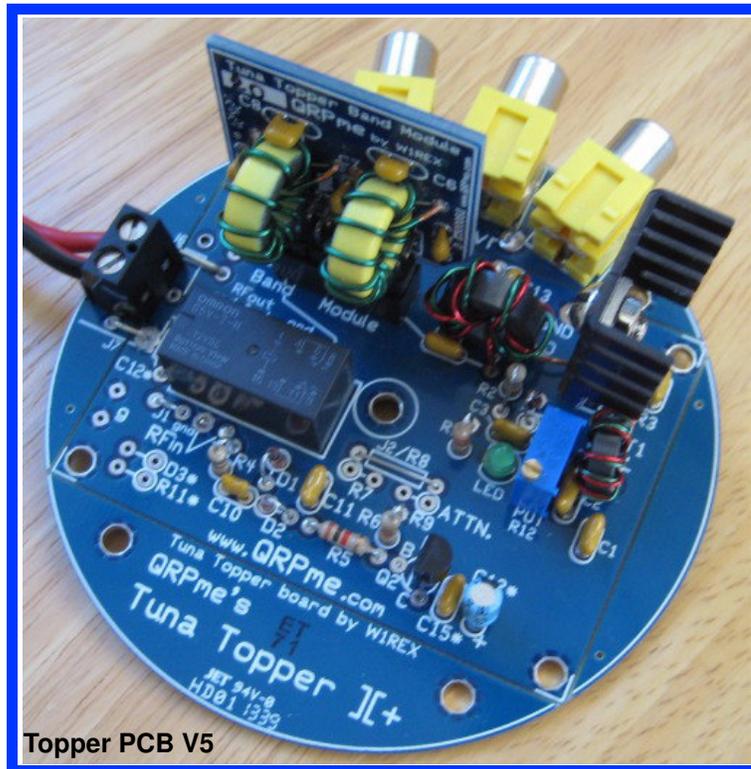


# QRPme.com Kits

Kits for the QRP and Electronics Hobbyist

## Tuna Topper ][+



## Assembly and Operation Guide

PCB V5 – 5 August 2016

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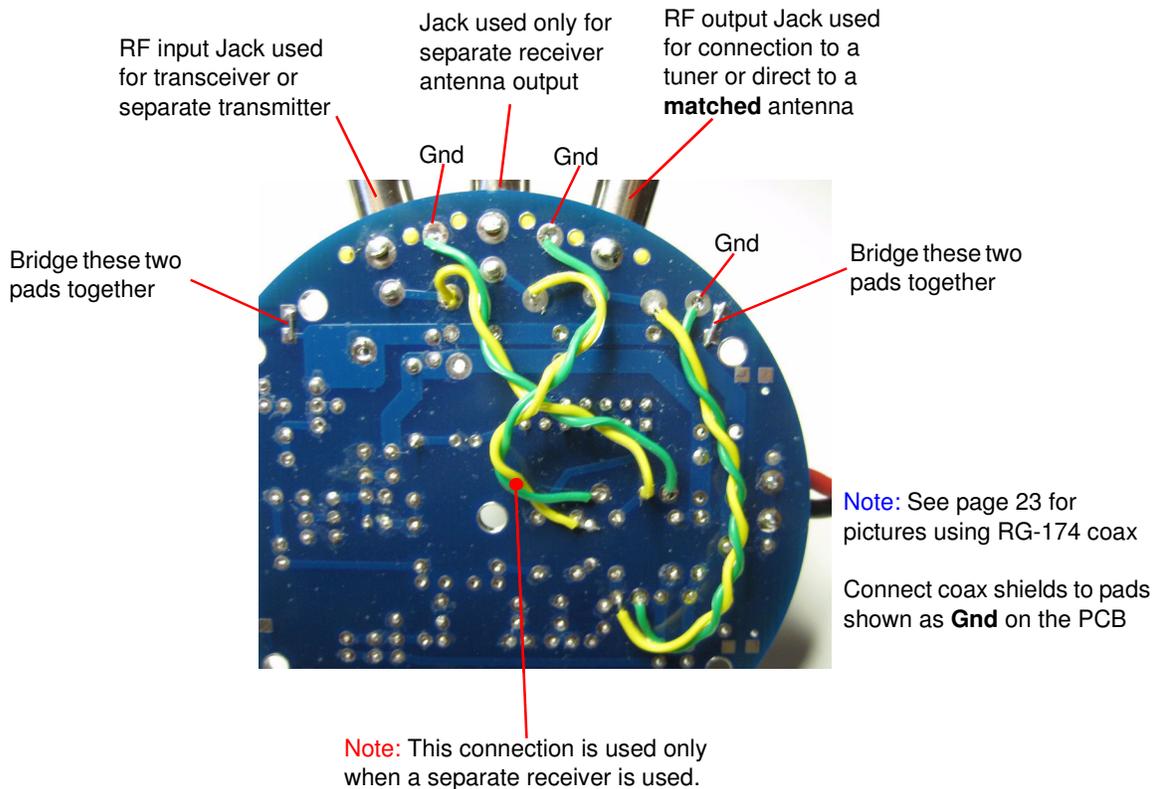
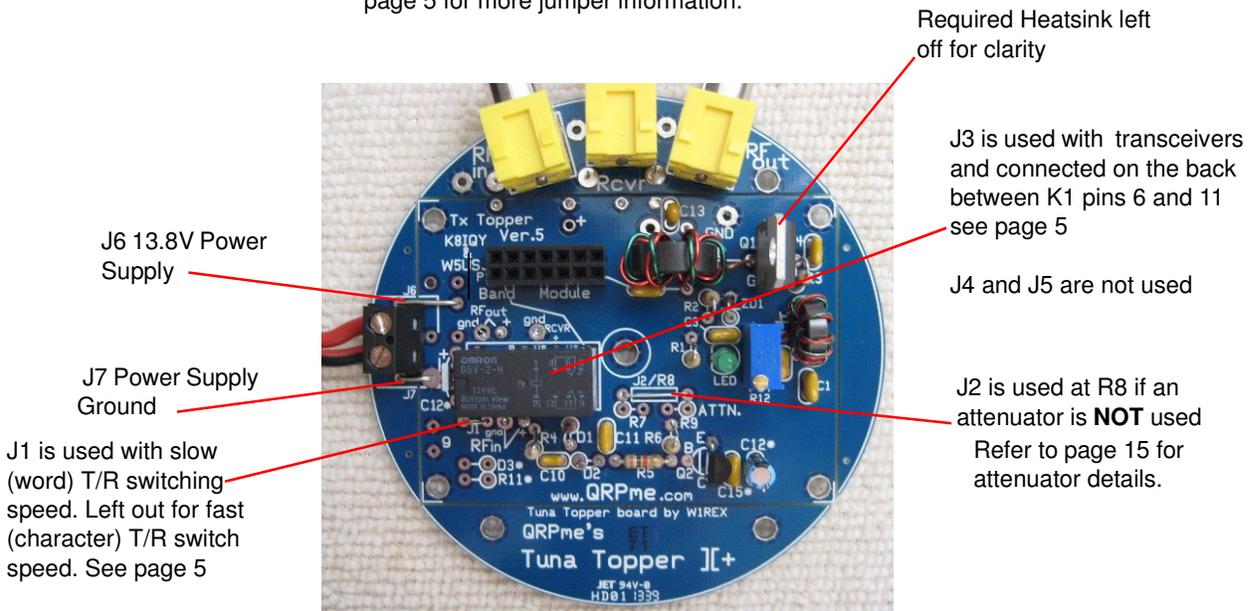
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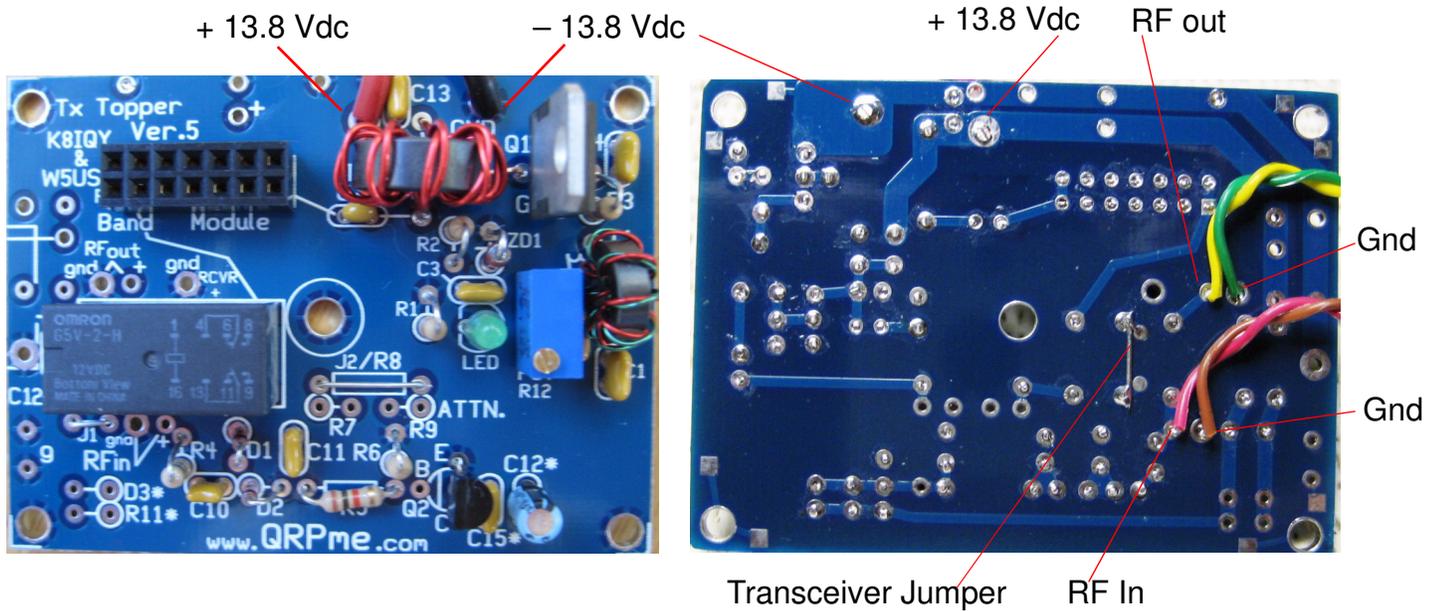
Manual written and illustrated by W5USJ  
CyM-TEC Documentation Services  
Original TxTopper developed and produced by W5USJ

# Jumpers

**Note:** Jumpers J1 through J2 are used the same for both Tuna and TxToppers. See page 5 for more jumper information.



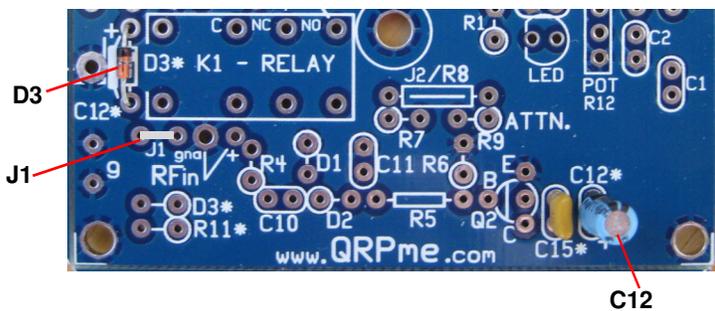
Tx Topper – PCB Wings Removed



Connections for *RF in* and *RF out* can be made easier from the bottom side

See page 23 for additional *RF in* and *RF out* connection options.

Slow T/R Switch



Fast T/R Switch

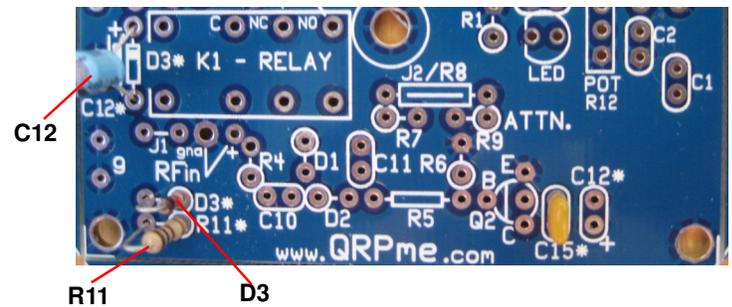


Figure 3. Tx/Tuna Topper Jumpers – T/R Switch Speed Options

## Tuna Topper

QRPme.com Kits "blue board" Tuna Topper ][+ is a third generation version of the Tuna Topper 5 Watt QRP amplifier. The Tx Topper is a Tuna Topper PCB with the "wings" removed. Features of the new version 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 connections on board
- Jumpers for options simplified
- V-grooved for TxTopper separation from the round board

## Background

Texas Topper, a 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 with the required heatsink removed).



<http://w5usj.com/TxTopperQRPamp.html>

Figure 4. The Original TxTopper and W5USJ 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 3rd generation of the popular Tuna Topper.



Tuna Topper



TxTopper

The current version is known as the Tuna Topper ][+. 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).

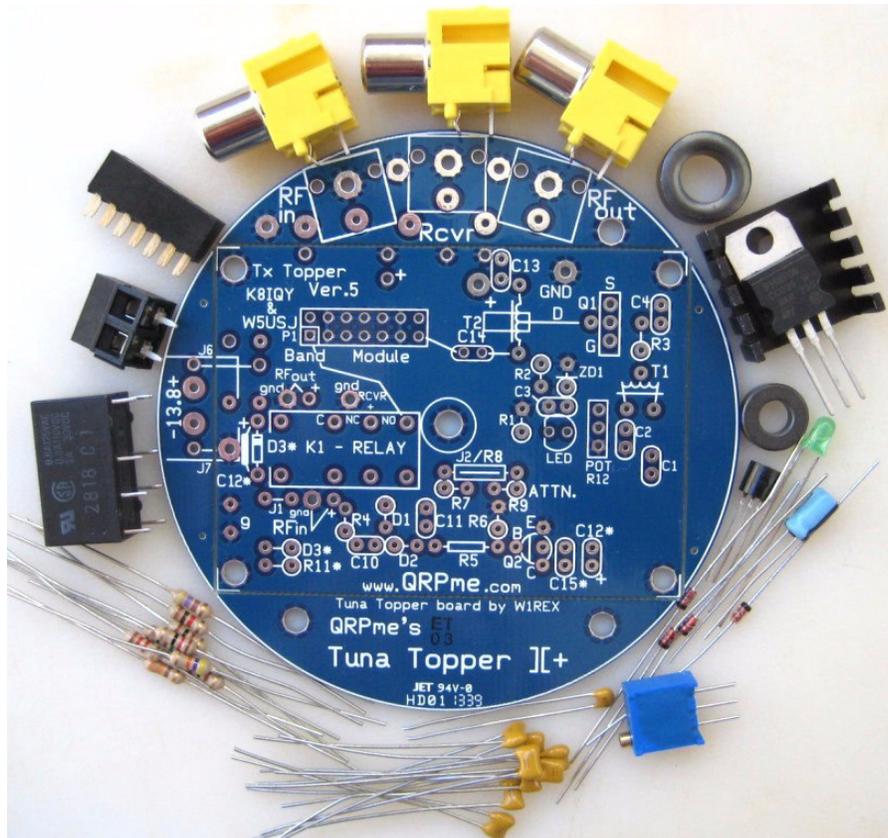
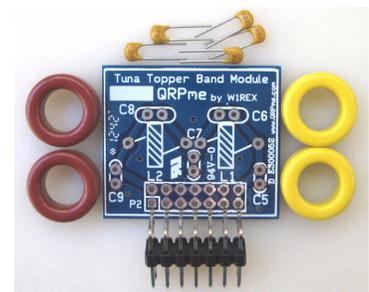


Figure 5. Tuna Topper Parts

Components shown with the 2-terminal power connector and three RCA jacks for separate transmitter / receiver and antenna inter-connection.

For the TxTopper ][ version the "wings" are sheared or snapped off. Also the 2-terminal power connector and RCA jacks are not included. Power wired direct to board.



**Band Module:** Module includes either Red or Yellow cores. Red for 160-30m and yellow for 20 m.

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

**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
<b>Capacitors</b>		
1	C1- 4, C11, 13-15	0.1uF, 104 Ceramic
2	C5, 6, 7, 8, 9	See Filters
3	C10	0.01uF, 103 Ceramic
4	C12	2.2uF Electrolytic
<b>Resistors 5% Gold Band</b>		
5	R1	1k $\Omega$ Brn Blk Red
6	R2	470 $\Omega$ Yel Vio Brn
7	R3	12 $\Omega$ Brn Red Blk
8	R4	51 $\Omega$ Grn Brn Blk
9	R5	1k $\Omega$ Brn Blk Red
10	R6	47k $\Omega$ Yel Vio Orn
	R11	100 $\Omega$ Brn Blk Bn
11	R12	5k $\Omega$ multi-turn pot
12	R7, R8, R9	Optional Attenuator A/R
<b>Semi-Conductors</b>		
13	LED	Grn, power on indicator
14	D1, D2, D3	1N914 / 1N4148 Diode
	ZD1	4.7 V Zener Diode
15	Q1	Power FET
16	Q2	PN2222 NPN Transistor
<b>Toroids</b>		
17	T1	FT37-43
18	T2	FT50-43
19	L1, L2	T50-2, 160, 80, 40, 30m
20	L1,L2	T50-6, Yel-20, 17m
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

**Note: Low Pass Filter Capacitors:**  
Capacitors are to be Kemet Golden Max MLCCs  
C5, C7, C9 - C0G, 5% 200 Vdc, C6, C8 50 Vdc

<b>Filters See Low Pass Filter Note</b>		
<b>160 Meters</b>		Value, Body Marking
25	C5, C9	1000pF, 102
26	C6	150pF, 151
27	C7	2000pF, 202
28	C8	560pF, 561
L1, L2 - 3.3 uH 26t #22 T50-2		
<b>80 Meters</b>		
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		
<b>40 Meters</b>		
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		
<b>30 Meters</b>		
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		
<b>20 Meters</b>		
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		
<b>Other</b>		
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	See Filters Pg. 12
49	2 x 7 Rt Angle Hdr	Square pin plug
50	2 x 7 Hdr Socket	Square pin receptacle
51	#22 bare wire	Hookup

52	#22 Insulated Wire	Hookup
53	#16 Black and Red	Power Hookup
54	RG-174 Coax	or equivalent
55	Solder	A/R — RS # 64-035 recommended

### Installing the Jumpers

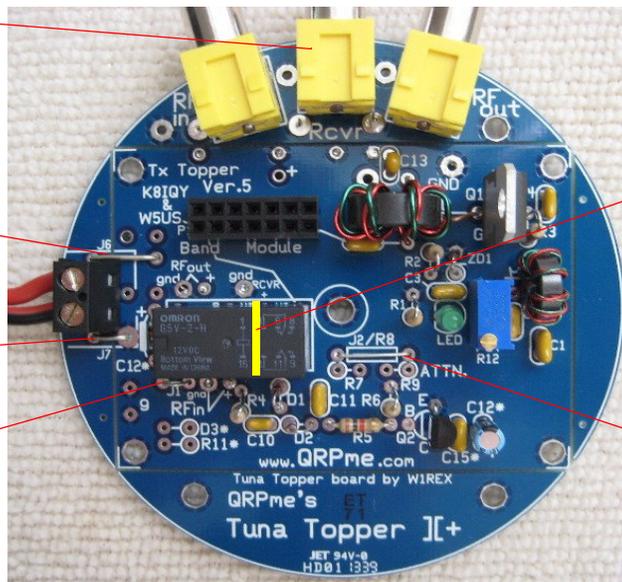
Page 5 shows the jumper options. Figure 6 below shows the most common configuration: separate TX/RX and slow T/R switching speed. The yellow wire is used here for emphasis. The power connections should be 20 gauge. Leads from clipped components can be used for the other jumpers.

The Rcvr (receiver) RCA jack is not needed with transceivers.

J6 Power Plus +

J7 Power Minus -

J1 is used for the slow relay switching speed (word)



J3 is used for transceivers and is connected on the bottom, K1 pins 6 and 11.

J4 and J5 Not Used

J2 is used when no attenuator is used, (R7, R8 and R9)

Figure 6. Most Common Jumper Configuration

**Tuna Topper** - round board, Jumper 6 (J6) and Jumper 7 (J7) are always required and 20 ga buss wire is recommended.

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

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 lose 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 will 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, R11, C12, C15 and D3 are marked with the asterisk character \*. (R11 is used only with the fast mode)

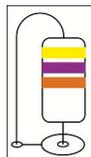
**Refer back to page 6 for reference drawings showing component locations for the T/R switch speed options.**

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

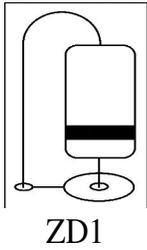
- Install capacitors C1 through C4, C11, C13 through C15 – 0.1uF
- Install capacitor C10 – 0.01uF
- Install capacitor C12 in the \*marked location for the chosen speed.
- Solder and trim the leads.

## Resistors



- Install resistors R1 through R6.
- Install R11 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.

## Gate Bias Adjustment



**Note:** This is a very important step *prior to installing Q1*. The gate bias voltage must be adjusted to prevent damage the FET, Q1.

- Install R1, R2, C3, LED and R12 the pot.
- Install ZD1, observe polarity. The band/body end is against the PCB.

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

- Hold R12 in place against the PCB, solder all parts and trim the leads.

Make a temporary connection with a 12V power source, e.g., a small battery. Connect + 12V to the pad shown in Figure 7. Connect -12V (ground) to any of the holes indicated or a corner hole shown in Figure 7.

Measure the voltage at the top end of R2. It should be about 4.7 Vdc.



Figure 7. Gate Bias Test Connections

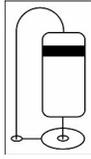
Adjust the R12, for 2.7 Vdc at the top end of C2 or the left hole where T1 is installed.

Before proceeding correct any problems that exist if the voltages are wrong or cannot be measured.

Disconnect the temporary test connections.

Note: The steps above performed the same for the TX Topper.

## 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

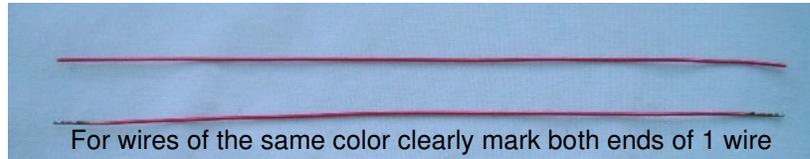
FT50-43

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

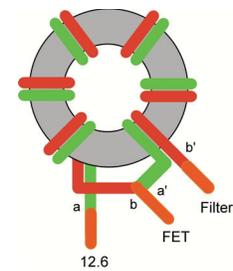
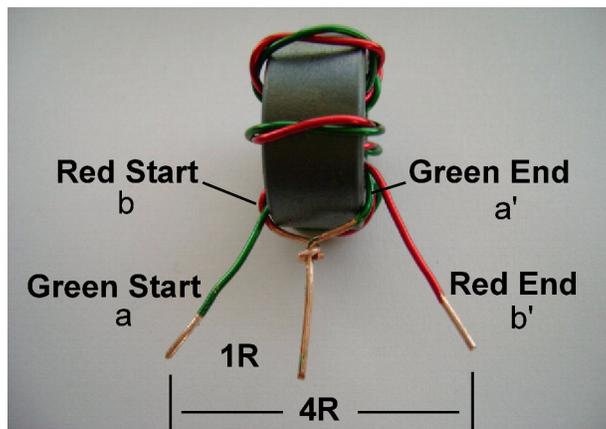


Twist the wires together: about 2 to 3 turns per inch

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.

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



Leads formed ready for installation.

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.

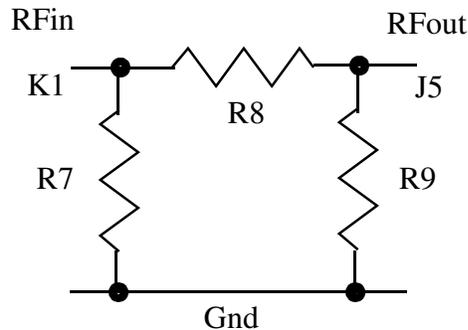


Figure 10. Resistive Pad (Pi) Attenuator

### 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 are installed at locations Q1 and Q2. Power leads are installed at the locations shown 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.

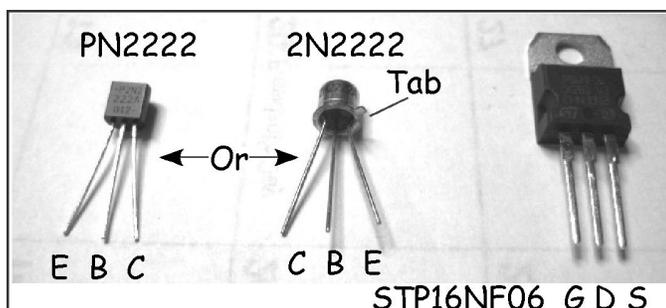


Figure 11. Transistor and FET Pin Out

## 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.

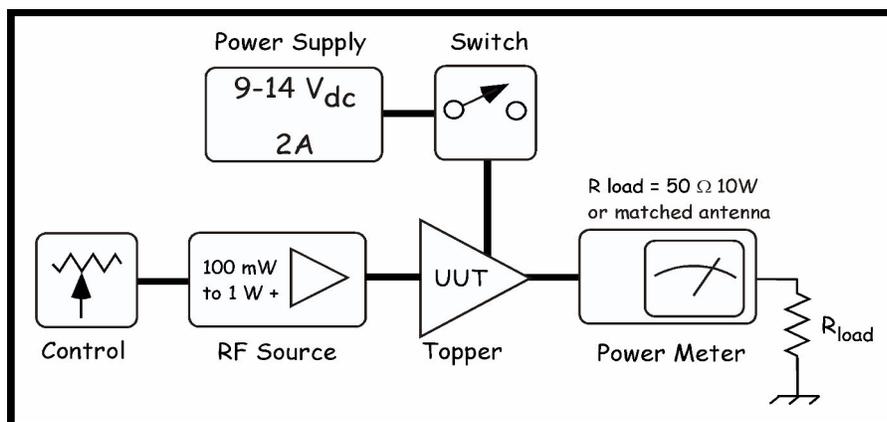


Figure 12. Topper Test Setup — UUT = Topper Amp

## 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 should be greater than

**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 Topper and use a peak detector to measure power.

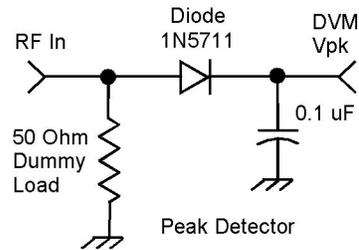


Figure 13. Peak Detector Circuit

Equation for calculating power using a peak detector

$$P_o = ((V_{dc} \times 0.707 + V_d)^2) / R$$

Where:  $P_o$  = power output in Watts

$V_{dc}$  = peak voltage measured with a DVM (also noted as  $V_{pk}$ )

$V_d$  = 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  $V_{pk}$  value of 10 Vdc and a  $V_d$  of 0.5, the equation above produces a  $P_o$  of about 1.15 Watt.

Note: If you cannot adjust the RF source drive level down as needed for the various bands, use an appropriate 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 separate mode you will need to measure before connecting to the Topper. In transceiver mode you can measure the power through 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.

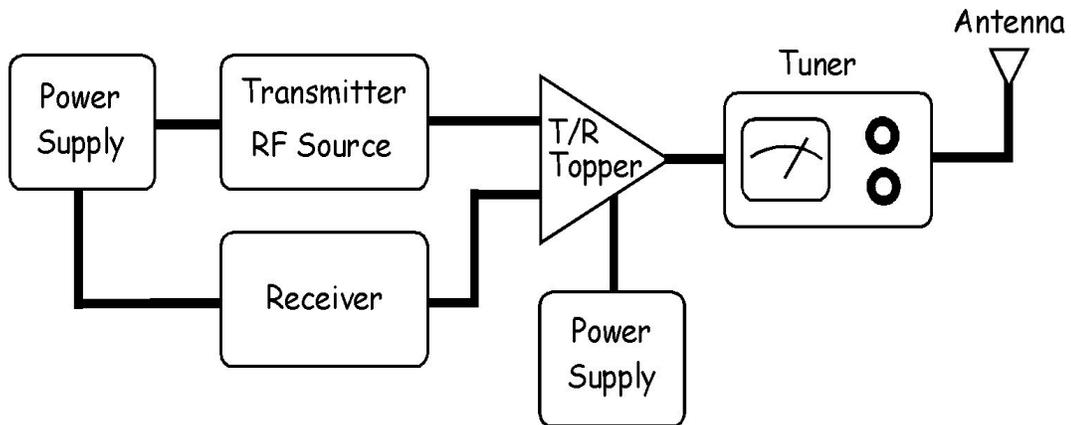


Figure 14. Separate RX and TX

Separates can include any QRP transmitter and a receiver of your choice. An example is the Sudden Receiver and any of the Tuna Tin ][s.

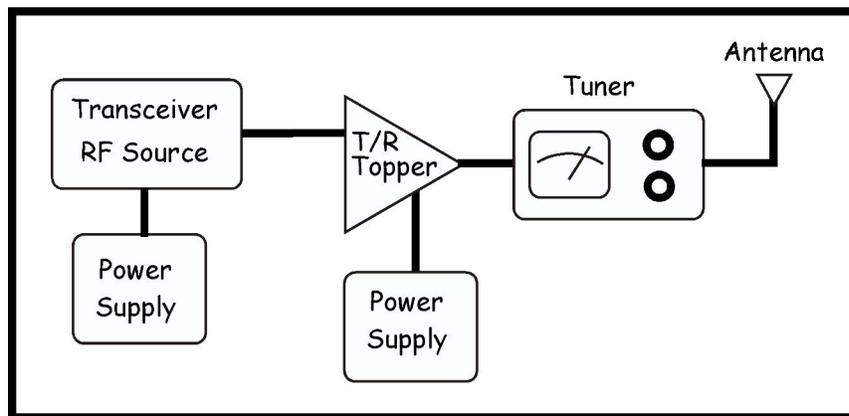


Figure 15. Transceiver

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

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



## Appendix

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

**Table 1: Filter Component Matrix (see Note)**

Band	160	80	40	30	20
	<b>Capacitors</b>				
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 (202)	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 (102)	680 pF (681)	330 pF (331)	220 pF (221)	220 pF (221)
	<b>Transformers and Inductors</b>				
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 and 14 for transformer and inductor winding details					

Wire gauge #26 is the thinner wire

Wire gauge #22 is the thicker wire

**Note: Low Pass Filter Capacitors:**

Capacitors are to be Kemet Golden Max MLCCs

C5, C7, C9 - C0G, 5% 200 Vdc or better

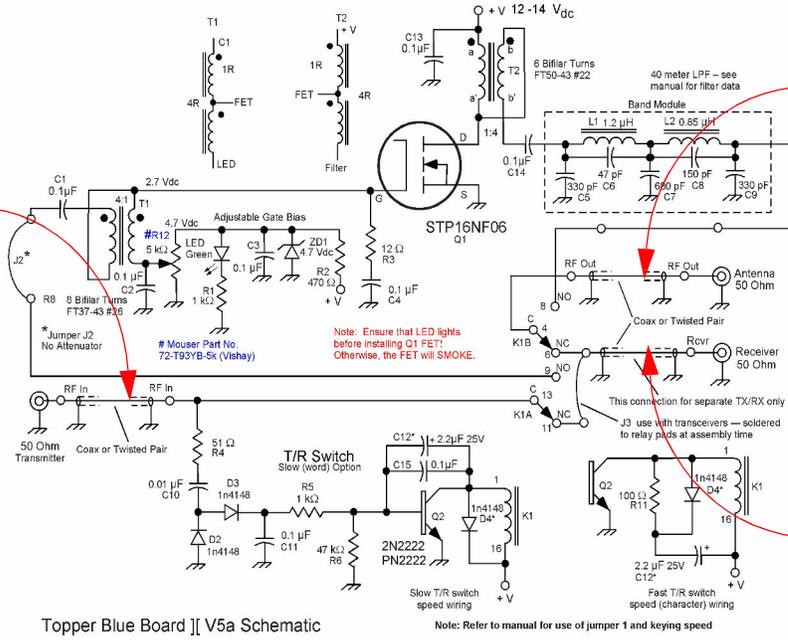
C6, C8 - 50 Vdc or better



# 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* pad on the board to the *RF in* pad on the back "wing".



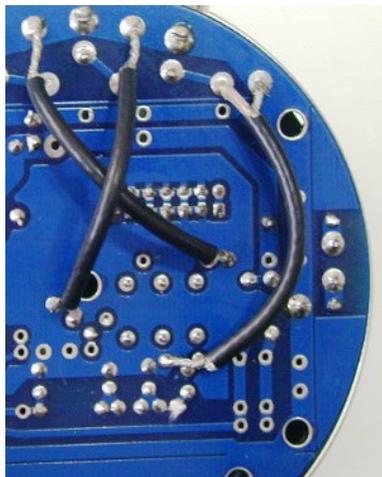
Connect this jumper from the *RF Out* pad on the board to the *RF Out* pad on the back "wing".

This jumper is used only for separate RX and TX. .

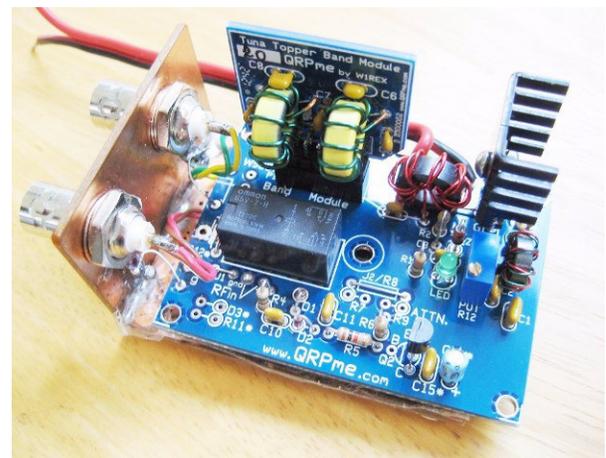
Topper Blue Board J[ V5a Schematic  
WSUSJ Drawing 5 Aug 2016

Note: Refer to manual for use of jumper 1 and keying speed

## Alternate RF Wiring



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



Example of connecting TxTopper *RF in* and *RF out* to enclosure BNC jacks..

## Appendix

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

**Table 1: Filter Component Matrix (see Note)**

Band	160	80	40	30	20
	<b>Capacitors</b>				
C5	1000 pF (102)	680 pF (681)	330 pF (331)	220 pF (221)	220 pF (221)
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C7	2000 pF (202)	1200 pF (122)	680 pF (681)	470 pF (471)	470 pF (470)
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C9	1000 pF (102)	680 pF (681)	330 pF (331)	220 pF (221)	220 pF (221)
	<b>Transformers and Inductors</b>				
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 and 14 for transformer and inductor winding details					

Wire gauge #26 is the thinner wire

Wire gauge #22 is the thicker wire

**Note: Low Pass Filter Capacitors:**

Capacitors are to be Kemet Golden Max MLCCs

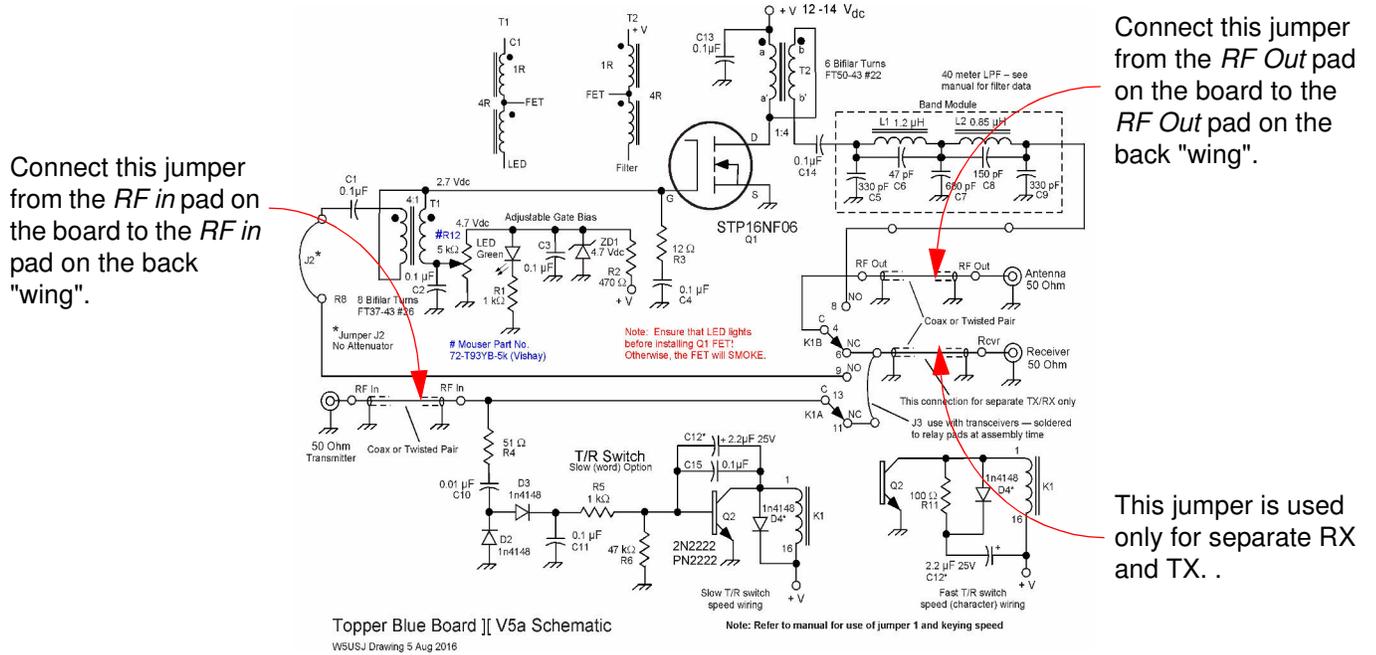
C5, C7, C9 - C0G, 5% 200 Vdc or better

C6, C8 - 50 Vdc or better

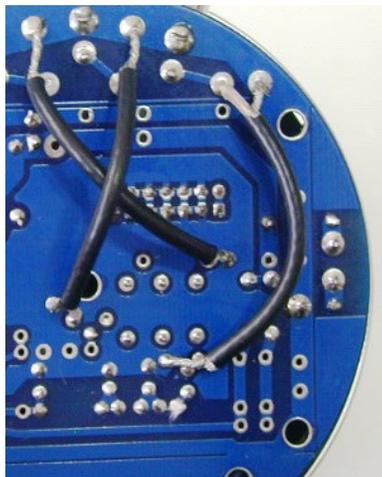


# Tuna Topper Alternate RF Connections

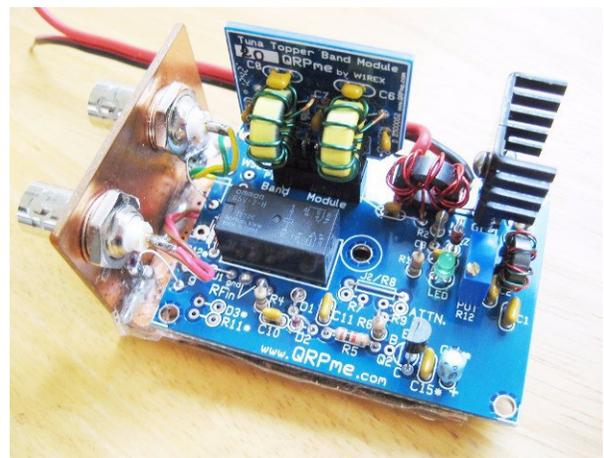
For use with separate TX and RX, wire the connections for the respective jacks as shown in the diagrams below.



## Alternate RF Wiring



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



Example of connecting TxTopper *RF in* and *RF out* to enclosure BNC jacks..