RABBIT HOLE

DIY BUILD DOCUMENT V1.3

APOLLO VIEW

WARNING!

THIS MODULE GETS LOUD

RABBIT HOLE IS CAPABLE OF PRODUCING 24Vpp

TOTAL MAXIMUM GAIN OVER 1000

ENSURE INPUT AND OUTPUT GAINS ARE TURNED DOWN BEFORE USE

(Note: Output Gain is an attenuverter, the minimum Output signal is achieved by setting the knob to the 12 o'clock position)

Nominal Eurorack audio levels are 10Vpp. Rabbit Hole can produce peak-to-peak voltage 2.4 times greater than standard Eurorack audio levels. This could potentially damage your speakers and ears. Please exercise caution, and use the Output Gain attenuverter. Even when the Tube stage is not used, the Dry signal can reach an Output voltage of 15Vpp. Specifically, an input audio signal of 10Vpp with maximum Input Gain on the Vintage VCA and maximum gain on the Output attenuverter will produce an output signal of 15Vpp. This additional gain is available to balance the output signal for lower Tube and Drive settings.

TABLE OF CONTENTS

SPECIAL THANKS

Thomaas Banks	Thomaas Banks
Ben Wilson	DivKid
Sam Battle	Look Mum No Computer
Tom Wiltshire	Electric Druid

INTRODUCTION

ORIGIN

I would like to shout out to Look Mum No Computer who first drew my attention to the Matsumin Valvecaster distortion pedal, through his Safety Valve module.

It is from experimenting with LMNC Safety Valve 2.0 design that Rabbit Hole developed. The aim was two-fold. Firstly, to have more accurate CV control over the gain/distortion of the system and secondly, to create a broader range of tube effects, from subtle saturation through to total audio destruction. On this journey of experimentation and discovery of tube circuitry and different tube characters, I truly fell down a Rabbit Hole. The module took on a life of its own, revealing more inherent features, namely sub-harmonic generation and self-oscillation.

Special mention also needs to go to Tom Wiltshire (Electric Druid). While designing a suitable VCA circuit to complement the characteristics of the vacuum tube circuit, I discovered Tom's design-a-eurorack-vintage-vca-with-the-lm13700 design. I didn't want any old clean sounding VCA. I had already made the LM13700 datasheet VCA and found it was indeed too clean for my purposes. With permission from Tom, his design has been implemented for all the VCAs in Rabbit Hole and Curiouser, and they sound fantastic. To quote Tom, "Since I was designing something that was specifically intended as a "vintage VCA" and because I like the soft differential-pair distortion of the chip, I deliberately tolerated several percent of distortion in the circuit. It adds character! Anyway, if you want a really clean VCA there are lots of other better options than the LM13700. It should be used for its strengths, I reckon."

WHAT IS IT?

Rabbit Hole is a 16HP summing mixer with characterful valve saturation & distortion. It is a hybrid solid-state and vacuum tube design. It has two input channels with independent vintage VCAs. The outputs of the VCAs are summed and passed to a solid-state Drive circuit which at higher gain settings hard clips the signal before entering the starved cathode dual-triode vacuum tube. The OWTH - Off With Their Heads diode LED clipping circuit can be engaged for further distortion.

Rabbit Hole is capable of adding subtle warmth or total audio destruction. The Curiouser expander module adds an additional 2 inputs. Multiple Curiouser modules can be daisy-chained to suit your mixing requirements.

- Expandable audio mixer
- Glue for your drum mix
- VCA to a synth voice
- Add subtle warmth and character or total audio destruction
- Capable of generating Subharmonics
- Self oscillates with extreme settings

TOOLS

ESSENTIAL

- Soldering Iron - a solder station with temperature control is best. Some components on this build are connected to the ground plane and require a large amount of heat. A low Wattage soldering iron that plugs directly into the power supply will not be good enough to achieve an effective solder joint. When soldering pots and jacks, 370°C is best; for everything else, 340°C (this is dependent on the solder you use, so check out your solder's data sheet).

- Solder - We find thin is best, around 0.6mm. We use a lead-free rosin core solder.
- 7mm & 10mm Nut drivers
- Bananut driver
- Side Cutters
- Pliers
- Solder Sucker
- Watchmaker screwdrivers, Phillips ≅2.3mm and flathead ≅2.3mm

CALIBRATION

- Voltmeter (multimeter) with standard probe and one crocodile clip attachment - to calibrate the Mix and Tone controls.

OPTIONAL

- Flux Pen
- Cleaning Brush (an old toothbrush will do)
- Masking Tape (It can help hold components in place when flipping the board over to solder)

CONSTRUCTION GUIDE

There are already excellent soldering guides in existence, so we will refrain from reinventing the wheel here.

If you need some guidance, please check out the Moritz Klein x Erica Synth Build Documents. The soldering appendix is an excellent resource.

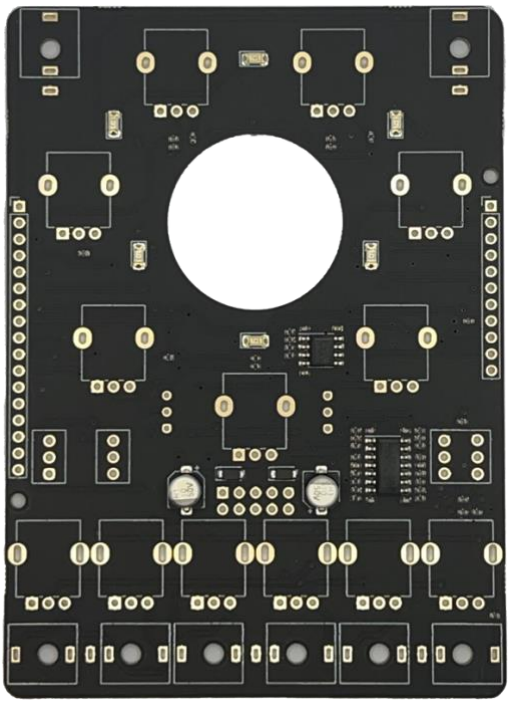
Or, if you prefer videos, this is a pretty good guide.
In most cases, components can be placed onto the PCBs, and then the board can be flipped upside down and laid facedown on the soldering mat to solder the legs to the back of the PCB.

PARTS LIST

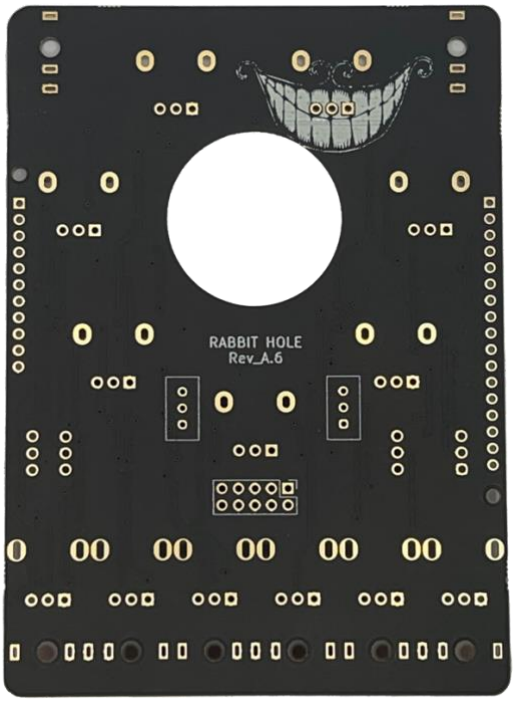
Component	Qty
Faceplate	1
Faceplate Screws	4
Front PCB	1
Back PCB	1
Tube	1
Tube Socket	1
Trimmer 100k Side Slot Adjustment	2
Trimmer 100k Top Slot Adjustment	2
8.2nF Poly Capacitor	2
68nF Poly Capacitor	2
Standoff	2
Standoff Screws	4
01 x 17 Pin Header	1
01 x 17 Pin Socket	1
01 x 11 Pin Header	1
01 x 11 Pin Socket	1
Straight Shrouded Power Header	1
02 x 03 Pin Header - Expander Connection pins	2
Thonkiconn Jack	8
Bananuts	8
Knobs	7
A100k Alpha D Shaft	3
B100k Alpha D Shaft	2
A500k Alpha D Shaft	1
B500k Alpha D Shaft	1
Black Hex Nut	7
B100k Song Huei Tall Trimmer	6
SPDT Switch	2
DPDT Switch	1
Power Cable	1

ASSEMBLY STEPS

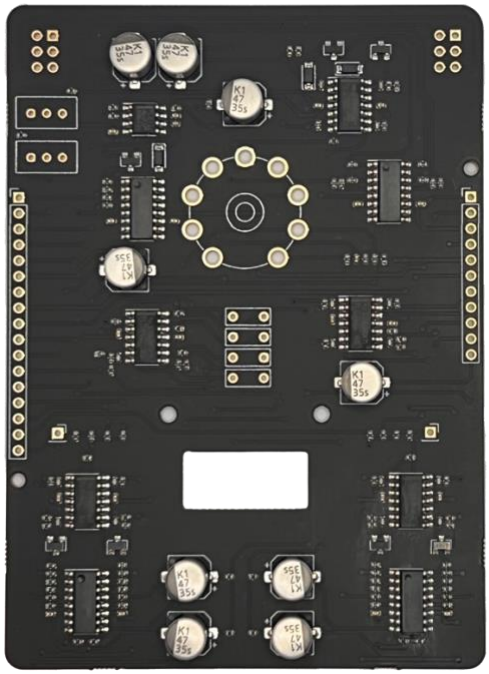
Note: when instructed to solder things in place, it is also implied to cut the legs off the components with legs once soldering is complete. This is only capacitors and trimmers. Once the legs are cut, you can apply heat again (and solder if required) from the soldering iron to make an aesthetically pleasing solder joint.



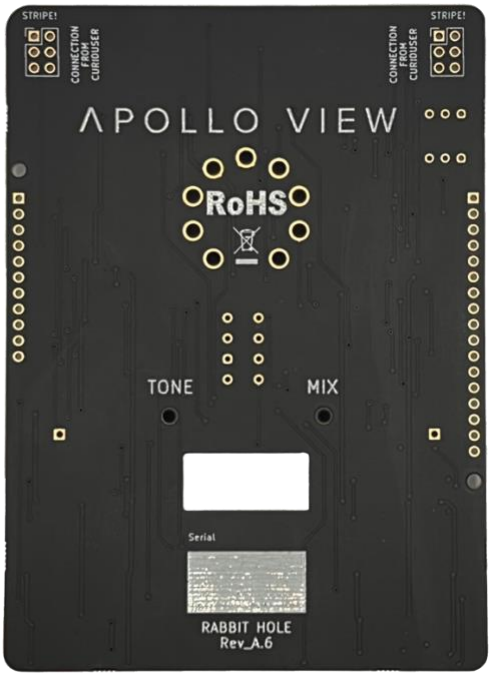
Front PCB Face



Front PCB Rear

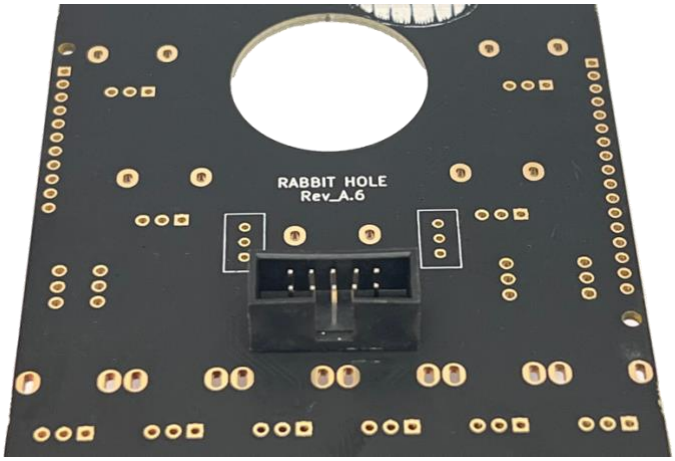


Back PCB Face

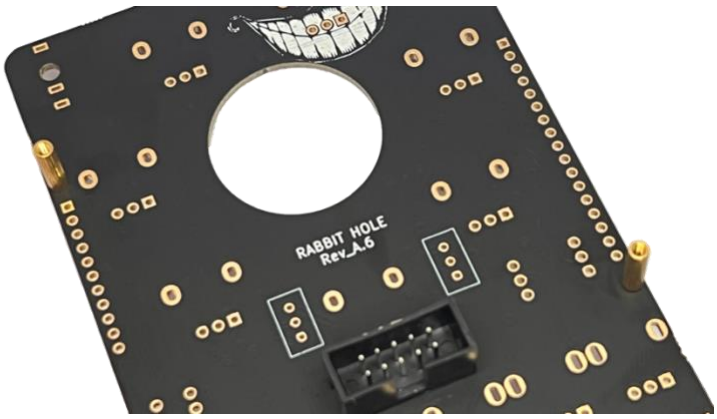


Back PCB Rear

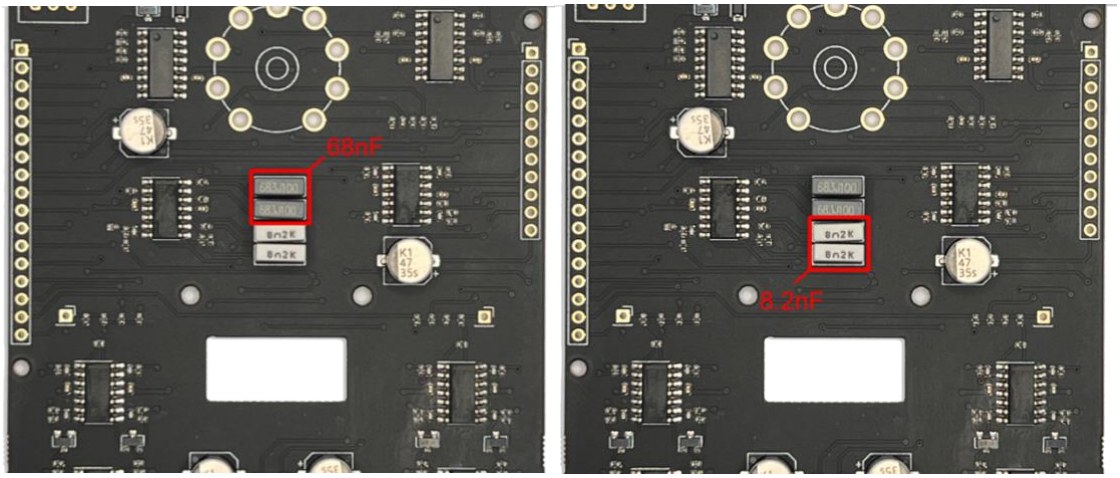
1. Find the Front PCB. Place the 2x5 pin shrouded power header onto the rear of the Front PCB. Ensure the key slot is towards the bottom of the PCB. Flip the board over and solder in place.



2. Attach the standoffs to the rear of the Front PCB with two M2 screws. Put the other M2 screws to the side for now.

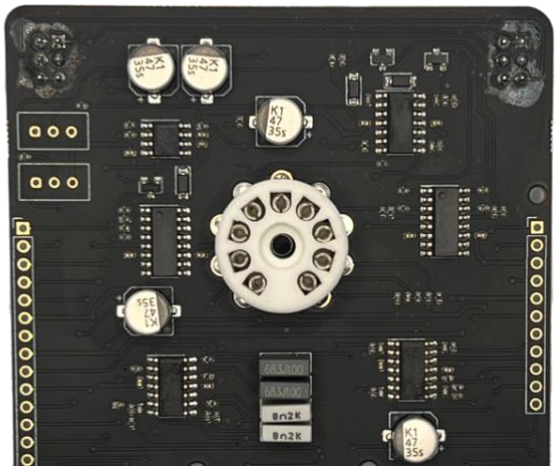


3. Take the Back PCB. Place capacitors on the face of the Back PCB. The two 68nF in the top two footprints and the two 8.2nF in the bottom top footprints. Flip over and solder in place.

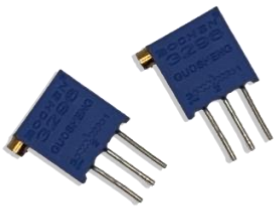


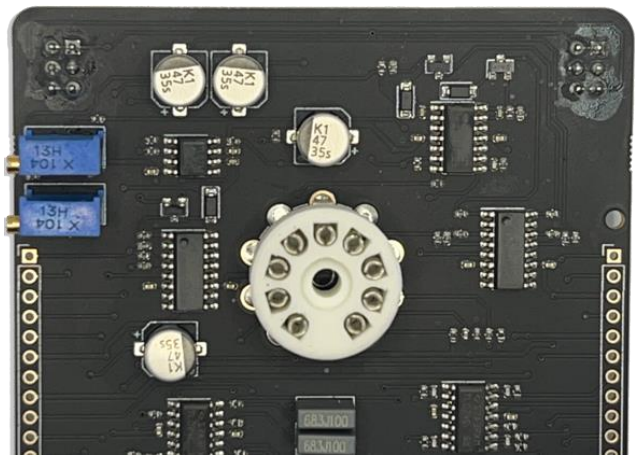
4. Place the two 2x3 pin headers in the footprints on the rear of the Back PCB. Flip the board holding them in place (masking tape is your friend here) and solder them in place. A flux pen can help get a good solder joint here; a light wipe over the pads is all that's required.

5. Place the tube socket on the footprint on the face of the Back PCB. Flip the board and solder, and try to ensure the socket is as level (flat against the PCB) as possible, as this affects the final position of the tube. Note: in the picture below, you can see the residue from the flux pen from soldering the 2x3 pin headers; we will clean this off later with the brush.



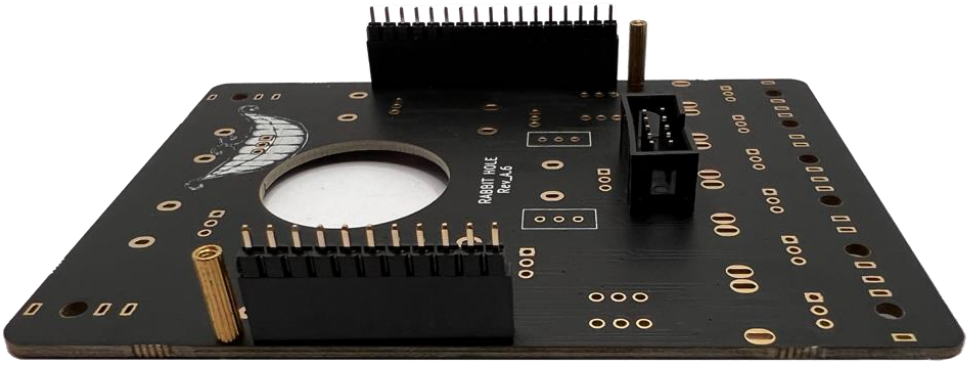
6. Select the two side adjustment 100k trimmers (not the top adjustment 100k trimmers, we will solder them shortly). Place them on the face of the Back PCB so the adjustment screws are outermost. Flip the board and solder; use masking tape here if you need to.



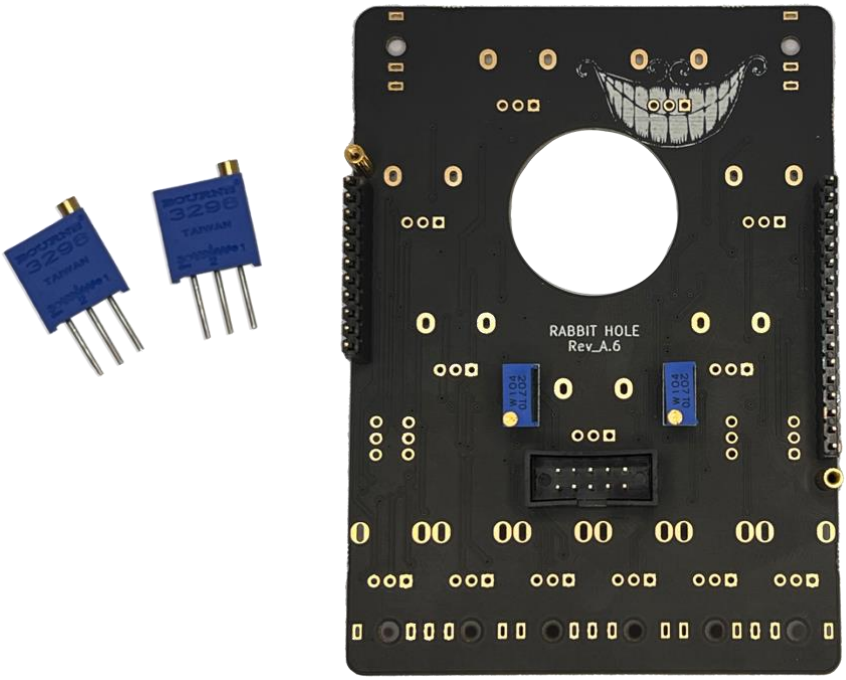


7. Lay the Front PCB face down and lay the pin headers and pin sockets onto the rear of the PCB. Don't solder yet.

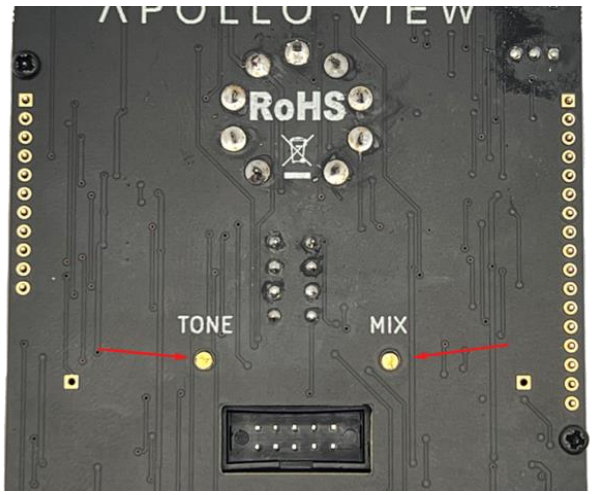
   Note: we kindly put the pins into the sockets already. We have a convention to place the sockets against the rear of the Front PCB; this will help compatibility if there are any future issues swapping any broken PCB parts around.



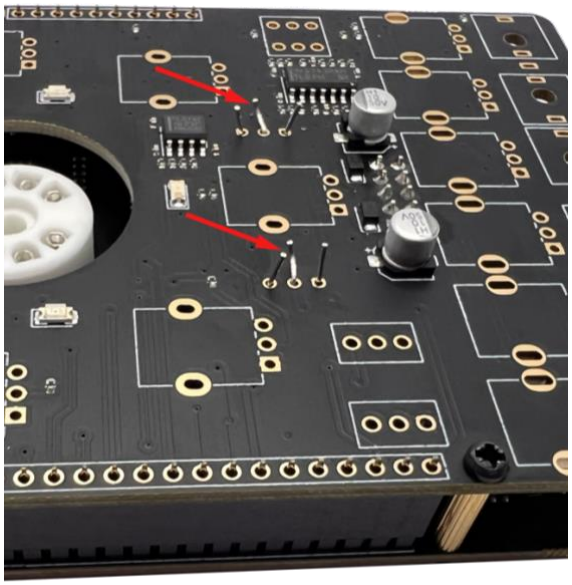
8. Locate the two top adjustment 100k trimmers. Place them into the rear of the Front PCB with the trimmer adjustment screw at the bottom. Don't solder yet.



9. Lay the Back PCB face down on the pin headers. Ensure that the trimmer adjustment screws are poking through the holes on the Back PCB (give everything a wiggle until everything is correctly aligned, this can be a little fiddly, but we have confidence in your skills!). Attach Back PCB to the standoffs with the remaining two M2 screws.

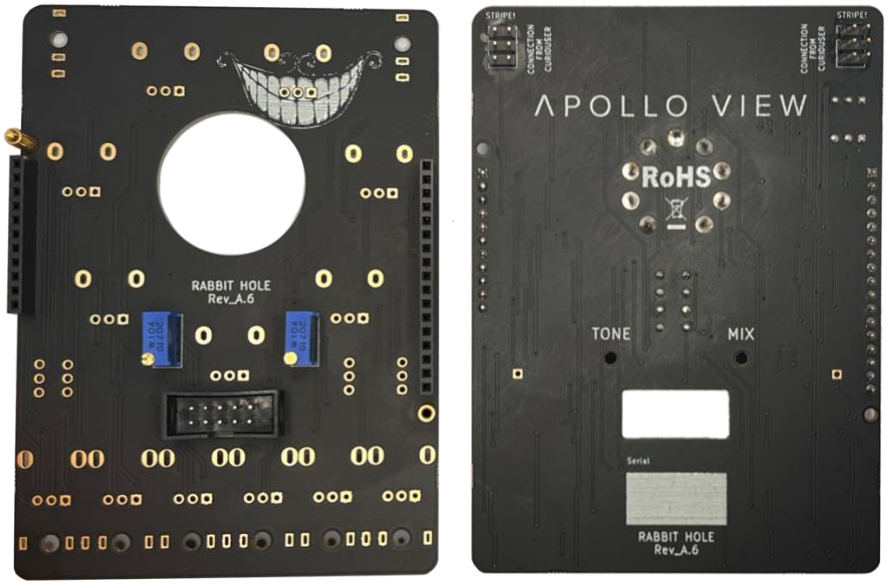


10. Flip the assembly over so the Front PCB is face up. Use the pliers to pull the middle leg of the trimmer up against the PCB and fold the middle leg of the trimmers to hold them in place. The purpose of this is so that when you solder the trimmers' legs in place, the trimmers do not drop down toward the rear of the module. If this happens, the trimmer adjustment screws will be flush with the rear surface of the Back PCB, but the base of the trimmer will stand a few millimetres away from the rear of the Front PCB, which will make it prone to misalignment later in the build process.



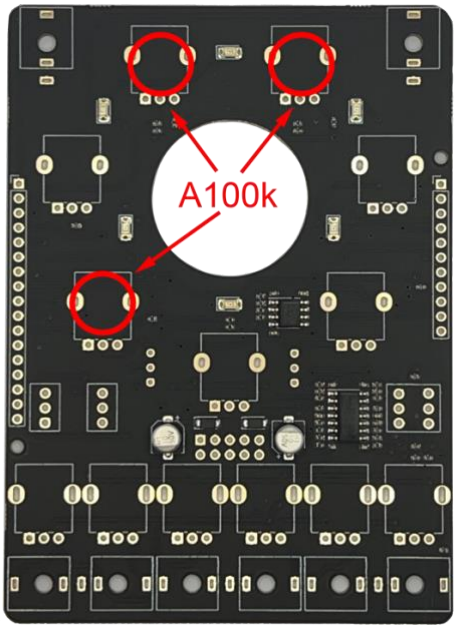
11. Solder pin headers and solder the trimmers in place.

12. Unscrew the Back PCB separate the boards, and set the two M2 screws to one side.

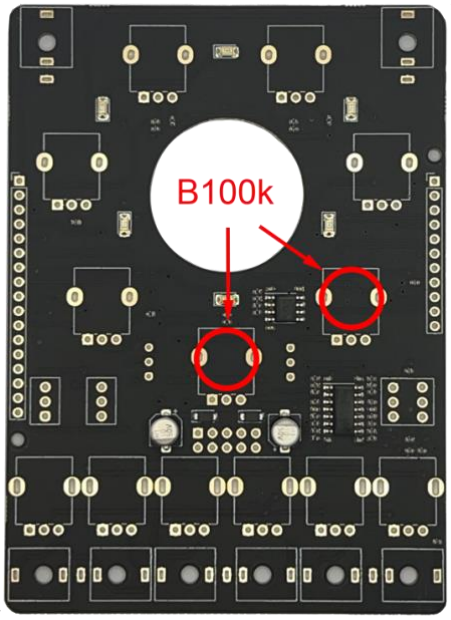


13. We will now populate the face side of the Front PCB, starting with the potentiometers for In A, In B and FB, which are all A100k (the potentiometers are clearly labelled with their value). Using pliers to straighten the kinked legs can help with positioning the potentiometers. The next four steps, 13-16, are all using the 9mm Alpha D shaft pots, which can be identified from the green body.

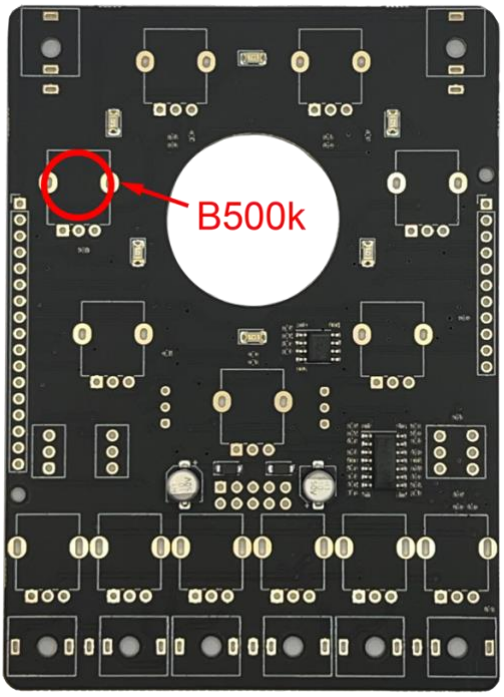
    Don't solder anything until the Faceplate is on.



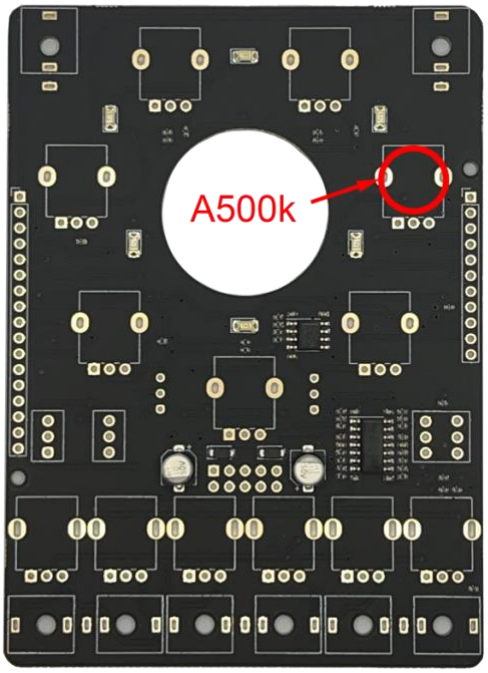
14. Next, place B100k in for the Mix and Tone controls.



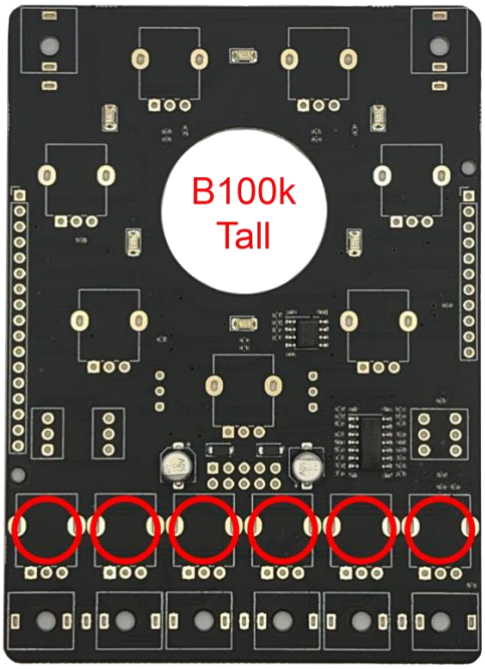
15. Next place the B500k for the Tube control



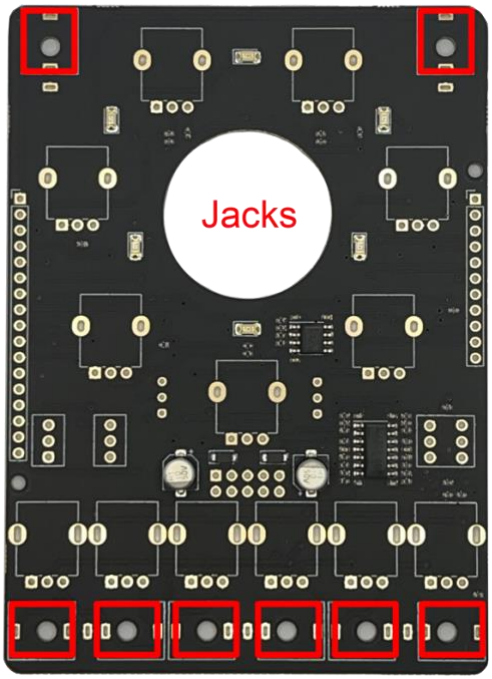
16. Then place A500k for the Drive control



17. Now place all the B100k tall pots. These can be identified from their blue body.



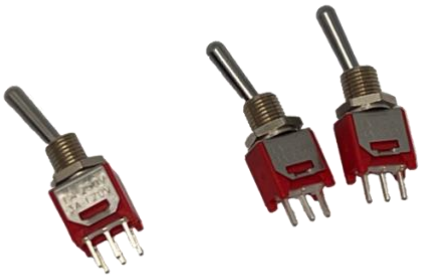
18. Populate PCB with Thonkiconn jacks



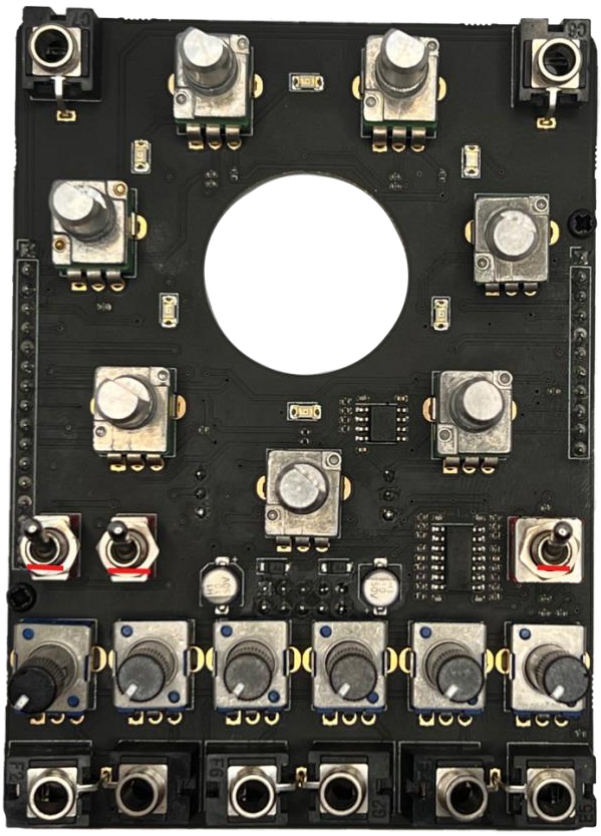
The orientation of adjacent jacks should alternate by 180°.

When placing the bottom row of jacks, groups of two jacks share the same ground pad.

19. Screw a nut onto the two SPDT, and the DPDT switches.



20. Place switches with the flat key (on the thread/barrel of the switch) at the bottom. When this step is done, the Front PCB should look as follows (the red line indicates the flat thread/barrel of the switch).



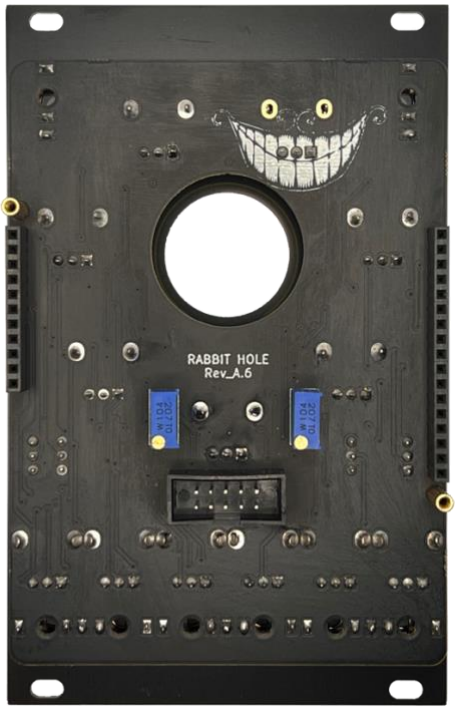
21. Place on the Faceplate. Take care not to dislodge any components. You will have to begin feeding the faceplate over the Tall B100k Pots, then take care with the switches. The switches should all be in the **Up** position.

22. Holding the faceplate on firmly, check the rear of the Front PCB and ensure that all the legs are through the holes. Take care that **all** of the jacks' ground pins are through, as these springy little legs, especially the bottom row where two jacks share one pad, are susceptible to popping out. If any components need realigning and the legs placed through holes, do this before moving on to the next step.
23. Put black hex nuts on first. Place them with the smooth/rounded side down. If you position them with the flatter side down, they scratch the Faceplate while tightening.

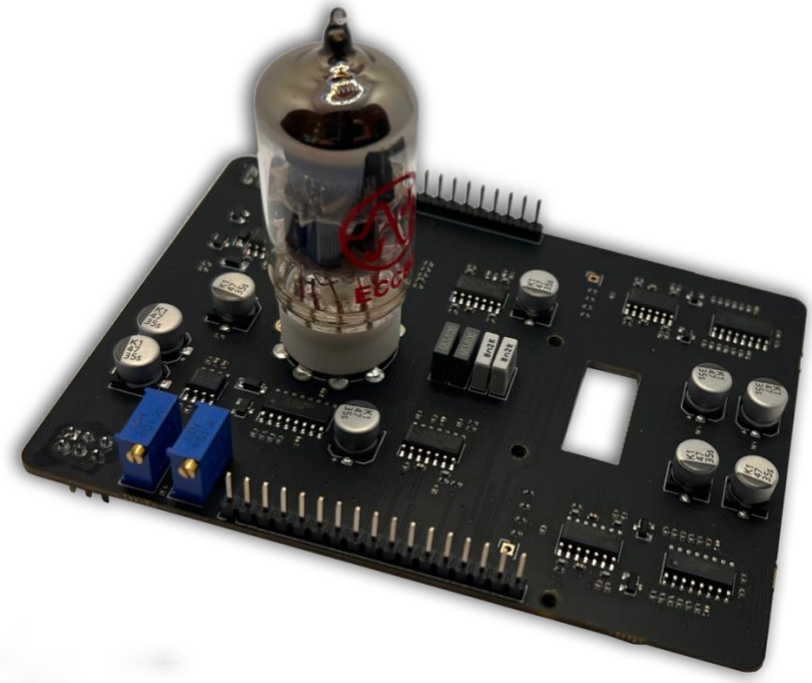
    Note: The washers aren't strictly necessary but can be used if desired. We chose to leave them off as we found it more aesthetically pleasing.

24. Finger Tighten the black hex nuts first before tightening with 10mm hex driver.

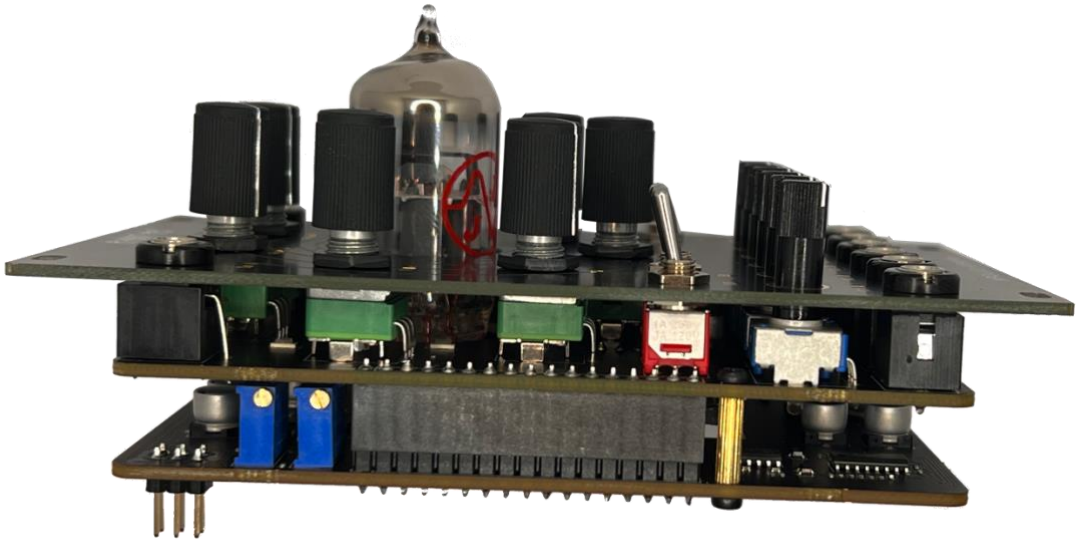
25. Then position and finger tighten the Bananuts onto the jacks. Do the final tightening with the Bananut driver.
26. Then position and finger tighten the switch nuts. Do the final tightening with the 7mm hex driver.
27. Boom! You are ready to solder everything in place, **except** leave the Cheshire Cat's eyes unsoldered. It looks good and doesn't affect the electrical or mechanical properties of the module.



28. Give all solder joints a quick scrub with a cleaning brush to remove flux.
29. Gently push the tube into the tube socket.



30. Screw the Back PCB onto the standoffs with the M2 screws you put to the side earlier.
31. Align the tube more centrally if necessary.
32. Gently push the knobs on.



33. Place the power cable into the shrouded header, and we are ready to calibrate.

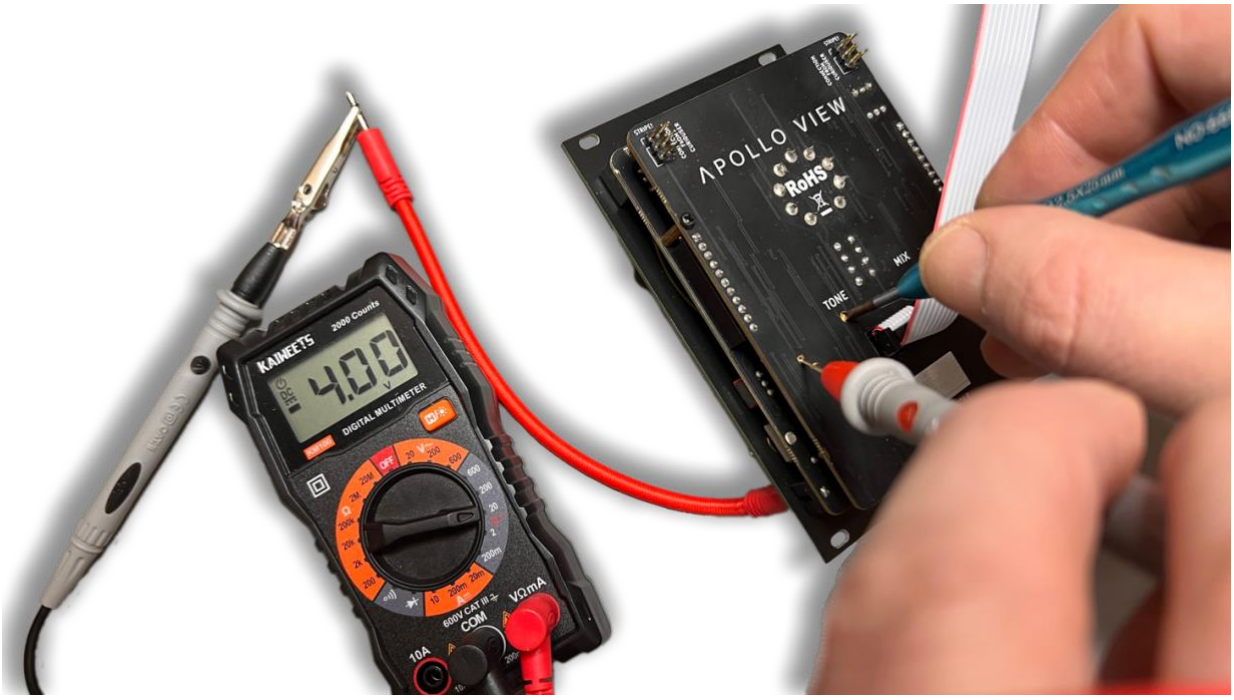
CALIBRATION

There are two types of calibration we need to perform on the trimmers. The first is to calibrate the crossover mixing point for both the Mix and Tone controls; this step requires a voltmeter (multimeter). The second is to ensure the VCAs are not bleeding any signal through when the Gain control is set to its minimum; this step requires your ears.

The module needs to be connected to the power supply and on for calibration. But you need access to the back of the module, so don't screw onto the rails of your rack just yet.

MIX & TONE CROSSOVER CALIBRATION

You will need a voltmeter (multimeter) with a crocodile clip on the common ground probe for this step. (Credit to Robin Vincent Molten Modular for using the ground on a patch cable to simplify these steps)



We are looking to measure -4.0V with respect to ground from each of the two test points, Mix and Tone.

1. Plug a patch cable into any socket.
2. Connect the common ground probe with the crocodile clip to the sleeve of the patch cable.
3. Position the test probe at the Mix test point.
4. Check the reading on the voltmeter.
5. Adjust the Mix trimmer while checking the voltage until you get -4.0V
6. Repeat for Tone.

VCA BLEED CALIBRATION

Due to the nature of the tolerances and differences between each of the vintage VCAs integrated circuit chips it is possible that there is some bleed from the VCA. Normally this is undetectable but due to the possible gain of x 1000, this bleed can become evident at high Drive and Tube settings.

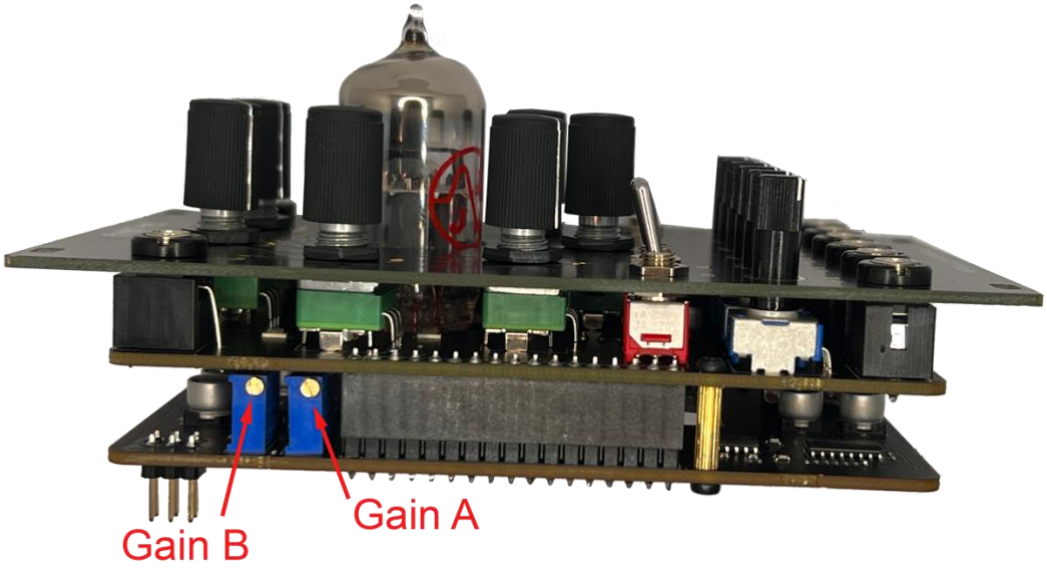
Therefore we need to counteract this by adjusting the trimmers, which compensate for the bleed.

1. Patch a signal into In A, a low-frequency ≅ 100Hz will do.
2. Patch the Output of Rabbit Hole so you can hear through your system or headphones. Ensure Rabbit Hole Output attenuverter is turned up.
   Note: this can be either fully clockwise or filly anticlockwise.
3. Turn the Tube and Drive to maximum.
4. The Mix knob also needs to be set fully wet (maximum clockwise).
5. Turn the Gain A & B to minimum.
6. Make sure L8, FB and OWTH are OFF (Up position).
7. Tone should be in the centre position.

See the example settings below.

8. Adjust the trimmer for Gain A (indicated below), so it is fully clockwise. It will click when you have hit the end of the trimmers travel.

If you cannot hear any signal, the calibration for this channel is complete skip the remaining steps for this channel



9. Make anticlockwise adjustments to the trimmer until there is no sound present.
   Note: Rotate clockwise for more gain and anticlockwise for less gain.
10. When you feel like you have cut the bleed out, check that the signal is present with the smallest of increases of the Gain knob.
    Note: For some VCA chips, the trimmer might be superfluous, and the trimmer will reach the end of its travel, i.e. fully clockwise. This isn't a problem.
11. Change the input from In A to In B and turn Gain B down to a minimum.
12. Repeat steps 8-10 with the trimmer for Gain B.

SERIAL NUMBER

Now you have completed your build, contact us at info@apolloviewmodular.com and we will issue your special DIY serial number. This can be written in indelible ink on the back PCB and the details of the registration card can be updated.

THAT´S IT; YOU´RE GOOD TO GO!

PLEASE READ THE MANUAL FOR MORE OPERATIONAL INFO

GO MAKE SOME FILTHY SOUNDS.

DON´T GET TOO LOST DOWN THE RABBIT HOLE!

RABBIT HOLE
DIY BUILD DOCUMENT V1.3

APOLLO VIEW

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