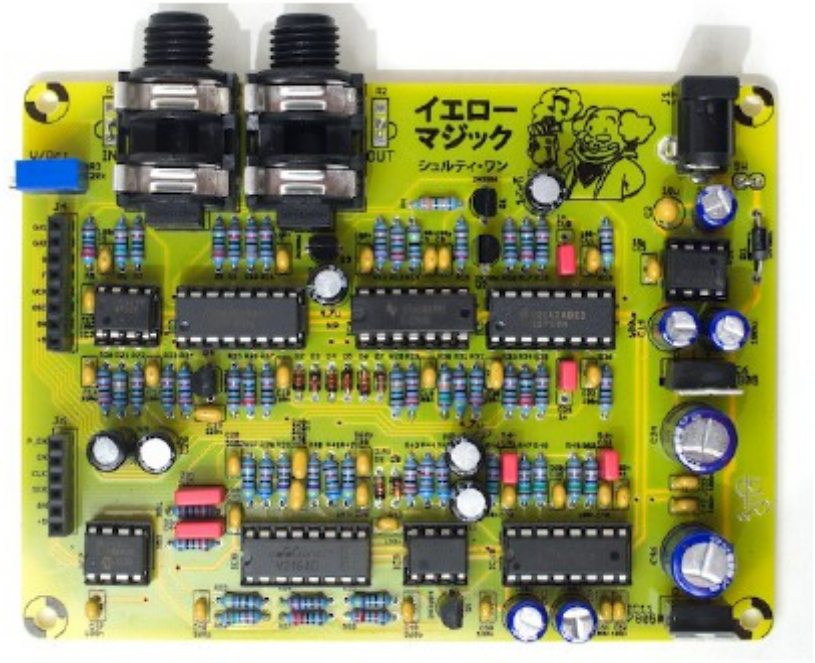
LP2+delay board
Yellow Magic

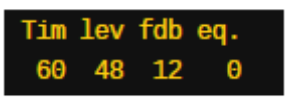


This filter boards combines a raw OTA-C 2-pole filter, combined with a classic lo-fi delay.

Using this filter board

Important! The Phoenix/Shruthi-1 control board needs to send specific digital control signals to drive this filter board.
Make sure that both the analog (CV1 to +5V) and digital (RX to +5V) ports of the filter and control boards are connected.
Make sure that the Shruthi-1 firmware v0.97 (or above) is installed, and that the **fil** (filter board) setting is set to **dly** on the system settings page.

The delay settings can be accessed by pressing the **S2** switch (Filter page) a second time:



The delay parameters are the following:

1. **tim (time)**: Delay time. The delay time is expressed in arbitrary units. Due to parts tolerance, the actual delay time might vary by a few percents, and this parameter is not accurately calibrated. The delay time typically ranges from 30ms (0) to 550ms (127). This parameter has a logarithmic scale, so the intermediate delay time (64) is close to 120ms.

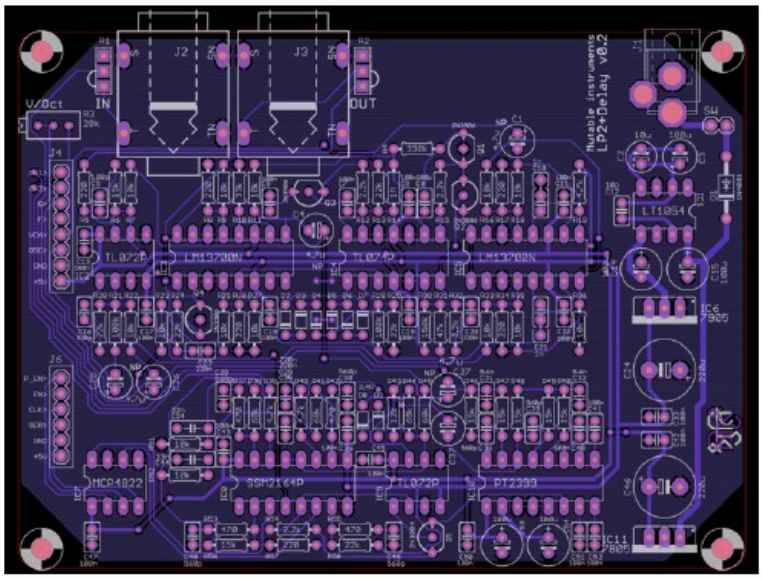
2. **lev (level)**: Delay level. This controls the wet signal level. No delay effect can be heard when this parameter is set to 0.

3. **fdb (feedback)**: Delay feedback. This parameter controls the level of the signal taken at the output of the delay loop and fed back to the input.

4. **eq. (fdbck. eq)**: Feedback tone color. A simple EQ circuit is present in the feedback loop. When this parameter is set to 0, the signal fed back into the delay is colored by a low-pass filter with a cutoff of 500 Hz. This causes the echoes to get darker and darker, an effect which is not unlike reverb with short delay times. When this parameter is set to 15, the signal fed back into the delay is colored by a high-pass filter with a cutoff of 500 Hz. This gives the echoes a “dub” flavor.

A few observations about the lo-fi-ness of the delay:
Using a longer delay time causes a degradation of the sound quality. Unlike traditional analog BBD delays, this degradation is not a bandwidth reduction, but rather a combination of a bandwidth reduction and the addition of quantization noise. This is due to the 1-bit sigma/delta conversion used in the PT2399.
The frequency response of the filter circuit in place around the PT2399 has a slight bump near 3kHz. This means that when feedback level is too high, a 3kHz tone will build up into the delay line. Whether this build-up is musically useful or annoying is up to you to decide, but we deliberately allowed this to occur. Thus, some combinations of the **fdb** and **eq.** parameter, particularly with **eq.** set to a high value and **fdb** greater than 10, will cause pathological feedback to occur.
In order to make quantization noise less audible when long delay times are used, the signal is heavily amplified in the mixer at the input of the delay line, with a soft-limiter in place to prevent clipping. Don’t be surprised if the echoes are more “fuzzy” than the original signal. This is particularly noticeable with high feedback times when many echoes add up to each other, causing the soft-limiter to get into action and add harmonics to the sound.

Schematics and PCB

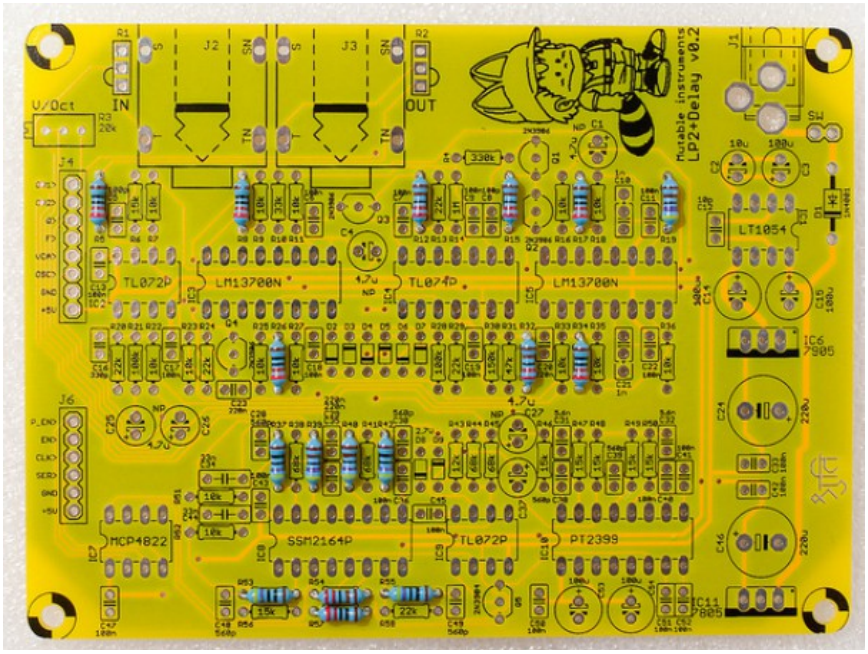


You can find the Eagle files for this board in the shruthi/hardware_design/pcb directory of the source code hosted on **github**

Important note to builders using self-sourced PT2399s.

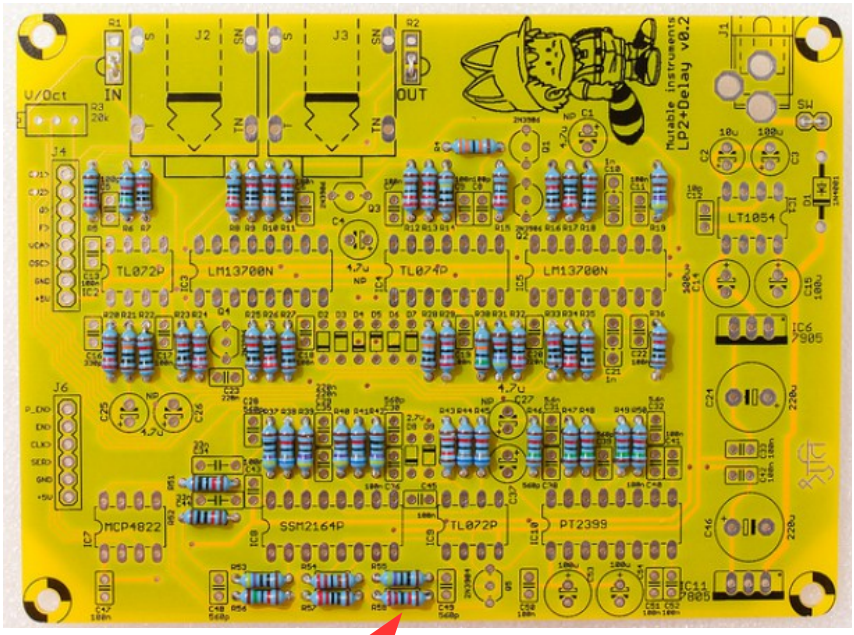
Some batches of PT2399s are more prone to clock latchup when short delay times are used (something that happens when the board is powered up and the delay time is initialized to its minimal value). If you encounter problems with the delay – such as the delay randomly not working when the board is powered on – simply replace R58 by a higher value, such as 27k or 30k. This has the side-effect of shifting up the delay times range.

We use here the PT2399 with R58 =39kOhm. All PT's are tested bevore shipping !!

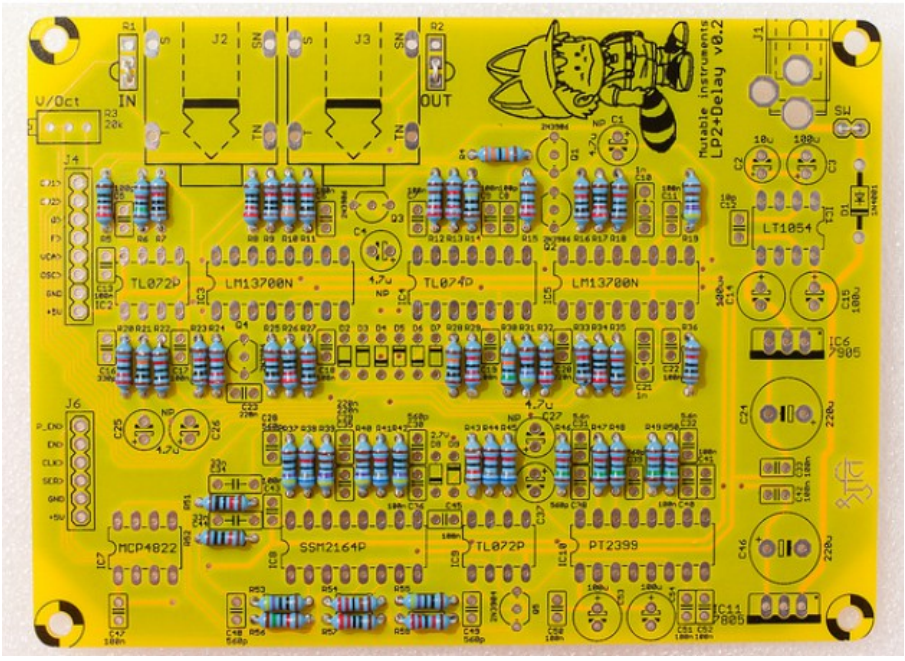


Start with the smaller resistors:

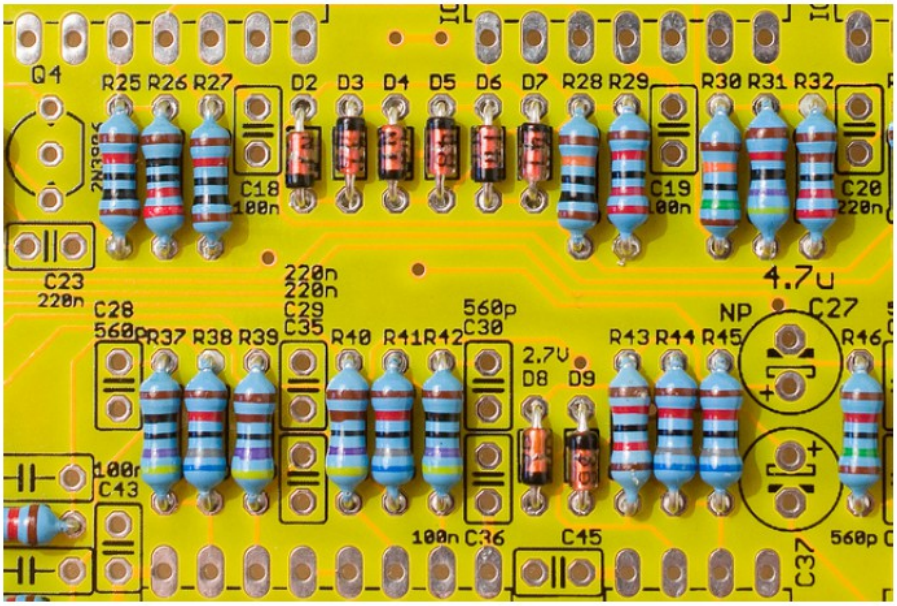
6x 220R (red, red, black, black).
4x 470R (yellow, purple, black, black).
4x 2.2k (red, red, black, brown).
3x 4.7k (yellow, purple, black, brown).



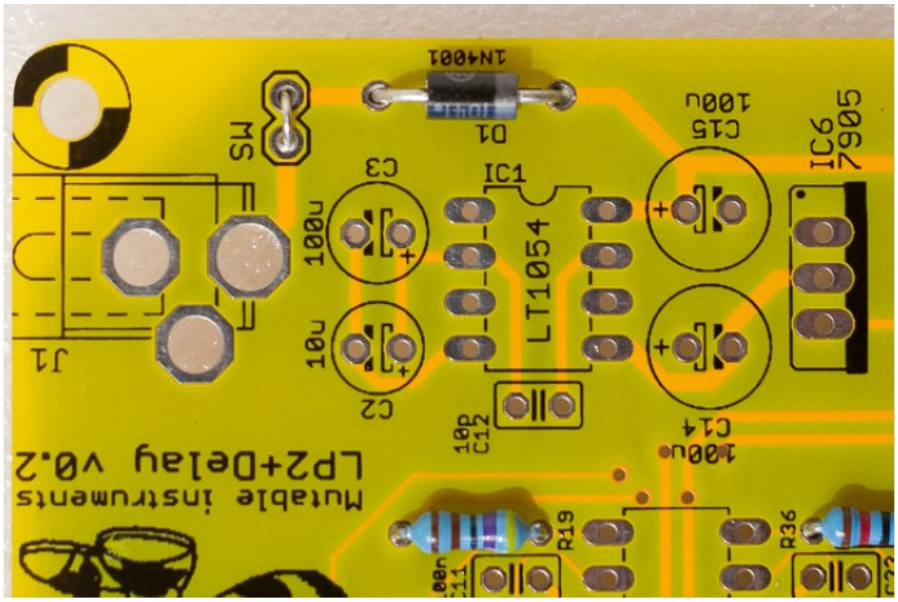
More resistors:
14x 10k (brown, black, black, red).
1x 12k (brown, red, black, red).
7x 15k (brow, green, black, red).
4x 22k (red, red, black, red).
1x 39 k R 58 for the selected PT2399
1x 33k (orange, orange, black, red).
1x 47k (yellow, purple, black, red).
4x 68k (blue, grey, black, red).



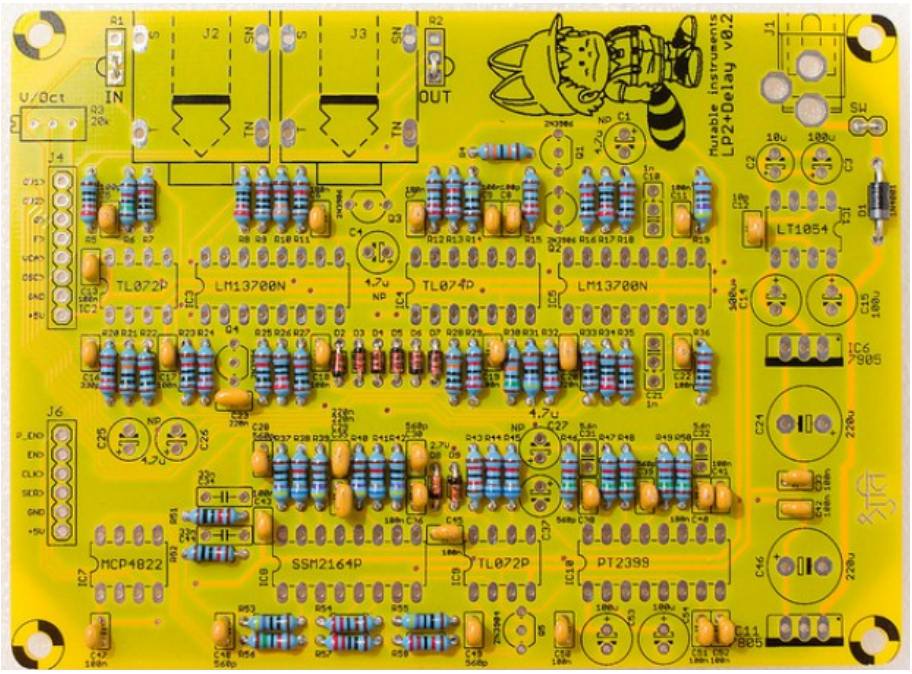
More resistors:
2x 100k (brown, black, black, orange).
1x 150k (brown, green, black, orange).
1x 330k (orange, orange, black, orange).
1x 1M (brown, black, black, yellow).
Note that 3 bridges have been added on the IN, OUT and SW pads – since we don't use input/output gain pots and power switches



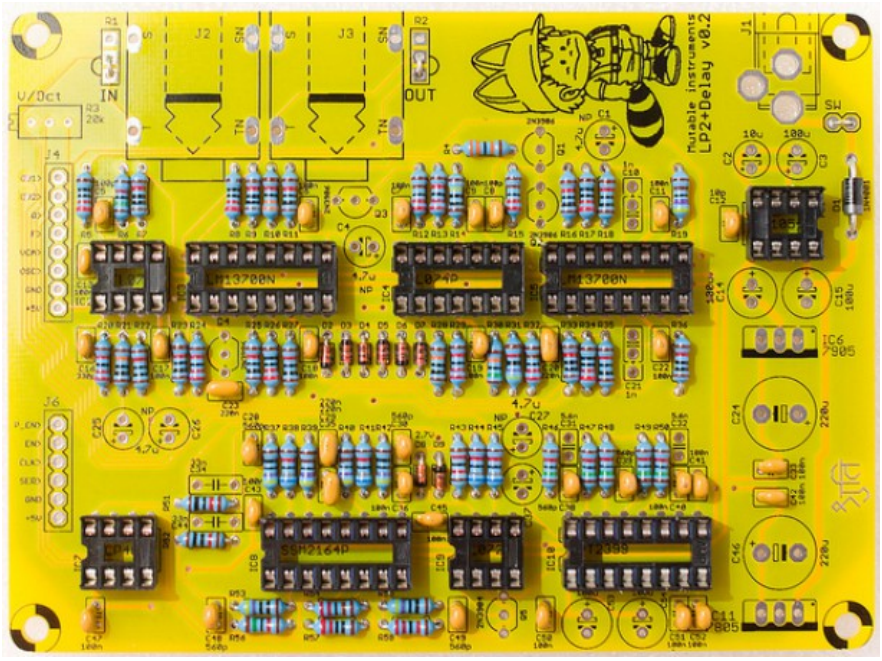
Add 6x 1N4148 diodes. They are polarized, make sure that the black ring follows the pattern silkscreened on the PCB. Add 2x 2.4V Zener diodes (this photo of an older board shows 2.7V, but the right value is 2.4V). They are polarized too.



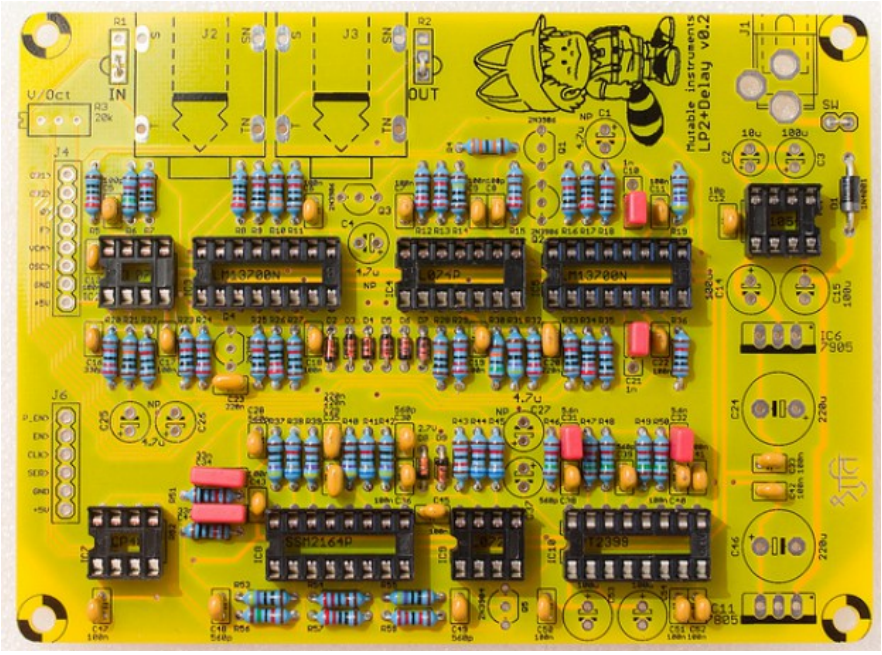
Add the polarity protection diode (1N4001 or 1N4004). It is polarized.



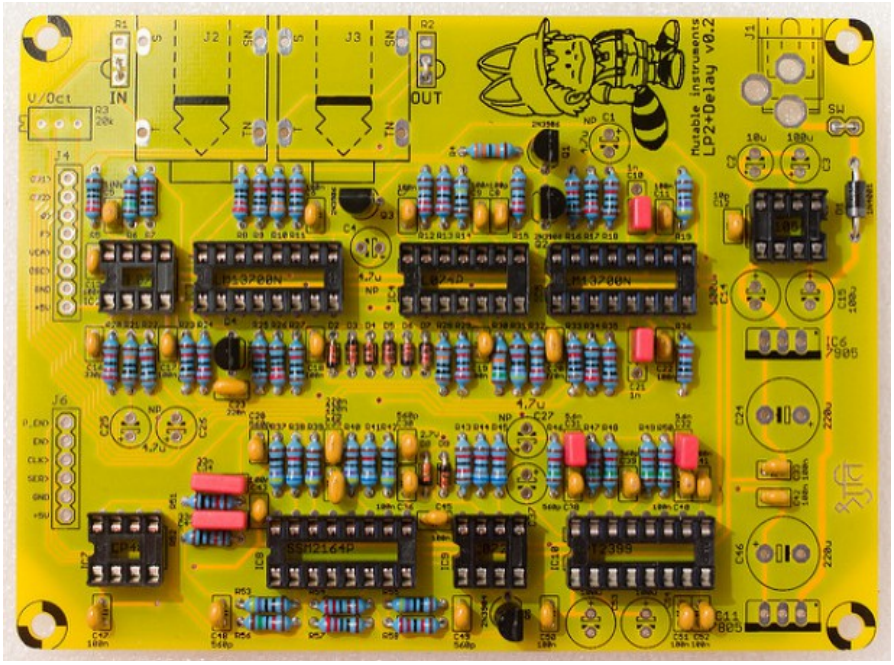
Add the ceramic capacitors. They are not polarized:
1x 10pF (labelled 100).
2x 100pF (labelled 101).
1x 330pF (labelled 331).
6x 560pF (labelled 561).
20x 100nF (labelled 104).
4x 220nF (labelled 224).



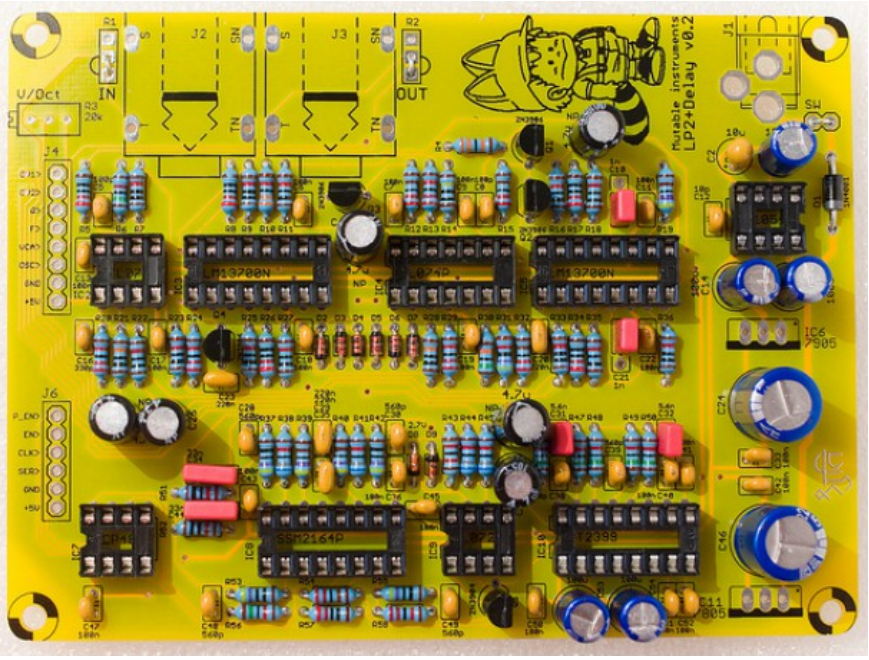
Add the IC sockets.



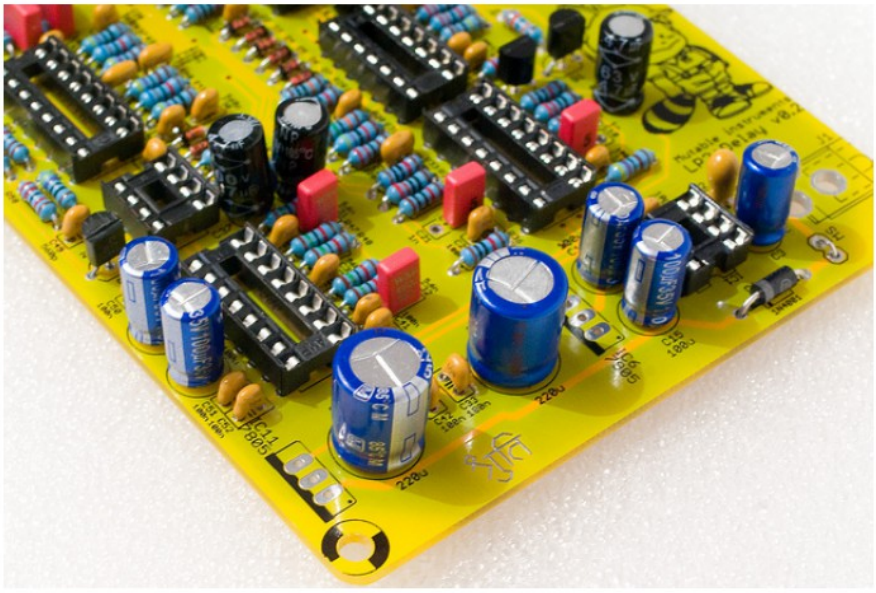
Add the film capacitors (2x 33nF, 2x 1nF, 2x 6.8nF or 5.6nF). They are clearly labelled with their value, and are not polarized.



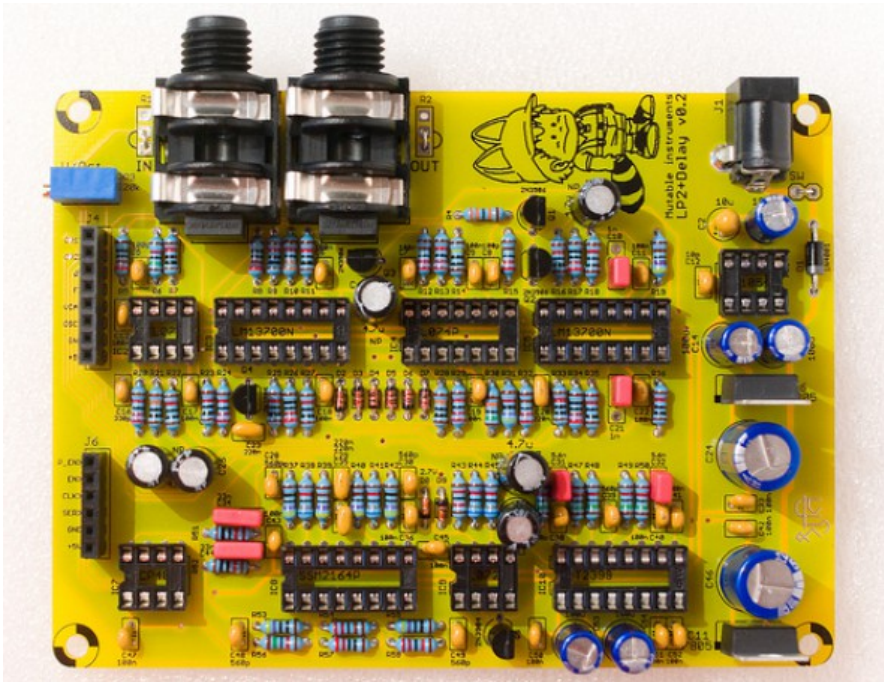
Add the 4x 2N3906 transistors, and the 2N3904 transistor. Beware of their polarity!



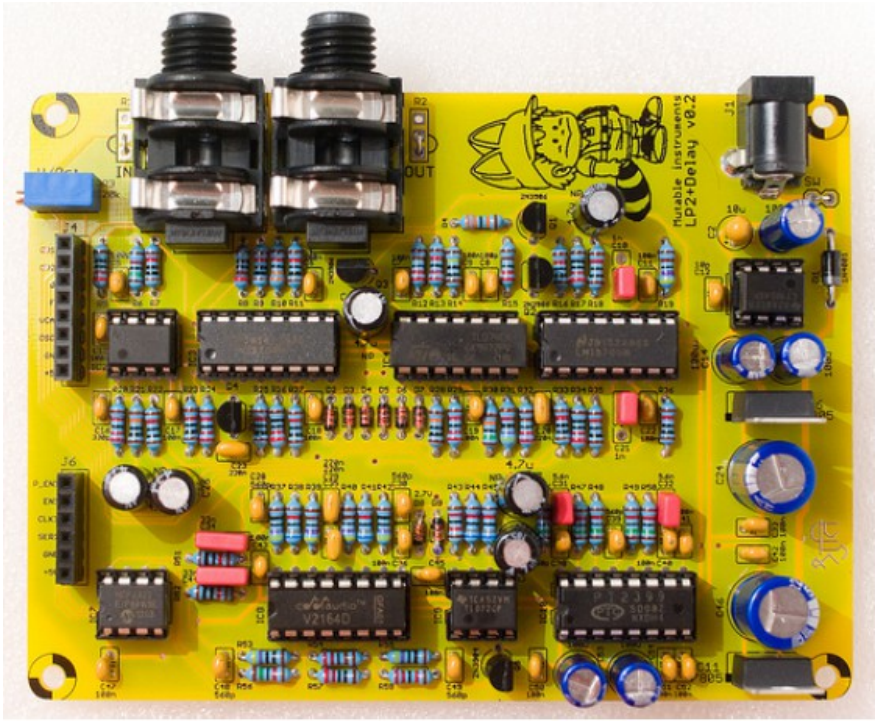
Add the electrolytic capacitors. The 6x 4.7uF capacitors are not polarized (a + and – are silkscreened on the PCB, don’t bother with those). The 5x 100uF and 2x 220uF capacitors are polarized. The white stripe on the edge of the capacitor indicates the minus lead (which is also the shortest one).
Here is another view of the board:



Add the tantalum capacitor. A stripe indicates the + the lead.



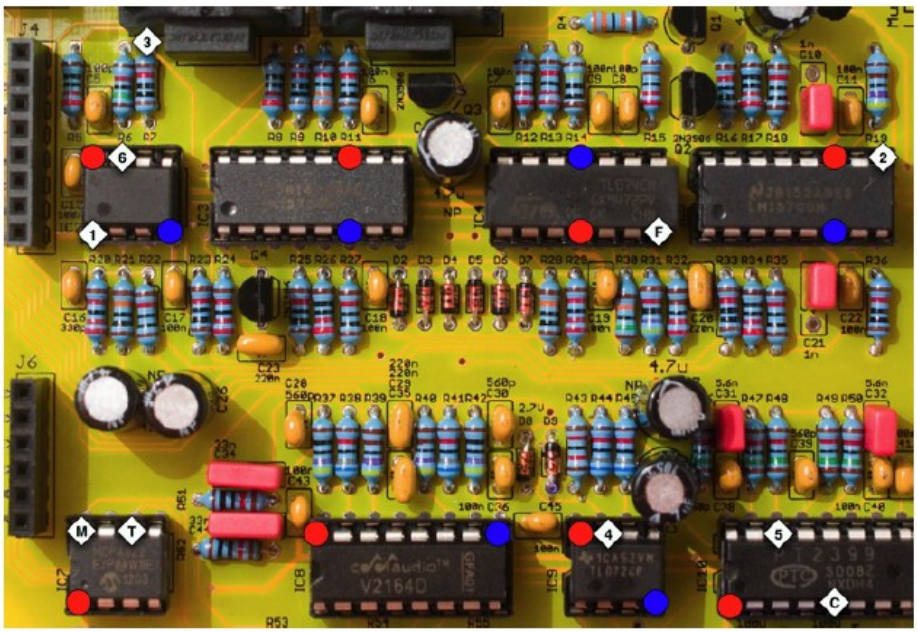
Add the 20k trimmer.
Add the connectors and the 2 voltage regulators (7905 and 7805). **Don’t mix them up, these are different parts!**
You can finally insert all ICs



The last step consists in tuning the filter, to make sure that the cutoff frequency of the filter follows a musical scale: increasing the cutoff setting on the Shruthi by 12 (or playing a note 1 octave = 12

semitones higher) should double the cutoff frequency.
First, you'll need to assemble the filter and control boards. Maybe you can start screwing them together onto the bottom plate of the enclosure or you can just temporarily sandwich female 1x8 and 1x6 connectors between the boards for testing.
Dial the following settings on the Shruthi-1:
Oscillator 1 shape: **none**
Oscillator 2 shape: **none**
Filter cutoff: **64**
Filter resonance: **63** (maximum value)
Filter envelope and LFO modulations: **0**
Play on the keyboard. You should hear a pure tone (sine wave), which does not come from the Shruthi-1 oscillators but from the filter self-oscillating. Adjust the V/Oct trimmer so that the **intervals are respected – that is to say, when you play C3 then C4, you should hear two notes, maybe not** C3s and C4s, but they must be one octave apart. If you do not have a good sense of pitch, you can try a software tuner like Tuna Pitch on OS X. If the filter is correctly tuned, you should be able to play the filter "self oscillation tone" across roughly 4 octaves with correct tuning.

Troubleshooting



RED: +5V
BLUE: -5V
1: Mixer output (raw oscillators signal)
2: Filter output
3: VCA output
4: Delay mixer input (this is what goes into the delay: input signal + feedback)
5: Delay output. This signal is referenced to +2.5V
6: Output amp output. This is the sum of the signal at the output of the VCA + the delay output

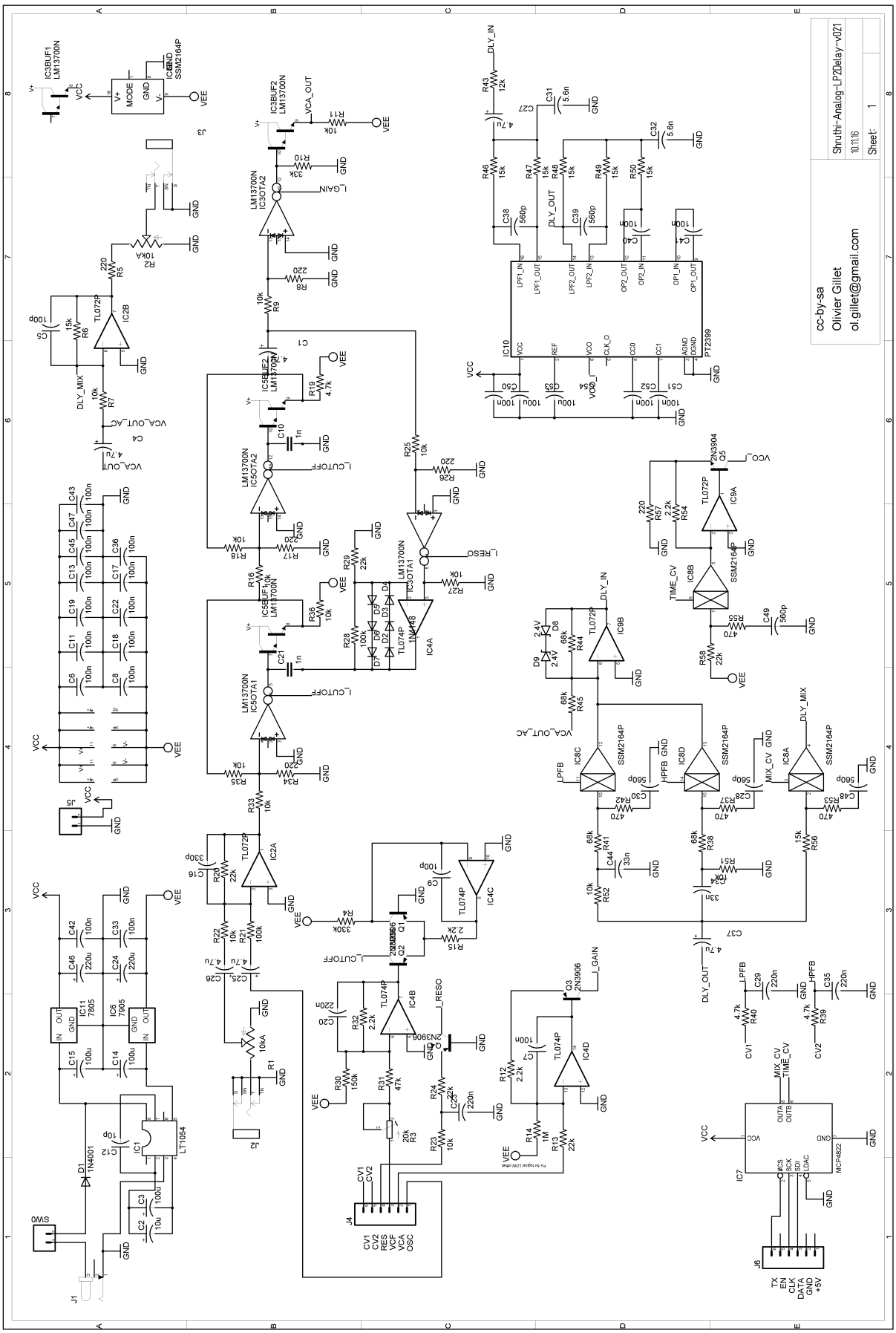
attenuated according to the dry/wet control.
F: Filter cutoff expo converter input. Should swing by +/- 100mV when cutoff is adjusted.
C: Delay clock. High frequency signal visible with a scope, should speed up/slow down proportionally to delay time.
M: Wet signal attenuation CV. 0V when delay level is set to 63 ; 4.1V when delay level is set to 0.
T: Delay time CV. 0V when delay time is set to 0 ; 1.0V when delay time is set to 127.

License

Releases

v0.21 TubeOhm

Schematics


Shruthi-Analog-LP2Delay-v021
cc-by-sa
Olivier Gillet
ol.gillet@gmail.com

BOM YELLOW MAGIC

Yellow magic for Shruthi/Phoenix							
				Reichelt	Digi Key	Farnell	Mouser
R5, R8, R17, R26, R34, R57	Resistor 1%	220	6	METALL 220	221XBK-ND	9341528	660-MF1/4DCT52R2200F
R37, R42, R53, R55	Resistor 1%	470	4	METALL 470	475XBK-ND	9341943	660-MF1/4DCT52R4700F
R12, R15, R32, R54	Resistor 1%	2.2k	4	METALL 2,20K	2.21KXBK-ND	9341536	660-MF1/4DCT52R2201F
R19, R39, R40	Resistor 1%	4.7k	3	METALL 4,70K	4.75KXBK-ND	9342060	660-MF1/4DCT52R4701F
R7, R9, R11, R16, R18, R22, R23, R25, R27, R33, R35, R36, R	Resistor 1%	10k	14	METALL 10,0K	10.0KXBK-ND	9341110	660-MF1/4DCT52R1002F
R43	Resistor 1%	12k	1	METALL 12,0K	12.1KXBK-ND	9341234	660-MF1/4DCT52R1202F
R6, R46, R47, R48, R49, R50, R56	Resistor 1%	15k	7	METALL 15,0K	15.4KXBK-ND	9341331	660-MF1/4DCT52R1502F
R13, R20, R24, R29, R58	Resistor 1%	22k	5	METALL 22,0K	22.1KXBK-ND	9341544	660-MF1/4DCT52R2202F
R58 - PT from TubeOhm	Resistor 1%	39k	1	Metall 39.0K			
R10	Resistor 1%	33k	1	METALL 33,0K	33.2KXBK-ND	9341757	660-MF1/4DCT52R3302F
R31	Resistor 1%	47k	1	METALL 47,0K	47.5KXBK-ND	9341960	660-MF1/4DCT52R4702F
R38, R41, R44, R45	Resistor 1%	68k	4	METALL 68,0K	68.1KXBK-ND	9342176	660-MF1/4DCT52R6812F
R21, R28	Resistor 1%	100k	2	METALL 100k	100KXBK-ND	9341129	660-MF1/4DCT52R1003F
R30	Resistor 1%	150k	1	METALL 150k	150KXBK-ND	9341340	660-MF1/4DCT52R1503F
R4	Resistor 1%	330k	1	METALL 330k	332KXBK-ND	9341765	660-MF1/4DCT52R3303F
R14	Resistor 1%	1M	1	METALL 1,00M	1.00MXBK-ND	9341137	660-MF1/4DCT52R1004F
C12	Ceramic cap	10p	1	KERKO 10P	478-4843-ND	1694176	594-K100K15C0GF53L2
C5, C8	Ceramic cap	100p	2	KERKO 100P	399-4142-ND	1694179	594-K101K15C0GF53L2
C16	Ceramic cap	330p	1	KERKO 330P	478-5212-ND	1216419	594-K331J15C0GF53L2
C28, C30, C38, C39, C48, C49	Ceramic cap	560p	6	KERKO 560P	490-3850-ND	1694300	594-K561J15C0GF53L2
C10, C21	Film cap	1n	2	MKS-02 1,0N	BC1659-ND	1685470	80-MMK5102K63J01TR18
C31, C32	Film cap	5.6n or 6.8n	2	MKS-02 6,8N	445-8391-ND	1185647	810-FK18C0G1H562J
C34, C44		33n	2	MKS-2-5 33N	BC1650-ND	9752986	871-B32529C333J189
C6, C7, C9, C11, C13, C17, C18, C19, C22, C33, C36, C40, C4	Ceramic cap	100n	20	X7R-2,5 100N	BC1148CT-ND	1694337	75-1C10Z5U104M050B
C20, C23, C29, C35	Ceramic cap	220n	4	Z5U-2,5 220N	445-8411-ND	1141778	810-FK18Y5V1H224Z
C2	tantalum cap, > 15V	10u	1	TANTAL 10/16	478-1839-ND	1753975	581-TAP106K016SRW
C3, C14, C15, C53, C54	Electrolytic cap	100u	5	RAD 100/16	P13476-ND	1600568	667-EEU-FR1E101
C24, C46	Electrolytic cap	> 220u	2	RAD 220/35	P10297-ND	9451099	667-ECA-1HM221
D1	Diode 1N400x		1	1N 4004	641-1311-1-ND	1651084	625-1N4001-E3/73
D2, D3, D4, D5, D6, D7	Diode 1N4148		6	1N 4148	1N4148TACT-ND	1612346	78-1N4148-TAP
D8, D9	Diode Zener 2.4V		2	ZF 2,4	1N5221BDO35MSCT-ND	1467581	78-1N5221B
Q1, Q2, Q3, Q4	PNP transistor	2N3906	4	2N 3906	2N3906FS-ND	1704728	512-2N3906TA
Q5	NPN transistor	2N3904	1	2N 3904	2N3904FS-ND	9846743	512-2N3904TA
	IC Socket DIP 8		4	GS8	A100204-ND	1654374	571-1-390261-2
	IC Socket DIP 14		1	GS14	A100205-ND	1183573	571-1-390261-3
	IC Socket DIP 16		4	GS16	A100206-ND	1183574	571-1-390261-4
R3	Trimmer	20k	1	64W-20K	T93XA-20K-ND	1141378	81-PV36X203C01B00
C1, C4, C25, C26, C27, C37	Electrolytic cap, NP/audio	4.7u	6		P1175-ND	1236689	647-UVP1E4R7MDD
IC1	LT1054 DC/DC converter		1	LT 1054 CN8	296-9591-5-ND	1652378	
IC11	LM7805 +5V Vreg		1	µA 7805	LM7805CT-ND	9666095	863-MC7805ACTG
IC6	LM7905 -5V Vreg		1	µA 7905	LM7905CTFS-ND	9666141	863-MC7905ACTG
IC2, IC9	TL072 dual op-amp		2	TL 072 DIP	497-2201-5-ND	1103005	595-TL072CP
IC4	TL074 quad op-amp		1	TL 074 DIL	497-2205-5-ND	9755934	595-TL074CN
IC3, IC5	LM13700 dual OTA		2	LM 13700 DIL	LM13700N-ND	1651866	926-LM13700N/NOPB
IC8	V2164 quad VCA		1	Available at Mammoth Electronics, Small Bear			
IC10	PT2399 digital delay		1	Available at Tayda Electronics, Das Musikding, Banzai, Small bear			
IC7	MCP4822 dual 12bits DAC		1		MCP4822-E/P-ND	1439413	579-MCP4822-E/P
J2, J3	Neutrik Audio Jack 6.35		2			4169244	550-10201
J1	DC Jack		1	HEBW 21	CP-202A-ND	1737246	163-7620-E
J4	8 pins female header		2	Sparkfun PRT-10007 or Coolcomponents 000348+000349			
J6	6 pins female header		2				
PCB	PCB		1	TubeOhm Instruments LP2+Delay v0.2			