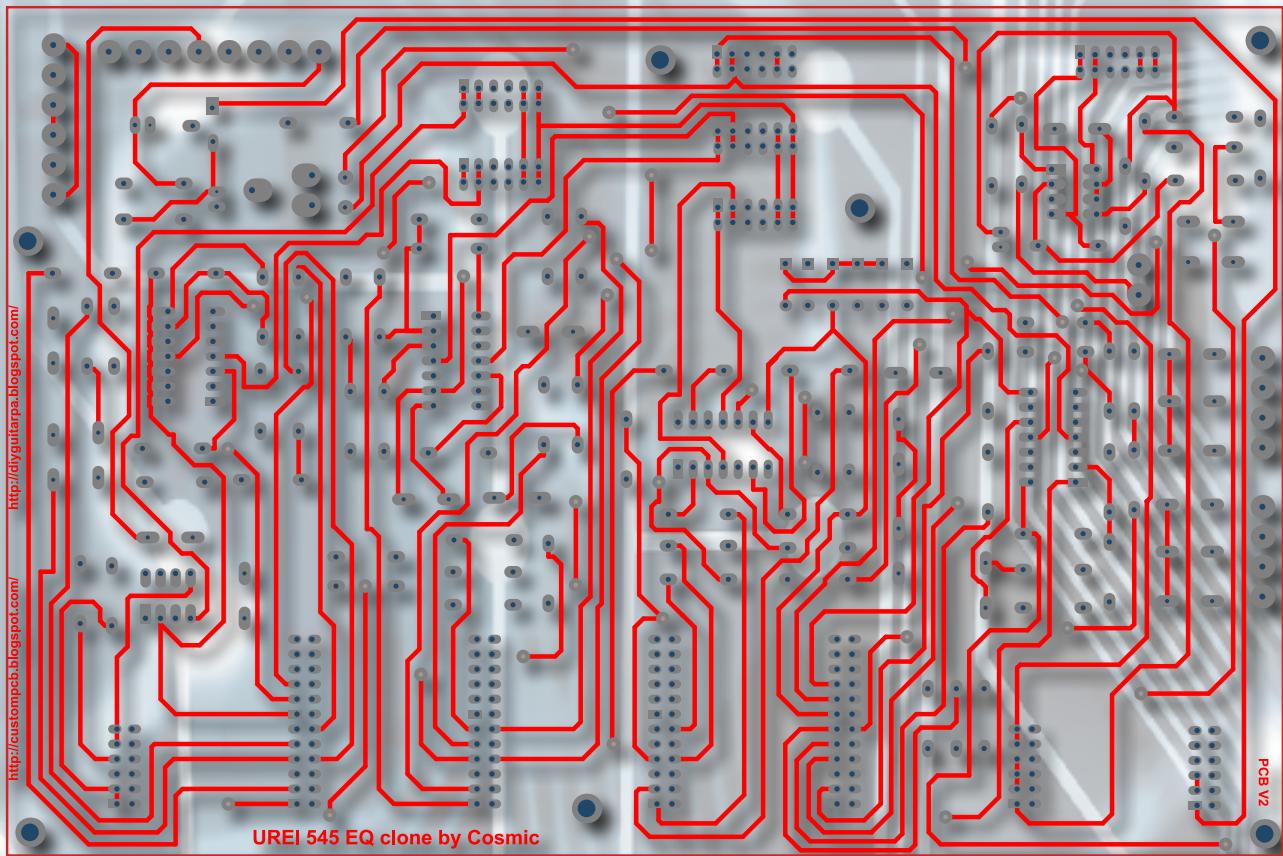
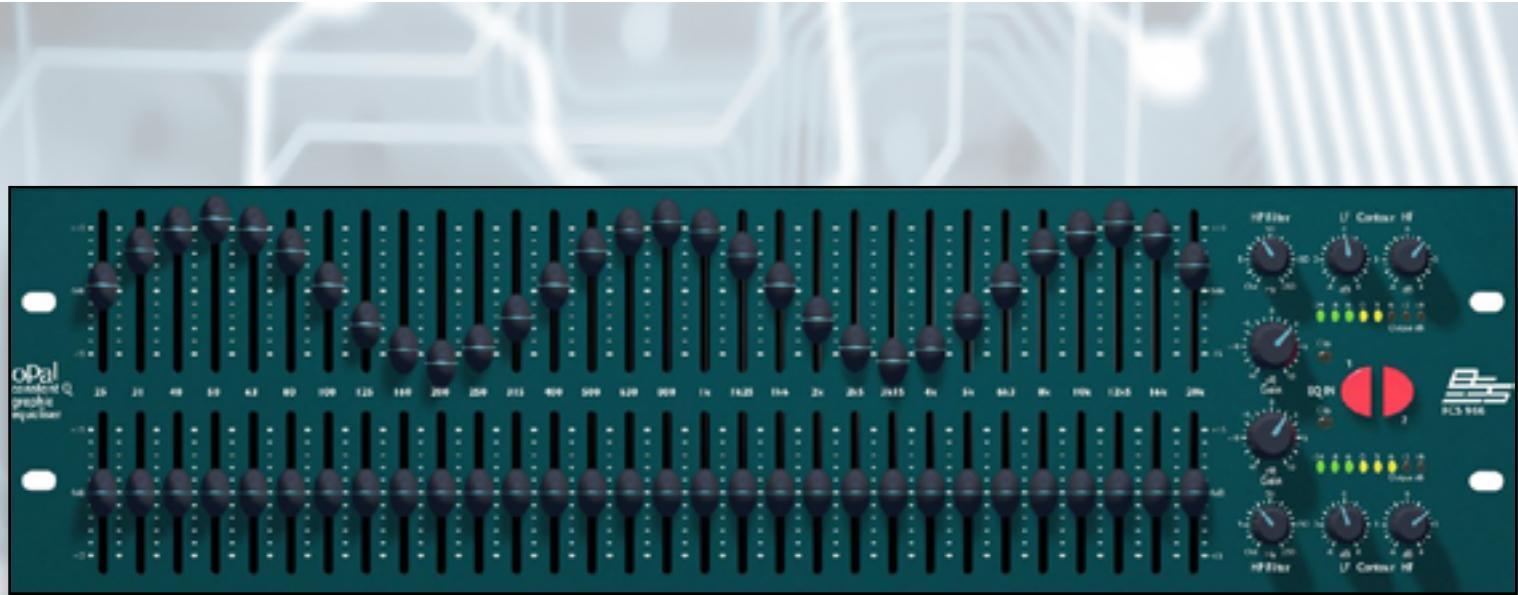


Modular EQ project with gyrators



Schematics and Bill of Materials for simple EQ circuits with gyrator filters

This project made to create and try **simple and noiseless EQ** with circuit called "gyrator". This method is very simple, easy to assemble, and good quality for home hi-fi systems. You can find very simple 5 band EQ with this method, and **modular EQ with sub-circuits and mainboard for 10 and 5 band equalizer**.

Read details, updates, advices on the page of schematics and notes. PCB-s and more notes, pictures, advices about this project are available on the author's blog and websites:

English blog and PCB order: <http://custompcb.blogspot.com/>

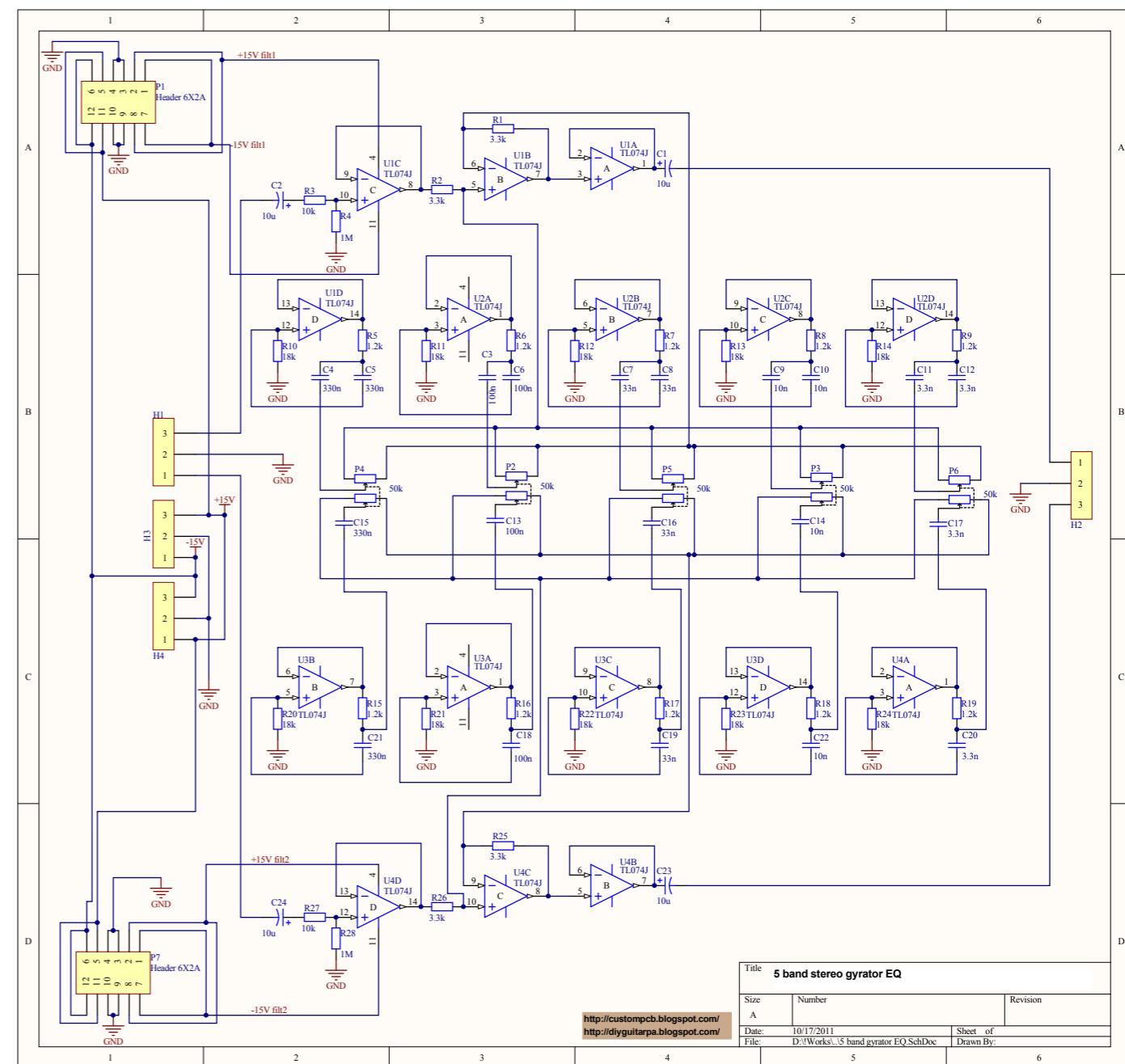
Hungarian blog and PCB order: <http://diyguitarpa.blogspot.com/>

[The Youtube Channel](#) • [Picasa gallery](#) • Email: gitarfogas@gmail.com

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Schematics and Bill of Materials for gyrator EQ project

Schematic and BOM of simple "5 band EQ"



Description	Value	Footprint	Quantity	Designator	Model:Footprint
Polarized Capacitor (Radial)	10u	Cap, Tantal, 1mil	4	C1, C2, C23, C24	
Capacitor	100n	RAD-0.3	4	C3, C6, C13, C18	Radial Cap, Thru-Hole; 2 Leads; 0.3 in Pin Spacing
Capacitor	330n	RAD-0.3	4	C4, C5, C15, C21	Radial Cap, Thru-Hole; 2 Leads; 0.3 in Pin Spacing
Capacitor	33n	CAP, WIMA, 2MIL	4	C7, C8, C16, C19	
Capacitor	10n	CAP, WIMA, 2MIL	4	C9, C10, C14, C22	
Capacitor	3.3n	CAP, WIMA, 2MIL	4	C11, C12, C17, C20	
		Panel Connector 3 input Small	4	H1, H2, H3, H4	
Header, 6-Pin, Dual row		HDR2X6_CEN	2	P1, P7	Connector; Header; 6x2 Position
Resistor	50k	FOTS Plastic Stereo	5	P2, P3, P4, P5, P6	
Resistor	3.3k	AXIAL-0.4	4	R1, R2, R25, R26	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Resistor	10k	AXIAL-0.4	2	R3, R27	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Resistor	1M	AXIAL-0.4	2	R4, R28	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Resistor	1.2k	AXIAL-0.4	10	R5, R6, R7, R8, R9, R15, R16, R17, R18, R19	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Resistor	18k	AXIAL-0.4	10	R10, R11, R12, R13, R14, R20, R21, R22, R23, R24	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Low-Noise JFET-Input Operational	J014	DIP; 14 Leads; Row Spacing 7.62 mm; Pitch 2.54 mm	4	U1, U2, U3, U4	

Notes

This is the **simplest** schematic of 5 band stereo gyrator EQ. The PCB is small, potentiometers inserted to the board. Cheap, low noise, good quality for home hi-fi applications.

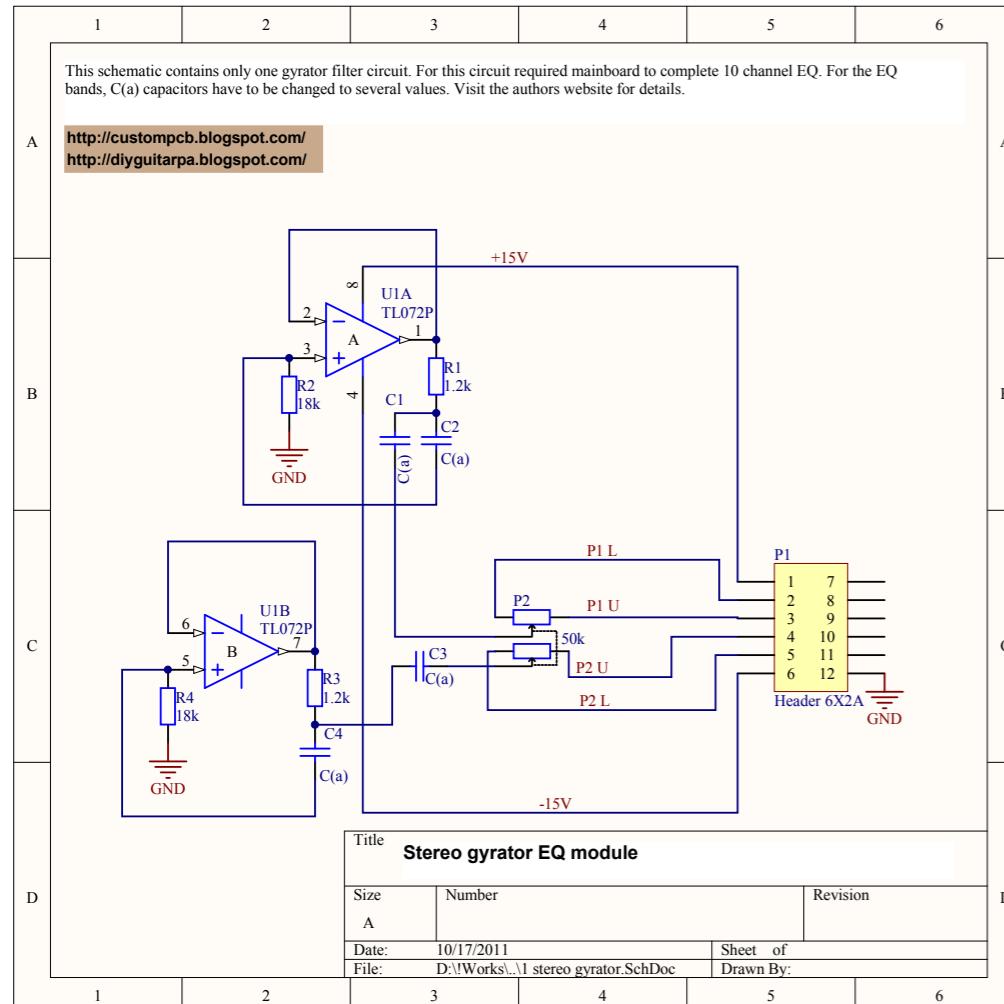
The band frequencies of this board: 100Hz - 300Hz - 1kHz - 3kHz - 10kHz.

Schematics and Bill of Materials for gyrator EQ project

One stereo gyrator filter module

Notes

This is the **part of modular EQ project**. This is the most important schematic: the **gyrator**. The gyrator is the main filter for the equalizer. The band frequency depend on the value of capacitors "C(a)" on the schematic. Because this is module only, another modules and **mainboard required to complete the multiband EQ**. Two version of PCB-s available for this one module: one of them have **stereo potentiometers to adjust both left and right channel** at one time. Another PCB **separated to two mono channel with two mono potentiometers to adjust left and right channels independently**. The first version is good for home hi-fi users, the second is better for instrument amplifications. With the EQ mainboard, you can build this module for any frequencies, set the Q and the boost/cut of the band. Look at the math expressions of this module to count the values of the resistors and capacitors.



Examples of C(a):

For 5 band EQ:

- 100Hz - 330n
- 300Hz - 100n
- 1kHz - 33n
- 3kHz - 10n
- 10kHz - 3.3n

For 10 band EQ:

- Change all of the 50K adjustable resistors to 25K

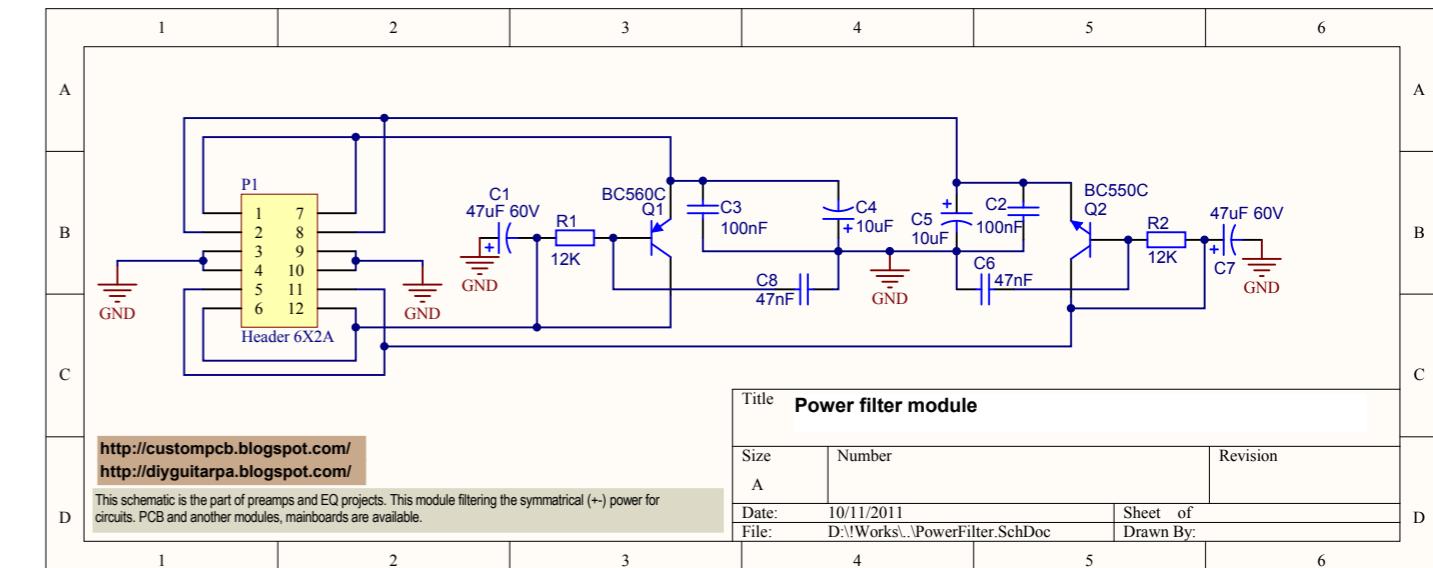
Hz	C3	C4	R3	R4
31	6.8μ	100n	470Ω	100k
63	3.3μ	47n	390Ω	100k
125	1.5μ	33n	390Ω	100k
250	680n	22n	330Ω	82k
500	330n	10n	330Ω	100k
1K	150n	4.7n	330Ω	100k
2K	100n	2.2n	330Ω	82k
4K	56n	1n	390Ω	82k
8K	22n	470p	390Ω	82k
16K	10n	220p	390Ω	100k

The values of R3 is same as R1, the R2 is same as R4. Also look the math expressions for another examples.

Comment	Value	Quantity	Description	Designator	Footprint	LibRef
Cap	C(a)	4	Capacitor	C1, C2, C3, C4	CAP, 2 and 3 MIL	Cap
Header 6X2A		1	Header, 6-Pin, Dual row	P1	HDR2X6_CEN	Header 6X2A
Pot stereo	50k	1	Resistor	P2	Pots Plastic Stereo	Pot stereo
Res2	1.2k	2	Resistor	R1, R3	AXIAL-0.4	Res2
Res2	18k	2	Resistor	R2, R4	AXIAL-0.4	Res2

Schematics and Bill of Materials for gyrator EQ project

The power filter module



Description	Value	Footprint	Quantity	Designator	Model:Footprint
Polarized Capacitor (Radial)	47μF 60V	E100 6mm, 1 mil pins	2	C1, C7	
Capacitor	100nF	RAD-0.3	2	C2, C3	Capacitor; 2 Leads
Polarized Capacitor (Radial)	10μF	Cap, Tantal, 1mil	2	C4, C5	
Capacitor	47nF	RAD-0.3	2	C6, C8	Capacitor; 2 Leads
Header, 6-Pin, Dual row		HDR2X6_CEN	1	P1	Connector; Header; 6x2 Position
Transistor PNP Silicon	BC560C	29-04	1	Q1	T0, Flat index; 3 in-line; Axial Leads; Body Dia. 4.8mm; Leads 0.48 x 0.5 mm (max)
Transistor NPN Silicon	BC550C	29-04	1	Q2	T0, Flat index; 3 in-line; Axial Leads; Body Dia. 4.8mm; Leads 0.48 x 0.5 mm (max)
Resistor	12K	AXIAL-0.4	2	R1, R2	Resistor; 2 Leads

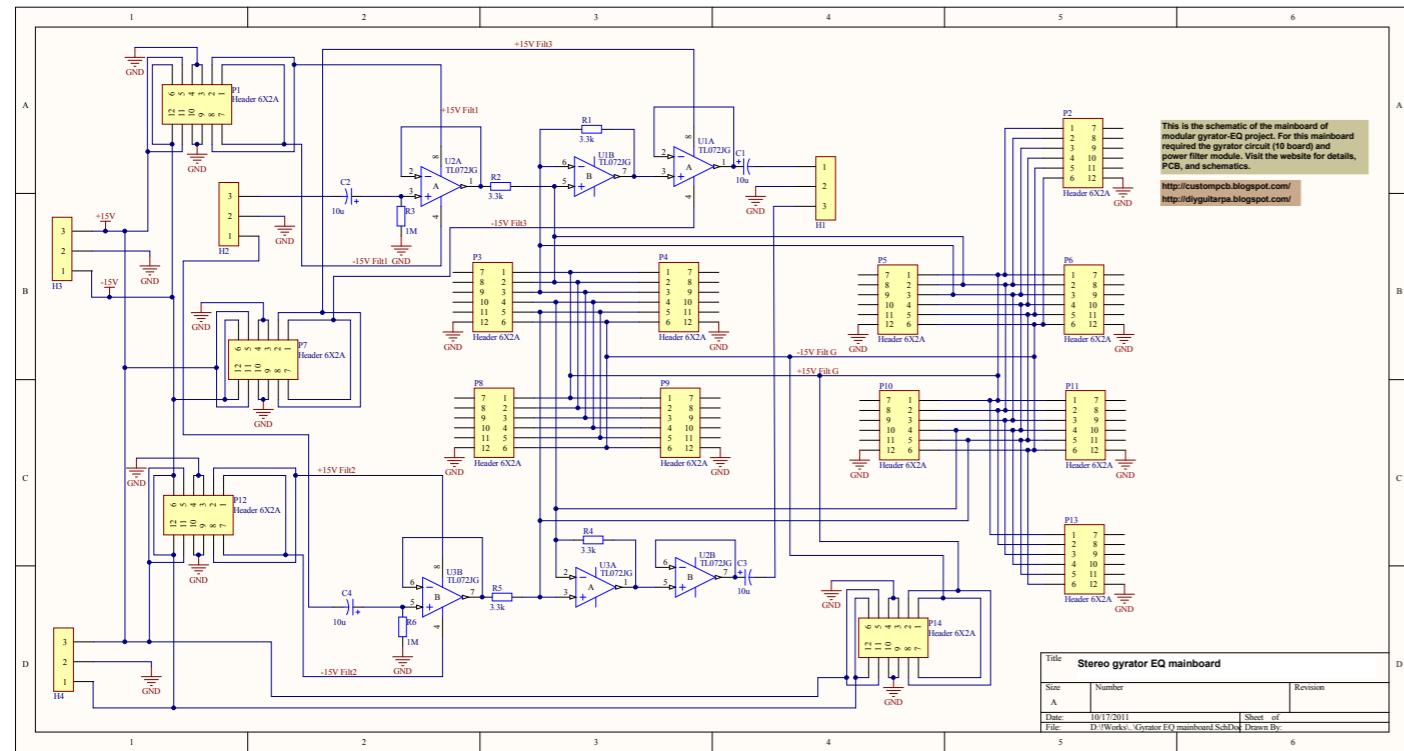
Notes

This module required for the EQ mainboard is the **power filter** circuit. I like to use this simple circuit to filter the problems of power. These circuits have to be connected to the headers of mainboard. These modules required for better power and less noise, but if you think this is not important, you can wire pin 8 to pin 11 and pin 7 to pin 12 to ignore these circuits and boards.

We have three versions of power filter PCB. No difference between schematics, the one of them is landscape, the another two is portrait orientation on PCB.

Schematics and Bill of Materials for gyrator EQ project

10 channel gyrator EQ mainboard



Printed Circuit

Boards for gyrator

EQ project

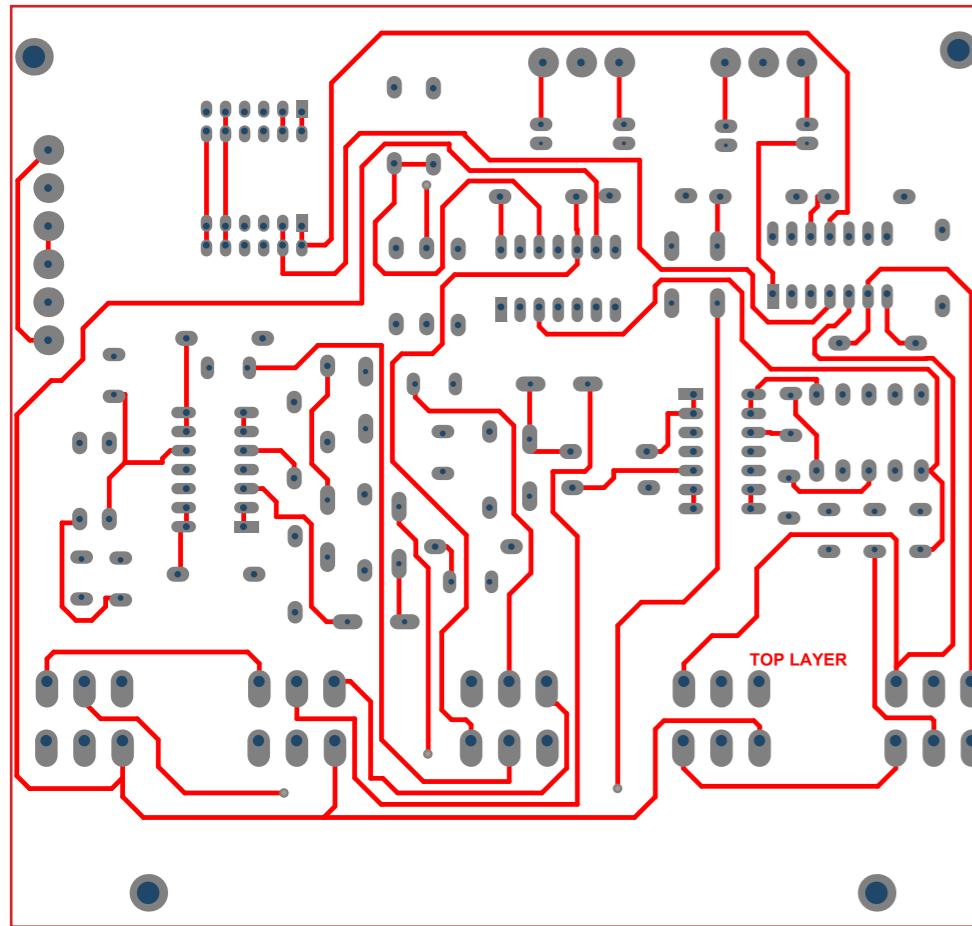
Description	Value	Quantity	Comment	Designator	Footprint	Model:Footprint
Polarized Capacitor (Radial)	10u	4	Cap Pol1	C1, C2, C3, C4	Cap, Tantal, 1mil	
		4	Connector	H1, H2, H3, H4	Panel Connector 3 input Small	
Header, 6-Pin, Dual row		14	Header 6X2A	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10, P11, P12, P13, P14	HDR2X6_CEN	Connector, Header, 6x2 Position
Resistor	3.3k	4	Res2	R1, R2, R4, R5	AXIAL-0.4	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Resistor	1M	2	Res2	R3, R6	AXIAL-0.4	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
Low-Noise JFET-Input Op	3	TL072JG		U1, U2, U3	dip-8	DIP; 8 Leads; Row Spa

Notes

This is the **mainboard for modular gyrator EQ**. The mainboard contains required circuits and headers to connect gyrator modules, potentiometers, and power filters. The finalized EQ can work with several frequencies and Q-s, and you can **choose two versions of gyrator modules, one for stereo solutions with only one stereo adjustable resistors, the second is two separated mono resistors for all bands for instrument amplifications**. Look at the difference on the PCB section.

PCB for the simple EQ project

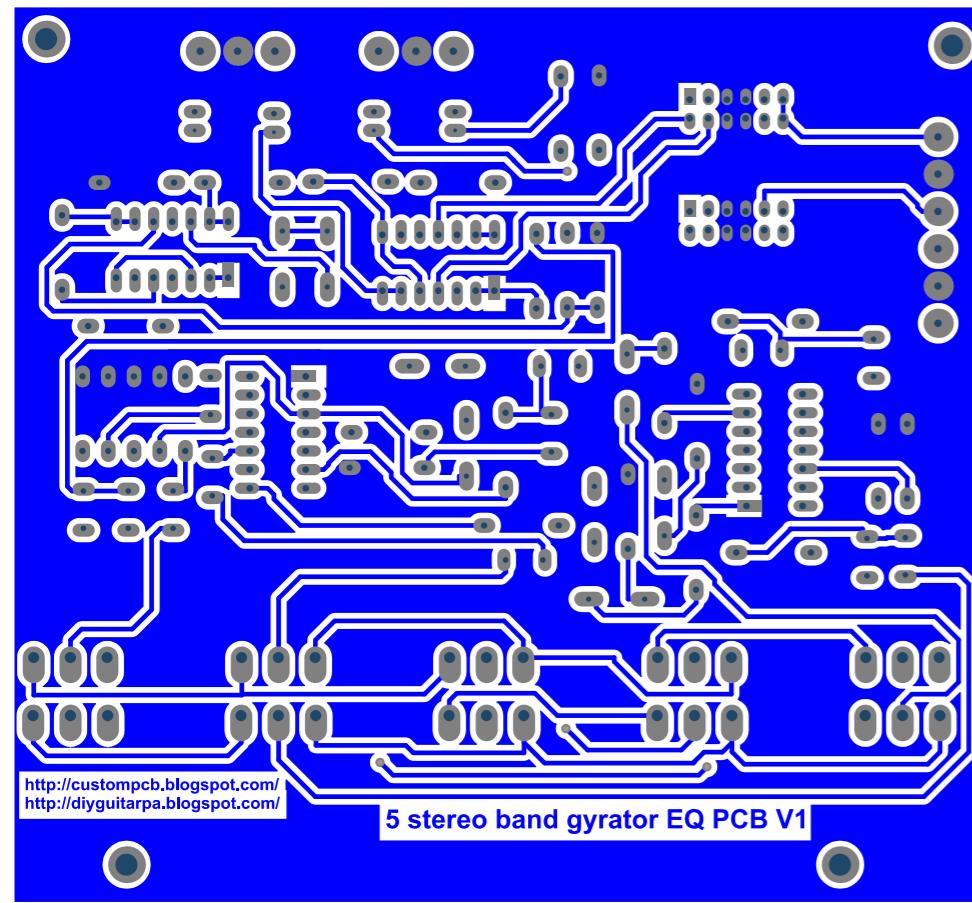
Top and bottom PCBs and overlay of simple 5 band EQ



TOP LAYER

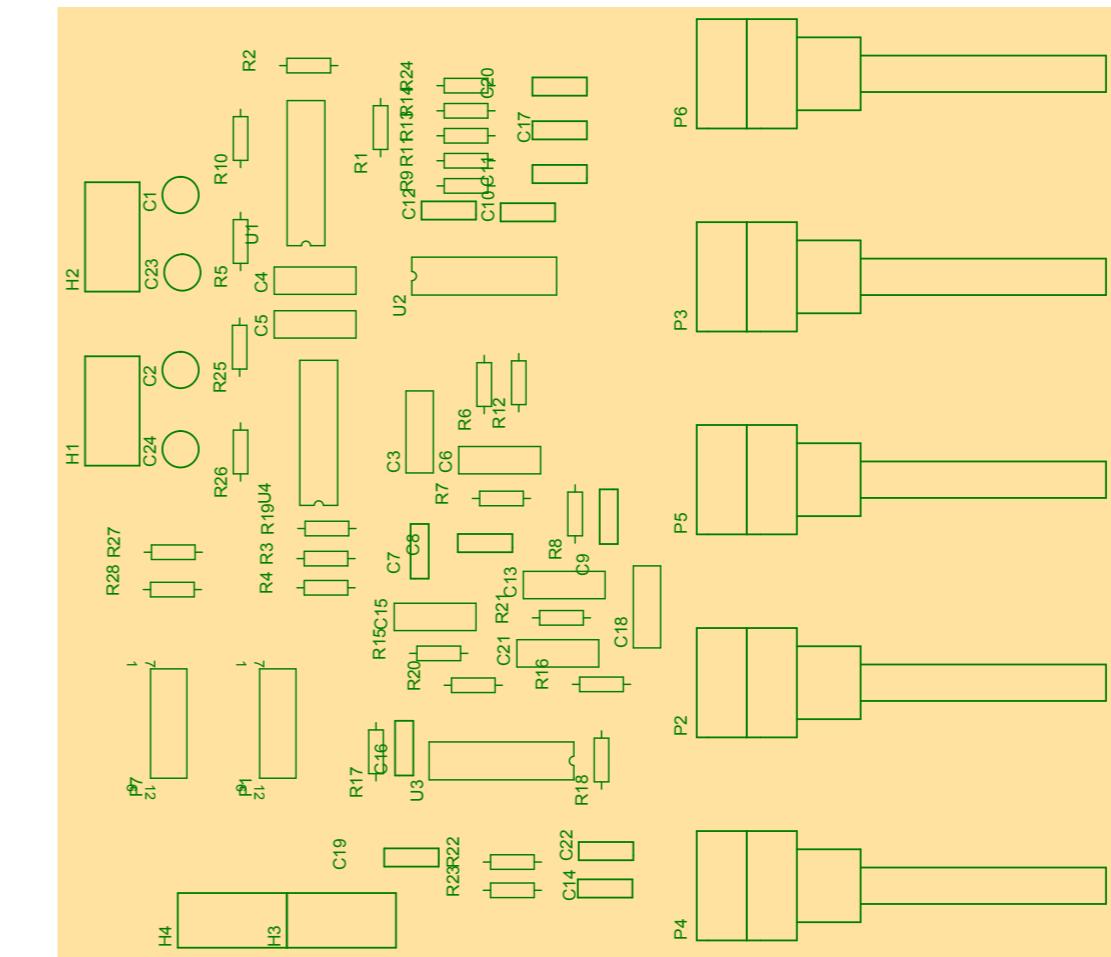
Notes

This is the **simplest** "all in one" 5 band EQ PCB. Very simple, low noise circuit for home hi-fi users. If you want more band, check the modular version of this project to insert any type of gyrator modules to the mainboard.

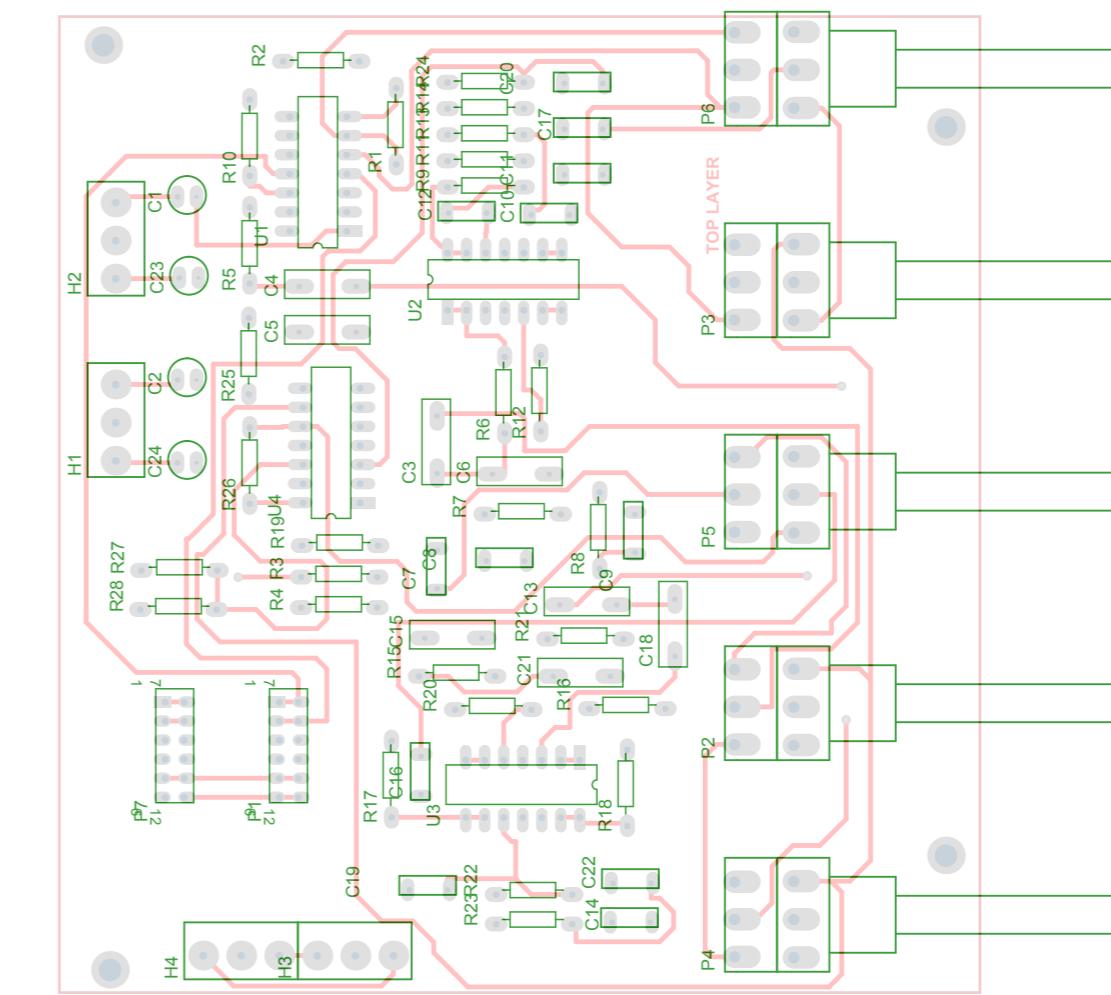


<http://custompcb.blogspot.com/>
<http://diyguitarpa.blogspot.com/>

5 stereo band gyrator EQ PCB V1



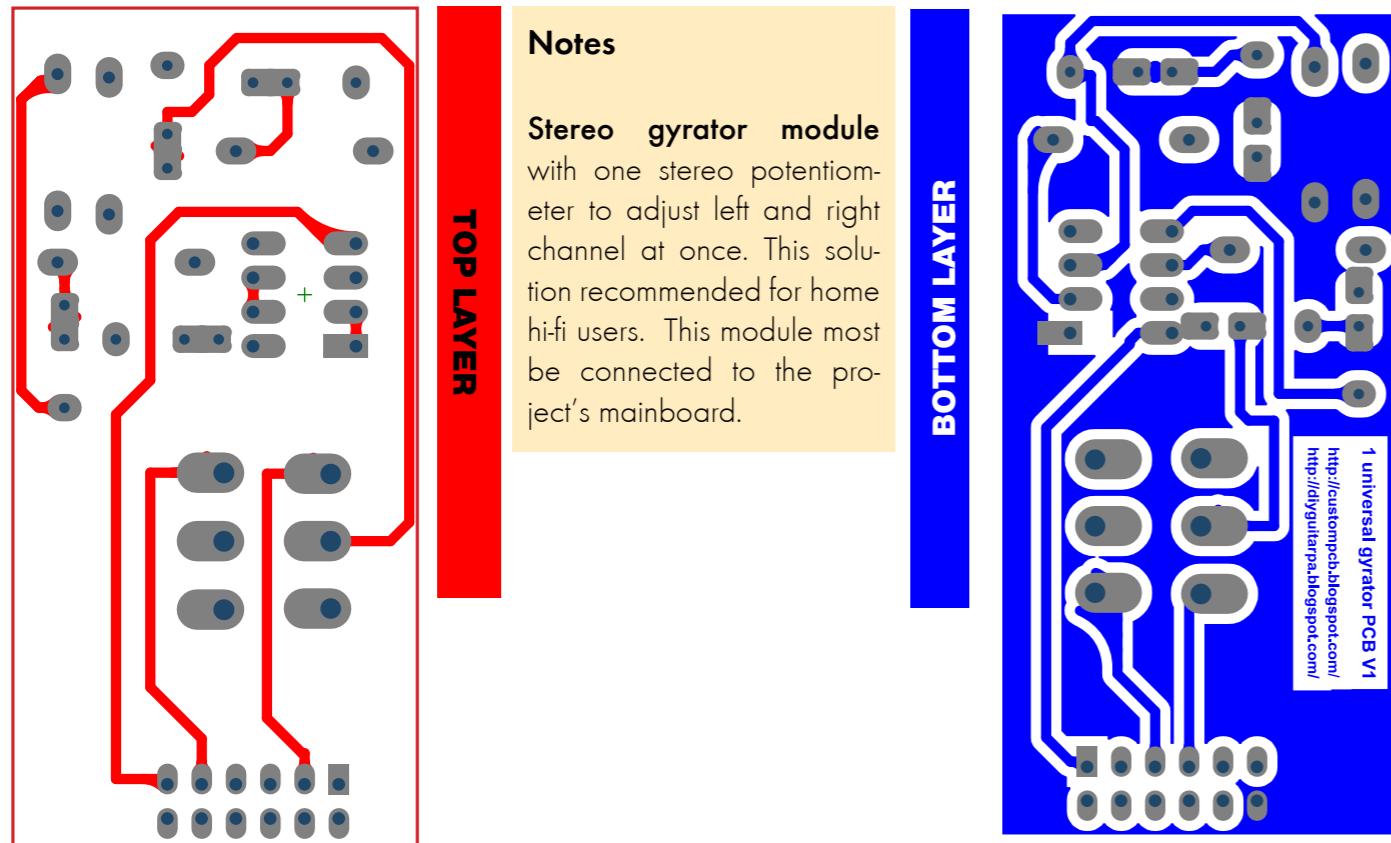
PCB TOP OVERLAY



TOP OVERLAY ON TOP LAYER

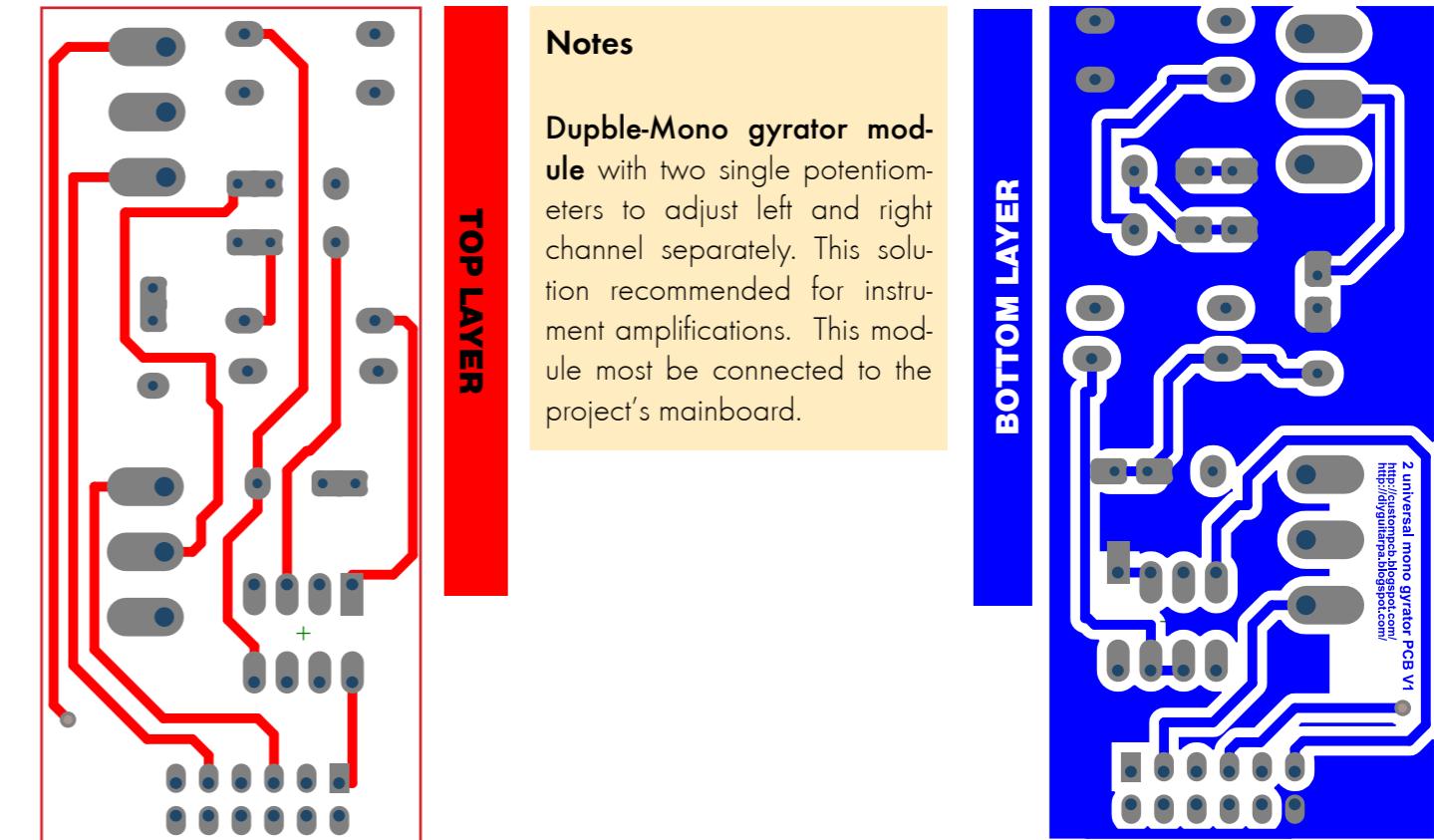
PCB for the modular EQ project

Top and bottom PCBs and overlay of stereo gyrator module

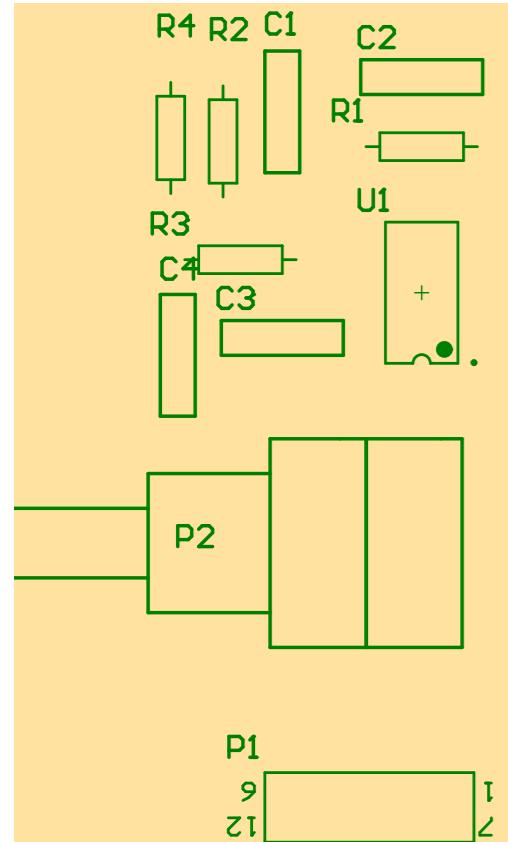


PCB for the modular EQ project

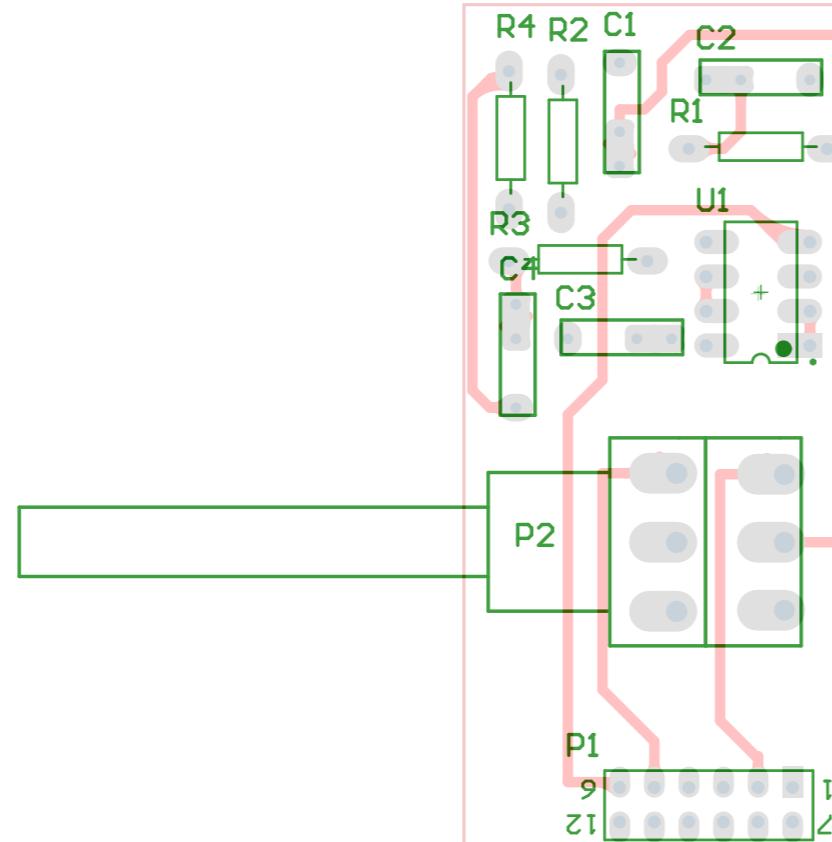
Top and bottom PCBs and overlay of 2 mono gyrator module



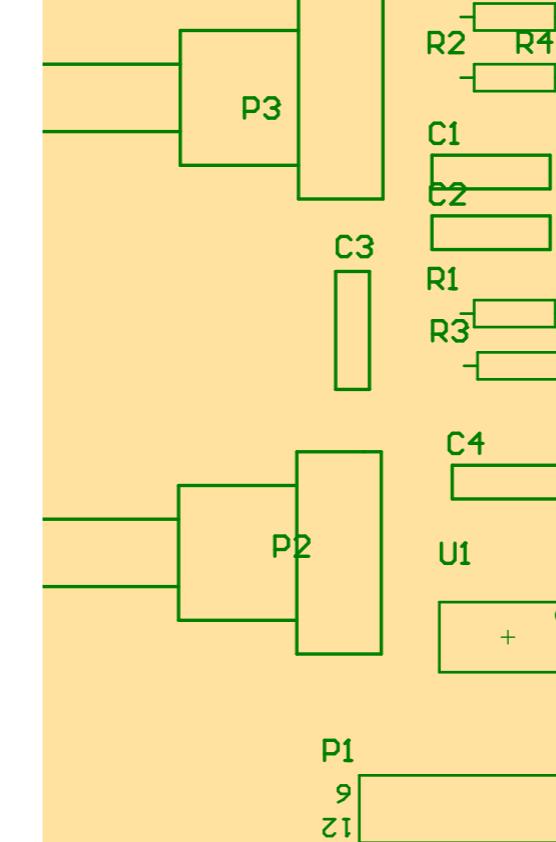
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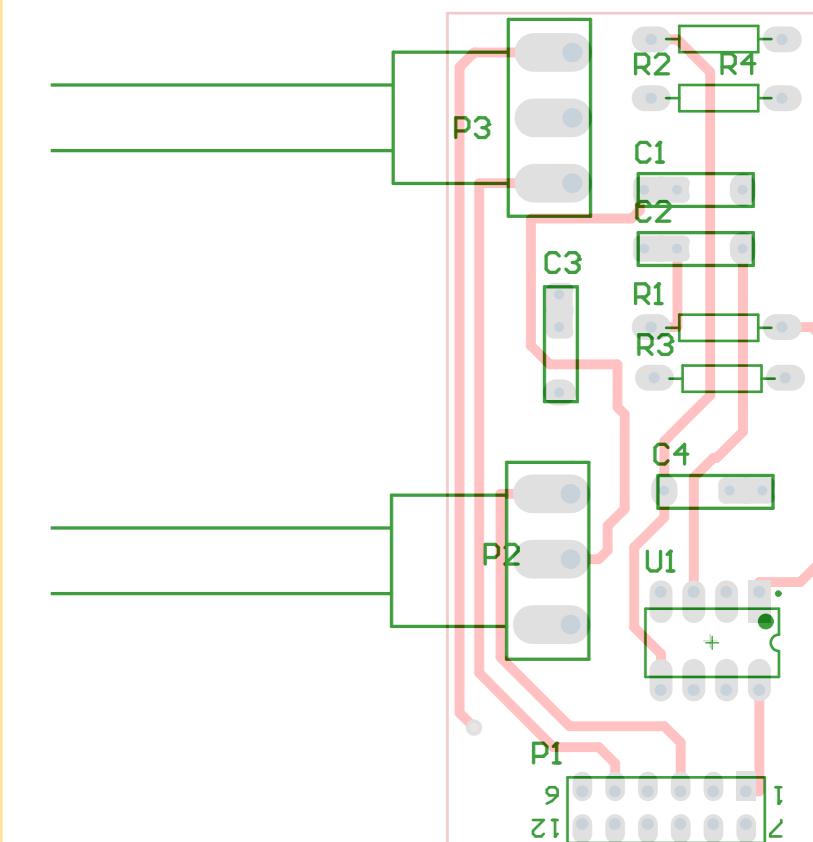
TOP OVERLAY ON TOP LAYER



PCB TOP OVERLAY

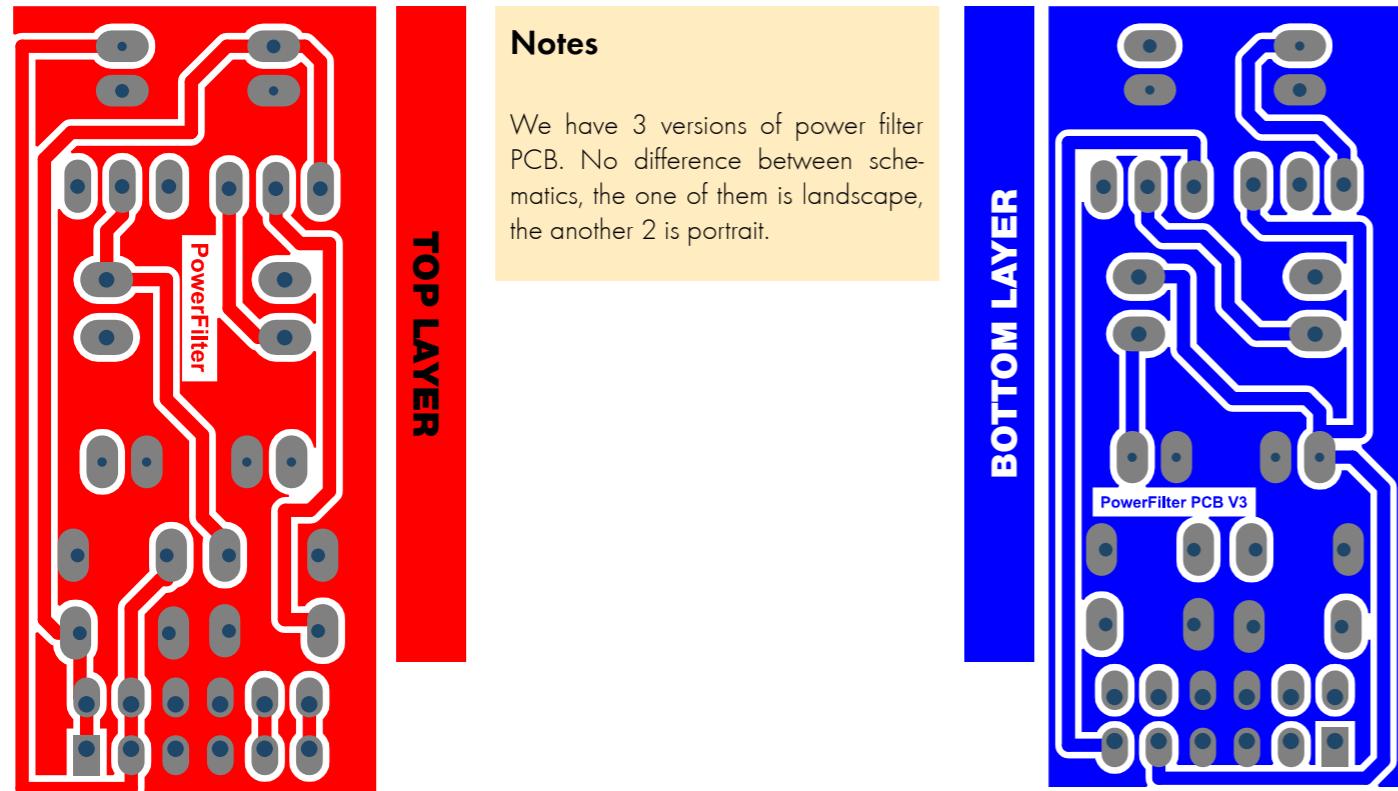


TOP OVERLAY ON TOP LAYER

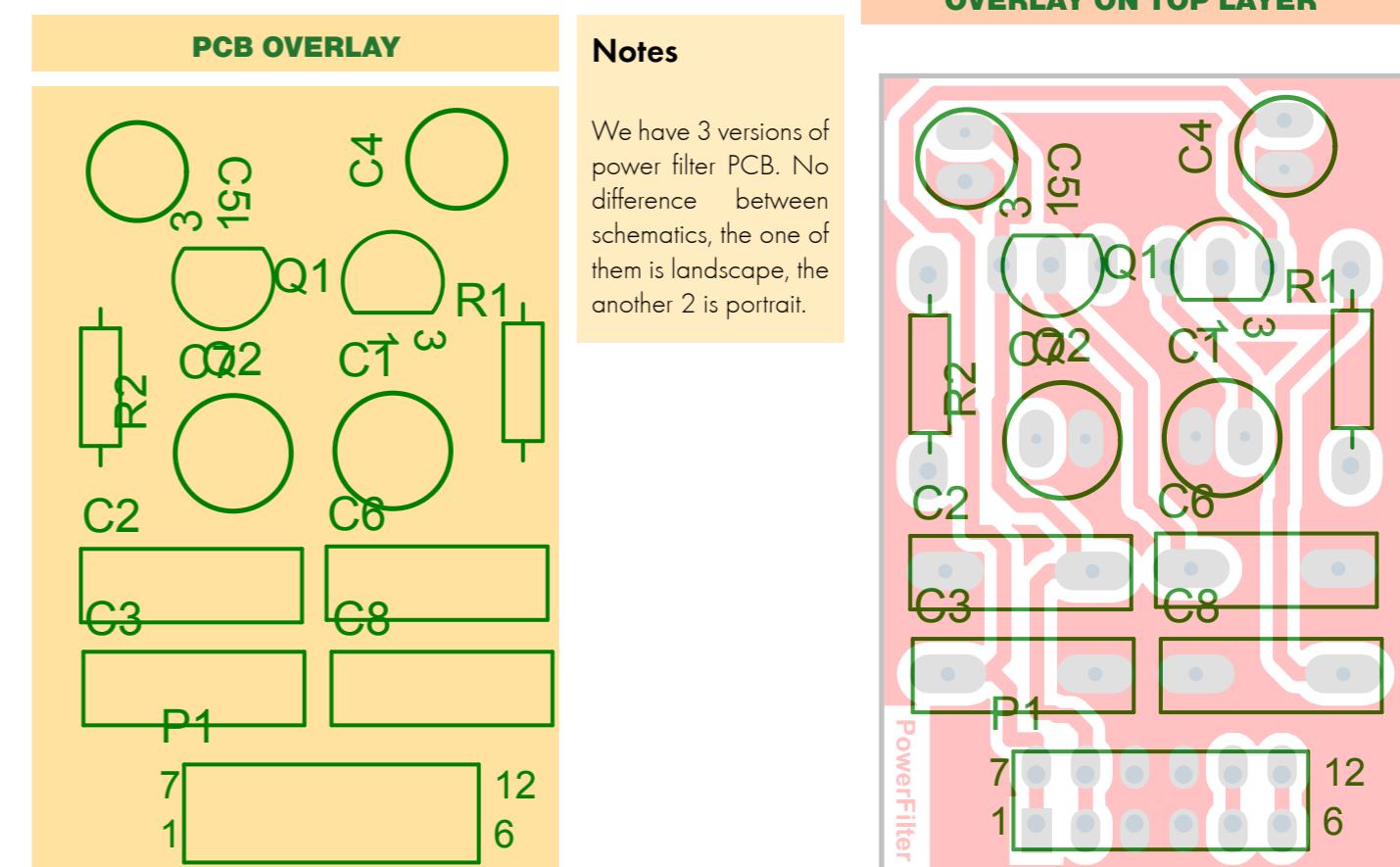
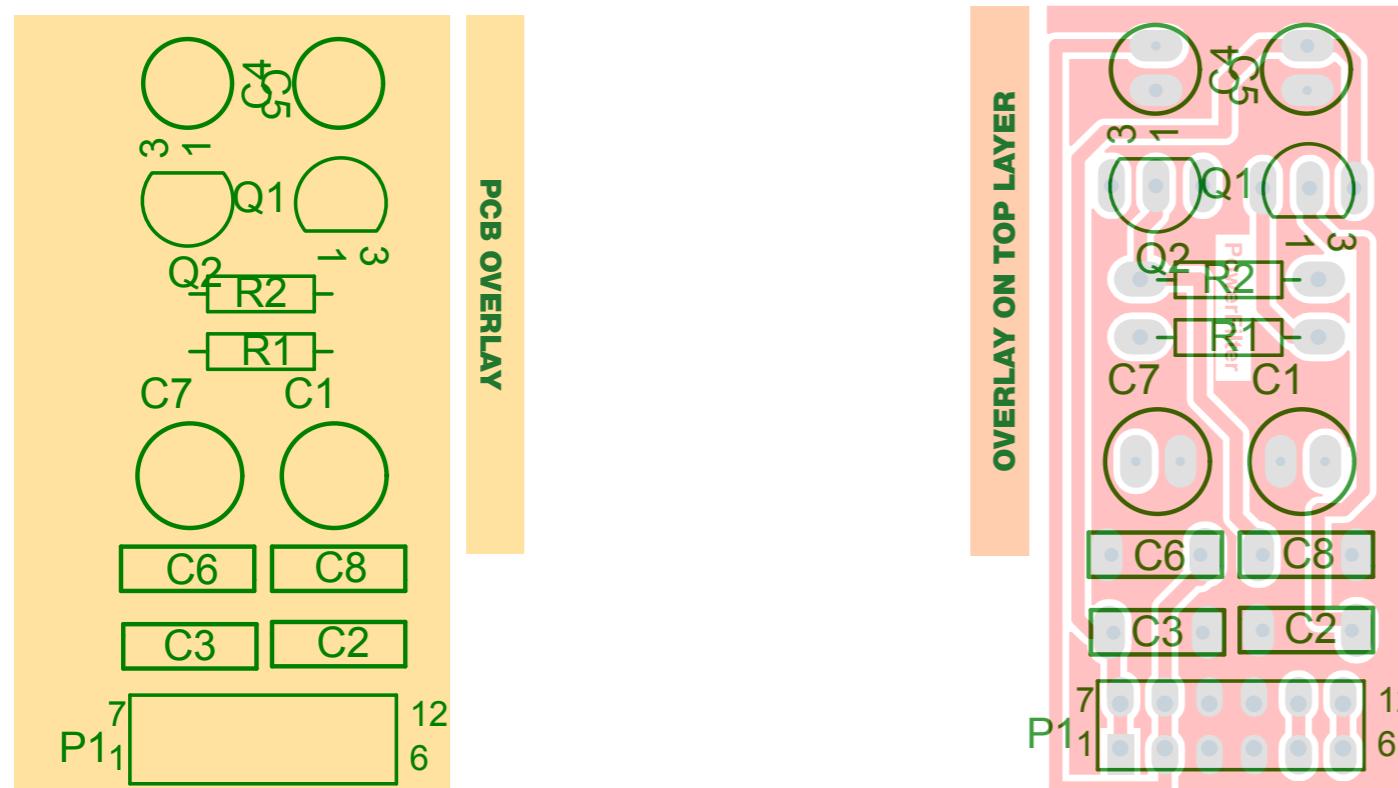
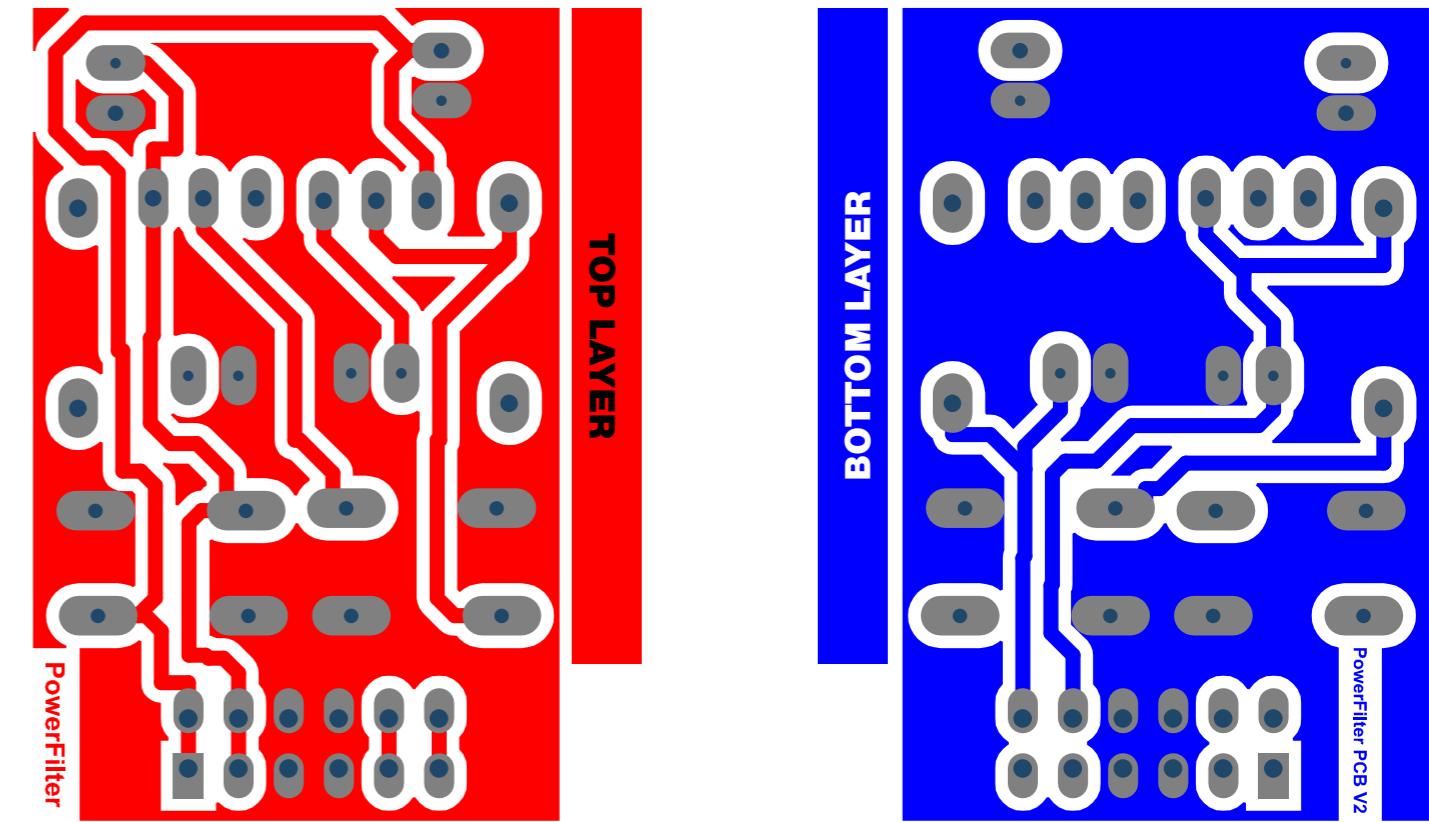


PCB for the modular EQ project

Top and bottom PCBs and overlay of power filters (ver.3)

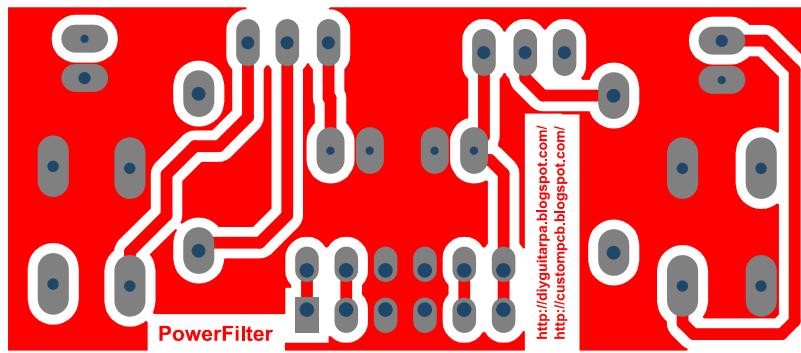
**PCB for the modular EQ project**

Top and bottom PCBs and overlay of power filters (ver.2)

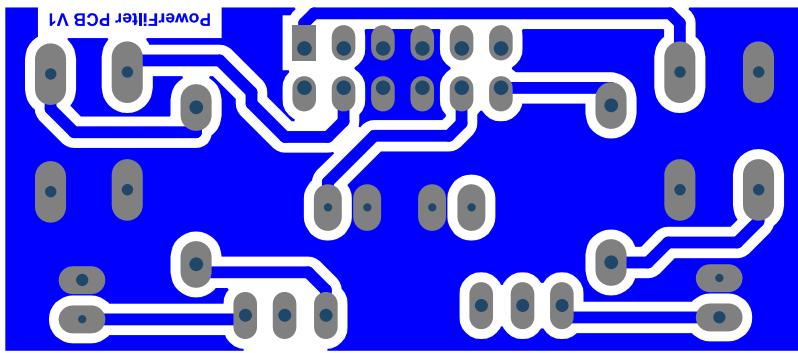


PCB for the module of Parametric EQ project

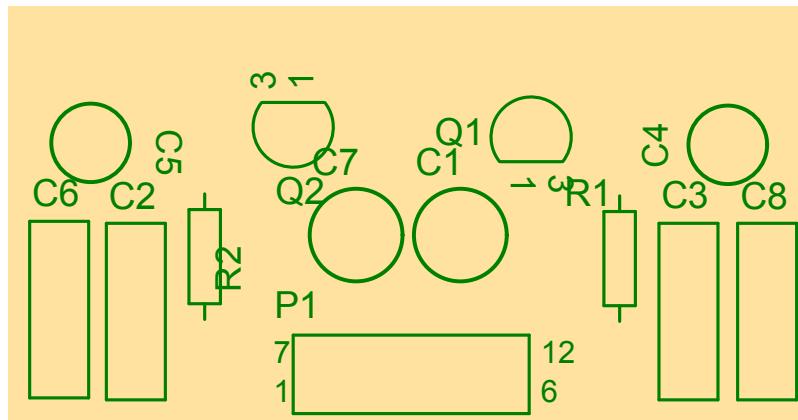
Top and bottom PCBs and overlay of power filters (ver.1)



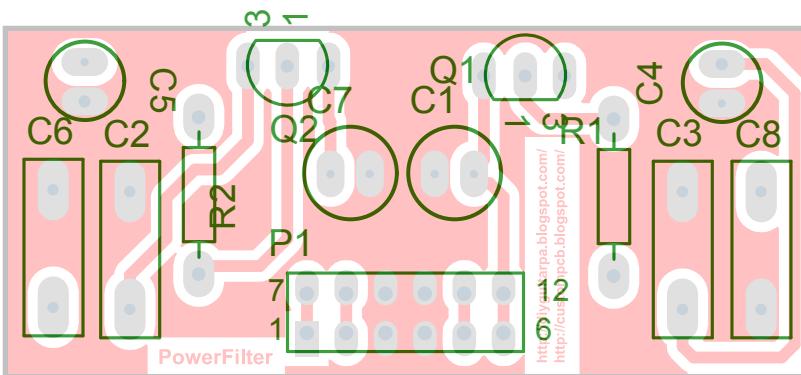
TOP LAYER



BOTTOM LAYER



PCB OVERLAY



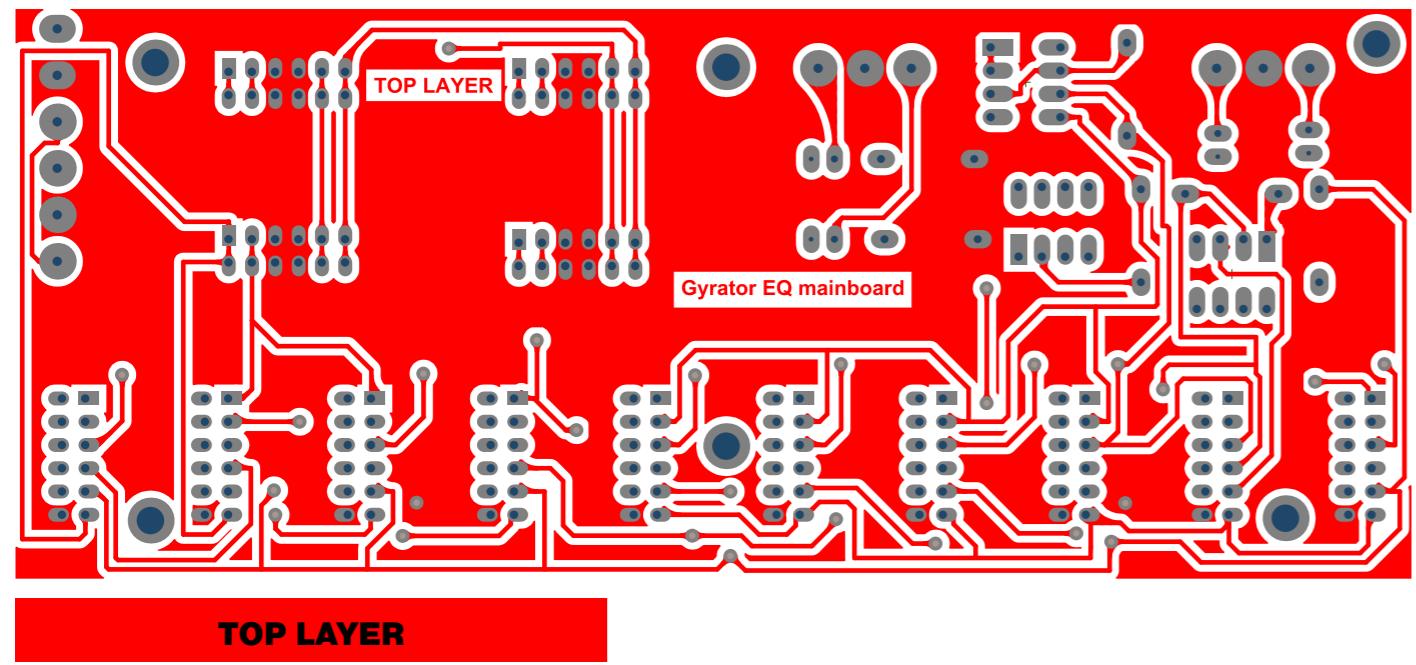
OVERLAY ON TOP LAYER

Notes

We have 3 versions of power filter PCB. No difference between schematics, the one of them is landscape, the another 2 is portrait.

PCB for the modular EQ project

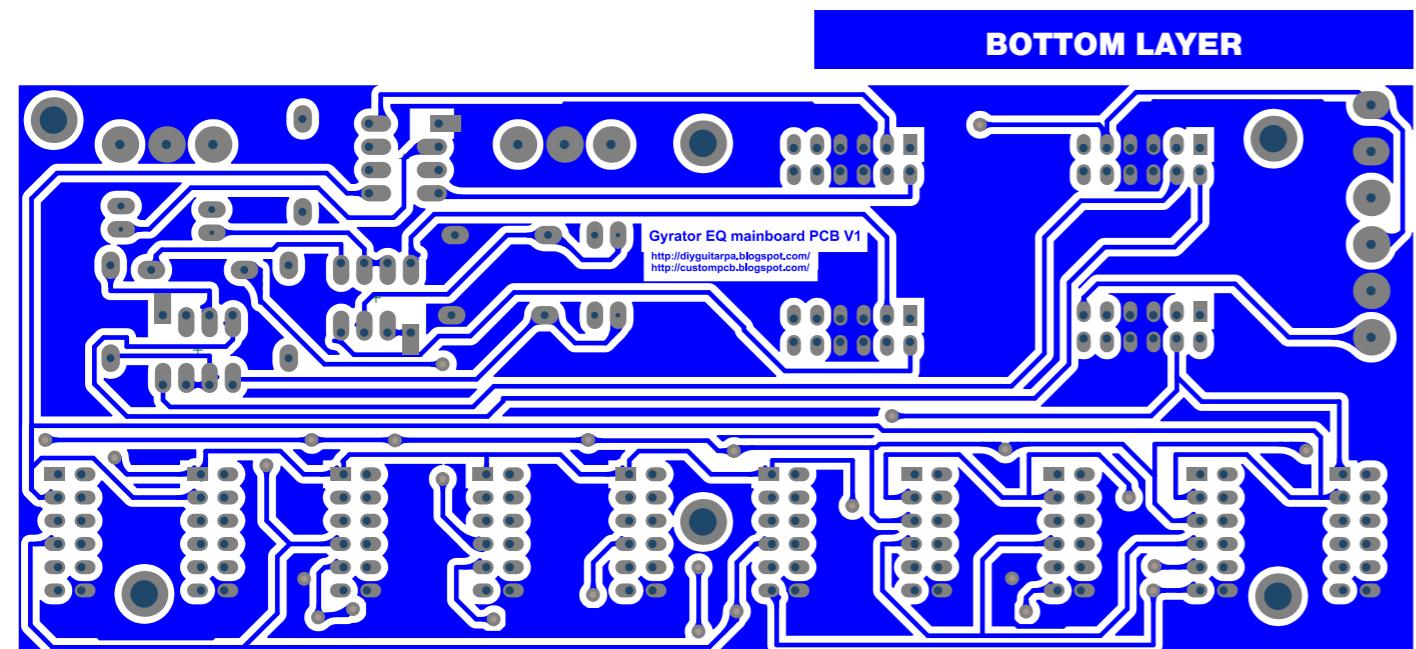
The mainboard of 10 band EQ for gyrators



TOP LAYER

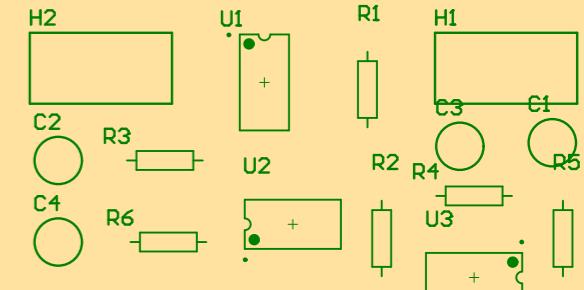
Notes

This is the mainboard for 10 band gyrator EQ. Gyrator modules and power filter modules required. The frequency, Q and cut/boost values depended on the parts of gyrator modules only. Look at the table on the gyrator's schematic page, and read the page about the math expressions.



BOTTOM LAYER

H3
H4



PCB OVERLAY

For 5 band EQ:

- 100Hz - 330n
- 300Hz - 100n
- 1kHz - 33n
- 3kHz - 10n
- 10kHz - 3.3n

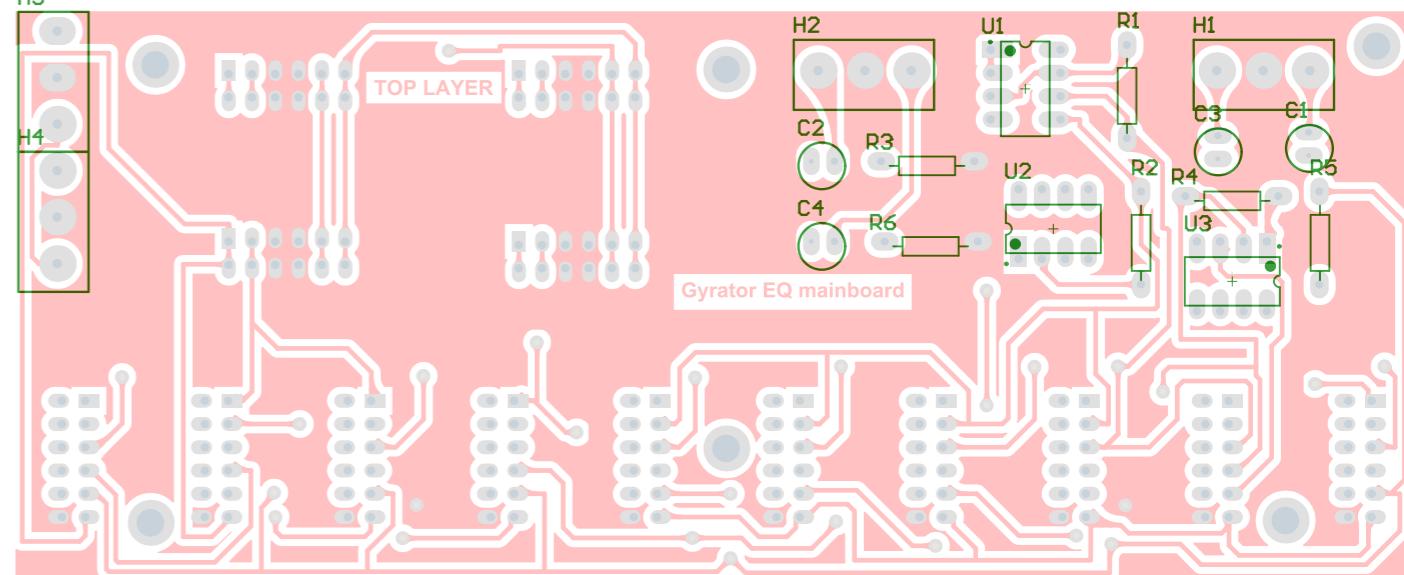
For 10 band EQ:

- Change all of the 50K adjustable resistors to 25K

Hz	C3	C4	R3	R4
31	6.8μ	100n	470Ω	100k
63	3.3μ	47n	390Ω	100k
125	1.5μ	33n	390Ω	100k
250	680n	22n	330Ω	82k
500	330n	10n	330Ω	100k
1K	150n	4.7n	330Ω	100k
2K	100n	2.2n	330Ω	82k
4K	56n	1n	390Ω	82k
8K	22n	470p	390Ω	82k
16K	10n	220p	390Ω	100k

The values of R3 is same as R1, the R2 is same as R4. Also look the math expressions for another examples.

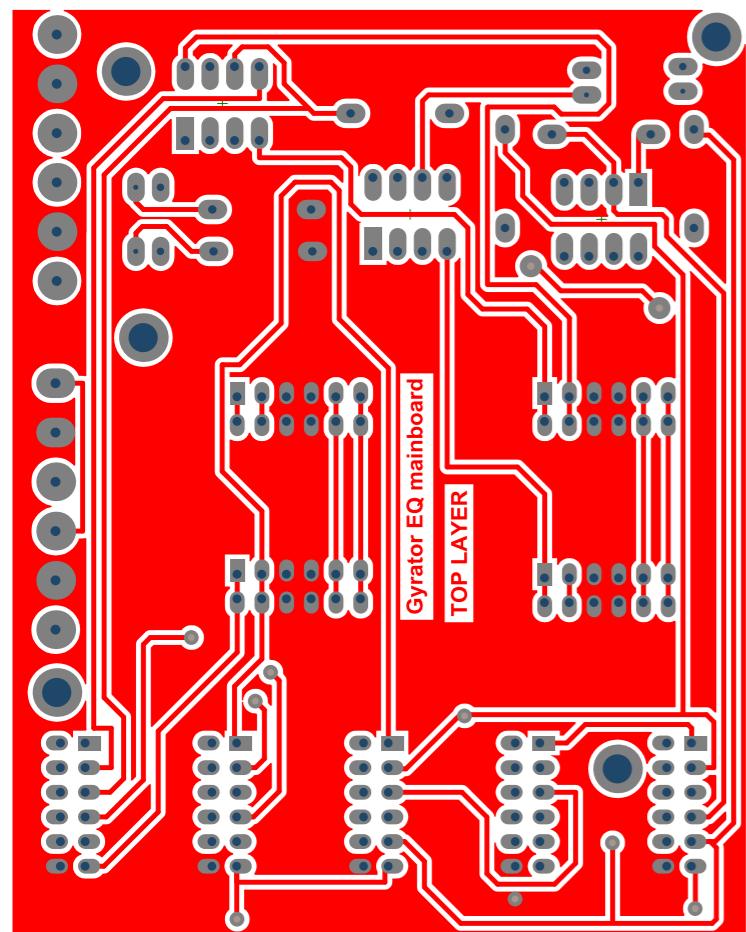
H3
H4



OVERLAY ON TOP LAYER

PCB for the modular EQ project

The mainboard of 5 band EQ for gyrators



TOP LAYER

For 5 band EQ:

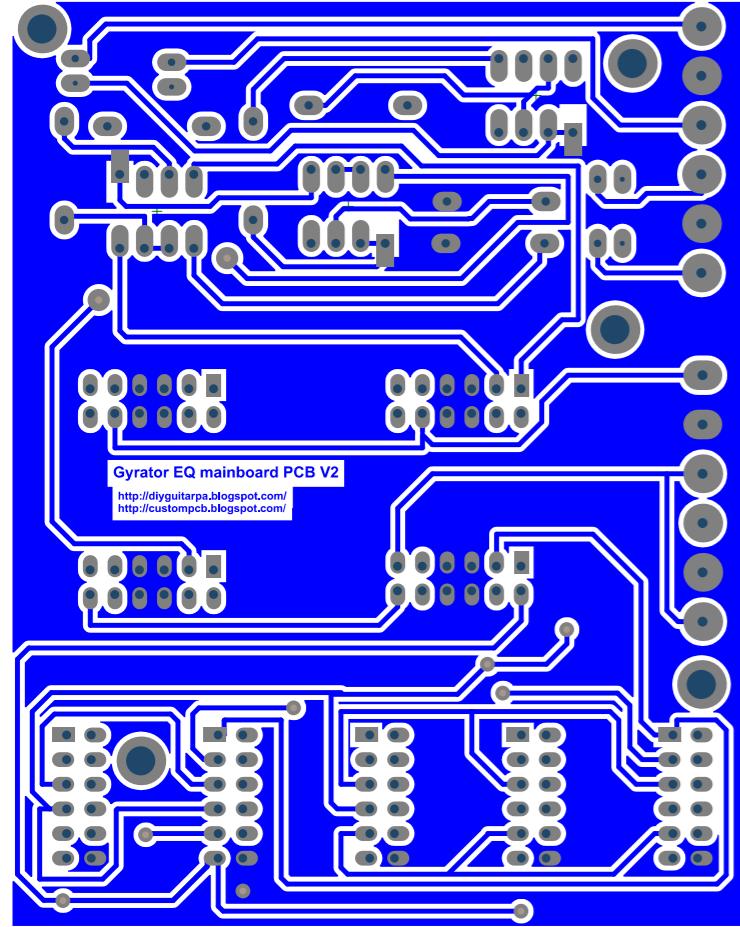
- 100Hz - 330n
- 300Hz - 100n
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For 10 band EQ:

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Hz	C3	C4	R3	R4
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500	330n	10n	330 Ω	100k
1K	150n	4.7n	330 Ω	100k
2K	100n	2.2n	330 Ω	82k
4K	56n	1n	390 Ω	82k
8K	22n	470p	390 Ω	82k
16K	10n	220p	390 Ω	100k

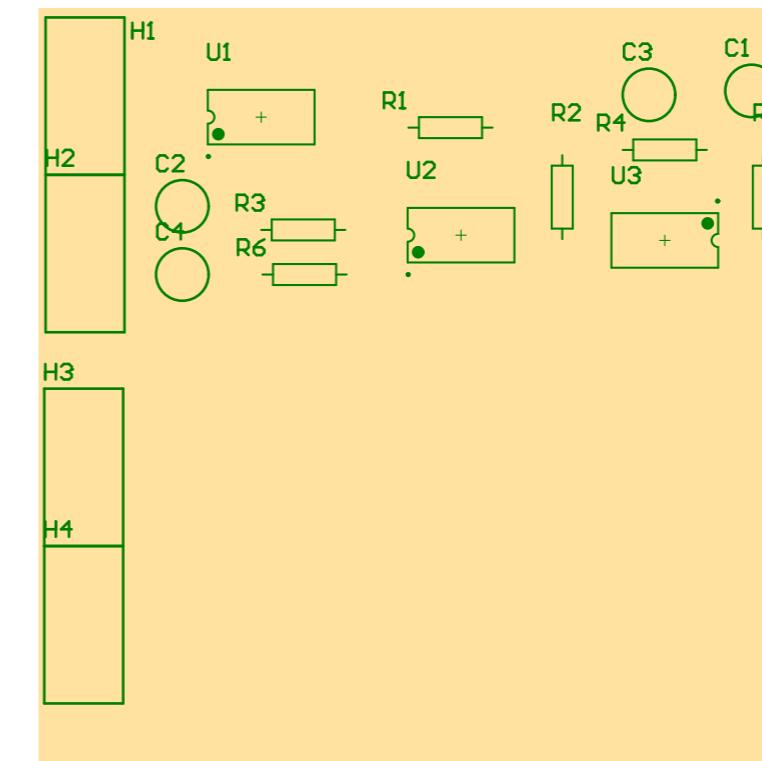
The values of R3 is same as R1, the R2 is same as R4. Also look the math expressions for another examples.



BOTTOM LAYER

Notes

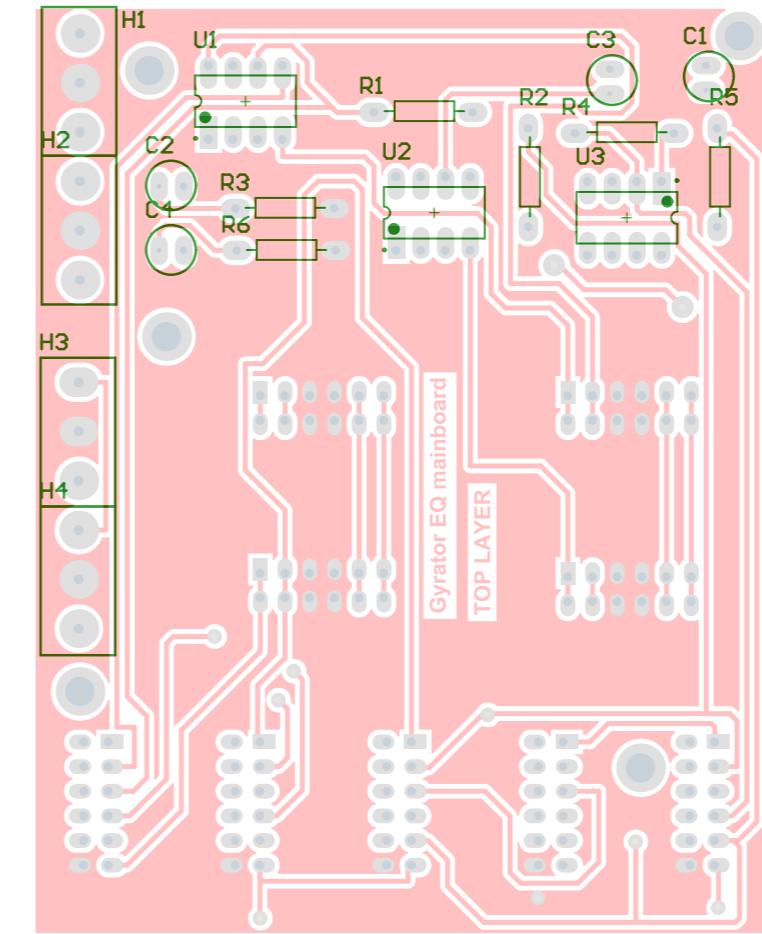
This is the mainboard for 5 band gyrator EQ. Gyrator modules and power filter modules required. The frequency, Q and cut/boost values depended on the parts of gyrator modules only. Look at the table on the gyrator's schematic page, and read the page about the math expressions.



PCB OVERLAY

Notes

This is the **mainboard for modular gyrator EQ**. The mainboard contains required circuits and headers to connect gyrator modules, potentiometers, and power filters. The finalized EQ can work with several frequencies and Q-s, and you can choose two versions of gyrator modules, one for stereo solutions with **only one stereo adjustable resistors**, the second is **two separated mono resistors for all bands for instrument amplifications**. Look at the difference on the PCB section.

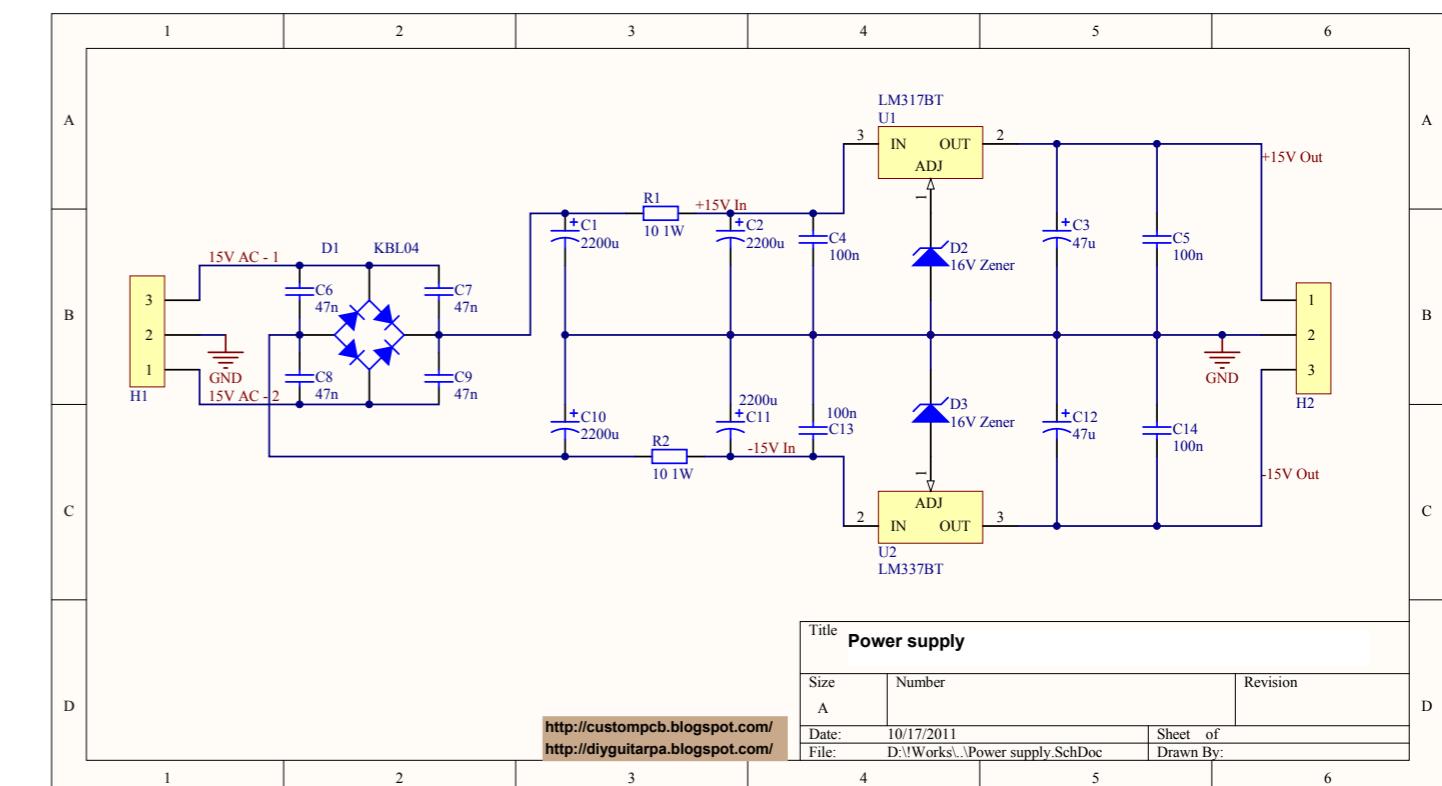


OVERLAY ON TOP LAYER

The power supply for all gyrator EQ projects

Schematics and Bill of Materials for all EQ project

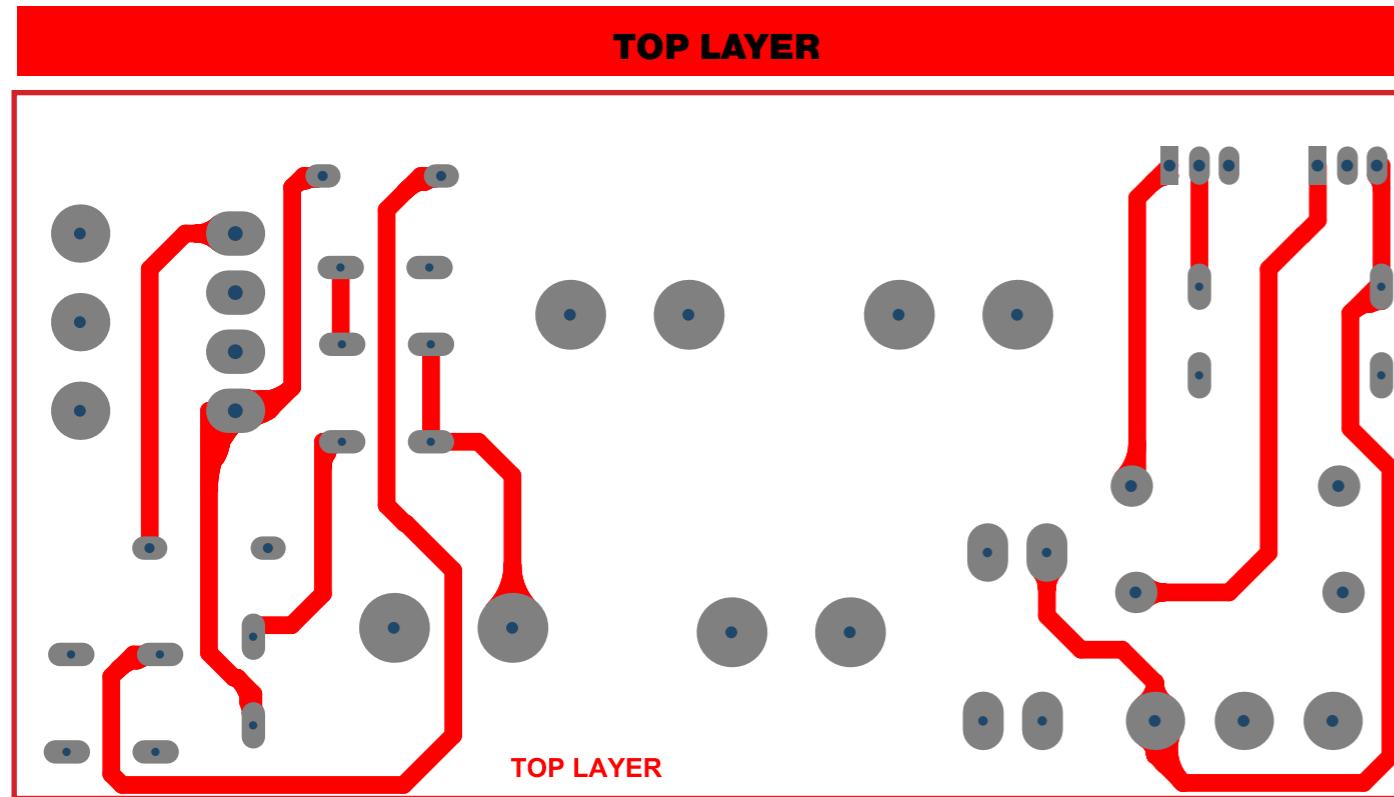
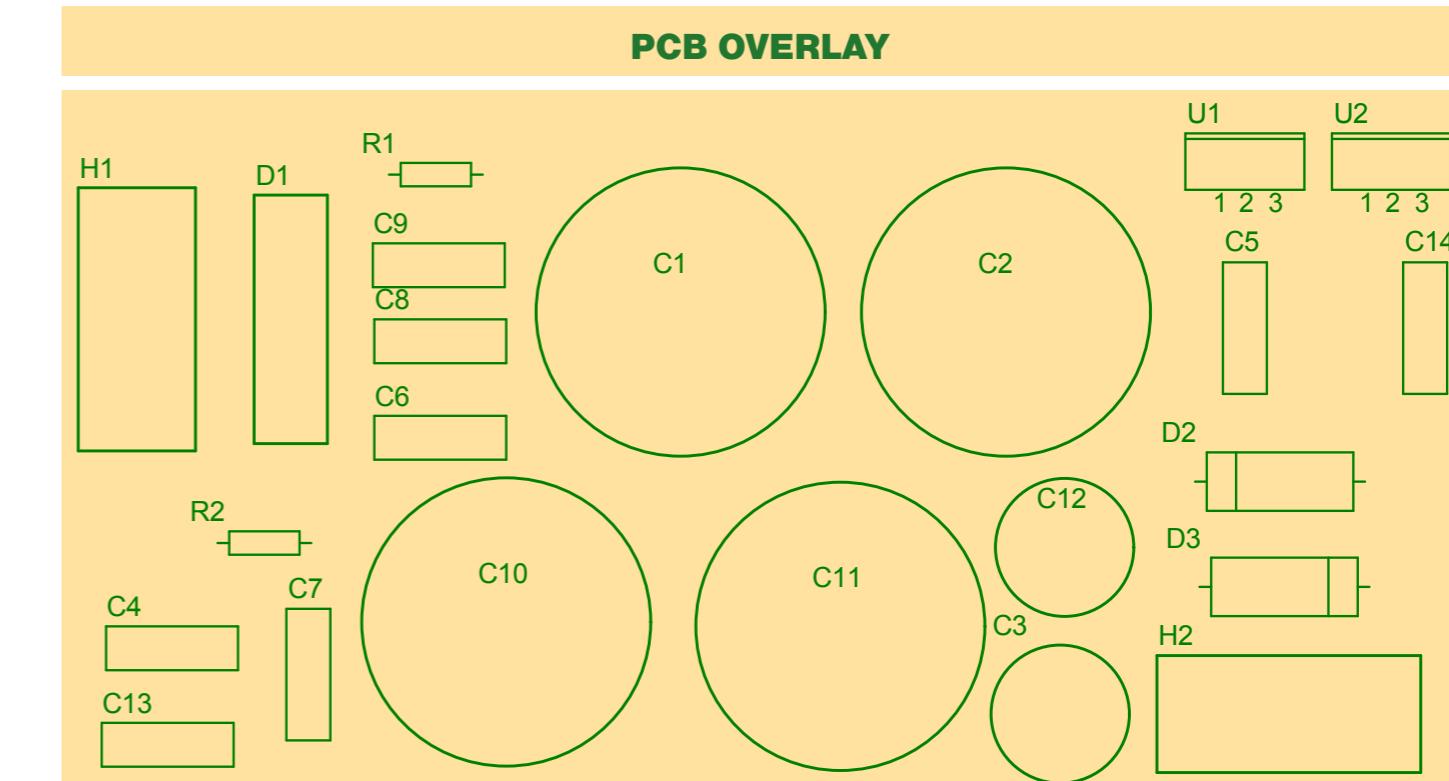
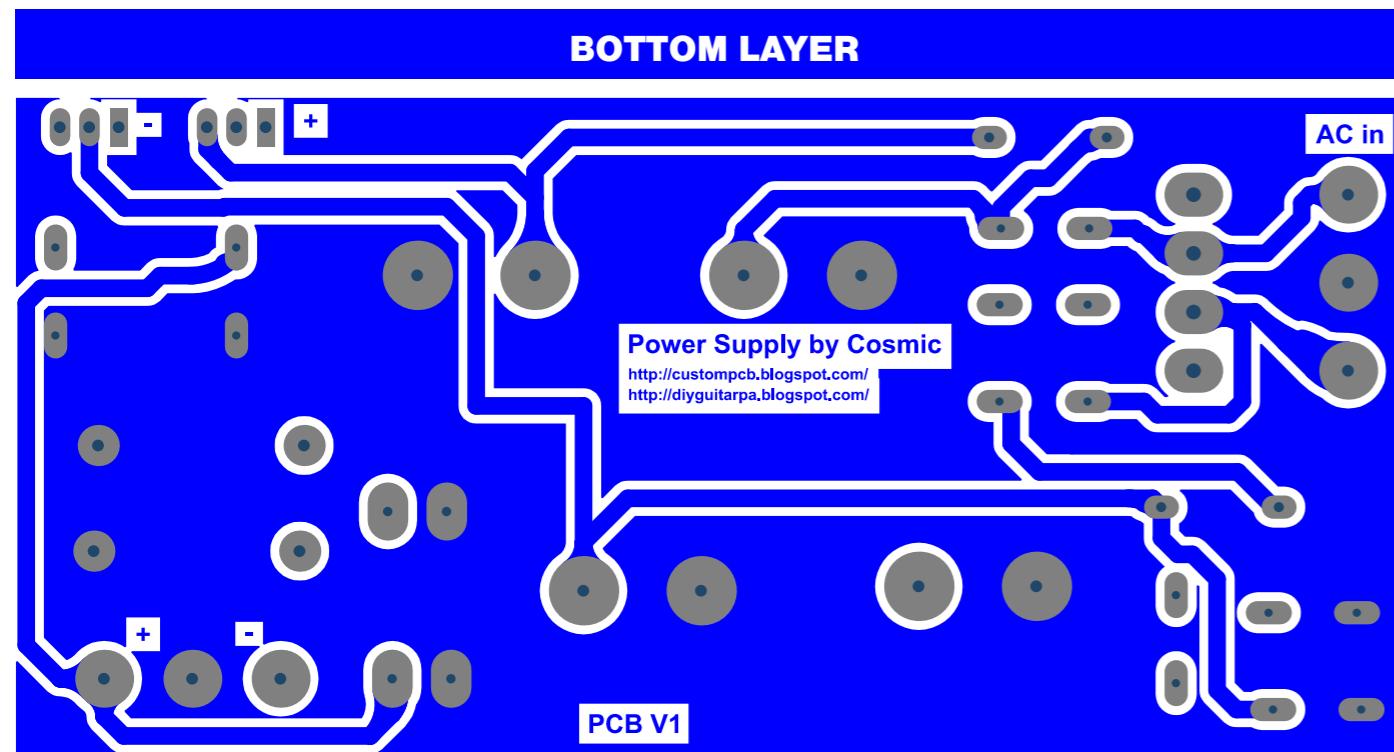
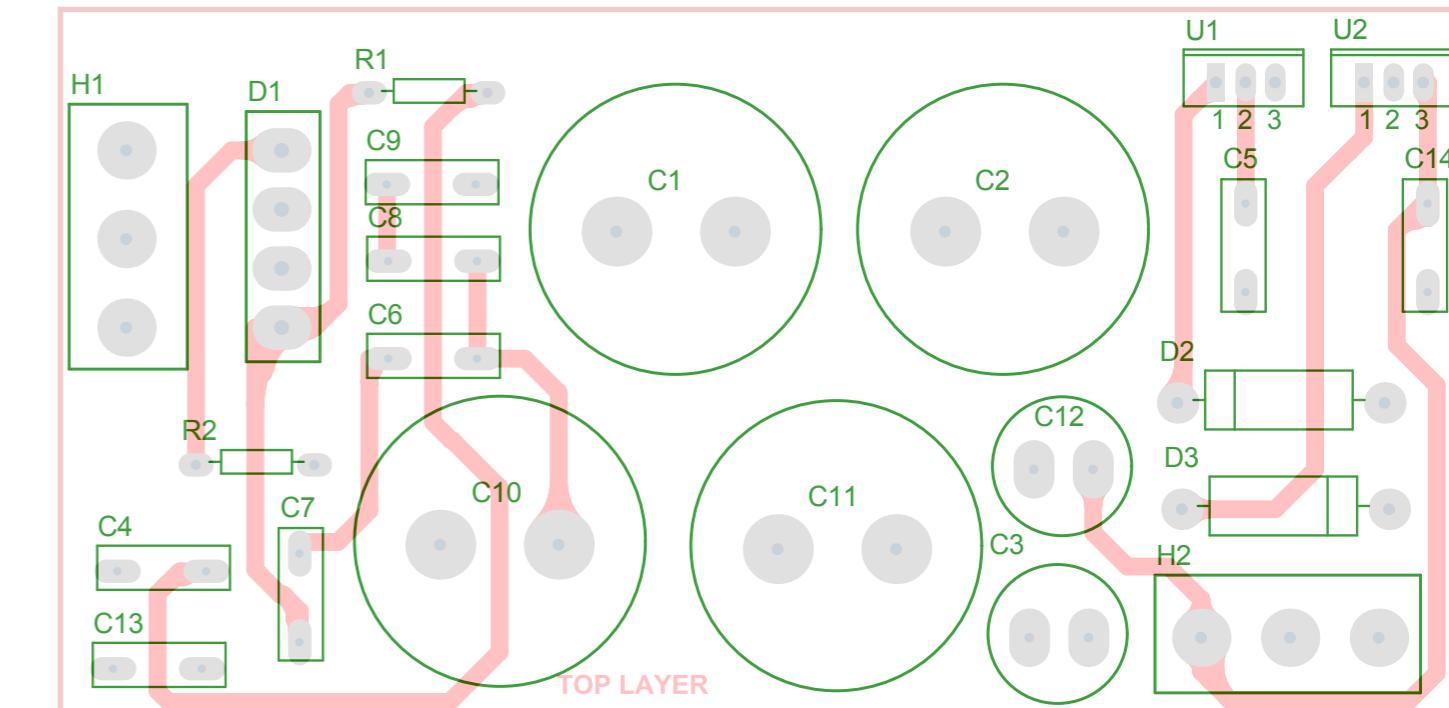
Schematic and BOM of power supply



Description	Comment	Quantity	Value	Footprint	Designator	Model:Footprint
Polarized Capacitor (Radial)	Cap Pol1	4	2200u	ELCO 22 MM 4 MIL	C1, C2, C10, C11	
Polarized Capacitor (Radial)	Cap Pol1	2	47u	Elco 12 mm, 2 mil pins	C3, C12	
Capacitor	Cap	4	100n	RAD-0.3	C4, C5, C13, C14	Radial Cap, Thru-Hole; 2 Leads; 0.3 in Pin Spacing
Capacitor	Cap	4	47n	RAD-0.3	C6, C7, C8, C9	Radial Cap, Thru-Hole; 2 Leads; 0.3 in Pin Spacing
Full Wave Diode Bridge	KBL04	1		Bridge hor.	D1	
Zener Diode	16V Zener	2		DIODE-0.7	D2, D3	Diode, Thru-Hole; 2 Leads; 0.7 in Pin Spacing
	Connector	2		panel connector 3 input big	H1, H2	3 pin, 3 mil connector
Resistor	Res2	2	10 1W	AXIAL-0.4	R1, R2	Axial Device, Thru-Hole; 2 Leads; 0.4 in Pin Spacing
3-Terminal Adjustable Positive Voltage Regulator	LM317BT	1		221A-04	U1	TO, Thru-Hole, Vertical, Heatsink Mounted; 3 In-Line Leads; Pitch 2.54 mm
3-Terminal Adjustable Negative	LM337BT	1		221A-04	U2	TO, Thru-Hole, Vertical, Heatsink Mounted; 3 In-Line Leads; Pitch 2.54 mm

PCB for all EQ project

The power supply PCB

TOP LAYER**PCB OVERLAY****BOTTOM LAYER****OVERLAY ON TOP LAYER**

Help for gyrator EQ designs

Articles and images about gyrator EQ projects

With this project, very important to inform about the adjustable EQ designs. Because the modules can be set to several adjustable values, maybe you need expressions to get the value of resistors or capacitors. Here is the page to help.

Useful links and articles:

[About Operator Adjustable Equalizers:](#)

- Equalizer History
- Industry Choices
- Terminology & Definitions
- Active & Passive
- Graphics & Parametrics
- Constant-Q & Proportional-Q
- Interpolating & Combining
- Phase Shift Examples

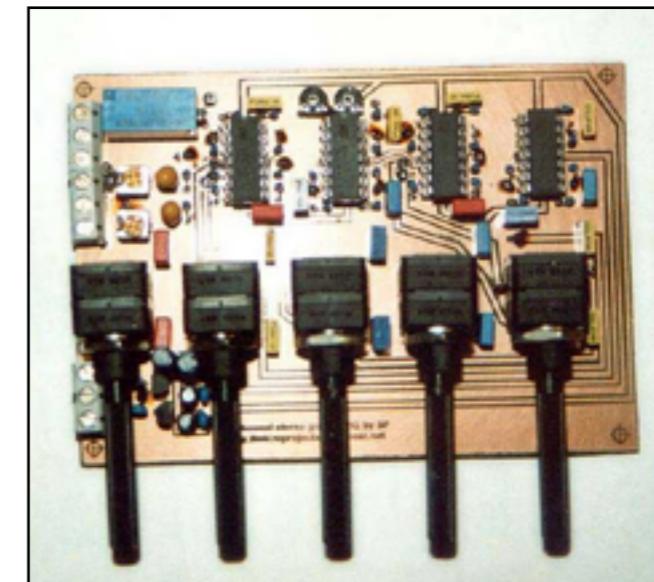
[Design aspects of equalizers with lots of expressions.](#)

[The Evolution of an EQ Design](#)

[Software for EQ filter design](#)

Images about this project:

- [The Picasa album of projects](#)
- [Prototype of 5 band and 10 band EQs](#)
- [The new PCBs of modular gyrator EQ](#)
- [PCBs and schematics of modular UREI clone parametric EQ project](#)
- [RSS channel of my Picasa gallery](#)



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Math expressions for gyrator design

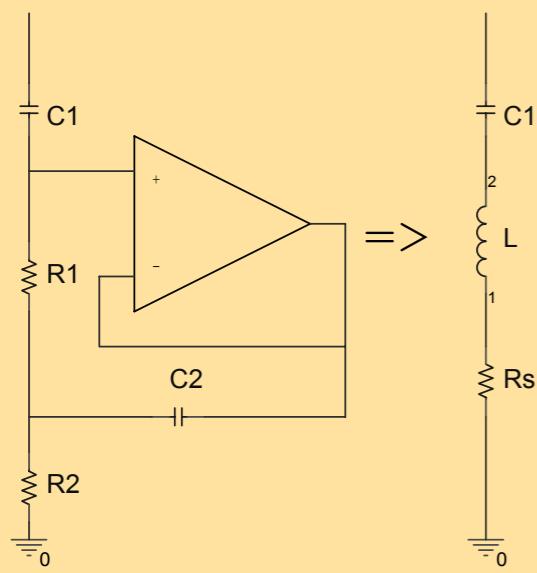


Figure 10: The gyrator

$$f_{\text{res}} = \frac{1}{2\pi\sqrt{C_1 \cdot C_2 \cdot R_1 \cdot R_2}} \quad R_s = R_1 + R_2 \quad L = C_2 \cdot R_1 \cdot R_2$$

There are at least two ways of making a capacitor act like an induction. One is called the gyrator, and one is called the active inductor. In the following the two circuits will be examined, and one will be chosen for this filter's EQ sections.

The Gyrator

The gyrator makes a nice RCL circuit. It gives symmetrical impedance (on a logarithmic scale) around the resonance frequency.

The symmetrical impedance makes it ideal for an equalizer.

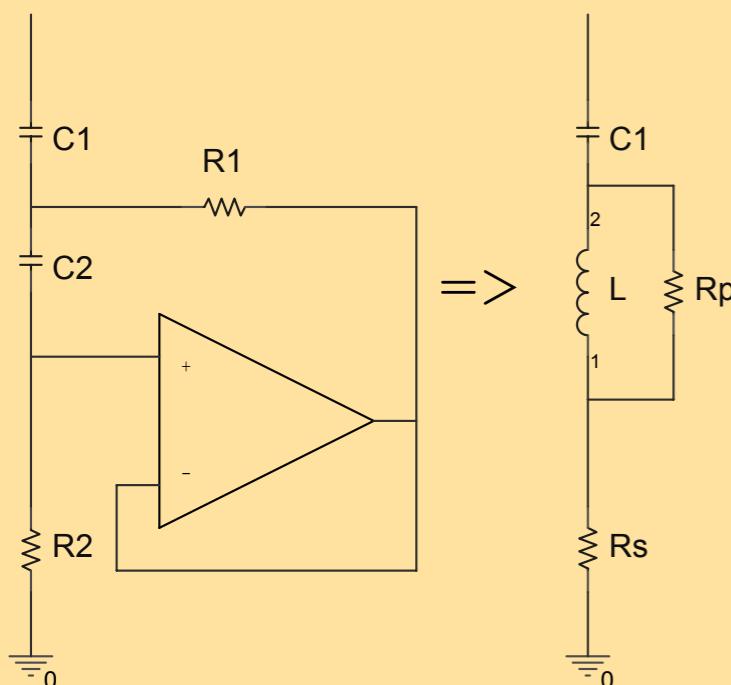


Figure 11: The active inductor

$$L = C_2 \cdot R_1 \cdot (R_2 - R_1) \quad R_s = R_1 \quad R_p = R_2 - R_1$$

The **active inductor** is actually just a Sallen and key HP filter drawn slightly differently. It too functions as a series connection between a capacitor and an inductor. The major difference is that the inductor has a parallel resistor. This parallel resistor makes the impedance of the circuit NON-symmetrical around the resonance frequency, thus making the circuit less suited for EQ's.

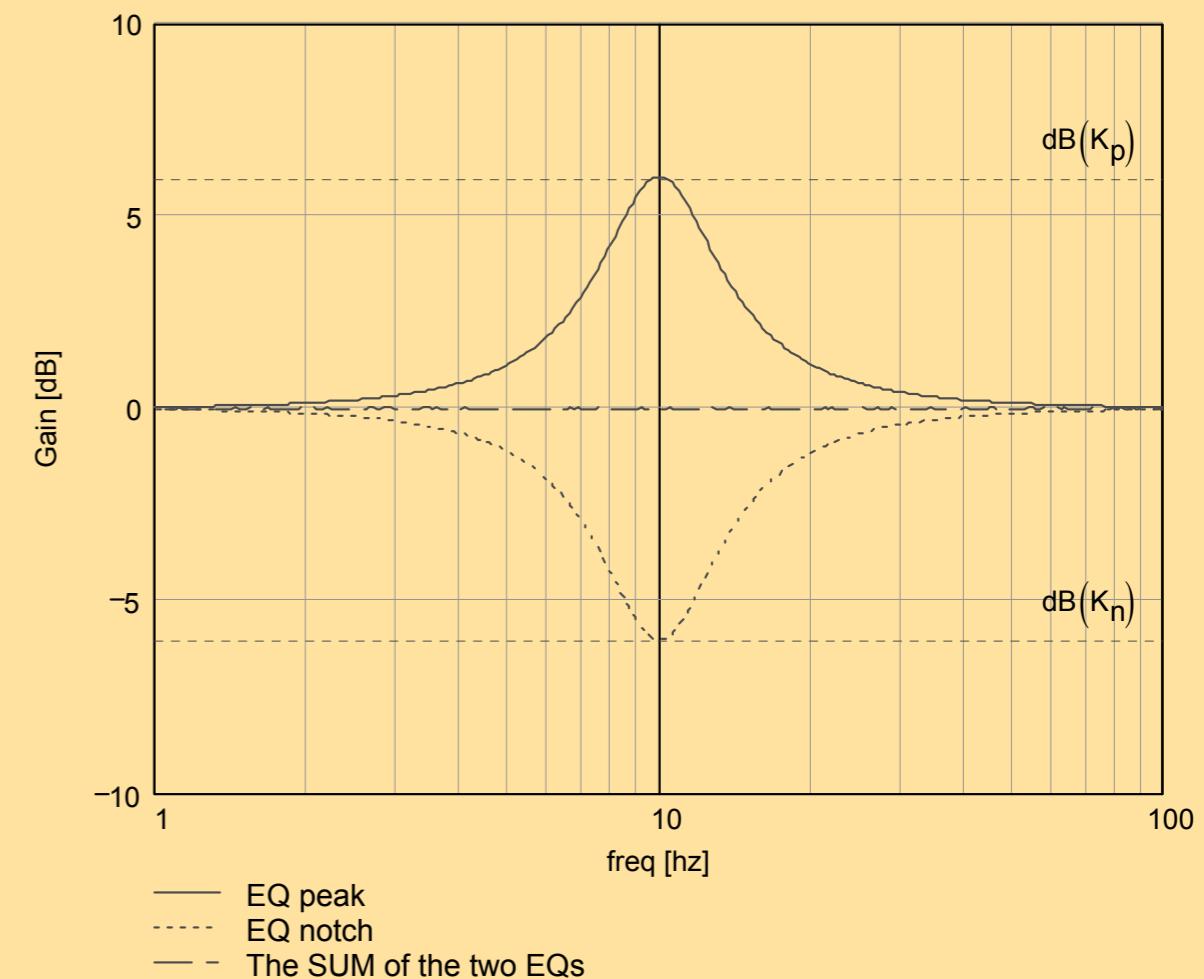
Because of this parallel resistor, the gyrator is preferred to implement the inductor in the EQ sections of this filter.

The EQ is described by a transferfunction as any other second order system. There is however a minor change to the way that it is written.

$$EQ_{\text{peak}}(s) = \frac{s^2 + \frac{K_p \cdot \omega_0}{Q} \cdot s + \omega_0^2}{s^2 + \frac{\omega_0}{Q} \cdot s + \omega_0^2}$$

$$EQ_{\text{notch}}(s) = \frac{s^2 + \frac{\omega_0}{Q} \cdot s + \omega_0^2}{s^2 + \frac{\omega_0}{Q \cdot K_n} \cdot s + \omega_0^2}$$

K_p and K_n are the gains of the EQ at their center frequency ω_0 . Their frequency response can look like this:

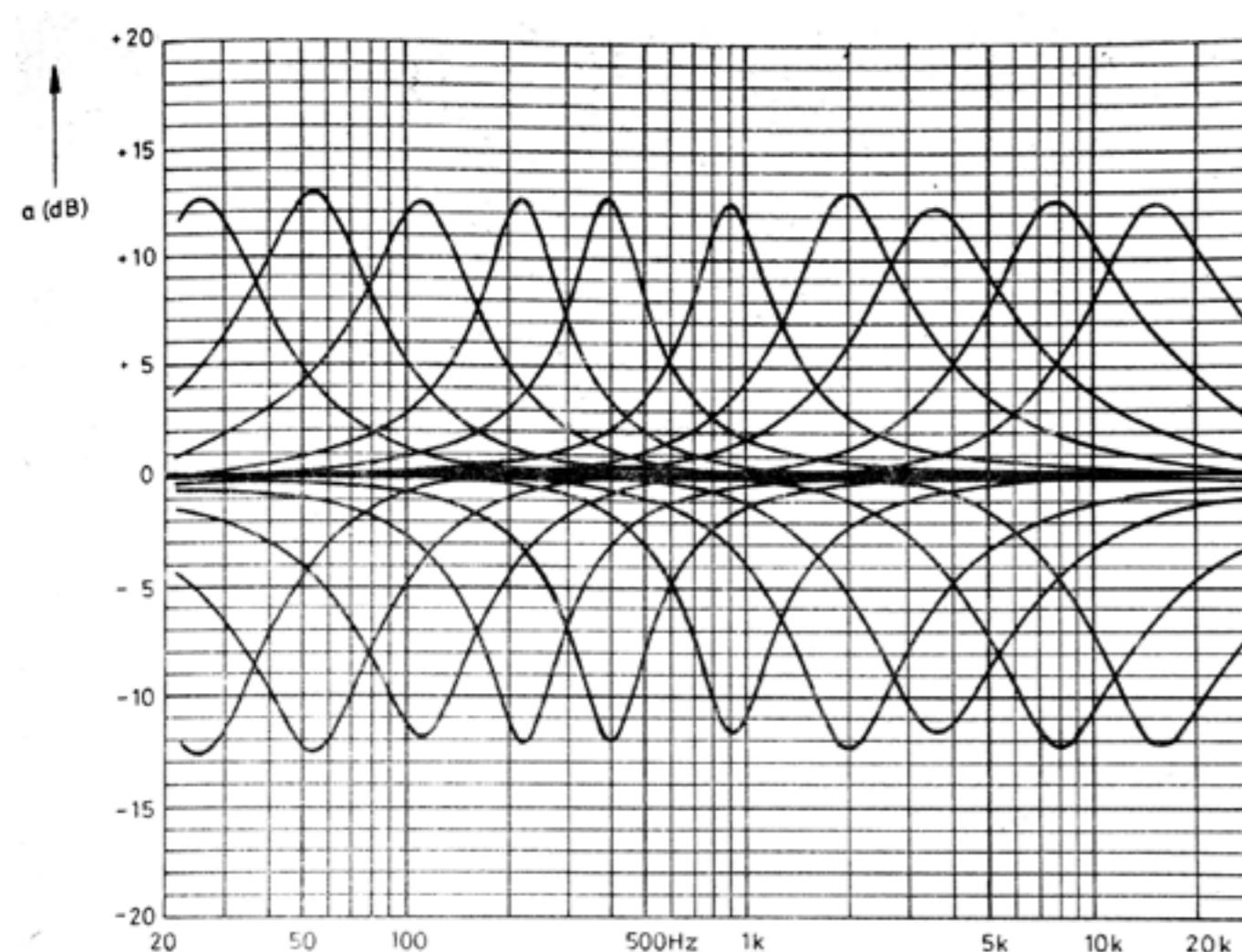


The two EQs have identical Qs of 2 and $f_0 = 10$ Hz. $K_p = 2$ and $K_n = 0.5$. The SUM of the two filters is 0 dB which means that two EQ sections can cancel each other out, if they share Q and f_0 . The gain in dB must be the same for the two (Notch is negative of cause and peak is positive)

The feature, that the EQs cancel each other when they have the same Q and "opposite" gains; is called "reciprocal". This is a special type of EQ, since there are also circuits that are "non-reciprocal".

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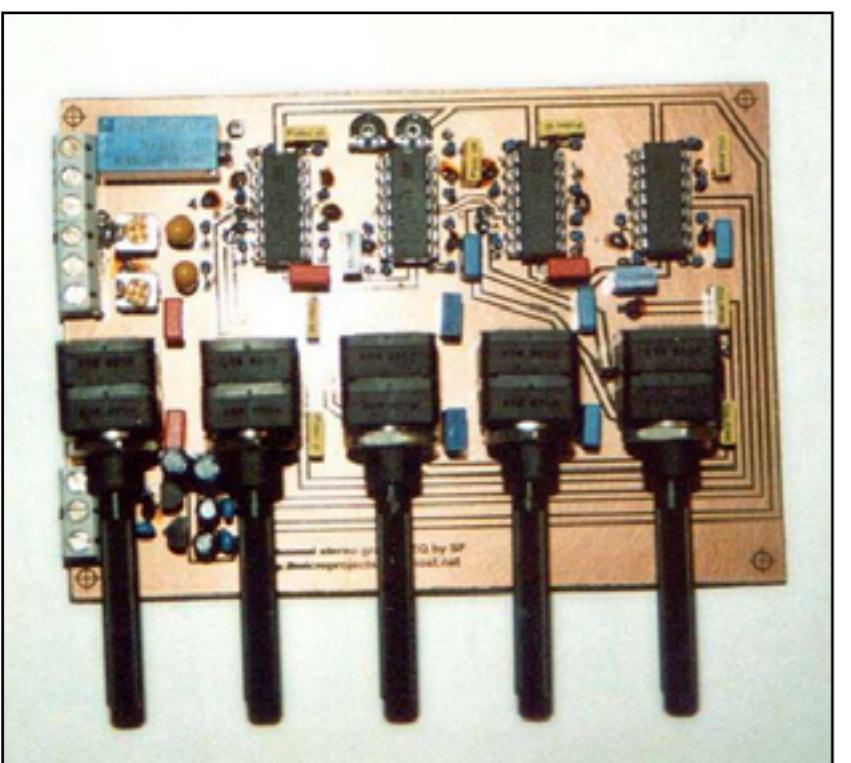
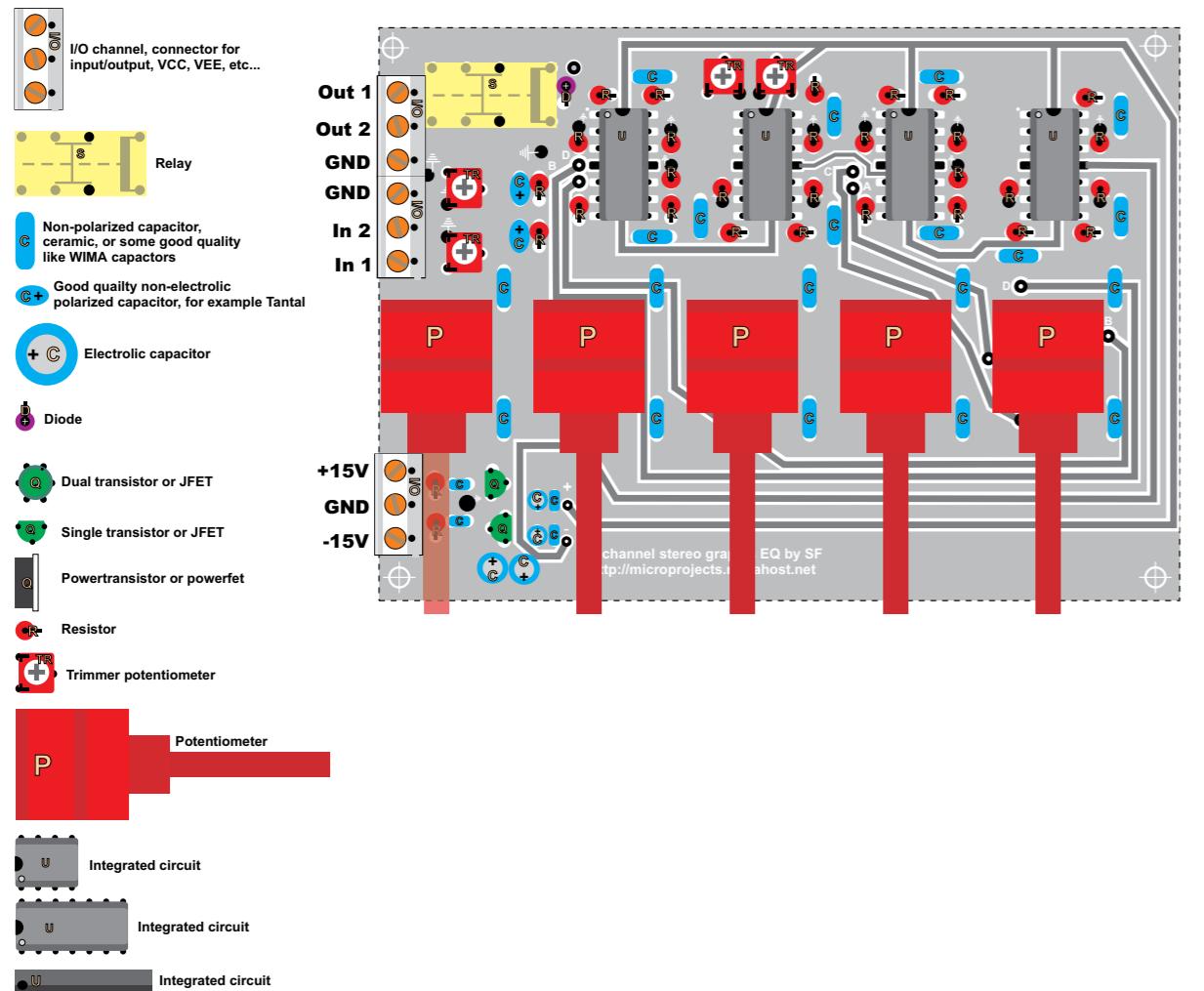
The frequency response of 10 channel modular EQ project



**Previous PCBs and
images for simple 5
band and permanent Q
10 band EQ**

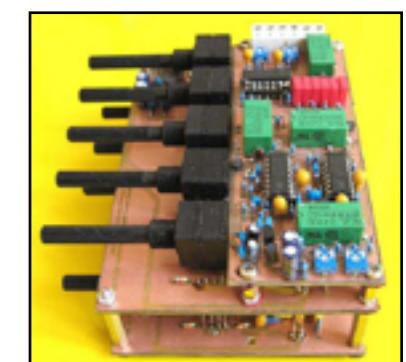
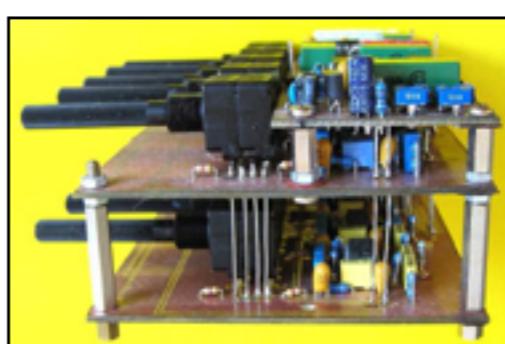
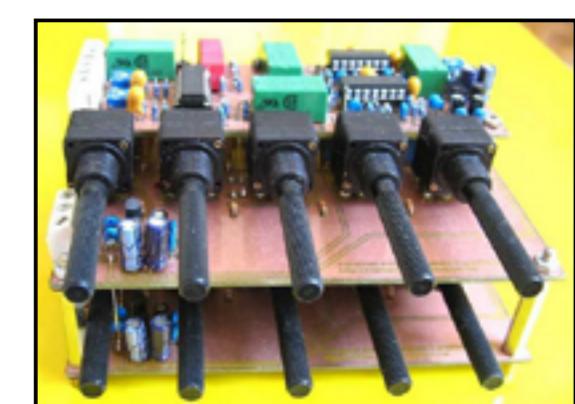
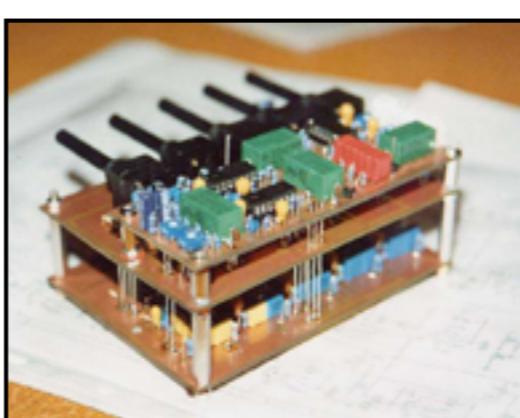
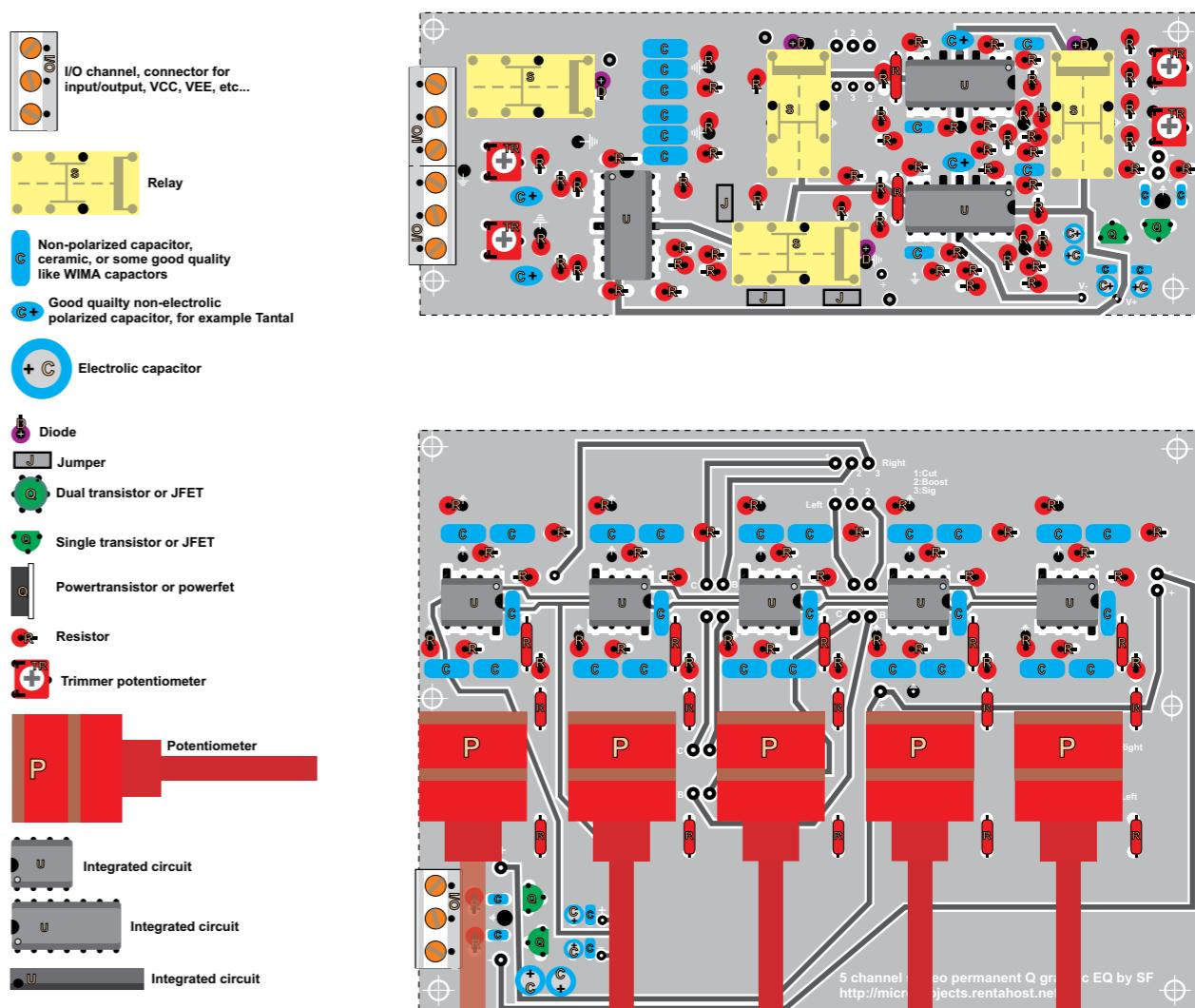
Images about first prototype

The previous version of simple 5 band EQ



Images about first prototype

The previous version of RANE based permanent Q project



English blog and PCB order: <http://custompcb.blogspot.com/>

Hungarian blog and PCB order: <http://diyguitarpa.blogspot.com/>

[The Youtube Channel](#) • [Picasa gallery](#) • Email: gitarfogas@gmail.com