

Salas Simplistic NJFET RIAA

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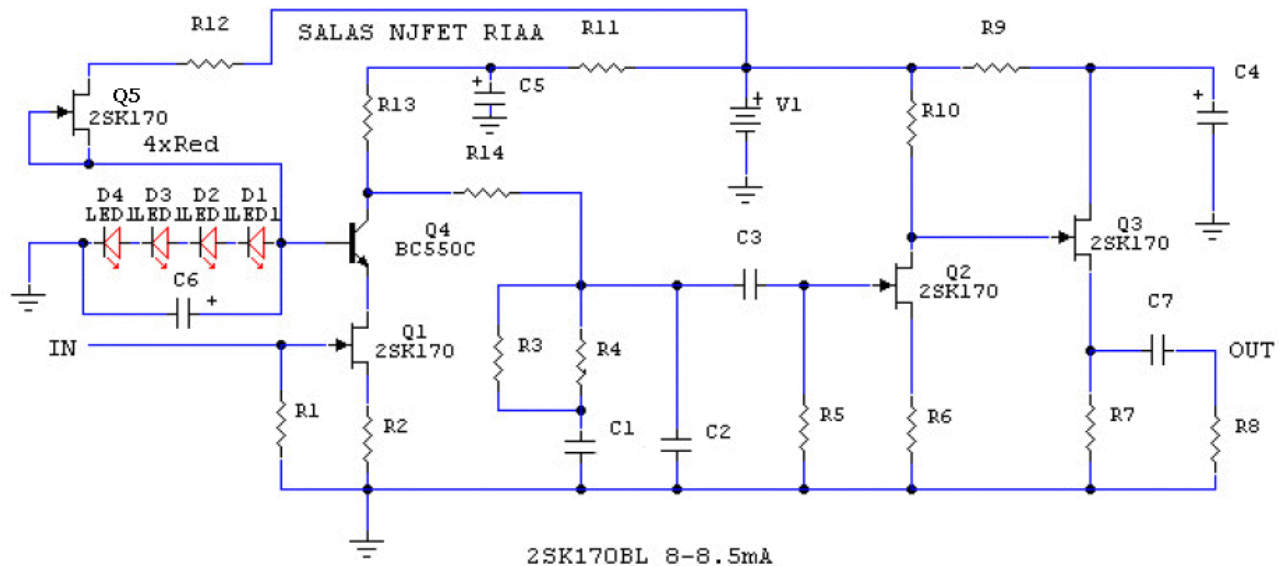
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Introduction

The initial idea was to create a simple circuit that could put to use some spare JFETs after the DCB1 line buffer experiments and just don't sound offensive.

The RIAA circuit

One thing led to another since it proved better than expected, and after experiment and research, I developed the following circuit (Ver.PDFF):



How it works

There is an input JFET-BJT cascode stage(Q1,Q4) with a local shunt type voltage stabilizer for base bias(Q5,D1-D4,C6), to keep input capacitance and distortion low and to give enough initial flat gain. The passive RIAA filter follows(R14,R3,R4,C1,C2). A JFET common source stage(Q2) amplifies the filtered signal further and hands it to a JFET source follower buffer output stage(Q3) for easy drive of cables and line input stages down to 20kOhm. The concept is about a simple, single ended, no loop feedback, adequate noise JFET phono circuit. The (R1) input load component can be chosen to cater for any cartridge loading needs. The circuit as a whole is non inverting and has about 30 Ohm output impedance. The values in the component table will work correctly only for 8-8.5 IDSS K170BL. You can find response curves in the appendix section. Other specialized MC versions with up to 4 input JFETs and V1.2 regulators are not to put in a general guide due to dedicated trimming of values that add difficulty of execution. Even scarce JFET types have been used in those.

Characteristic and Component Table

	HiMC/MM**	Regular MC
Gain	43 db	56db
Input sensitivity	1.5 – 2.5 mV	0.4 – 0.6 mV
Output Impedance	30 Ohm	30 Ohm
Operating Voltage	28V	38V
Q1	2SK170BL	2SK170BL
Q2	2SK170BL	2SK170BL
Q3	2SK170BL	2SK170BL
Q4	BC550C	BC550C
Q5	2SK170BL	2SK170BL
D1	1.7V/20mA	1.7V/20mA
D2	1.7V/20mA	1.7V/20mA
D3	1.7V/20mA	1.7V/20mA
D4	1.7V/20mA	1.7V/20mA
C1	47nF	47nF
C2	15.33nF (15n//330p)	15.33nF (15n//330p)
C3	100nF	100nF
C4	470uF/35V	470uF/50V
C5	470uF/35V	470uF/50V
C6	470uF/16V	470uF/16V
C7	2.2uF	2.2uF
Clload (not shown, // to R1)	*	*
R1(Rload)	47K *	330R *
R2	33R **	4.7R
R3	1M	1M
R4	6.8K	6.8K
R5	1M	1M

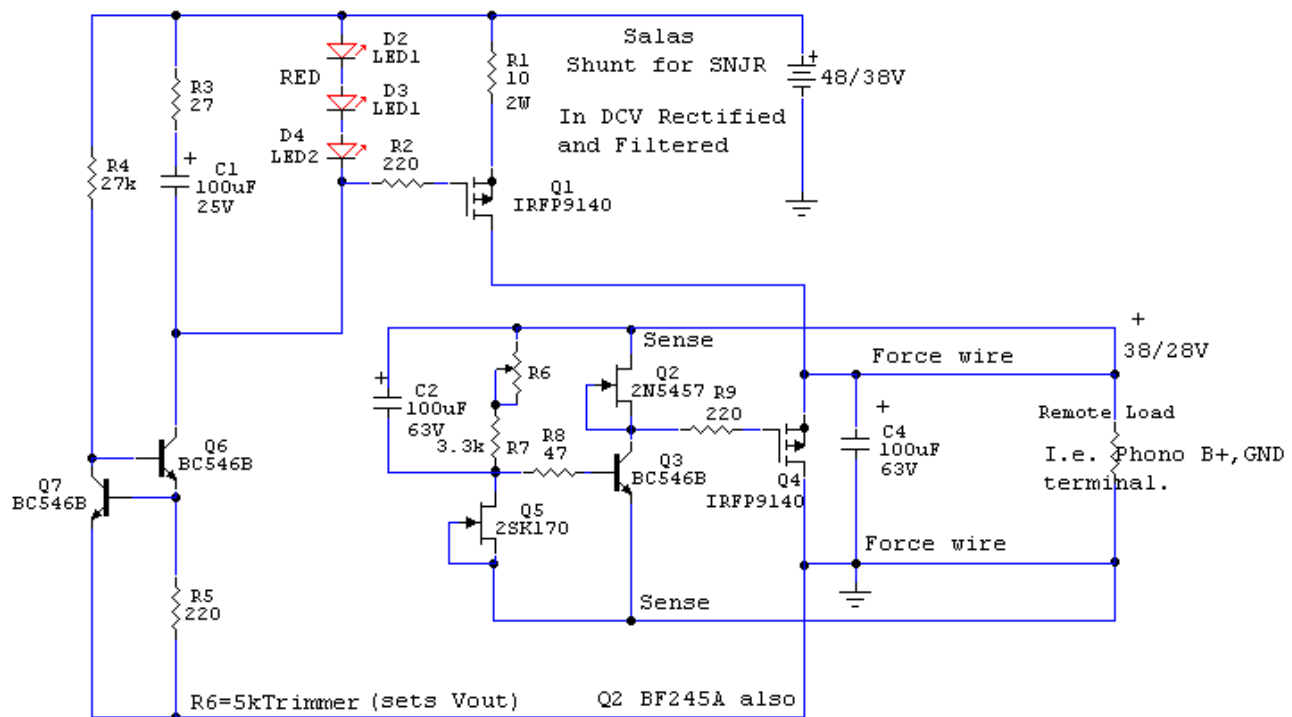
R6	39R	39R
R7	1.5K	1.5K
R8	1M	1M
R9	1.2K	2.7K 1/2W
R10	4.3K	6.8K
R11	220R	120R
R12	1.2K	2.7K 1/2W
R13	2.4K	3.3K 1/2W
R14	47K	43K+2.7K in series

* For the values of Cload and R1, check your cartridge's manual, for the manufacturers recommended values. For Cload consider 150pF in TT cable and 50pF residual in phono, and subtract this from the total that your manufacturer recommends. MC cartridges normally don't need Cload.

** In the case that your cartridge has high output, 4-5mV (most MM type do) the value of R2 should be 100R, this change makes the circuit a 37 db gain version.

Power Supply

To power the RIAA circuit, a Salas type shunt regulator version 1.0.5 is used. This is recommended for optimum sonic performance.



This is an adjustable Shunt regulator, by adjusting R6 you can select the desired output voltage of the

shunt. A 0.25 – 0.5 W rated trimmer is good for R6 (0.5 W is preferred).

The input voltage of the shunt is 38 or 48 V DC, so a 28 or 36 V AC transformer is needed.

If you are to build the HiMC/MM version go for a 28V transformer, otherwise go with a 36V transformer. 50VA in both cases. This way you avoid unnecessary thermal buildup in the shunt.

The force and the sense wires form a Kelvin connection, this ignores their resistance. It's good to twist these pairs per function, the force pair and the sense pair. This regulator only works with all 4 wires to the load. Q1 and Q4 should be mounted on a 1C/W common heat sink, if you can't find the IRFP9140 you can try the IRFP9240, they will work fine. Use insulation pads. Also IRF9520 for Q1 and IRF9540 for Q4 have been used by builders in cheaper TO-220 package. Those need insulated mounting screws also. Each channel of the RIAA consumes about 30mA.

Use $R=V/I$ and $P=V*I$, to compute the value of your load resistor for testing your shunt.

Where V is the output voltage of the shunt and I is the consumed current. (If you are going to use one shunt for both channels then $I = 0.06\text{ A}$).

This resistor is not part of the circuit, it's just a dummy load resistor that we use for setting up the shunt, and should be removed afterwards when the shunt is connected to the RIAA.

Construction

First decide which version is right for you. This depends on the cartridge that you use. Gather the necessary parts for the version that you are building, refer to the Components Table.

In general, for resistors you can use 0.25W rated resistors, unless it is otherwise noted. Use good quality metal film like PRP or modern carbon resistors like Takman. Up to Bulk Foil Z have been reported in use by some builders. In general, the users feedback favors good quality parts in this. For Cloadx, Polystyrene or Silver Mica should be used. For the RIAA caps(C1, C2 the 15.33nF and 47nF) good film caps (like Vishay MKP 1837) or Silver Mica, and Teflon or MKP for interstage, other types of capacitors will also work. If you have a capacitance meter or DMM with this capability, measure your RIAA caps, you might need to add a small trimming cap to round their values close to the needed values. For the output cap, use a good audio grade cap (Obbligato Gold or Auricap is recommended or whatever you can afford). For the Electrolytic caps, Panasonic FC or FM or Elna Silmic are good(Black Gates even better). For Cfilter, Panasonic FC or TS-HA. For the rectifiers, you can use your favorite rectifying bridge or diodes.

For the RIAA you must match your 2SK170BL JFETs. The JFETs are to be matched per stage between channels at 8-8.5mA Idss. You can refer to the appendix for more info on how to match your semiconductors. Use your best matched Idss JFETs pairs for Q1 and Q2. Q5 is not an amplifying JFET, it is just a constant current source for the LEDs. The LEDs are happy between 6-10mA. Use a couple of JFETs between 6-10mA for those positions that match 1-2mA between them (near one another). Use one of those to prepare the LEDS like in the document's appendix. Finally for the Q3 pair use your slightly worse matched JFETs between 8-8.5mA. Those are unity gain positions.

For the Shunt, no matching is necessary. For Q5 left outs from the RIAA matching will suffice, however, prefer the lower remaining IDSS BL JFET for Q5. One common reg for both channels is fine, one per channel is better. 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 to 1.9V generic LEDs (R,Y colors are OK, avoid the blue and ultra bright ones as they are noisy).

In the appendix, you can find a diagram for measuring the voltage across a string of LEDs.

In general, red Leds are normaly 1.7-1.9 Vf, green Leds are 2-2.2 Vf.

So that $R1 = (LedStringV - VgsQ1) / targetIccs$.

Where targetIccs is around 200mA(0.2A) and VgsQ1 should be around 4V. You can measure it with

your DMM. At 170-200mA, this is a good current, enough for running two RIAA channels and providing enough bias for Q1.

At the time of this writing there is no PCB for this version of the RIAA. The circuit is fairly simple, you can build it P2P. The direct connecting technique is alleged to can be subjectively better also.

If you have any questions or need help fill free and use the thread:

<http://www.diyaudio.com/forums/analogue-source/129126-simplistic-njfet-riaa.html>

to get answers.

Enjoy the Music

Disclaimer

The use of the materials described in this document is for private DIY use only. Any build for profit demands the consent of Salas.

Epilogue

I PSGR created this document. I gathered some information and with the help and guidance of Salas I completed this document. I tried to cover everything, I hope I did.

“Ουδέν προ του τέλους μακάριζε”
an old Greek saying.

Appendix

Matching Jfets

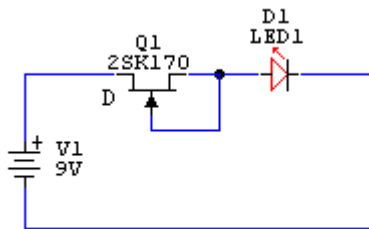
You can go to :

http://www.diamondstar.de/transistor_matching_jfet.html

and read about how to match your Jfets.

Measuring a LED

The following diagram shows a simple circuit that you can use to measure the Voltage across a LED. Connect a K170BL Drain to a 9V battery (+), G&S together, then your LED in series with its cathode to (-). Measure the Voltage across the LED. Note down for enough LEDs and combine to spec for the needed triplets in PSU and quartets in the phono. This is a method near to conditions in the circuits.



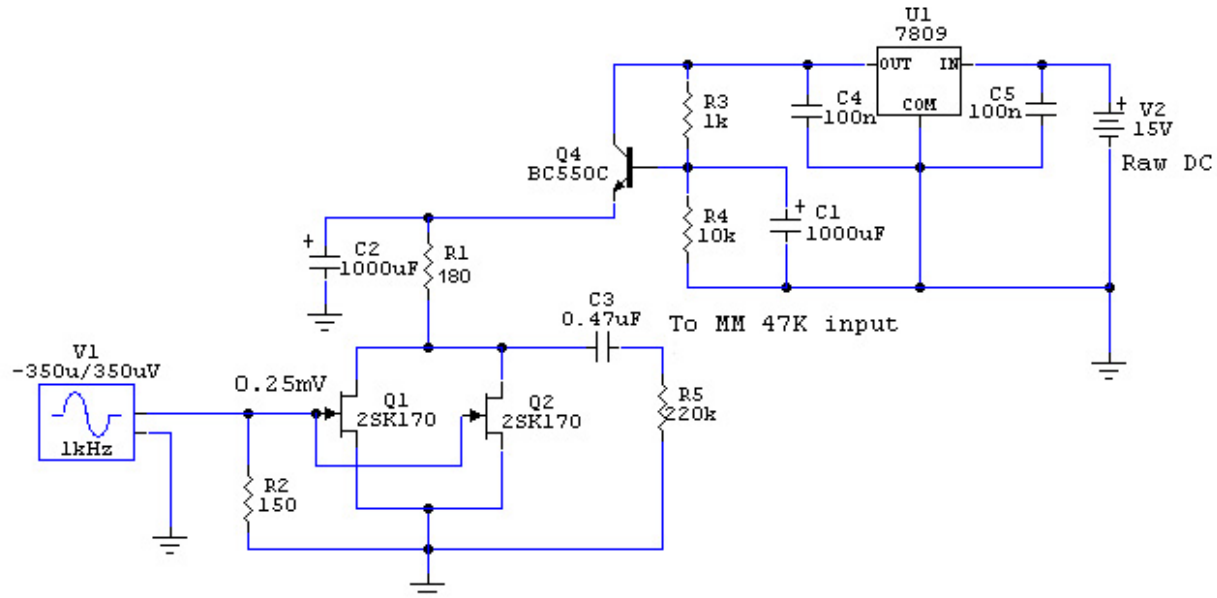
The voltage across the LEDs

must be approximately:

for the Shunt: 5.4-6V(3 LEDs),

for the RIAA: 6.8 - 7.6V(4 LEDs). For the RIAA, try to keep the Voltages the same between channels (match them). You can even mix red, yellow, and green if it helps matching and correct total voltage.

Low MC pre-pre

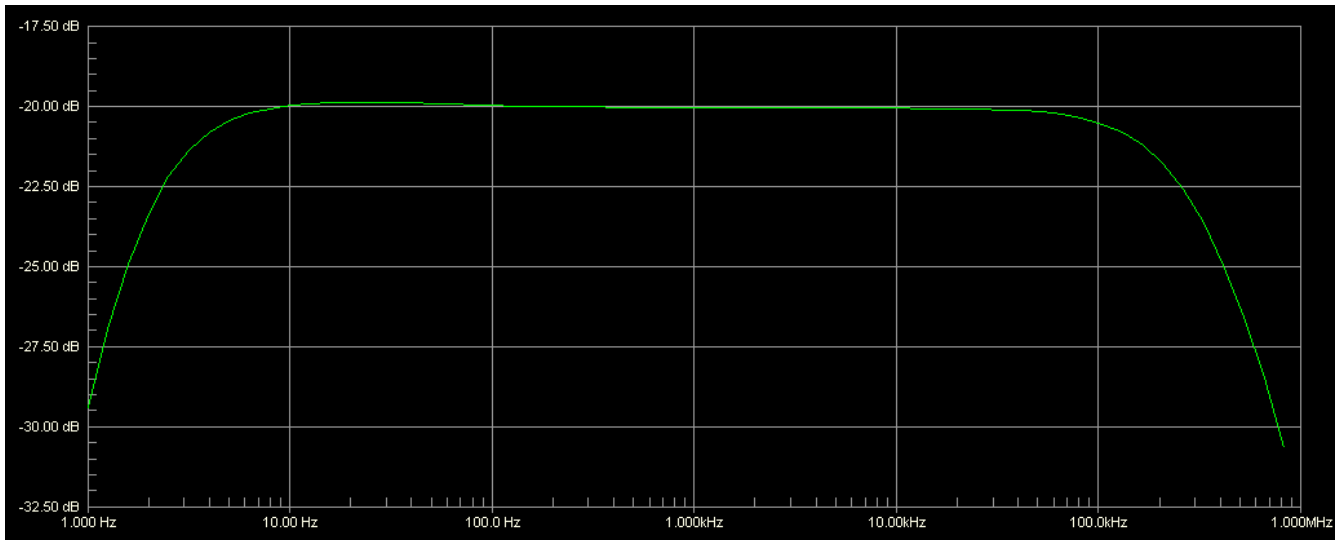


(20dB) Low MC pre-pre
7mA K170BL 0.71nVrtHz on
a good day :-) Salas 010

In case you have a Low MC 0.15-0.25 mV type cartridge, you can use the above circuit and build a Low MC pre- pre. This will give you enough signal gain to drive the HiMC/MM RIAA circuit. They will reach 63dB gain together. That gain is usually adequate for LowMC cartridges. R2 is the load resistor and can be changed to the one recommended by the individual LowMC cartridge's spec. Another option to building the active pre-pre is you integrate a 1:10 step up transformer with a HiMC/MM build. To build this simple circuit you will need to match its 7mA IDSS JFETs. It has a local chip regulator and a further filter, since its very sensitive to power supply noise. Its not in need of very low power supply impedance as it swings next to nothing. You can use a small 12VAC transformer and bridge rectifier plus a good quality 4700uF capacitor to feed it its own raw DC housed in a separate box.

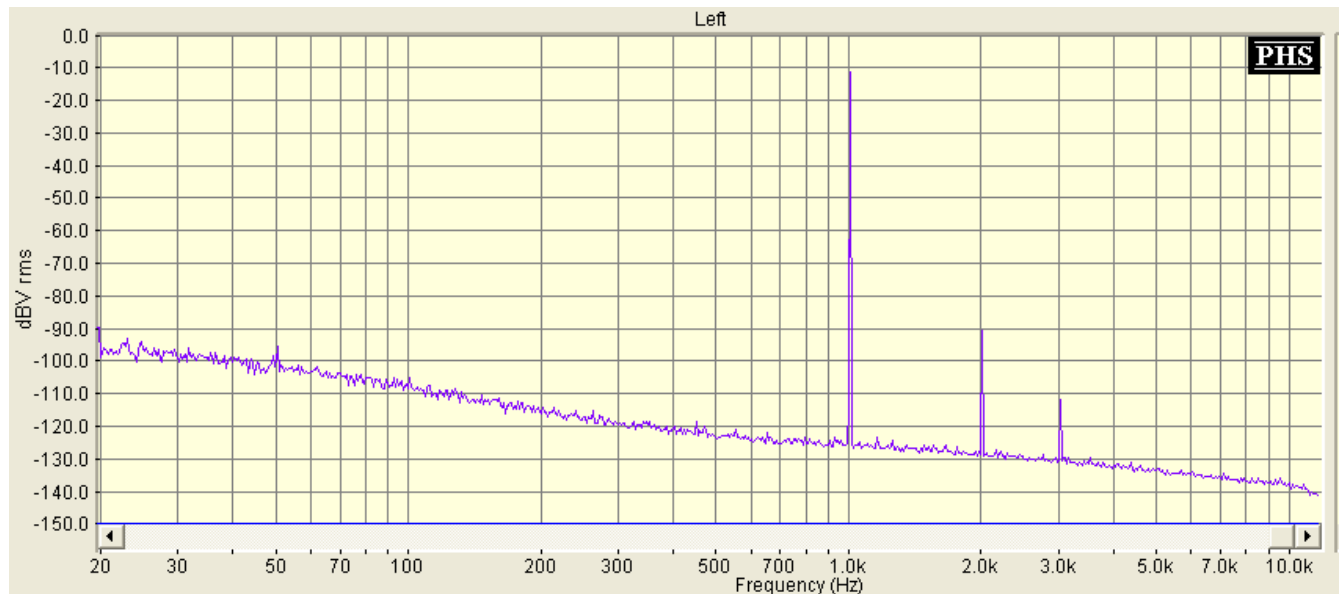
Response Curves

Frequency response, of the MC version:



This phono adheres to Lipshitz classic RIAA alignment and avoids the “disk cutter” boost extra zero, due to Salas subjective preference. It has been tested by Salas on the majority of his vinyl collection.

THD and noise floor, of a sample Low MC build:



The above achieved 0.012% THD with 0.25mV input and near 300mV output.

0.02-0.04% THD occurs in most builds with higher input level leading to different stages stress.

Noise can be even lower with the less gain builds. It has been reported as satisfactorily non intrusive by many builders in several systems. Chart's 0dBV=1VRMS.