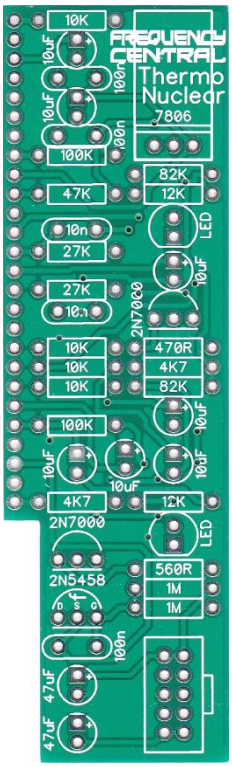
FREQUENCY CENTRAL

Build documentation for:

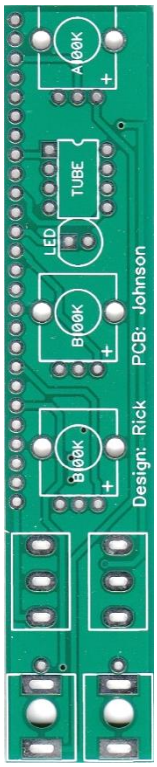
THERMO NUCLEAR

Sub-miniature vacuum tube based overdrive. The first stage is a MOSFET with switchable mu-amp. The second stage is a self biased sub-miniature pentode with switchable triode/pentode. Then there's a tonestack based on the EH Big Muff. Finally, there's a blend control and another MOSFET stage for some gain recovery after the tonestack.

Main PCB



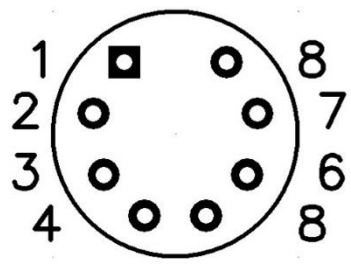
Control PCB



About the tube

Sub-miniature vacuum tubes were first designed for use in ordinance proximity fuses. The one we're using here is wire ended, which means we are going to solder it directly to the PCB. Don't worry – these babies are very tough. In this design it has 24V running through it, courtesy of eurorack +/-12V supply. The filament (heater) of the tube is powered from the 7806 regulator. Both the tube and the regulator are likely to get hot – that's normal.

Here's the pinout of the tube when looking at it from above (with the crimped glass nipple pointing towards you, and with the legs pointing away from you).



You will notice that there is a gap between pins 1 and 8 of the tube. You'll need to bend the legs into shape in order to mount it onto the PCB. Take your time – you really don't want to get this part wrong!

Although the filament of the tube will glow, it's not a lightbulb, and the level of glow may vary between different tubes.

Current draw – yes it's high isn't it!? A whopping 175mA on the +12V rail – guess where all that heat comes from? You wanted a tube in your rack, you got one, the current draw is the unforeseen consequence. Although it's only 4mA on the -12V rail 😊

About the LEDs

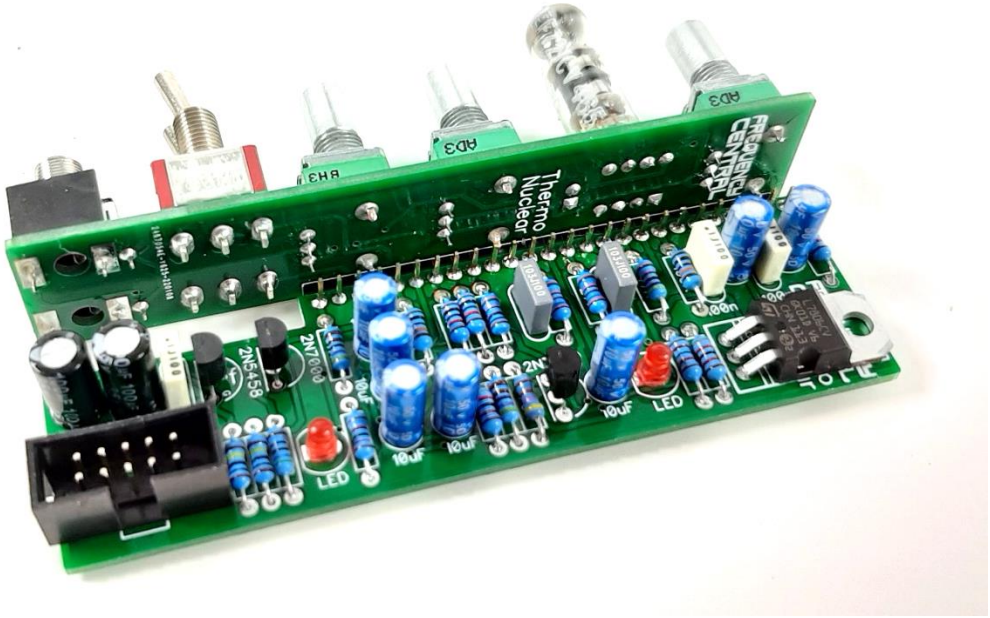
There are 3 LEDs in this design:

- The two on the main PCB are being used for their diodic properties to protect the MOSFETs. Whether they light up or not is irrelevant (they might, just a tiny bit).
- The third LED on the sockets PCB is used to bias the tube's cathode. This has the same effect as a bias resistor with a perfect bypass capacitor. The LED will slowly come on as the valve warms up.
- Yes, all 3 LEDs DO need to be RED, as other colours have different forward voltages and would compromise the circuit.

Bill of Materials

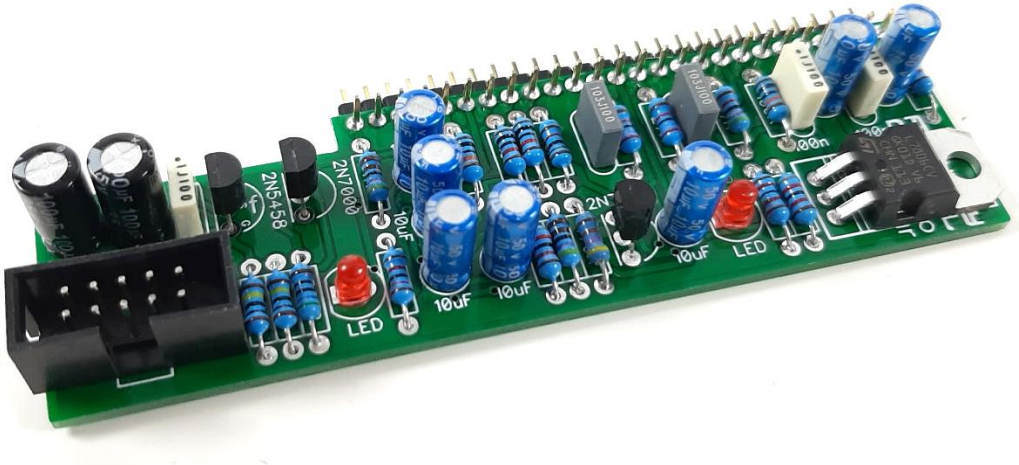
You will notice that almost all of the components listed below are also hyperlinks to where I buy each specific part from. You can also use the hyperlinks to find out more about what each component looks like. If you want to know even more, Google is your friend.

470R x 1 560R x 1 4K7 x 2 10K x 4 12K x 2 27K x 2 47K x 1 82K x 2 100K 2 1M x 2 All resistors ¼ watt metal film.	10nF x 2 100nF x 3 10uF x 7 47uF x 2	EF72 or 5840 tube 2N7000 x 2 2N5458 x 1 3mm red LED x 3 7806 x 1	A100K x 1 B100K x 2 SPDT toggle x 2 3.5mm socket x 2 90° male header x 1 cut to size Power header x 1 Knobs x 3



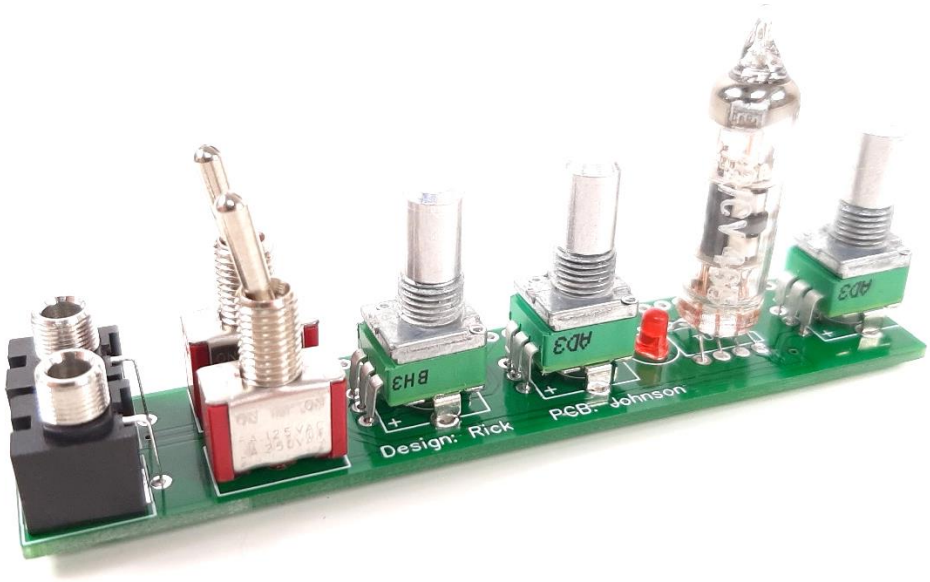
Main PCB assembly

1. Solder the resistors
2. Solder the 7806 and bend it over as in the photo
3. Solder the 2 x LEDs (short leg to square hole)
4. Solder the non-electrolytic capacitors
5. Solder the 2 x 2N7000 and the 2N5458 – watch the polarity! Take care not to mix up the 2N7000 and the 2N5458 near to the box header (the 2N5458 has an '**f**' on the screenprint)
6. Solder the box power header. Make sure the notch lines up with the screenprint legend. If in doubt, have a look at a power cable, and make sure when inserted into the header the red stripe lines up with the -12V screenprint.
7. Solder the electrolytic capacitors
8. Cut 90° male header to size and solder into place. See photo below.



Control PCB assembly

1. Solder the LED (short leg to square hole)
2. Solder the 3 x pots, 2 x switches and 2 x sockets. Use the panel to ensure these line up nicely. You can use cut off resistor legs to make the ground connections of the sockets.
3. Solder the tube. Take your time with this process, pin 1 goes through the square hole. Use the panel to ensure it sits nicely.

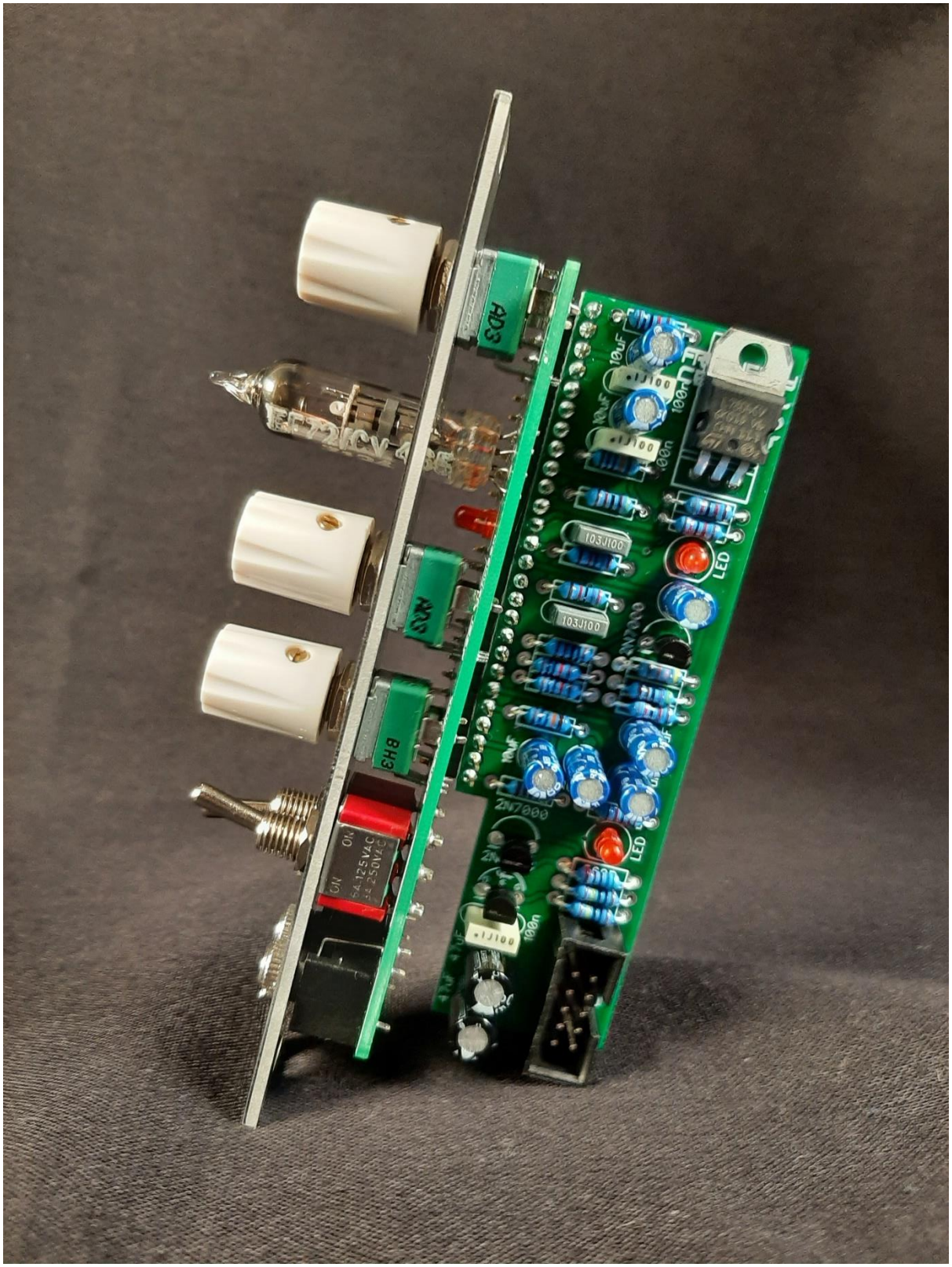


Final assembly

1. Slot the header from the assembled Main PCB into the Control PCB. Ensure a nice tight fit and solder into place
2. Bolt the pots, switches and the sockets to the panel using their nuts and washers.

Troubleshooting

1. No, it's probably not a bad tube, these things are very resilient and hard to kill. Not all DIY builds work first time.
2. The vast majority of build issues are down to soldering inconsistencies. This is far more likely than a bad tube, for example. The first step of successful troubleshooting should always be to reflow all soldering to eliminate any dry joints (bad connections) or solder bridges (short circuits). This is also an opportunity to closely inspect your work – you might find some unsoldered pads.
3. Next steps are to double check all resistor values are correct, and to check polarities of all diodes, transistors, tube and electrolytic capacitors. This is not an exhaustive troubleshooting guide, but should address 95% of build issues.



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