

Module R

Voltage Regulator for Power Amplifiers

Assembly Manual

Copyright © Audial d.o.o Belgrade, Serbia

Assembly Manual Revision A, 02 August 2008
This manual is valid for PCB rev0-02062008



www.audialonline.com
info@audialonline.com

Copyright © 2008 Audial d.o.o. Belgrade. All rights reserved.

The content of this document is not public domain and may not be reproduced or published without written permission of copyright owner.

IMPORTANT PRECAUTIONS



1. This product uses potentially lethal voltage. Building should be attempted only by skilled and competent persons. No liability is assumed by Audial d.o.o.



2. This Assembly Manual is a guide only. Again, no liability is assumed by Audial d.o.o.

The lightning flash with arrowhead symbol within an equilateral triangle is intended to alert the user to the presence of uninsulated “dangerous voltage” within the product’s enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

The exclamation point within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the product.

Warranty

Audial claims proper conditions of the parts and materials sold. This applies to the Printed Circuit Board, passive and active parts, whether soldered to the board or not, as well as to the transformers. Warranty is valid for two years since the day of purchase.

Audial also claims bug free project but shell take no responsibility for proper working of the units, or the parts of the units, which are not assembled by authorized personnel.

For all the items sold directly by Audial invoice is also guarantee certificate. Warranty is fully transferrable from original to subsequent owner(s).

Module R

The Module R is relatively simple voltage regulator without a feedback (so, if you like, you can rather call it a “stabilizer”, but it changes nothing really). It has been initially released in January 2004 via www.pedjarogic.com/gc/supplies.htm (scroll down, please).

Module R can feed class AB amplifiers, delivering instant currents of 5A or more. This way it can feed two channels of 25-30W / 6 Ohms amplifier. It can be also used with small class A amplifiers, supplying constant currents up to 1-1.5A.

Principle of operation

Transformer secondary AC voltage is rectified by Schottky diodes based bridges, and separate bridge is used across each secondary winding. The first caps (C1/C3) are charged directly, and second pair (C2/C4) is fed via resistors placed across each rail, forming thus a common mode CRC filter. Such a smoothed voltage supplies JFET current sources Q1/Q5, set by R6/R12 to 3-8mA, which feeds Zener references. These Zeners voltages are further smoothed by RC network (R7/C5 and R13/C7), and they are controlling the bases of the output Darlington's (Q2/Q3/Q4 and Q6/Q7/Q8). Caps C6/C8 bypass the outputs and they are actually better if placed as close as possible to the amplifier itself, instead to the regulator board.

This regulator can be used either with one or with two channels of amplifier. Recommended wiring layout is shown at this end of this document.

Normally, two separate secondary windings are recommended, however center tapped transformer can be used as well. This will however discard the use of common mode CRC filter, and will make a choice of Schottky diodes harder, since their reverse voltage rating would have to be able to hold twice higher voltage. A couple of changes are needed for use with centre tapped transformer. Firstly, D3/D4/D5/D6 have to be omitted, and input connections have to be jumpered (two inner and two outer have to be tied together). Thus the bridge will be formed by D1/D2/D7/D8. Resistors R2/R3 have to be replaced by jumpers, and transformer center tap has to be connected to this point (preferably the right side of these jumpers). Resulting setup is shown at the end of this document.

Setting up the output voltage

Once you choose particular voltage to feed you amplifier, you need to consider the following to set it and make the regulator work correctly.

1. The output voltage is set by Zeners D9/D10 and is about 1.8V lower than the voltage of the Zeners themselves (this 1.8V is the sum of V_{be} of three Darlington transistors). So you will normally choose 20V Zeners to set 18V output voltage.
2. When determining needed transformer voltage, please consider the following issues:
 - Transformer voltage is always specified as an RMS voltage (of loaded transformer). Since, as we all know, it is (ideally) the sinewave that we are dealing with, the peak voltage is $\sqrt{2}$ i.e. 1.4 times higher.
 - Rectified voltage is equal to the peak and not to the RMS voltage, however you should consider “loss” of at least 1-2V. This is due to a drop across the diodes, but also because capacitors can not fill to the real peak value. The 22V AC transformer, along with SB560 diodes and 4700uF TSHA caps, will produce about 30V DC at quiescent current of about 80mA. Also, a higher current consumption will further decrease the voltage that capacitors fill to (“voltage sagging”).
 - Take into account the voltage drop across R1-R4, and its relation to the load current; it will increase as the load current will increase.
 - Considering all this, you should determine transformer voltage so the voltage across C2/C4 is at least 4V higher than the Zeners voltage. It is fine if you provide additional 3-4V of headroom.

So, for example, if you want 18VDC output to feed 15W AB class amplifier, a 20VAC transformer, along with 5W 0.68R-1R for R1-R4, will suffice for one, and 22VAC will be more than adequate for both channels of stereo amplifier.

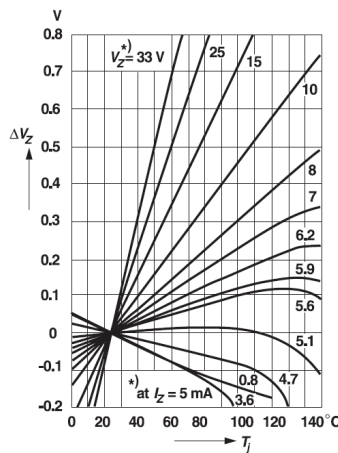
3. Transformer voltage, determined as suggested above, is minimal required transformer voltage. Going with higher transformer voltage will increase the voltage drop and power dissipation on Q4/Q8 and thus it will also increase heatsinks requirements. Use of a higher transformer voltage however won't hurt in itself, so long as you can provide adequate heatsinking, and so long as you are not going beyond proposed voltage rating of the parts used.

(R TEST + and R TEST - are required to load the regulator output during the test, pulling some current through the Darlington. These resistors are not needed in normal use.)

Thermal drift

The whole regulators have positive temperature drift. This is mostly associated to the positive temperature coefficient of the Zeners, but is also caused by the negative temperature coefficient of transistors V_{be} ($-2\text{mV}/^\circ\text{C}$), which increases the voltage drop on Darlington for -6mV with each $^\circ\text{C}$. The total drift anyhow shouldn't be higher than 0.7-0.8V for regulator set for 20V output, which is normally of no

concern. The following graph shows an example of temperature dependency of one Zener diode (Vishay BZX79).



Accommodating Module R to specific requirements; Technical Support

It is possible to accommodate Module R both to the different output voltages as well as to the different current requirements. It is however important to choose the parts and heatsinks with proper ratings i.e. capabilities.

Also, since local availability of some parts normally differs, it is possible to swap most of the listed parts by the other ones.

It would however take too long to name here all possible variants. Hence, as long as you have specific needs and you are not sure what to do and how, it is recommended to ask, either directly, via www.audialonline.com/contact/ , or using Audial DIY forum at www.diyhifi.org/forums/viewforum.php?f=35 .

PCB

PCB revision 0 is 1.6mm, FR4, one sided board, with 70 μm copper. It will accept many standard PCB heatsinks, up to 2.7 $^{\circ}\text{C}/\text{W}$, or even some bigger ones (if one can come across them at all, of course).

Errata: Revision 0 PCB misses connection between the negative regulator output and negative end of C8. As said, it is anyhow recommended to place caps C6/C8 as close as possible to the amplifier and not to this PCB, but if one still wants them there, it is easy to fix this missing track leaving C8 capacitor lead a bit longer and connecting it to the neighboring output terminal (rev 0 users will be provided by the picture that shows this).

Module R :: Parts List

Semiconductors

#	qt.	designation	part	comment
1	8	D1-D8	Schottky	SB560
2	2	D9, D10	Zener	see text
3	2	LED1	Red LED	
4	2	Q1, Q5	J309	
5	2	Q2, Q3	BD139	
6	1	Q4	BD911	
7	2	Q6, Q7	BD140	
8	1	Q8	BD912	

Capacitors

#	qt.	designation	value	part	suggestion / comment
1	4	C1-C4	4700uF/35V	elco	Panasonic TSHA (ECOS1VA472CA)
2	2	C5, C7	100uF/25V	elco	Panasonic FM or FC, or Black Gate Std
3	2	C6, C8	33-100uF/25V	elco	Black Gate N or Std, or Panasonic FC or FM

Notice: Electrolytic capacitors voltages ratings shown are guiding values only. They should suit voltages of actually used transformer and Zener.

Resistors

#	qt.	designation	value	part	comment
1	4	R1-R4	see text	see text	
2	6	R5, R6, R9, R11, R12, R15	220R	1/4W carbon	
3	4	R7, R8, R13, R14	1k	1/4W carbon	
4	2	R10, R16	100R	1/4W carbon	
5	1	RLED	10k	1/4W carbon	
6	2	RTEST+, RTEST-	1k	1W	required for testing only

Mains Transformer

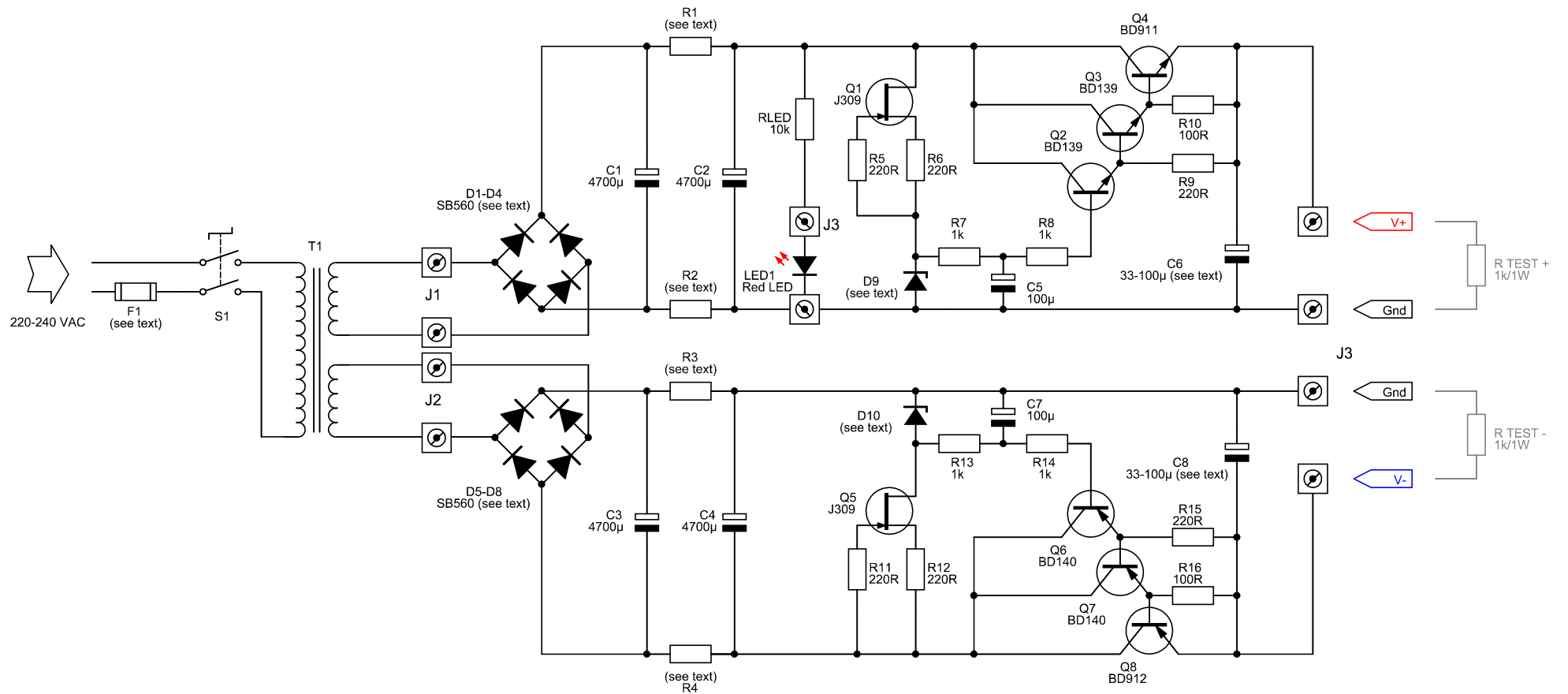
<i>primary</i>	<i>secondary windings</i>	<i>voltage / current</i>	<i>comment</i>
<i>220-240V AC (or 110-120VAC) 200 or 400VA</i>	two or four equal windings	see text	

The kits comprise the mains transformer using a double (bifilarly wound) 115VAC primary.

For use in countries with 220-240V mains voltage, these windings have to be connected in series and out of phase, and this is achieved by tying up the leads 2 and 3 together; mains power is then connected to pins 1 and 4.

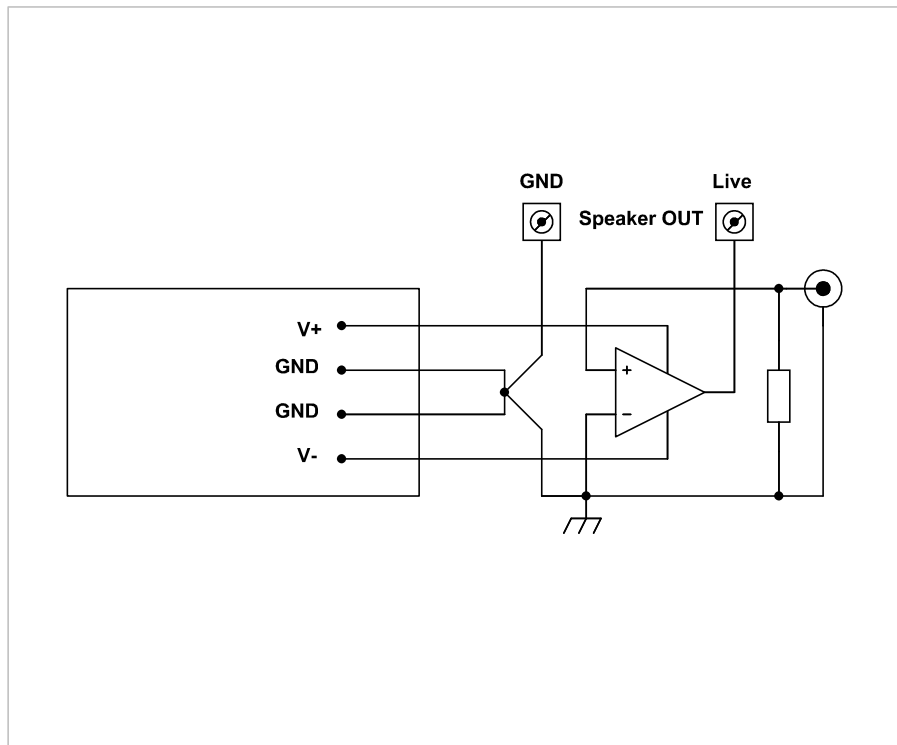
For use in countries with 110-120V mains voltage, these windings have to work in parallel and in phase, and this is achieved by tying up the leads 1 and 3 (one mains lead goes there), and 2 and 4 (the other goes here).

Yellow/green lead is an electrostatic shield between primary and secondary windings, and it has to be connected to the earth ground.

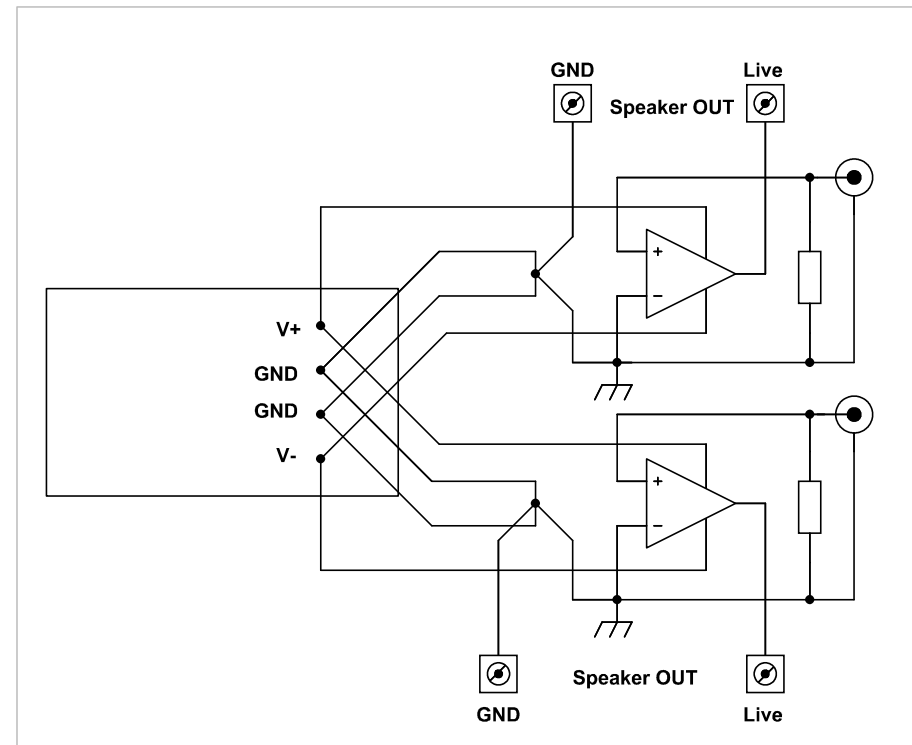


Company	Audial d.o.o. Belgrade			Sch revision		
Description	Module R :: Regulator for Power Amplifiers			No.	Date	By
Sheet	1 of 2 (Schematic)					
Drawn by	PR	Date	22 Jul 2008			
PCB revision	0	Date	02 Jun 2008			

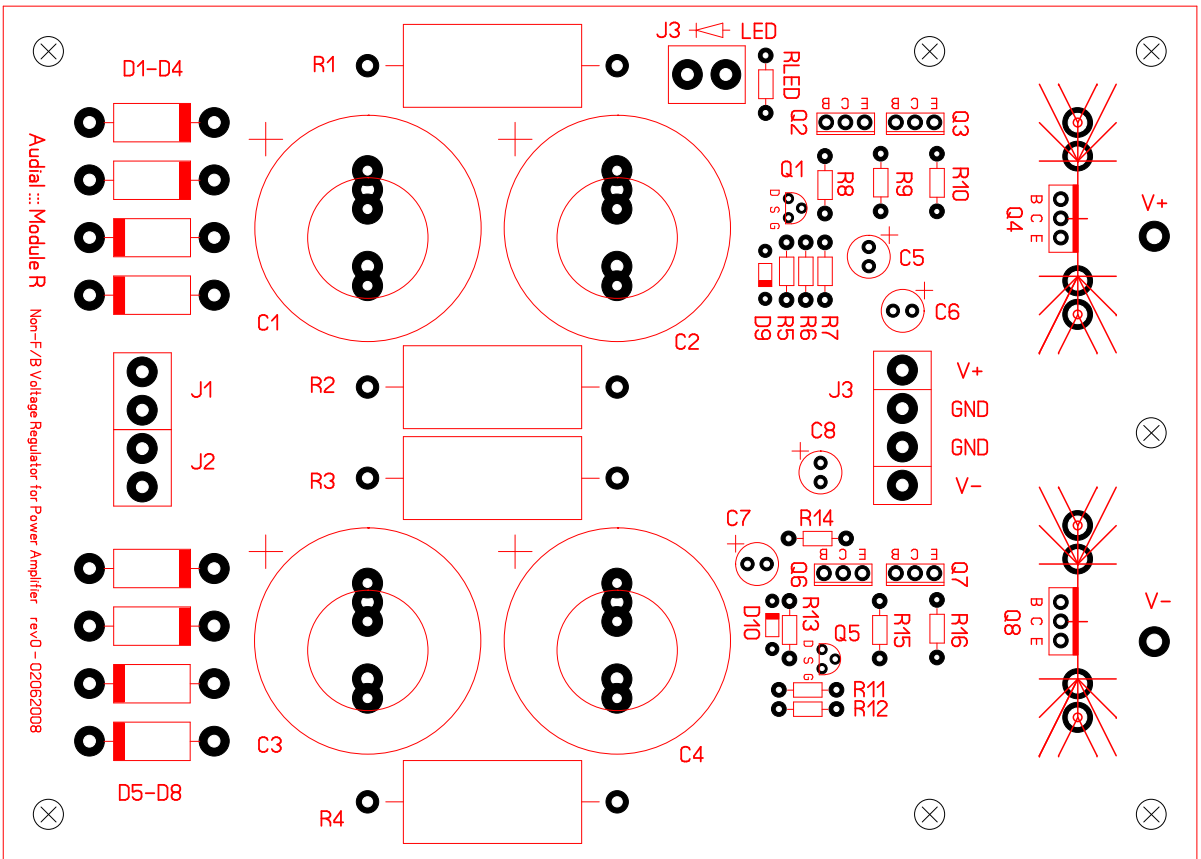
Module R, feeding one channel

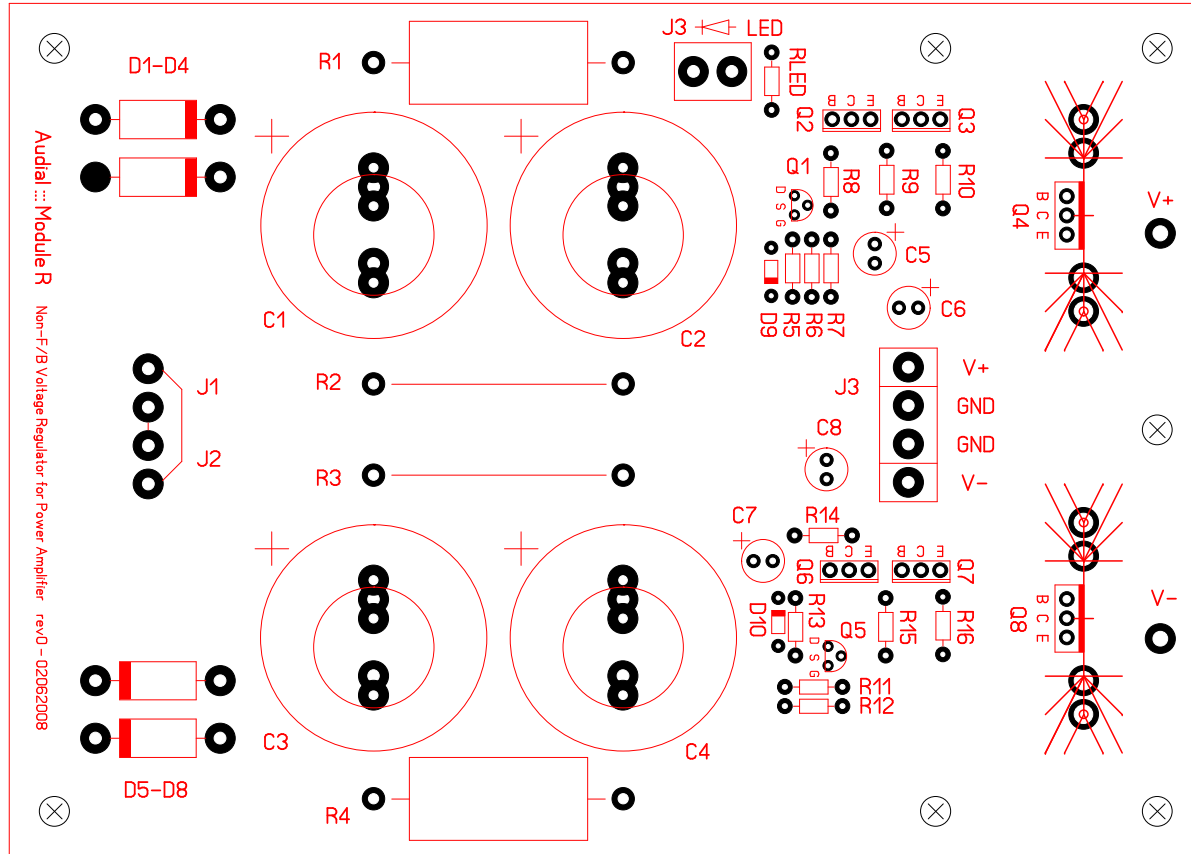


Module R, feeding two channels



Company	Audial d.o.o. Belgrade			Sch revision		
Description	Module R :: Regulator for Power Amplifiers			No.	Date	By
Sheet	1 of 2 (Wiring)					
Drawn by	PR	Date	25 Jul 2008			
PCB revision	0	Date	02 Jun 2008			





Module R
including the changes for use with
center tapped transformer

Module R Assembly Manual revision history

Revision 0, 26 July 2008 (the first release)

Revision A, 02 August 2008:

- Current capabilities clarified for use with both class AB and class A amps

