KK1L 2x6 Antenna Switch
KK1L 2x8 Antenna Switch

Relay Board Assembly

Ronald Rossi, KK1L
http://kk1l.com

Design Features:

- ***Relays are selected by +12V on port select input***
- ***Two relay contacts isolate a selected antenna on one radio port from a selected antenna on the other radio port***
  - ***Measured worst case port to port isolation of -61.2dB!***
- ***50Ω stripline RF paths***
- ***Unused ports are terminated to 50Ω to reduce reradiation and port to port coupling***

Parts List:

2x6 Mouser Parts: https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=5b441ca29e
2x8 Mouser Parts: https://www.mouser.com/ProjectManager/ProjectDetail.aspx?AccessID=8488521D89

Basic Build Parts:

- 12 (16) Diodes 1N4001 (relay back EMF suppression)
- 12 (16) 0.01uF ceramic capacitor (relay noise suppression)
- 6 (8) 50 Ω 50W Thick Film TO-220-2 (or 51Ω 3W Metal Oxide Resistor)
- 18 (24) RZH3-1C4-D012 Relay or equivalent (Form-C SPDT non-latching 12V 16A 5mm pin pitch)
- 8 (10) SO-239 Launcher (chassis mount)
- 2 Euro 10 port Fixed Terminal Block (optional, but convenient)
- 16 (20) 6-32 x 1" stainless screws (length is generous)
- 32 (40) 6-32 stainless nuts
- 1 **2x6:** 7"x11"x 2" Hammond Al Chassis and bottom plate
- 1 **2x8**: 8"x16"x 2" Hammond Al Chassis and bottom plate

Raspberry Pi Zero / FreqEZ Parts:

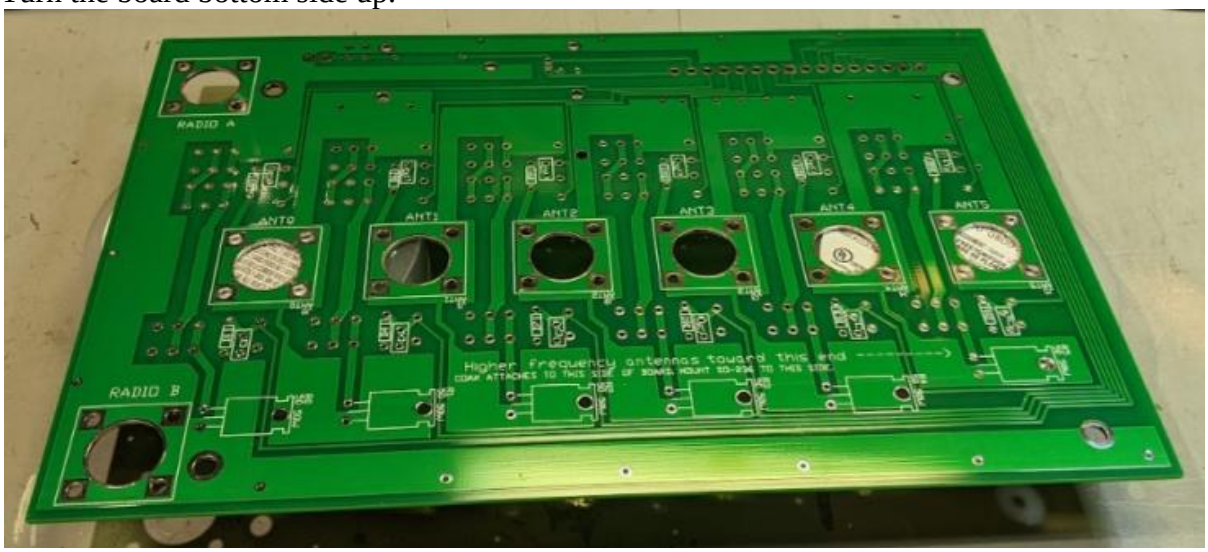
- 1 Raspberry Pi Zero 2 W or Zero W (any RPi works, but small form factor is important for this install)
  - ❑ UFL SMD connector (if not already on the R Pi Zero)
  - ❑ UFL to SMA chassis mount cable
- 1 FreqEz2 Band Decoder / switch control (https://hamprojects.info/freqez/)
- 1 100uH choke (optional…can substitute with a jumper/short)
- 1 5V 1A voltage regulator TO-220
- 1 100uF 16VDC electrolytic capacitor
- 1 22uF 35VDC tantalum capacitor

- 1 14V MOV
- 1 Euro 2 port Fixed Terminal Block (optional, but convenient)
- 10 M3 hex 10.0mm nylon threaded standoff (M2.5 fits better, but not available at Mouser)
- 5 M3 hex 15.0mm nylon threaded standoff (M2.5 fits better, but not available at Mouser)
- 6 M3 hex nylon nut (M2.5 fits better, but not available at Mouser)

Construction:

Note that using the Raspberry Pi / FreqEz2 to control the relay board is optional. The steps necessary to install the components for this are noted by "RPi/FEZ only". If using the board directly from a rotary switch or using the KK1L Decoder/Controller board, then skip those steps.

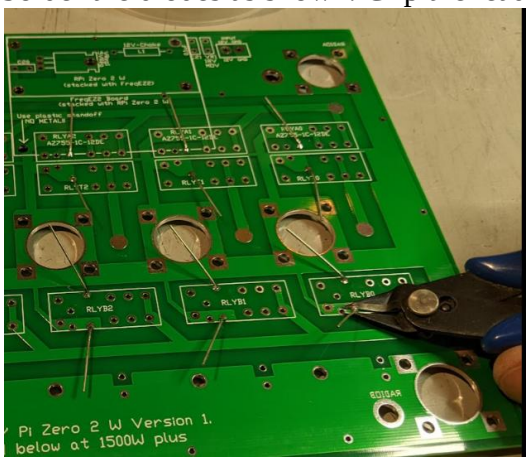
- ❑ Turn the board bottom side up.



NOTE that the ground side of the components may be difficult to solder. The ground plane is a pretty good heat sink. Make sure your soldering iron and tip are of adequate size and the tip is well wetted.

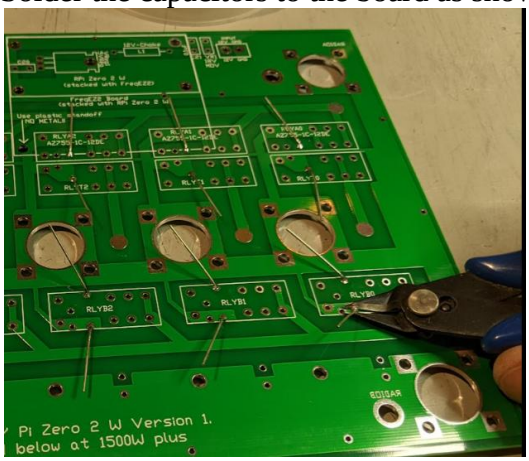
- ❑ Insert the diodes paying attention to the orientation. It is important that the band matches the marking on the board.

❑ Solder the diodes as shown. Clip the leads flush.



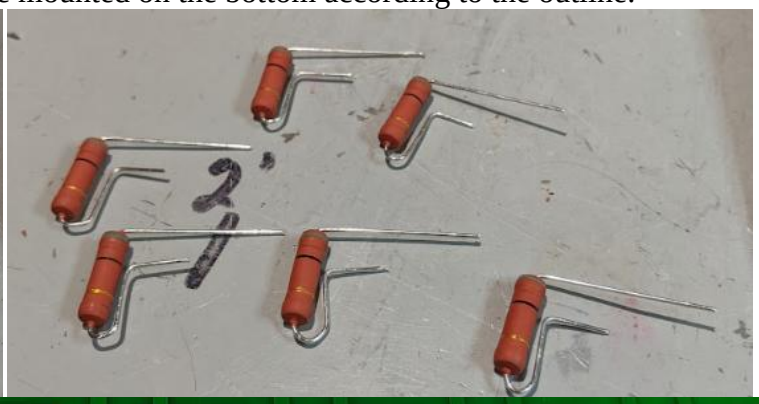
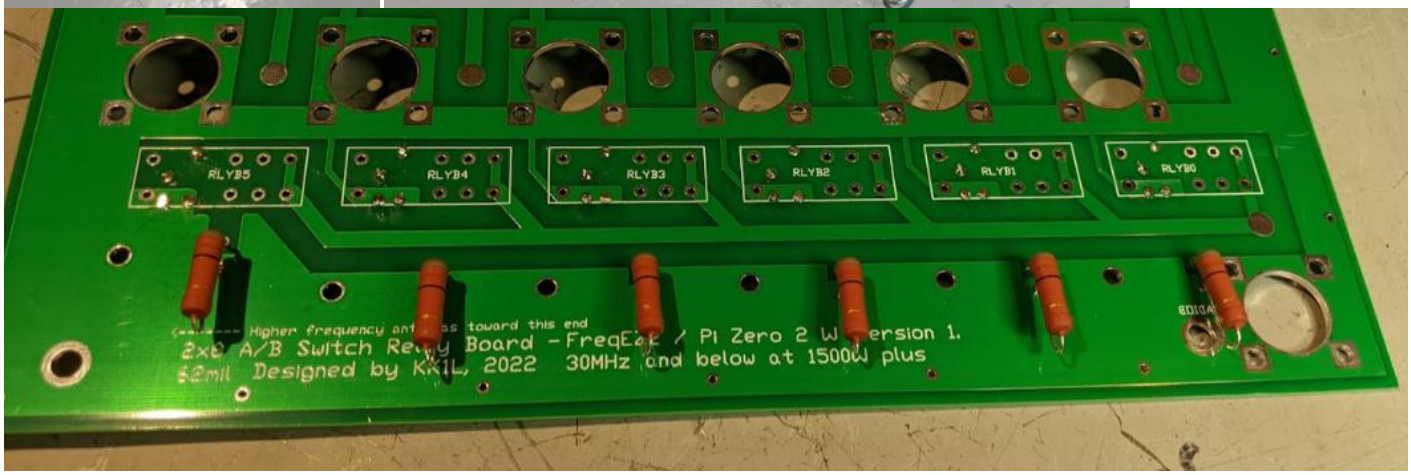
❑ Insert the capacitors to the board as shown. Orientation is not important.

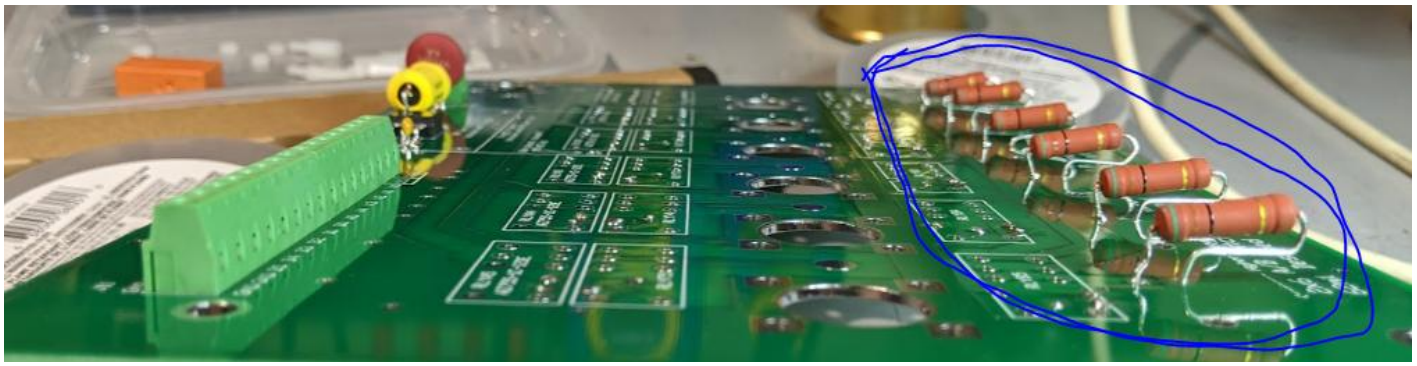
❑ Solder the capacitors to the board as shown. Clip the leads flush as done for the diodes.



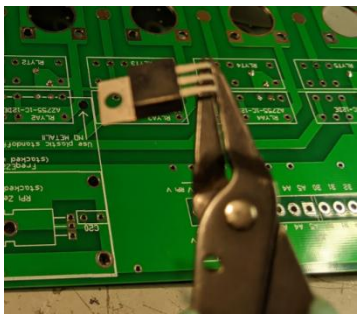
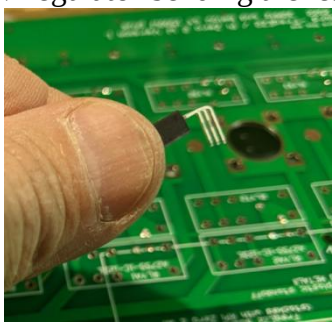
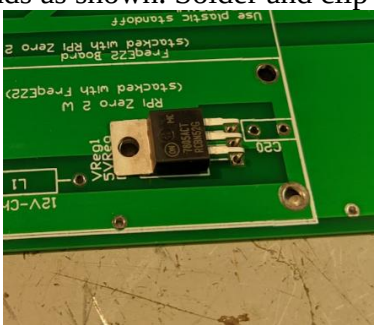
❑ Solder the 51Ω resistors on the top of the board where shown. You could use either the high wattage TO-220-2 package resistors or 3W axial. I show the axial installation below. TO-220-2 is installed similar to the 5V regulator for the Raspberry Pi / FEZ2 (optional install). These resistors absorb coupled power on the unused port and minimize reradiation. 3W resistors will be just fine for most installations. You might consider 50W in legal limit+ under highly mismatched conditions.
NOTE: The axial are installed from the top of the board. There is no outline for their insertion. Orientation does not matter, but the body of the resistor must be over the grounded area of the board as

shown. DO NOT have the resistors hover over the RF trace.
NOTE: The TO3 resistors are mounted on the bottom according to the outline.

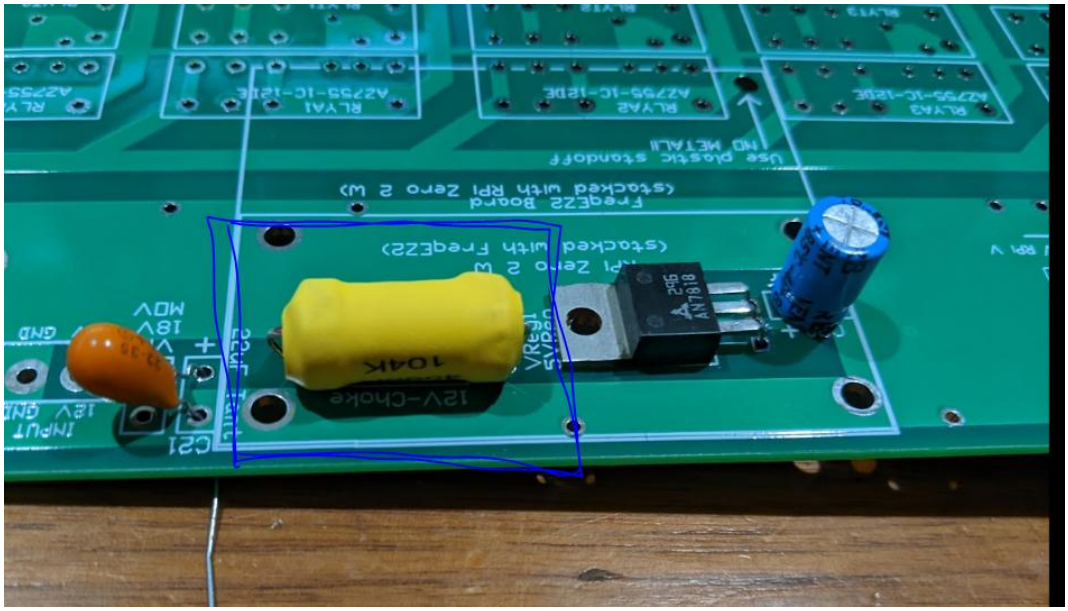





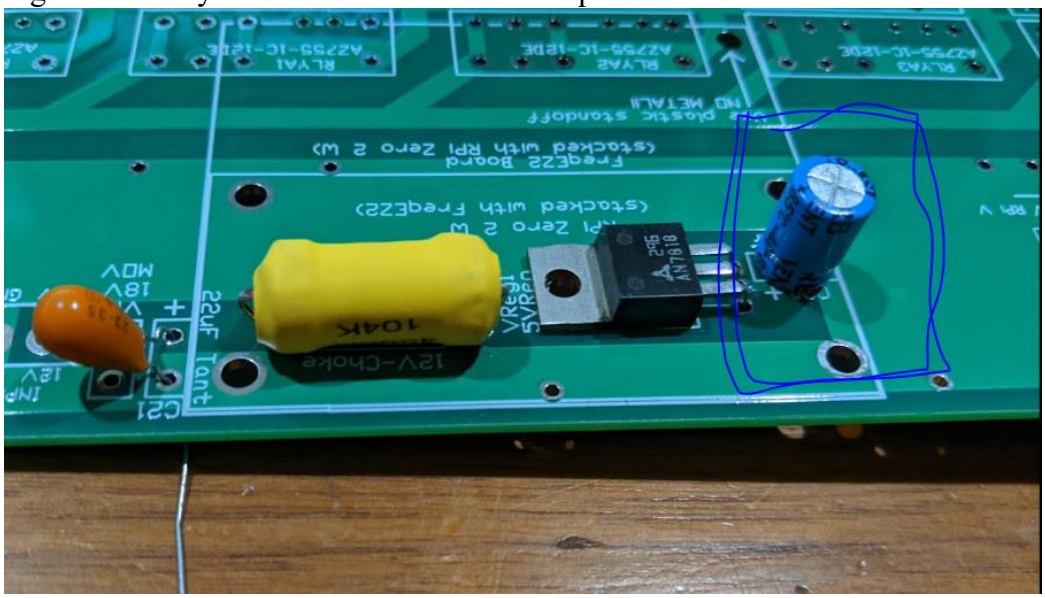
❑ **RPi/FEZ only:** Install the 5V regulator bending the leads as shown. Solder and clip the leads.

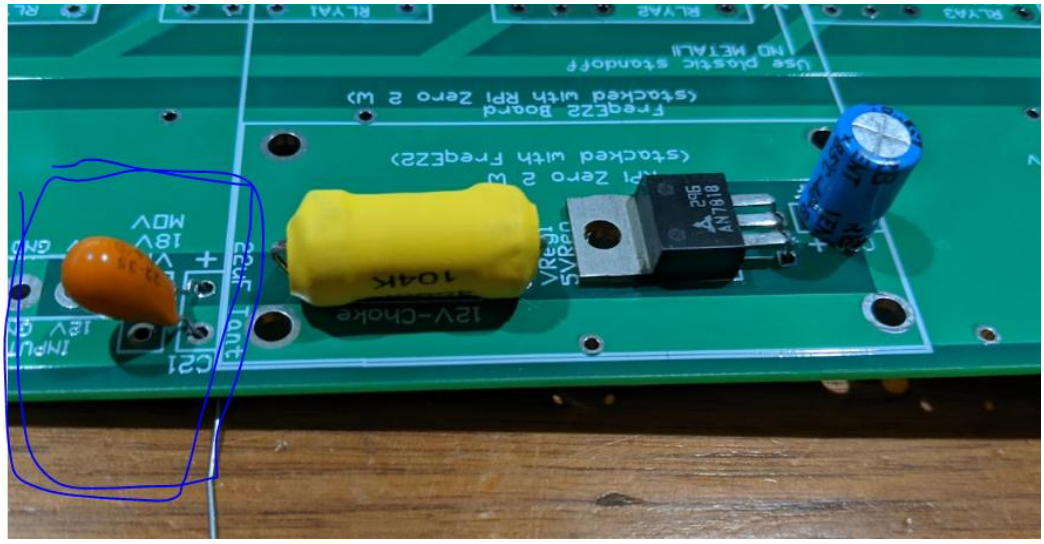
❑ **RPi/FEZ only:** Install the 100uH choke OR a shorting wire. Solder to the board and clip the leads.
NOTE: The choke is not strictly necessary. It can help keep RF off the 12V feed to the FEZ2 or relays.



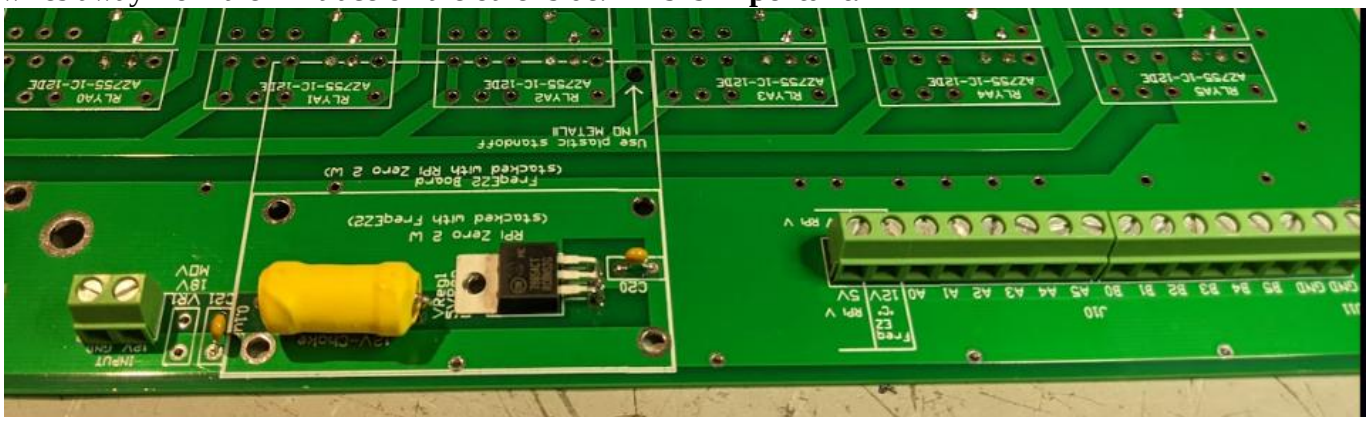
- ❑ **RPi/FEZ only:** Insert the 100uF electrolytic capacitor as shown. Orientation is important. Make sure the negative is away from the "+". Solder and clip the leads



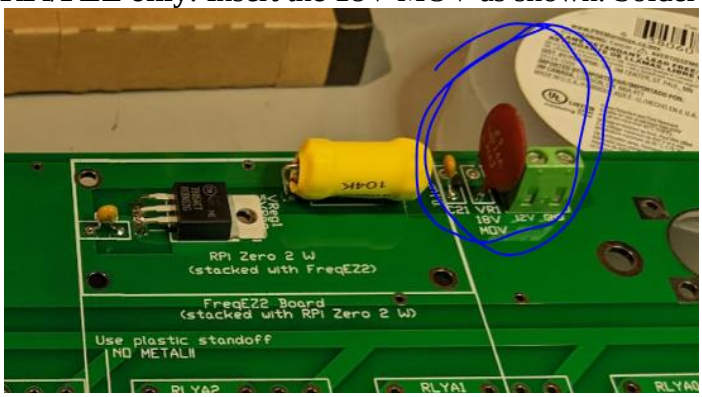
- ❑ **RPi/FEZ only:** Insert the 22uF tantalum capacitor as show. Orientation is important. Make sure the "+" marking matches the PCB marking. Solder and clip the leads.



- ❑ Solder on the euro connectors if you choose to use them. The two position connector is for **RPi/FEZ only**
  Note: Install the connectors so the wire entry is toward the edge of the board. This will keep the control wires away from the RF trace on the other side. **This is important.**

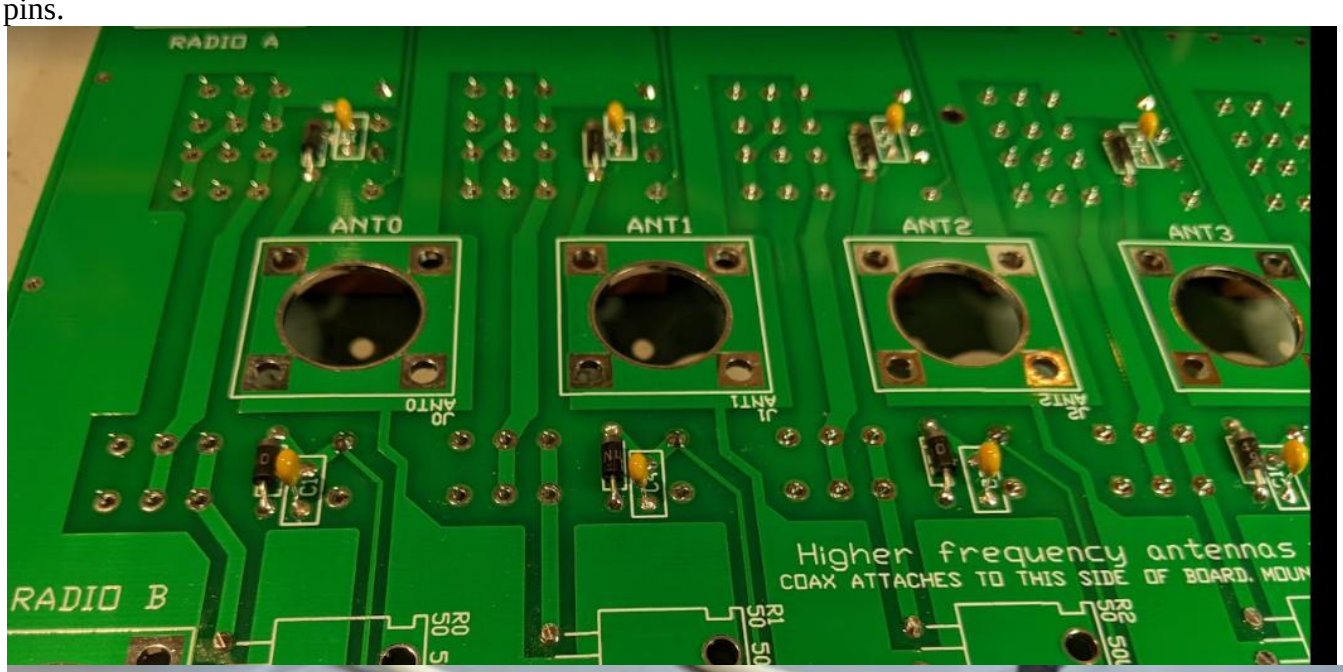


- ❑ **RPi/FEZ only**: Insert the 18V MOV as shown. Solder and clip the leads.



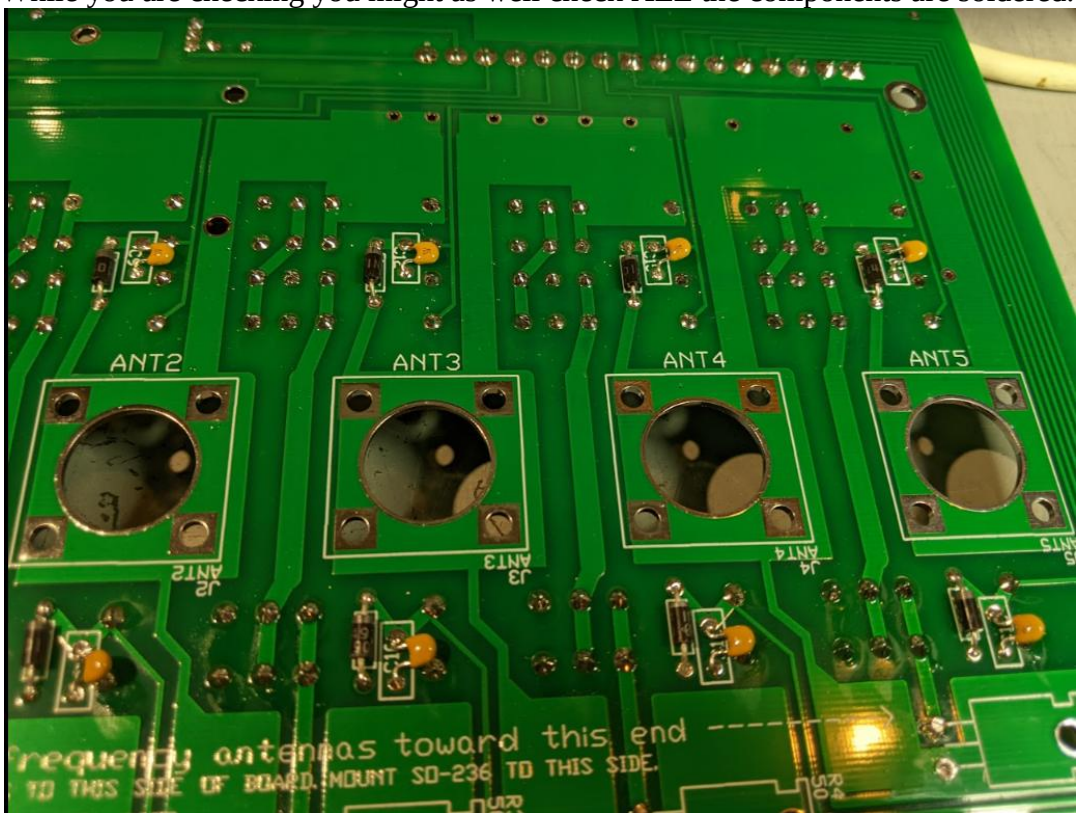
- ❑ Install the 18 relays. This can be a bit tricky to get all the relays flush and even with each other. You can install them one at a time or all at once.
- ❑ Relays one at a time. Starting from one end of the board insert a single relay. It will only fit one way. Tape or hold the relay in place while soldering a pin. Flip the board so the relay top is on the table/bench making sure the pins are evenly poking out of the bottom of the board. Solder all 7 remaining pins. Repeat for all 18 relays.

- [ ] All relays at once. I like this way. Insert all 18 relays. Cover the tops of all the relays with a single thin plywood or metal or thick cardboard sheet. While squeezing the PCB and the plywood together flip the whole unit so the plywood sits flat on the bench. The 18 relays should still be in the holes. Solder all the pins.

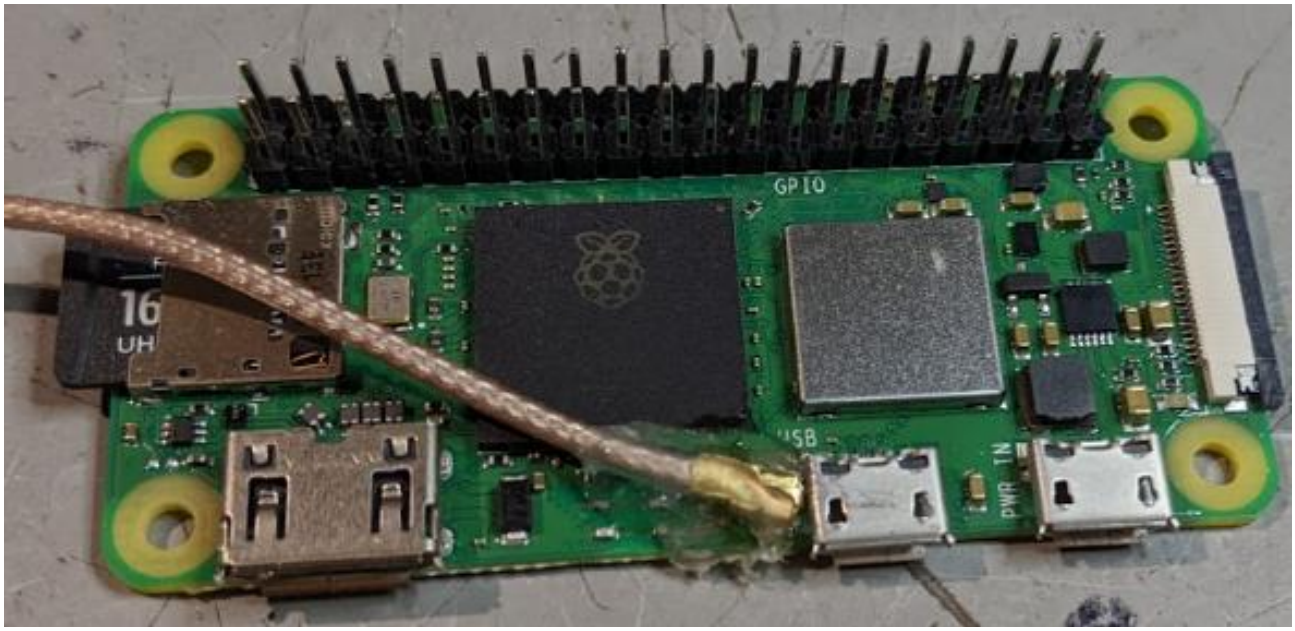


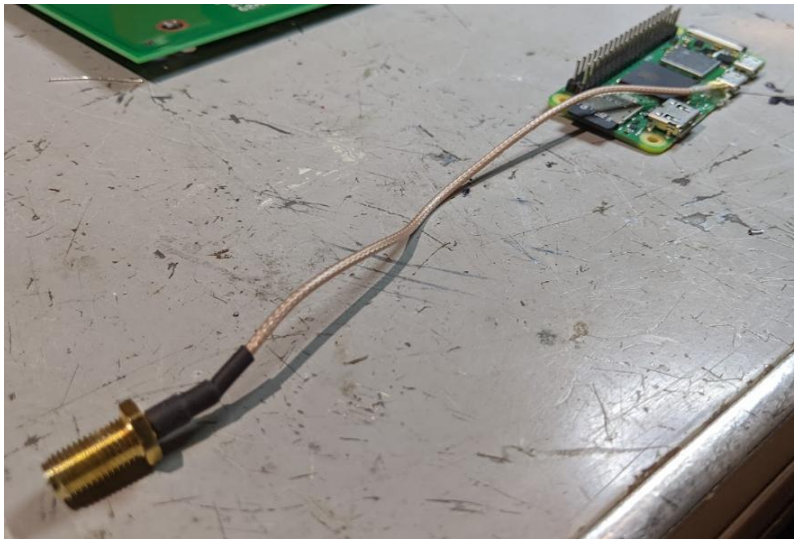
- [ ] There are LOTS of relay pins to solder. Now is the time to check that you have soldered each one correctly.

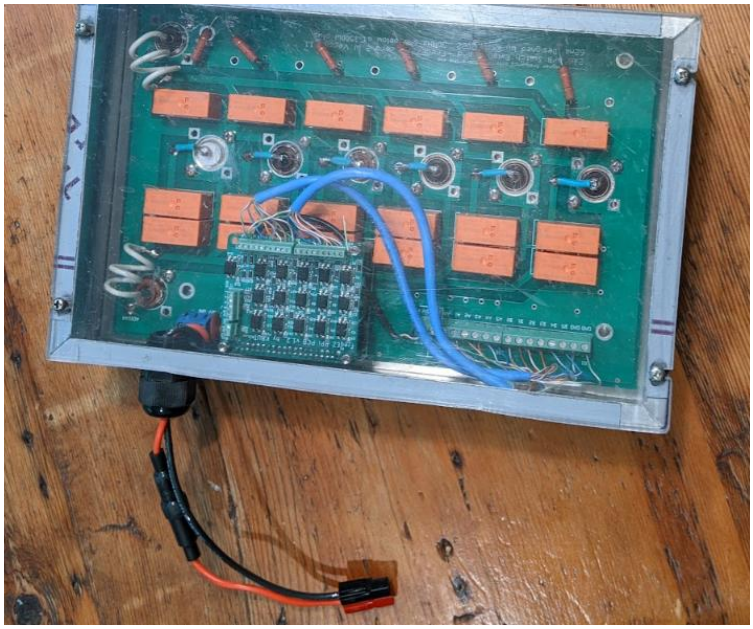
- ❑ While you are checking you might as well check ALL the components are soldered.



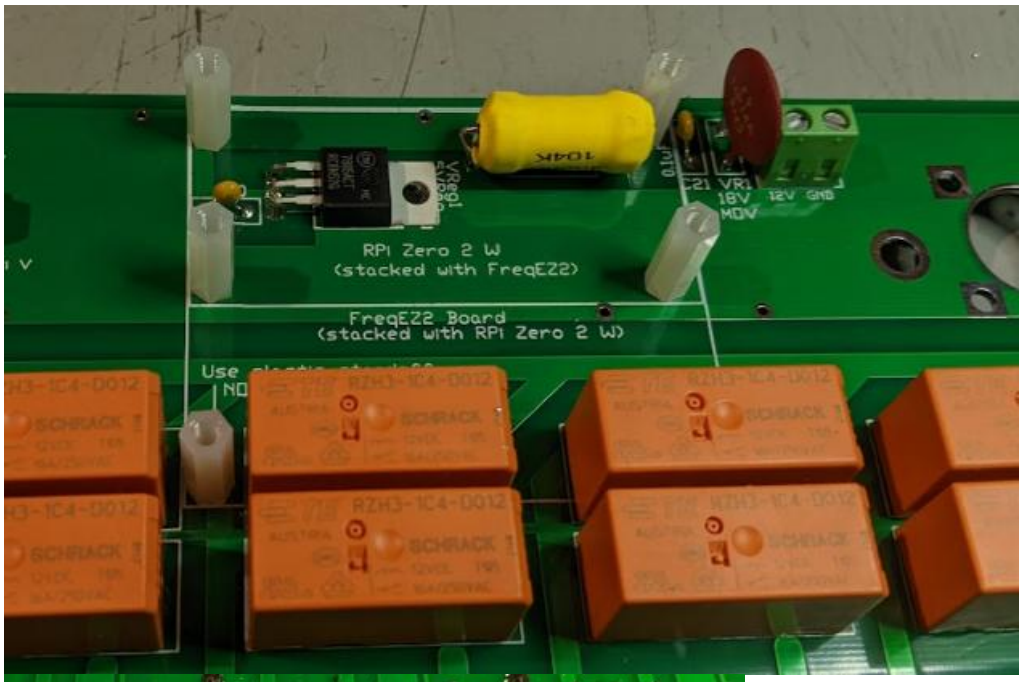
- ❑ **RPi/FEZ only**: If your RPi does not come with a connection for an external antenna you will have to install one. THIS IS NOT EASY. The connector is TINY (tiny)! There are some good videos how to do this on line. Google is your friend for this one. After installing the antenna lead I hot glued it to make sure it did not come undone. You will want to do this.
  https://www.youtube.com/watch?v=IZqaKZLIqFg
  https://www.youtube.com/watch?v=Y648CjIiEv8
  https://www.youtube.com/watch?v=KonrpeVRRjc
  NOTE: In cases where the unit is close to an access point you could instead use a Plexiglas or Lexan cover to the chassis. The WiFi antenna on the Pi is pretty good. You could "try it out" before adding the antenna connector to see if it works for you! I use a plastic cover in the unit we use at ARRL Field Day.


GPIO
USB
PWR IN



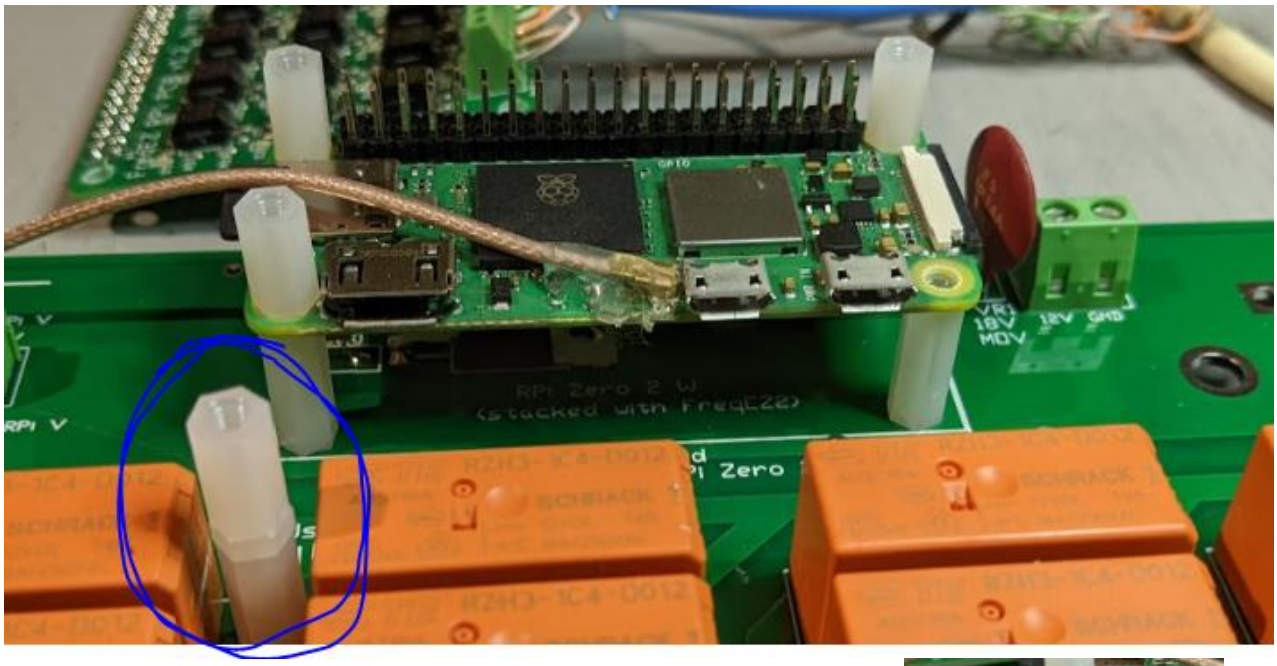


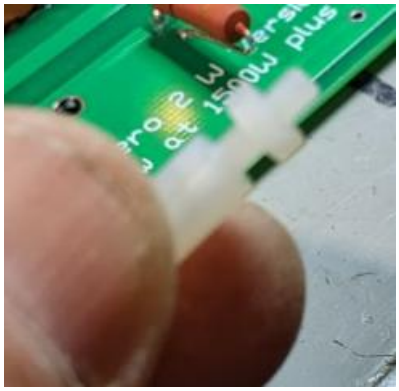
- ❑ **RPi/FEZ only**: Install the five standoff supports for the RPi Zero and FEZ2. Top and bottom views below.

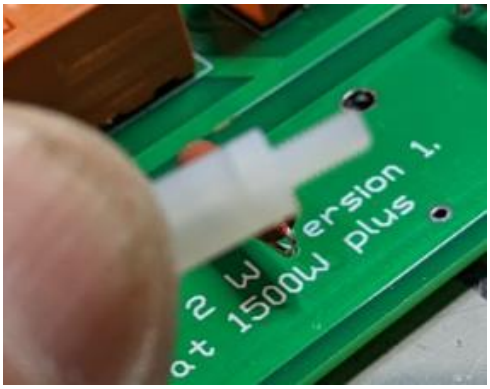


- ❑ **RPi/FEZ only:** Place the RPi Zero on the four standoffs and screw in **three** more standoffs as shown. NOTE: You might need to slightly drill out the mounting holes on the Pi.

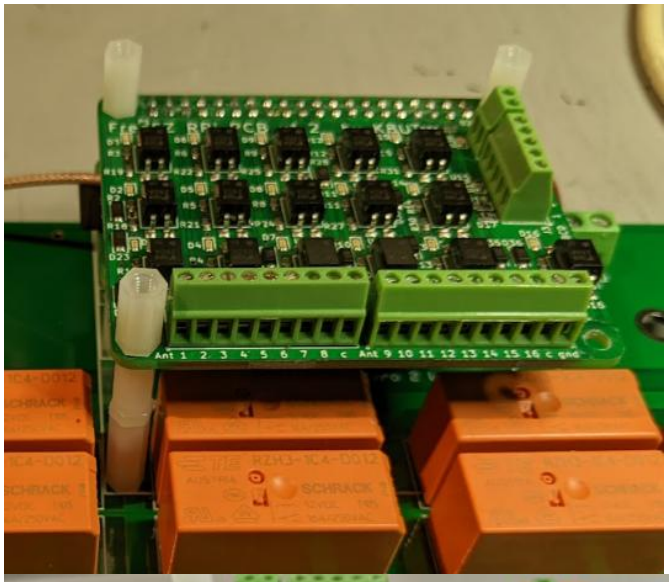
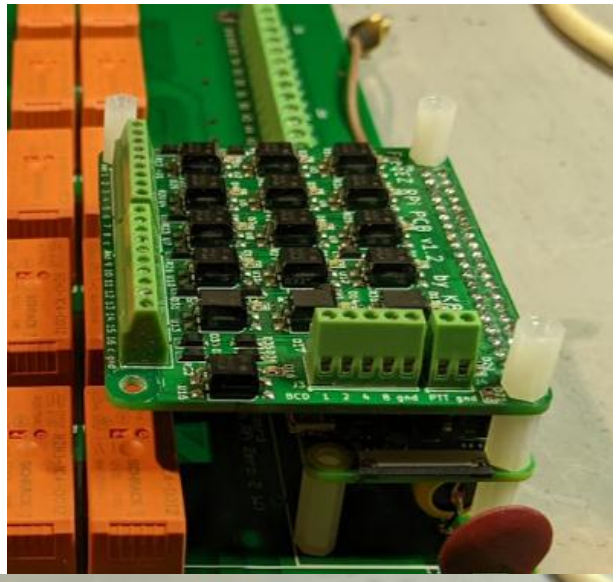
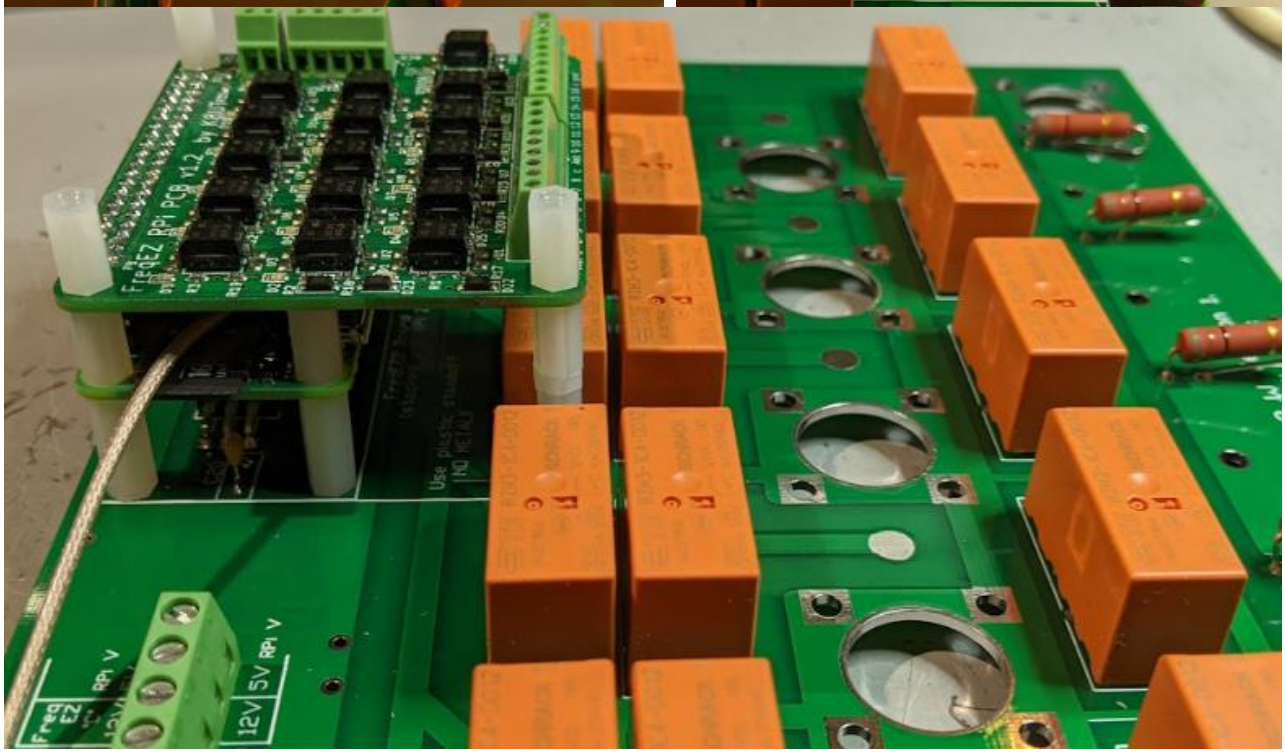
- ❑ **RPi/FEZ only**: The standoff between the relays will need a nut installed as a spacer as shown.



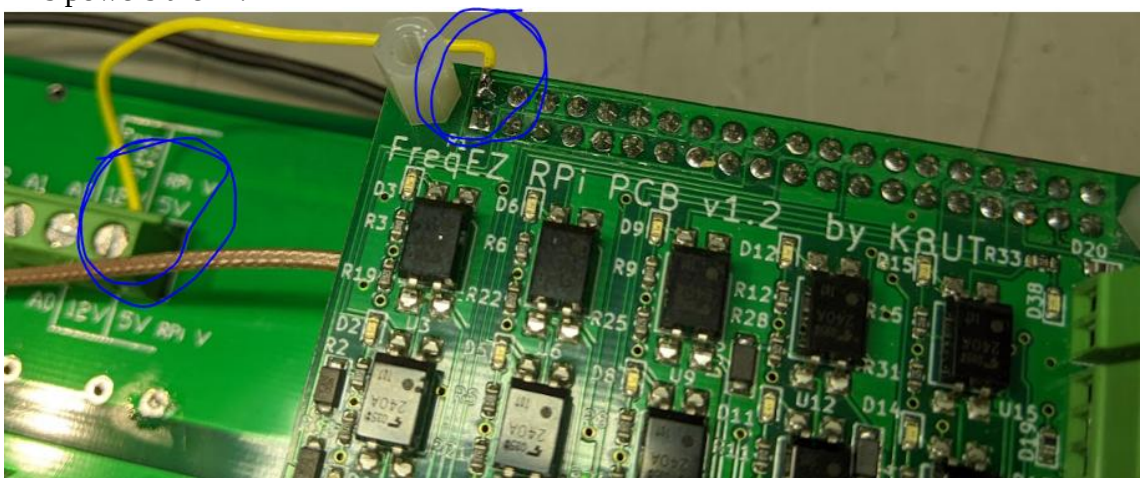




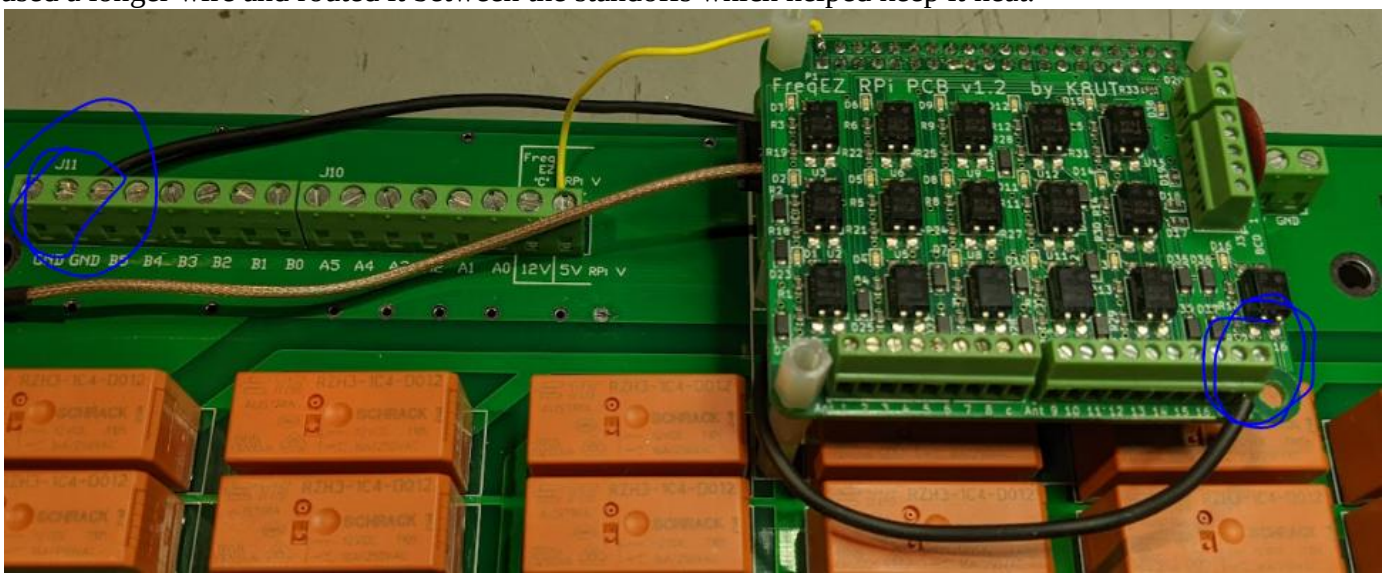
- ❑ **RPi/FEZ only**: The FEZ2 (FreqEz2) is installed on top of the spacers in the same way as the Pi. Note you may also need to drill out the mounting holes slightly.

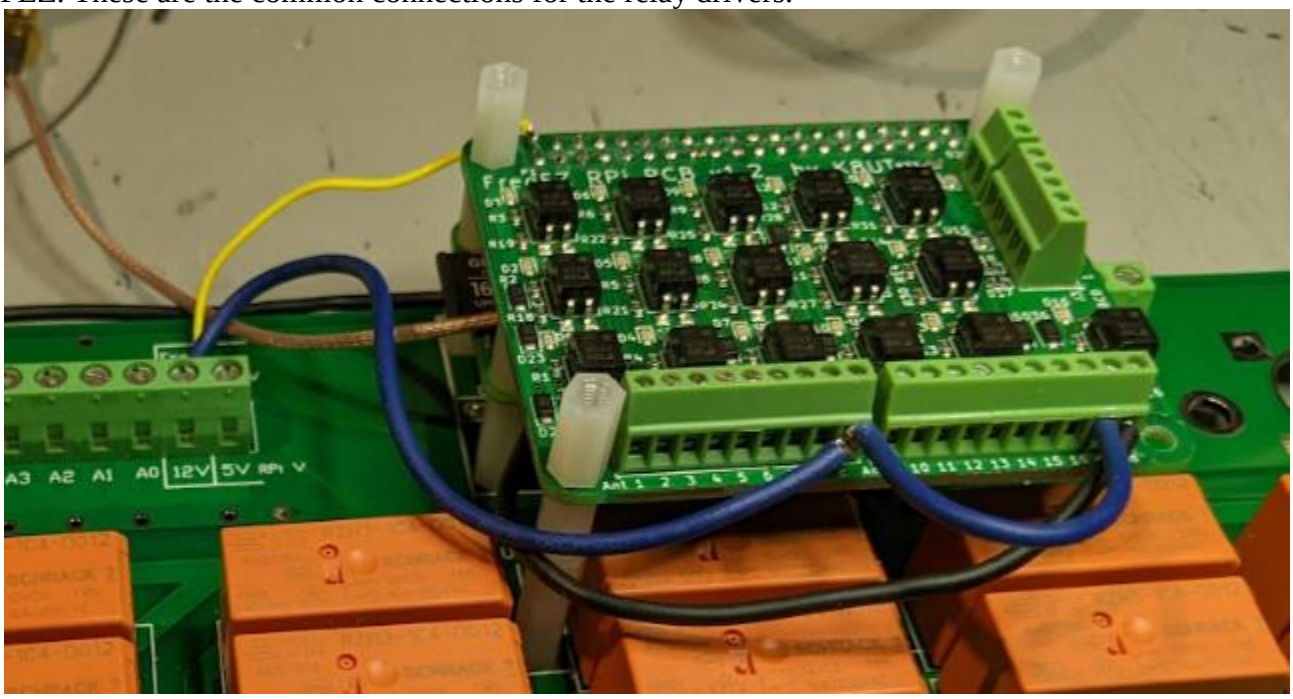
- ❑ **RPi/FEZ only**: Attach a wire from the “RPi V 5V” terminal to the upper left corner pin as shown below. This powers the Pi.



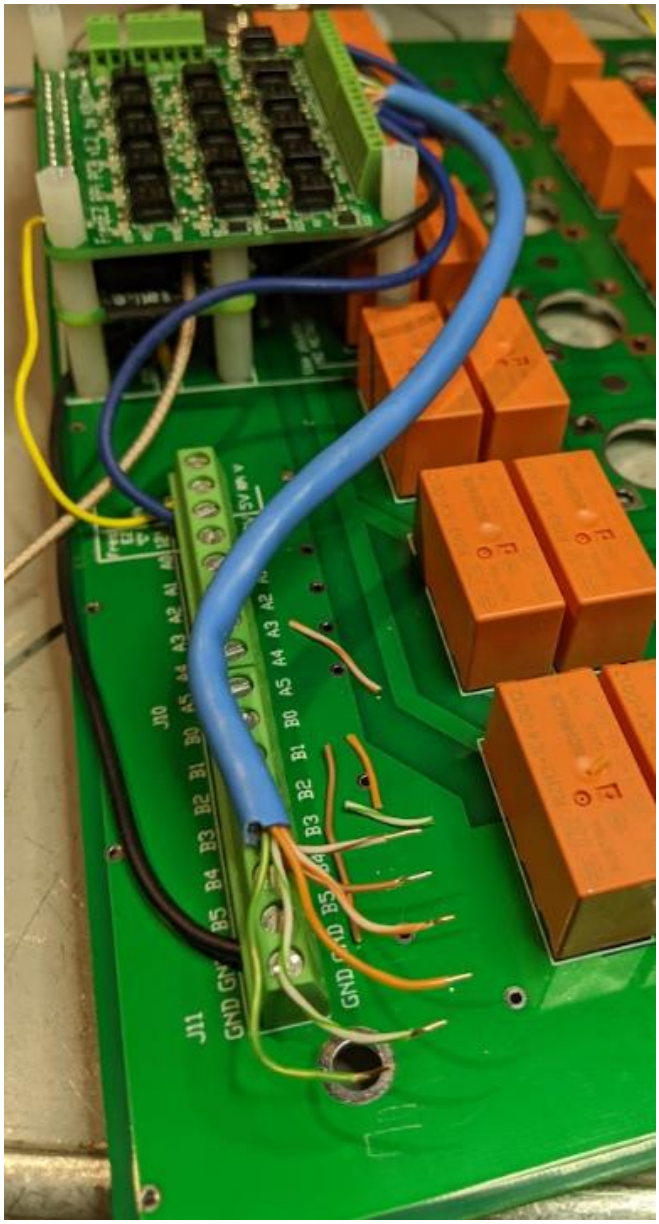
- ❑ **RPi/FEZ only**: Attach a wire from the relay board GND terminal to the FEZ GND terminal as shown. I used a longer wire and routed it between the standoffs which helped keep it neat.



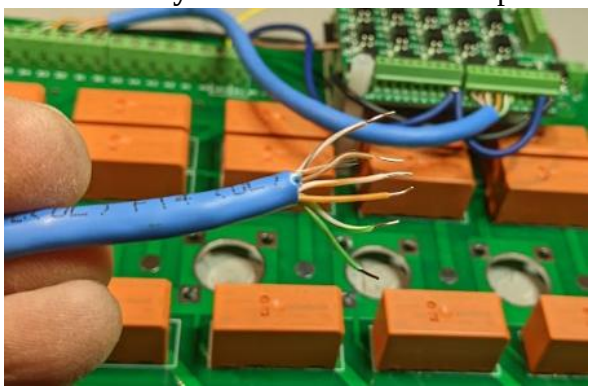
- ❑ **RPi/FEZ only**: Attach a wire from the relay board "FreqEZ C" terminal to the two "C" terminals on the FEZ. These are the common connections for the relay drivers.

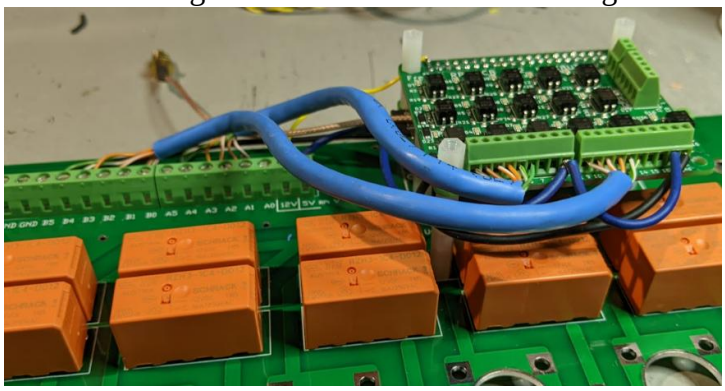


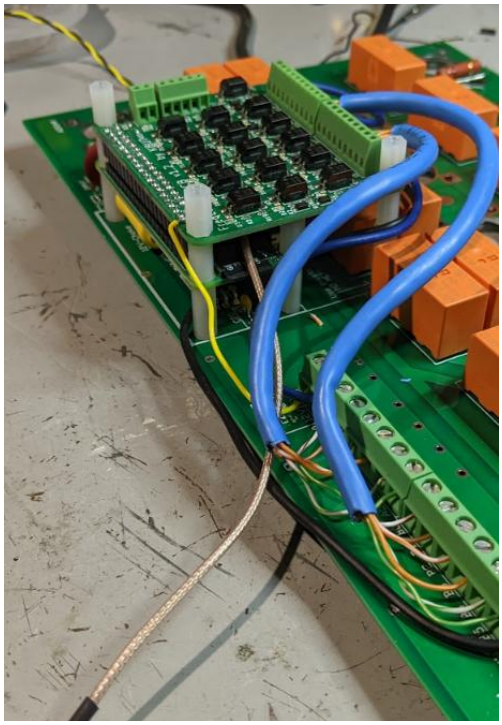
- ❑ **RPi/FEZ only**: Wire each of the B port controls to terminals 10 through 15 on the FEZ.
  Note: The routing of the wires as shown is important. It keeps the wires away from the RF trace below. The wires should enter from the edge of the board as shown.
  If you "goofed" and installed the connectors the wrong way, then make sure the control wires do not lay over the RF trace.



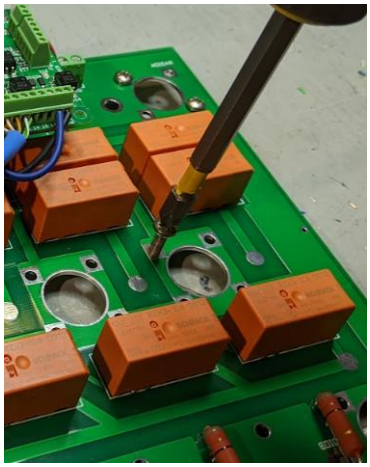
❑ **RPi/FEZ only**: Do the same for the A port connections wiring them to FEZ terminals 1 through 6.

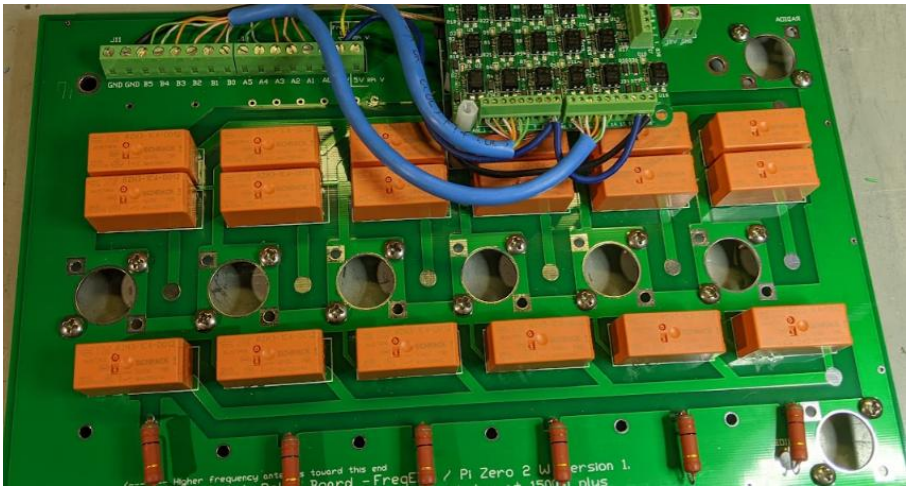




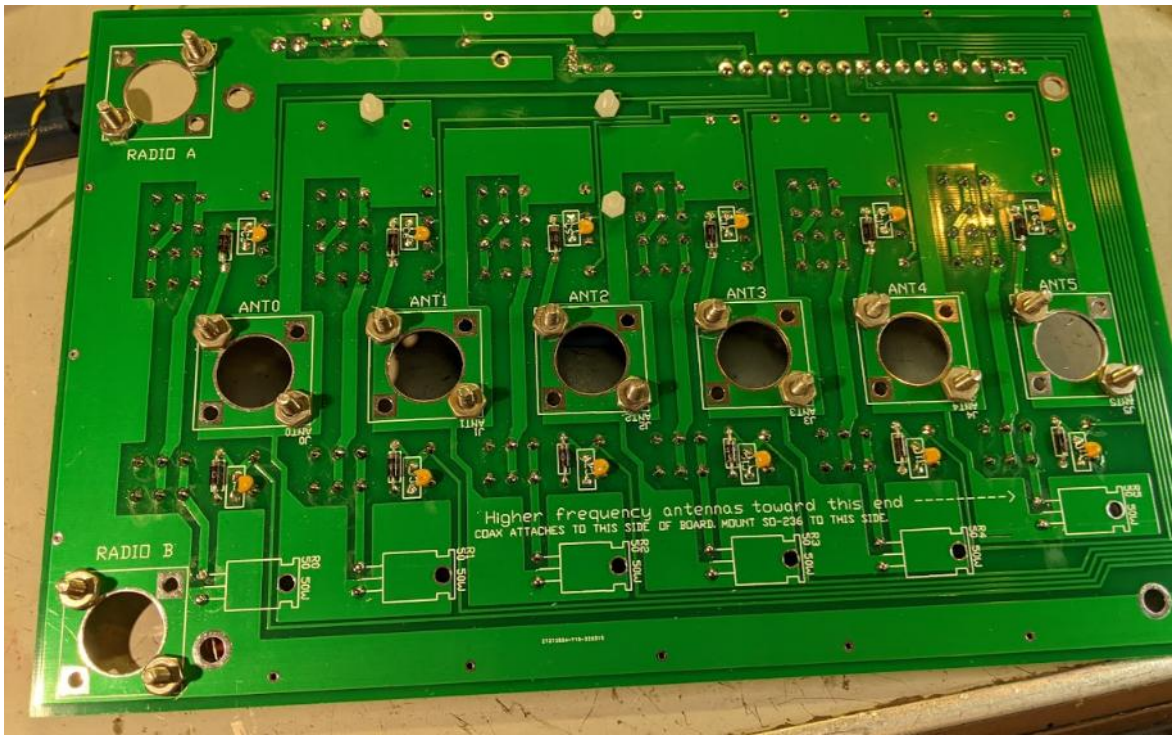


- ❑ For each of the 8 SO-239 launchers follow the instructions below.
- ❑ You will need the following for each launcher
  - 2 screws
  - 4 nuts
- ❑ Insert two screws in opposite corners from the “top” of the board. The fit is snug, so you might need to screw them in.

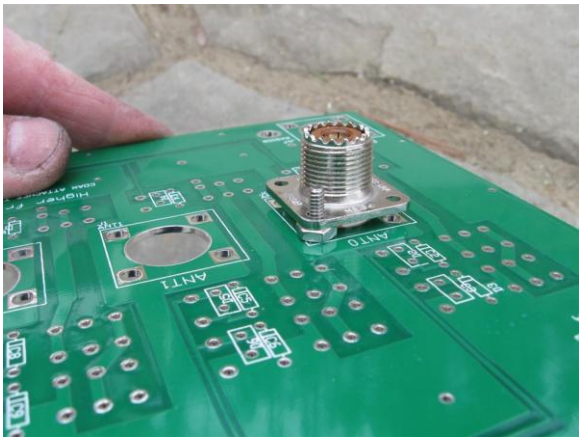




- ❑ Flip the board and tighten a nut on to each screw. This will act as a spacer to allow clearance for the diode and the capacitor.

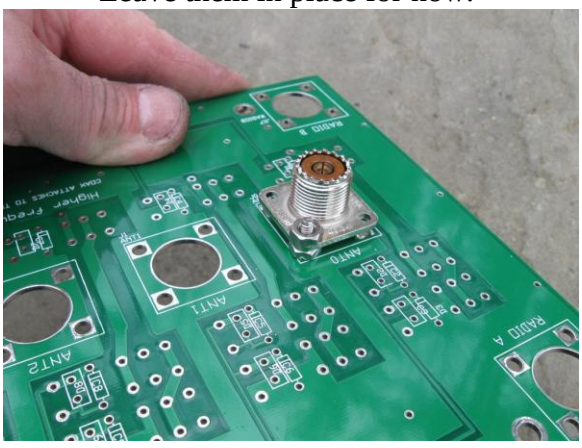


❑ Place the launcher on the screws.



❑ Attach another set of nuts. This will hold the launcher while you solder the RF connection.

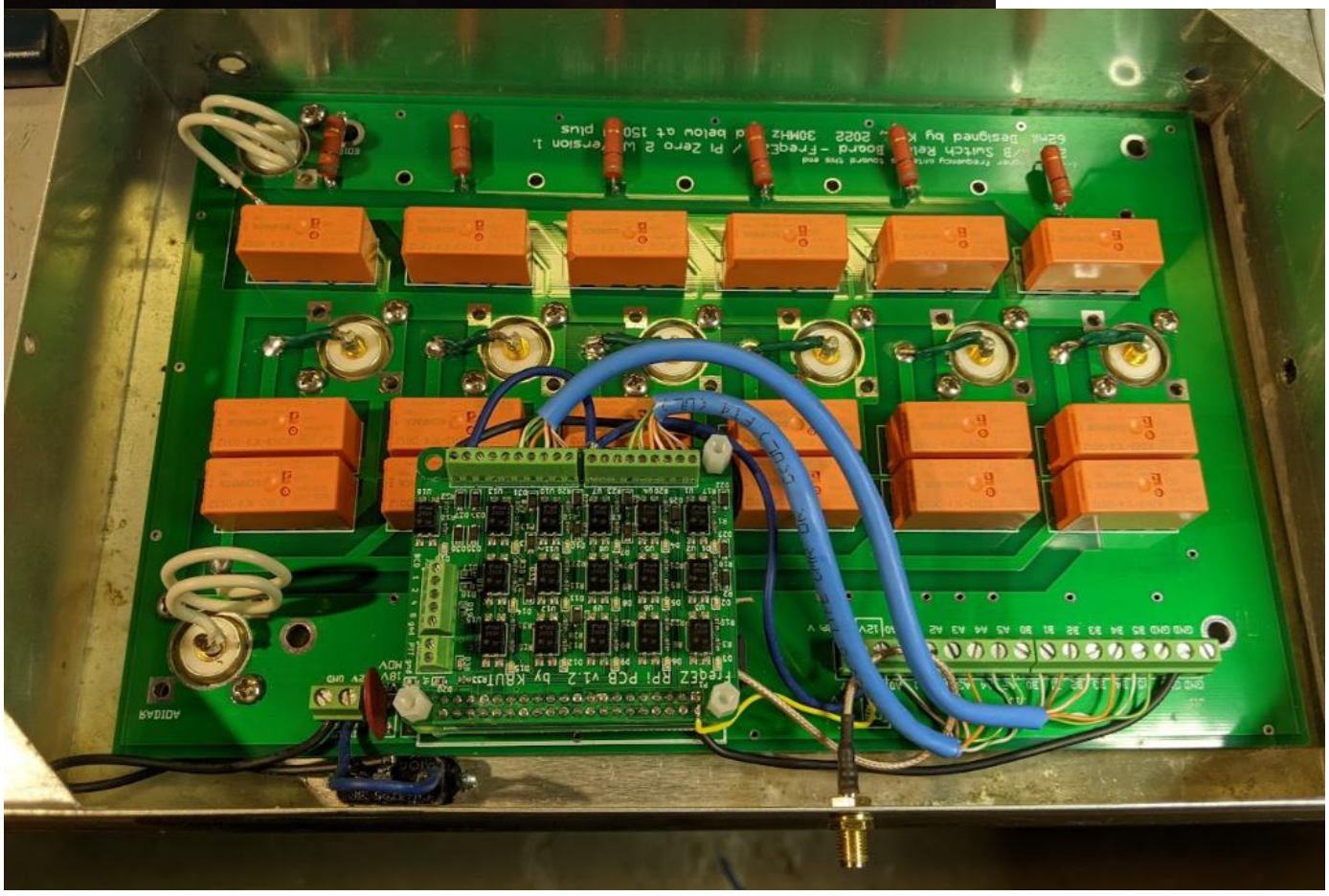
- This will be temporary to allow the RF wire to be soldered between the board and the launcher.
- Leave them in place for now.



- ❑ Repeat the above steps until all the launchers are attached.
- ❑ Attach a short piece of insulated 16 gauge or 14 gauge wire from the launcher to the pad on the board as shown. Stranded or solid is fine.
    - Repeat for each of the six antenna port launchers

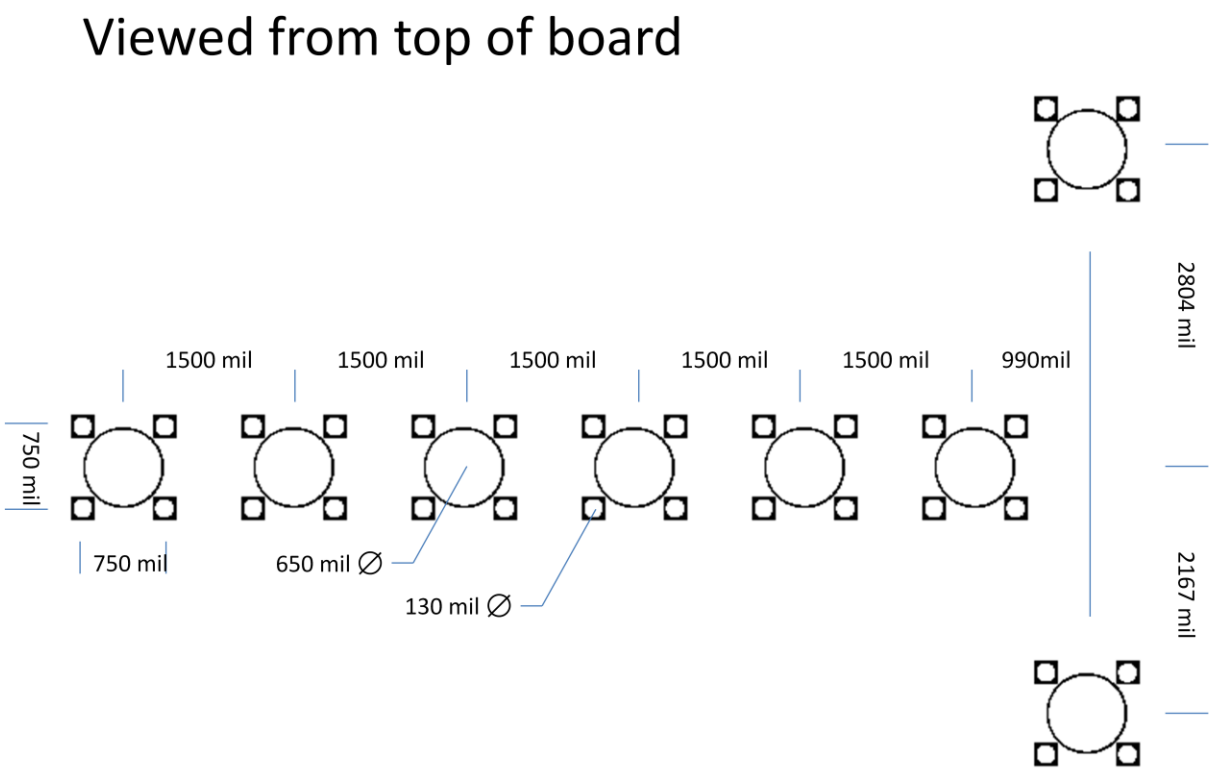
- ❑ For the radio port connections use 6 inches of insulated solid 16ga or 14ga formed with three turns as shown. This compensates for non-ideal SWR on 10m.
  NOTE This is an excellent idea contributed by AC0C, Jeff Blaine, and is documented at https://www.ac0c.com/main/page_so2r_kk1l_2x6_ant_switch.html and "KK1L2x6SwitchRelayBoardPerformanceAnalysis.pdf" on my website.

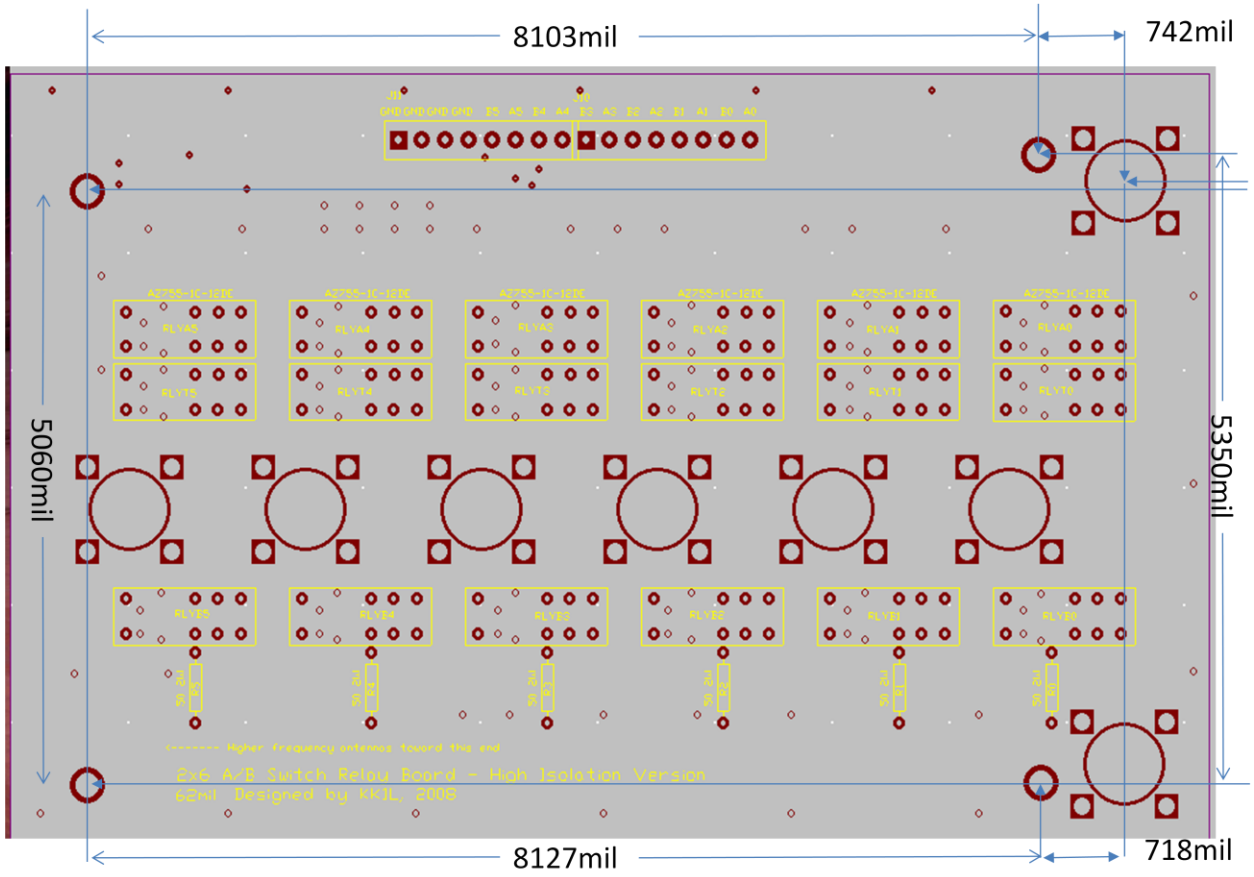
- ❑ To mount the board to the chassis you will remove the two (2) temporary nuts attached to each launcher and use them to secure the chassis.
- ❑ Put the board inside the chassis so the screws fit in the chassis holes.
- ❑ Attach the nuts on the outside of the chassis.
- ❑ Tighten them snuggly.



- ❑ You are done.
- ❑ If you have questions please email KK1L@COMCAST.NET

Relay Board Dimensions for Chassis Drilling




8103mil
742mil
5060mil
5350mil
8127mil
718mil
2x6 A/B Switch Relay Board - High Isolation Version
62mil Designed by KK1L, 2008