OSCILLARP 1.5 - Build Document

(15-03-12)

This is a eurorack “clone” of the 4027-1 (VCO-2) Oscillator used in ARP 2600.
Some substitutes needed to be done due to the no longer existing parts.
Great care has been taken to not only match the functionality of those parts, but also that raw power in sound.

Take note however, due to the conversion from 15V to 12V, some “spikes” may become audible if layering 2 or more VCO's together. (I will never stop trying to find a fix for that)

Additions & changes on the original circuit are a few recalculated resistor values for the eurorack standard, removal of Low-Frequency option, Buffered in & outputs, Precision Reference Voltage and added Hard-Sync inspired by the Odyssey. (though realized differently)

The 10V Reference Voltage keeps the Frequency part of the Oscillator immune from any noise or cross-modulation that might happen thru the power-rails.
This is particularly useful when having several different VCO's on the same rail, as they have a tendency to intervene/latch up with each other. However, if this is a desired effect, it's easy to bypass the Ref Volt section.

Having everything Buffered means the CV-inputs wont cross-modulate, multing the in/outs will not have any signal-loss, and generally keeps the Module protected from the outside world. To add on that, the Power input is also protected from any mistakes when connecting it to your PSU.

No other modern improvements/simplifications have been made. Authenticity was of highest importance. The cost of having a few more parts results in a living organic sound, with all the analog oddities I personally love in the original.

- Rickard Steffensen

Build notes

It's a good idea to match the differential pair of Q1 & Q2, albeit a bit tedious.
I have found getting my transistors on tape works well, and I personally cant hear any difference to my matched versions.

The Sine shaper (Q3-2 & Q3-3) needs either a matched pair of 2N5459's, or a Monolithic Dual JFET as ARP used (2N3954). As the latter one is pretty costly the layout is made with the 2N5459's as they work just perfectly for this.
If you however decide to go with the 2N3954, watch the pinout as it differs from the 2N5459.
There are markings printed on the board to assist you with what legs that needs to be crossed on the 2N3954 for it to be mounted properly.
(Use a socket here if you feel insecure about the mounting or matching)

The extra bonus of using 2N5459's is that the shape of the Sine can actually be made in to a Sine rather than the Tri with rounded corners as with the original.
That shape can also be tuned in of course!

Here is a simple and great working JFET-matcher:
http://runoffgroove.com/fetzervalve.html#11

The Tri shaper is somewhat sensitive to what power you run the Oscillarp from.
That means if you use a bench-supply when adjusting it, you might have to do a final very minor adjustment to it later on when put in your main case.
Also, as the Sine is derived from the Tri, it too might need a nudge.

The Core and Control PCBs are mounted on top of each other, back to back.
"Sandwich-style"
The Core-PCB contains the main circuit, while the Control-PCB house the controlling elements, Buffers, and in this case also the Sync-Trigger circuit.

I would recommend installing the standoffs at the same time as the 8-pin headers. Make sure the PCB's line up and tighten the standoffs so it all sits firmly before soldering the headers up.
A similar approach is recommended when attaching the PCB to the Panel. Tighten the top potentiometer nut once you have made sure the PCB is lined up with the panel. Then a lower/mid potentiometer nut (don't forget the jacks) for the final stability before soldering it all up.

As a last note, take notice of how the 25K Trimmer (R78) is intended to have its legs bent and laid down according to the printed lines.

A few notes about parts:

- Pots needs to be as linked below. That is, 9mm with nuts to be fastened to the panel.
- Erthenvar PJ-301B Jacks are used on the board for simplicity, but any Jacks can be used if you watch the placement orientation. (be creative, its DIY!)
- The 1K87 Tempco (TC in BOM) used is a 1% 3500ppm by KLR.
  I understand these are costly and not overly common, but for best result these are the ones I recommend.
  That said, I know people have been getting good results with soldering legs on a SMT Tempco, feel free to experiment.
- Recommendations for the 680pF would be anything by Polypropylene, Silver mica, Styroflex or Polystyrene.
- The LM4040 used is the TO-92 10V version. Mouser number: 926-LM4040AIZ100NOPB
- TL072 is printed on the Core-PCB for the Reference Voltage opamp. It works, but I would recommend using a OPA2132/34 instead for better results.

Examples of what Pots, Jacks & Headers to use:

http://www.taydaelectronics.com/100k-ohm-linear-taper-potentiometer-round-shaft-pcb-9mm.html

http://www.taydaelectronics.com/100k-ohm-logarithmic-taper-potentiometer-round-shaft-pcb-9mm.html

http://www.taydaelectronics.com/40-pin-2-54-mm-single-row-pin-header-strip.html

http://www.taydaelectronics.com/8-pin-2-54-mm-single-row-female-pin-header.html

README!

Somehow 2 wrong resistor values slipped thru to the production of the boards, here is what needs to be changed from the values printed on the Core-PCB:

R1: 316K (475K printed on the board)
R2: 80.6K (95K3 printed on the board)

BOM

Resistors		Capacitors		Semiconductors		Pots & Jacks		Headers	
Part	*Pcs*	*Part*	*Pcs*	*Part*	*Pcs*	*Part*	*Pcs*	*Part*	*Pcs*
220ohm	1	5pF	1	2N3904	2	100K Aud 9mm	2	8-pin Single Row Female Header	2
1K	10	22pF	1	2N3906	2	100K Lin 9mm	4	8-pin Single Row Male Header	2
1.37K	1	27pF	3	2N4125	1	Jacks	9	10-pin Power Header	1
1.5K	1	100pF	3	2N5459	5			11-12mm Standoff	3
1.65K	1	680pF	1	LM4040	1				
2.2K	3	10nF	2	CA3046	1				
3.9K	2	10uF	2	LM301	4				
8.87K	1	100nF (Ceramic)	7	TL072**	2				
10K	3			TL074	1				
12K	2			1N4148	2				
15K	4			1N5817	2				
20K*	1								
22K	1								
30.1K	4								
33K	2								
33.2K	1								
39K	1								
45.3K	1								
47K	1								
61.9K	2								
68K	2								
80.6K	1								
84.5K	1								
100K	10								
120K	1								
121K	1								
130K	1								
150K	1								
180K	1								
191K	1								
316K	1								
2.2M	1								
3.3M	1								
1.87K (TC)	1								
10K (Trim)	2								
25K (Trim)	1								
100K (Trim)	3								

*R34, 10K-20K works fine. **OPA2132/34 for Ref Volt opamp, located on Core-PCB.

TRIMMING

Frequency Calibration	1. Monitor the VCO output with a oscilloscope or a frequency counter. 2. All FM potentiometers set to zero. 3. Make sure nothing is plugged in to CV. 4. Put FREQ pot to max – fully CW. 5. Put FINE pot to a middle position. 6. Adjust CAL R68 for 10KHz. (or as close as you can get)
Triangle Adjust	1. Adjust SYMETRY R115 for best triangle waveform. 2. Adjust DC OFFSET R125 so the peaks of the triangle are not flat at either end. (simply put, setting DC to 0V)
Sine Adjust	1. Adjust PURITY R127 for Sine waveform. 2. Adjust GAIN R128 for a preferred level.
1V/OCT	1. Connect keyboard to CV input and depress low C. (0V) 2. Adjust initial FREQ pot and FINE pot for 200Hz. 3. Depress C three octaves higher and adjust V/OCT R78 for 1600Hz. (3 volts) 4. Repeat steps 1-3 until low C remains at 200Hz, and C3 remains at 1600Hz.

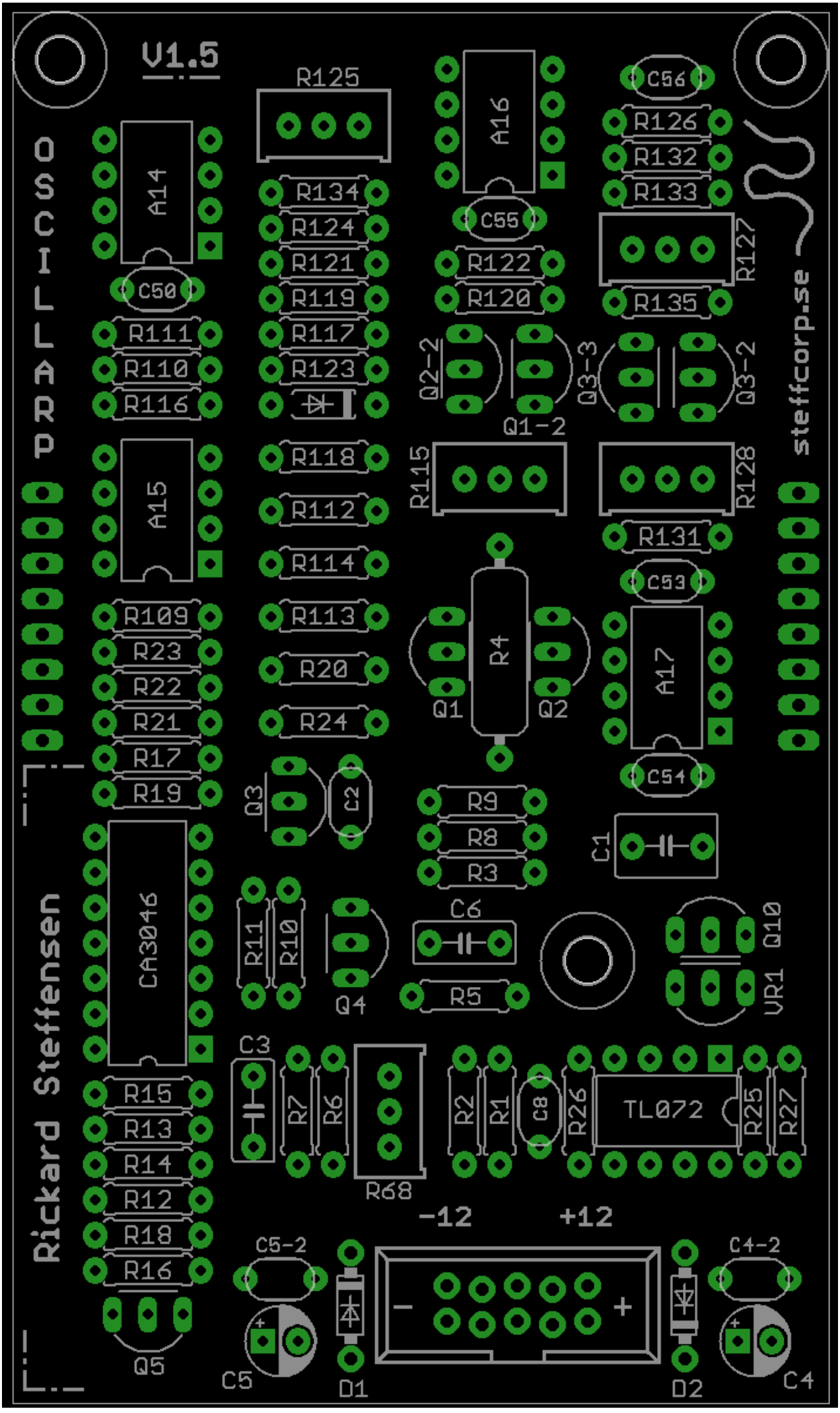
Details

Main controls: - Frequency & Fine-tune - PW - Attenuators for PWM and FM **Inputs:** - 1V/OCT - 2x FM - PWM - Hard Sync **Outputs:** - Saw, Pulse, Triangle and Sine	**Technical:** - 10V Precision Reference Voltage - Power protection - Buffered in & outputs - Tracking well over 10 octaves - FREQ control 10hz – 10KHz - FINE control about +/- 5 semitones - Width 12HP - Depth about 35mm, depending on choice of components - (mA measures added soon)

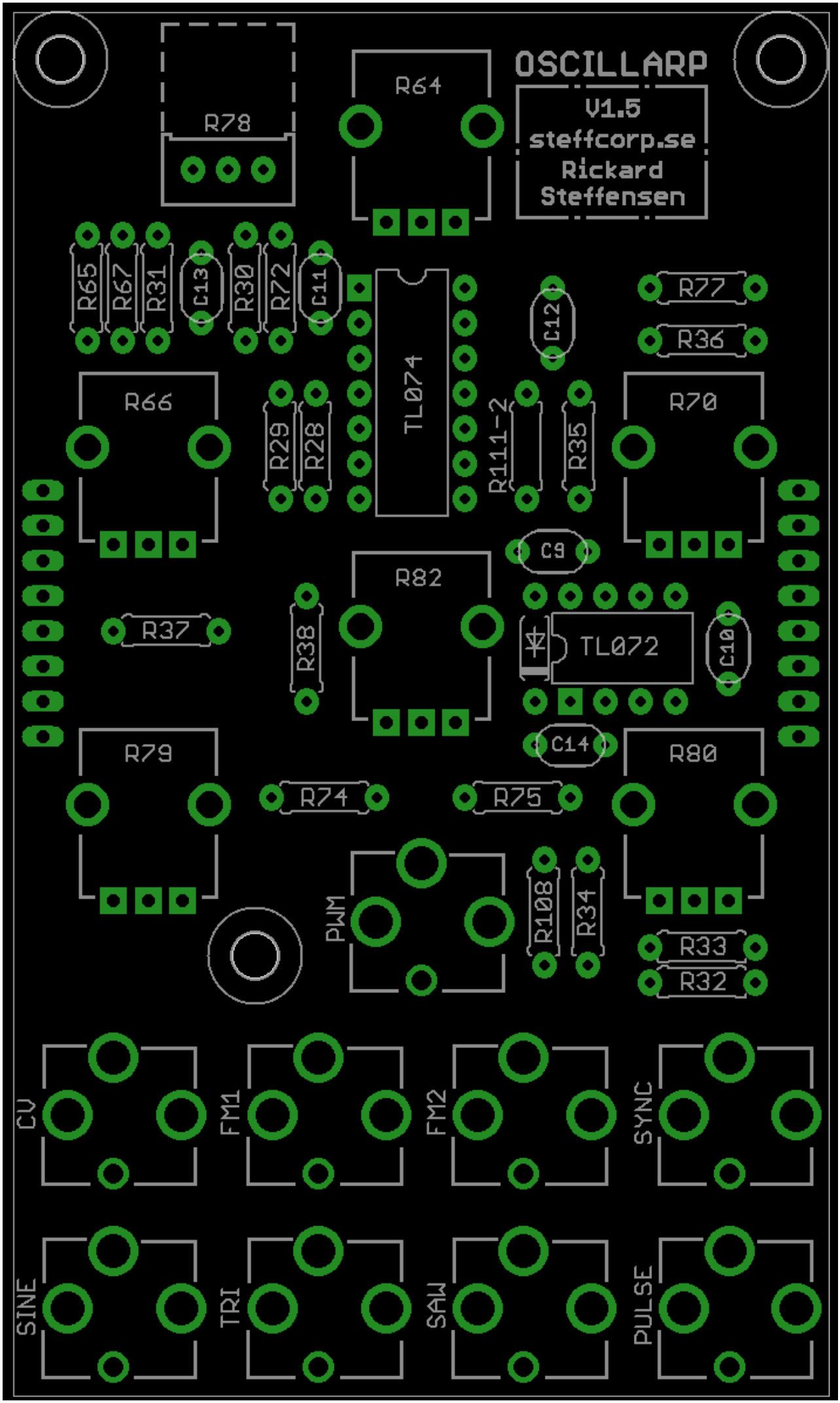
LAYOUTS

Below are the PCB-layouts for reference or any possible troubleshooting.
I have kept as many of the original part-names as possible.
The physical boards have values printed on them for faster building.

Core-PCB:


V1.5
Rickard Steffensen
steffcorp.se
CA3046
TL072
A14
A15
A16
A17
R125
R134
R124
R121
R119
R117
R123
R118
R112
R114
R113
R20
R24
R109
R23
R22
R21
R17
R19
R15
R13
R14
R12
R18
R16
R111
R110
R116
R126
R132
R133
R127
R135
R122
R120
R115
R128
R131
R4
R9
R8
R3
R5
R11
R10
R7
R6
R68
R2
R1
R26
R25
R27
C50
C55
C56
C53
C54
C1
C2
C3
C6
C8
C5-2
C4-2
C5
C4
Q1
Q2
Q3
Q4
Q5
Q1-2
Q2-2
Q3-3
Q3-2
Q10
VR1
D1
D2
-12
+12

Control-PCB:


OSCILLARP
V1.5
steffcorp.se
Rickard
Steffensen
R78
R64
R65
R67
R31
C13
R30
R72
C11
C12
R77
R36
TL074
R66
R29
R28
R111-2
R35
R70
C9
R82
R37
R38
TL072
C10
C14
R79
R74
R75
R80
PWM
R108
R34
R33
R32
CV
FM1
FM2
SYNC
SINE
TRI
SAW
PULSE