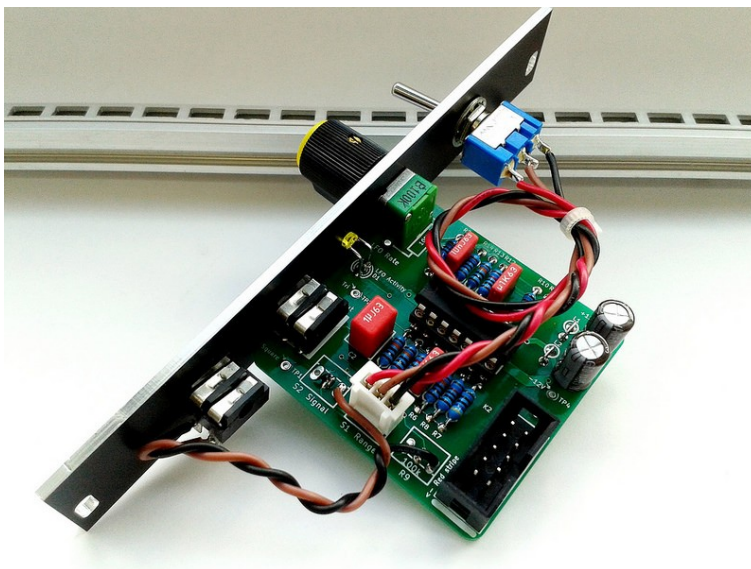


Simple LFO 1.1

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 (+12V, GND and -12V).

Powered at -12 / +12V, the output swings between -10 / +10V peak to peak.

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

The two waveforms are available at the same time. They present a phase shift of 90°: 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”.

It 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.

The output jack connector's active contacts are Tip+Ring. Be careful when using stereo cables. Mono cables should be privileged to ensure compatibility with Tip+Sleeve connectors.

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
100µF 35V Aluminum (<i>polarized!</i>)	2	C5 C6
LED (If 10mA, Vf 2V)	1	D1
Jack mono Cliff	1	J1
HE10/header 2x5 pins	1	K2
470 Ohm 0.25W 5% 	1	R2
1k Ohm 0.25W 5% 	1	R14
4k7 Ohm 0.25W 5% 	1	R7
10k Ohm 0.25W 5% 	3	R8 R11 R12
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) <i>Alpha RD901F</i> style ¹	1	R1
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

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. The tab is designed to prevent the potentiometer from spinning around its shaft. 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 increasingly bigger components.

Resistors

Warning! R10 and R11 values have been updated:

R10 is now 2k2 (was 22k) and R11 is now 10k (was 100k).

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

Color	1 st ring	2 nd (and 3 rd) ring	3 rd (or 4 th) ring		suffix	4 th (or 5 th) 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.

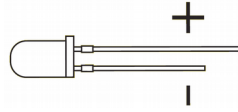
Aluminum electrolytic capacitors are polarized. The longest leg is the positive side. The negative side is identified both on the component and the PCB with a thick white marking.

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.



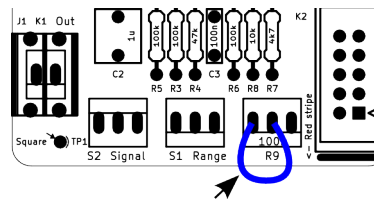
Switches

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

R9 is an optional potentiometer for output volume setup. It is recommended to bypass it and shortcut it:

Use a piece of cut leg for R9 and shortcut pins 2&3:



Shortcut R9 pins 2 & 3

Figure 1: Bypassing volume control

L1 and L2 need to be populated. Either with a simple wire (cut leg from a resistor) or with two diodes. The wire can be better replaced with a choke (a wire through a ferrite bead) to reduce high freq noise on the power rails.

The diodes could prevent any damage due to a reverse polarity from the power supply.

Potentiometer

Potentiometer R1 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 highly 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.

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 Jack Connector. It

is 6.35mm higher.

Before soldering the potentiometer and the jack connector, 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.

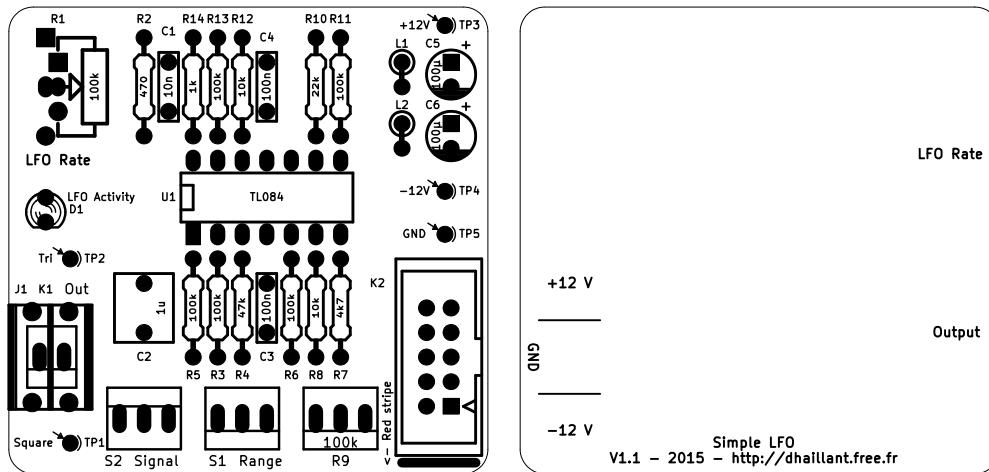


Figure 2: Components Overlay (Top side on the left, bottom side on the right)

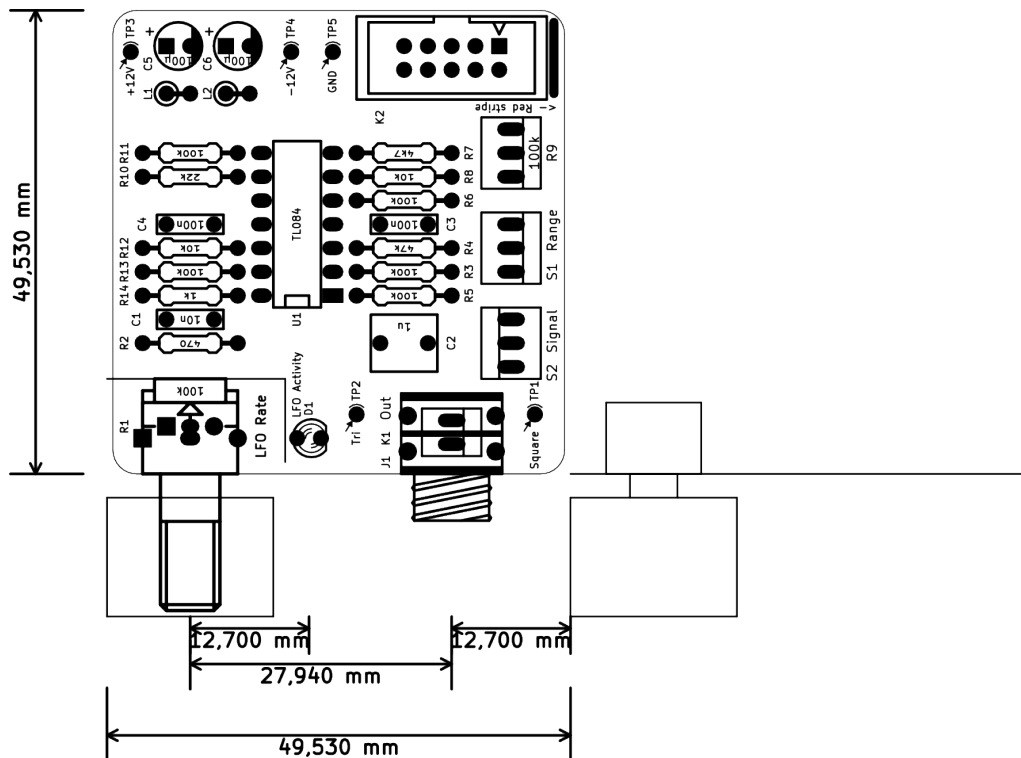


Figure 3: Layout and dimensions (suggested layout for a dual gang configuration)

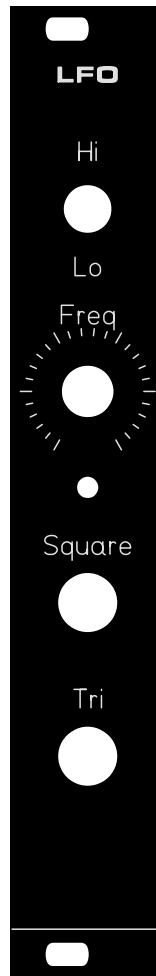


Figure 4: Example of one Simple LFO module in a 4HP Eurorack Front Panel

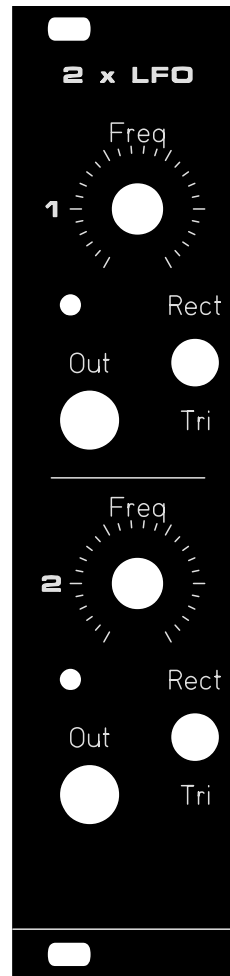


Figure 5: Example of two Simple LFO modules in a 6HP Eurorack Front Panel

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

Measure your own parts before ordering a front panel.

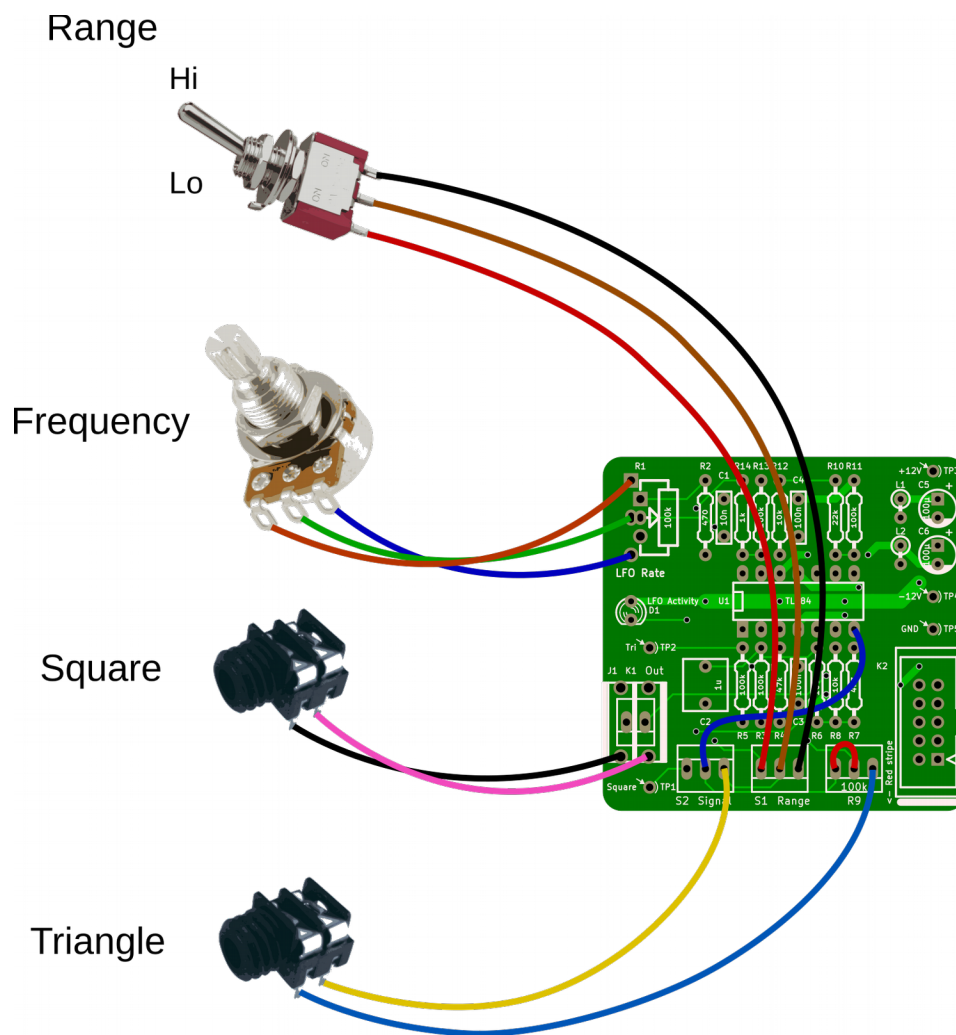


Figure 6: Wiring modification for dual output jacks and a range switch

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	Ground (GND)
9, 10	+12V

Table 5: Power Input Pin-out

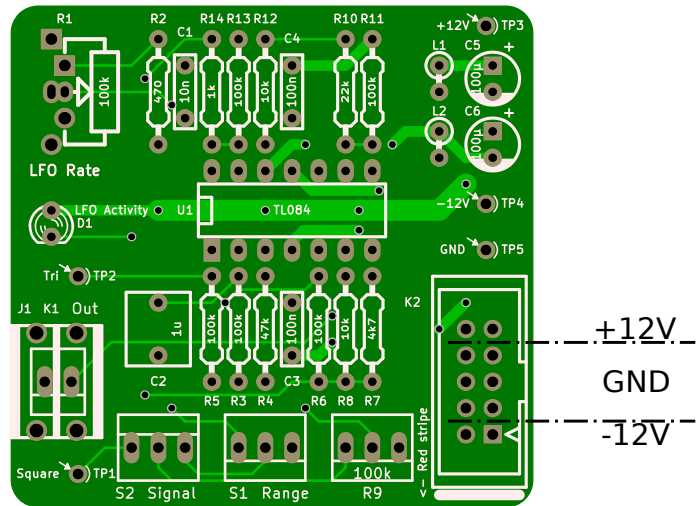


Figure 7: Power Input Pin-out

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

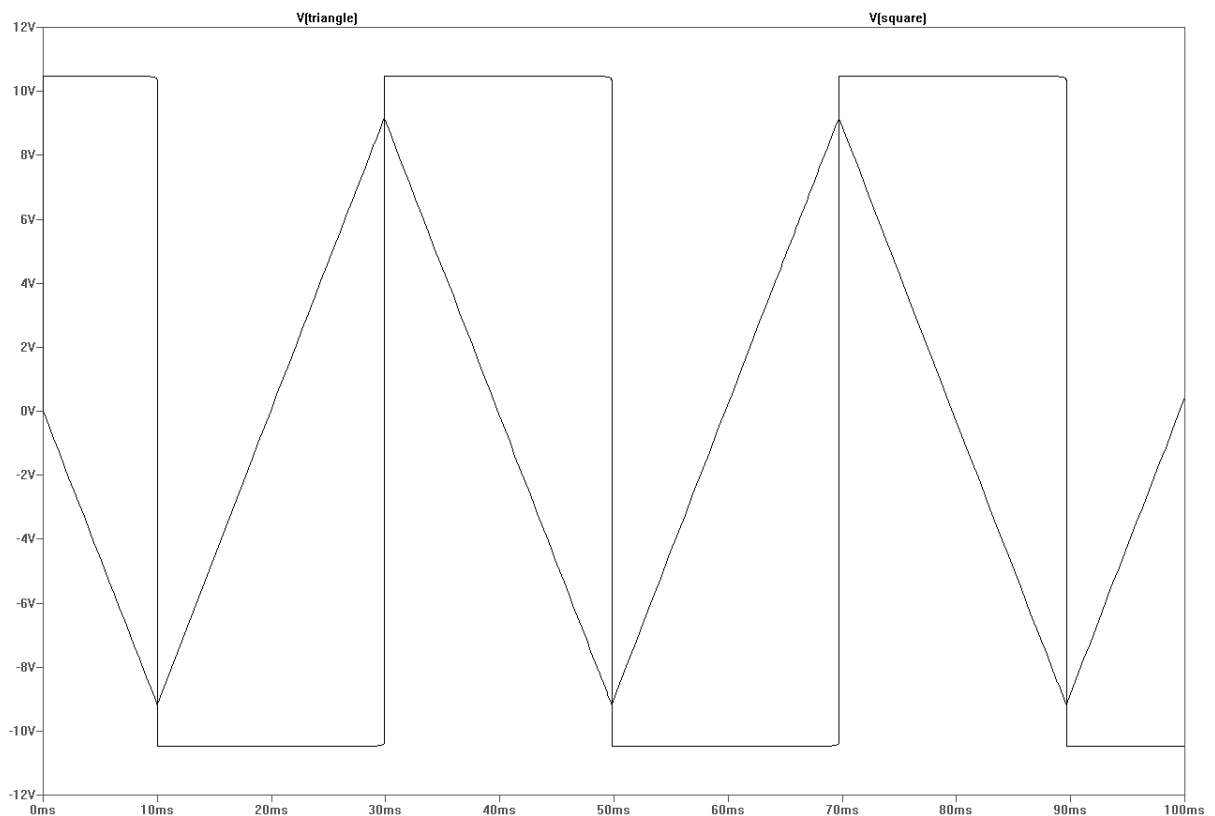


Figure 8: Square and Triangle Outputs

8. Schematics

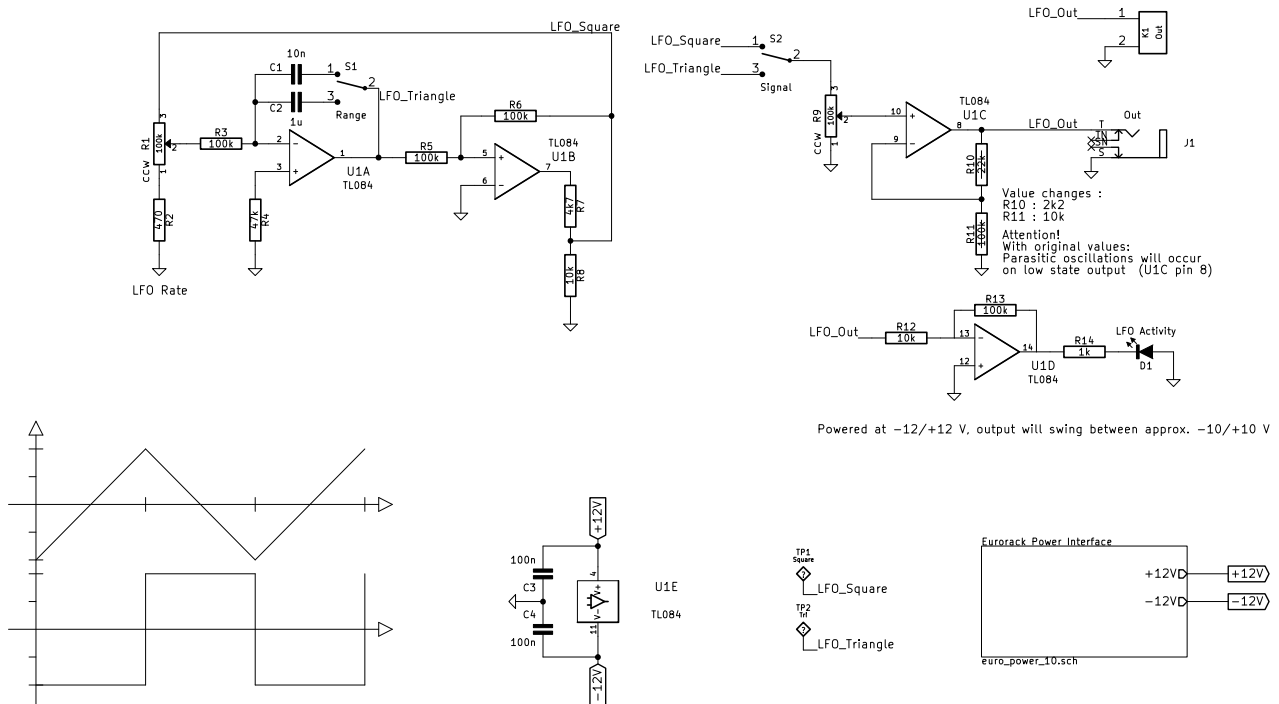


Figure 9: Main Schematics

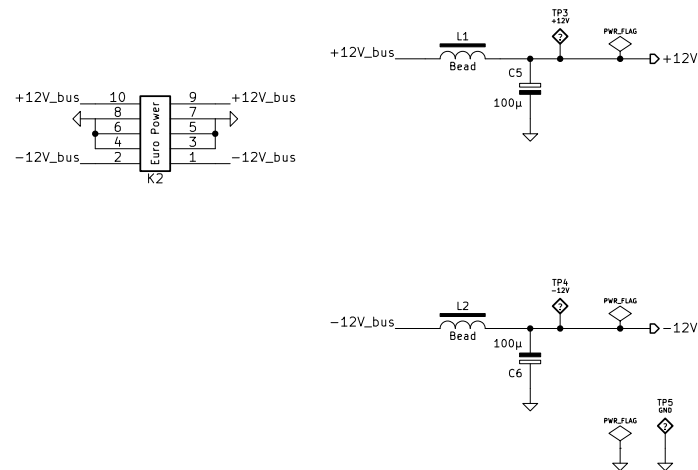


Figure 10: Eurorack Power Bus Interface

9. Contacts

Any question or problem? Please contact me:

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