Software Defined Radio Transceiver

Written By: AE9RB

TOOLS:

- #1 Phillips Screwdriver (1)
- #2 phillips screwdriver (1)
- ESD safe parts tray (1)
- ESD safe work area (1)
- Electronics Multimeter (1)
- Flux core solder, 0.020" or 0.015" (1)
- Illuminated magnification (1)
- Measuring tape/ruler (1)
- Pencil or pen (1)
- Pliers or socket driver for #4 & #6 nuts (1)
- SMT tweezers (1)
- Safety glasses (1)
- Scissors or knife (1)
- Soldering iron with 1/32" tip (1)
- Tape, clear adhesive (1)
- Wire cutter (1)

PARTS:

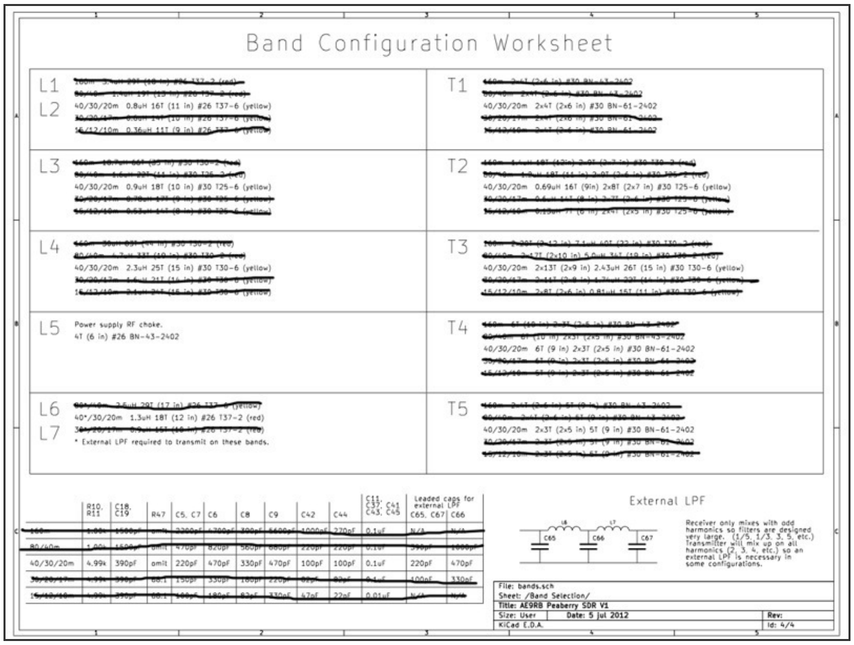
- 13.8V 1A linear power supply (1)
- 50 ohm Antenna, BNC terminated (1)
- Peaberry SDR kit from AE9RB.com (1)
- Computer to run SDR applications (1)
- Power supply hookup wire, 20AWG or better (1)
- USB cable, standard A-B, with ferrite bead (1)

SUMMARY

This is an amateur radio transceiver that operates on the medium or short wave bands. It is a software defined radio, meaning that it uses a computer to control the radio, to demodulate the signals received, and to modulate the signal transmitted. The computer control and signals in and out go through the USB connection, the antenna connects to the big silver BNC jack, the pink and green jacks are for microphone and headphones/speakers, and the black jack is for a telegraph key or iambic paddle for sending morse code.

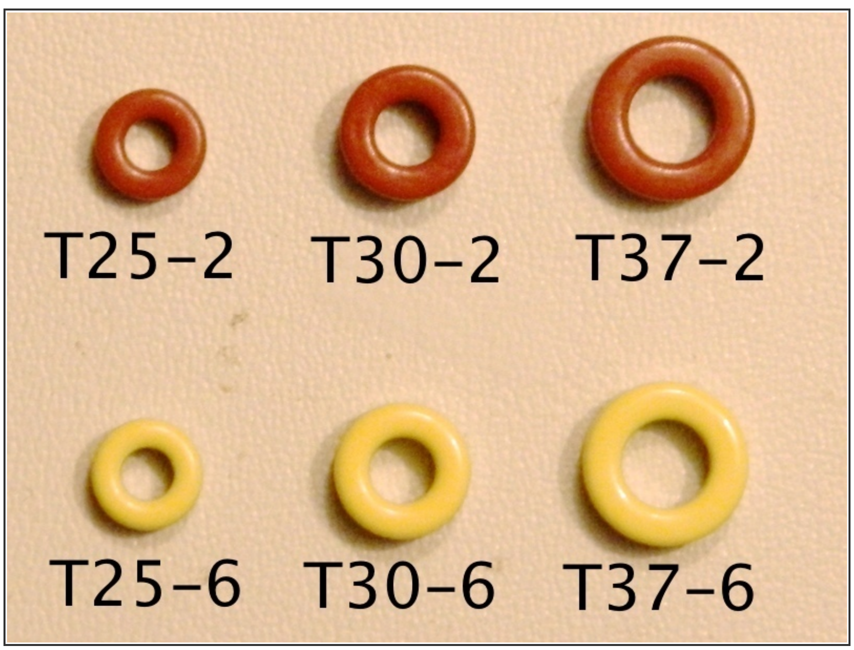
Complete kits are available from AE9RB.

Step 1 — Select a band option



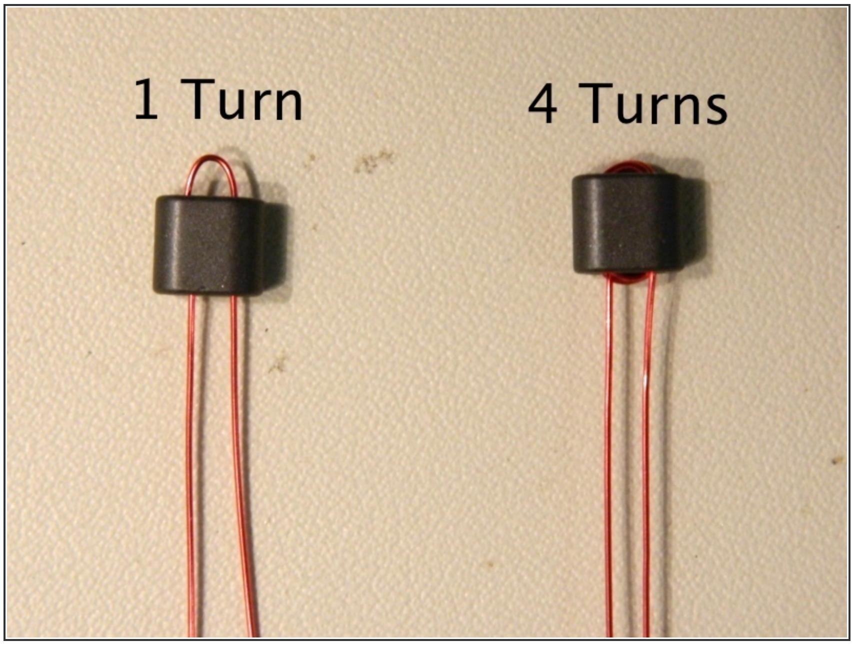
- Obtain the [schematic PDF](#) from the support forum.
- Print page 4. The layout is designed with plenty of room for you to tape the finished coils to the worksheet.
- Strike out all the data for the bands you are not building. This will keep you from accidentally building the wrong coils.

Step 2 — Identify the magnetic parts



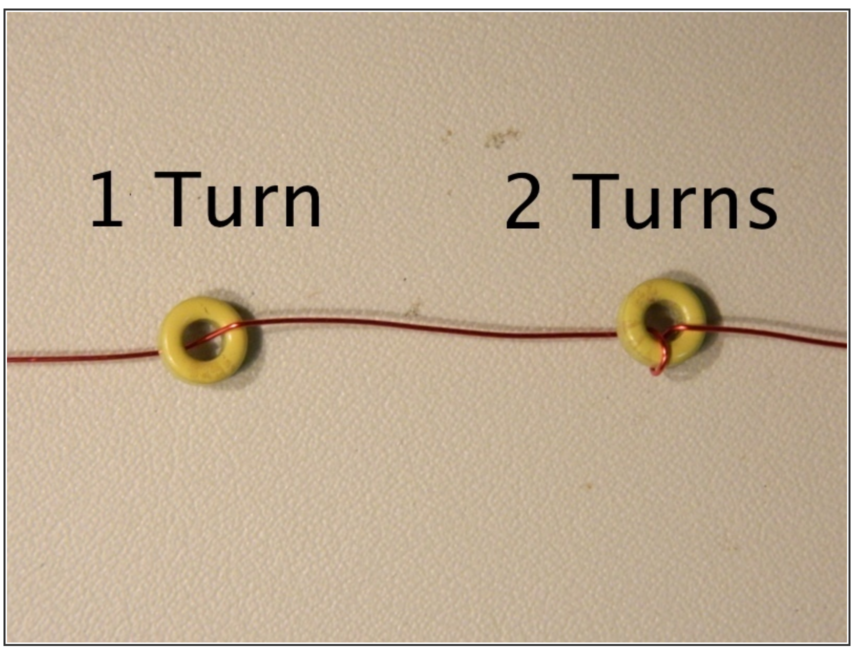
- Use the photo to identify the toroid cores.
- #26 gauge wire is thicker than #30 wire.
- The binocular cores all look the same so refer to the number on the bag.

Step 3 — RF Choke L5



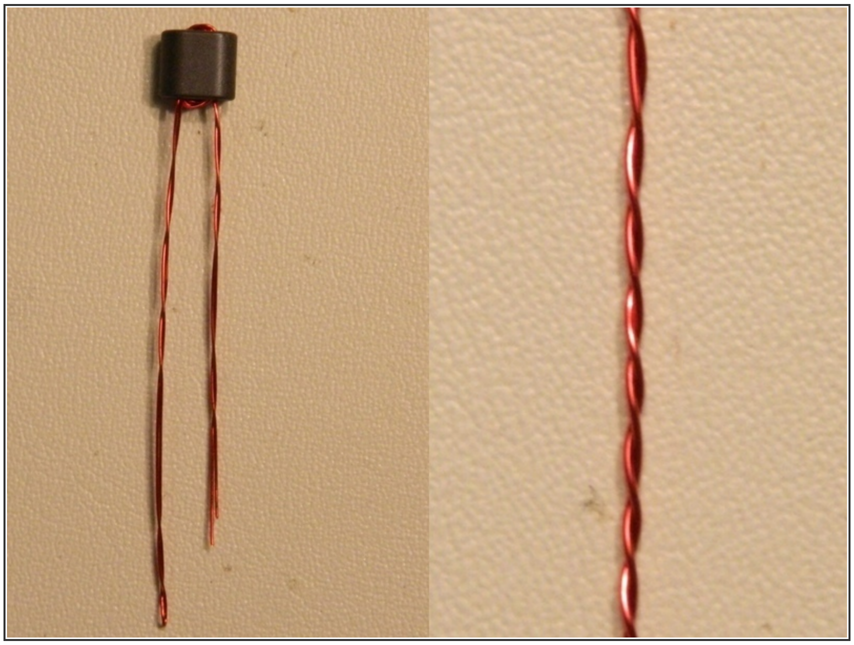
- The worksheet indicates 4T (6 in.) #26 BN-43-2402. This means use 6 inches of #26 wire to create 4 turns on a BN-43 core.
- Up one hole and down the other is one turn. The wire is shaped like a U at this point.
- Do this three more times and you're done. You'll end up with 4 strands of wire in each hole with the ends coming out of the same side.

Step 4 — Toroids L1, L2, L3, L4, L6, L7



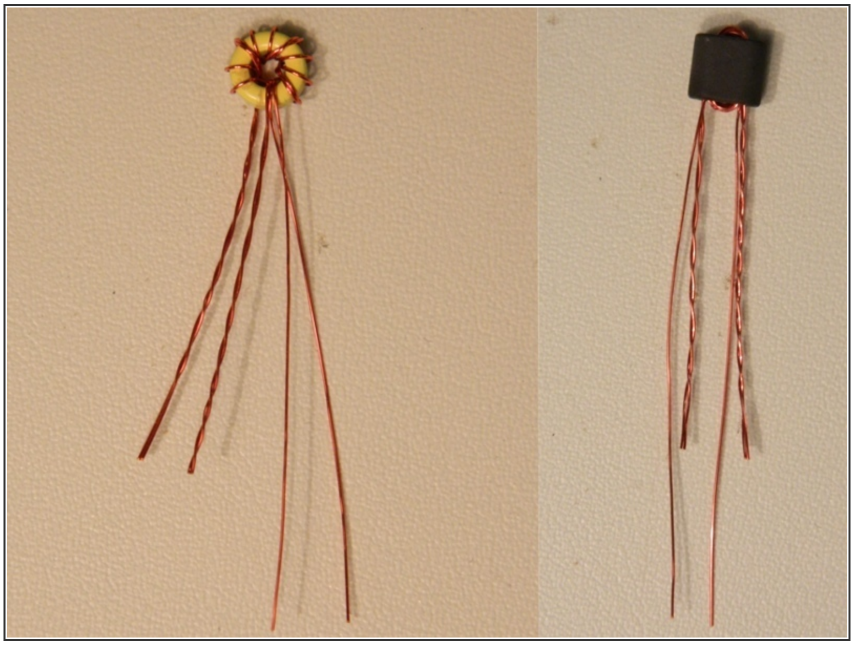
- Wind all the toroids next. Follow the worksheet to determine the configuration of each coil.
- Each pass through the core counts as one turn. Refer to the picture to make sure you don't make a common mistake.
- The coils should be pulled tight with only your fingers. Don't use pliers and don't leave the loops sloppy.

Step 5 — Bifilar transformer T1



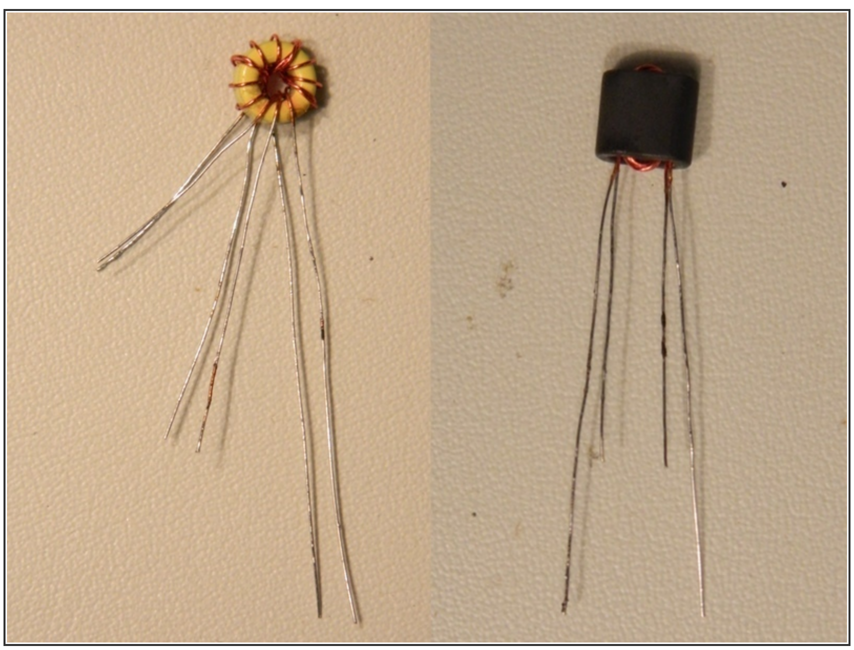
- Cut off 12 inches of #30 wire. Fold in half and twist together. The worksheet refers to this as 2x6 inches. You could twist two 6 inch lengths but having one end folded makes it easier to thread.
- A bifilar wire is simply two wires that are in very close proximity. We are twisting the wires to make sure they don't separate during construction. Several turns per inch is sufficient.
- Wind T1 just like you did for L5. 2x4T means 4 turns of the bifilar wire you just twisted. When you are done you will have eight strands in each hole with four wires coming out the same side.

Step 6 — Transformers T2, T3, T4, and T5



- These have a single winding and also a bifilar winding. T3 and T5 list the bifilar windings first and these should be done before the single winding. T2 and T4 should have the single windings first with the bifilar wound over these.
- Be sure that both windings on the toroids are done in the same direction. It doesn't matter if you go clockwise or anti-clockwise so long as they are all the same.
- Cut the wires to different lengths before you untwist the bifilar pairs.

Step 7 — Tin the wires

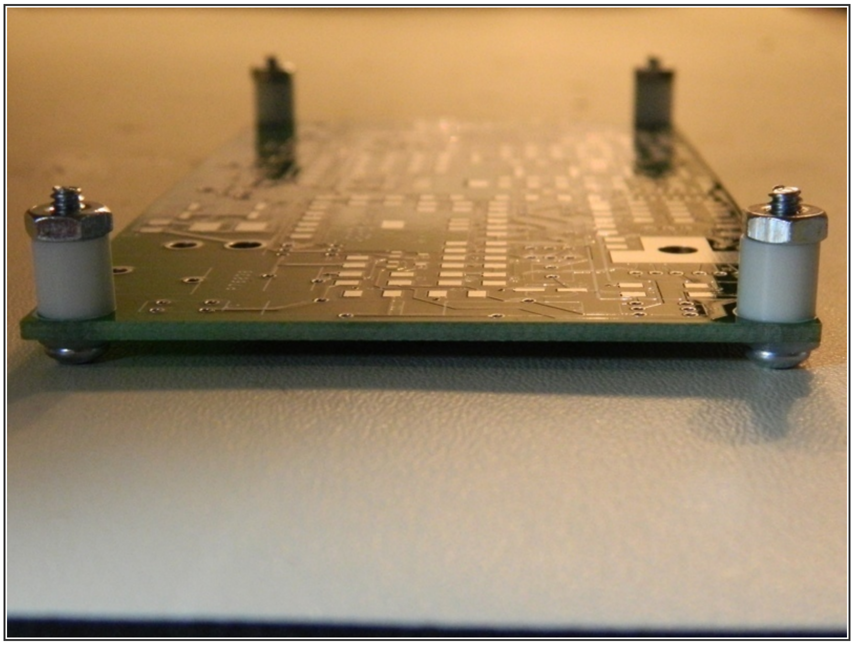


- If your soldering iron has temperature control, turn it up to 750 degrees F or more. If not, you may need to scrape off some of the coating first.
- Use your soldering iron and flux core solder to prepare the wires for mounting on the PCB.
- The bifilar wires can now be identified with the continuity feature of your multimeter. Cut one of the bifilar wires a little shorter.

Step 8 — Identify the electronic parts

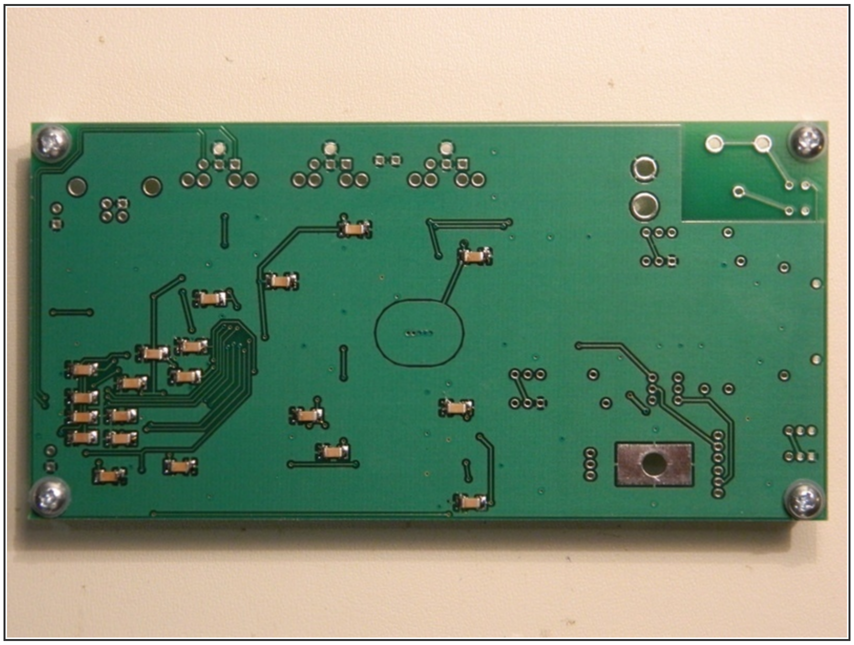
- Open the foil shielded bag and put the parts in an ESD-safe tray they can't fall out of. I use a metal cake pan with 2" sides.
- Parts with confusing, unusual, or varying markings, such as the transistors, will be identified with the possibilities in square [brackets]. You may need to peel off the covering to read these parts.
- The SOICs and SSOPs all have unique pin counts so will be impossible to confuse. There's only one type of diode.
- Resistors and leaded capacitors are marked using numbers with the last digit being a positive exponent of 10 or an R to indicate a decimal. For example, 50R0 is 50.0 ohms, 5000 is 500 ohms, 5001 is 5k and 5003 is 500k.
- Surface-mount capacitors are not available with markings. There are a few places you won't use all the caps on the parts sheet so be sure to keep them labelled somehow. The easiest thing to do is simply tape them back on the sheet.

Step 9 — Mounting hardware



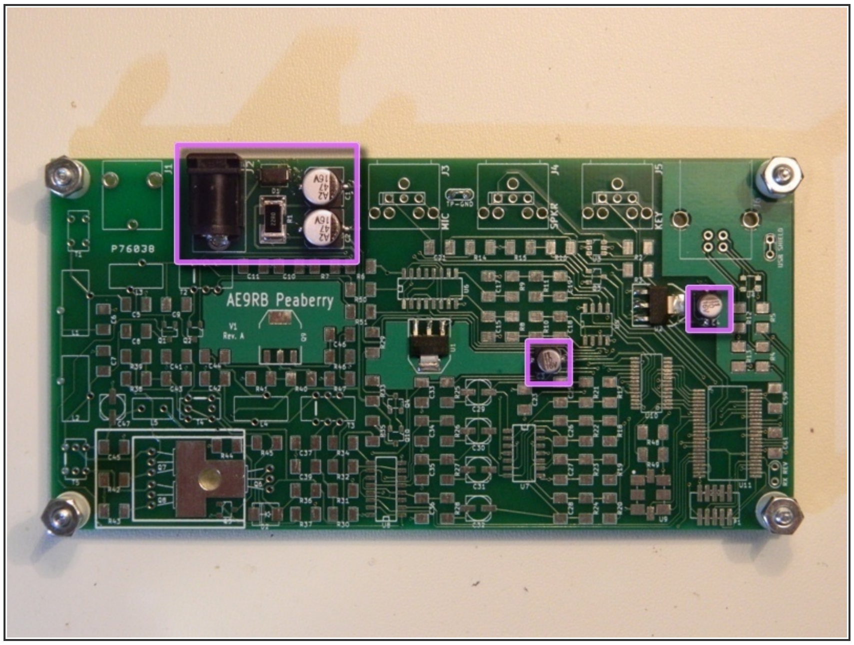
- Installing the mounting hardware "upside down" will make assembly easier as well as protecting the components. The screw heads and washers should be on the bottom of the board with the 1/4" spacer and nut on the top to protect the coils after they are installed.
- If you are working on a hard surface, the board will now slide around too much. An ESD-safe work mat will not have this problem. The screws will protect your mat from soldering iron heat.
- Don't use a PCB vise or helping hands for this project. These devices sound good in theory, but holding your hands and arms up in the air while soldering makes it impossible to keep from shaking.

Step 10 — Bypass capacitors



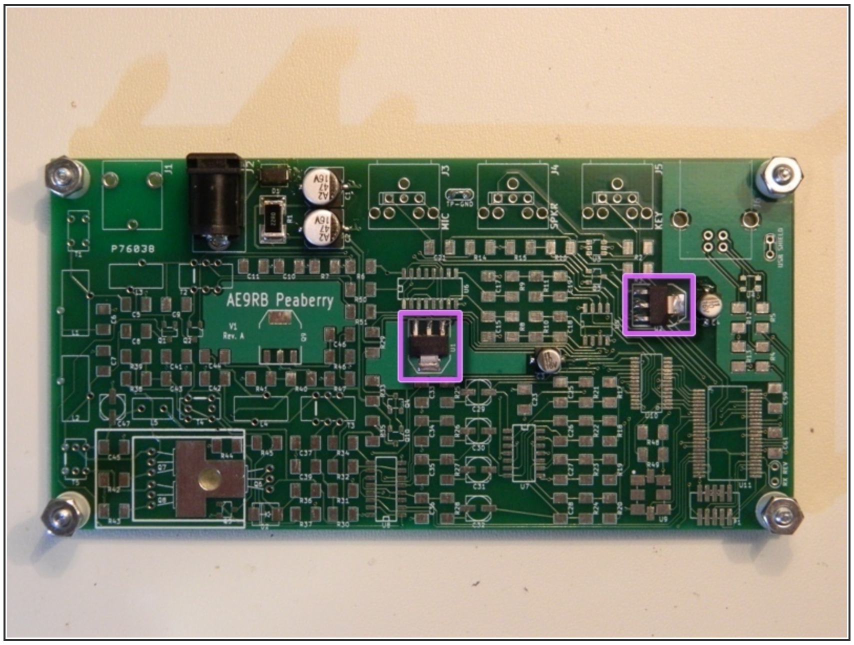
- The bottom of the board has no silkscreen printing. To avoid needing a map, all parts on this side are 0.1µF capacitors. Begin by installing capacitors on every set of 1206 pads. There are 20.
- These are the first parts you will remove from the Cs & Rs sheet. I use an X-ACTO knife but scissors can also be used. In addition to the obvious tape, the parts strips have another piece of tape over them that is sometimes tricky to peel off.
  - C12, C13, C14, C16, C22 - 0.1µF
  - C24, C38, C40, C48, C50 - 0.1µF
  - C51, C52, C55, C56, C57 - 0.1µF
  - C58, C60, C62, C63, C64 - 0.1µF
- Inspect your work. Component failures are extremely rare. Bad soldering, even by experts or automated machinery, happens all the time.

Step 11 — Power Supply (1/2)



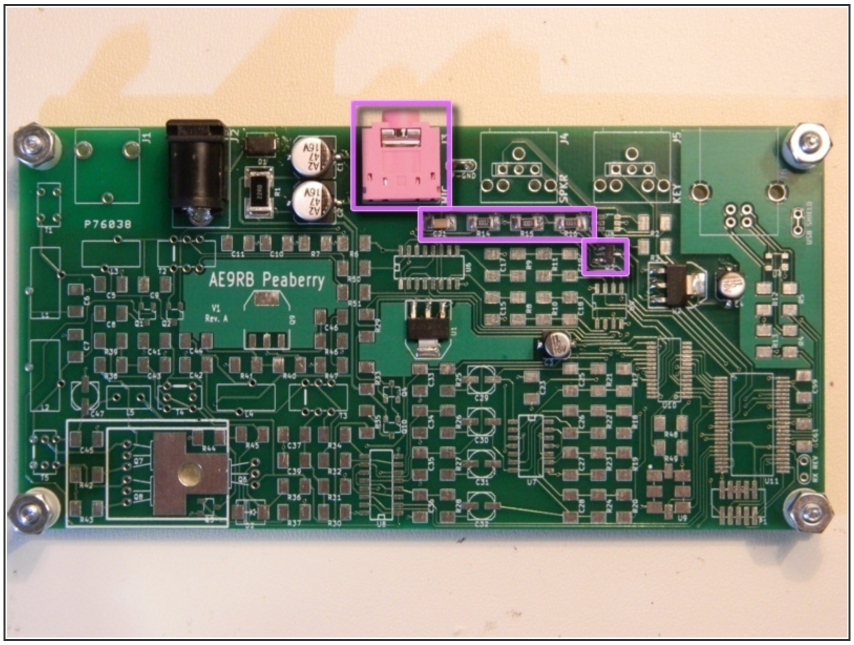
- The 22 ohm 2W resistor is the only one that is not 1206 sized, it is a larger 2512.
  - D1 - 1N4003 rectifier diode [R13]
  - R1 - 22 Ω 2W resistor
  - C1, C2 - 47µF electrolytic
  - C3, C4 - 10µF electrolytic
  - J2 - 5.5mm x 2.5mm barrel socket

Step 12 — Power Supply (2/2)



- The 5V regulator tab will take some time to heat up enough for the solder to flow. It may take 15 seconds or more and the PCB will get very hot.
  - U1 - NX1117CE50Z 5.0V regulator
  - U2 - NX1117CE33Z 3.3V regulator
- The TP-GND is available for you to install a small loop of wire for an alligator clip. This is optional but very handy if you own an oscilloscope.
- Connect the board to a 12-15V power supply using a 5.5mm x 2.5mm barrel plug. Test the tabs on U1 and U2 for 5.0V and 3.3V.

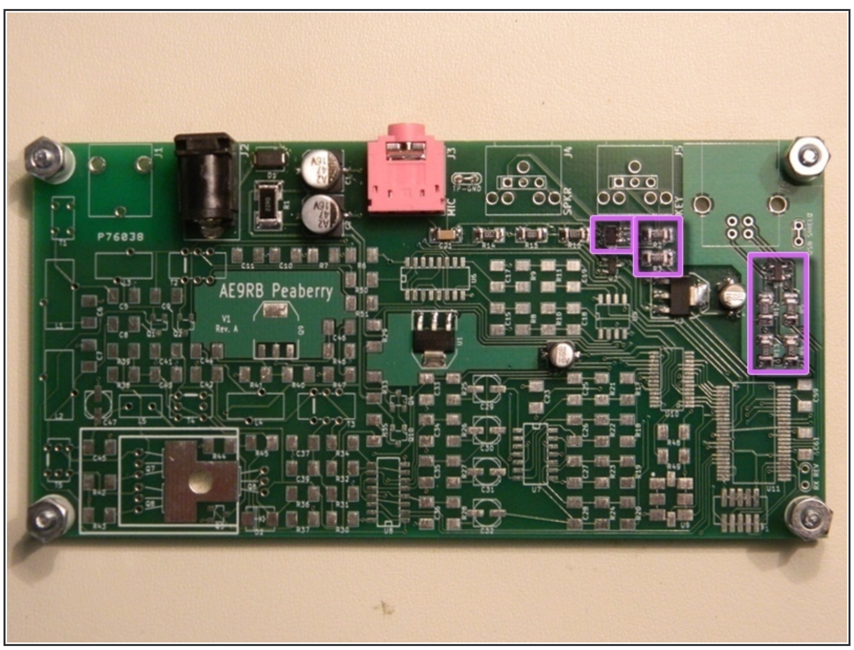
Step 13 — Microphone



- J3 - pink stereo jack
- R14 - 10k
- R15 - 1K
- R16 - 100k
- C21 - 0.1µF
- Q3 - MMBT3904 [K1N]

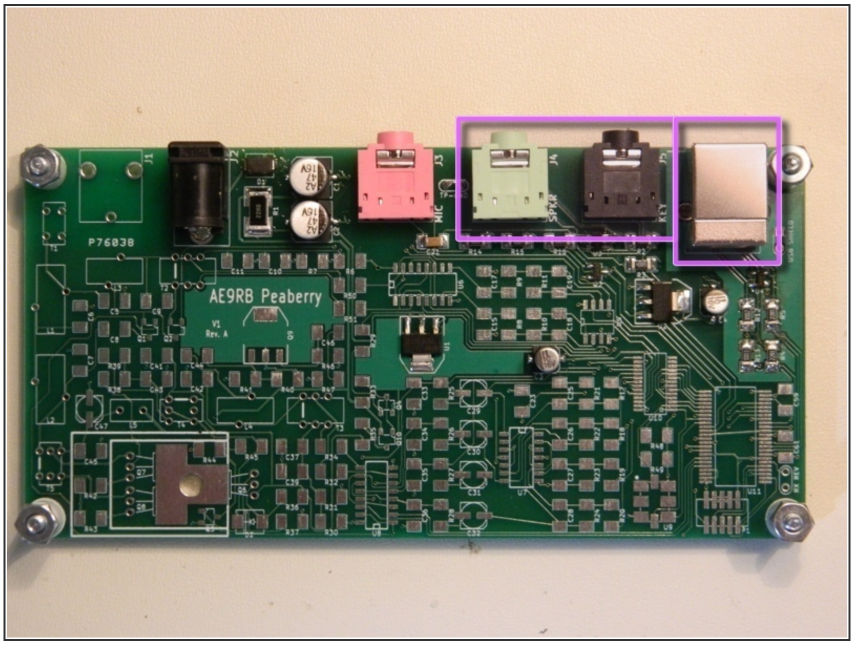
- The collector of Q3 should measure 2.0-2.5V. This is the pin by itself on the right of the board. If you have an oscilloscope, you can hook up an electret computer mic and observe the waveform on Q3 when you speak.

Step 14 — Jack ESD Protection and Resistors



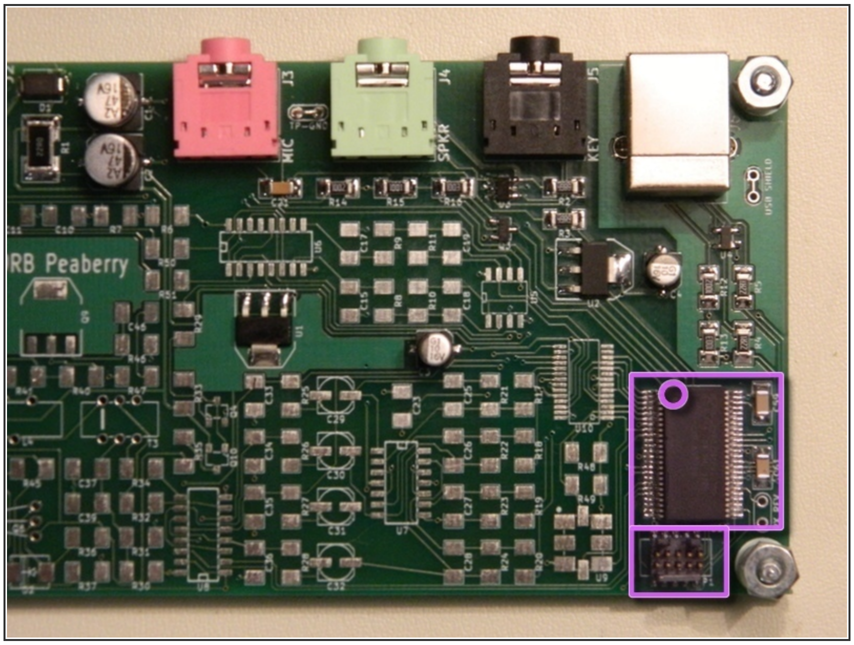
- U3 - PRTR5VOU4D [4D] pin 1 at top-left
- U4 - PRTR5VOU2X [WR1] pin 1 at bottom-right
- R2, R3 - 49.9 Ω
- R12 - 10k
- R13 - 100k
- R4, R5 - 22.1 Ω

Step 15 — Jacks



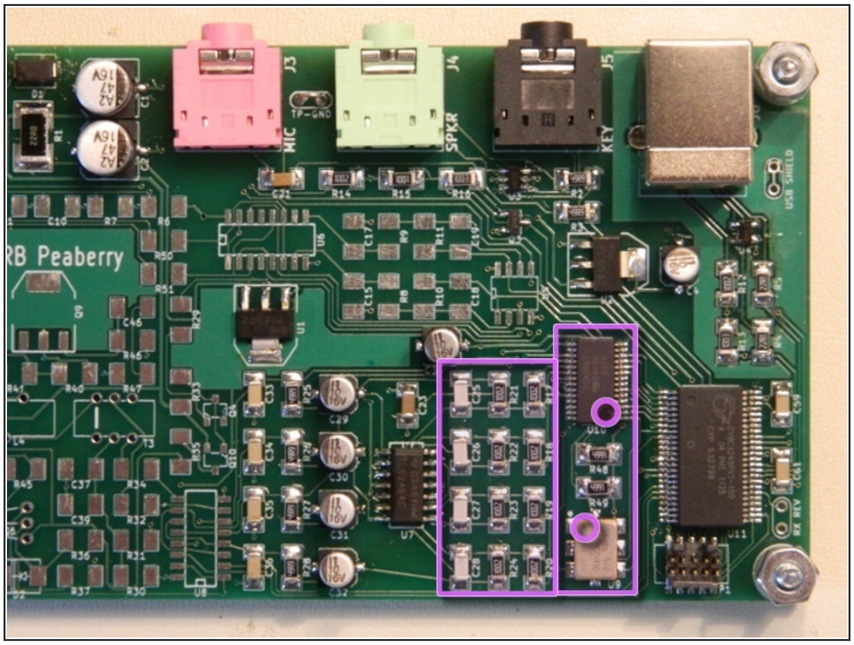
- J4 - green stereo jack
- J5 - black stereo jack
- J6 - USB Jack

Step 16 — Cypress PSoC



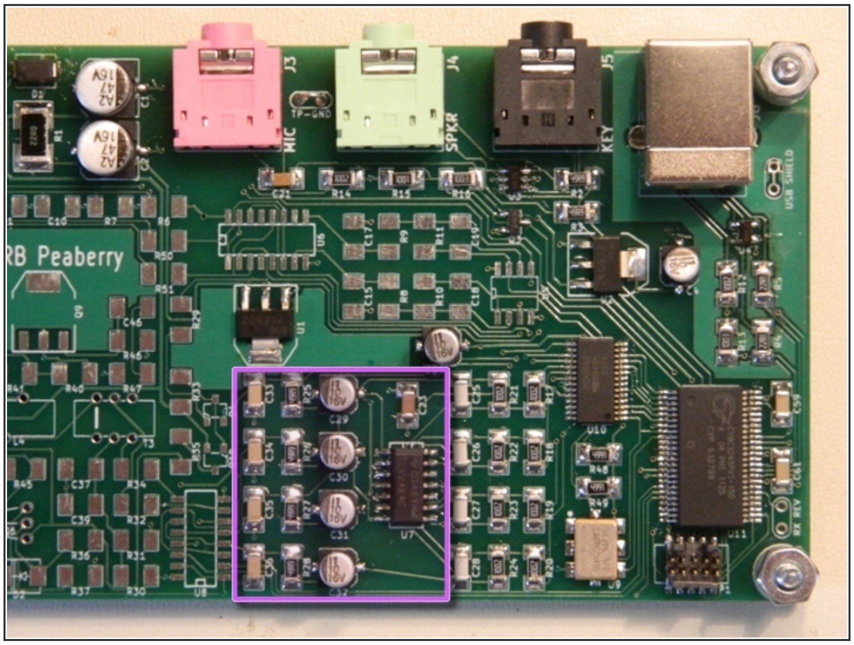
- U10, and U11 are the most difficult part of assembly so look forward to it being all downhill after these next steps. Take your time and make sure there are no solder bridges before attempting to power up.
  - P1 - SWD Debug Port, notch on U11 side
  - U11 - CY8C3XXX PSoC 3
  - C59, C61 - 1µF
- You can now power up and connect the USB to a computer. The Peaberry does not use any USB power so you must have the 12V supply hooked up. Current draw is 120mA-180mA and will remain in this range unless transmitting.
- If you have a Windows system, install the driver available from the [support forum](). This driver is for the control interface that sets the LO frequency and other radio features.
- In some cases you may not see the Peaberry Audio and Peaberry Radio devices on Windows systems. This can be fixed in the device manager by uninstalling and deleting the device driver that's assigned to the Peaberry.

Step 17 — Si570, DelSig and Quad OpAmp (1/2)



- U9 can be tricky because it has no pins. Make sure your iron tip heats both the PCB pad and the small metal notch on the side of the device.
  - U9 - Si570
  - U10 - PCM3060
  - R48, R49 - 4.99k
  - R17, R18, R19, R20 - 10k
  - R21, R22, R23, R24 - 10k
  - C25, C26, C27, C28 - 100pF

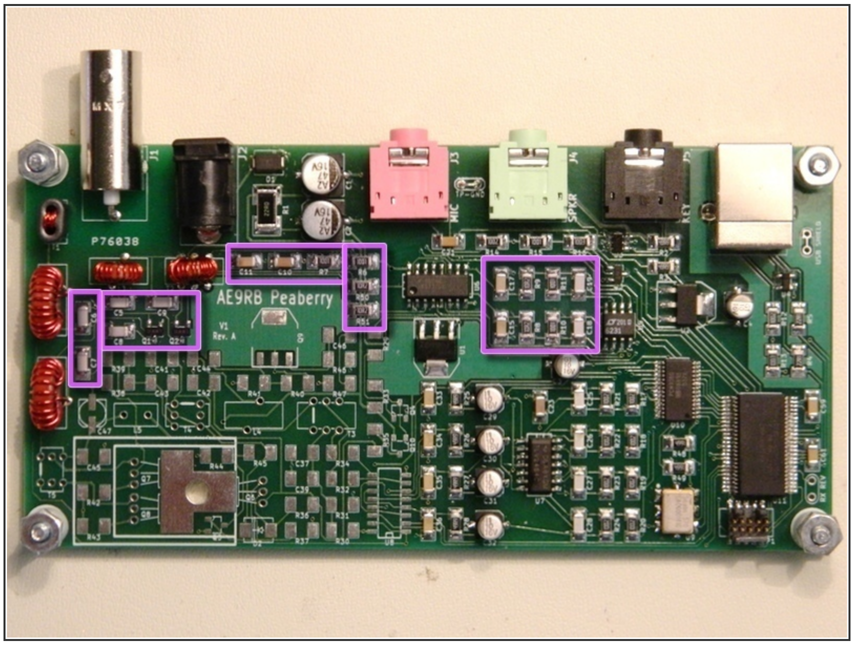
Step 18 — Si570, DelSig and Quad OpAmp (2/2)



- C23 - 4.7µF
- U7 - TLV2464
- C29, C30, C31, C32 - 10µF electrolytic
- R25, R26, R27, R28 - 49.9 Ω
- C33, C34, C35, C36 - 0.022µF

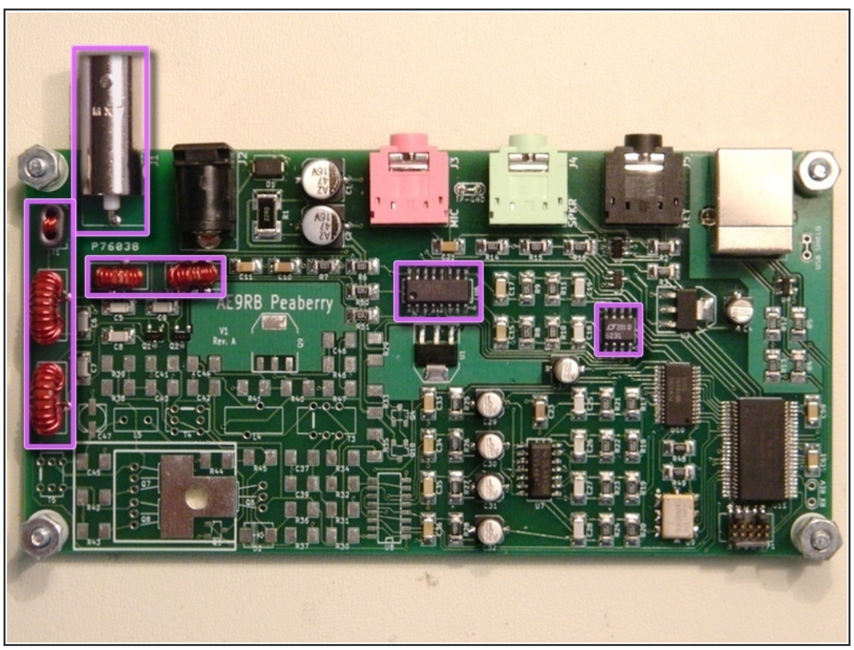
- Test for approximately 2.5V on pads 2 and 14 of U6. If you have an oscilloscope, you can observe a 14.08 MHz 5V p-p square wave on these pads.
- The SPKR jack will now function as stereo sound card. Play some music through the "Peaberry Audio" device that appears on your computer and connect amplified speakers to the green jack.

Step 19 — Receiver (1/2)



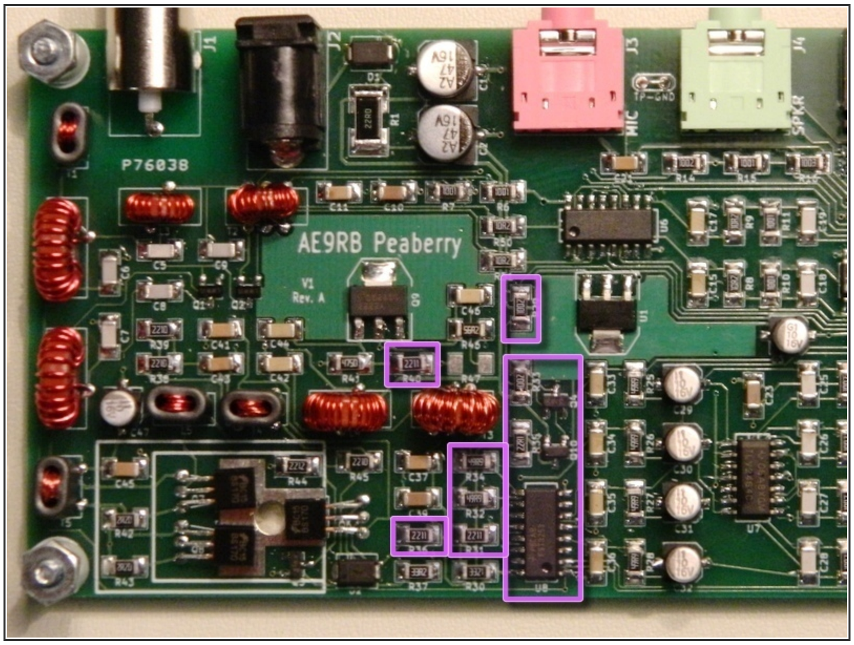
- C5, C6, C7, C8, C9, C11, C18, C19 - see worksheet
- R10, R11 - see worksheet
- R6, R7 - 1k
- R50, R51, R8, R9 - 10.2 Ω
- C10 - 4.7µF
- C15, C17 - 0.047µF
- Q1, Q2 - 2N7002 [LWW]

Step 20 — Receiver (2/2)



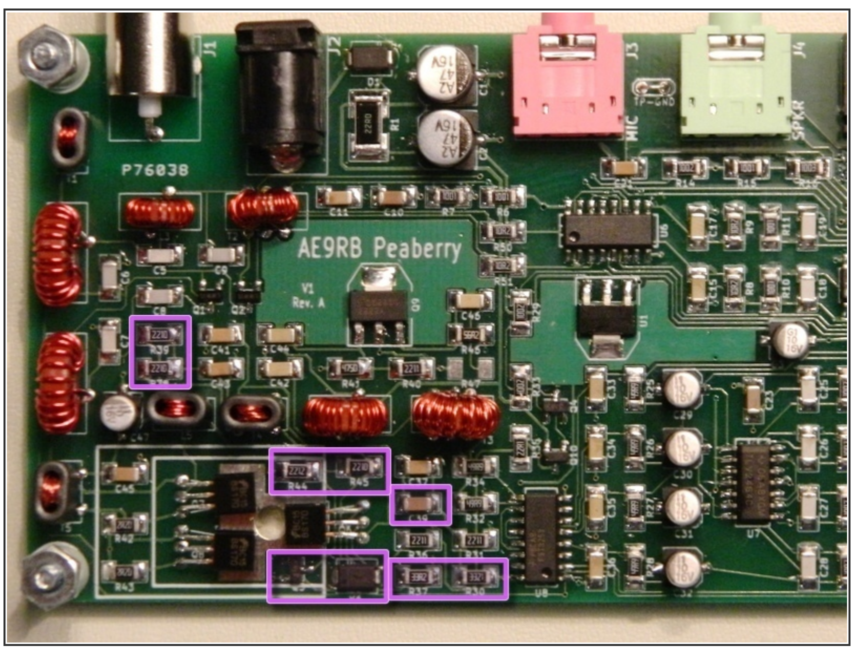
- The BNC jack will require a lot of heat so remember to give it a few minutes to cool down.
  - J1 - BNC jack
  - U5 - LT6231
  - U6 - FST3253
  - L1, L2, L3 - see worksheet
  - T1, T2 - see worksheet
- The receiver should be fully functional now.

Step 21 — Transmitter (1/5)



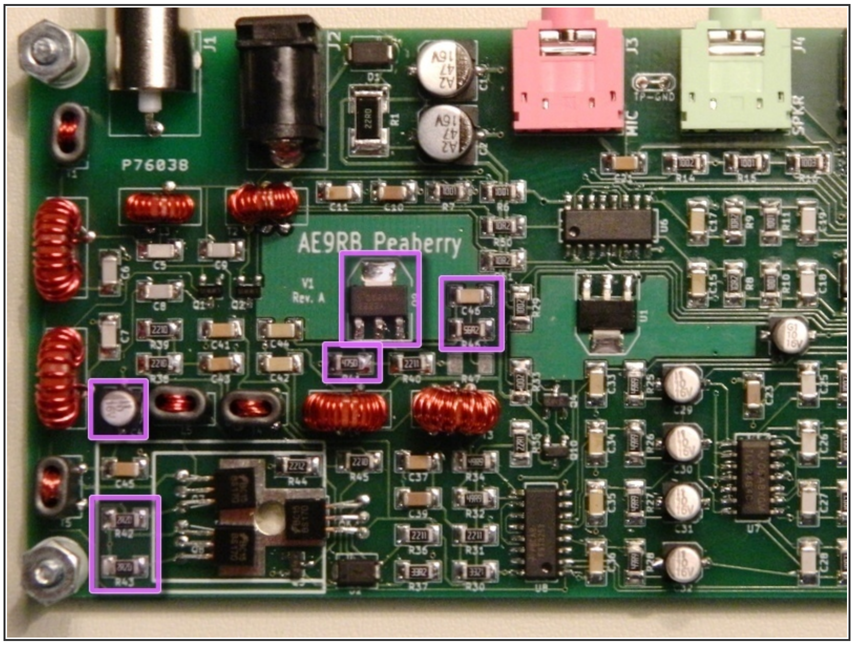
- U8 - FST3253
- Q10 - BSS84 [SP]
- Q4 - MMBT3904 [K1N]
- R29, R33 - 10k
- R35 - 22.1 Ω
- R32, R34 - 49.9 Ω
- R31, R36, R40 - 2.21k

Step 22 — Transmitter (2/5)



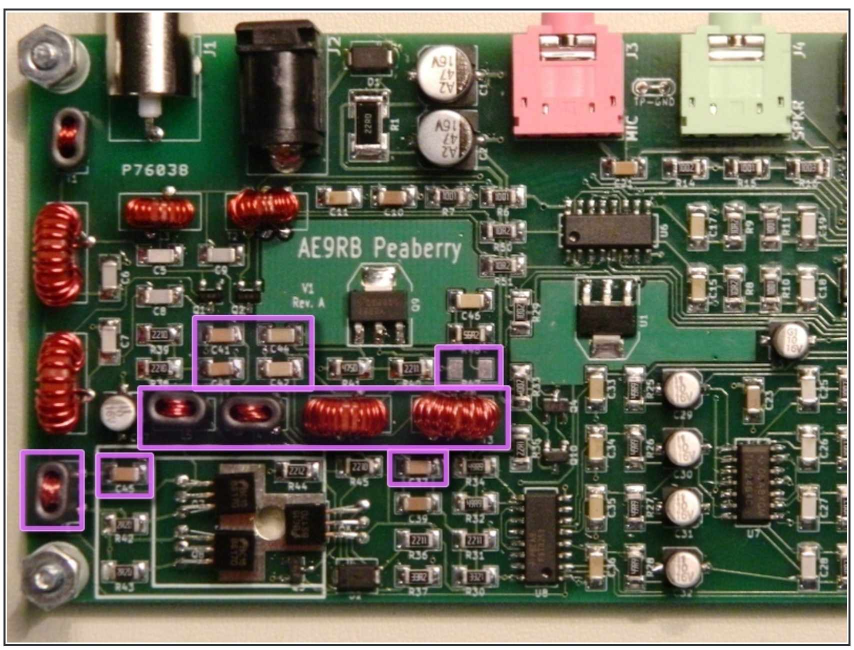
- R30 - 3.32k
- C39 - 4.7µF
- R37 - 33.2 Ω
- R45, R38, R39 - 221 Ω
- R44 - 22.1k
- D2 - 1N4003 rectifier diode [R13]
- Q5 - MMBT3904 [K1N]

Step 23 — Transmitter (3/5)



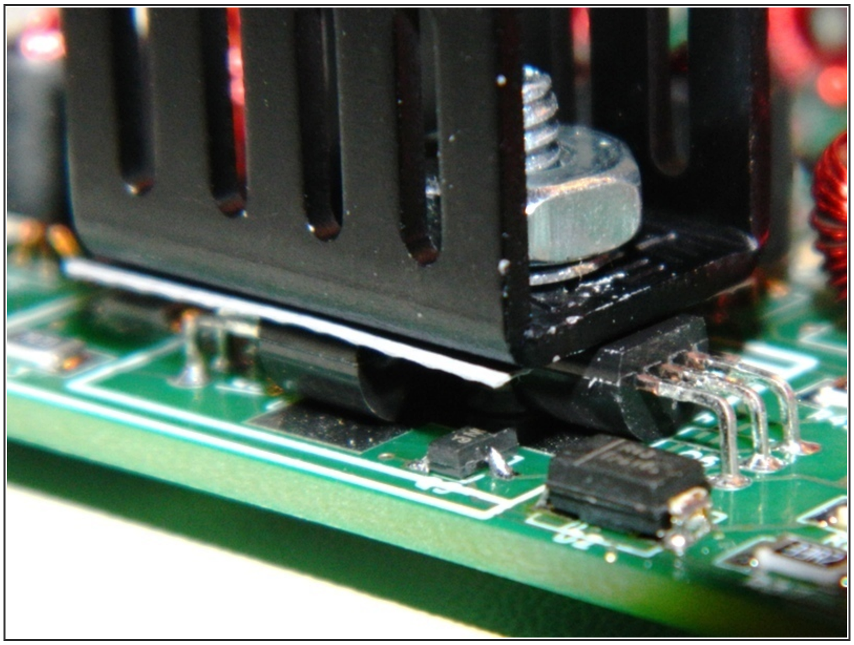
- C47 - 10µF electrolytic
- R42, R43 - 2.21 Ω
- Q9 - PZT2222A
- R46 - 56.2 Ω
- C46 - 220pF
- R41 - 475 Ω

Step 24 — Transmitter (4/5)



- R47 - see worksheet
- C37, C41, C42, C43, C44, C45 - see worksheet
- L4, L5 - see worksheet
- T3, T4, T5 - see worksheet

Step 25 — Transmitter (5/5)



- Bend the BS170 leads so it mounts with the flat side facing up. Temporarily use the #6 hardware and heatsink to hold all three in position while soldering.
  - Q6, Q7, Q8 - BS170
  - Heatsink hole - #6 screw, #6 nut, #6 lock washer, sil-pad, heatsink
- Your software-defined ham radio is now complete. You may need an external LPF to lawfully transmit on some bands in certain configurations. The worksheet has more information about this.

Step 26 — Software

- There are dozens of free SDR applications available for all modern operating systems. Many are open source.
- Figuring out what you want to use and improving support for Peaberry is now up to you.
- Join us on the support forum to learn more about what you can do with these amazing radios.

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