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 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 about this project are available on the author’s blog and websites:

English blog and PCB order: [http://diyguitarpa.blogspot.com/](http://diyguitarpa.blogspot.com/)
Hungarian blog and PCB order: [http://diyguitarpa.blogspot.com/](http://diyguitarpa.blogspot.com/)
The Youtube Channel  •  Picasa gallery  •  Email: gitarfogas@gmail.com

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

- Schematic and BOM of simple “5 band EQ”
- One stereo gyrator filter module
- 10 channel gyrator EQ mainboard

### Printed Circuit Boards for gyrator EQ project

- Top and bottom PCBs and overlay of simple 5 band EQ
- Top and bottom PCBs and overlay of stereo gyrator module
- Top and bottom PCBs and overlay of power filters (ver.3)
- Top and bottom PCBs and overlay of power filters (ver.2)
- The mainboard of 10 band EQ for gyrators

### The power supply for all gyrator EQ projects

- Schematic and BOM of power supply
- The power supply PCB

### Math expressions, articles for gyrator EQ designs

- Articles and images about gyrator EQ projects
- Math expressions for gyrator design
- The frequency response of 10 channel modular EQ project

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

- The previous version of simple 5 band EQ
- The previous version of RANE based permanent Q project

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### 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.
Simple gyrator and permanent Q active filter EQ project

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 band. Another PCB separated to two mono channel with two mono potentiometers to adjust left and right channels independently. This is better for instrument amplifications. With the EQ mainboard, you can build this module for any frequencies.

Examples of C(a):

For 5 band EQ:
- 10kHz - 3.3n
- 3kHz - 10n
- 1kHz - 33n
- 100Hz - 330n

For 10 band EQ:
- 20kHz - 390n
- 10kHz - 3.3n
- 5kHz - 10n
- 1kHz - 33n
- 100Hz - 330n

Notes

This module required for the EQ mainboard is the power filter circuit. 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.

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

Examples of C(a):

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<td>4.8mm; Leads 0.48 x 0.5 mm (max)</td>
<td></td>
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<tr>
<td>Resistor</td>
<td>1K</td>
<td></td>
</tr>
<tr>
<td>Resistor</td>
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<td>Resistor</td>
<td>4K</td>
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http://diyguitarpa.blogspot.com/
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Title

Power filter module

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File: D:\!Works\..\PowerFilter.SchDoc Drawn By:
**Schematics and Bill of Materials for gyrator EQ project**

10 channel gyrator EQ mainboard

**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 Qs, 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

Notes
This 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.
Simple gyrator and permanent Q active filter EQ project

PCB for the modular EQ project
Top and bottom PCBs and overlay of stereo gyrator module

Notes
Stereo gyrator module with one stereo potentiometer to adjust left and right channel at once. This solution recommended for home hi-fi users. This module must be connected to the project’s mainboard.

PCB TOP OVERLAY
TOP OVERLAY ON TOP LAYER

PCB for the modular EQ project
Top and bottom PCBs and overlay of 2 mono gyrator module

Notes
Duple-Mono gyrator module with two single potentiometers to adjust left and right channel separately. This solution recommended for instrument amplifications. This module must be connected to the project’s mainboard.

PCB TOP OVERLAY
TOP 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.

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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

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.

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

<table>
<thead>
<tr>
<th>Hz</th>
<th>C3</th>
<th>C4</th>
<th>R3</th>
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<tr>
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<td>6.8µ</td>
<td>100n</td>
<td>330n</td>
<td>10K</td>
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<td>63</td>
<td>3.3µ</td>
<td>4.7K</td>
<td>33K</td>
<td>10K</td>
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<td>125</td>
<td>1µ</td>
<td>82K</td>
<td>10K</td>
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<td>250</td>
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<td>10K</td>
</tr>
<tr>
<td>2K</td>
<td>10K</td>
<td>2.2K</td>
<td>10K</td>
<td>82K</td>
</tr>
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<td>4K</td>
<td>1K</td>
<td>1µ</td>
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<tr>
<td>8K</td>
<td>1µ</td>
<td>670p</td>
<td>82K</td>
<td>92K</td>
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<tr>
<td>16K</td>
<td>100p</td>
<td>22µ</td>
<td>100K</td>
<td>10K</td>
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</table>

The values of R3 is same as R1, the R2 is same as R4. Also look the math expressions for another examples.
Simple gyrator and permanent Q active filter EQ project

PCB for the modular EQ project
The mainboard of 5 band EQ for gyrators

For 5 band EQ:
- 100Hz - 330n
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- 1kHz - 33n
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For 10 band EQ:
- Change all of the 50K adjustable resistors to 25K

<table>
<thead>
<tr>
<th>Hf</th>
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<td>1k2</td>
<td>1k2</td>
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The power supply for all gyrator EQ projects

Schematics and Bill of Materials for all EQ project

Schematic and BOM of power supply
PCB for all EQ project
The power supply PCB
Math expressions, articles for gyrator EQ designs

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
3.3.1 The Gyrator vs. The active inductor

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.

3.3.1.1 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.

\[
L = C_2 \cdot R_1 \left( R_2 - R_1 \right) \quad R_s = R_1 \quad R_p = R_2 - R_1
\]

3.3.1.2 The active inductor

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.

3.3.2 The mathematical EQ

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

\[
EQ_{\text{peak}}(s) = \frac{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}
\]

\[
EQ_{\text{notch}}(s) = \frac{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}
\]

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

The two EQs have identical Qs of 2 and \(f_o = 10\) 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 \(f_o\). 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 the 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”.

$$\text{EQpeak}(s) = \frac{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}$$

$$\text{EQnotch}(s) = \frac{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}{s^2 + \frac{\omega_o}{Q} s + \omega_o^2}$$
Help for gyrator EQ designs
The frequency response of 10 channel modular EQ project

Previous PCBs and images for simple 5 band and permanent Q 10 band EQ
Simple gyrator and permanent Q active filter EQ project

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