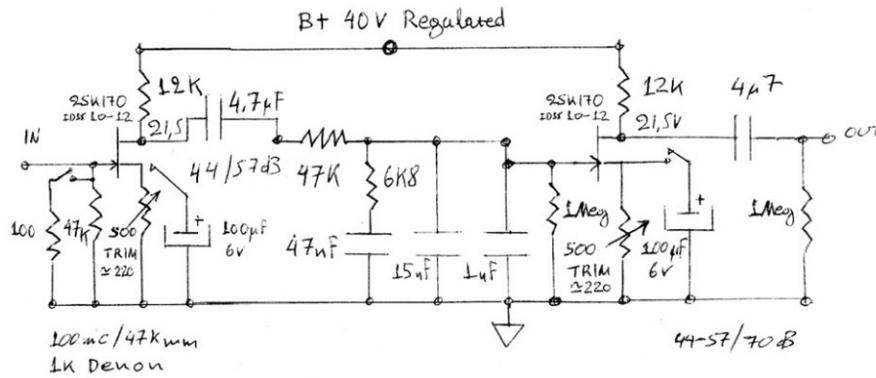


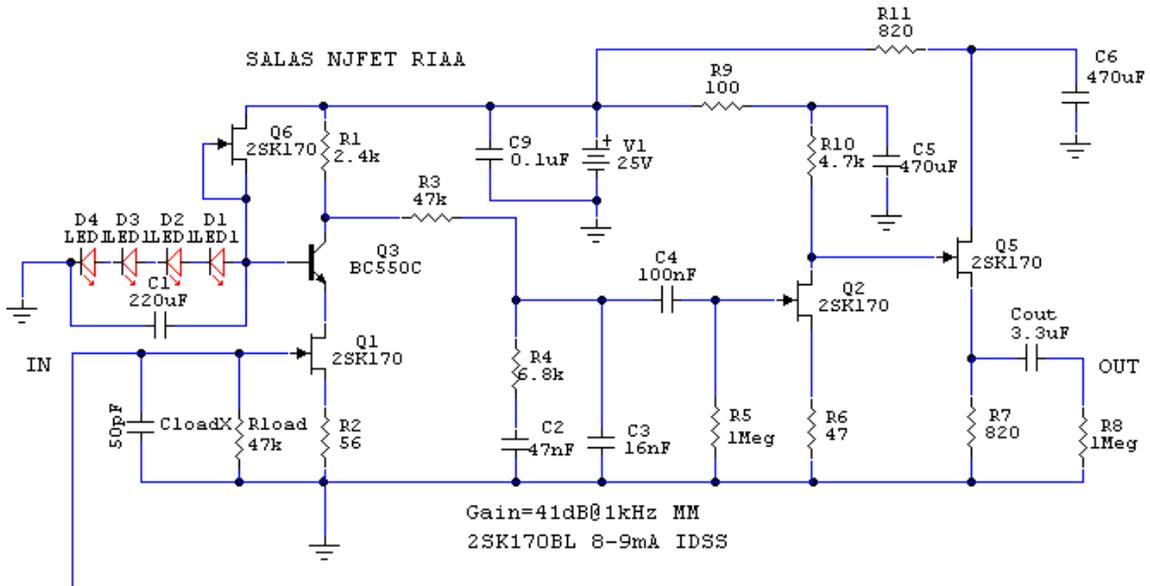
# Salas Simplistic NJFET Buffered RIAA

## Introduction

This started as a concept. This is the initial thought:



After a lot of research, testing and development, the circuit evolved to the following:



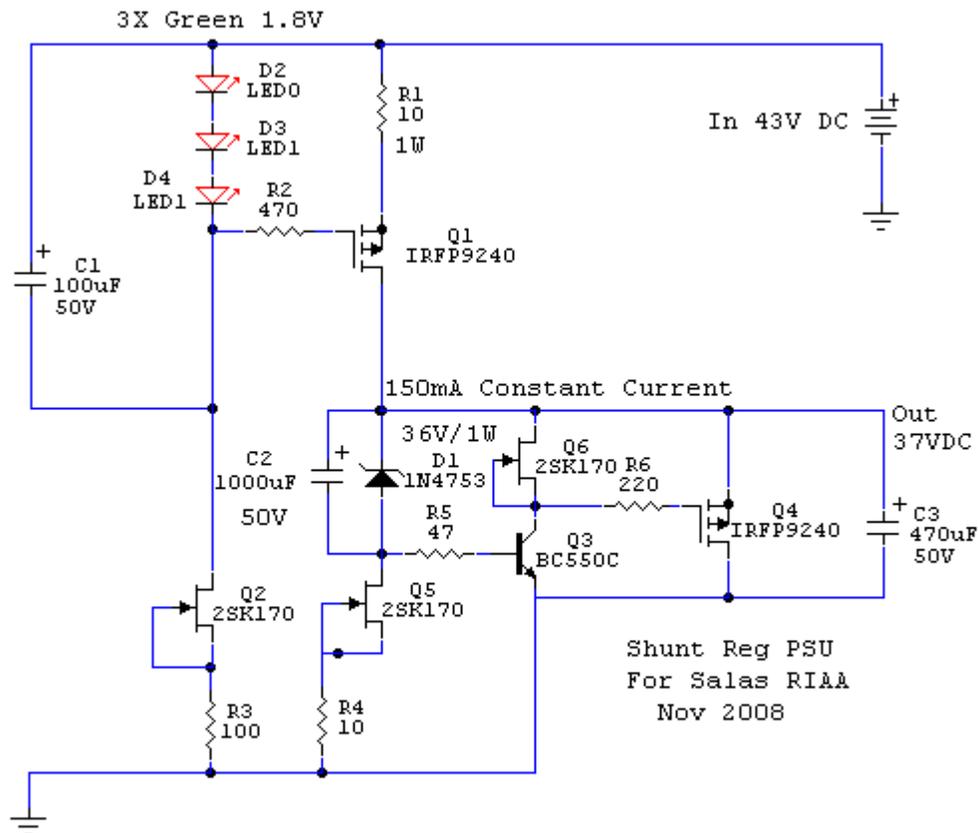
Shown here is the MM 41db version.

There are three versions of the RIAA circuit. Each version is optimized for the type of cartridge used. These are:

- a) MM or MC High version 2-5mV, 41db
- b) MC Medium-High version 0.8-1mV, 48db
- c) MC Low version 0.5mV, 56db

Along with the RIAA circuit a Shunt Regulator circuit was designed to be used together. The following

circuit is the shunt regulator:



Shown here is the 37V version. This schematic includes the R6/Q6 mod..

**Attention:** Q1 and Q4 should be mounted on heatsinks.

This shunt regulator, should be used for optimal performance of the RIAA circuit.

Alternative power supplies can be used for powering the RIAA circuit, you can look at the appendix for more info. However don't expect the same sonic performance as with the above Shunt.

### How it Works

There is an input JFET-BJT cascode stage with local shunt bias Voltage stabilizer so to keep input capacitance very low and give enough initial flat gain. The passive RIAA filter follows. A JFET stage amplifies the filtered signal further and hands it to a JFET buffer output stage for easy drive of cables and line input stages down to 20kOhm. The whole concept is about a simplest possible class A single ended, no loop feedback, low noise JFET circuit. There are the Cloadx and Rloadx input load components that can be chosen to cater for any cartridge loading needs.

You can find response curves in the appendix section.

## Parts List

As stated above there are three versions of the RIAA, one for each type of cartridge.

The following table shows the specs and the parts for the three versions:

Cartridge Type:	<b>MM or MC High</b>	<b>MC Medium</b>	<b>MC Low</b>
Gain:	41db @1KHz	48db @1KHz	56db @1KHz
Sensitivity:	2-5mV	0.8-1mV	0.5mV
Output Impedance	30.5 Ohms	30.5 Ohms	30.5 Ohms
Operating Voltage:	25V	27V	37V
<b><u>RIAA:</u></b>			
Q1	2SK170BL	2SK170BL	2SK170BL
Q2	2SK170BL	2SK170BL	2SK170BL
Q3	BC550C	BC550C	BC550C
Q5	2SK170BL	2SK170BL	2SK170BL
Q6	2SK170BL	2SK170BL	2SK170BL
D1-LED1	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
D2-LED2	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
D3-LED3	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
D4-LED4	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
C1	220uF/25V	220uF/25V	220uF/25V
C2	47nF	47nF	47nF
C3	16nF	16nF	16nF
C4	100nF	100nF	100nF
C5	470uF/35V	470uF/35V	470uF/50V
C6	470uF/35V	470uF/35V	470uF/50V
Cout	3.3uF	3.3uF	3.3uF
Clload** See below			
C9	0.1uF	0.1uF	0.1uF
R1	2.4K	3.3K	6.2K
R2	56R	33R	33R
R3	47K	47K	43K
R4	6.8K	6.8K	6.8K
R5	1M	1M	1M
R6	47R	33R	27R

R7	820R	820R	820R
R8	1M	1M	1M
R9	100R	100R	100R
R10	4.7K	4.7K	6.2K
R11	820R	1.2K	2.4K/1W
Rloadx** See below	47K Typical	2.2K Typical	1K Typical
<b><u>Shunt Regulator:</u></b>			
Q1	IRFP9240	IRFP9240	IRFP9240
Q2	2SK170BL	2SK170BL	2SK170BL
Q3	BD550C	BC550C	BC550C
Q4	IRFP9240	IRFP9240	IRFP9240
Q5	2SK170BL	2SK170BL	2SK170BL
Q6	2SK170BL	2SK170BL	2SK170BL
D1	1N4749A 24V/1W	1N4750 27V/1W	1N4753 36V/1W
D2	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
D3	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
D4	LED 1.7V/20mA	LED 1.7V/20mA	LED 1.7V/20mA
C1	100uF/35V	100uF/35V	100uF/50V
C2	1000uF/35V	1000uF/35V	1000uF/50V
C3	470uF/35V	470uF/35V	470uF/50V
R1	6.8R/1W	10R/1W	10R/1W
R2	470R	470R	470R
R3	100R	100R	100R
R4	10R	10R	10R
R5	47R	47R	47R
R6	220R	220R	220R
Bridge or Rectifying Diodes	MBR3100 100V/3A Fast Recovery	or your choice	of rectifying bridge or diodes
Cfilter	10,000uF/35V	10,000uF/50V	10,000uF/50V
Transformer	24V 50VA	28V 50VA	30-32V 50VA

\*\* Cloadx and Rloadx are used for cartridge loading, and these values depend on the cartridge used. Please refer to your cartridges user manual for the manufacturers recommended loading values. Cloadx is mainly there for MM cartridges, and its value must be chosen to supplement the turntable cable capacitance. For MC carts it may be omitted, or used if some carts state an optimum capacitance along the resistive load( Rloadx ) optimum.

## Construction

First decide which version you need, so refer to your cartridges user manual to decide which version is right for you. Then gather the necessary parts for the version that you are building, refer to the Parts List Table. You must match your 2sk170BL JFETs. The JFETs are to be matched per stage between channels at 8-9mA Idss. You can refer to the appendix for more info on how to match your semiconductors. Use your highest Idss JFETs pairs for Q1 and Q5. Q6 is not an amplifying JFET, it is just a constant current source for the LEDs. The LEDs are happy between 5-10mA. Use a couple of jfets between 5-10mA for those positions that match 1-2mA near one another. Finally for the Q2 pair use matched JFETs between 8-9mA.

For the Shunt, no matching is necessary, left outs from the RIAA matching will suffice. JFETs with 7-9 Idss are ok. However, prefer the lowest Idss JFET for Q5. If you have a couple of GR 4-5mA, even better. There is a reason. The lower the Idss, the lower the pinch off, and more the breathing space under Vbe. But we don't want too low, so to keep the Zener working strong enough.

Matching the BJTs is not critical, if your DMM has Hfe capability you could use that for matching. For the LEDs you could use 1.7V or 1.8V generic LEDs( if you can find yellow or green go with those as they are less noisy, red is the third choice, try to avoid the blue ones as the are noisy ).

String your LEDs ( in series ) together in series with a 1K resistor and connect this to a 9V battery. Measure the voltage across the string of LEDs. The voltage across the LEDs must be approximately, for the RIAA: 7.2 - 7.8V( 4LEDs ). Keep the Voltages the same between channels.  
for the Shunt: 5.4V( 3 LEDs )

If you go with LEDs that are rated more than 1.8V, in the shunt regulator, the value R1 must be changed to  $R1 = (LedStringV - V_{gsQ1}) / I_{ccs}$ . Where Iccs is 150-200mA and VgsQ1 should be around 3.4V. You can measure it with your DMM.

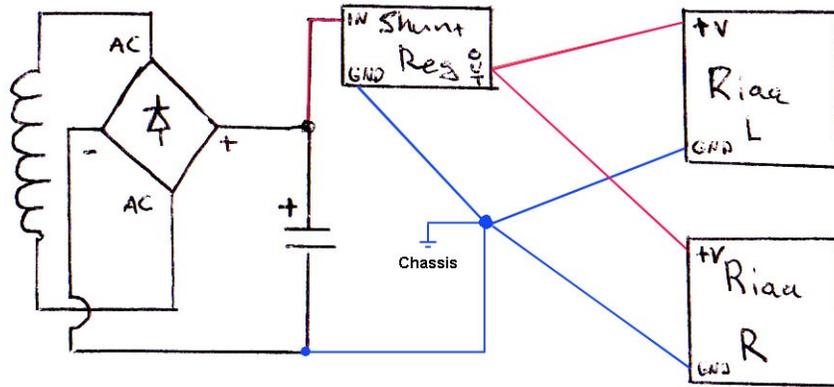
For resistors you can use 0.25W rated resistors, unless it is otherwise noted. Carbon film type are preferred as they are softer sounding( Takman pink carbon resistors ).

For Cloadx, Polystyrene or Silver Mica should be used. For the RIAA caps( C2, C3, C4 ), prefer Silver Mica ( for the 16nF and 47nF ) and Silver Teflon( for the 100nF ), other types of capacitors will also work. For the output cap, use a good audio grade cap ( Obbligato is recommended ). For the Electrolytic caps, Panasonic FC are good( Black Gates even better ). For Cfilter, Panasonic FC or TS-HA. For the rectifiers, fast recovery type are preferred. You can use your favorite rectifying bridge or diodes( Fairchild FF60SB60DS are recommended ).

Decide how you are going to build your RIAA and Shunt, are you going to use a prototype board and do point to point(p2p), or use one of the board layouts that some members of the DIYAudio forum, have contributed to this project. You can look at the appendix for more info. Off course you can create your own.

Build your RIAA and Shunt.

A wiring scheme is shown below:



This diagram shows the wiring between one shunt circuit and the RIAA circuits. Some have experimented with dual shunts, one per channel, and have reported improved performance over the single shunt. It's up to you to decide, what's good for you. Initially some burn in time is required for the Caps to settled.

### **Enjoy the Music.**

Off course if you have any question(s), feel free to use the thread to get your answer(s).

### **Epilogue**

I PSGR created this document. The reason, I had a hard time following the 70 plus pages of this thread. Important and useful information was all over the 70 pages. I gathered some information and with the help of Salas I completed this document. I tried to cover everything, I hope I did.

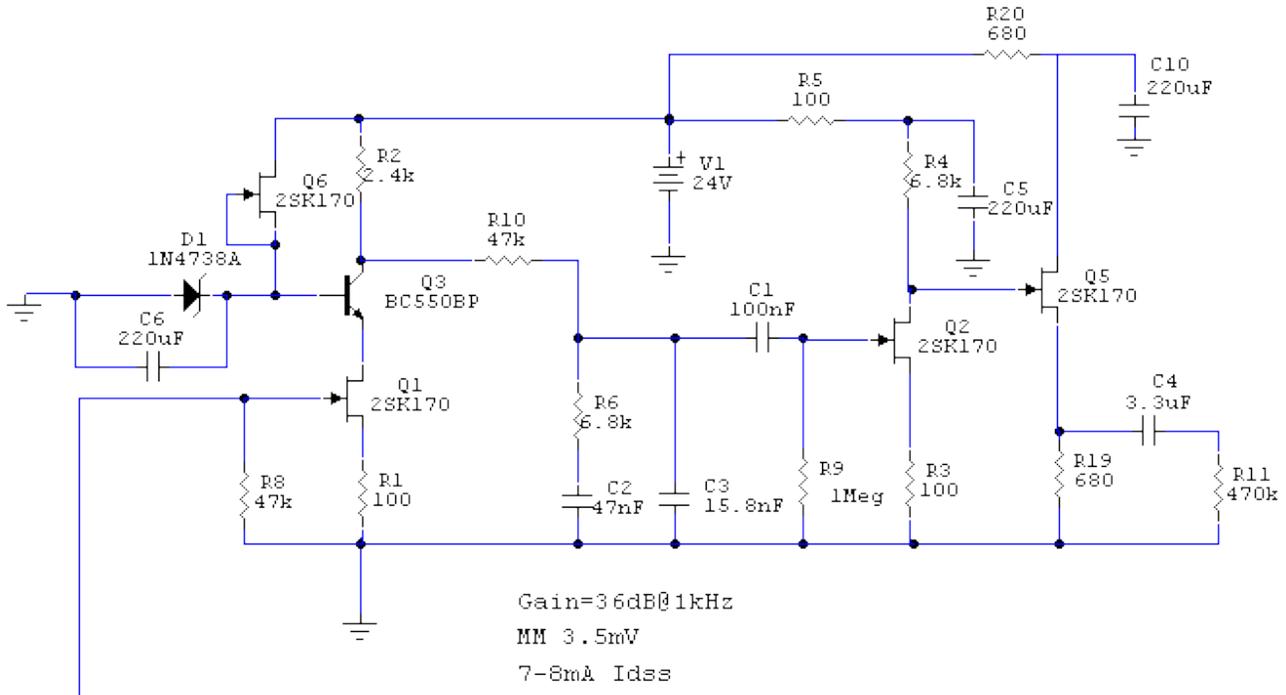
“Ουδεν προ του τελους μακαριζε”  
an old Greek saying

## Appendix

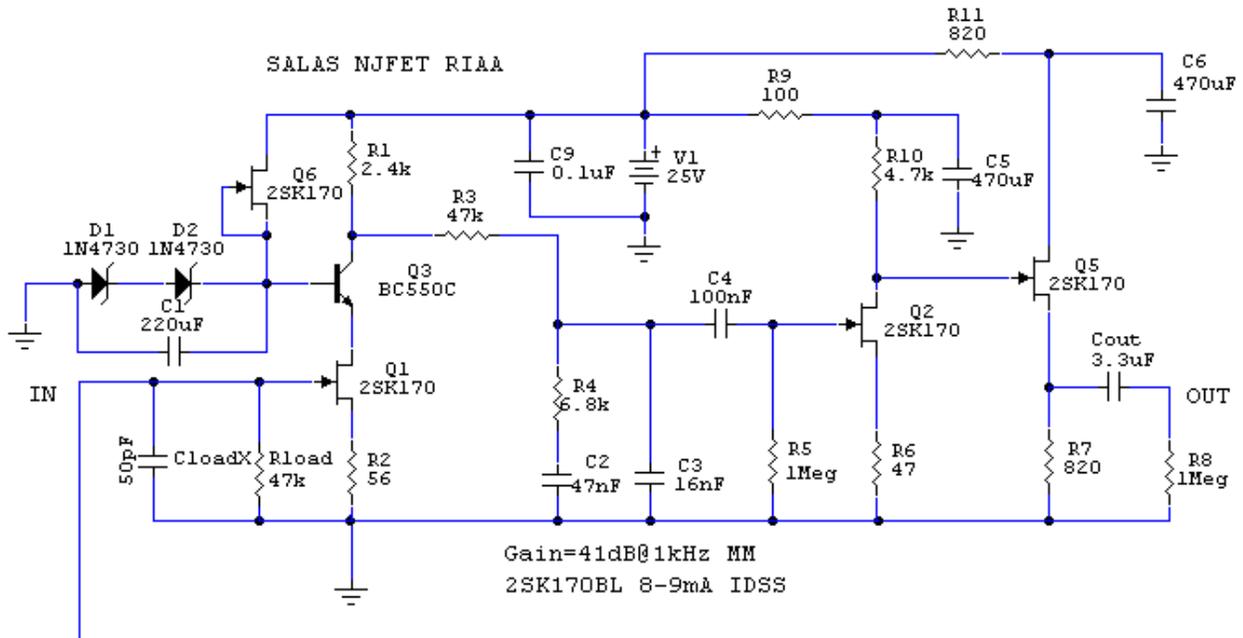
### Other Schematics-Early Versions

These schematics, are shown here as a reference.

Shown here is an early version of the RIAA circuit. It uses a single 1N4738 zener(8.2V). Several users had created PC boards for their RIAA, based on this schematic.(See the Boards section below)



The following schematic shows the RIAA circuit, using two 1N4730 zeners(3.9V each), this produces less noise than the single zener version above.



## Matching Semiconductors

You can go to :

<http://www.passdiy.com/pdf/matching.pdf>

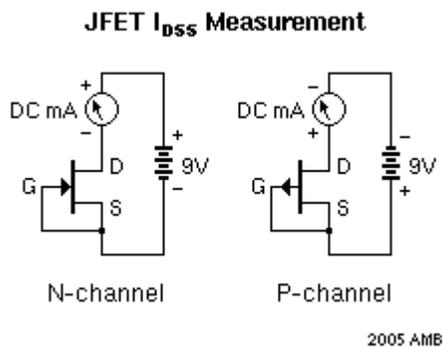
<http://www.passdiy.com/pdf/mos.pdf>

and/or

[http://www.diamondstar.de/transistor\\_matching\\_jfet.html](http://www.diamondstar.de/transistor_matching_jfet.html)

and read more on how to match your JFETs and BJTs.

The following diagram shows a simple diagram that can be used for JFET matching. Many people prefer to add a resistor (100-470R, depending on your power source) in place of the ammeter, and use the DMMs voltmeter to measure the voltage drop across the resistor. The voltmeter measurement is more accurate than the ammeter measurement. Then compute the  $I_{DSS} = V_{drop}/R$ .



## Some Useful Links(maybe)

[http://www.tnt-audio.com/sorgenti/load\\_the\\_magnets\\_e.html](http://www.tnt-audio.com/sorgenti/load_the_magnets_e.html)

<http://www.head-fi.org/forums/f21/orgy-capacitors-cap-thread-284863/>

<http://www.humblehomemadehifi.com/Cap.html>

<http://www.vhaudio.com/21capacitorshootout.pdf>

## Fabricating PC Board

<http://www.diyaudio.com/forums/showthread.php?s=c5d3359453fe4396226171fdec324d88&threadid=129126&perpage=25&pagenumber=29>  
(Post 708)

<http://electronics.psychogenic.com/modules/arms/art/10/PrintedCircuitBoardPCBHOWTOAnIllustratedGuide.php>

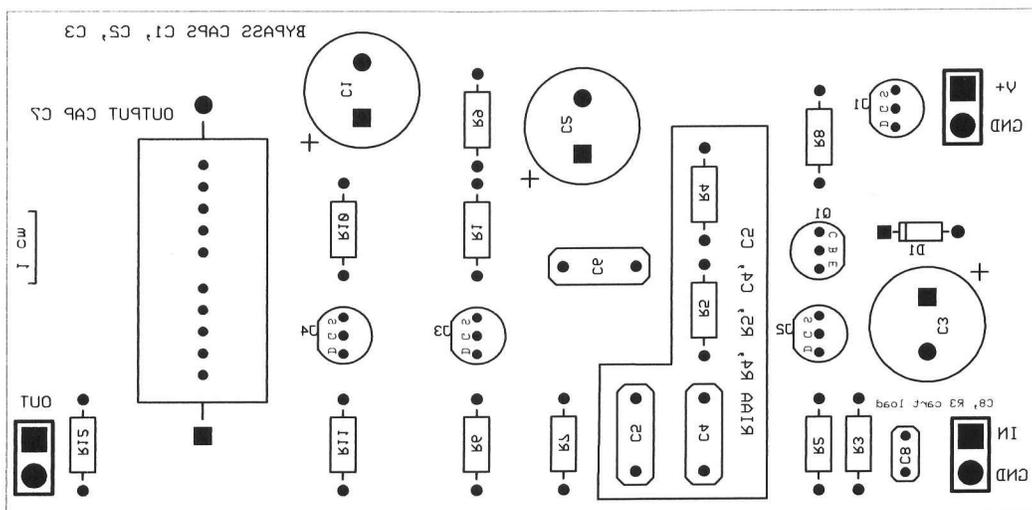
## Boards

Several members of the DIYAudio forum have created PC boards for this project. Presented below are a few examples of board layouts.

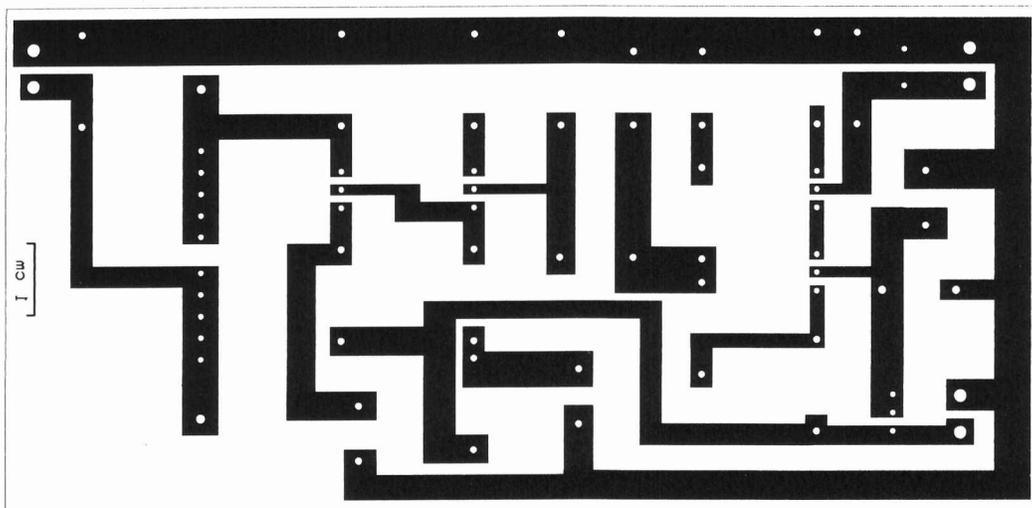
For the RIAA:

Board A, designed by Ikoflexer:

Top side, silk screen:



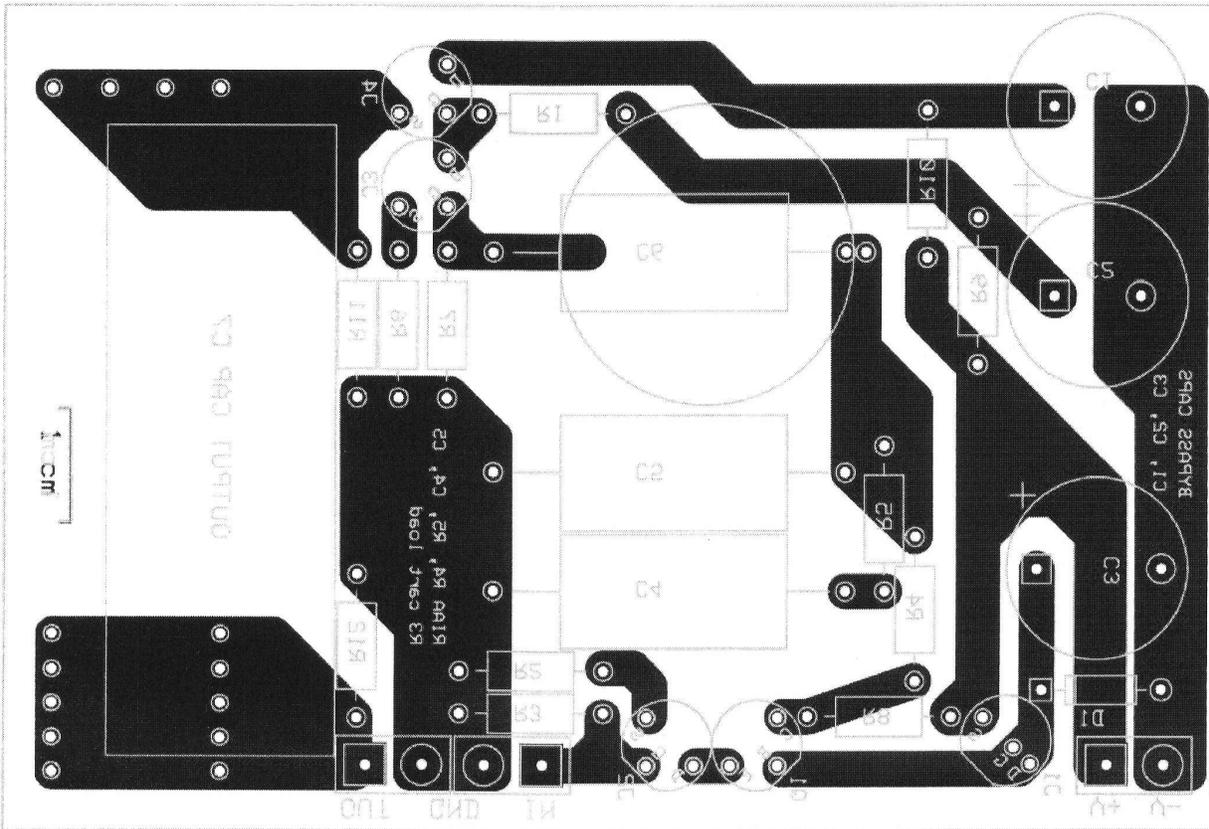
Bottom, Copper side:



Do you know the dimensions, if you do I can include them, like the other boards ???

This is an early design, it uses a single D1 zener. You will need to replace D1 by two 3.9V zeners (1N4730) or the four LEDs as shown in the diagram.

Board B, designed by Kent:



**Do you know the dimensions, if you do I can include them, like the other boards ???**

This is bottom view, copper side, shown with parts placement.

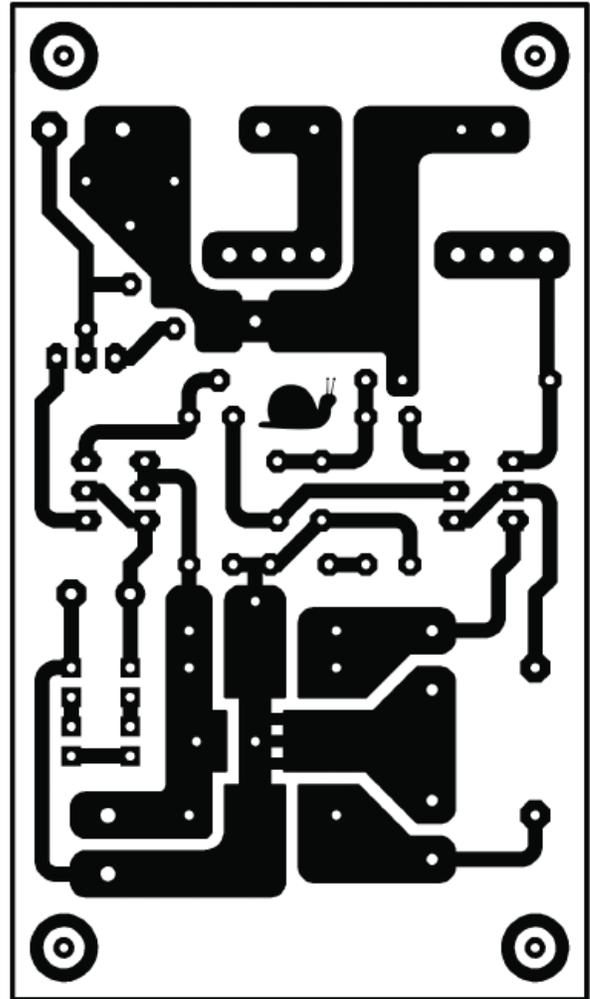
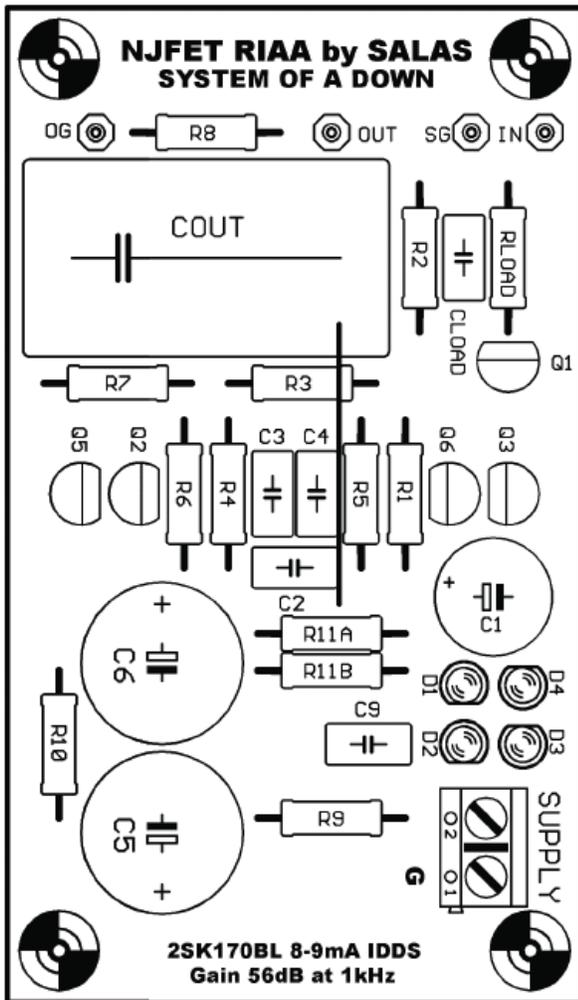
Here the designer used his own way to label the parts that he used. You will need to trace the parts placement and relabel them according to the schematic.

The above board has an error in the silk screen. The JFET at the lower right corner is shown with the wrong orientation, needs to be rotated 180 degrees. This design also uses a single zener D1, so as described above. You will also need to run two ground wires (-V and GND) from the board to the star ground.

Board C, designed by Crt:

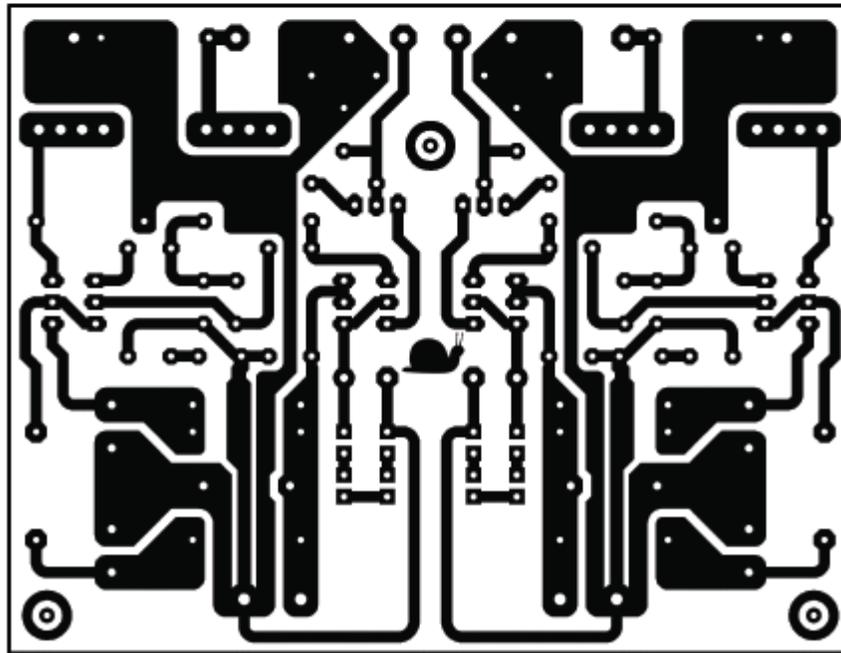
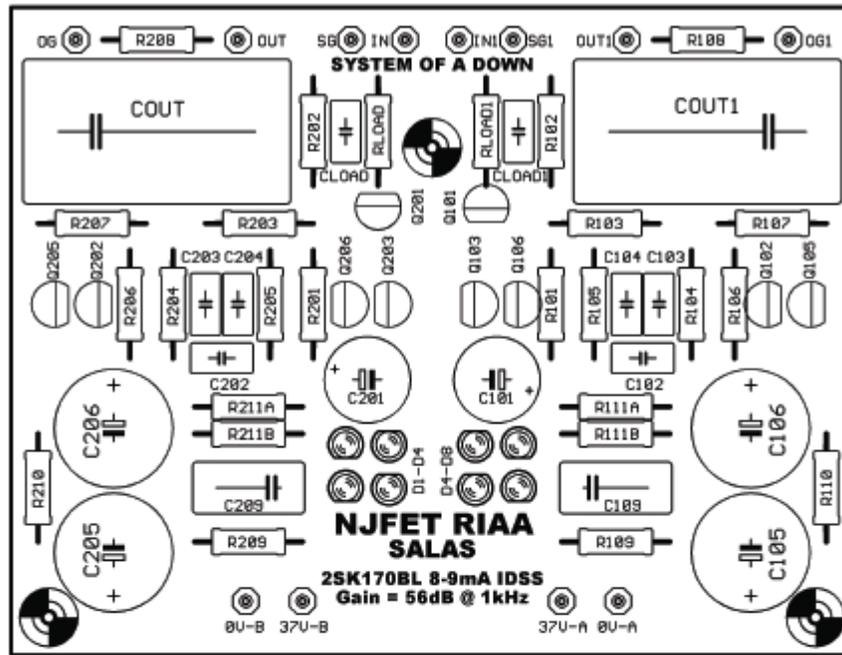
Note that Crt has created both a Mono and a Stereo board layout.

Crts Mono:



He made a compact board(must print at 86X50mm) and accepts only modern small polypropylene filter and interstage capacitors.

Crts Stereo:



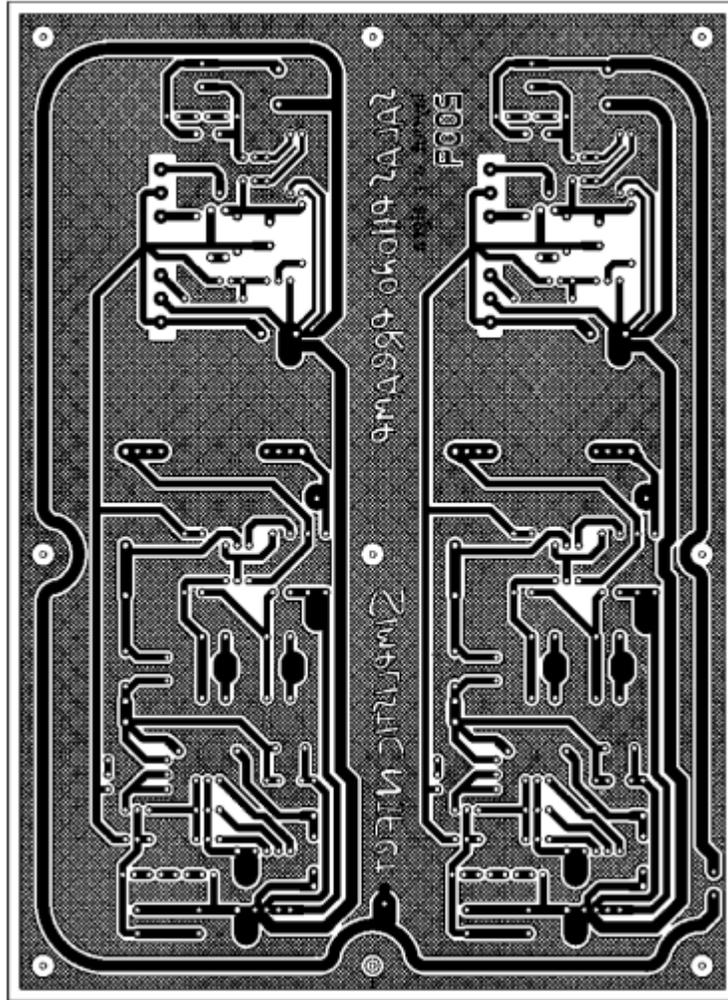
The dimensions are 99,44 mm x 76,59 mm

Board D, designed by Roy Algra:

Do you know the dimensions, if you do I can include them, like the other boards ???

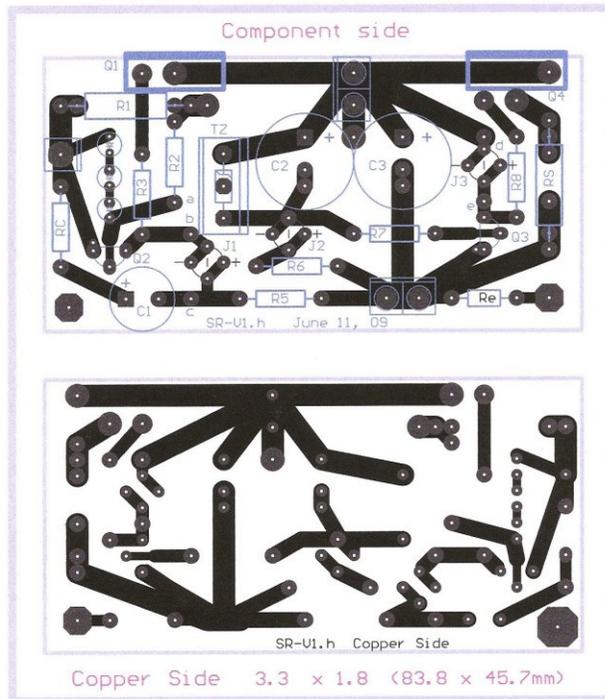
Top view, Component placement:





For the Shunt:

Board A, designed by James:



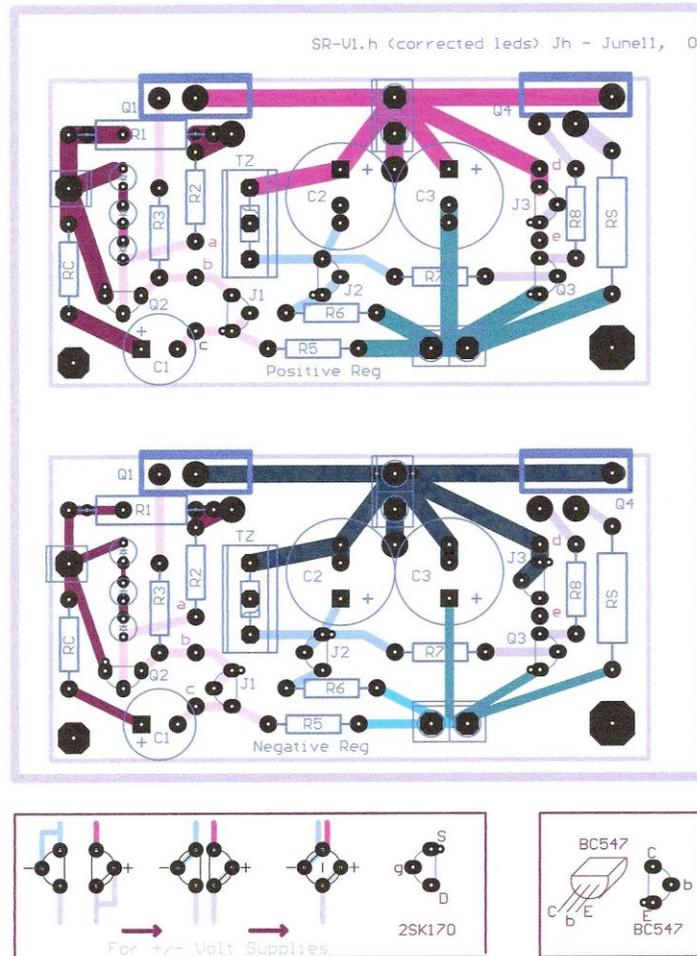
#### Options for +/- Universal PCB

1. Leds/R2,Q2 (use a,b )
2. J1/R4 (use b,c )
3. J3/R6phono (use d,e )
4. Rc, Rs, Re, TZ (zener), //R1
5. Note J1, 2, 3 orientation

Circuits - posts 8, 72, 219, 255

CygnusX version (#313) not incl.

*(will add do MiVoH version)*

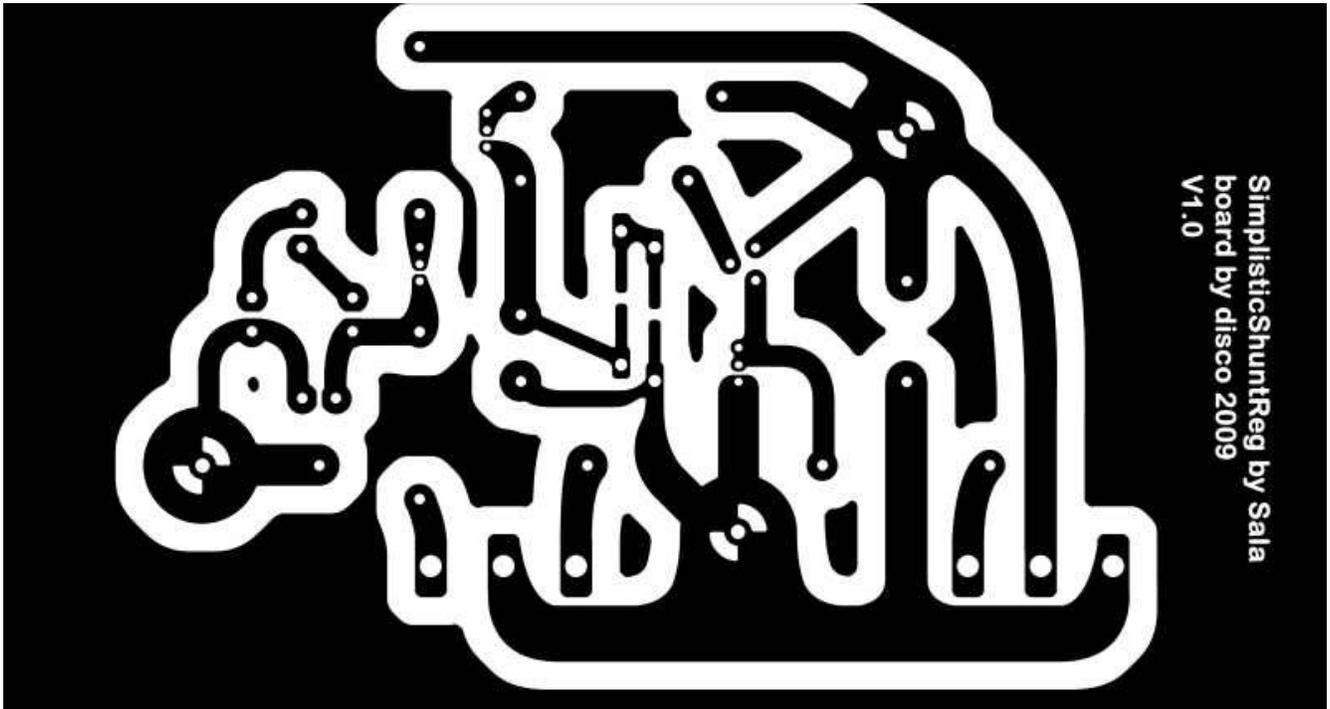


Please note that this is a universal type of board, it can be used for positive and negative type Shunts. Look at the above “Positive Reg” schematic, for RIAA usage. More on this topic can be found(post 460):

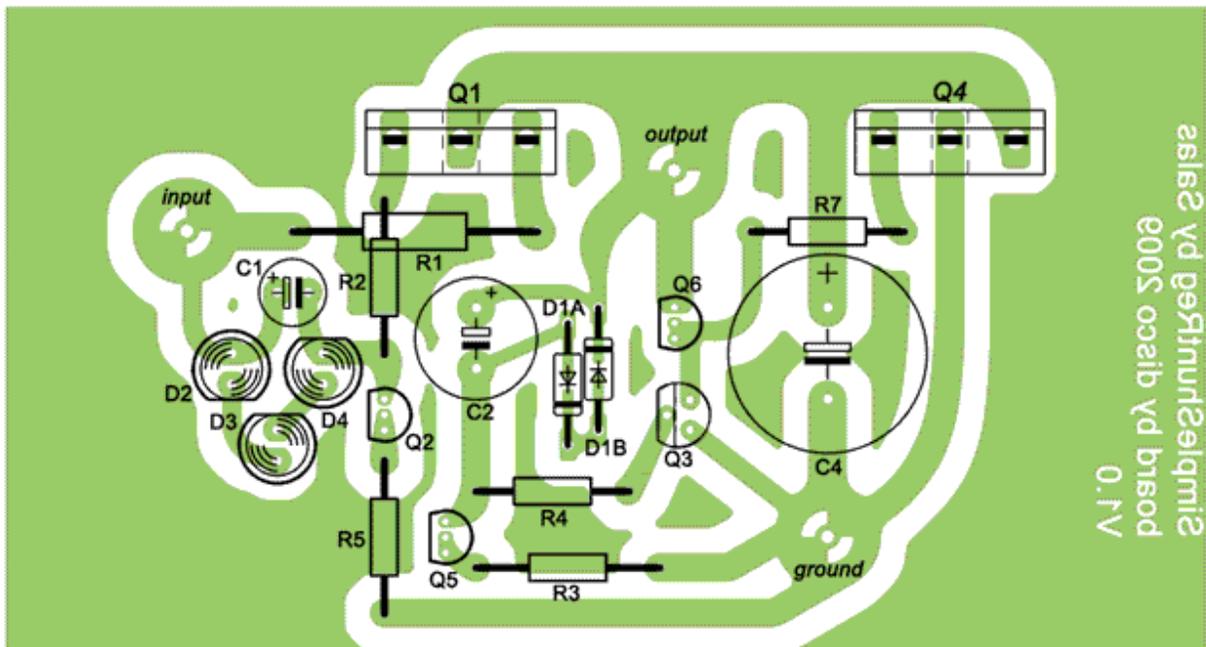
<http://www.diyaudio.com/forums/showthread.php?s=f18baedd0e9b53a262ebc1b12a8c2576&threadid=143693&perpage=25&pagenumber=19>

Board B, designed by Disco:

Here is the Bottom View, copper side of his board:



Here is the Top View with components placement:



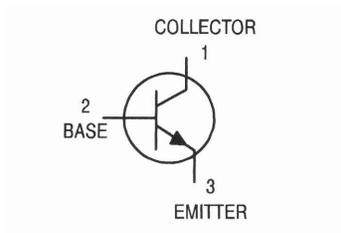
Its for a Eurocard format (10X16cm). It uses 2X12V Zeners in series, you can jumper one position and use the proper Zener for your Voltage version. Please note that the mapping of the resistors is different, as Disco used a different schematic than the one used in this document. Trace the circuit to find the right mapping.

**Semiconductor Package Outline:**

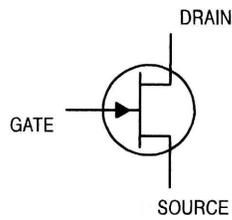
The 2SK170 and the BC550 are both case type TO-92:



The BC550:



The 2SK170:

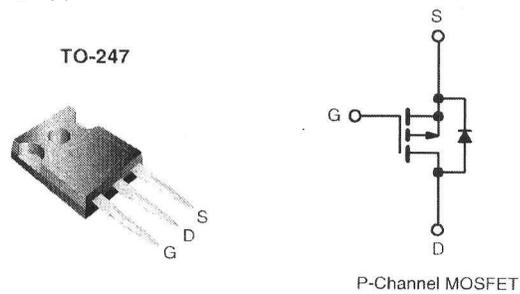


Drain: 1

Gate: 2

Source: 3

The IRFP9240 is of case type TO-247:



### Alternative Power Supplies

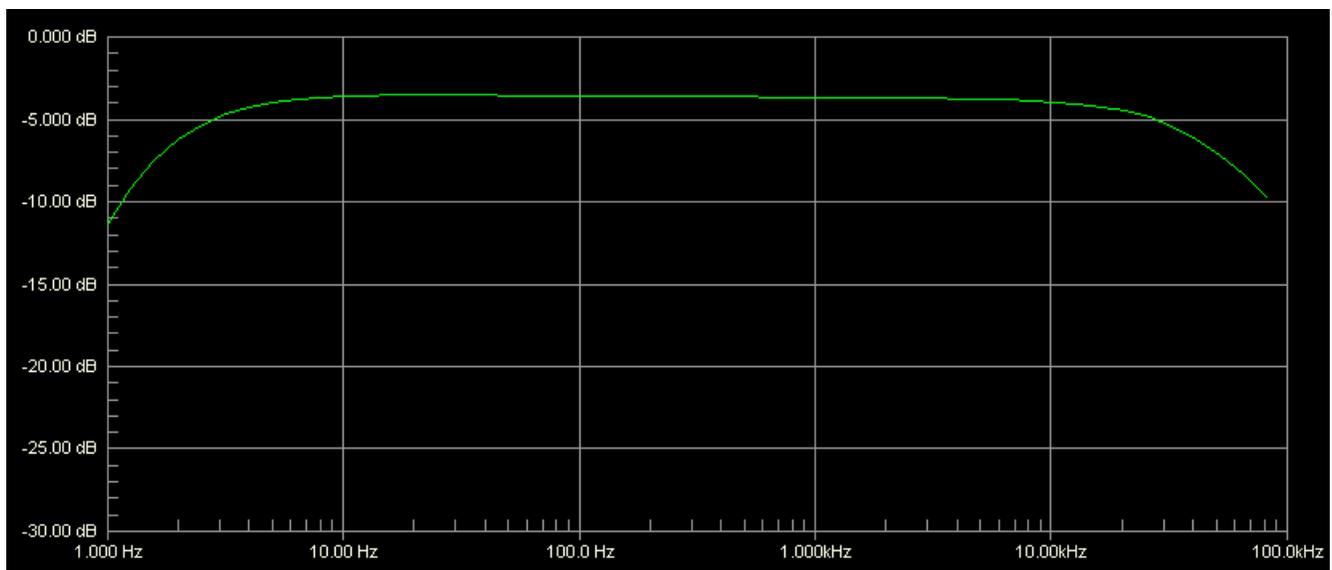
The link below, is an alternative regulated variable power supply, it uses an LM317. By adjusting VR1 you can obtain the desired voltage.

<http://www.electronics-project-design.com/VariableDCPowerSupply.html>

This can be used for powering the RIAA, but don't expect the same sonic performance as the shunt regulator that is described in the document. This is good for temporary use, or for troubleshooting.

### Response Curves

Frequency response: Total transfer function when fed with RIAA equalized vinyl signal



Inverse: Measured actual RIAA response.

Left

PHS

