evaton technologies

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http://www.evatontechnologies.com/

AModulator SDIY Kit Assembly Manual

Revision A

Introduction

Thanks for purchasing the AModulator SDIY kit from Evaton Technologies! The AModulator SDIY kit is an RF signal generator kit designed to be a companion to the popular RF Nomad voltage-controlled shortwave receiver Eurorack module. The AModulator SDIY kit consists of two printed circuit boards and thru hole components required to complete the kit. One circuit board contains the actual electronics of the module, and the other circuit board serves as both the faceplate of the module as well as a touch-plate antenna.

The AModulator is a very simple RF oscillator that employs amplitude modulation to vary the amplitude, or "volume" of a radio-frequency signal. The amount of amplitude modulation is directly controlled by the amplitude of an audio signal that is input through a front-panel jack on the AModulator.

In short, the AModulator puts those classic squelchy, squealy, hissy sounds of a shortwave radio into your modular, via reception on an RF Nomad! Use your own audio program source to create material to mangle with your RF Nomad.

Skill Level

The AModulator SDIY kit requires intermediate soldering skills to complete. All components are thru-hole; no SMT required. 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[1]. 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.

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[1] A wise person once said of soldering irons, "If it smells like chicken, you're holding it wrong."

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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.

- **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-core[2] (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.
- **10mm wrench or socket**, for tightening potentiometer nut.
- **7mm wrench or socket,** for tightening toggle switch nut.
- **5/16" open-end wrench or socket** for tightening jack nut.
- **Small Philips (cross-point) screwdriver**, for bias adjustment
- **Short (2-3inch) length of 22AWG wire or smaller**.
- **An RF Nomad Eurorack Module**

[2] Acidcore music is great. Acid core solder is not.

Kit Contents

- 1 electronics printed circuit board (PCB)
- 1 faceplate printed circuit board (PCB)
- 2x 47 pF ceramic capacitors
- 3x 1.5 µF 50V Aluminum Electrolytic capacitors
- 1x 3.5mm audio jack
- 1x 10-pin Eurorack power header
- 1x 78L05 +5V regulator
- 1x 9.8403 MHz Oscillator Module
- 2x 1N4001 diodes
- 1x 9mm 10kΩ Audio Gain Pot (Input Audio Gain)
- 1x 6mm 10kΩ Linear Trim Pot (bias adjust)
- 2x 100Ω resistors
- 1x 1.1kΩ resistor
- 1x 4.7kΩ resistor
- 1x 22kΩ resistor
- 1x DPDT Toggle Switch
- 1x 2N3904 NPN Transistor
- 1x Eurorack power ribbon cable
- 1x Plastic knob
- 2x Eurorack panel screws

Assembly Instructions

Preparation

To begin assembly, clear a space on your workbench[3]. 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 clean[4]. 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.

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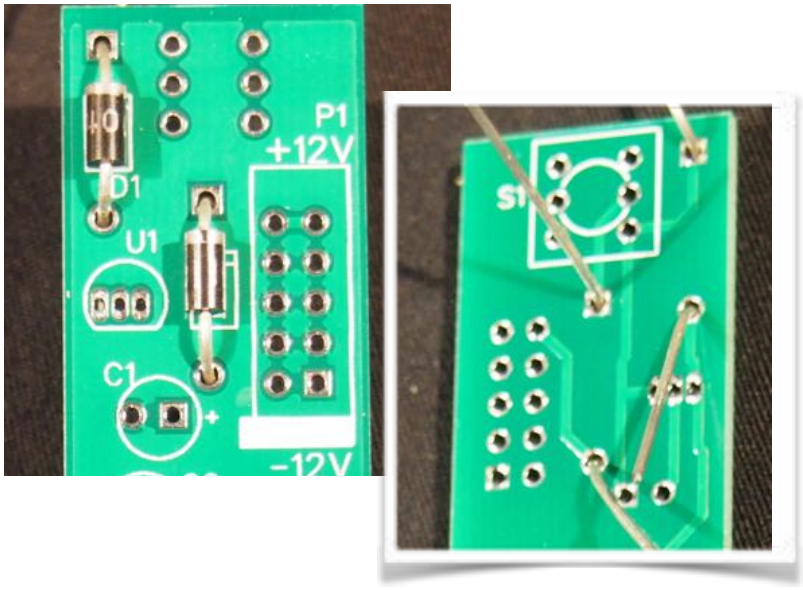
[3] Hey, that's **my** first step. My bench is always a complete mess!

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

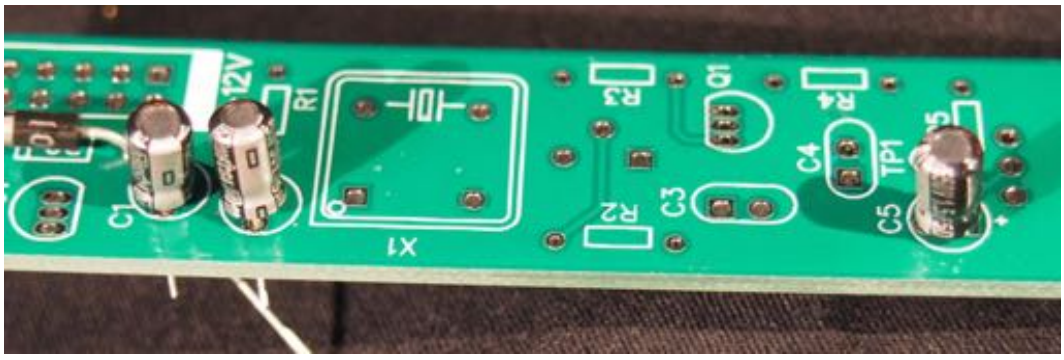
____ 1N4001 Diodes

D1 and D2 are 1N4001 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.



____ 1.5 μF Electrolytic Capacitors

There are three electrolytic capacitors on the AModulator. 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. The 3 capacitors go into the 3 capacitor locations on the PCB, which appear as a circle around 2 pads, with a "+" sign off to one side. The + side also has a square pad; whereas the negative side has a round pad. The photo at right shows the location of the 3 capacitors, at C1, C2, and C5.



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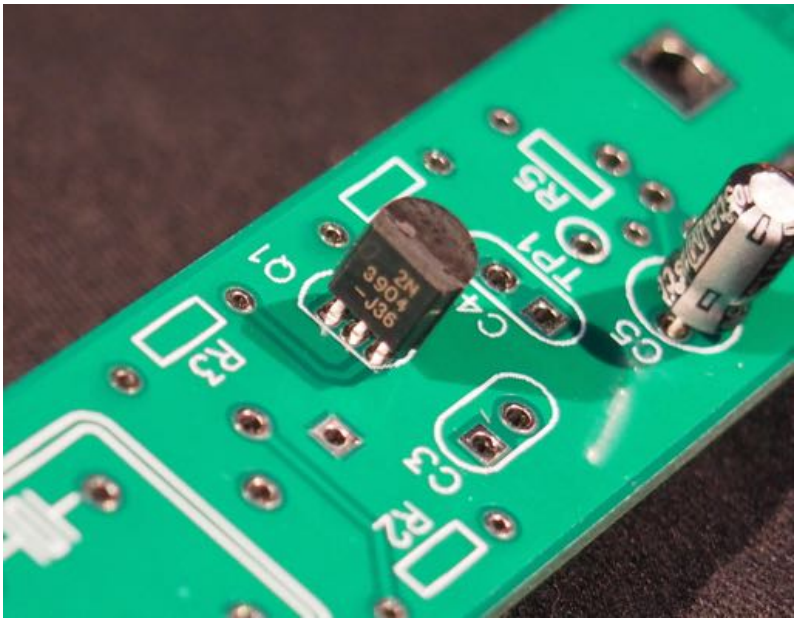
____ U1, 78L05

The 78L05 positive 5V voltage regulator goes into the location U1.. Make sure the flat edge of the 78L05 matches the flat edge of the silkscreen. Be careful not to bridge the pads with solder; they are a bit close together. Use some solder wick to clean up if you have to.



____ Q1, 2N3904 Transistor

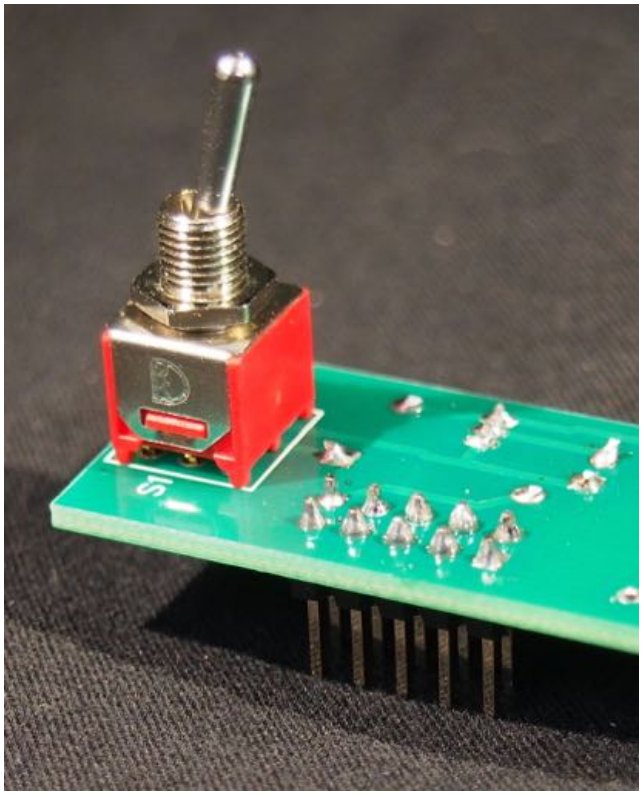
Q1 is an NPN Transistor. Just like, the 78L05, make sure the flat spot on it lines up with the flat on the silkscreen on the PCB. Also be careful not to solder-bridge the pads together.

___ 47 pF Ceramic Capacitors

Install the two 47 pF ceramic capacitors at locations C3 and C4.

___P1 Eurorack Power Header

Install the 10-pin Eurorack power header at the P1 location. Sometimes it helps to solder just a single pin of this header, then, while heating that solder joint, move the header so that it is flat against the circuit board. Then you can go ahead and solder the remaining pins.



___ Switch S1

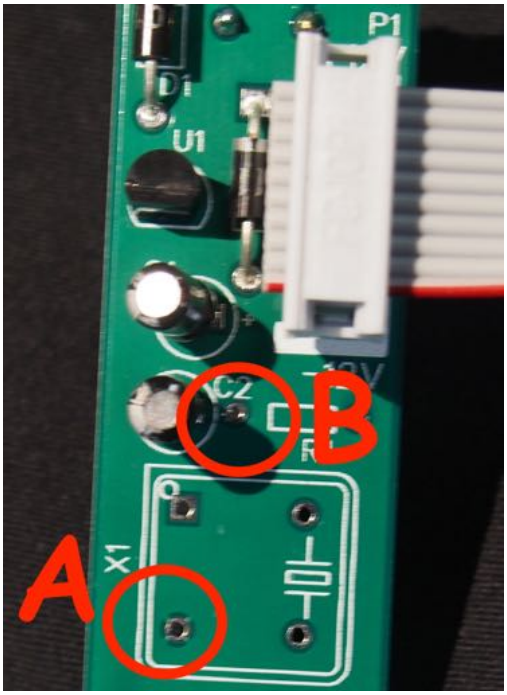
Turn the PCB over. The S1 Power Switch gets installed from the "back" side of the board. Again, it may help to solder a single pin first, then while heating that solder joint, wiggle the switch into position so that it fits squarely against the circuit board. This is **VERY** important, or otherwise the switch won't line up with the faceplate later. Once you are certain that the toggle switch is seated flat against the PCB, then go ahead and solder the remaining 5 pins on it. Remove the nut and washer, but leave one nut on the switch and make sure it is fastened down.

___ Intermediate testing

At this point, enough components are installed to allow our first test of the PCB. Attach the power cable to the Eurorack power header, with the red strip facing the thick white stripe indicated on the PCB next to the header.

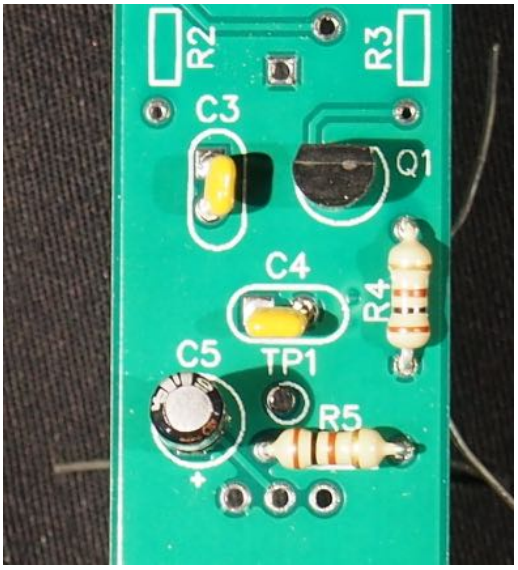
Flip the toggle switch towards the center of the PCB. This is the **OFF** position. Now, apply power to the Eurorack power cable (Turn on your power supply).

With a voltmeter set to a DC voltage range of greater than 5 volts full scale, connect the black (negative) lead of the voltmeter to the pad marked "A" in the photo, and the red (positive) lead of the voltmeter to the pad marked "B" in the photo. With the toggle switch off, you should read zero volts. Now flip the toggle switch on. You should see 5.0 volts DC. If not, disconnect everything and go back and check your work up to this point.



___ **100Ω Resistors R4 and R5**

On the component side of the PCB, install resistors R4 and R5.



___ **1.1kΩ Resistor R3**

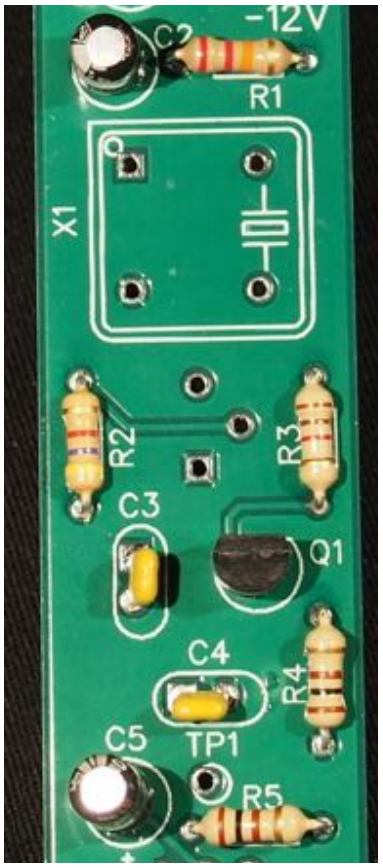
Install R3.

___ **4.7kΩ Resistor R2**

Install R2.

___ **22kΩ Resistor R1**

Install R1.



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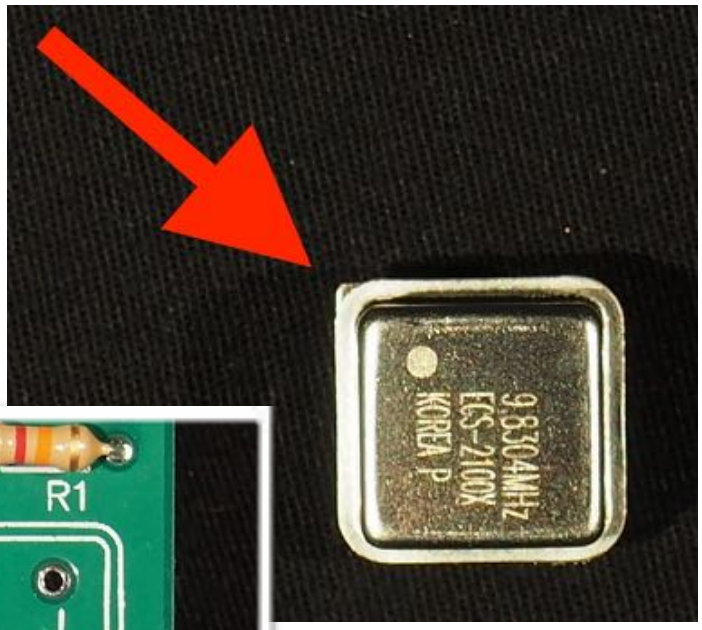
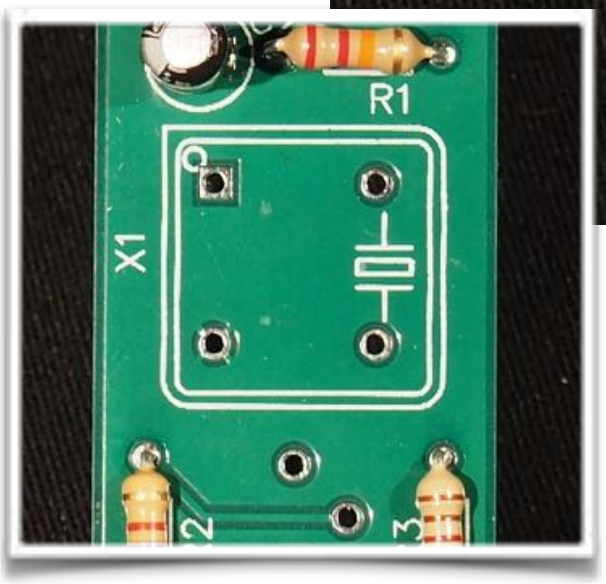
___ 9.8304 MHz TTL Oscillator Module X1

Before installing this component, take a close look at it. Three of the corners of the can are rounded, but one of the four corners has a tiny point on it, and is also marked with a dot on top of the can. This marks pin 1. Look at the silkscreen for X1; there is a dot and a point on the top left corner, as viewed in the photo. Make absolutely certain you install the Oscillator Module with the point and dot oriented the same way as the point and dot on the PCB silkscreen.

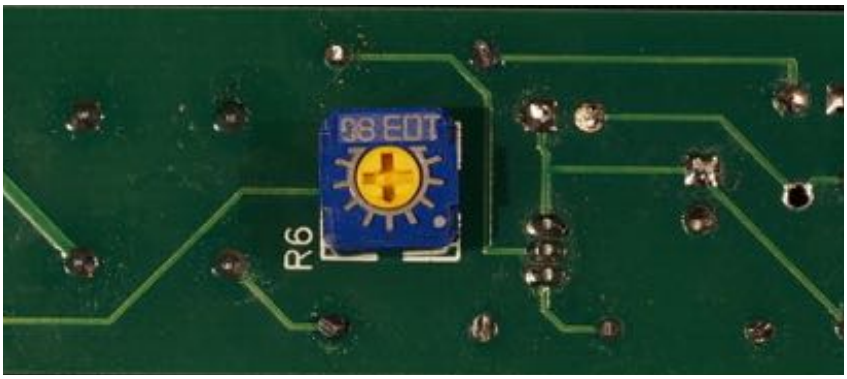




___ 10kΩ Trimmer Pot R6

Flip the PCB over again, so that the toggle switch is facing you. Install the blue 10k Trim Pot into the location R6 near the center of the PCB. Again, make sure that it is flush to the PCB, before soldering all the pins, so that it will line up to the hole in the faceplate later.

If it is not already, turn the adjuster screw so that it is approximately half way between the two ends of its travel. Do not force it.



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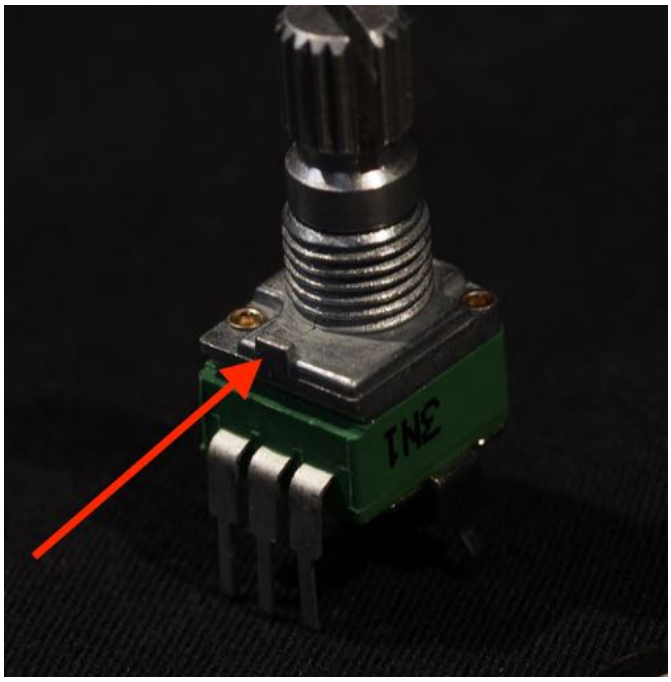
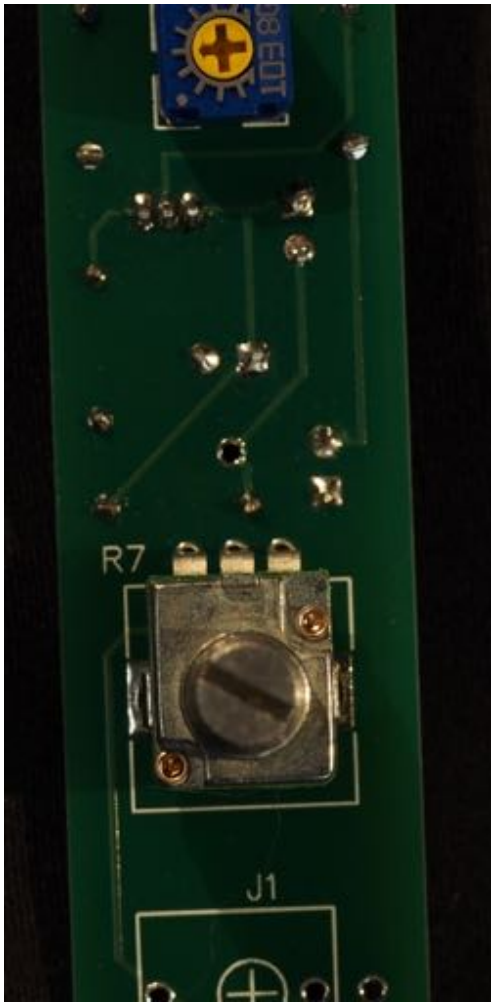


___10kΩ Audio Gain Pot R7

Before installing the 10kΩ audio gain pot, remove the anti-rotation lug on its top surface, either with a pair of wire cutters, or a file.

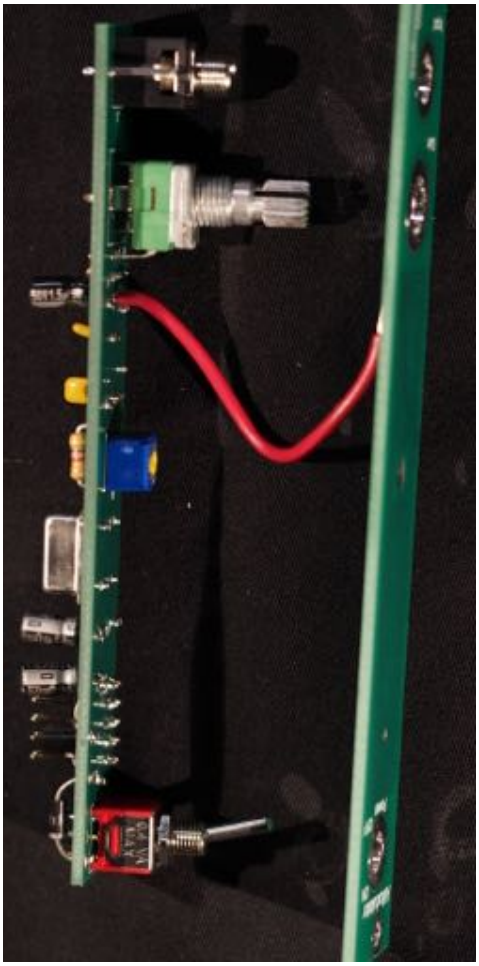


Install the 9mm 10kΩ audio gain pot at R7.

The legs are spring-loaded slightly so that the potentiometer clips into the holes in the board. You may have to squeeze them in a little to get them to go into the holes. Make sure that the potentiometer is flush to the PCB before soldering. Solder all 5 holes.

___ Audio Input Jack J1

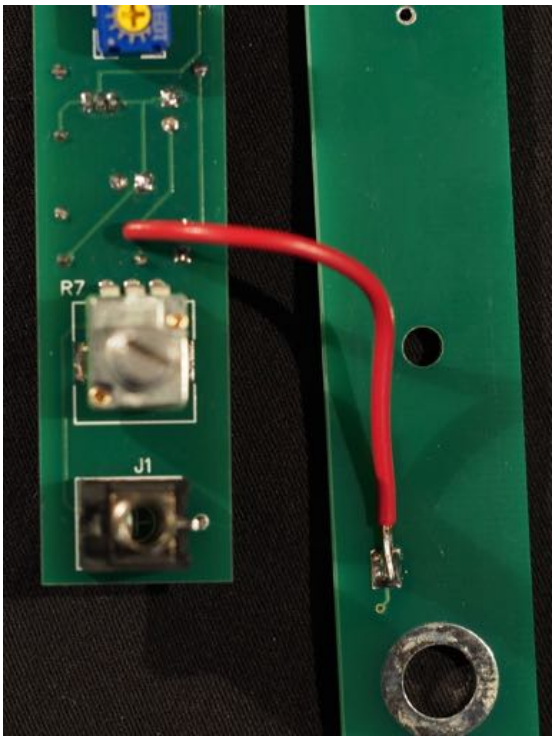
Install jack J1. Be sure the jack is completely flush to the PCB before soldering all the pins.



_____ Assembling the Faceplate

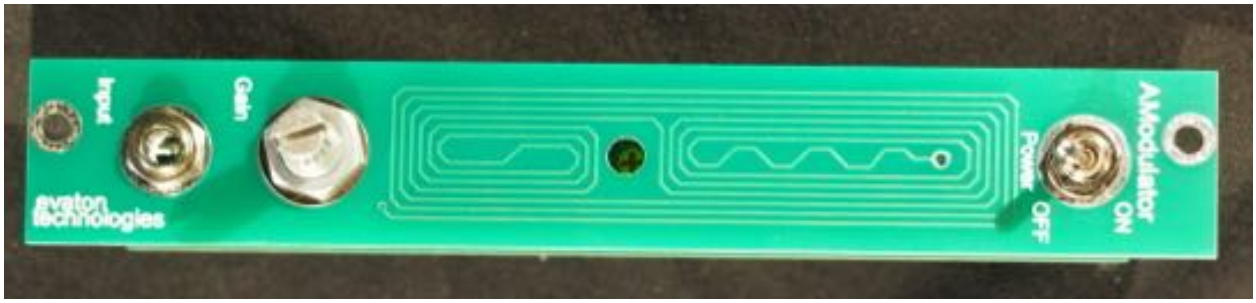
Now, cut a 2 inch or so length of 22AWG or smaller wire, and strip about 3 millimeters off each end. Solder one end to the rectangular solder pad on the back side of the faceplate PCB, as shown in the photo, with the wire tailing away in the direction shown.

Insert the other end of the wire into the side of the electronics PCB with the jack, pots, and switch, into the hole marked "TP1". The marking is on the opposite side of the board. You will be inserting the wire thru from the back side of the board, and soldering it on the side with all the electronic components.



If you haven't already, remove the nuts and washers from the audio jack and the audio gain potentiometer and set them aside. Also remove the nut and star washer from the toggle switch. Leave one nut on the toggle switch and secure it.

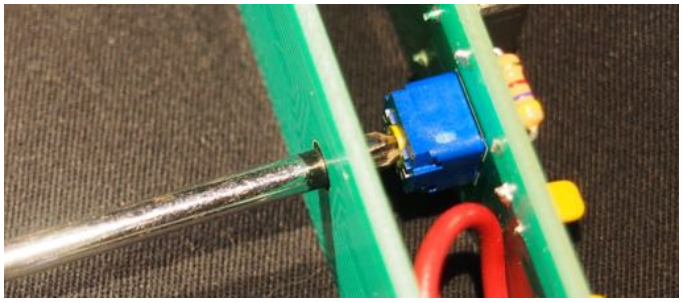
Now, assemble the faceplate to the circuit board as shown. Install the washers and nuts to secure the faceplate to the PCB. Take care to route the wire connecting the two so that it does not get pinched, and also does not block access to the bias adjust trim potentiometer.



_____ Assembling the Knob

The knob has a small blue cap that needs to be installed. Just push the cap into the hole in the top of the knob and push down with your thumb.

Next, twist the Audio Gain potentiometer on the AModulator fully counter-clockwise. Install the knob so that the white line is pointing to roughly the 7-o'clock position. Push the knob on, but don't push it on so far that it binds against the pot nut. If they do, gently pull the knob back up (or pry with a plastic object, so you don't scratch the faceplate.



_____ Adjustment

Finally! We are ready to power up the fully assembled AModulator. Insert the AModulator into your Eurorack case, noting polarity of the power cable. The red stripe goes towards the white stripe on the PCB.

Switch on the AModulator. Make sure you have an antenna plugged into your RF Nomad. Slowly tune the **Tuning** knob on your RF Nomad until you hear a strong heterodyne squeal. To make sure it's your AModulator you are hearing, switch off the AModulator. If the squeal stops, you've tuned into the AModulator! Switch the AModulator back on.

Plug a mono audio cable into the input of the AModulator. Turn the Audio Gain knob up about halfway or more, and adjust the volume of whatever device you are using to supply the audio signal.

Tune the RF Nomad carefully until you hear the heterodyne frequency drop to nearly zero. Now you should be able to at least faintly hear the output of the AModulator. Poke a small Philips screwdriver through the hole in the faceplate on the AModulator, and adjust the bias trim potentiometer carefully to get the best sound. You may have to experiment a bit with antenna placement to get the best signal also. If you are having difficulty, leave the bias trim approximately at the mid way point until you get the hang of tuning in the AModulator's signal on your RF Nomad.

If you happen to have an oscilloscope handy (not necessary!), you can get very precise adjustment of the bias level by watching the RF output at TP1 versus the audio input. A properly biased Q1 will have fairly symmetric output when an audio signal is applied. But if you don't have an oscilloscope, just use your ears!

Theory Of Operation

The AModulator works on a simple principle: It uses a standard off-the-shelf TTL crystal oscillator as the basis for its radio frequency signal. The TTL oscillator creates a frequency-stable square wave signal at 9.8304 MHz, which is a frequency that is within the tuning range of the RF Nomad.

The output of the square wave oscillator is filtered by the R3/C4 combination, to reduce the harmonics generated by the square wave. R3/C4 form a low pass filter that allows 9.8304 MHz to pass, but attenuates signals above that frequency.

Transistor Q1 is biased so that it partially attenuates the RF signal at all times. As the input to the base of Q1 increases, more of the signal is "shorted" to ground, making the RF signal smaller. A larger input to the base of Q1 causes the RF signal to be shorted less hard, allowing a larger signal to be output. In this way, the audio signal applied to the base of Q1 modulated the amplitude of the RF signal. R4 is a negative feedback component that helps keep the bias adjustment of Q1 more stable over temperature changes.

See the included schematic at the end of this manual.

Using the AModulator

Using the AModulator is simple: Switch on the AModulator, send an audio signal into the Audio Input jack, and tune it in on your RF Nomad. Note that the AModulator is **intentionally** a very low power output transmitter, so you may have to adjust your RF Nomad's antenna and RF Gain to be able to pick up the audio program cleanly. This is on purpose for two reasons:

1. This allows you to "Play" the AModulator; varying the antenna position of the Nomad can be used to fade the signal in and out, giving it that vintage shortwave vibe. Notice also that the front panel of the AModulator has a touch-plate "Antenna". Try touching it in different ways, to cause more or less signal to be picked up in your RF Nomad.
2. While the FCC[5] allows individuals to construct experimental low power transmitters for personal educational use, it is up to that individual to make sure that no harmful interference is generated. The AModulator's signal output level is so small as to barely be measurable, while still yielding useful results.
3. If the signal quality were perfect, you could have just used a patch cord to send the audio signal instead!

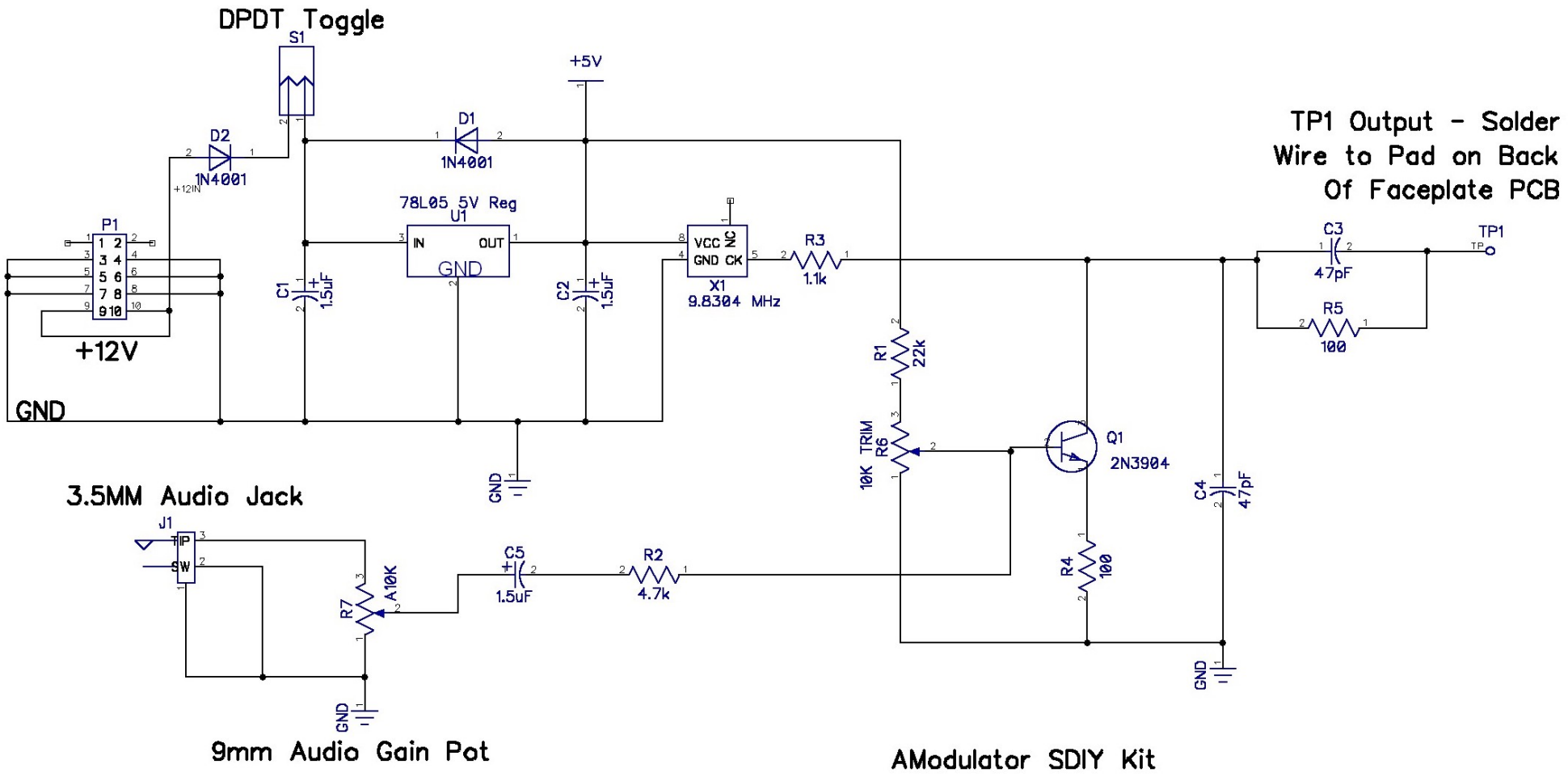
Patch Ideas

Although the simplest patch is to run audio from something like an MP3 player or another Eurorack module into the audio jack, and use the RF Nomad to mangle that audio, there are some other interesting possibilities to explore.

Try patching the audio output of the RF Nomad into a mult, and run a copy of the RF Nomad's audio output signal into the audio input jack on the AModulator. Now you've got a feedback loop that has an RF component to it that you can "play" with the touchplate!

Weirder still, patch another copy of that signal in to the CV Input jack on the RF Nomad! Crazy feedback fun!

[5] Federal Communications Commission, the United States body governing radio waves. See your country's laws regarding constructing and operating this device.


DPDT Toggle
S1
+5V
D1
1N4001
D2
1N4001
+12IN
TP1 Output - Solder
Wire to Pad on Back
Of Faceplate PCB
78L05 5V Reg
U1
IN
OUT
GND
P1
1 2
3 4
5 6
7 8
9 10
+12V
GND
C1
1.5uF
C2
1.5uF
VCC NC
GND CK
X1
9.8304 MHz
R3
1.1k
C3
47pF
TP1
R5
100
R1
22k
10K TRIM
R6
Q1
2N3904
C4
47pF
3.5MM Audio Jack
J1
TIP
SW
R7
A10K
C5
1.5uF
R2
4.7k
R4
100
GND
GND
GND
9mm Audio Gain Pot
AModulator SDIY Kit

Congratulations!

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

Please join the Evaton Technologies user forums at:

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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

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.