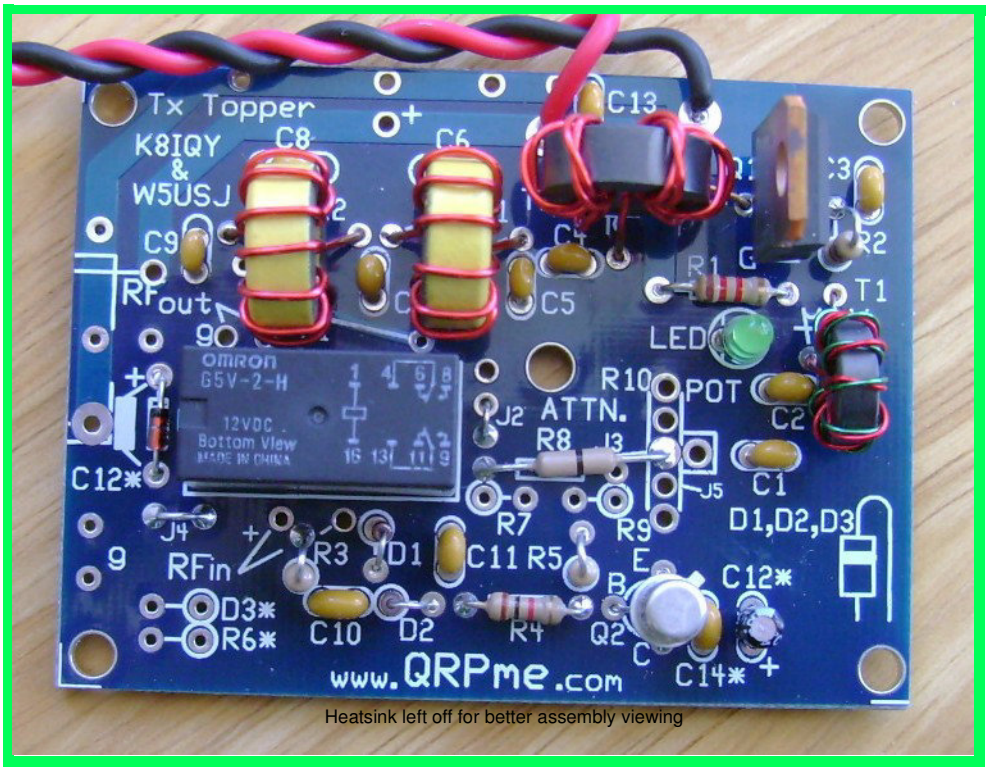
QRPme.com Kits

Kits for the QRP and Electronics Hobbyist

Tx/Tuna Topper



Heatsink left off for better assembly viewing

Assembly and Operation Guide

Contents

Figures and Illustrations

Manual written and illustrated by W5USJ
CyM-TEC Documentation Services
Created with Adobe FrameMaker
Original TxTopper developed and produced by W5USJ

Jumpers

Note: Jumpers J2 through J5 are used the same for both Tx and Tuna Toppers. See page 5 for more jumper information.

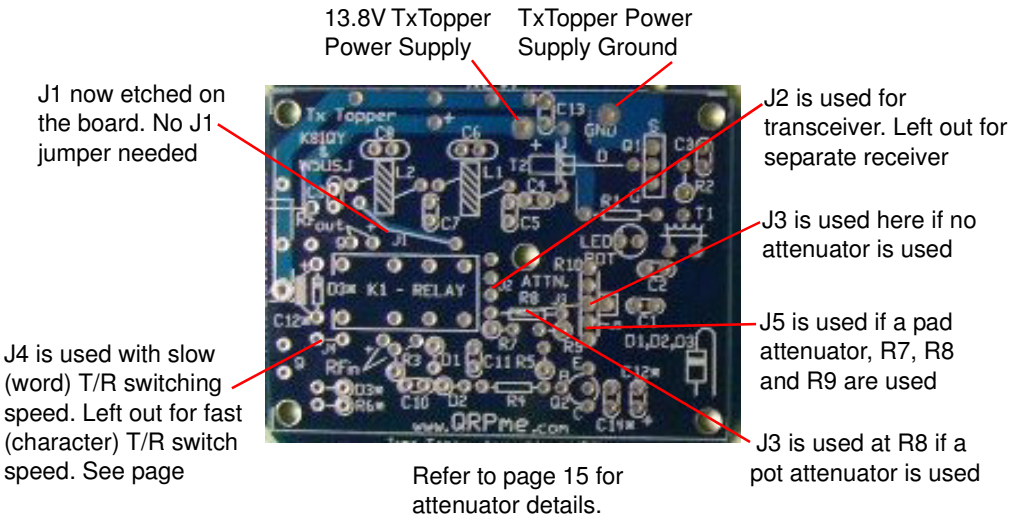


Figure 1. Jumper Identification

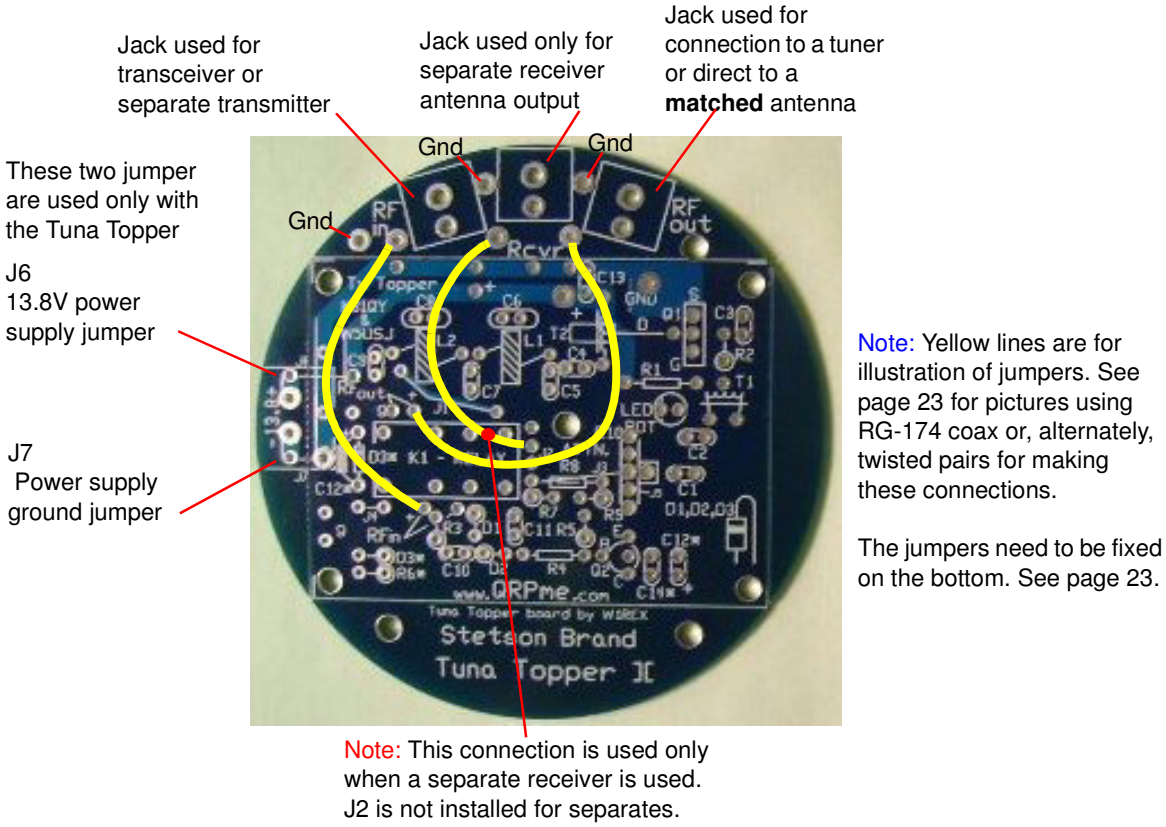
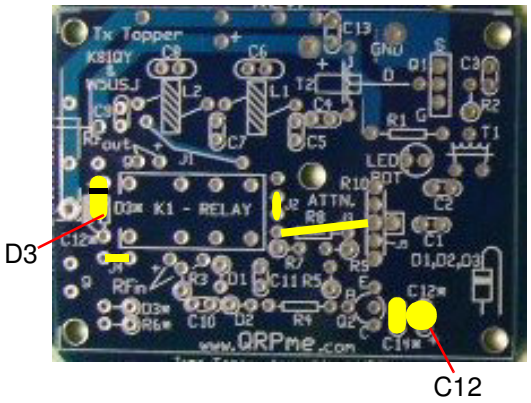
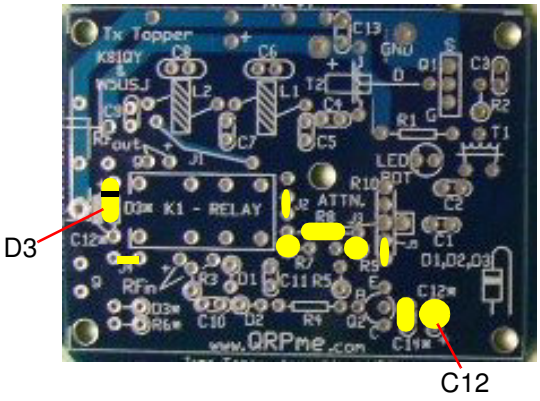


Figure 2. Tuna Topper Jumper & Antenna Connections

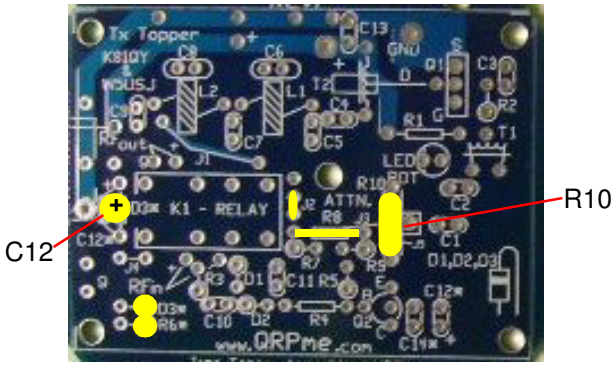
Transceiver, Slow T/R Switch, No Attenuator



Transceiver, Slow T/R Switch, Pad Attenuator



Transceiver, Fast T/R Switch, Pot Attenuator



Separate Tx/Rx, Fast T/R Switch, Pot Attenuator

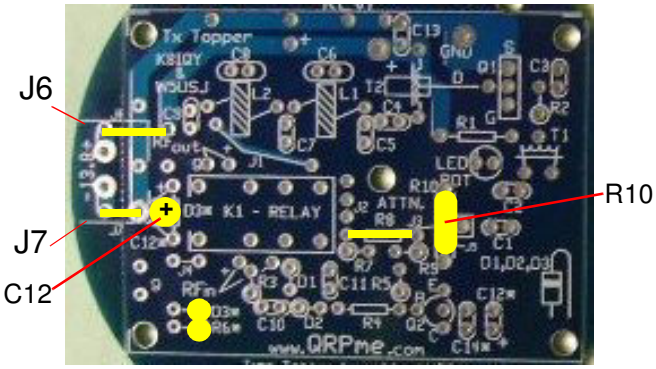


Figure 3. Tx/Tuna Topper Jumpers – T/R Switch Speed Options

Note: Jumper 1 and Jumper 5 are now etched on the PCB – no wired jumper is needed. The hole pads are left in place for possible future use.

Tx/Tuna Topper

QRPme.com Kits "blue board" Tx/Tuna Topper is a second generation version of the TxTopper and Tuna Topper 5 Watt QRP amplifier. Features of the new blue board amplifier include:

- Two-sided FR-4 PCB with plated through holes
- Silk screen showing all part locations and IDs
- Blue solder mask both sides to facilitate soldering
- T/R switch for separate receiver modified on board
- Jumpers rearranged and renumbered for clarity
- Scored lines for TxTopper separation from the round board

Background

Texas Topper QRP 5Watt amplifier was created to fill a need. At the time there were no longer any kits available. The NB6M Mini Boots amplifier was gone but there was still a lot of interest. Wayne's work was the inspiration for the W5USJ amplifier that first became the TxTopper. The figure below is one of the first TxToppers (shown for clarity without the required heatsink).

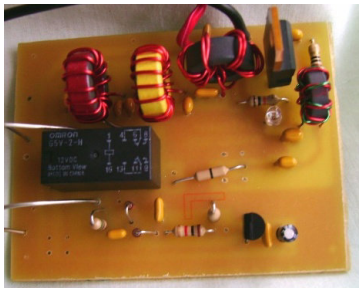
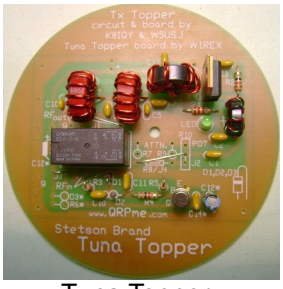


Figure 4. The Original TxTopper and Homebrew PCB

To share the development of the TxTopper, a webpage was created. This was a help but not everyone wanted to scrounge for parts. Discussions with Rex at QRPme.com led to the creation of a kit — the original Tx/Tuna Topper. The kit featured a round board for the tuna tins with the TxTopper rectangle inside. Featured in the remainder of this manual is the 2nd generation of the popular Tx/Tuna Topper.



Tuna Topper

TxTopper

The current version is known as the Tx/Tuna Topper "blue board". The contents of this manual will facilitate assembly using the builder's choice of configurations. Have fun...

Parts Inventory

Before starting the assembly, inventory the parts and verify that you have the parts described in the following list of materials (LoM).

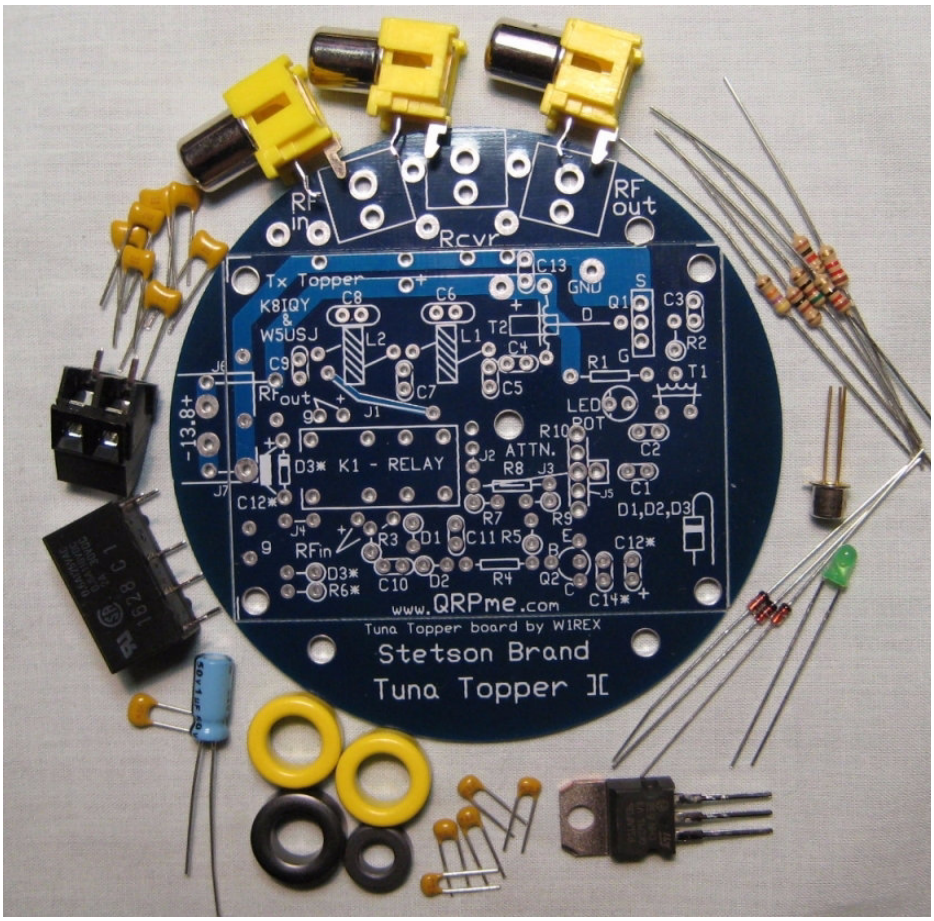


Figure 5. Tx/Tuna Topper Components. Tuna Topper Shown

Components are shown for a 20 meter filter along with the 2-terminal power connector and three RCA jacks for transceiver or separate transmitter / receiver and antenna interconnection. For the TxTopper version the "wings" are sheared or snapped off. Also the power connector and RCA jacks are not included. The required heatsink is not shown in the photo.

Note: Some supplied parts may vary from those shown in the pictures but will work the same.

NOTE: The FET is sensitive to static discharge. Be sure to drain static from your body by touching a ground before handling the FET. Use of a grounded soldering iron is recommended.

List of Material

#	ID	Description
Capacitors		
1	C1 – 4, C11, 13, 14	0.1uF, 104 Ceramic
2	C5, 6, 7, 8, 9	See Filters
3	C10	0.01uF, 103 Ceramic
4	C12	2.2uF Electrolytic
Resistors 5%		
5	R1	1.2k Ω Brn Red Red
6	R2	12 Ω Brn Red Blk
7	R3	51 Ω Grn Brn Blk
8	R4	1k Ω Brn Blk Red
9	R5	47k Ω Yel Vio Orn
10	R6	100 Ω Brn Blk Blk
Note: See page15 for attenuator details		
11	R7, R8, R9 (Pad)	Optional A/R
12	R10	Optional 500 Ω Pot
Semi-Conductors		
13	LED	Grn, FET bias ~2.1V
14	D1, D2, D3	1N914 / 1N4148 Diode
15	Q1	Power FET
16	Q2	2N2222A NPN Transistor
Toroids		
Note: See page 13 for toroid winding details		
17	T1	FT37-43
18	T2	FT50-43
19	L1, L2	T50-2, Red-80, 40, 30m
20	L1,L2	T50-6, Yel-20m
21	K1	DPDT Relay, 12V
22	RCA Jacks (3)	Tuna Topper only
23	2-term Power Jack	Tuna Topper only
24	Magnet Wire	40 inches #22 20 inches #28

Filters (AllCaps = Kemet C0G 5% 200V)		
160 Meters		Value, Body Marking
25	C5, C9	1000pF, 102
26	C6	150pF, 151
27	C7	2000pF, 202
28	C8	560 pF, 561
L1, L2 – 3.3 uH 26t #22 T50-2		
80 Meters		
29	C5, C9	560pF, *561*
30	C6	100pF, 101
31	C7	1200pF, 122
32	C8	220pF, 221
L1, L2 – 2.2uH 21t #22 T50-2		
40 Meters		
33	C5, C9	330pF, 331
34	C6	47pF, 470
35	C7	680pF, 681
36	C8	150pF, 151
L1, 1.2uH 15t #22 L2, 0.85uH 13t #22 T50-2		
30 Meters		
37	C5, C9	220pF, 221
38	C6	47pF, 470
39	C7	470pF, 471
40	C8	82pF, 820
L1, 1.0uH 14t #22 L2, 0.75uH 12t #22 T50-2		
20 Meters		
41	C5, C9	220pF, 221
42	C6	27pF, 270
43	C7	470pF, 471
44	C8	68pF, 680
L1, 0.525uH 11t #22 L2, 0.475uH 10t #22 T50-6		
Other		
45	Tuna Topper PCB	Tx Topper PCB (Rect)
46	Heat Sink	6-32 x 1/4 bolt and nut
47	Tuna Tin & Labels	1 set – Tuna Topper only

LoM Continued

48	Band Module PCB	Mod. Contact Rex
49	2 x 7 Rt Angle Hdr	Square pin Male
50	2 x 7 Hdr Socket	Square pin Female
51	#22 bare wire	Hookup

52	#22 Insulated Wire	Hookup
53	#14 Black and Red	Power Hookup
54	RG-174 Coax	or equivalent
55	Solder	A/R

Installing the Jumpers

Page 5 shows the jumper options. Figure 6 below shows the most common configuration: separate TX/RX and slow T/R switching speed. The yellow wire is used here for emphasis. The power connections should be 20 gauge. Leads from clipped components can be used for the other jumpers.

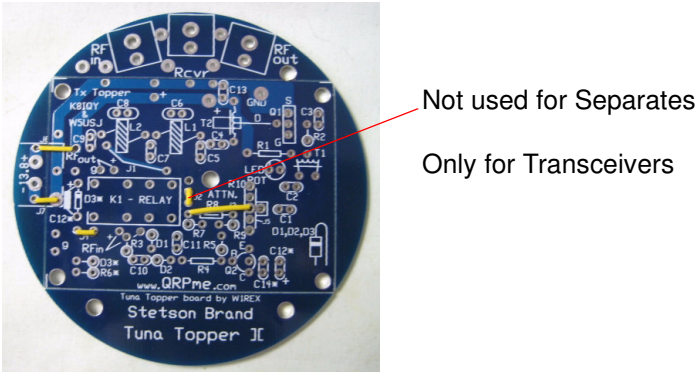


Figure 6. Most Common Jumper Configuration

Tuna Topper - round board, Jumper 6 (J6) and Jumper 7 (J7) are always required. Jumper 2 (J2) is not required.

Tx Topper - Jumper 6 and Jumper 7 are not used with the rectangular board.

Note that Jumper 1 (J1) and Jumper 5 (J5) are etched on the PCB.

Additional jumper combinations and options are shown on page 5.

Refer to page 23 for Tuna Topper RFin, RFout and separate receiver connections made during the final assembly steps.

Assembling the Parts

Generally, it's a good approach to install the short parts first. Then work up and out to the larger parts. It's also helpful to wind the coils and transformers first. That way you don't have to stop in the middle of the assembly process and loose your train of thought. If you'd like to do the transformers and coils first, skip to those sections then come back here.

Note: The FET and heatsink are installed last.

Choosing T/R Switch Speed

The T/R switch relay can be set for slow or fast switching speed.

Slow T/R Speed: The T/R relay switches (pulls in, drops out) between words at keying speeds to about 15wpm (semi QSK).

Note: Increasing the value of C12 will slow the T/R speed, decreasing the value with increase the speed. A value of 1uF is minimum for C12.

Fast T/R Speed: The T/R relay switches (pulls in, drops out) between characters at keying speeds to about 15wpm. Fast speed is comparable to semi-breakin (QSK).

Some T/R switch components are installed differently for slow or fast switching speed. These parts, R6, C12, C14 and D3 are marked with the asterisk character *. (R6 is used only with the fast mode)

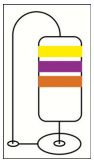
Refer back to page 6 for reference drawings showing component locations for the T/R switch speed options.

Once you have decided on the T/R switch speed you want, continue on with the parts assembly as directed in the following sections.

Capacitors

- Install capacitors C1 through C4, C11, C13 and C14 – 0.1uF
- Install capacitor C10 – 0.01uF
- Install capacitor C12 in the *marked location for the chosen speed.
- Solder and trim the leads.

Resistors



- Install resistors R1 through R5.
- Install R6 in the *marked location if you chose fast T/R switching.
- Resistors R7, R8 and R9 are optional for use with a pad attenuator.

Refer to the *Attenuator* section, page 15, for more information.

- Solder and trim the leads except for R1. One of these leads will be used for the *LED Test* step below.

LED and Testing

Note: This is a very important step. The LED supplies bias voltage for the FET. It must light when power is applied to prevent FET damage.

- Install the green LED in the marked location. Observe polarity. The flat side or short lead goes in the hole next to the LED ID mark (ground).

  You may find it useful to space the LED up a little from the board. A tooth pick works nicely as a spacer.

- Solder but do not trim the leads. The short (ground) LED lead connection will be used during the following *LED Test*.

LED Test

Do this test to ensure that the LED will light when power is applied for the final test. The FET can be damaged if the LED doesn't light when power is applied.

- Except for the two leads shown if Figure 7 below, trim off the other remaining leads.

Make a temporary connection with a 12V power source, e.g., a small battery. Connect + 12V to the end of R1 at the point shown in Figure 7. Connect -12V (ground) to the LED ground lead as shown in Figure 7.

The two leads are not soldered in the picture taken as a reference illustration.

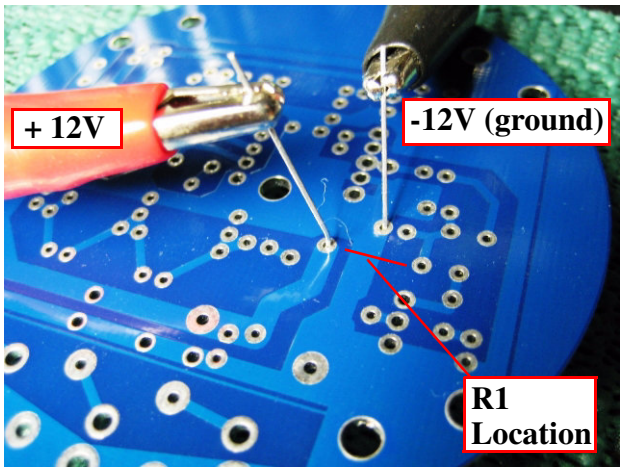
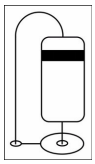


Figure 7. LED Test Power Connections

Verify that the LED is lit. Before continuing, correct any problem that prevents the LED from lighting. When finished with this step, clip off the leads.

Diodes



Install diodes D1, D2 in the marked locations. Use hairpin lead bending as illustrated on the board. Note the band end. The circle on the board indicates the position of the part body. The lead end goes in the adjacent hole.

For the slow speed option, D3 is mounted horizontal in the location shown at the end of K1.

K1 Relay

Install the K1 relay in the marked position and solder the leads.

Low Pass Filter Capacitors

Install the lowpass filter capacitors C5, C6, C7, C8 and C9 for the band selected. To ensure proper operation with possible RF voltages and currents, capacitors are Kemet 200V 5% mono ceramics, e.g.,
Mouser part number series 80-C3xxC"value"J2G C0G.

160 meters
C5-1000pF, C6-150pF, C7-2000pf, C8-560pF, C9-1000pF

80 meters
C5-680pF, C6-100pF, C7-1200pf, C8-220pF, C9-680pF

40 meters
C5-330pF, C6-47pF, C7-680pf, C8-150pF, C9-330pF

30 meters
C5-220pF, C6-47pF, C7-470pf, C8-82pF, C9-220pF

20 meters
C5-220pF, C6-27pF, C7-470pf, C8-68pF, C9-220pF

Note: Verify that the correct capacitor is installed in each location before soldering.

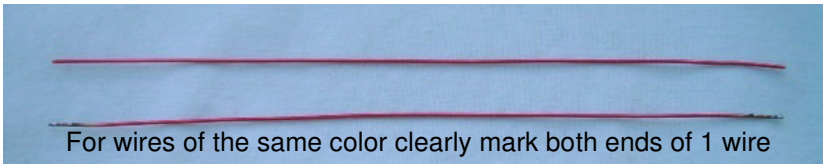
Note: A table showing the capacitors and inductor winding details is included in the *Appendix* section of this guide.

Toroids used for transformers and inductors in the next section

FT37-43 FT50-43 T50-2 T50-6

Winding T1 and T2 Toroids

Input transformer T1, 8 bifilar turns and T2, 6 bifilar turns are wound the same way. The differences are core and wire size and the number of turns. The wire used can be one color or two colors.

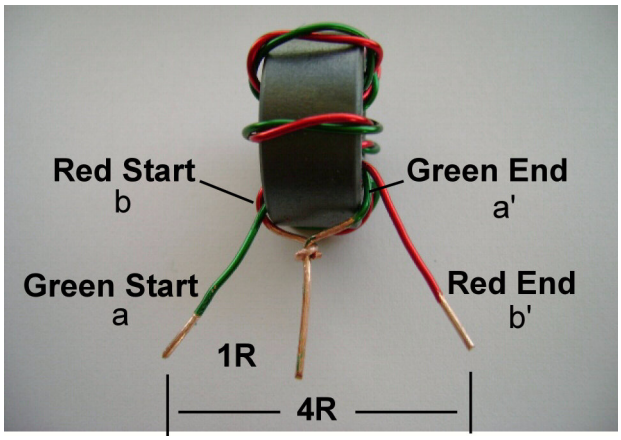


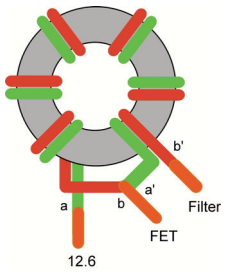
Cut 2, 6 inch lengths of wire: #22 for T2 -- #26 for T1

Twist the wires together: about 2 to 3 turns per inch

Wind T2 as shown in the drawing below with 6 bifilar turns of 22 gauge wire wound on a T50-43 toroid. T2 is connected for impedance step up, 1:4.

Another view of T1/T2 with one wire color.





Bifilar transformer connections

Figure 8. Bifilar T1 & T2 Transformer Winding

Input transformer T1 is similar but has 8 bifilar turns of #26 on a T37-43 core.

Leads formed ready for installation.

Input transformer T1 is connected for impedance step down, 4:1. Refer to the schematic on Appendix page 22 for additional information.

After winding the transformer strip the center tap wires. Connect and solder as shown. Strip the insulation on the other two leads to within about 1/8 inch of the core. Form the leads as shown.

Winding L1 and L2

Coils L1 and L2 for the output filter are wound on T50 toroids using #22 wire. The toroids used and the windings required for each band, 80, 40, 30 and 20, are listed below.

160 meters
L1 and L2 — 3.3uH, 26t #22 on a T50-2 (red) core

80 meters
L1 and L2 — 2.2uH, 21t #22 on a T50-2 (red) core

40 meters
L1 — 1.2uH, 15t #22 on a T50-2 (red) core
L2 — 0.85uH, 13t #22 on a T50-2 (red) core

30 meters
L1 — 1.0uH, 14t #22 on a T50-2 (red) core
L2 — 0.75uH, 12t #22 on a T50-2 (red) core

20 meters
L1 — 0.525uH, 11t #22 on a T50-6 (yel) core
L2 — 0.475uH, 10t #22 on a T50-6 (yel) core

Wind the turns evenly distributed around the core. Strip the insulation to within about 1/8 inch of the core. Form the leads as shown in the picture below for installing on the PCB.

Figure 9. Filter Toroid Winding

Orientation

Preferred orientation of T1, T2, L1 and L2 is shown on page 6. Forming the leads as shown above will facilitate this orientation. It's not critical but will provide a neat final assembly.

Install T1, T2, L1, L2

Install T1 and T2 in the marked locations, solder and trim the leads.

Install L1 and L2 in the marked locations, solder and trim the leads.

Attenuators – Pad and Pot

Note: Pad and pot attenuators are optional.

If the RF drive source needs to be reduced, either a fixed pad (Pi) attenuator or adjustable pot attenuator can be installed in the marked locations provided on the PCB.

When no attenuator is used, Jumper 3 is installed between K1 and C1.

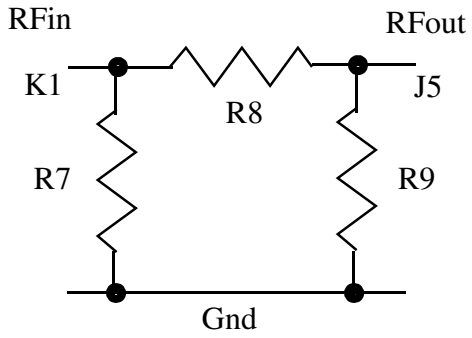


Figure 10. Resistive Pad (Pi) Attenuator

Pad Attenuator Resistor Values

Resistor values used for various attenuation levels are shown in the following list. The resistor values in Ohms are closest 5% values needed to provide the approximate attenuation listed. The pad power rating is 1Watt maximum.

dB	R7	R8	R9
0	Install jumpers		
1	910	5.6	910
2	470	12	470
3	300	18	300

When the pad attenuator is used, install Jumper 5 between R9 and C1.

Pot Attenuator

Alternate pot attenuator R10 is installed when variable adjustment of RF drive level is preferred.

If the variable pot attenuator is used, install Jumper 3 at the R8 location.

Final Assembly

The two transistors arre installed at locations Q1 and Q2. Power leads ae installed at the locations show as follows:

TxTopper: Refer to page 4, Figure 1.
Tuna Topper: Refer to page 4, Figure 2

Install Tansistors

Install FET Q1. Note the G, D and S markings on the PCB. Install Q2 designated xx2222. As supplied, use either the in-line holes for the PN2222 and the tripod holes for the 2N2222. Note the E, B and C markings on the board. Solder and trim the leads.

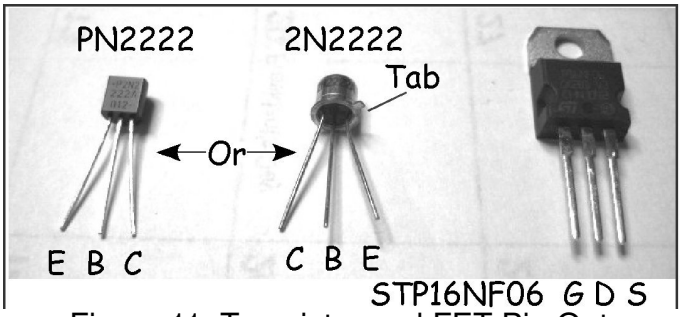


Figure 11. Transistor and FET Pin Out

Attach Power Leads

Voltage drop in wiring connected to the TxTopper amp can be significant.

Note: With 13.8 V and 5 W+ Po, a 40m Topper draws about 900 mA.

For example, measurements from the development test setup:
- starting with 13.8V at the power supply,
- through a 2 foot length 10 gauge wire with Anderson power poles,
- connected to a 4 inch jumper of 14 gauge at a switch box,
- and a 6 inch jumper of 20 gauge to the TxTopper amp,
- the voltage on the board with only 4 Watts output was 13.4V

Increasing the supply voltage to 13.8 on the board boosted the output power to 4.5 Watts.

To minimize voltage drop, use at least 16 gauge wire from the PCB to an intermediate power connection. Then at least 14 gauge wire to the power supply. Keep the wire lengths as short as possible.

Tuna Topper: Connect power wire to the 2-terminal clamp connector. Tin the wire ends for best results and snug the screws down securely.

TxTopper: Connect power wires to the + (red) and – (black) pads at the top edge of the PCB. Solder and trim the lead ends.

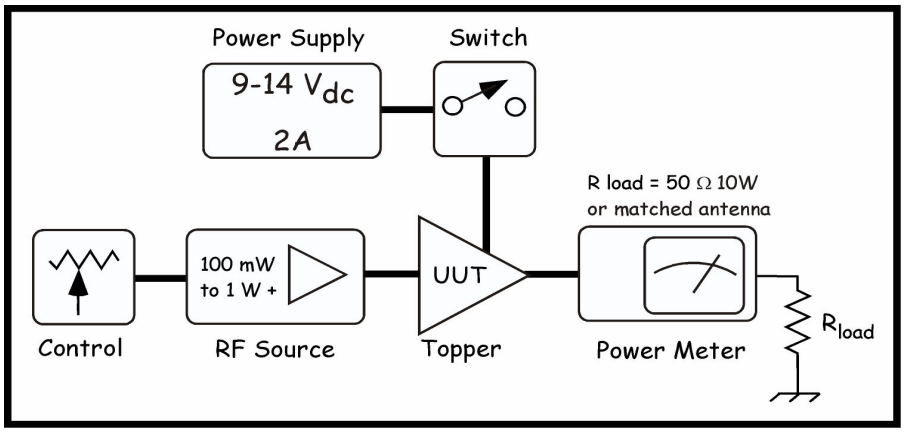


Figure 12. Topper Test Setup — UUT = Topper Amp

Testing and Operation

Before making connections to your power supply make the following pre-operational checks.

- Verify that all parts are installed correctly
- Verify all solder connections
- Inspect all soldering for whiskers, bridges and potential shorts
- Measure the resistance between the power lead connections resistance, after capacitors charge,should be greater than 100 k Ohms

Note: Bench testing the Topper before fitting it into an enclosure is strongly recommended.

Connect the Topper to your power supply capable of up to 14 Vdc and up to 2 amps of current. A switch to control the power to the Topper is recommended. Connect the RF source capable of delivering about 1 Watt or more of RF and at least 250 mW minimum. The RF source frequency must be the same as the band for which the Topper was built.

Connect a power meter to the Topper and a dummy load that will handle at least 10 Watts to the power meter.

Note: Careful! even 5 Watts dissipated in a 10 Watt rated dummy load will get very hot!

Alternately, connect the dummy load to the Toppere and use a peak detector to measure power.

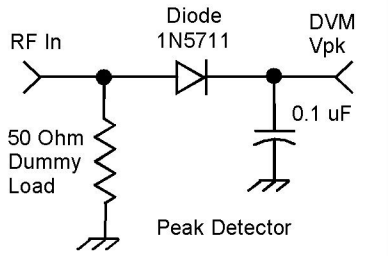


Figure 13. Peak Detector Circuit

Equation for calculating power using a peak detector

$$Po = ((Vdc \times 0.707 + Vd)^2)/R$$

Where: Po = power output in Watts
Vdc = peak voltage measured with a DVM (also noted as Vpk)
Vd = diode voltage drop, e.g., silicon 0.7 V, Schottky 0.5 V and germanium 0.3 V.
R = termination load resistance (dummy load) typically 50 Ohms.
Using a Vpk value of 10 Vdc and a Vd of 0.5, the equation above produces a Po of about 1.15 Watt.

Note: If you cannot adjust the RFsource drive level down as needed for the various bands, use an appropiate fixed attenuator at locations R7, R8 and R9. See attenuators on page 15. A 3dB attenuator will reduce power by 1/2. Alternately use a variable resistor at R10.

Apply power to the RF source and adjust the output to about 500 mW. In transceive mode you can measure the power through the Topper. In separarate mode you will need to measure before connecting to the Topper. When connected, switch on the Topper power. On 40 meters and with 13.8 Vdc applied to the topper key down at the PCB, you should measure about 5 Watts.

On 160, 80 and 40 meters a drive power level of about 500 mW or less will produce a power output of at least 5 Watts. Amplifier gain is less on 30 and 20 meters. More RF drive power is required on these bands. Possibly 750 mW on 30 meters and about 1 Watt on 20 meters

Turn off the amplifier power, disconnect equipment and prepare the amplifier for installation into an enclosure of your choice.

Once you have completed the installation, repeat the test described above.

Typical Amplifier Installation

The two basic configurations for Topper installation are shown in figures 14 and 15 below.

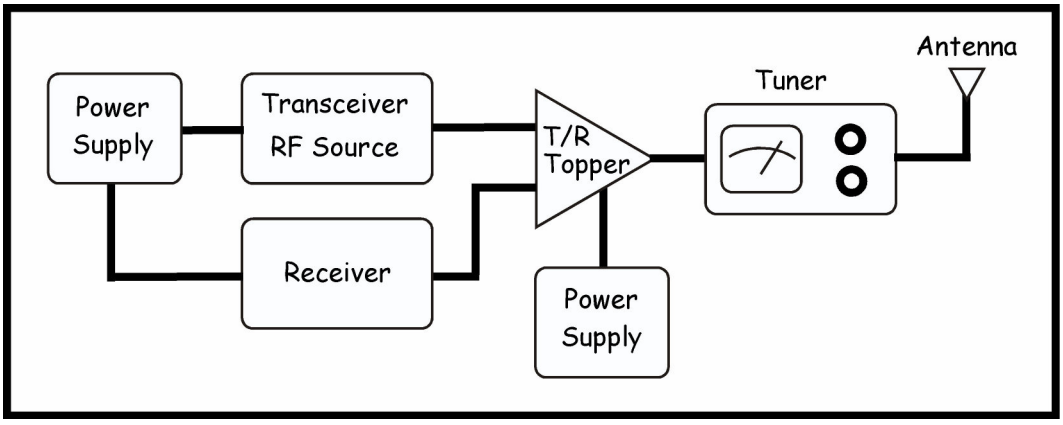


Figure 14. Separate RX and TX

Separates can include any QRP transmitter and a receiver of your choice. Examples are

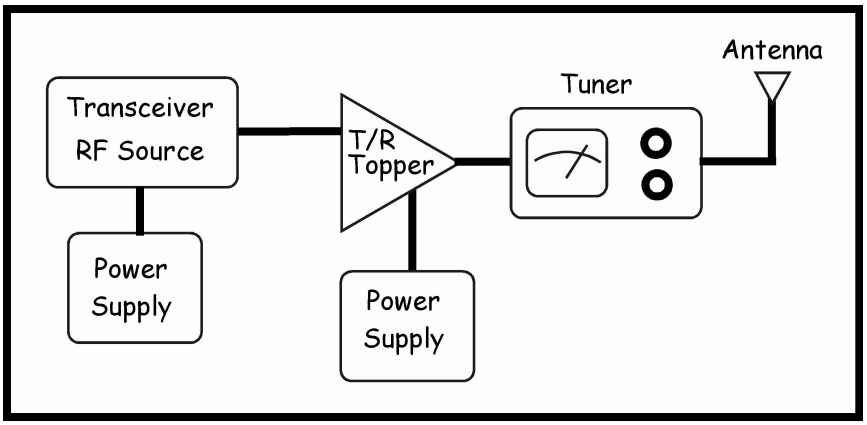


Figure 15. Transceiver

Note: See the *Appendix* for wiring of Toppers for connections to equipment.

Options for use are also included in the *Appendix*.

Notes

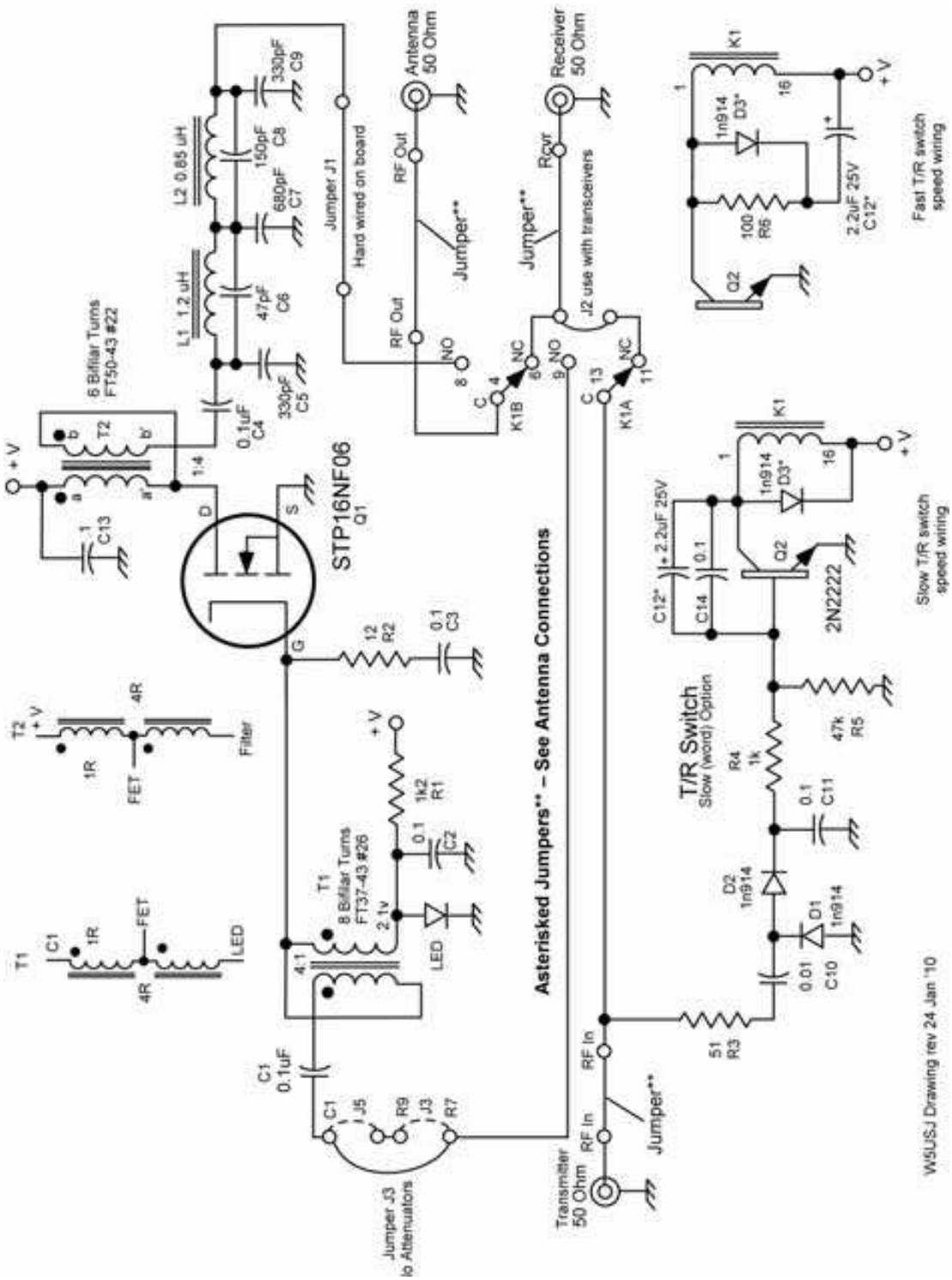
Appendix

Supplements to help build and operate the Tx/Tuna Topper Amp.

Table 1: Filter Component Matrix

Band	160	80	40	30	20
	Capacitors				
C5	1000 pF (102)	680 pF (681)	330 pF (331)	220 pF (221)	220 pF (221)
C6	150 pF (151)	100 pF (101)	47 pF (470)	47 pF (470)	27 pF (270)
C7	2000 pF (162)	1200 pF (122)	680 pF (681)	470 pF (471)	470 pF (470)
C8	560 pF (561)	220 pF (221)	150 pF (151)	82 pF (820)	68 pF (680)
C9	1000 pF (511)	680 pF (681)	330 pF (331)	220 pF (221)	220 pF (221)
	Transformers and Inductors				
T1	8 Bifilar Turns #26 Wire	8 Bifilar Turns #26 Wire	8 Bifilar Turns #26 Wire	8 Bifilar Turns #26 Wire	8 Bifilar Turns #26 Wire
T2	6 Bifilar Turns #22 Wire	6 Bifilar Turns #22 Wire	6 Bifilar Turns #22 Wire	6 Bifilar Turns #22 Wire	6 Bifilar Turns #22 Wire
L1	26 Turns #22 T50-2 (red)	21 Turns #22 T50-2 (red)	15 Turns #22 T50-2 (red)	14 Turns #22 T50-2 (red)	11 Turns #22 T50-6 (yel)
L2	26 Turns #22 T50-2 (red)	21 Turns #22 T50-2 (red)	13 Turns #22 T50-2 (red)	12 Turns #22 T50-2 (red)	10 Turns #22 T50-6 (yel)
See pages 13 and14 for transformer and inductor winding details					

Wire gauge #26 is the thinner wire
Wire gauge #22 is the thicker wire

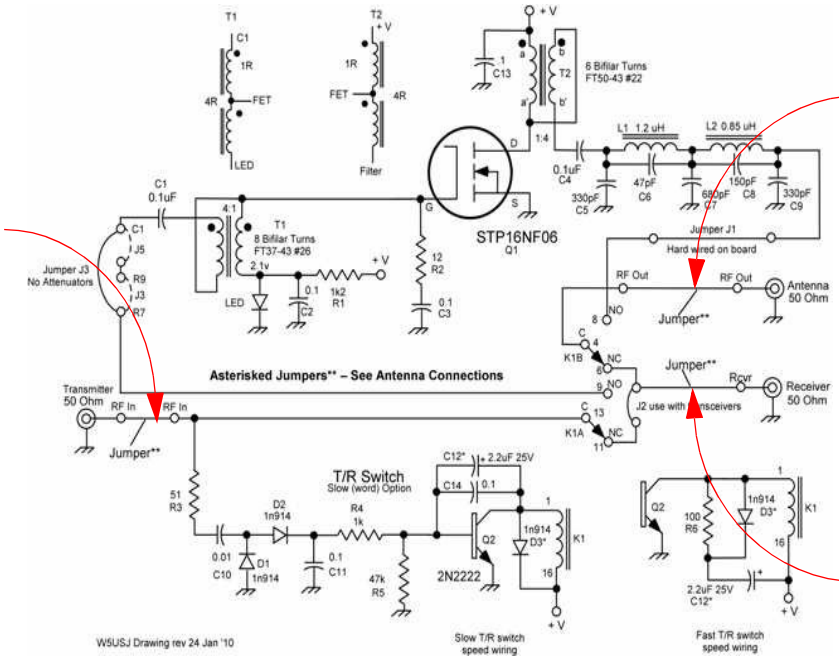


TX/Tuna Topper Schematic

Tuna Topper Alternate RF Connections

For use with separate TX and RX, wire the connections for the respective jacks as shown in the diagrams below.

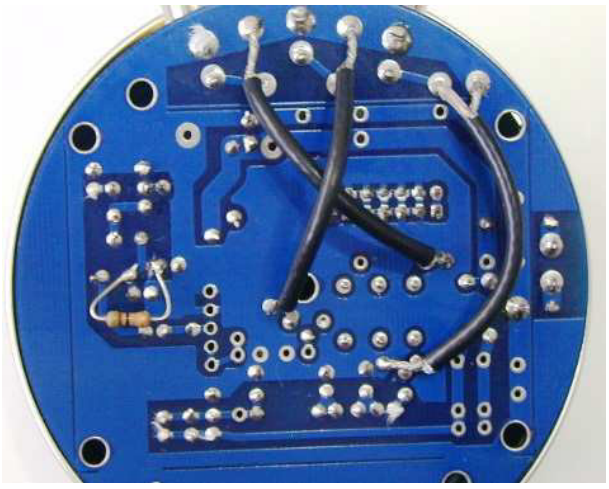
Connect this jumper from the RF in hole on the board to the RF in hole on the back "wing".



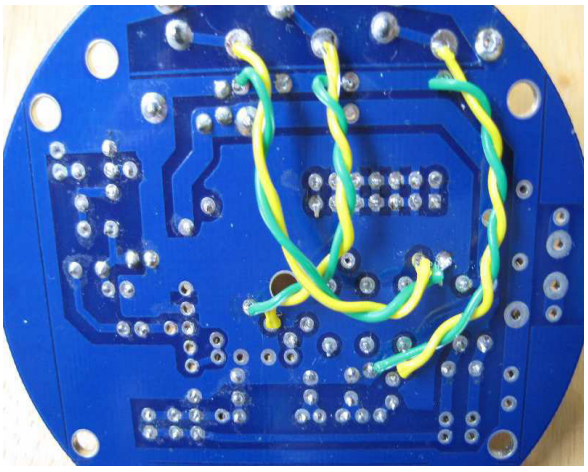
Connect this jumper from the RF Out hole on the board to the RF Out hole on the back "wing".

This jumper is only used for separate RX and TX. J2 is not used.

Alternate RF Wiring



Use of the RG-174 coax to make the interconnections for separate RX and TX. Photo and fine work done by Kozo JA1MTO



Use of twisted leads to make the interconnections for separate RX and TX.

For use with transceivers, the photo below shows one method of fitting the board into an aluminum enclosure. This Topper is a 40 meter version.

The enclosure is a BC-1 from QRPkits.com. Unfortunately this neat enclosure is no longer available. A comparable replacement is the LMB CR-422.