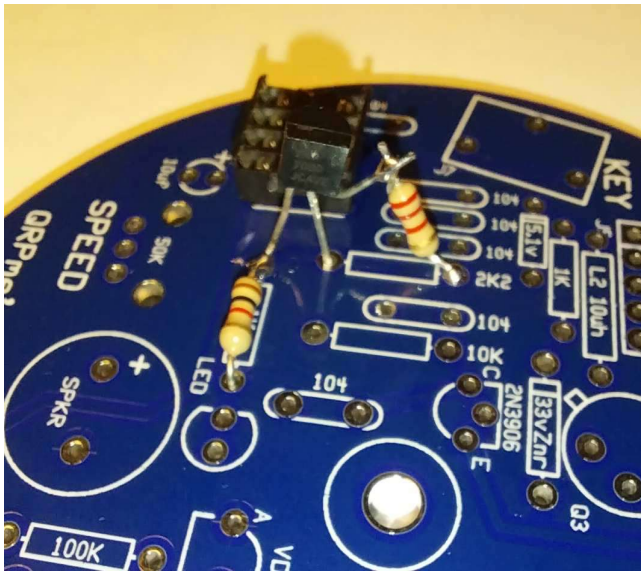
Keep you good flush cutters good by **NOT** cutting hard metal with them. Your GOOD flush cutters should only be used to cut soft wires and component leads!

Moving on to STEP 3: The keying section.



This is where I made a pretty big goof. I left out a 2N7000 FET on the output line from the keying microcontroller to the rest of the keying circuit. A simple mod can be made without any pcb trace additions or cutting. Look at the MOD circle in the right image.

MOD = install the 1K resistor to the left of the LED. Add a tiny dollop of solder on the top side of the 1K resistor's left end pad. Now install the right lead of the 2.2K resistor and position the resistor at about 30 degrees sloping up towards the bottom of the pcb. Install the center lead of the 2N7000 FET into the left end pad marked for the 2.2K resistor. The 2 FET outer leads should be pre-formed and tinned LIGHTLY to make the job of soldering very easy. You don't want the solder all blobbed up on the lead so that it won't fit into the holes in the center pad. AS ALWAYS, when making a circuit MOD it is best to dry-fit the components in question to make the job easy and clean,



The remaining parts to install for the Keyer section are:
Resistors:
1K (brn-blk-red) QTY=2
2.2K (red-red-red)
10K (brn-blk-org)

Semiconductors:
2N5231B 5.1V zener (mindful of orientation)
LED (short lead on flat side of LED as indicated on the silk screen)
2N3906 transistor (mindful of flat side aligned with flat on silk screen)

Capacitors:
.1uf (104) QTY=5
NOTE: .1uf just to the left of the 2.2K resistor is **NOT** installed
10uf aluminum electrolytic (mindful of orientation)

Miscellaneous:
Membrane switch at FUN
Speaker at SPKR location (match + on speaker with + marked on pcb)
Stereo jack at KEY
install 8 pin micro keyer into the IC socket (mindful of orientation of pin 1)
50K potentiometer at SPEED

You should now be able to insert paddles into the KEY jack and apply power to the kit. You should hear the keyer wake up with a greeting in code and you should be able to 'send' some code using the paddles. You should see the LED flash in sync with your code and hear your code in the sidetone speaker. If not, turn off the power and inspect your soldering, parts placement and proper orientation of the parts that need proper orientation.

The keyer is a slightly modified PicoKeyer from HamGadgets so there are a lot of functions contained inside it.

STEP 4: Oscillator, buffer and driver section

Parts for this section:

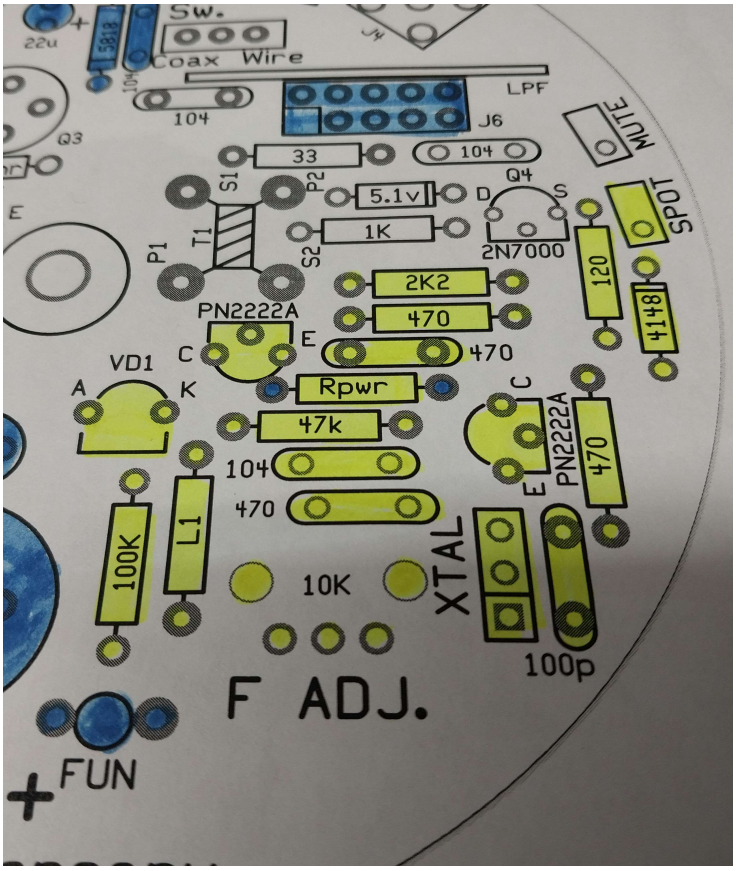
Capacitors:
47uf (470) QTY=2

100pf (101)
.1uf (104)

Miscellaneous:
1N4148 diode
BB910 varactor diode
PN2222A transistor QTY=2
10uh axial choke (brn-blk-blk)
40m crystal
1x2x.1" male straight header
(or 1x2x.1" screw terminal block)

Resistors:
120 ohm (brn-red-brn) QTY=2 (1@Rpwr)

470 ohm (yel-vio-brn) QTY=2
2.2K (red-red-red)
47K (yel-vio-org)
100K (brn-blk-yel)
10K rt ang. Potentiometer



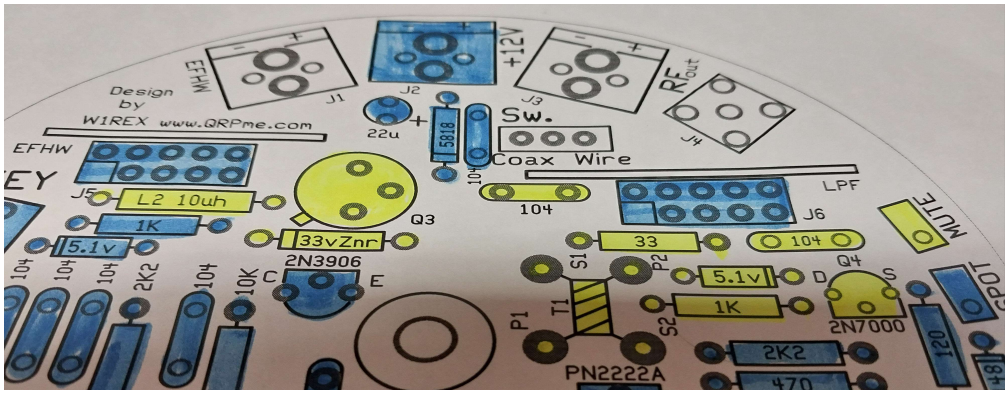
As usual, I solder in the flat stuff first: resistors, axial chokes and diodes. Then install the slightly taller stuff like the monolithic capacitors. Then solder in the transistors and varactor diode paying attention to the the orientation as shown on the silk screen. Now install the tall stuff.

At this stage, you can put a shorting jumper across the SPOT location, apply power and have the crystal oscillator section work when keyed. You should be able to hear the crystal operating somewhat near the marked frequency on a 40m receiver placed close to the TT2+.

STEP 5: RF final output and MUTE function

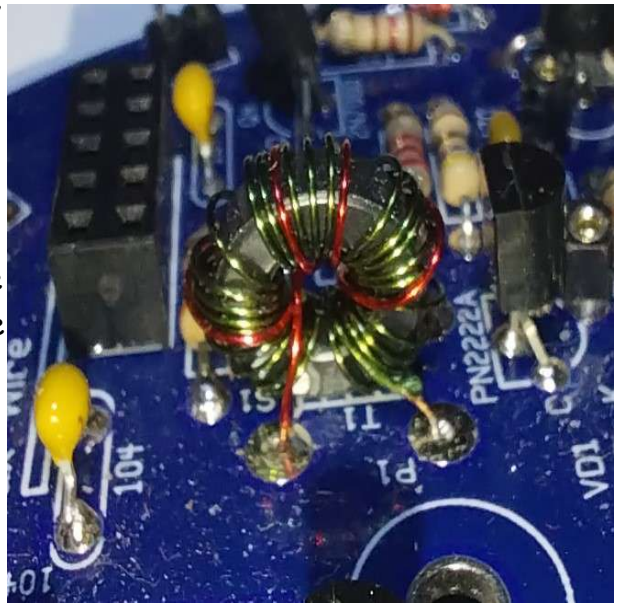
It shouldn't be difficult to gather the required parts from the dwindling parts left in your parts pile...

33 ohm resistor (org-org-blk)
1K resistor (brn-blk-red)
.1uf capacitor (104) QTY=2
1x2x.1" st male header
OR screw terminal block
red & green magnet wire
10uh axial choke (brn-blk-blk)
33V zener diode
5.1V zener diode (2N5231B)
2N7000 FET diode
2N2219 or 2N3866 transistor
FT37-43 toroid (black) for T1



This section is pretty straightforward. Resistors, capacitors, axial choke and diodes are all 'flat' devices and would be the first parts to place. Q3, (2N2219 etc), should have the SIP socket pins on the leads and pressed into the heat sink before installing on the pcb. already installed so installing the 2N2219 or 2N3866 transistor should be just shortening the leads and inserting them in the SIP sockets. The 2N7000 transistor can be installed mindful of the silk screen orientation.

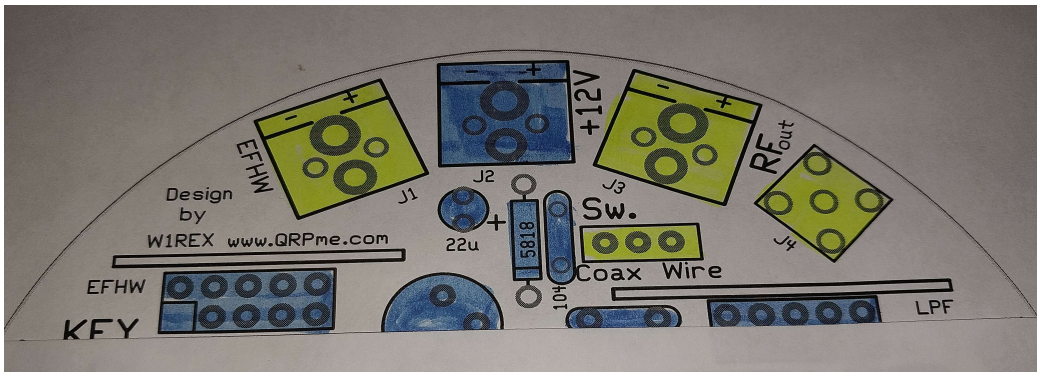
The T1 transformer is pretty straight forward but with a small twist. There are 25 turns (19") of RED magnet wire on the **PRIMARY** terminals P1 & P2. Then 5 turns (6") of GREEN wire spread across the 25 turn primary windings are now the **SECONDARY**.



The magnet wire has a thermal coating so you can burn the coating off the areas that you want to solder and then clean off the residue or use a razor knife to scrape off the enamel. Use the blade perpendicular to the copper wire so you don't nick the wire as it can be cut quite easily. Personally, I am a scrape-guy followed with a light sandpaper clean.

STEP 6: RF output connections

I modeled most of the RF section of the Tuna Tin2+ 50th Anniversary kit after what I thought would be the biggest baddest tuna tin transmitter I could think of back in 2010, the SUPER Tuna][. I updated the original 2010 design in 2015 by giving it more RF output power and a couple more neat features. I thought putting the crystal on the band module would make for practically instant band changes was a good idea but hard wiring the crystal on the band module made changing frequencies within the same band an 'issue' as a socket on the main board is a more practical solution to the problem. I also implemented a 7 pole low pass filter capability but I never heard from anyone using more than the 5 poles included in the documentation. The extra pads and space just wasn't necessary. So I made a more compact low pass filter module for the TT2+ so I could use the space for different purposes. Likewise the switchable output to the antenna OR dummy load power measurement circuit was also history so I could use the space for something more useful, an adapter for a simple wire antenna connection with a 'switch' to decide which way the RF goes: RCA & newly added SMA connector OR over to the EFHW coupler module. I initially laid out the pcb for a subminiature SPDT toggle switch but it didn't fit so I ended up with a 3 pin header with a shorting jumper with handle. Lots cheaper for something you really don't change that often. A result from that decision is that the coax/wire label on the silk screen is now OPPOSITE from where the jumper directs the RF.



Just a few parts:
2 white RCA jacks
1 SMA jack
1 1x3x.1" straigt pin male header
1 1x2x.1" shorting jumper with handle

REMINDER: The silk screen for the SW. is wrong. There is now a 3 pin header and jumper as the switch didn't fit and it's not aN often used function. The silk screen shows the THROW position for the switch function the header jumper position is opposite from the silk screen markings

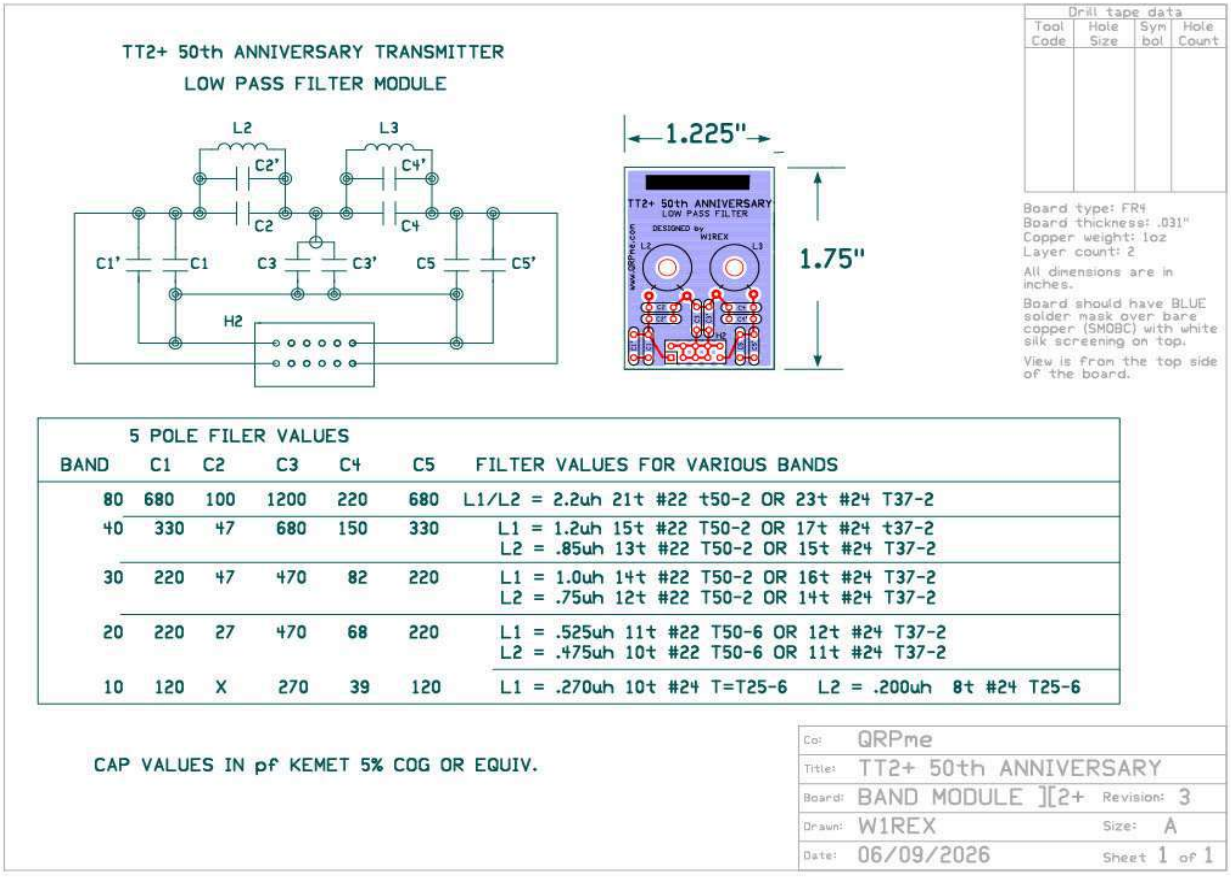
STEP 7: The low pass filter module.

The TT2+ has effectively the same low pass filter design as the SUPER Tuna][+ but on a more compact circuit board with a 5 pole filter instead of a 7 pole filter with 2 unused poles. I did double up all the capacitor pads so you could use parallel capacitors to construct non-standard cap variables if you wanted to construct a different type of filter where non-standard values are required. The TT2+ is kitted with parts to construct a 40m filter.

Parts for this step are:

47pf capacitor (470)
150pf capacitor (151)
330pf capacitor QTY=2 (331)
680pf capacitor (680)
T37-2 toroid QTY=2 (red)
2x5x.1" right angle male header
magnet wire (red) 2 pieces 16" long
Low Pass Filter pcb

NOTE: EARLY LPF pcbs only have single capacitors in each location. Double caps enable easy paralling caps to create non-standard cap values in different filter configurations.



Solder the capacitors onto the pcb using the table in the above image. Wind the chokes using the red magnet wire onto the T37-2 toroids included.

For the power levels in the TT2+ 50A kit, 26 gauge magnet wire will suffice in the low pass filter application.

L1 = 17 turns red magnet wire onto a T37-2 toroid
L2 = 15 turns red magnet wire onto a T37-2 toroid

Wind the toroids and dry fit them into the appropriare pads one at a time. Clip the leads to the appropriate soldering lengths and prep the ends for soldering. When the leads are nice and clean, you can reinsert the toroid, solder it and perform a final clip of the excess magnet wire.

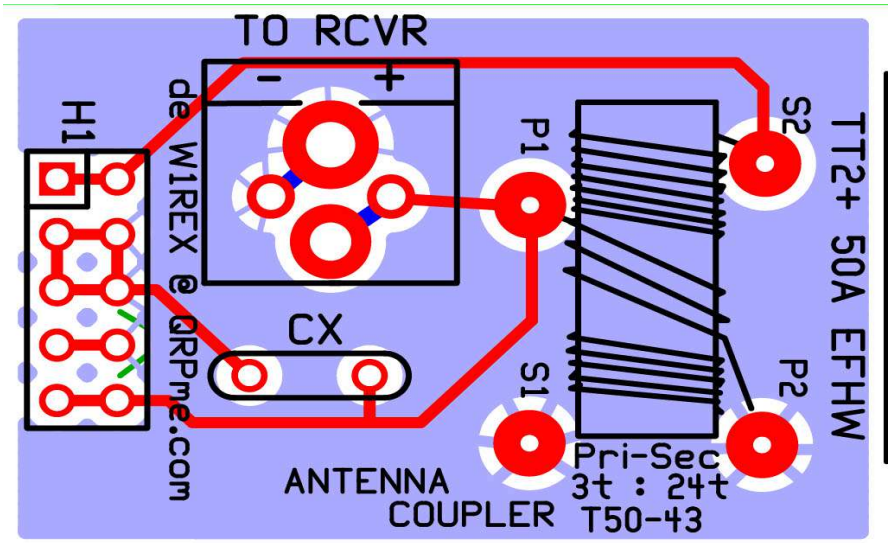
The magnet wire has a thermal coating so you can burn the coating off the areas that you want to solder. You need to set your soldering iron for 500+ degrees C , melt a nice blob of solder on the iron and run the magnet wire slowly through the blob to remove the coating. Some builders have modified the tip of an inexpensive soldering iron to make a very skinny solder pot with the iron mounted vertically. Just dip magnet wire into the hot solder pool and wait for the coating to melt off.

NOTE: I'm old school when it comes to prepping the magnet wire. I use a small snap razor knife to carefully scrape the prepped area and then a final clean with a fine piece of sandpaper.

One common problem with soldering magnet wire is not having a good connection after soldering due to the solder not making it through the enamel layer on the wire to the actual copper. So make sure the area of the magnet wire that you are going to solder to is nice and clean and bright..... After soldering, you can use a multimeter in the continuity test mode and check the resistance between pads P1 & P2 and S1 & S2. There should be practically zero resistance between the corresponding pads.

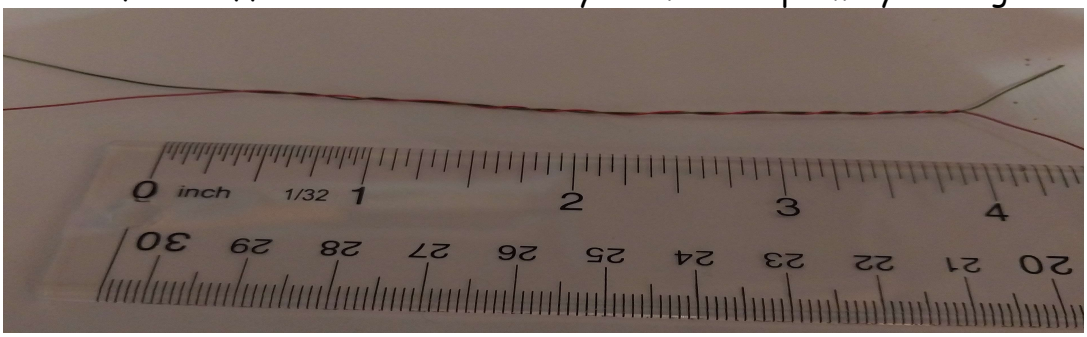
STEP 8: The EFHW coupler module

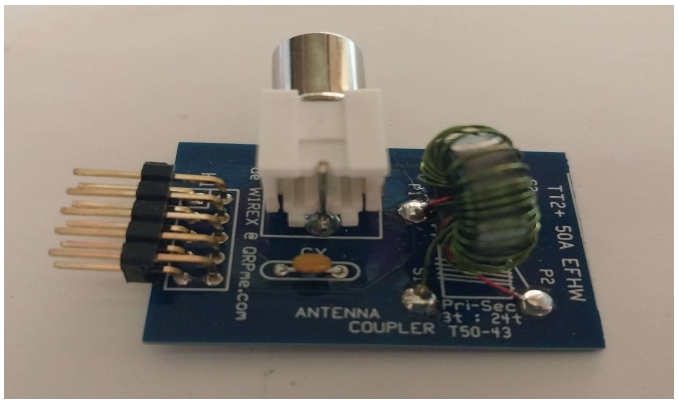
Even fewer parts here:
white RCA jack
2x5x.1" rt angle male header
150pf capacitor = Cx (150)
T50-43 toroid (blk)
20" red magnet wire
6"green magnet wire
EFHW pcb board



Pretty easy to figure out what to put where... tricky thing is the toroid transformer.

Take about 6" of green magnet wire and 20" of red magnet wire and twist the two together (about 3 turns/in.) on one end for about 4" total. Then wrap the 2 twisted wires around the toroid for 3 turns. Separate the remaining green wire so you now have the 2 primary leads. Continue winding the red wire for another 21 turns to finish off the second secondary lead. Green primary leads go to P1 & P2. Secondary leads are soldered into S1 & S2. The starting leads that begin the twisted pair are P1 (green) and S1 (red). The green end of the twisted pair is installed at P2 while the remaining red end is soldered into S2.





More info....

With a 120 ohm resistor at Rpwr, the TT2+ transmitter should give you about 500mW of RF output. Using SIP pins in the Rpwr pads allows easy resistor changes. I tested several resistors and measured power using a very nice PM-1300a power meter.

Results **<u>on 40m</u>** were:

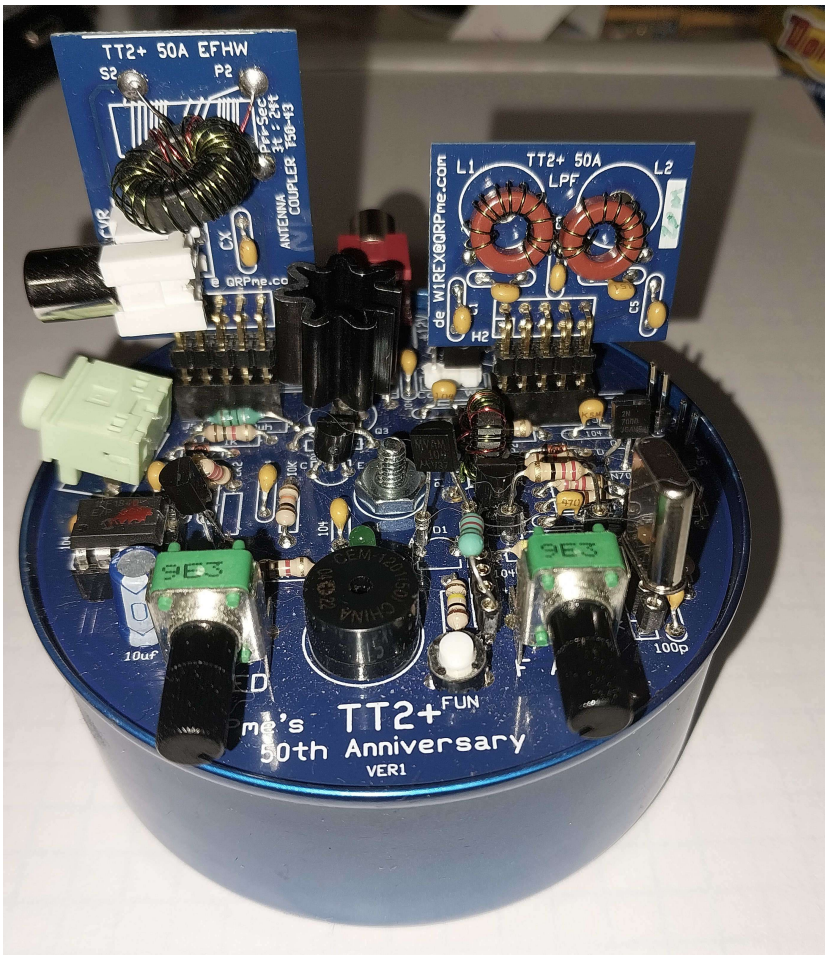
395 ohms = .05W	150 ohms = 400mW	90 ohms = 800mW
310 ohms = 100mW	120 ohms = 500mW	78 ohms = 900mW
240 ohms = 200mW	110 ohms = 600mW	70 ohms = 1W
180 ohms = 300mW	100 ohms = 700mW	44 ohms = 1.5W
		16 ohms = 2W

I will attempt to build low pass filters for 80m, 30m & 20 meters soon in order to check the power levels on those bands.

FINAL thoughts:

I found this **BEAUTIFUL** blue tuna can at Walmart. The picture doesn't due it justice but is is one of the prettiest tins I have run across. It perfectly matches the blue pcb solder mask I specify on all my tuna tin creations. Check it out!

Here is my completely assembled TT2+ 50th Anniversary transmitter in the Delores tuna tin from Walmart.



Looks nice and works FB>

Rex
W1REX