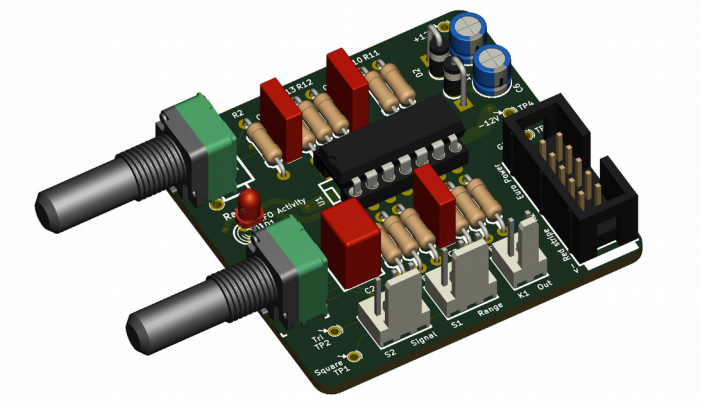
Simple LFO 1.3

Simple and easy to build LFO module for Analog Synthesizers.

1. Features

- Square and Triangle waveforms (90° phase shifted)
- Dual range frequencies
- Frequency ranges from under 1Hz up to several kHz
- Very stable
- Buffered Output
- Compatible with Eurorack Power Bus System (connector and voltages)
- Low power
- Versatile configuration



2. Application

Low frequency oscillator for slow variations of Control Voltage input on Analog Synthesizers modules.

Hi frequency oscillator for FM style effects.

Audio oscillator (drone).

3. Description

The Simple LFO module is a *Low Frequency* Square and Triangle Oscillator, designed to be integrated into an analog synthesizer. It is compatible with the Eurorack format: 10-pin power supply connector and voltages (+12, 0 and -12V).

The frequency, ranging from under 1Hz up to several kHz (audio domain), is adjusted with the potentiometer R1 (Rate). There is no Voltage Control (CV) input.

Powered at -12 / +12V, the maximum output swings between -10 / +10V peak to peak. The output amplitude can be attenuated with the potentiometer R9 (Amplitude).

The waveform is selected between Triangle and Square with the switch S2 (Signal).

If required, both waveforms can be used, separately, but in this case, only one waveform can be attenuated via R9. Also, there's a phase shift of 90° between the two signals: the square wave is “low” when the triangle waveform is “going up”, and the square wave is “high” when the triangle wave is “going down”.

The circuit is based around two operational amplifiers. The first op amp (U1A, R1..R4, C1, C2) is an *integrator* circuit. The second part (U1B, R5..R8) is a *schmitt trigger* comparator.

The output is buffered, insuring a stable frequency, independent of the output load. It can be directly linked to the CV input of any voltage controlled analog module.

4. Characteristics

Nominal Power supply voltages	-12 / 0 / +12 volts
Power consumption @ -12/+12V	*TBD*
PCB dimensions	5 x 5 cm
Output Voltage	-10 / +10 volts

Table 1: Characteristics

5. BOM

Designation	Qty	Reference
10nF MKS 5mm pin pitch	1	C1
100nF MKS 5mm pin pitch	2	C3 C4
1µF MKS* 5mm pin pitch	1	C2
1µF 35V Aluminum (*polarized*!)	2	C5 C6
LED Bi-color (If 10mA, Vf 2V)	1	D1
1N4007	2	D2 D3
Jack mono (wired)	1	K1
HE10/header 2x5 pins	1	K2
470 Ohm 0.25W 5%	1	R2
4k7 Ohm 0.25W 5%	1	R7
10k Ohm 0.25W 5%	3	R8 R11 R12 R14
2k2 Ohm 0.25W 5%	1	R10
47k Ohm 0.25W 5%	1	R4
100k Ohm 0.25W 5%	4	R3 R5 R6 R13
100k Ohm pot. (2.5 or 5mm pin pitch) *Alpha RD901F* style[1]	1	R1
100k Ohm pot. (2.5mm pin pitch) *Alpha RD901F* style	1	R9
SPDT switch + cables + 3 pin connector	1	S1 or S2 (depends on application)
Pin header 3 pins + Jumper	1	S1 or S2 (depends on application)
TL084 or low noise equivalent	1	U1
14 pin DIL socket	1	U1
Ferrite bead	2	L1 L2

Table 2: Bill Of Material

1 See text for differences between various types of potentiometers

6. Build Instructions

Some potentiometers present a protruding tab which could prevent the potentiometer to be mounted flush on the front panel. We don't need it. **With pliers, remove the potentiometer protruding tab first**.

Start by soldering small components: first the resistors then followed by the DIL socket. Then, continue with bigger components.

It is recommended to place the potentiometers on the panel before soldering them.

Resistors

Resistors are not polarized. It's best practice to align them in the same direction, for better reading of the color coded rings.

Color	1st ring	2nd (and 3rd) ring	3rd (or 4th) ring		suffix	4th (or 5th) ring
Black	0	0		10^0		
Brown	1	1	0	10^1		±1%
Red	2	2	00	10^2		±2%
Orange	3	3	000	10^3	k (kilo)	
Yellow	4	4	0000	10^4	0k	
Green	5	5	00000	10^5	00k	
Blue	6	6	000000	10^6	M (mega)	
Violet	7	7	0000000	10^7	0M	
Gray	8	8	00000000	10^8		
White	9	9	000000000	10^9		
Gold						±5%

Table 3: Resistor Color Codes

Capacitors

MKS/MKT plastic capacitors aren't polarized.

Aluminum electrolytic capacitors are polarized. The longest leg is the positive side. The negative side is identified both on the component and the PCB with a thick white marking.

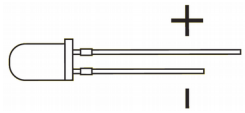
Diodes

Diodes are polarized. They are mounted vertically. The Cathode (the white band marking) is up. The diodes can prevent any damage from a reverse polarity of the power supply.

LED

Fold the LED legs at 90° approximately 1 or 2mm from the body. Ideally, it's easier to first mount the front panel, then solder the LED in place.

LEDs are polarized. The longest pin is the positive side. Silkscreen shows a "flat" side: it's the negative pole.



Switches

Use SPDT switch either for frequency Range (S1) or for signal shape (S2), depending on the application. Use pin headers and jumper for the other, or use a second SPDT switch. For each SPDT switch, you need the corresponding wires and connectors if required.

Miscellaneous

L1 and L2 are optional. The Ferrite beads can be added to the longest leg of diodes D2 and D3. They reduce high frequency noise on the power rails.

Potentiometers

Potentiometer R1 (Rate) can be either a 9mm or a 16mm type. 9mm type is recommended for narrower front plates (see below the 4HP example for a single LFO module).

The 16mm type is recommended in larger setups (see the 6HP example with a dual module configuration).

- 9mm potentiometer fits in 2.54mm footprint.
- 16mm potentiometer fits in 5.08mm footprint.

R9 (Amplitude) is potentiometer, 9mm only.

Note that Alpha 9mm and 16mm potentiometers have different heights. 16mm potentiometer is taller than 9mm potentiometer: The shaft axis will be unaligned with the potentiometer R9. It is 6.35mm higher.

Before soldering the two potentiometers, it is best practice to bolt them in place on the panel and solder them *after* onto the PCB. Try to avoid soldering before mounting on the panel because when you tighten the components to the front panel, it puts in tension and weakens the solder joints.

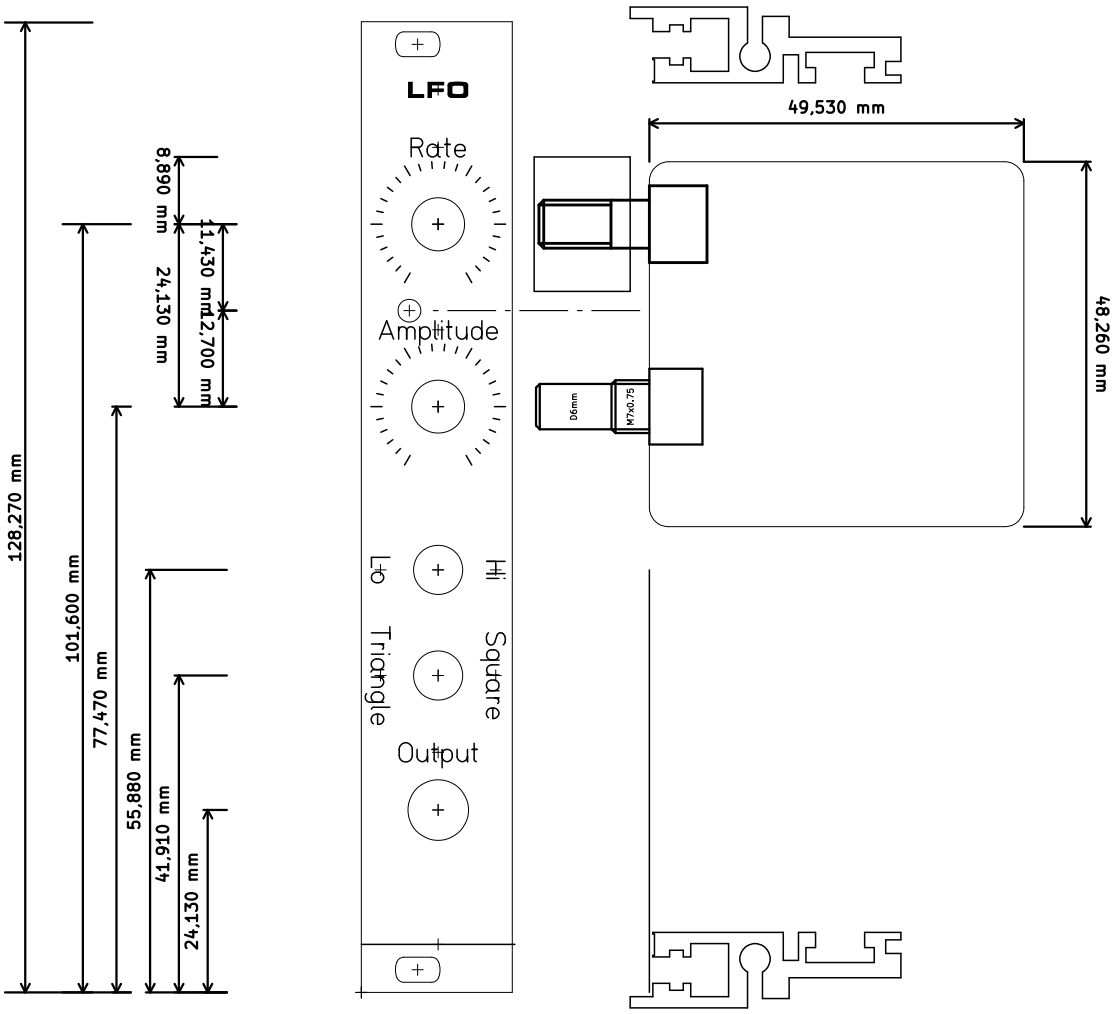


Figure 1: Layout and dimensions

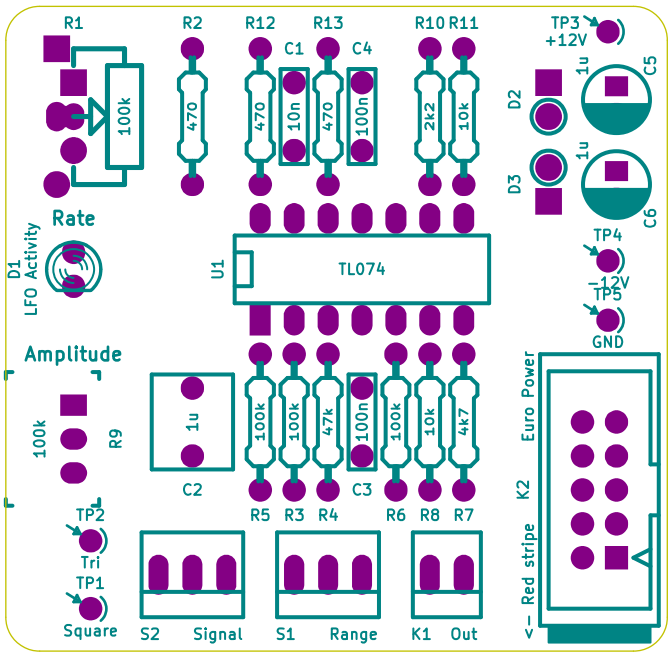


Figure 2: Components Overlay

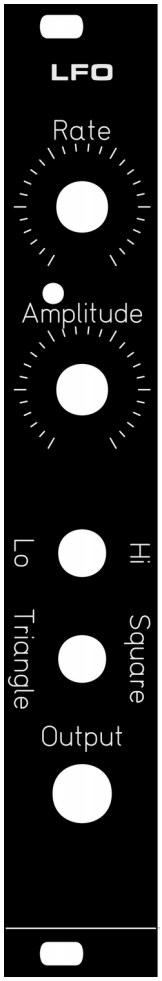


Figure 3: Suggested Front Panel design

Front Panel Components Cutouts

Component	Hole diameter (mm)
Alpha style 9 or 16mm Potentiometer	7
Cliff Jack Connector	8
3mm LED	3
Standard SPDT lever switch	6.5

Table 4: Usual Front Panel Cutout Dimensions

7. Powering and testing the module

Before powering your module DOUBLE CHECK EVERYTHING!

“Red Stripe” label shows the -12V Power Rail and should be the “lower” side of the Power Connector (the arrow should point toward the floor). This is a common practice in Eurorack Synths, not an absolute truth. **Never trust the red stripe.**

Pins	Polarity
1, 2	-12V
3 to 8	0V (“Ground” or “GND”)
9, 10	+12V

Table 5: Power Input Pin-out

Verify twice you connected the right polarity and the right voltage values before turning on your PSU. If everything is fine, you should be able to see the LED blinking. The rate is modified by the potentiometer position.

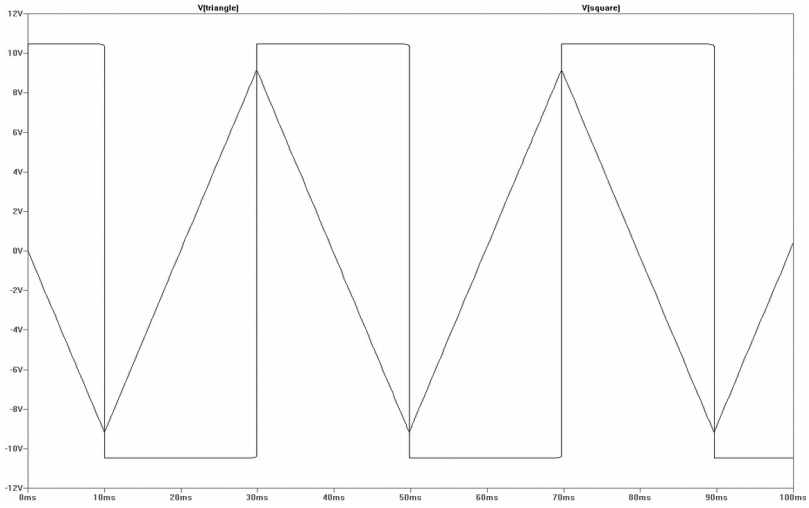


Figure 4: Square and Triangle Outputs

8. Contacts

Any question or problem? Please contact me:

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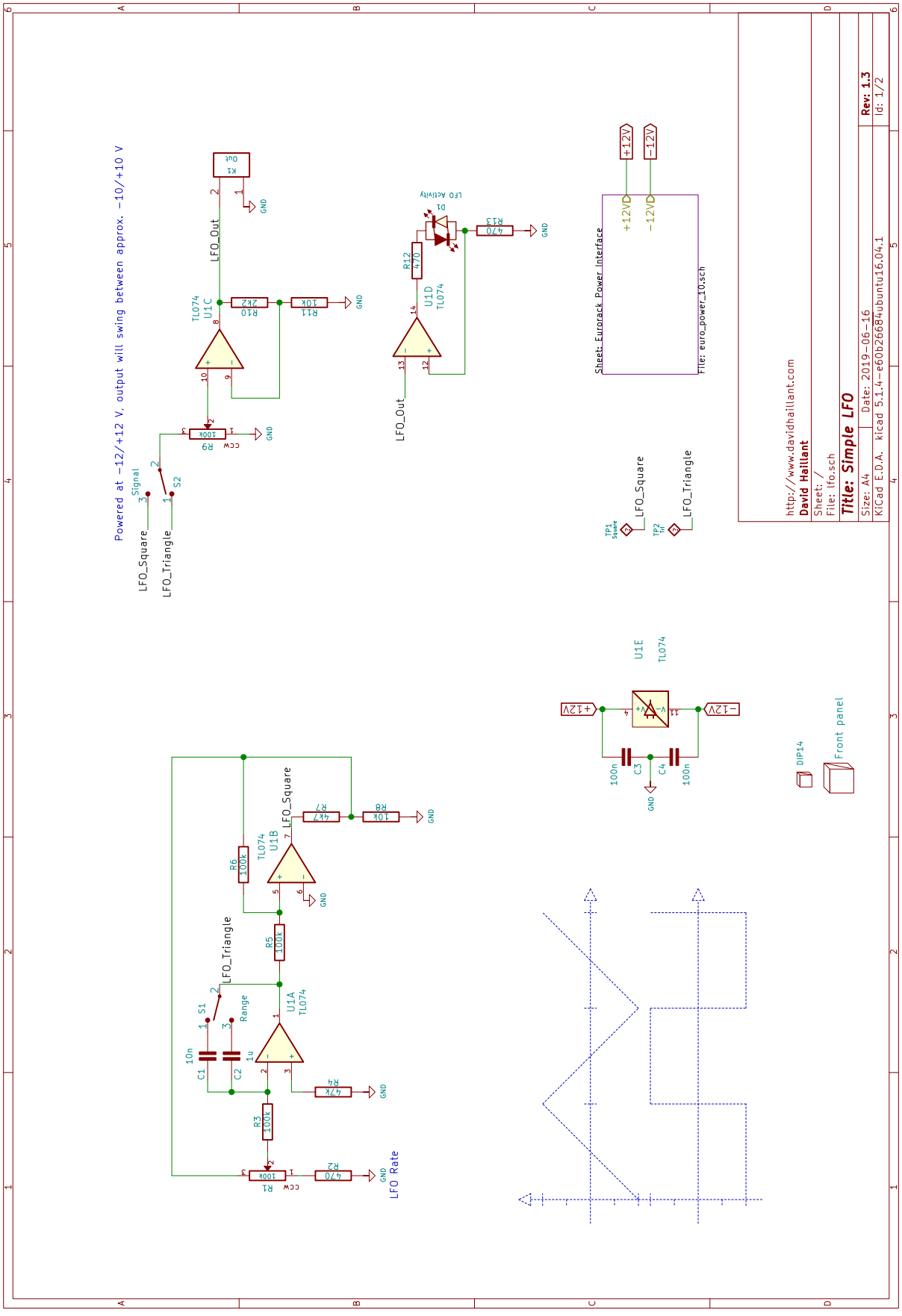
http://www.davidhaillant.com/category/electronic-projects/simple-lfo/

9. Schematics



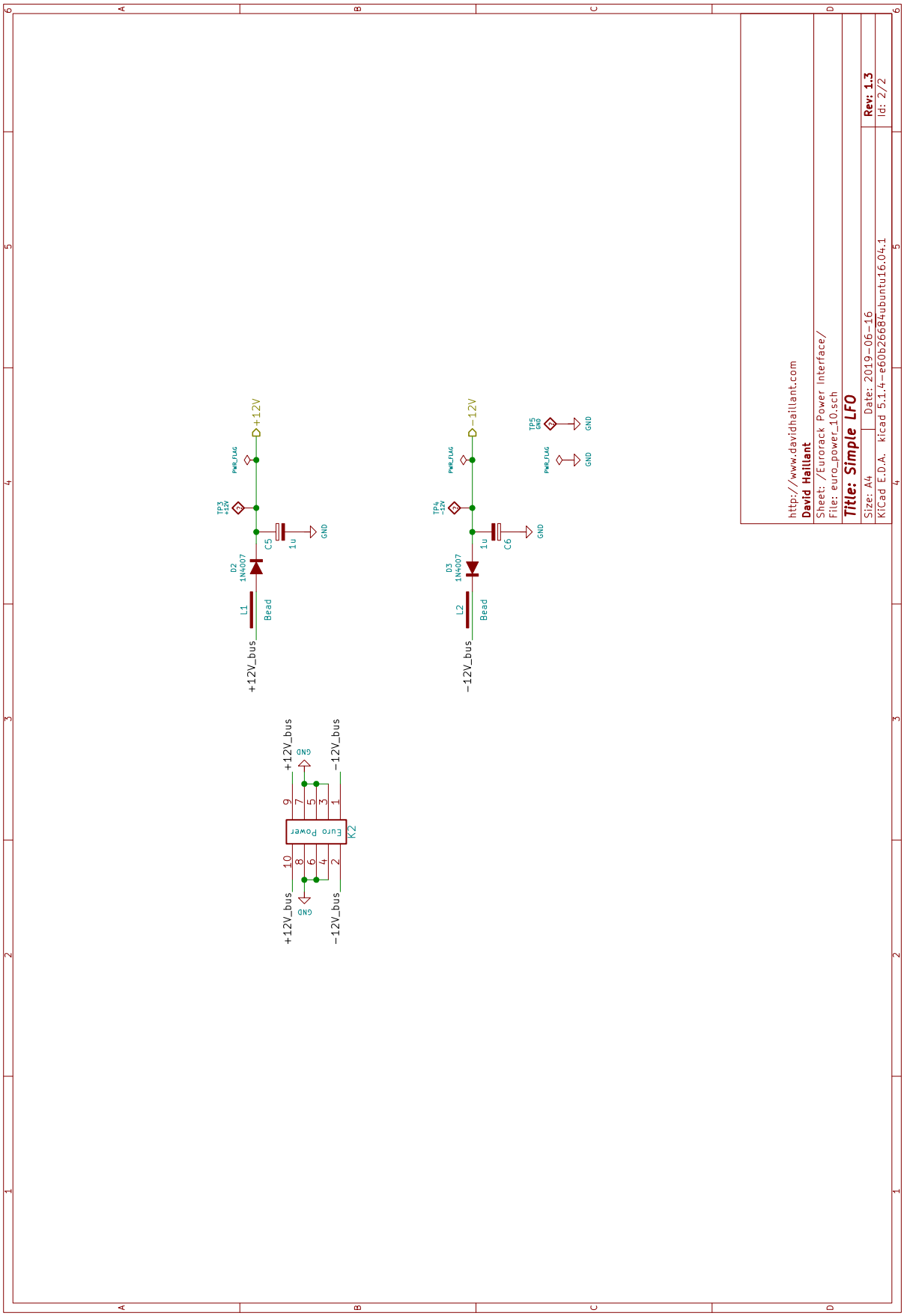


Figure 5: Eurorack Power Bus Interface