OMEN

DUAL PASSIVE RESONANT LPG

BUILD GUIDE

V1.1 - APRIL 2023

HERZLICH

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INTRODUCTION

Thank you for choosing an **OMEN DIY KIT** - this build guide will help you in your endeavor to successfully build your new dual passive, resonant LPG - I recommend you read the build guide before starting your build, and I suggest leaving everything in the bags they came in until you are instructed to retrieve something from them. The **OMEN** is not a difficult build, but you can avoid many potential pitfalls by following and familiarizing yourself with the build process before beginning.

SAFETY

Building electronics is a fun and rewarding hobby, but just as you practice basic safety procedures while cooking, so should you practice basic safety precautions in your workshop. Below are some recommendations on measures you should take while working:

- **Your soldering iron is dangerously hot.** When not in use, be sure to put it somewhere where it will not fall or roll away, and where you are not at risk of snagging the cable and making it fall on something, or yourself, as you work.

- **Be mindful of toxic chemicals and fumes.** I recommend using lead-free solder, working in a well-ventilated area to dissipate fumes, and if you opt to use leaded solder, be sure to wash your hands after soldering, and do not eat or drink in your work area.

- **Wear adequate eye-protection.** A good pair of safety glasses will not obstruct your vision, will be comfortable to wear for extended periods of time, can be had for less than €9 and will, most importantly, protect your eyes from injury. Hot solder can spit, and trimmed leads can turn into projectiles, both of which can cause irreversible damage to your eyes. Make it a habit to wear safety glasses while working.

You are responsible for your own safety while working – so please don't e-mail me if you decided squinting your eyes while trimming LED leads was a sufficient alternative to a pair of safety glasses and end up in the emergency room. With proper health and safety precautions, you can look forward to practicing your hobby for years to come.

EQUIPMENT

You will need some basic hand tools and, ideally, some proficiency with them to successfully complete this project. If you need to buy tools, or if your tools are not up to the task, I recommend buying the best quality tools you can afford - it will serve you best in the long run, and you will not have to continuously upgrade every time a cheap tool breaks or proves insufficient.

I have added some tool suggestions in parenthesis, but please note I have no commercial interest in recommending one tool over another, this is only to help other people find tools they will be happy to use for years to come. You will need:

- A temperature-controlled soldering iron
- Needle-nosed pliers (Engineer PS-01)
- Low-profile side cutter (Knipex 78 71 125 ESD w/ lead catch)
- Good quality lead-free solder
- Safety glasses (Bollé Silpsi)
- Cyanoacrylate glue

The following tools are not strictly necessary, but will prove useful:

- Knurled nut driver (Xicon 382-0006)
- Socket wrenches (Bahco SL25)
- A decent multimeter
- Anti-static tweezers
- Solder braid and liquid flux
- Desoldering pump (Engineer SS-02)

These tools will all prove useful in countless other DIY projects – if you do not own some or any of the tools above, try reaching out to friends or even local hackerspaces, who will more than likely be happy to lend you the tools. Alternatively, you can of course also buy the tools you need, especially if you think you will build more DIY projects in the future.

DESIGN NOTES

The Omen is an unusual take on the familiar trope of the passive LPG, as it brings resonance and a -6dB filter slope to the typical -3dB non-resonant LPG design. You may also meet people in your musical journey who call your new passive, resonant filter "witchcraft" or "impossible," but take comfort in the fact that they are sadly misinformed and may soon be corrected by your superior knowledge of filter topology.

Before transistors, options for designing audio filters were fairly limited, as transistors (and later, ICs) form the prerequisite for active filter topology. A favored method of creating audio filters for radio and cinema, however, was using so-called LC filters - filters comprised of a capacitor and an inductor. LC filters had many desirable characteristics over other passive filters, among them the fact that they were able to create resonance, dependent on the relationship between the capacitor and inductor, and they were not as prone to signal loss as other passive filter topologies were, allowing for steeper filter responses. With the advent of active filters, however, LC filters quickly fell out of favor, as inductors are expensive, imprecise and tend to be invariable, compared to continuously sweepable active filters.

A variant of the LC filter, called an RLC filter, allows for variation over the resonant characteristics of the filter, while the filter cutoff is fixed, determined by the relationship between the inductor and capacitor. The Omen uses this principle, as the optocoupler inside forms both the volume response and resonant response of the circuit, while the cutoff can be varied with a three-way toggle switch choosing different capacitor values. The result is an LPG that sounds quite unlike anything else, where the resonance brings some character and bite to the sound, without compromising signal strength and remaining a passive unit.

For the adventurous builder, the included capacitors can be exchanged for other capacitors to achieve different filter cutoff values. The math involved is slightly beyond the scope of this build guide, but searching online for LC filter calculators will provide plenty of easy calculation options.

The Omen was designed entirely on paper, with inspiration from the book Audio Cyclopedia (Tremaine, 1969) during an unexpected stay at Hvidovre Hospital in 2022 - a stay which led to the birth of my son, Nemo, to whom I dedicate this design.

BOM

Component	Designator	Quantity	Identifier
47nF film capacitor	C1	1	47nJ
220nF film capacitor	C2	1	224J
330nF film capacitor	C3	1	334J
680nF film capacitor	C4	1	684J
22nF film capacitor	C5, C6	2	223J
1N4148 diode	D1, D2	2	
3,5mm jack		6	
120mH SMD inductor	L1,L2,L3	3	
3mm LED	LED1, LED2	2	
470 ohm resistor	470	4	
Subminiature Toggle Switch	U1, U2	2	
5mm LED		2	
5mm LDR		2	
50k potentiometer	VR1, VR2	2	
Optocoupler shell		2	
Potentiometer knob		2	

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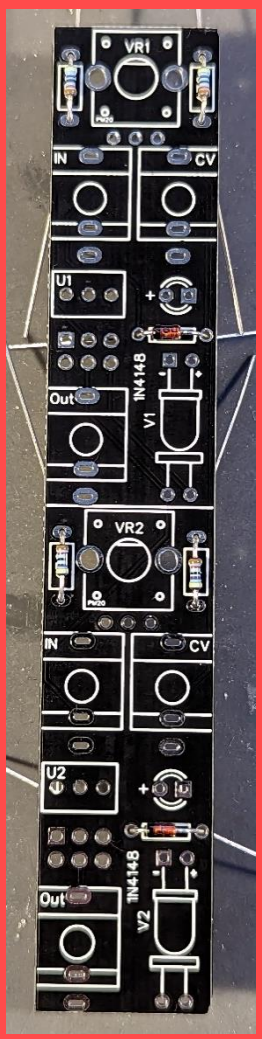


Time to build - you will find the front panel and PCBs inside the kit bag, as well as several smaller bags. These are intended to help you sort and identify the required components, and the guide will mention when to retrieve something from a particular bag. This guide assumes you already have basic familiarity with soldering and will not go into further details with this. If you are inexperienced, there are plenty of excellent written and video tutorials on this online, but ultimately the best way to learn is to practice.

STEP 1: DIODES AND RESISTORS

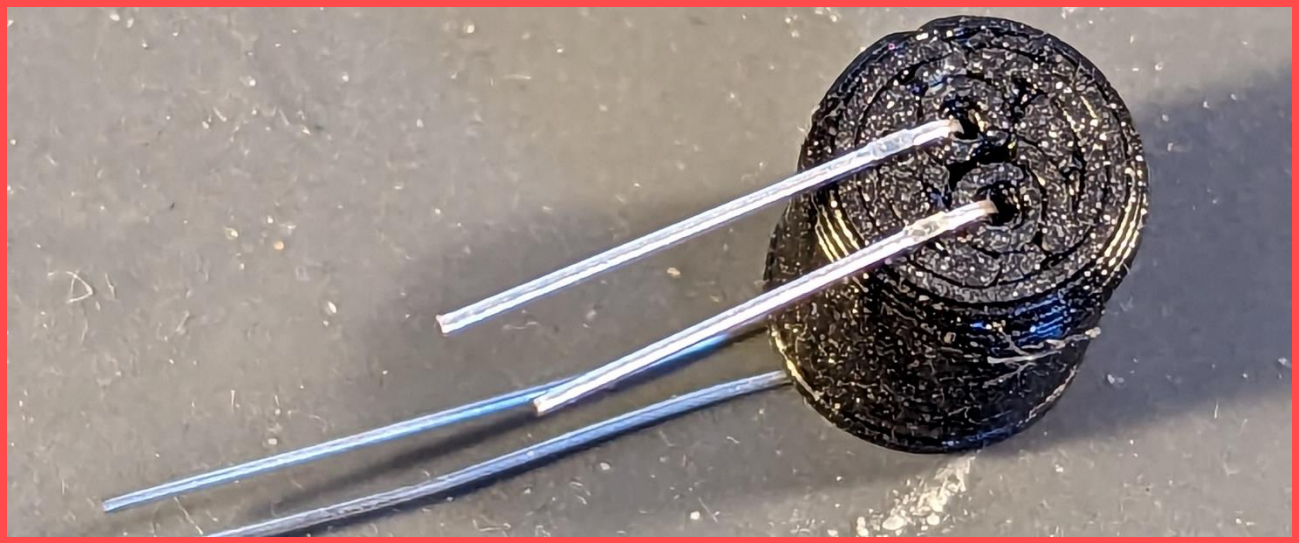
Locate the **red bag**, which contains four resistors and two diodes, which we will begin by inserting into the top PCB. The orientation of the resistors (marked with 470 in silkscreen print on the board) does not matter but pay attention to the orientation of the diodes. The black band on the diodes should align with the white print on the PCB. Make sure the components are flush with the board and bend the leads outwards to hold them in place before turning the board around and soldering the components in place. When they are all soldered in, trim the leads before you continue.

STEP 2: PINHEADERS

Locate the two 2x3 pinheaders in the **red heart bag**, and insert them on the other side of the PCB - the silkscreen print indicates the correct side for the pinheaders. Turning the PCB around carefully, solder one pin of each pinheader as you hold the pins flat against a hard surface, then check that both pinheaders are installed flush with the board. If they are flush, proceed by soldering the rest of the pins - if they are not, reheat your joint and try again, applying pressure to make the pinheader flush with the board.

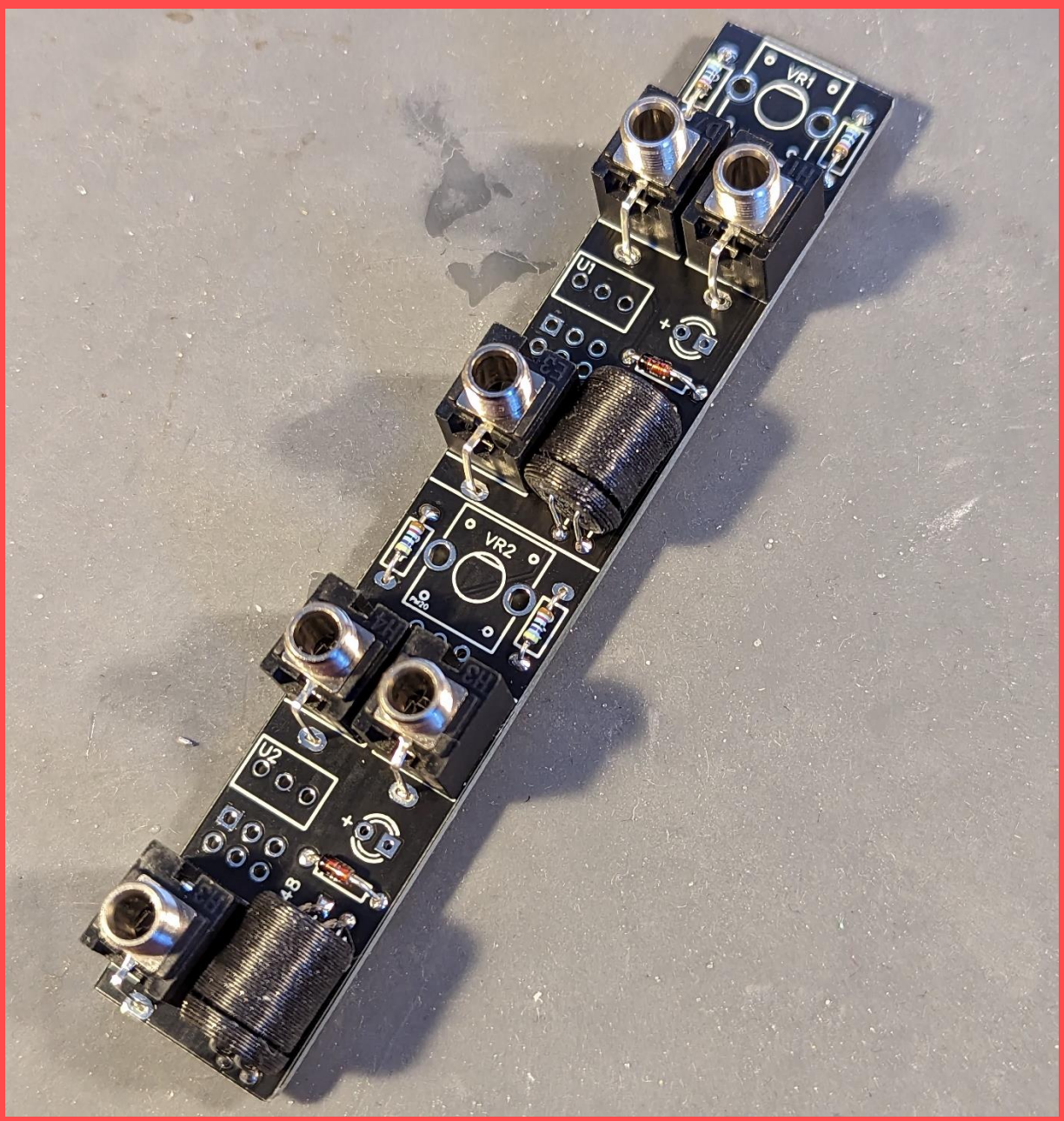
STEP 3: OPTOCOUPLER ASSEMBLY

Locate the **blue dolphin bag,** which contains the components necessary to produce two optocouplers - also referred to as vactrols. Each vactrol is comprised of a plastic shell, a 5mm LED and an LDR (light dependent resistor). Insert the LDR in the shallow part of the plastic shell, it should fit snugly inside, then insert the LED in the deeper recess of the plastic shell. It should also be a snug fit. Now, carefully align the two pieces of the plastic shell - they will fit loosely together - and glue the shell together with a dab of super glue, holding the shell firmly together while the glue bonds. Repeat for the other vactrol. It is important to the function of the vactrol that the shell is joined tightly, as it should be lightproof.



STEP 4: OPTOCOUPLER SOLDERING

The vactrols are a polarized components, and must be aligned correctly with the board - but as we have now obscured the components inside within a plastic shell, we need to rely on the legs to identify the correct alignment. LEDs follow a convention where the cathode (the negative side) always has a shorter leg than the anode. The LDR will also have comparatively long, flexible legs. Having identified the LED side and the anode and cathode, align this side with the silkscreen print on the board, fold the legs down 90 degrees, and insert the vactrol such that the cathode goes in the hole marked with a minus sign, and the anode goes in the hole marked with a plus sign. The LDR is not polarized and the direction does not matter. Solder one leg into place, ensure that the vactrols are flush and within the boundary of the board, and then solder the remaining legs. Trim the leads close to the board when you are done.

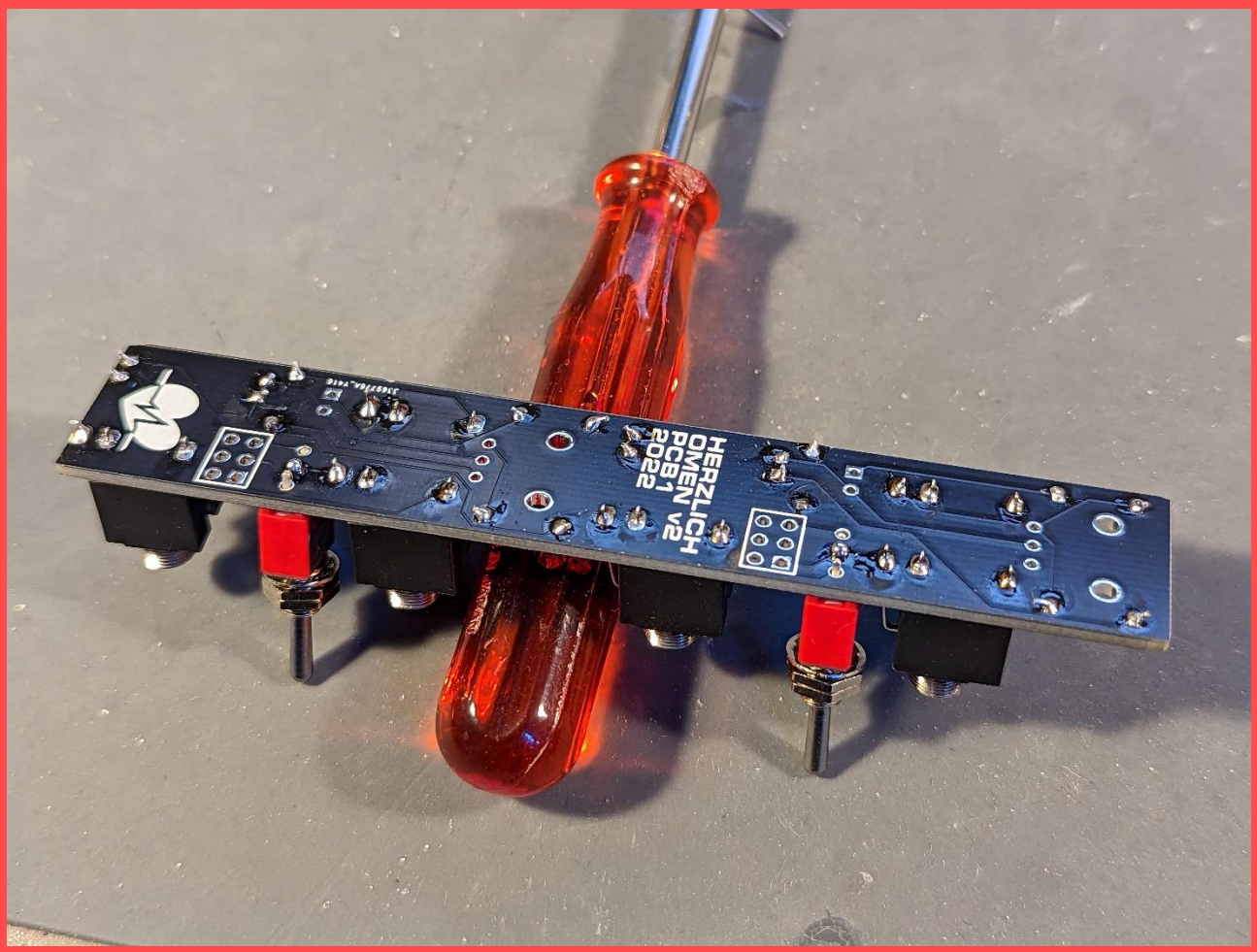


STEP 5: JACKS

Locate the **yellow smiley bag**, which contains six 3,5mm jacks. Insert the jacks with respect to the print as before, and carefully turn the board over. Once again, solder one pin on each jack, then turn the board around and check that all the jacks are flush with the board. Reheat the joints and press the jacks against a hard surface while you do, if necessary, and continue until everything is flush, then solder the rest of the legs.

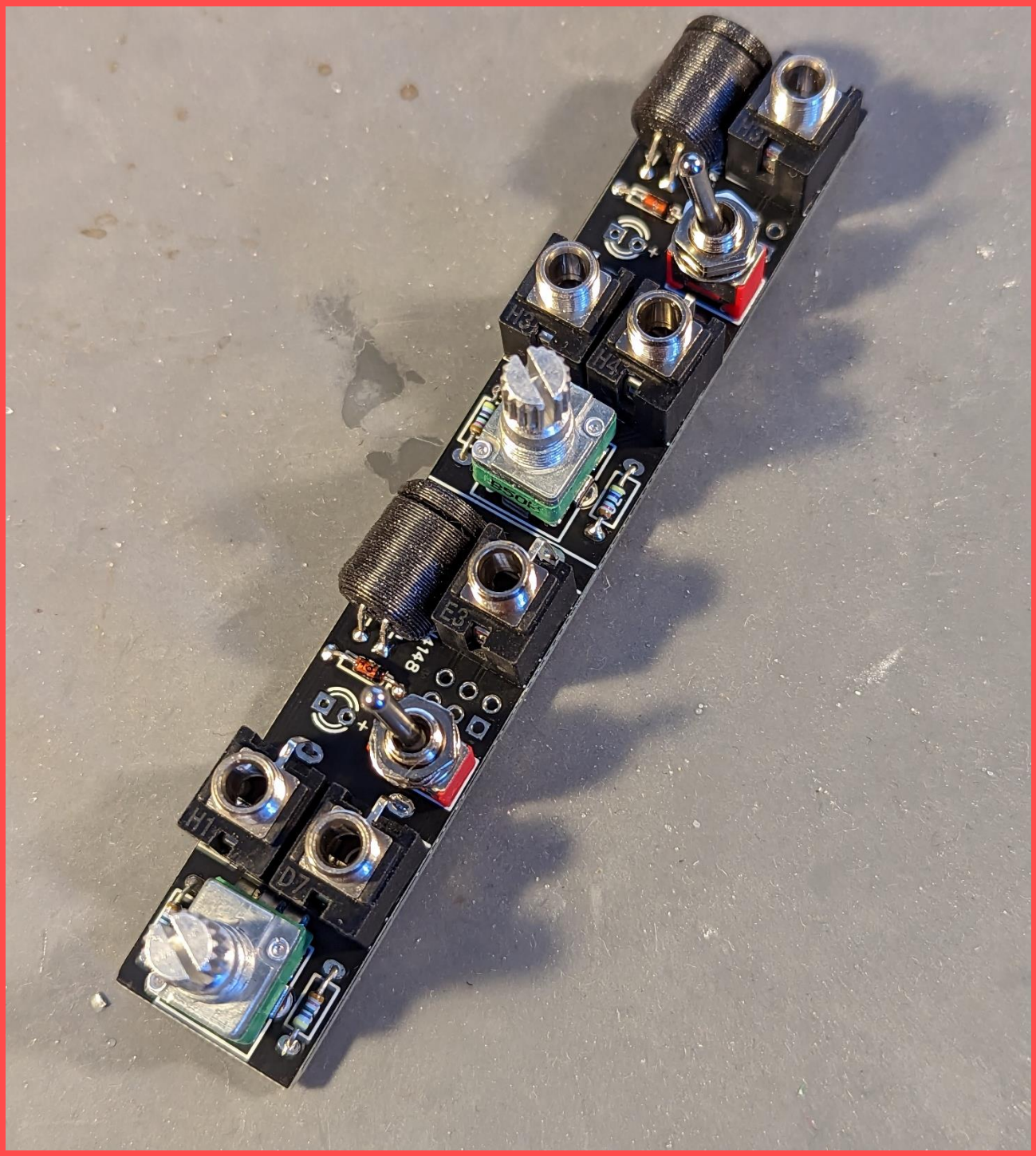
STEP 6: TOGGLE SWITCHES

Locate the toggle switches in the **green alien bag**. These may prove a little challenging, but once again, insert them with respect to the silkscreen print (don't worry about their orientation), and solder one leg on each. You may find it useful to prop up the board with something to make balancing the switches easier, but it's not strictly necessary. Once you have soldered one leg, check if they are flush and straight, and use the technique from before to adjust them if they sit crooked on the board. You may find it helpful to temporarily slip the front panel over them to help with the alignment at this point. When you are satisfied with their position, solder the remaining legs in place.



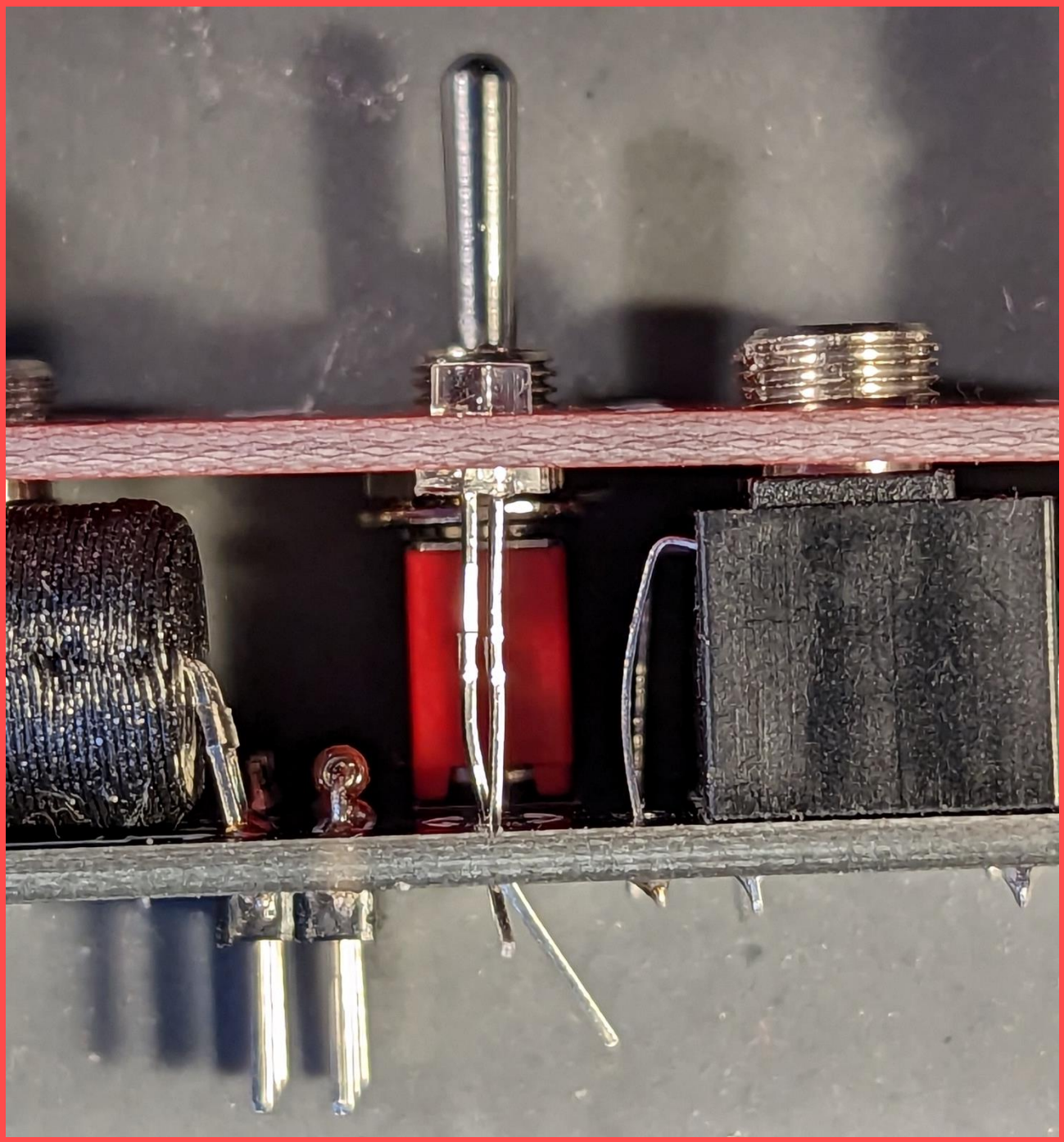
STEP 7: POTENTIOMETERS

Locate the potentiometers in the **green alien bag**. You may need to squeeze the side legs slightly to make them fit, and if the front legs have become misaligned, you can carefully realign them. Inserting them into the board may require a firm push, but be careful not to use excessive force. Start by verifying the three front legs are all correctly aligned in each their hole, then solder them. Then, checking that the potentiometers sit straight and flush with the board (you can use the front panel to make extra sure) solder the remaining two legs for support.



STEP 8: LEDS

Finally, locate the 3mm LEDs in the **green alien bag**. Insert both in the board, but do not solder anything yet, paying careful attention to align the cathode (short leg) with the square pad and the anode with the round pad. Place the front panel over the components you have soldered so far, and secure it in place by adding nuts to a few of your jacks. Now gently push the LEDs through the holes immediately above them - a pair of tweezers or needle-nosed pliers can be helpful here - making sure they are firmly secured in the front panel, standing slightly proud of the panel. Solder the legs and trim them close to the board when you are satisfied with their position.

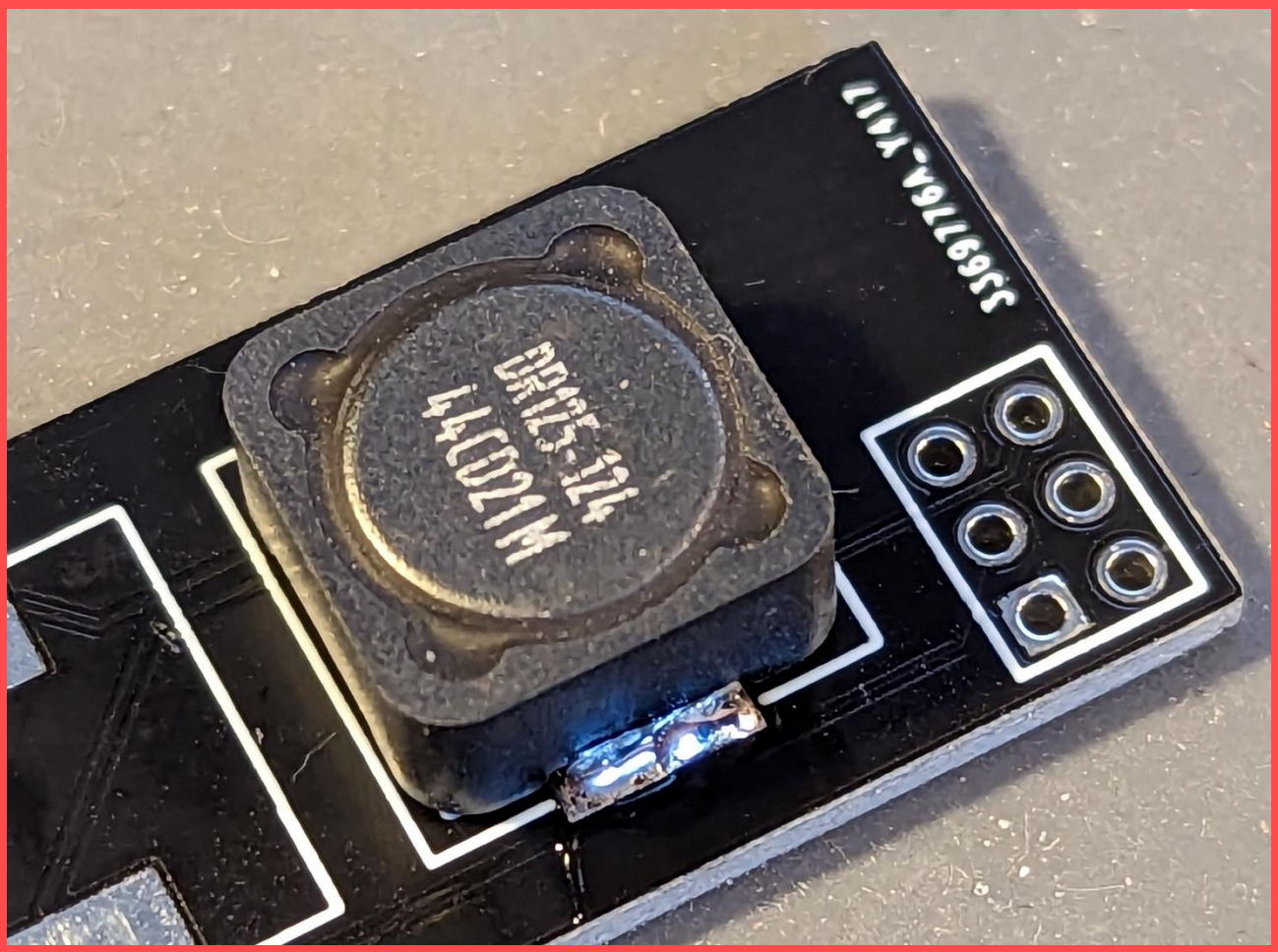


STEP 9: NUTS AND KNOBS

You are well past halfway done now! Using the nuts that came with the jacks, potentiometers and toggle switches, carefully screw everything down firmly, securing the panel and your components in place. Finally, press the knobs down over the potentiometers.

STEP 10: SMD INDUCTORS

Locate the SMD inductors in the **red heart bag**. They are not polarized, but pay attention to the orientation of the leads on the bottom. This part is slightly more tricky than what we have covered so far, but with the confidence you have built up until this point, you will do fine. Make sure your soldering iron is hot, as all the components here will behave like heat sinks. To solder the inductors, wet one pad with solder, making sure it is covered. Then, align the inductor with the pads, and working quickly and accurately, solder the lead of the inductor to the wetted pad. If done correctly, the solder on the pad will reflow, and solder will easily attach to the lead, joining the lead and pad. Provided that you were successful, you should now be able to solder the other side with ease.

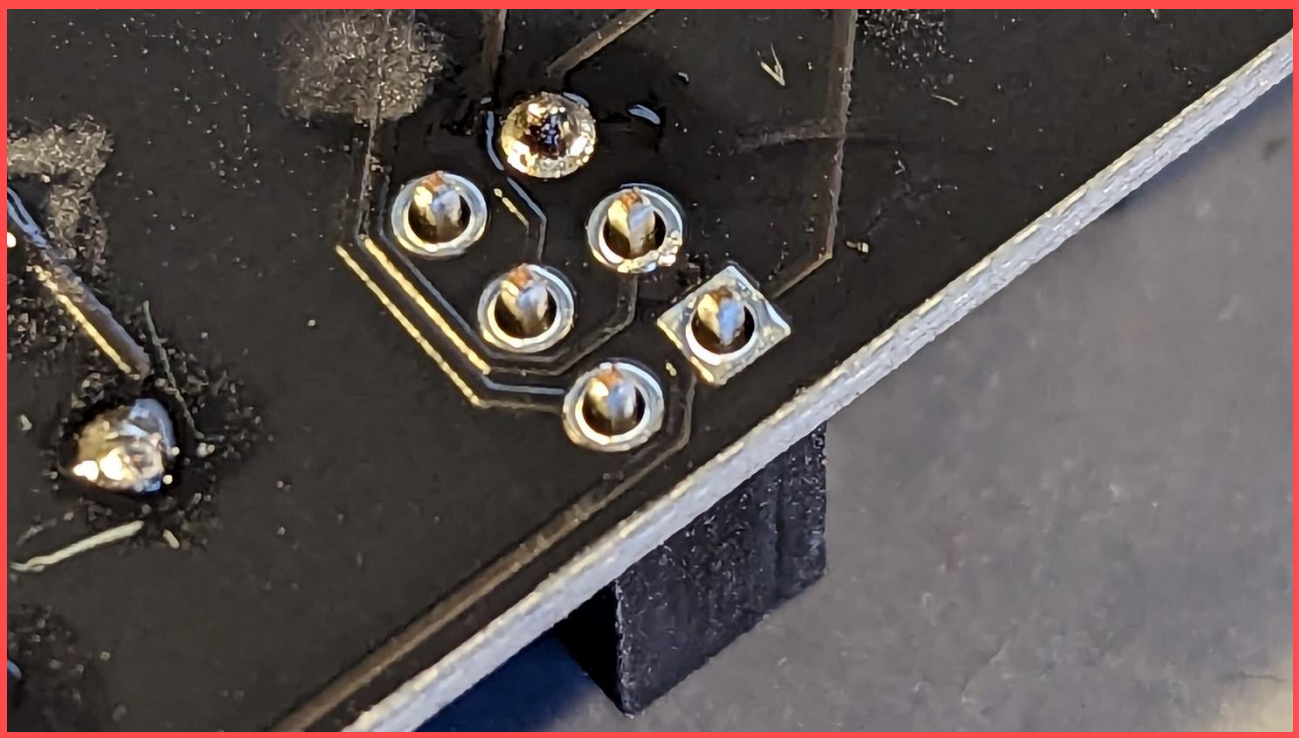


STEP 11: CAPACITORS

Locate the film capacitors in the **red bag**, and refer to the BOM to identify the correct location for each capacitor. Once again, be sure to solder one leg of each in place before checking if they are flush with the board, and reflowing your joints if they are not. Don't forget to trim the leads when you have soldered all the capacitors.

STEP 12: SOCKETS

Finally, identify and solder in the sockets from the **green alien bag**. As always, make sure to place the sockets on the side with the silkscreen print, solder one leg, check if they sit flush against the board, and then solder the remaining legs. At last, you can turn off your soldering iron and breathe a sigh of relief.



STEP 13: ASSEMBLY

Assembly is easy - simply press the pins on the top PCB into the sockets of the bottom PCB, and you're done! If anything doesn't fit, you may need to trim the leads on the top PCB a little more to ensure a nice, snug fit. Provided that you have dilligently made sure everything sits nice and flush against the boards, this assembly should be smooth.

STEP 14: TEST

Time to test your new **OMEN** - one of the best ways to test functionality, is to start by inputting a square wave in IN_1 and some type of modulation signal in CV_1, such as an LFO. Audio will not be present at OUT_1 without a positive voltage in CV_1. Try both the toggle switch and potentiometer to verify that they affect the filter response.

CV1 is normalled to CV_2, and OUT_1 is normalled to IN_2. Verify that both indicator LEDs glow when a signal is plugged into CV_1 and nothing is plugged into CV_2 and connect your audio output to OUT_2 to verify that both filters are working in unison. Plugging in a different modulation signal into CV_2 should also affect the signal processing. If anything fails during the test, double check your soldering - you may have missed something, or a joint may not be adequately soldered.

Congratulations, you have built an **OMEN** - now, go explore the endless sonic potential of the Omen, and don't forget to have fun, experiment and break the rules from time to time.

MODDING

The **OMEN** is easy to mod! Although exceptional care to make the LPG the best it can be from the get go, you can still achieve different results by varying capacitors, the LED color in the vactrol, the LDR type or the value of the inductors. If you come across an interesting mod, please do share it, and I'll be glad to include it in this section for others to find.

DGX MOD

Submitted by @geusens.dries.music, this mod changes the timbre and cutoff to be very similar to a popular, sought-after American LPG:

C1: replace with 6.8nF capacitor
C4: replace with 470nF capacitor
C5: replace with 10nF capacitor

SUPPORT

Sometimes things go wrong - that's OK! If you have run into trouble while building your module, and you can't seem to get yourself out of trouble, you can reach out to lb@herzlich.technology for assistance. Please send well lit, high resolution photos of your PCBs to help me investigate and identify the problem with you.

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2023 Herzlich Audiovisual Technology, Denmark