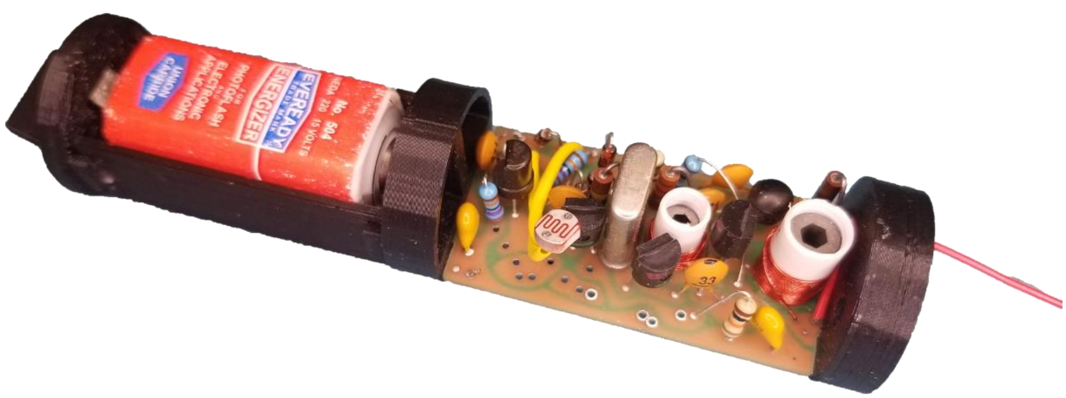
This manual is a Work in Progress

Building the
TRANSROC
Model Rocket Transmitter



Project Page

https://www.github.com/d5aa962e/Transroc

This project is dedicated to all those Born Again Rocketeers out there who have been just itching to get their hands on a piece of 50 year old model rocket electronics technology!

Contents

Table of Illustrations

This manual will take you through the steps of building an authentic *TRANSROC Model Rocket Transmitter* as first released by Estes in their 1972 catalog. Your TRANSROC will be as close to the original design as modernly possible.

The base TRANSROC is built in the *Rocket Finder Mode*. This mode will sound a "pulse" about once a second on your walkie-talkie. This manual documents building the TRANSROC in the *Spin Rate Mode*. Building the transmitter in other modes is an exercise left to the builder.

Many parts supplied in the original kit must be 3D printed or made by hand.

Don't get discouraged by the length of this manual. There are several parts of the TRANSROC that are no longer commercially available, so this document includes sections to help you build those parts with modern equivalents.

Wherever possible, Open-Source tools were used in this project.

Design Decisions (How Accurate Do You Want to Get)

In kit form, Estes supplied all the components to build the TRANSROC in *Rocket Finder Mode*. The parts list included all of the electronics, molded plastic mounting pieces, and a circuit board / coil assembly.

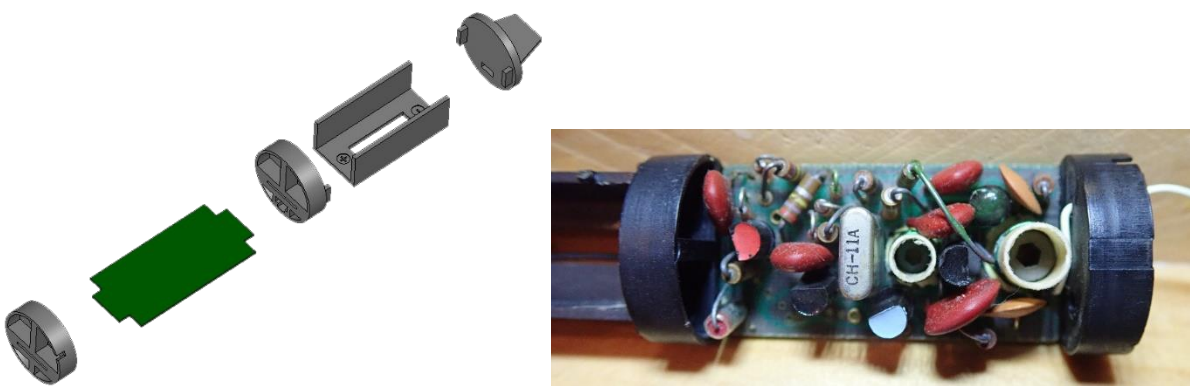


Figure 1- Exploded View and Photo

For this project, we have to consider how accurate you wish to make your TRANSROC. Many of the parts are no longer available in the original packages and/or values, so compromises have to be made.

1. Plastic Mounting Pieces – These were recreated with the help of photographs of an actual TRANSROC, as well as from photos in the manual. The parts were designed in FreeCAD and 3D printed on an Ender 3 V2 printer.
2. The 2N5172 and 2N6027 transistors are hard to find in their original TO-98 package. You can occasionally find them on eBay, but modern TO-92 packaging is perfectly acceptable if you are willing to ignore the package differences.

3. DZ805 diodes are no longer available. Based on the data sheet and how the diodes are used in the TRANSROC, generic 1N914 / 4148's were substituted with no apparent issues. They look the same, so no one will know.
4. The original coil forms appeared to be made of paper. As luck would have it, based on measurements, readily available polystyrene tubing can be used.

Tools and Build Supplies

- ~40W Soldering Iron with Fine (~1mm) Tip
- Rosin Core Solder
- Water Soluble Flux
- Narrow Pliers
- Tuning Tools (0.1" and 0.078"
- Thin CA Glue
- 10-32 Bottoming Tap
- ¼"-28 Bottoming Tap
- Access to a 3D printer

Sourcing the Components

Please see the Parts List document for a complete list of components you'll need to build your TRANSROC. In addition to the parts, you'll need a CB Radio walkie-talkie, or another radio capable of receiving on the Citizen Band (27MHz). Please refer to the TRANSROC Owner's Manual for guidelines on the type of radio that works best.

Print the Plastic Parts

The Battery Holder and three Mount pieces must be 3D printed. The prototype parts were printed with PLA+ filament, a 0.4mm nozzle, and a layer height of 0.12mm. The parts should be printed at a fine resolution as there are very tight tolerances involved in this build. Once the parts have been printed, test fit all the pieces and trim / clean up the parts as necessary. Do NOT glue any parts at this time!

Print these two parts: Battery_Holder-Main.stl Bottom_Mount-Main.stl

If you were an early adopter, and are using cut strips of the 0.01" brass, print these two parts:

Thumb_Mount-Main.stl Top_Mount-Main.stl

If you will be using the 0.016" x 1/4" brass strips, print these three parts:

Thumb_Mount-Part1_v2.stl Top_Mount-Main_v2.stl
Thumb_Mount-Part2_v2.stl

Glue the two Thumb Mount pieces together, aligning the rectangular cutout of both pieces.

Figure 2 - 3D Printed Parts

Test fit the board into the Top and Bottom mounts. The board should fit into the Top Mount and Bottom Mount parts very snuggly. As in the TRANSROC manual, carefully scrape the board (or more likely, the 3D printed part), until a complete, but snug fit is made.

Building the Coils

The original TRANSROC kit supplied you with a printed circuit board that included the two coil forms glued to the board, and the coils were already wound and soldered in place. For the modern version, you'll have to cut the forms to size, cut (tap) the threads of the form, and then finally wind the coils. This isn't as hard as it sounds, but takes a bit of patience. Take your time to let glue dry and you should be able to build both coils over the course of two evenings (or a long day if you're ambitious).

The general process is:

1. Cut the threads (tap) into a piece of polystyrene tubing.
2. Cut the tubing to length.
3. Glue the tubing to the board.
4. Wind the coils around the tubing.

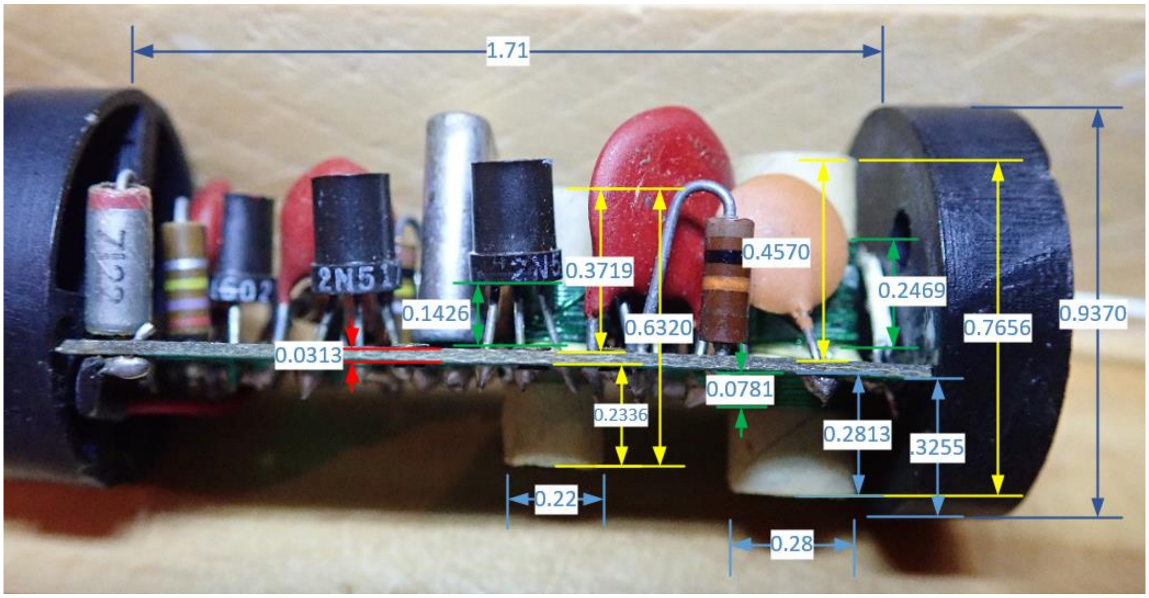


Figure 3 - Coil Dimensions

Cutting and Tapping the Coil Forms

Large (Antenna) Coil	Evergreen #229 – 9/32” polystyrene tubing ¼”-28 NF Tap; bottoming tap best Cut final length to ¾" (19 mm) after tapping
Small (Oscillator) Coil	Evergreen #227 – 7/32 polystyrene tubing 10-32 NF Tap; bottoming tap best Cut final length to 5/8" (16 mm) after tapping

For each coil form:

1. Place the appropriate tap into a variable speed drill (you can tap by hand, but it will take longer).
2. Hold the tubing in one hand, and with the drill in your other hand, place the tap up against the tubing and slowly start the drill.

Figure 4 - Tapping the Styrene Tube

3. Tap about 1/8” to ¼” and stop.
4. Reverse the drill and completely back out slowly. Clean the tap with a brush to dislodge the plastic shavings.
5. By hand, carefully thread the tubing back onto the tap. It's important that this step be done manually to ensure you don’t strip the threads you’ve previously cut. Once you’re sure the tap is on the existing threads, you may continue to tap the tube with the drill.
6. Repeat Steps 3-5 until you have reached the end of the tap.
7. Run the tap 2-3 more times up to the end of the tap, cleaning the tap each time. This will refine the threads.
8. Test fit the iron slug to make sure it can freely travel the length of the cut threads. Do NOT force the slug. It *will* break (don't ask me how I know this!) If the slug can't travel the length of the threads without binding, repeat Step 7 until the slug moves freely through all threads.

Figure 5 - Test fit the slug

Cut the threaded tube and test fit the slug one more time (you may need to run the tap through by hand to clean up the cut end of the tube. Mark the bottom of the coil form with a marker (you want to be sure the forms are placed on the circuit board in the correct orientation.

The large tube should be cut to 3/4", and the small tube to 5/8".

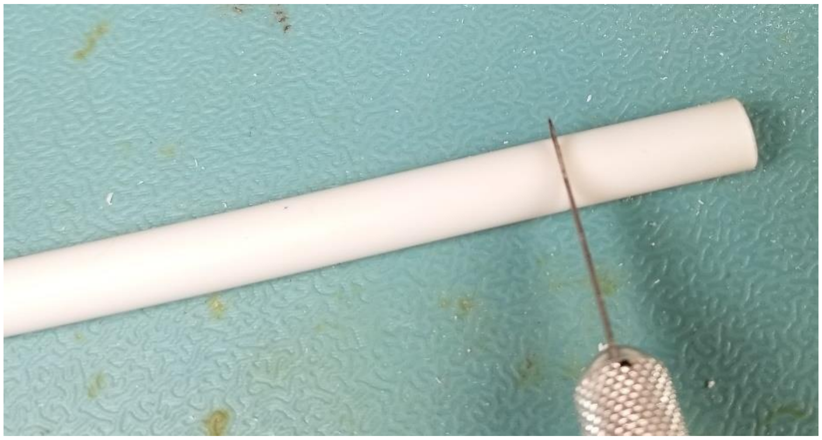


Figure 6 - Cut the tube to length

Test fit a coil form in the corresponding hole of the circuit board. The forms should fit very snug, but do not force the form into the hole. If the form still will not fit, gently file the hole. Alternatively, you can scrape the hole with an X-Acto knife a little at a time. You should not have to file/scrape much material from the board hole.

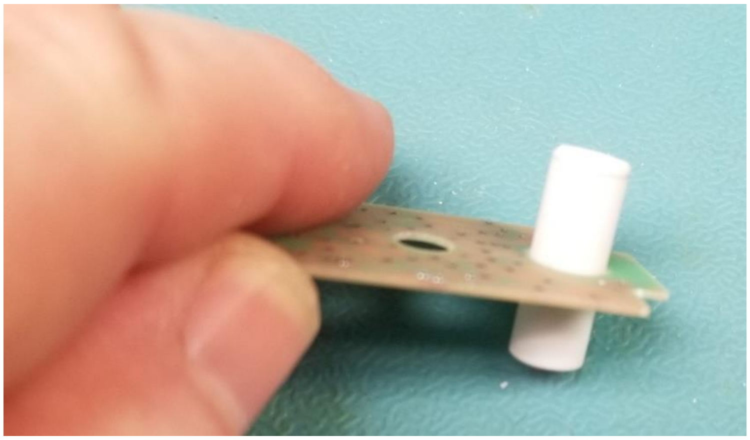


Figure 7 - Test fit tube into the circuit board

Position the forms on the board as shown in Figure 7 and Figure 8. Make sure the forms are perpendicular to the board from both the side and end views. One more time, test that the slugs can smoothly travel the length of the form before gluing.

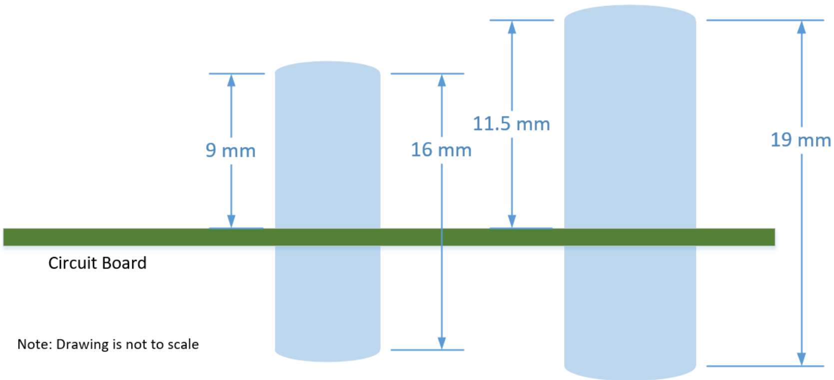


Figure 8 - Coil Form Positions

Once you're satisfied that the forms are square to the board, use a fine tip applicator to put a drop or two of CA glue around each form to make a fillet around the top side of the board. Make sure you don't get glue on any component hole as you won't be able to solder the corresponding part. If you do get glue where it shouldn't be, use CA Remover on a cotton swab to clean the board.

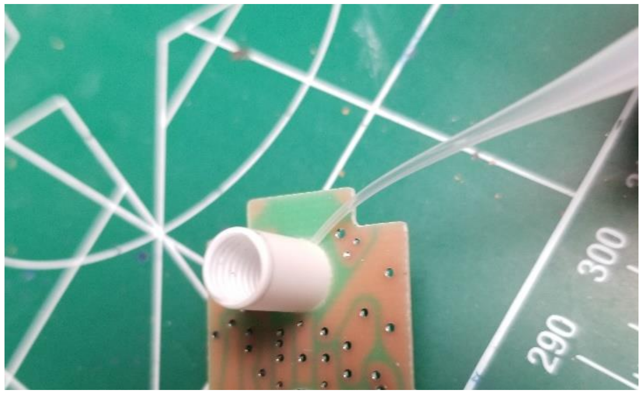


Figure 9 - Applying CA glue to the coil form

Let the glue dry thoroughly.

Winding the Coils

In short, do what works best for you. Although this next set of instructions worked for me, your situation may be different. Comments and alternative methods are welcome!

The coils are wound with 30-gauge enameled magnet wire. Be careful not to kink the wire when feeding it through the holes and pulling it tight.

Conventions

up, feed wire up	Feed the wire starting from the bottom of the board up through the hole to the board top.
down, feed wire down	Feed the wire starting from the top of the board down through to the board bottom.

When soldering the coil wire to the circuit board, be very aware of where the soldering iron is. It is very easy for the iron to touch the styrene forms and melt them.

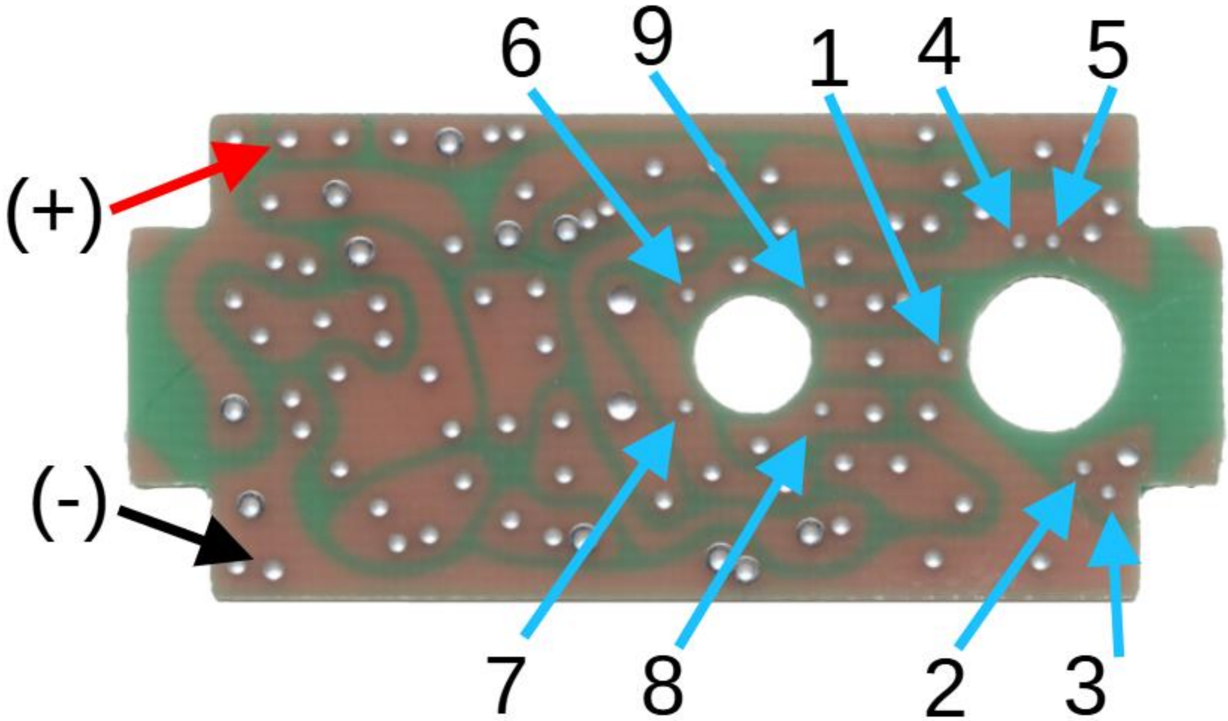


Figure 10 - Circuit Board Top (Component) View

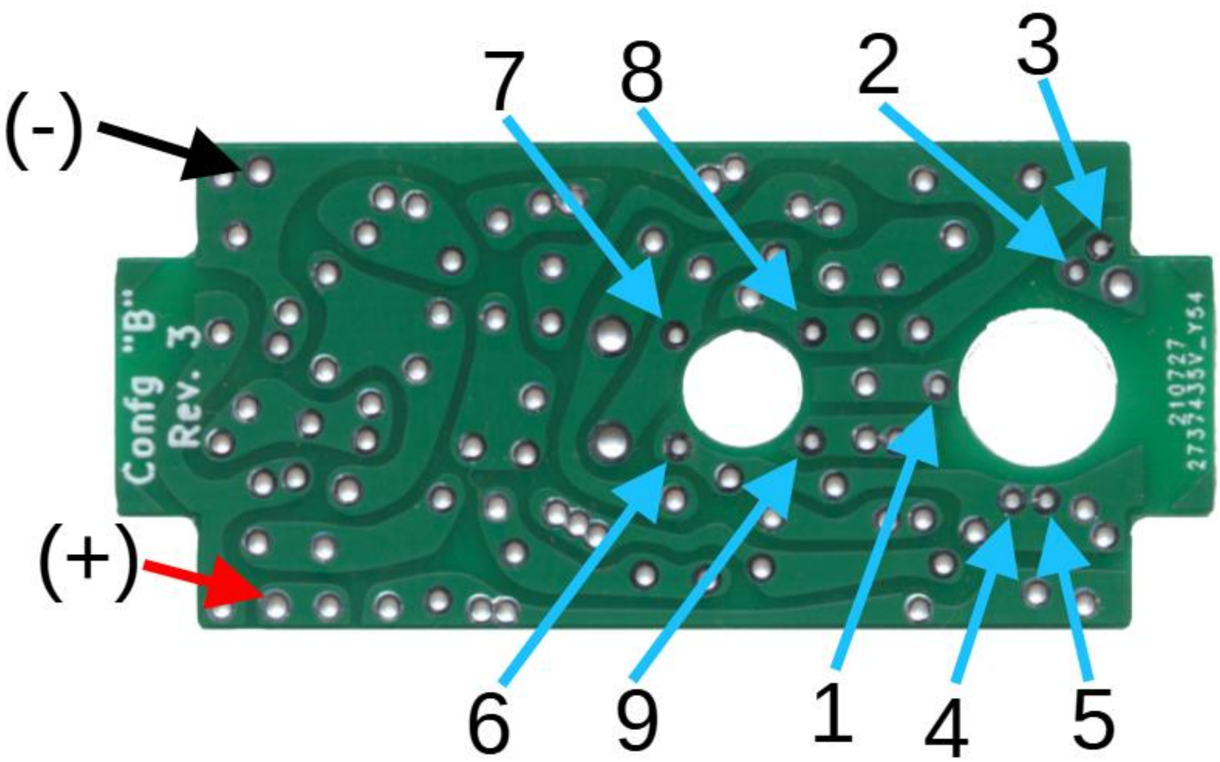


Figure 11 - Circuit Board Bottom (Copper) View

Refer to Figure 10 and Figure 11 when winding the coils per the steps below.

Large (Antenna) Coil

1. Cut a 40” piece of wire for the large coil. Scrape 1/8” of insulation at the 9” mark (Figure #). Thread the wire *down* through Hole #1 so that there is nine inches of wire below the board. Solder the wire into Hole #1.

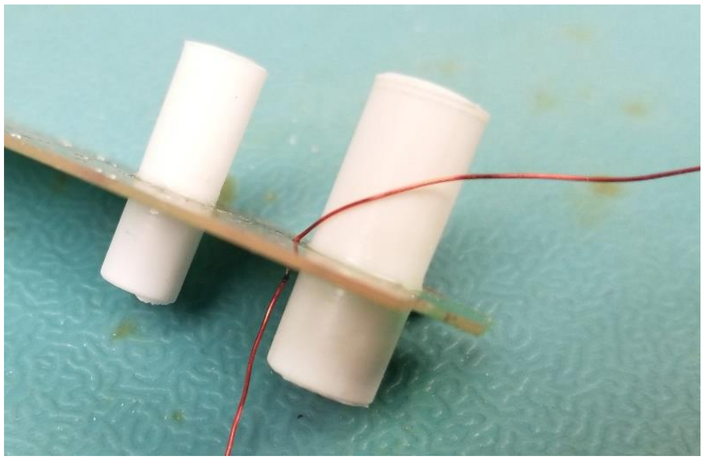


Figure 12 - Winding the Large Coil (top coil)

2. Wind 22 full turns plus an additional 1/3 turn counterclockwise on the top of the form. Wind 3-4 turns at a time, sliding the turns tight against each other as you go. Secure the remaining wire along the tab at the end of the board (do not thread the wire through the final hole just yet. Run thinned white glue along the coil to secure the winding in place. Let the glue dry.

   Alternatively, you can thread the wire down through Hole #2 and wrap the remaining wire as shown in Figure 13 to temporarily hold the windings in place. Be careful not to kink the wire!

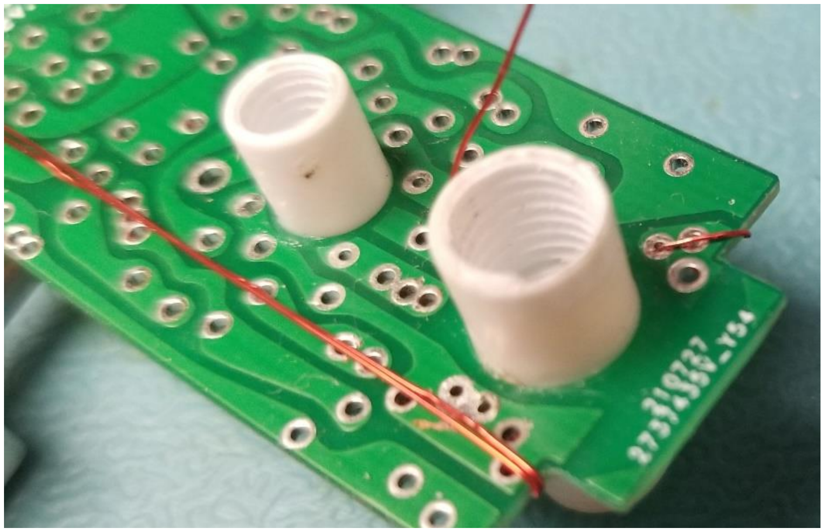


Figure 13 - Anchoring the Large Coil wire

3. If you went with the gluing method, now thread the loose end of the wire *up* through Hole #3. Scrape the insulation off with a knife and solder it in place. Congratulations, you’ve completed the first of FOUR windings!

Now for the bottom winding.

4. Wind the lose 9" wire counterclockwise around the bottom of the form. Wind four full plus ¼" turn and feed the wire *up* through Hole #4. Again, be careful not to kink the wire.

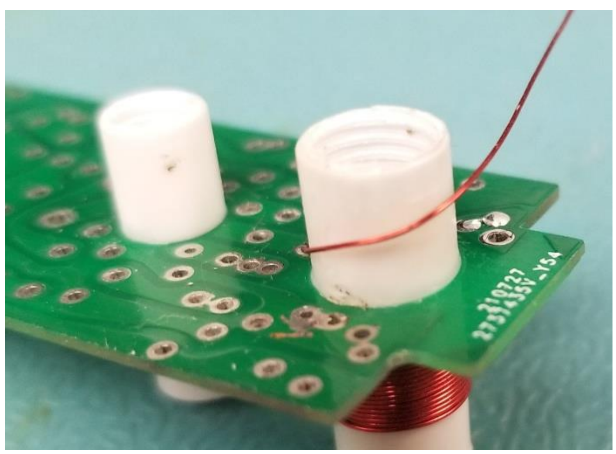


Figure 14 - Winding the Large Coil (bottom coil)

5. Scrape the insulation from the wire around Hole #4 and solder in place. Pass the loose end down through Hole #5 and cut to 1/8". Again, scrape insulation from the wire and solder it to Hole #5.

Test the continuity of the solder connections for both coils. If there isn't any continuity for a coil, the most likely cause is not enough insulation was removed.

Small (Oscillator) Coil

For the smaller coil, you will need to make two separate windings. Both windings are wound on the **top** side of the board. Cut at least 20” of magnet wire for the inner winding and 15" for the outer. Following the above procedure, first wind the inner coil, then the outer coil, noting direction [enhance this].

a. Feed the 20" wire *down* through Hole #6. Solder in place.
b. Wind 12 ¾ turns clockwise; wrap the loose end around the board and add thinned white glue to hold the windings in place. When dry, feed the loose end *down* through Hole #7 and solder in place.
c. Feed the 15" wire down into Hole #8 and solder in place.
d. Wind 4 ¼ turns counterclockwise; again, wrap the loose end and add glue. When dry, feed the loose end down through Hole #9 and solder in place.

Congratulations!!

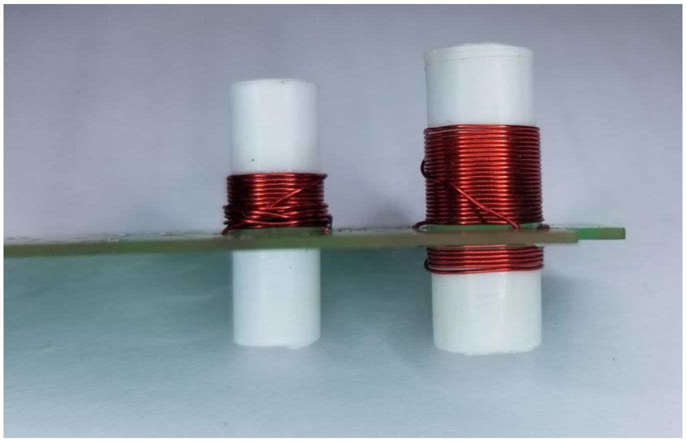


Figure 15 - Finished Coils

Your board should look like Figure 15. In 1972, Estes would sell you a board, with all the work you just put in to make your own, for just $4.00 USD! You probably wish they still would!

The Battery

The TRANSROC kit included battery clips bent into the correct shape. For this recreation, you'll have to bend a brass strip into the proper shape. In addition, depending on how authentic you want to get, you may wish to "build" an authentic Eveready 504 battery.

Making the Battery Contacts

The battery contacts are made from 0.016" x ¼" brass strips, or cut from a 0.01" brass sheet. There are different STL files you will need to print depending on which brass solution you use.

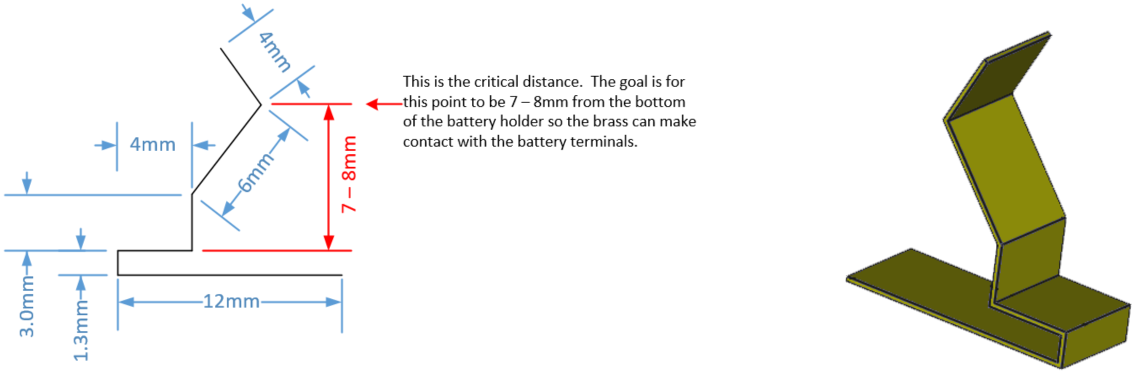
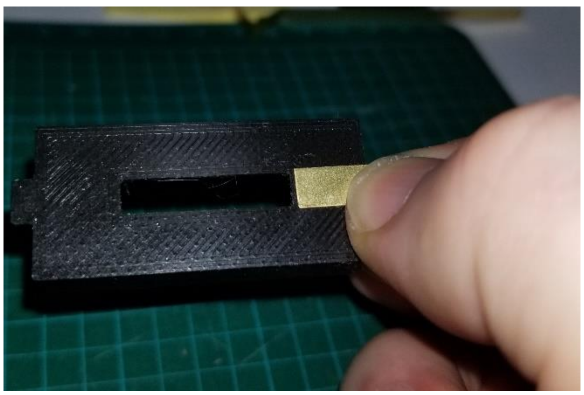
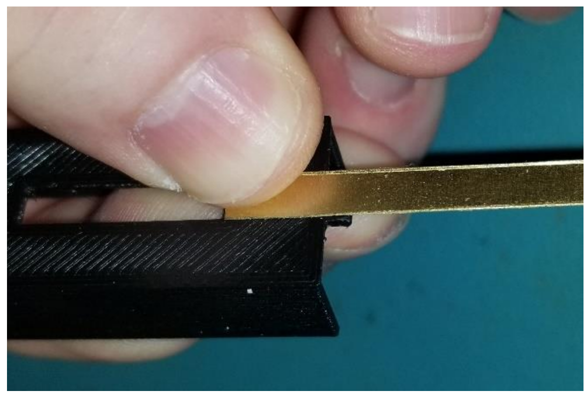
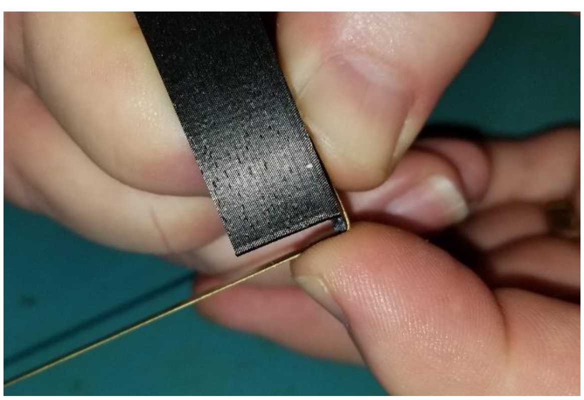
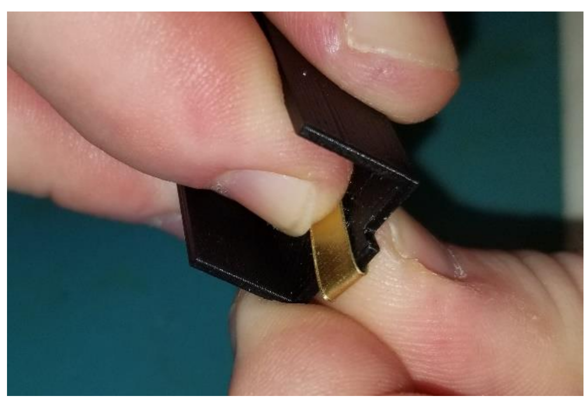


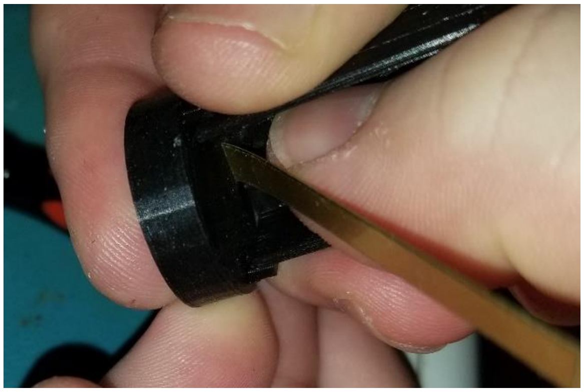
Figure 16 - Battery Clip Dimensions

Follow the next set of photos to bend the brass strip into the correct form. It's important to hold the brass firmly against the plastic parts to help keep the bends clean.

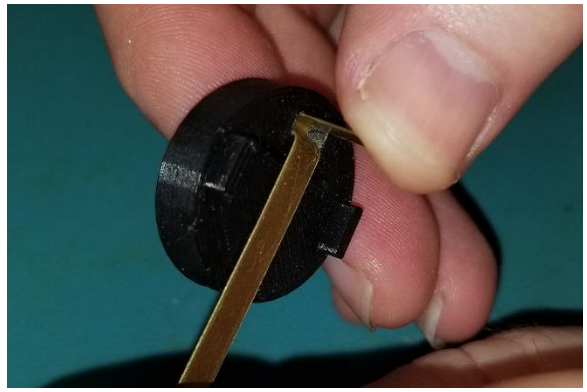
 Step 1 – Position the brass strip on the bottom of the battery holder so that the end about lines up with the cutout.	 Step 2 – Hold the strip against the battery holder and line it up with the tab.
 Step 3 – Bend the brass strip up against the tab so that the bend forms a right angle.	 Step 4 – Fold the strip over the top of the battery holder.

Step 5 – Place the Top Mount over the brass strip / battery holder assembly. While holding the parts together, place a small screwdriver up against the space between the holder and brass.

Step 6 – While holding the screwdriver firmly, bend the brass strip up against the Top Mount so as to get a clean bend.

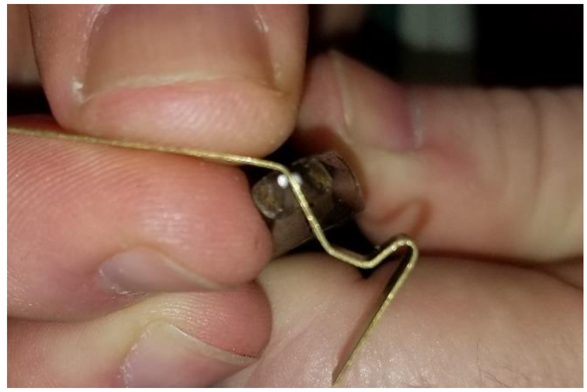


Step 7 – Use your fingers to complete the bend.



Step 8 – You should now have something that looks like this photo.

Step 9 – Make the first bend with a pair of pliers, making sure the pliers are perpendicular to the long edge of the brass strip.



Step 10 – Repeat for the second bend.

Now cut the brass strip to length and you will be done!

Figure 17 - Completed Battery Clip

Test fit each contact as shown in Figure 4 of the Transroc manual.

Once you are satisfied with the fit, attach the wires as per the manual. Do not solder the wires to the contacts while the contacts are touching the plastic. You will melt your newly printed parts!

Assembling the Battery Box

As per the manual. Use CA glue on the 3D printed parts. Test fit all parts before gluing.

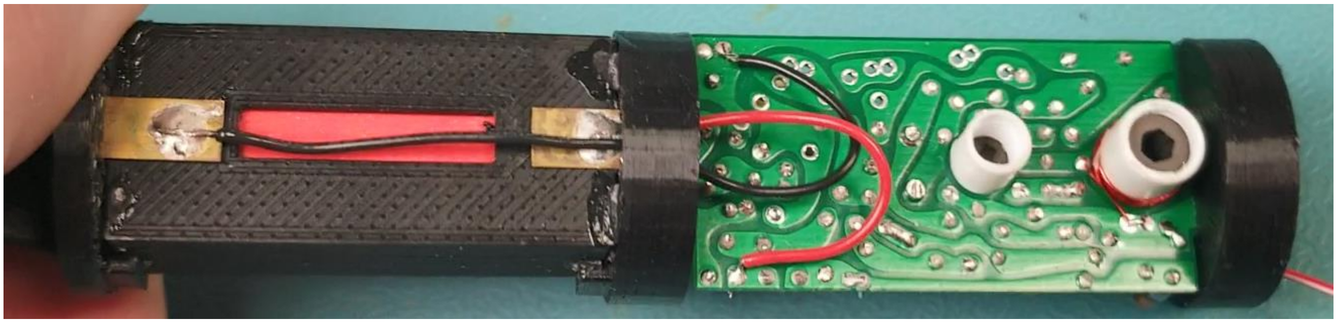


Figure 18 - Battery Connections

Making an "Authentic" Battery

There are two options for powering the TRANSROC. First is with a modern 504 battery (15 volts), while the second is with an A23 battery (12 volts). While no field strength tests were done, the A23 seemed to perform on par with the 504. The A23 is also cheaper, and three grams lighter. As both batteries will require a "carrier", it really doesn't matter which battery you choose.

The recommendation is to use the A23. Steps to build a "battery" using a modern 504 can be found at the end of this document under *Alternatives*.

Print the two A23 STL files:

- Battery_Carrier-A23_v2-Cover.stl
- Battery_Carrier-A23_v2-Main.stl

Put a drop of CA glue into one of the holes in the Main part of the battery carrier. Take a scrap piece of wire from one of the components and place it in the hole. Repeat for the other three holes. Once the glue has dried, cut the "pins" to length and test fit the cover.

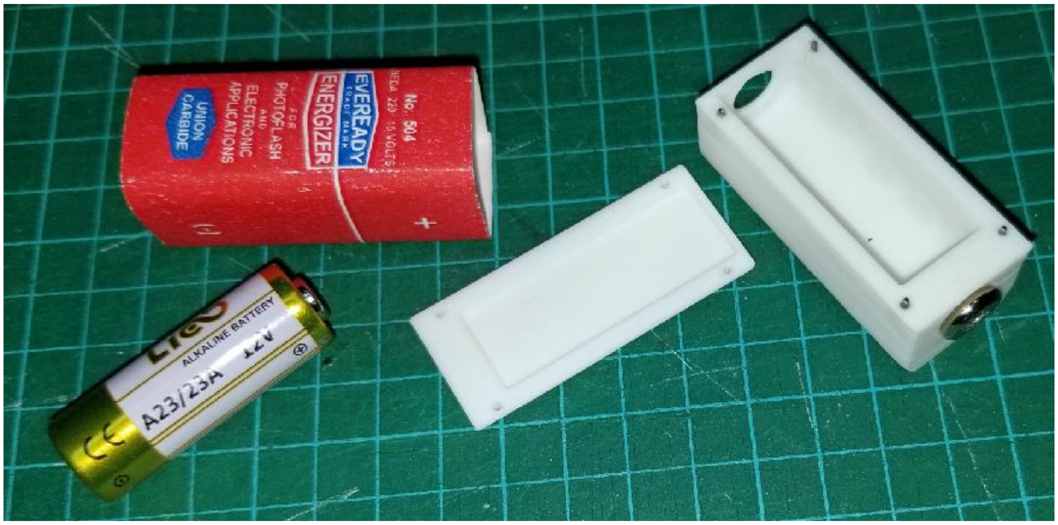


Figure 19 - A23 Battery Carrier

Place an A23 battery into the carrier with the positive end through the larger hole at the thin end of the carrier. Thread a 6-32 through the other end to secure the battery in place.

The screw is standard desktop computer screw – you should have many laying around!

Any similar screw should work, but ideally it should be a 3/16" long 6-32 screw with a flat, rounded head.

Test fit your new battery in the TRANSROC battery holder.

Finally print out the Battery_Wrapper.pdf on a color printer. <u>Print this PDF at 50%</u>. Cut on the lines, wrap it around the battery holder, and you'll have yourself an "authentic" Eveready Union Carbide 504 battery! ***Just make sure the + / - signs of the wrapper match up with the + / - of the actual battery.***

Populating the Circuit Board and Intermediate Testing

The assembly order is a bit different than in the manual so as to allow for testing of the Modulator section prior to moving on to the rest of the parts. Use a fine tip soldering iron. A 40-watt iron should be perfect.

Please be careful when soldering so as to not let the hot iron touch the coil forms. As they are plastic, the hot iron will quickly make a mess if the iron gets too close.

Assembling the Modulator Section

Using the TRANSROC Owner's Manual, place and solder the parts of the following Steps to build the Modulator. Each Step listed matches the corresponding Step number from the original TRANSROC Manual.

a) Steps 2 – 6
b) Step 7 – Skip for Spin Rate
c) Steps 8 – 14
d) Step 15 (or leave until last)
e) Step 22
f) Step 24
g) Step 25 – Solder both ends carefully
h) Step 23 – Solder close to board
i) Step 26 – Solder both ends carefully
j) Step 30
k) Step 15 is OK here too

Solder temporary battery leads to the (+) and (-) points as shown in Figure 10 and Figure 11.

Clean the board. This is important! The Modulator will not work properly until the board is cleaned thoroughly.

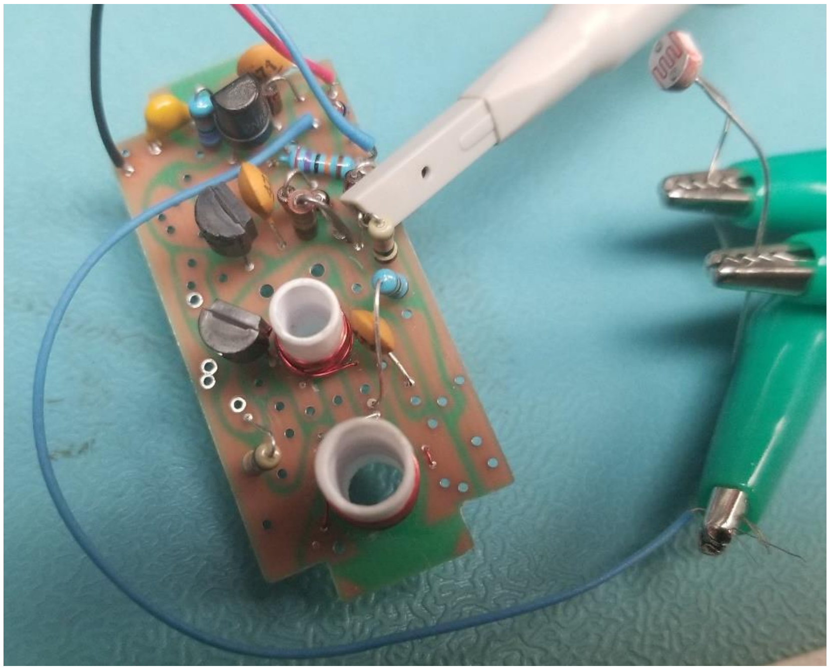


Figure 20 - Testing the Modulator

Spin Rate vs. Rocket Finder Modes

Only two components differentiate the Spin Rate from the Rocket Finder modes, R5 and C7.

Component	Rocket Finder Mode	Spin Rate Mode
R5	270k Resistor	CdS Photocell
C7	3.3µf Capacitor	0.047µf Capacitor

While the fixed value components of the Rocket Finder Mode provide a stable pulse approximately once every 600ms, the varying light hitting the photocell modulates the pitch of the tone which can then be used to measure how fast the rocket is spinning.

While this project built out the TRANSROC in the Spin Rate Mode, you are free to assemble your TRANSROC in any configuration.

For a more in-depth discussion on the various modes, please see the individual telemetry manuals found on Transroc.org.

Testing the Modulator

The idea behind testing the Modulator at this point is to prevent any issues with the RF Section interfering with the workings of the Modulator.

If you built your TRANSROC in the Rocket Finder Mode, the Modulator pulses the transmitter about once a second (Figure 21). The voltage difference is small, only about 0.6v (which agrees with the original TRANSROC manual). In the figure below, the ΔY is referenced to the top (15v) trace. The oscilloscope probe was placed at the "top" of R3 (10k). See Figure 20.

Figure 21 - Modulator Waveform - Rocket Finder Mode

As the Modulator's frequency increases, as in the Spin-Rate Mode, the waveform becomes less "square" (Figure 22).

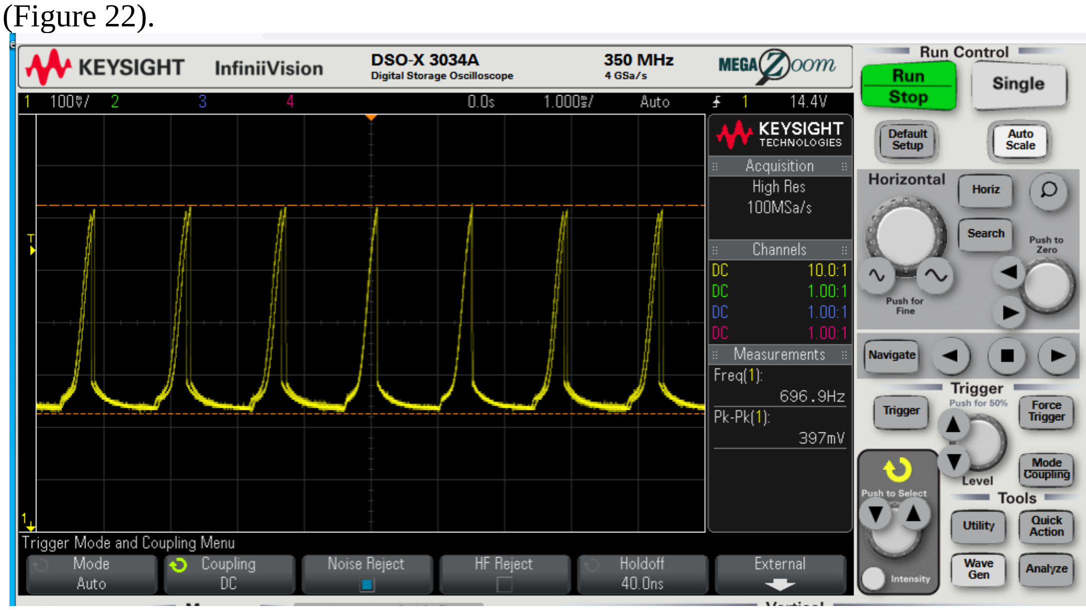


Figure 22 - Modulator Waveform - Spin Rate Mode

If the Modulator is working, continue with the next section to assemble the RF Section. If you are not seeing waveforms similar to the above figures, doublecheck your soldering. Check for loose connections and for components inserted incorrectly. Diodes and transistors are easy to insert backwards. Also, be sure to clean the board! Tests have proven that a board covered in flux will not work!

Assemble the RF Section

Assembling the RF Section pretty much follows the manual.

a) Step 16
b) Step 17
c) Step 18
d) Step 19
e) Step 20
f) Step 21
g) Step 27
h) Step 28
i) Step 29
j) Step 1

Again, clean the board!

The manual has extensive testing procedures, so please refer to the manual at this point.

Final Assembly and Testing

When satisfied the TRANSROC is working, unsolder the test wires from the (+) and (-) holes. Insert the circuit board into the Top and Bottom Mounts. The fit will be *very* snug. Cut the Red and Black wires from the battery carrier to length, leaving some slack (see Figure 18), and solder the wires to the (+) and (-) holes.

Alternatives

Using a Modern 504 Battery

Authentic Eveready 504 batteries are no longer being made. Amazingly though, you can still find old 504's on eBay. Those are obviously dead, cannot be recharged, and would be for show only.

Modern versions of the 504 are available from Amazon.

3D print two copies of the *Battery_Carrier-504-Half.stl*. That will give the round battery the squarish look of the original. Be careful with the battery holder. At one point, the print is only one layer thick!

As with the A23 battery, print out the Battery_Wrapper.pdf on a color printer at 50% scale. Cut on the lines, wrap it around the battery holder, glue the end in place, and you'll have yourself an "authentic" Eveready Union Carbide 504 battery! ***Just make sure the + / - signs of the wrapper match up with the + / - of the actual battery.***

Figure 23 - 504 Battery Wrapper

Alternate Battery Clips

The only difference between the primary and alternate battery clips is the thickness of the brass and the battery carrier mounts.

Measurements from the original photos drove the cutouts of the Top Mount and Thumb Mount to be wide enough for a 4-5 mm brass strip, and that's how the prototype was built. After realizing how difficult it would be to cut strips each time, it was determined that by slightly widening the cutouts, standard ¼" strips could be used.

If you prefer to use the prototype dimensions and brass, print these two parts instead of the "v2" parts.

Thumb_Mount-Main.stl   Top_Mount-Main.stl