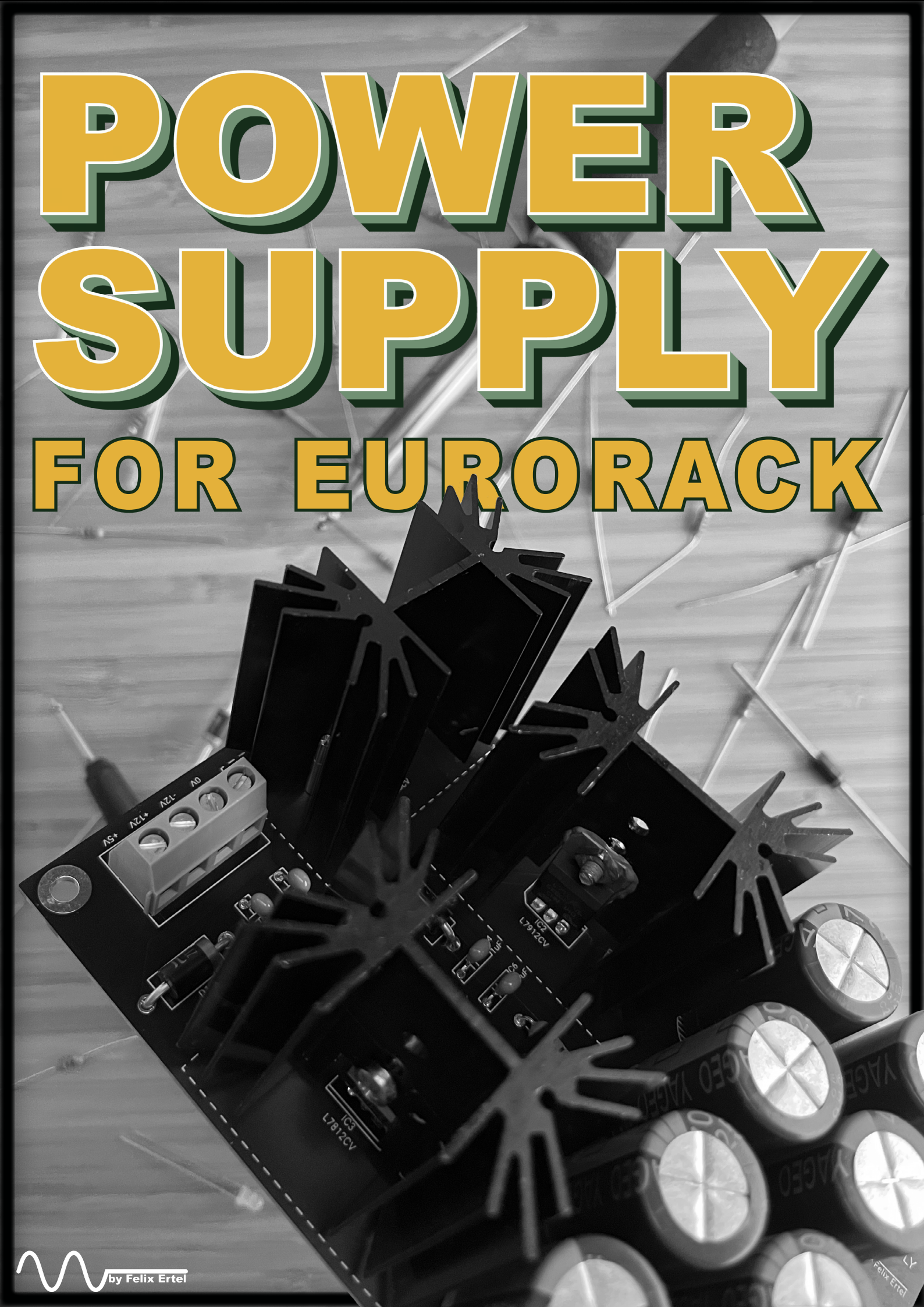
POWER SUPPLY

FOR EURORACK



by Felix Ertel

INTRODUCTION

This is the DIY manual for my open source project, “Power Supply for Eurorack”. The Power supply utilizes a 12 V/AC power adapter at its input and delivers three direct current signals, 5 Volt, 12 Volt, and -12 Volt, at its output, enabling you to power Eurorack modules.

This manual contains the power supply’s specifications, PCB layout, schematic, the Bill of Materials, and detailed building instructions. All other necessary files are available on my GitHub page.

If this is your first DIY eurorack project, don’t worry. This manual will explain everything you need to know to build your own power supply.

If you also require a Bus Board to connect your power supply to and like the style of this manual, you can check out my GitHub page, as I also worked on designing a Bus Board that comes in four sizes, making sure you find the right one for your Eurorack case.

Finally, I hope you have lots of fun building this power supply.

SPECIFICATIONS

current rating and dimensions

The power supply offers three distinct voltage levels of 5 Volt, 12 Volt, and -12 Volt at up to 1,5 Ampere depending on your choice of power adapter*[1]. It also offers a 0 Volt/Ground connection.

You can find all this on a PCB with a length of 12,8 cm and a width of 7,5 cm.

output

The power supply’s output features four soldering pads offering three distinct voltage levels and a 0 Volt/Ground connection. For connecting cables, you have two options. You can either solder wires directly to the soldering pads or use a suitable terminal block and connect wires to it instead.

heat sink area

Each of the integrated circuits (IC) has an area with a length of 4 cm and a width of 2,5 cm around it to ensure that you can mount a heat sink to it without interfering with other components.

12 V/AC input/output

The power supply’s 12 Volt alternating current input and output section features four soldering pads. The two soldering pads labeled as “12VAC In” should be connected to the alternating current signal of your 12 V/AC power supply. You can use the remaining two pads labeled “12VAC Out” to chain multiple power supplies together utilizing only one power adapter. For this, connect the “12VAC Out-”pads of one power supply to the “12VAC In” pads of a second unit.

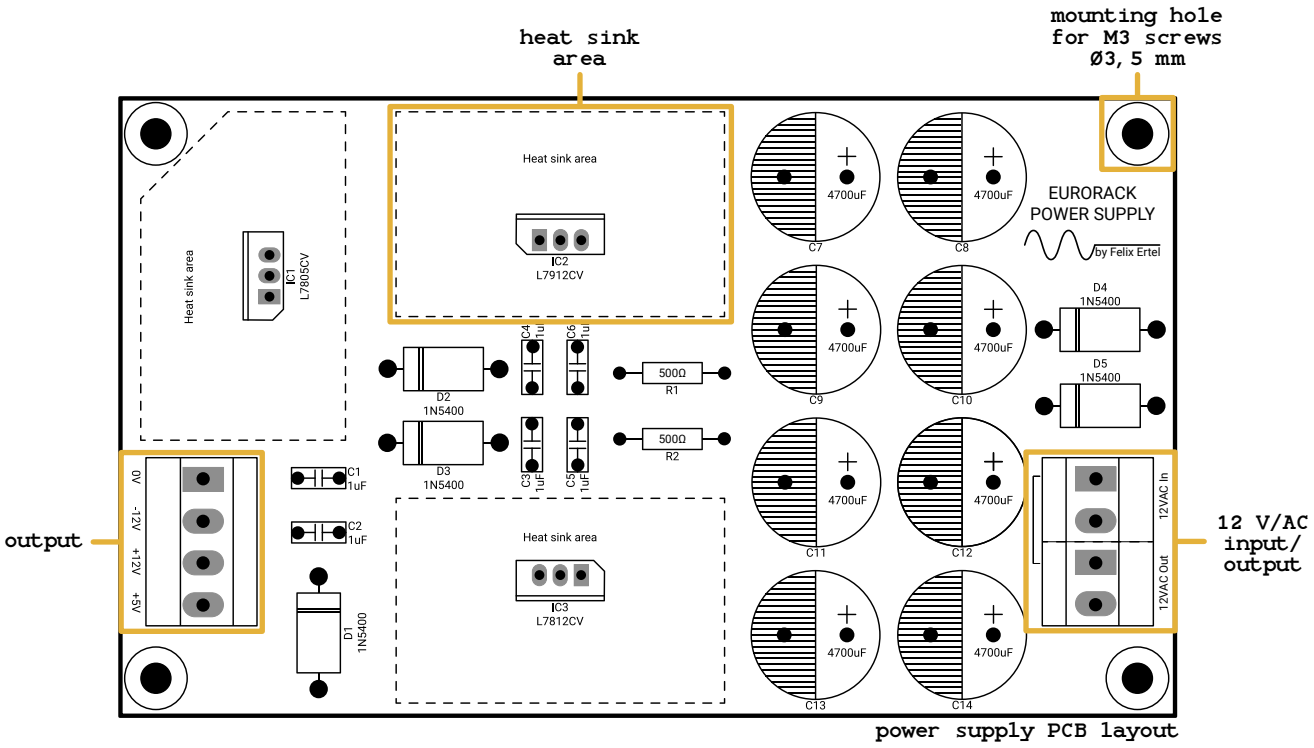
You must connect the square and oval pads to each other, respectively. The elongated square bracket above the 12 V/AC input and output pads on the PCB points at the two oval pads so you can identify them even when installing a terminal block.

This also brings us to the two options to connect cables to the input and output. You can either solder wires directly to the soldering pads or use a suitable terminal block and connect wires to it instead.

mounting holes

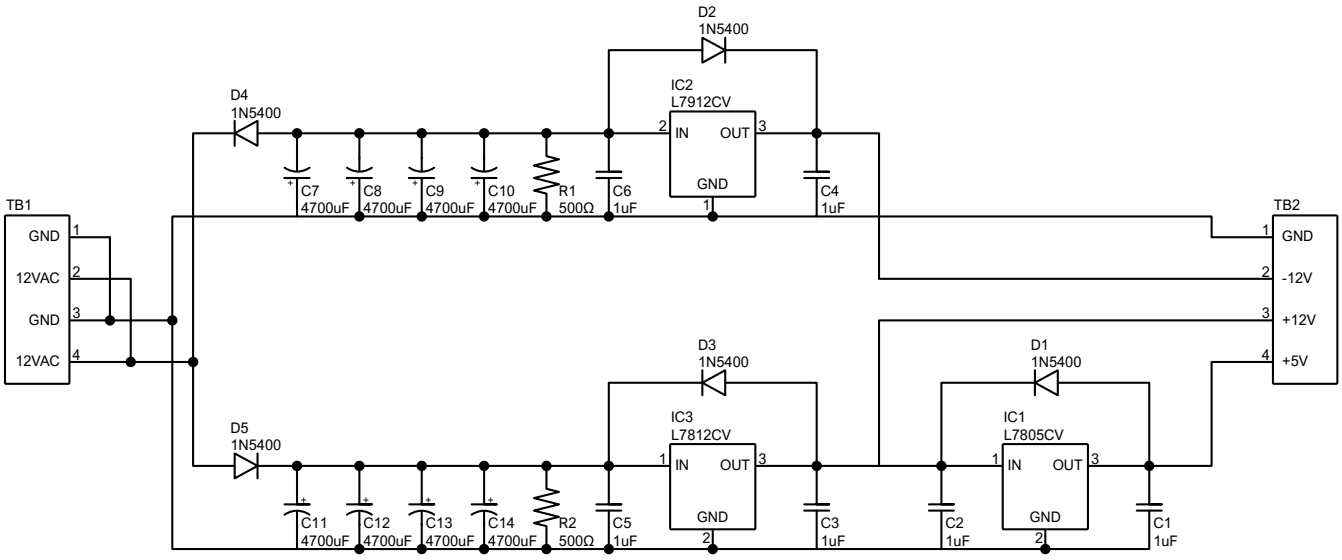
Additionally, the power supply offers four mounting holes intended for use with M3 screws (the same size used to mount Eurorack modules). Using these in conjunction with M3 standoffs, you can easily secure the power supply to the bottom of your Eurorack case — this process will be explained in greater detail in the building instructions later in the manual.

*[1] You can use this power supply with a power adapter that has a low maximum output current. However, the maximum current it can supply to your modules will be significantly reduced.



schematic*²

Beneath, you can see the schematic diagram for the power supply.



*² If you aren't familiar with reading electrical schematics, don't worry. For simply building the power supply, it's not all too important to be able to read them. Understanding some basics, however, can be quite helpful. So I'd recommend you watch the following YouTube video to learn about them: https://www.youtube.com/watch?v=9cps7Q_IrX0&ab_channel=Make%3A

BILL OF MATERIALS

The Bill of Materials shows you all the components you need to build the power supply. The category and part name help you roughly identify what component you need. The Part specification gives you more detailed information about it. You must buy components that satisfy all the given specifications unless stated otherwise. The description gives you some more information that may be useful to you when selecting your parts. The Quantity provides the number of components you need to buy. Finally, the last column shows whether a part is optional or strictly necessary to complete building the power supply (Y: necessary; N: optional).

Most of these components should be readily available online and relatively easy to find.

category	part name	part specification	description	quantity	needed
PCB	power supply PCB	please refer to the “ordering a PCB” part of this manual	/	1	Y
Resistor	R1, R2	500Ω; 1W; THT*[3]	/	2	Y
Diode	D1-D5	1N5400; Package: DO-201	Rectifier Diode	5	Y
Capacitor	C1-C6	1uF; ceramic capacitor; voltage rating: ≥ 25V; THT	/	6	Y
Capacitor	C7-C14	4700uF; electrolytic capacitor; voltage rating: ≥ 25V; pitch (Pin spacing): 7,5 mm; THT	/	8	Y
IC	IC1	L7805CV; Package: TO-220	+5 V voltage regulator	1	Y
IC	IC2	L7912CV; Package: TO-220	-12 V voltage regulator	1	Y
IC	IC3	L7812CV; Package: TO-220	+12 V voltage regulator	1	Y
Terminal Block	TB1, TB2	4 Pins; pitch (Pin spacing): 5 mm	instead of using terminal blocks, you may solder wires to the solder pads directly	2	N
Hardware	heat sink	thermal resistance: ≤ 5,67 °C/W; maximum dimensions:40x25 mm	/	3	Y

*[3] Through-hole-technology (THT): components with leads meant to be inserted into drilled holes in the PCB to be soldered

category	part name	part specification	description	quantity	needed
Hardware	/	thermal compound	for connecting the heat sinks to the ICs	/	Y
Hardware	power adapter	12 V/AC power adapter; output current: 3 A*[4]	/	1	Y
Hardware	wire	24 - 15 AWG stranded wire	for connecting the power supply to a Bus Board	/	Y
Hardware	screws	M3 screws	mounting heat sinks to ICs	3	Y
Hardware	nuts	M3 nuts	mounting heat sinks to ICs	3	Y
Hardware	screws	M3 screws	for mounting the PCB to the bottom of your case	4	N
Hardware	standoffs	M3 standoffs	for mounting the PCB to the bottom of your case	4	N
Hardware	inserts	M3 threaded inserts	can be used to secure standoffs to a wooden case	4	N

*[4]You can also use a power adapter with a lower maximum output current. However, the maximum current it can supply to your modules will be significantly reduced. A power adapter with a higher maximum output current can be used without problems.

ORDERING A PCB

Ordering a PCB online might seem daunting at first, but it's not too complicated.

First, you need to download the Gerber file from my GitHub page. Then you have to choose a PCB house that you'd like to manufacture your PCB. Since every PCB house has a slightly different process for ordering a PCB, I will only give detailed information on the PCB house I chose, which is JLCPCB.

Luckily they have a straightforward article on their website explaining how to order from them. You can find this article here: https://support.jlcpcb.com/article/21-how-do-i-place-an-order.

This leaves the question of what options to choose for your PCB when ordering. Here are the options I'd recommend to you.

OPTION	CHOICE
Base Material	FR-4
Layers	2
Dimensions	filled out automatically when inserting Gerber
PCB Qty	choose the amount of PCBs you want
Product Type	Industrial/Consumer electronics
Different Design	1
Delivery Format	Single PCB
PCB Thickness	1,6
PCB Color	choose whatever option you like

OPTION	CHOICE
Silkscreen	white or black depending on the PCB color
Silkscreen Technology	Ink-jet/Screen Printing Silkscreen
Surface Finish	HASL(with lead) or LeadFree HASL-RoHS
Outer Copper Weight	1 oz
Gold Fingers	No
Confirm Production File	No
Flying Probe Test	Fully Test
Castellated Holes	No
Remove Order Number	choose whatever option you like

TOOLS

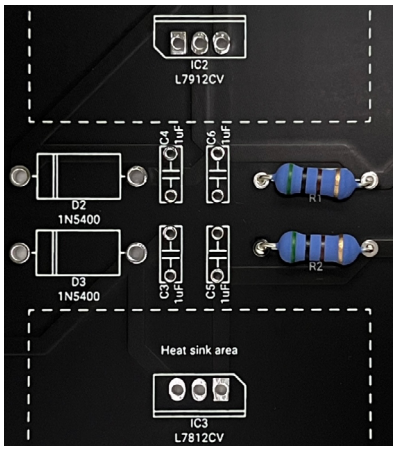
Building the power supply also requires some tools. While some are essential, others are simply nice to have, and you can certainly finish the build successfully without them.

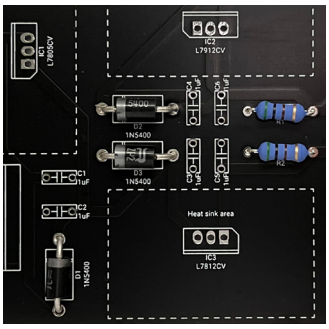
tool name	description	needed
Soldering Iron and Solder	/	Y
Side Cutter	small ones designed with electronic work in mind function exceptionally well, but normal ones would suffice, too	Y
Wire Stripper	you can use a knife instead, being careful not to injure yourself	N
Multimeter	to test the finished power supply	N
Oscilloscope	to test the finished power supply	N
Painters Tape	can help you hold components in place while soldering	N
Isopropyl Alcohol	to clean the PCB after assembly	N

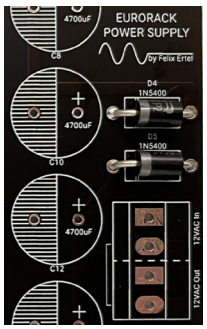
BUILDING INSTRUCTIONS

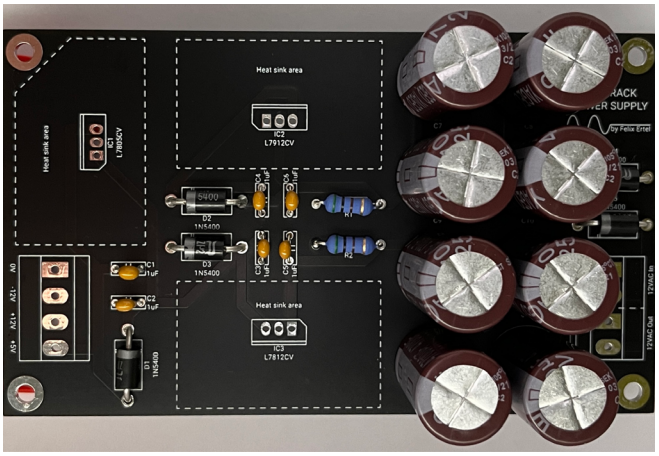
This part of the manual gives you a step-by-step guide you can follow to build your power supply once you have sourced all the necessary components and tools. It includes pictures as well as written explanations for every step. For some stages of the build, there are multiple options on how to proceed — choose the one you like best.

Building the power supply requires you to solder. If this is your first time soldering, I'd recommend you watch the following YouTube video to understand how to do so: https://www.youtube.com/watch?v=Qps9woUGkvI&ab_channel=oneTesla









Note: The electrolytic capacitors store quite a bit of energy when operating the power supply. This energy is also stored for a couple of minutes after turning the power supply off. For this reason, you shouldn't touch the power supply while and shortly after operating it. Wait for about three after turning it off before touching it.

resistors

To start, place the PCB on top of some spacers (You can use two empty boxes, wire coils, or whatever you have lying around). Next, you can start populating the PCB by bending the resistor leads and placing them in their correct positions. The PCB shows the component's value and name to identify where it goes quickly.

After inserting all resistors, turn around the PCB, solder all resistors in place, and cut off the excess leads.

diodes

Next, you can turn the PCB to the front again and place the diodes into their respective places. With diodes, orientation matters. The stripes on the PCB indicate the cathode of the diode. Match it with the stripe on the diode itself.

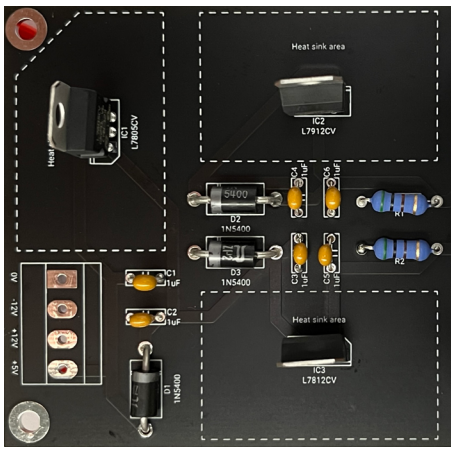
Turn the PCB around again, solder the diodes, and clip the excess leads.

capacitors

Now it's time to solder the capacitors to the board. Start with the ceramic capacitors — the smaller ones. With these, the orientation doesn't matter. Just place them on the board and solder them in place from the back side of the PCB.

Next, add the electrolytic capacitors — those are the big cylindrical-shaped ones. With this type of capacitor, the orientation does matter. Each electrolytic capacitor will have a stripe on one side indicating the negative lead. Place this lead into the hole surrounded by the stripes on the PCB. The lead that does not have the stripe on its side of the capacitor should be placed in the hole marked with a "+".

Turn the PCB around again, solder the capacitors, and clip the excess leads.



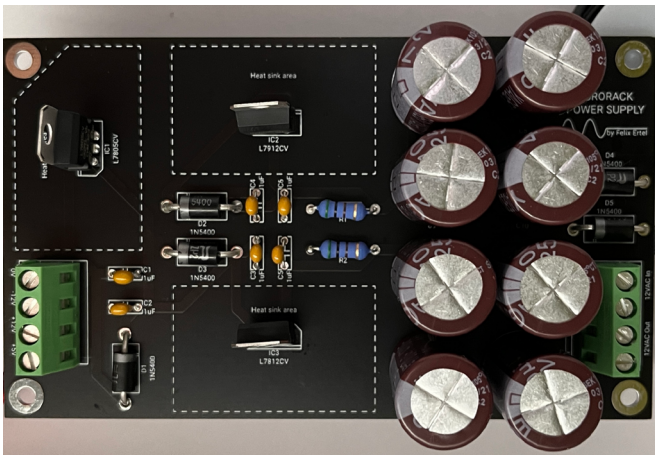
ICs

Next, you can add the ICs. Place each one in their respective place on the PCB. Orient them so that the metal tab of the IC aligns with the double line on the PCB. Solder the components in place from the backside and clip the excess leads.

connecting wires

As stated earlier, in this manual, you have two options for attaching wires to this power supply — soldering directly to the soldering pads or using terminal blocks. Both options work perfectly fine. If you decide to use terminal blocks, you should install them at this point. Place them on the PCB with the openings for the wires pointing outward from the PCB and solder them in place. You can use tape to secure them while soldering.

In case you want to solder wires directly to the soldering pads, you might want to first install the power supply to your Eurorack case to better measure the required length of the wire.



mounting

In the following, I'll explain how to use M3 threaded inserts, standoffs, and screws to mount the power supply to your case. If you haven't bought these items, you can skip this part and mount the power supply differently.

First, you should lay out where you want the power supply to go inside your case. Then you can mark the center of all the mounting holes.

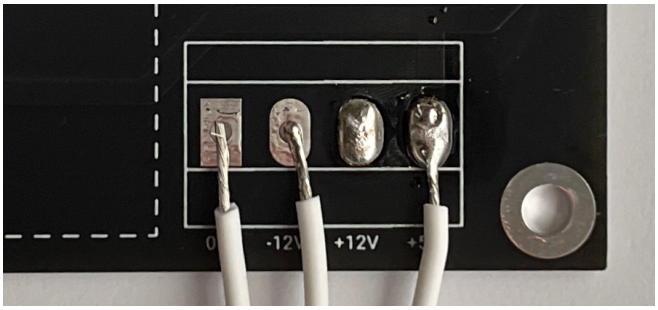
Next, you should drill holes for your threaded inserts where you put your markings. Make sure to select the correct size drill bit and only drill as deep as the inserts are tall.

These pictures show mounting holes I layed out for the Bus Board I also designed but don't worry. The process is the same for mounting the power supply. Just be aware that the spacing of the holes shown in the picture is not identical to the spacing you need for your power supply.

Now you can install the threaded inserts.

After that, screw in your standoffs.

You can now place your power supply on the standoffs and secure it using screws.



connecting wires

You can skip this part if you use terminal blocks to connect your wires.

When soldering wires directly to the soldering pads on the PCB, you want to ensure the wire you are attaching isn't too short so you don't have to desolder it again. Now that your power supply is installed in your case, you can easily measure how long your wire has to be to reach from your power supply to it.

After cutting your wires to length, remove about half a centimeter of insulation from one end and twist the wires together.

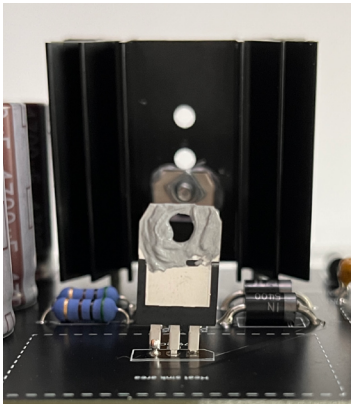
Now find a way to hold this end of the wire in place, heat it with your soldering iron and apply solder to it, evenly coating the wire. This is called tinning the wire.

After this, heat the soldering pad you want to solder the wire to and apply a generous amount of solder so it makes a dome shape. Let it cool down for a bit.

Finally, place your tinned wire on top of the solder you just added to the desired pad and apply heat with your soldering iron. Once the solder is melted and the wire sits in place, remove the soldering iron and wait until the solder cools down.

If you feel comfortable doing so, you can do all of this inside your case. Otherwise, remove the power supply PCB from your case and attach the wires outside of it.

heat sinks

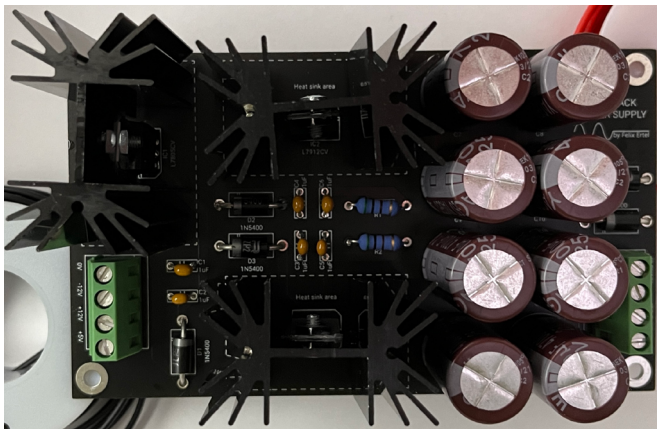


Now it's time to attach a heatsink to each of the ICs. For this, you will need an M3 screw and nut for each heatsink and some thermal compound.

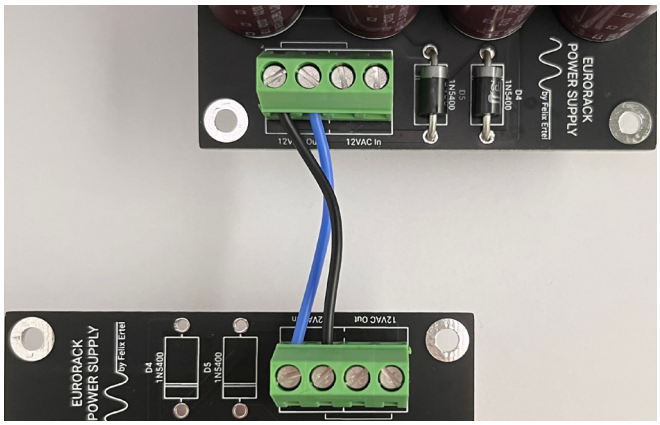
If your power supply is not yet installed in your case, this is the right time to do it as one of the heatsinks may block one mounting hole when installed.

Start by applying some thermal compound to the area of the IC that is going to come into contact with the heatsink.

Then, fasten the heatsink to the metal tab using a screw and nut.



chaining power supplies together



To chain your power supplies together, simply connect multiple units as shown so that the square pad of the output of one unit connects to the square pad of the input of the other unit. The same applies to the oval pads.

connecting the power adapter

There are many different ways to connect your 12 V/AC power adapter to this power supply. You could plug it into a jack mounted to your case and solder wires to the jack or cut off the power adapter's end and connect it directly to your power supply. Whichever option you choose, you have to connect the two wires from your power adapter to the input of the power supply PCB. It does not matter which wire goes left or right. Both pads of the input can be considered identical for this purpose.

CONGRATULATIONS!

You just finished building your own power supply! Now it's time to test if everything is working. Just connect a Bus Board and some modules and see if it all runs fine. If you didn't make any mistakes, there shouldn't be any problems. In case something is not working, check if all the solder joints look good and all cables are connected correctly. If you still have issues, try troubleshooting using a multimeter and oscilloscope, and definitely feel free to contact me — I'll try my best to help you out.

If everything works fine, you can clean the underside of the PCB with isopropyl alcohol to get rid of the leftover flux. Other than that, there is nothing more to do. Just enjoy your new equipment and take a bit of pride in having built it yourself ;)

If you are interested in how exactly the power supply converts the incoming alternating current into direct current, you can check out this video by Moritz Klein: https://www.youtube.com/watch?v=pQKN30Mzi2g.

He explains how every component affects the signal in a straightforward way that's easy to understand, even if you have little understanding of electronics.

ABOUT ME

My name is Felix Ertel, and I'm a student living in Germany.

While I have certainly done a fair bit of research and testing before writing this manual, I'm by no means an expert in electronics. If you find anything in this document that is wrong or could be improved upon, feel free to contact me. I'm eager to improve my knowledge and the work I share with you.

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