

RF Nomad Semi-SMT SDIY Kit Assembly Manual

Introduction

Thanks for purchasing the RF Nomad SDIY kit from Evaton Technologies! The RF Nomad SDIY kit is a voltage-controlled shortwave radio receiver in Eurorack format. The RF Nomad SDIY Kit comes with a PCB that has most of the surface-mount components pre-installed, plus a few surface mount components that must be installed, and the remainder of the thru-hole parts required for assembly. An anodized aluminum faceplate is included, to complete the kit, for those who wish to get up and running right away!

The RF Nomad is a direct-conversion radio receiver, which tunes to frequencies from approximately 9.6 to 10 MHz and decodes the audio as single sideband.

Various RF noise generators, such as computers, appliances, etc., as well as shortwave broadcasts and ham radio stations, can be decoded and used as useful and interesting sound sources. The RF Nomad's tuning can be varied under voltage control, allowing LFOs, envelopes, and even audio sources to modulate the tuning parameter in real time. In short, the RF Nomad puts those classic squelchy, squealy, hissy sounds of a shortwave radio into your modular!

Skill Level

The RF Nomad SDIY kit requires intermediate to advanced soldering skills to complete. While most of the surface-mount components come pre-installed, the three SOIC integrated circuits must be soldered by the builder. All remaining components are standard thru-hole components. These instructions assume you already know how to solder.

Precautions

Soldering irons are **HOT**! Be careful not to touch the business end of your soldering iron at any time. Also note that components that have been soldered will remain hot for a few moments. If you need to hold something to solder it, it is recommended **NOT** to use your fingers. Wear long pants and long sleeves to avoid solder splash from burning exposed skin.

Tools Required

A few basic electronic assembly tools are needed to complete the assembly of the circuit board.

Soldering iron. Minimum 25 watt pencil iron; preferred temperature-controlled, but not necessary. Fine tip required for surface-mount soldering.

Magnifying equipment. A binocular microscope of 10x power or more is ideal, but a large magnifying viewer can be used.

Small wire cutter

Electronic solder. 60/40 lead/tin or 63/37 lead/tin, or lead-free. Use rosin-core solder. Do **NOT** use acid-core¹ (plumbing) solder! Small-diameter solder is preferred (0.039")

Pair of needle nose pliers for bending leads and holding components

Small bench vise or "helping hands" (optional) for holding the PCB.

Small adjustable wrench or 10mm deep-well socket, for tightening potentiometer nuts

13/32" open-end wrench for tightening jack nuts. In a pinch, a 7/16" or 11mm open-end wrench will also work.

De-soldering braid (included) for cleaning SMT pads

Small flat-blade screwdriver, for tuning alignment

¹ Acidcore music is great. Acid core solder is not.

Kit Contents

- A partially populated printed circuit board (PCB)
- Small roll of desoldering braid
- 5x 10 μ F 35V capacitors
- 2x 3.5mm audio jacks
- 1x 78L05 +5V regulator
- 1x 79L05 -5V regulator
- 2x 10 MHz tuned-slug inductors. **NOTE:** these are **NOT** identical. The L4 inductor is marked "L4". The other inductor is L5.
- 3x 1N4004 diodes
- 1x RCA jack
- 1x 16-pin Eurorack power header
- 3x 100k Ω linear taper potentiometers
- 1x 10k Ω linear taper potentiometer (RF Gain Pot)
- 1x SA602 RF Mixer / Oscillator IC
- 2x LM324 or TL084 op-amp IC
- 1x Eurorack power ribbon cable
- 1x Anodized aluminum faceplate
- 4x Plastic knobs
- 1x 5' antenna
- 2x Eurorack panel screws
- 1x Hector The Space Monkey Sticker

Assembly Instructions

Preparation

To begin assembly, clear a space on your workbench². It helps to have good lighting, and your tools located where they can be easily reached. Plug in your soldering iron and let it come up to temperature. It helps to have a dampened sponge nearby, to wipe the solder tip on to keep it clean³. Place the bare circuit board in the middle of your work area, with the white silkscreen legend facing you.

The next few paragraphs will go step-by-step through the process of assembling the circuit board. You may wish to check these steps off as you go, to keep track of your place.

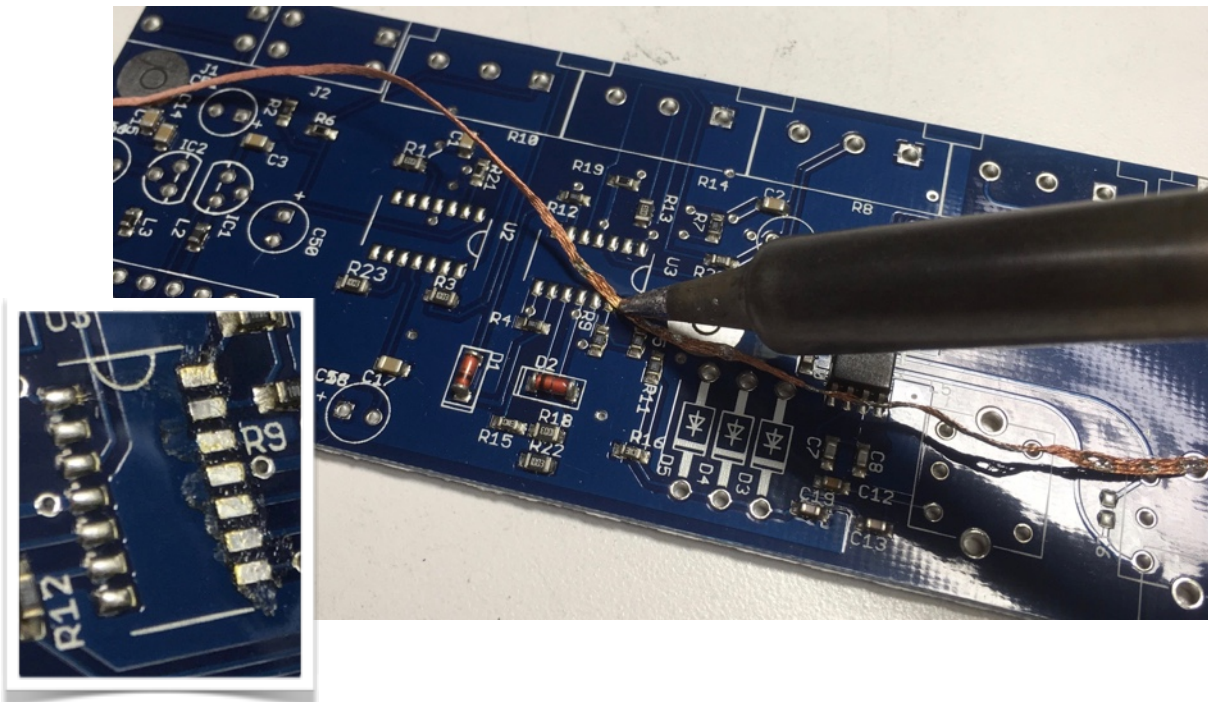
² Hey, that's **my** first step. My bench is always a complete mess!

³ Actually, those nifty brass-wool sponges work even better. Wish I had figured that out 30 years ago...

____ Prep the SMT pads

The RF Nomad SDIY kit is based on a batch of PCBs that were accidentally manufactured without any thru-hole components, and missing a few SMT components. Because these boards already went through a reflow solder process that soldered most of the SMT components, the three SMT components that were missing also got “soldered”, even though they were missing. This process has left solder “bumps” on the SMT pads for these parts, which will make it difficult to solder the components.

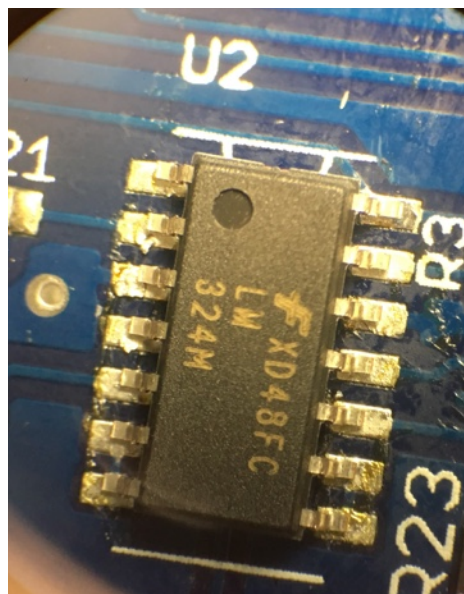
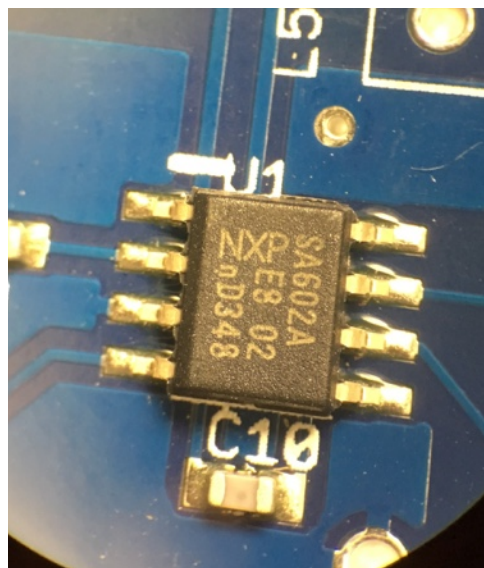
So, the first step in building the RF Nomad SDIY kit is to use the supplied desoldering braid to remove the solder bumps from U1, U2, and U3. Place the solder braid over the IC pads and heat with your solder iron to wick-up the solder on those pads. You will have to keep moving to a fresh section of braid as the solder is wicked up.



The inset photo shows the solder bumps removed from the right side of U3.

____ Install U1, SA602

Carefully align the SA602 IC on the pads for U1. Note that Pin 1 of the SA602 is in the upper left corner of the chip, with the beveled edge of the chip on the left side. The Pin 1 location on the PCB is marked next to the “U1” designation with a horizontal white line. See the photo at right. Solder each pin individually. It sometimes helps to solder one corner pin first, then, while keeping that solder joint melted with the soldering iron, gently nudge the chip back into place if needed. Let that solder joint cool, then move on to the remaining pins.

**____ Install U2, U3 - LM324 or TL084**

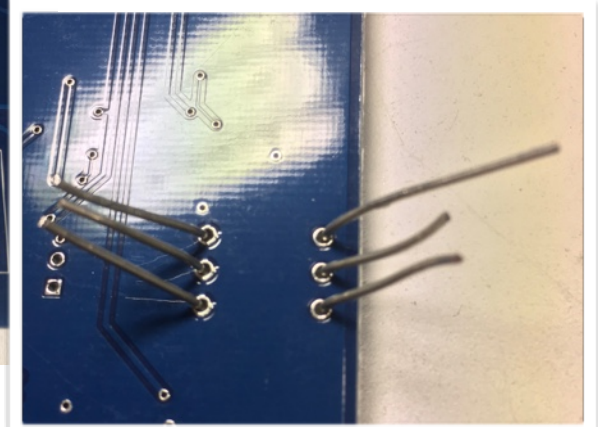
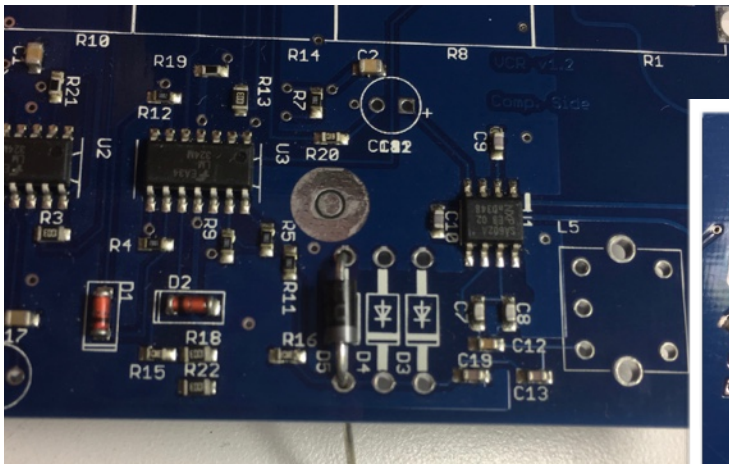
U2 and U3 are both quad op-amps. Your kit may be supplied with either LM324 or TL084 chips; for the purposes of the RF Nomad, they are interchangeable.

Following the same method as for U1, solder U2 and U3 in place. Note that on the LM324, Pin 1 is marked with a round dot in the upper left corner of the chip. Make sure to align that as shown in the photo.

Congratulations, you’ve completed the SMT portion of the assembly! You may wish to carefully inspect all of your solder joints, and make sure there are no solder bridges between pins.

1N4004 Diodes

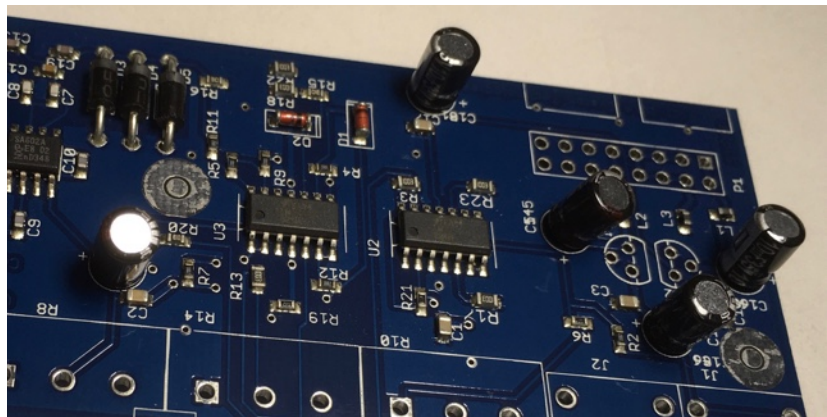
D3 through D5 are 1N4004 thru-hole diodes. Carefully bend the leads on the diodes, and insert them into the PCB, making sure the silver band on the diode lines up with the white line on the PCB silkscreen. It helps to bend the leads backwards a little bit before soldering them on the back side of the PCB.



After soldering, clip off the excess component leads.

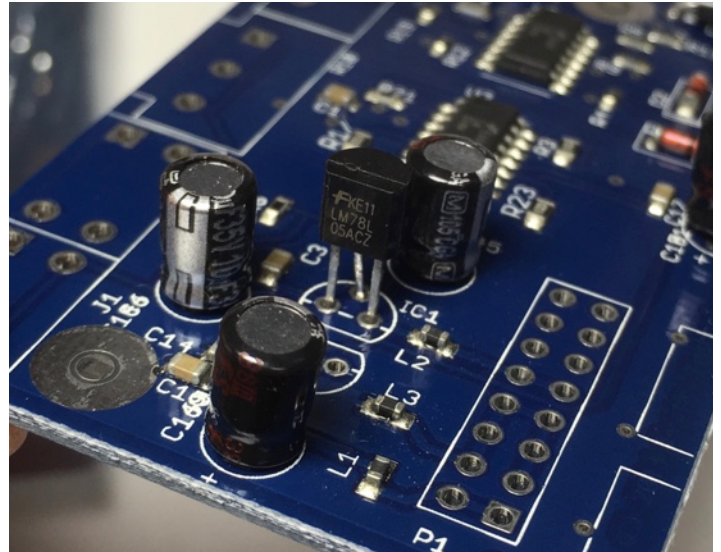
10 μ F Electrolytic Capacitors

There are five electrolytic capacitors on the RF Nomad. These are polarized capacitors, so be careful to insert them in the correct orientation on the PCB. The gray stripe on the side of the capacitor indicates the **NEGATIVE** lead of the capacitor. It should be inserted into the capacitor holes **OPPOSITE** the "+" sign on the PCB. You may notice the capacitor reference designators are a bit smudged. This was a defect in the silkscreen on this particular run of PCBs. Just know that the 5 capacitors go into the 5 capacitor locations on the PCB, which appear as a circle around 2 pads, with a "+" sign off to one side. The photo at right shows the location of the five capacitors.



___ IC1, 78L05

The 78L05 positive 5V voltage regulator goes into the location IC1. Note that you'll have to bend the center leg backwards a little bit to get it to go into the holes. Make sure the flat edge of the 78L05 matches the flat edge of the silkscreen.

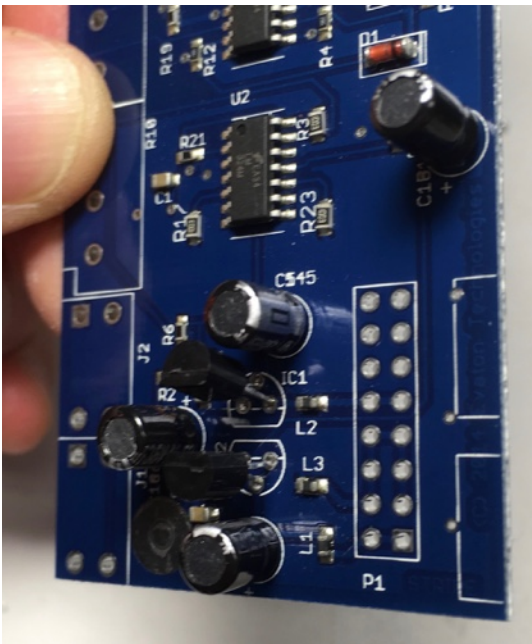


___ IC2, 79L05

The 79L05 is a negative voltage regulator. Install it in location IC2, and, like the 78L05, bend the middle leg backwards. Note the orientation; the flat spot on the 79L05 should face the flat spot on the 78L05.

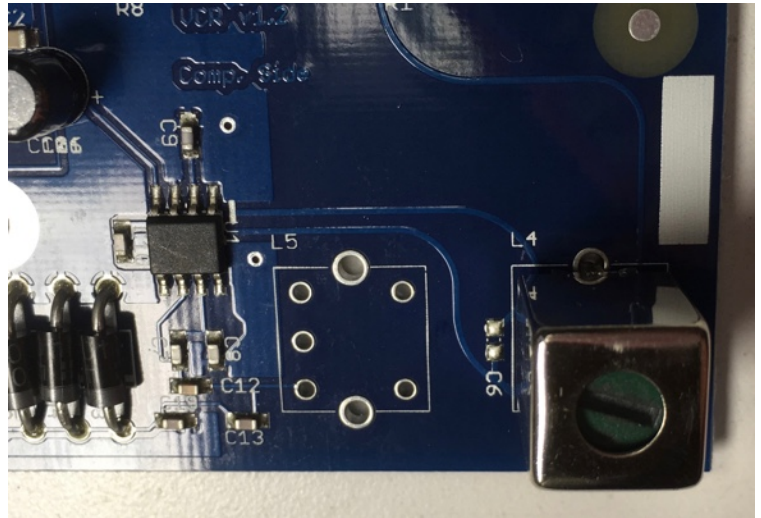
___ Eurorack Power Header

Install the power header at location P1. The power header is in the same little baggie as the RCA jack.



___ Inductor L4

Install the slug-tuned inductor L4 in the L4 location on the PCB. Note that the L4 inductor is marked “L4”. While L4 and L5 look identical, they are not. L4 has an internal capacitor, and L5 does not. You can see the internal capacitor in L4 if you turn it over and look at the bottom side. L5 doesn’t have that capacitor.



When soldering the inductors, it helps to solder just a single pin first, then, while heating that pin, adjust the position of the inductor so that it is flush with the PCB. Then go back and solder the remaining pins. Also, note that SMT capacitor C6 is not installed. It’s not supposed to be. The internal capacitor in L4 does that job.

___ Inductor L5

Install the slug-tuned inductor L5 in the L5 location on the PCB, in the same way as L4.

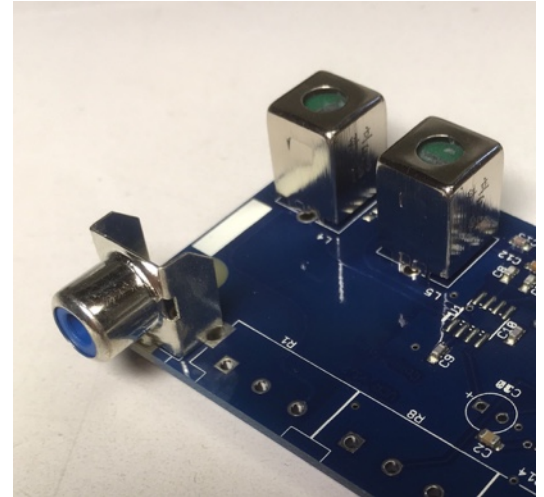
___ Take a Break!

At this point, nearly all the thru-hole components have been soldered to the board. Only the front-panel components remain. Take a break for a moment⁴, and re-check your solder joints; make sure all the components you installed so far have good joints. You’re almost ready to install all the front panel components, and then assemble the faceplate!

⁴ It was at this very moment that I also took a break from writing this assembly manual. Whew!

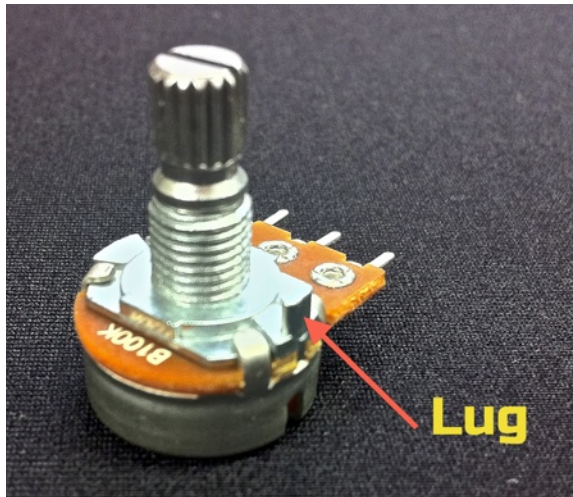
___ RCA Antenna Jack (J3)

Snap the RCA jack into the location J3 and solder all 4 pins. You might need a larger tip for this component, or just a little more patience.



And Now, A Few Words About Potentiometers

There are four potentiometers included with the kit. Three of them are 100k Ω audio-taper potentiometers, and one is a 10k linear-taper pot.



The included potentiometers feature an anti-rotation lug. You'll need to remove the anti-rotation lug. This is easy to do with a small pair of pliers. Just hold the potentiometer firmly in one hand, grasp the anti-rotation lug firmly with the pliers, and wiggle the pliers back and forth. The tab will usually break very cleanly.



When soldering the pots to the PCB, make sure to leave just a tiny gap between the shoulders of the potentiometer pins and the PCB. If you jam the pot down tight against the PCB, over time the shoulders of the pins might wear thru the soldermask and short against the PCB traces. You can use a thin sheet of paper to space the pots up off the PCB if you like. Just remove the paper after you're done soldering!

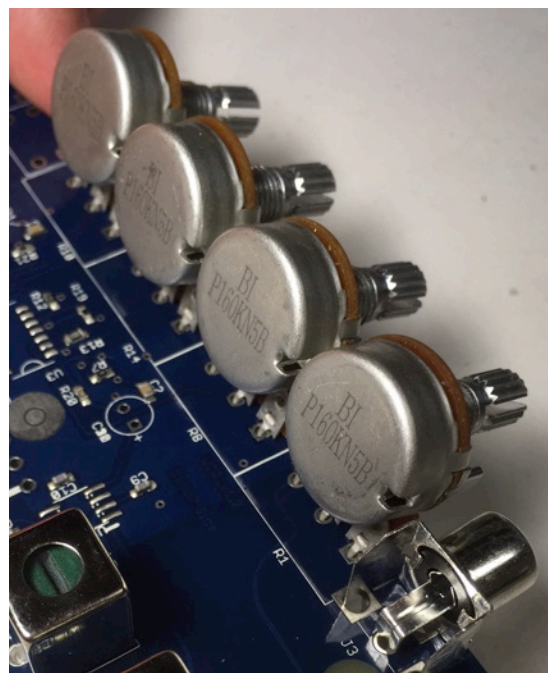
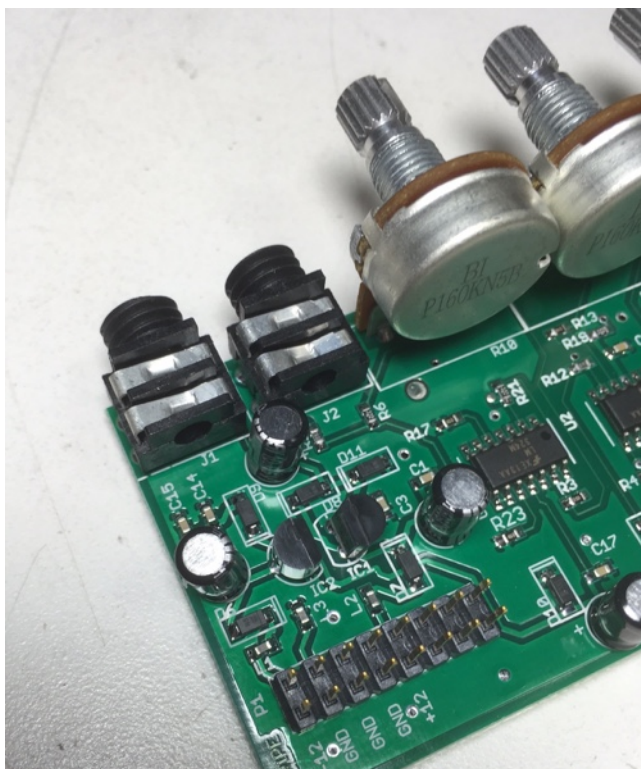
Keep track of the washers and nuts from the potentiometers; you'll need those later to install the faceplate.

_____ 10k Ω Linear Potentiometer (RF Gain Pot)

Install the 10K Linear potentiometer (Labelled B10K) in to the R1 location, facing away from the edge of the PCB.

_____ 100k Ω Audio Potentiometers (Tuning, CV, and Audio Gain)

Install the remaining potentiometers (Labelled A100K) in locations R8, R14, and R10.



_____ Panel Jacks, J1 and J2

The final electronic component that needs to be soldered to the PCB are the two CLIFF 3.5mm mono jacks. Again, use the technique of soldering one pin, then, while heating that pin, move the jack into position so that it is flush to the board and level. This is rather important on the jacks, so that they line up properly with the holes in the front panel. You may want to test-fit the faceplate before finishing up the soldering.

Assembling the Faceplate

Peel off the protective sheet of clear plastic from the faceplate. Now, align the holes in the faceplate with the shafts of the potentiometers and the jacks. You may need to bend the pots forward or backward slightly to get them to line up.

Install flat washers on the potentiometer shafts, and then install the nuts, and tighten with a 10mm deep-well socket. There is a little wiggle room on the panel holes, so make sure the RCA Antenna jack lines up in the center of its hole before tightening down.

Next, install the nuts from the CLIFF jacks. Note that these nuts are made so that they are flat on one side, and domed on the other. Put the flat side towards the faceplate, and tighten with 13/32" (or 11mm) open-end wrench. Be careful not to scratch the faceplate!



Assembling the Knobs

The knobs have small blue caps that need to be installed. Just push the cap into the hole in the top of the knob and push down with your thumb.

Next, twist all the knobs on the RF Nomad fully counter-clockwise. Install the knobs so that the white line is pointing to roughly the 7-o'clock position. You can use the black indicator line on the CV Amount label on the faceplate as a guide. Push the knobs on, but don't push them on so far that they bind against the pot nuts. If they do, gently pull the knob back up (or pry with a plastic object, so you don't scratch the faceplate).

____ Calibration

The RF Nomad is a radio receiver, and, as such, requires a small amount of calibration for optimum performance. The calibration is best done if you can possibly power up the module on the benchtop. Aside from that, perhaps you can put it in a Eurorack case with several modules removed so that you can access the two slug-tuned inductors, L4 and L5.

The inductors are adjusted by turning with a flat-blade screwdriver. Turn **GENTLY**. If you meet resistance when turning, stop. The ferrite core slugs in the inductors are ceramic and a bit fragile; **DON'T** force them.

L5 adjusts the center tuning frequency of the RF Nomad. Begin by turning it counter-clockwise until it stops. (Remember, be gentle; it doesn't have to stop hard...) Now, turn it clockwise about 1 full turn. This sets the Nomad for roughly 9.6 to 10.0 MHz tuning range. You can always come back and adjust this later, to change what portion of the 31m shortwave band is received.

L4 adjusts the pre-selector circuit. Again, turn L4 fully counter-clockwise to begin. Now, with the RF Nomad powered up, and an antenna plugged in, turn the **RF Gain** fully clock wise. Set **CV In** fully counter-clockwise. Set the **Tuning** knob in the center position. Turn the **Audio Gain** up about half way.

Plug something into the **Audio Out** jack so you can hear the output of the RF Nomad. You should hear at least some hissing at this point. If not, go back and check your work!

Turn the **Tuning** knob left and right; you should hear some slight changes in the audio; maybe even a heterodyne squeal or a station! Now, turn the **Tuning** knob to a place where all you hear is static noise.

Slowly turn L4 clockwise until you hear the static noise get louder. It may take a few full turns. If you turn L4 far enough, you will go past the loudest point, and it will start getting quieter again. If so, turn L4 backwards until you hit that loudest point again. This is called "peaking" the reception.

Once that is done, your RF Nomad is ready to use! The full user manual for the RF Nomad is available online at:

<http://www.evatontechnologies.com/RFNomadUserManualForWeb.pdf>

Congratulations!

With some skill and a little luck, you should now have a fully functioning RF Nomad that you built yourself. Congratulations!

Please join the Evaton Technologies user forums at:

<http://www.evatontechnologies.com/apps/forums>

Or, follow us on Facebook at <https://www.facebook.com/evatontechnologies>

And please join the mailing list: <http://www.evatontechnologies.com/join>

If you have any questions, mail info@evatontechnologies.com or check out the RF Nomad FAQ at <http://www.evatontechnologies.com/rf-nomad>

Warranty

Regretfully, because this is a DIY project, Evaton Technologies cannot warrant the finished project, but please do contact info@evatontechnologies.com if you have any questions or concerns with your DIY kit, and Russ will try to help you out.