Superregs for your signal level projects **updated for V 2.3 Jun 2015**

Jan Didden

It's a recurrent issue: you want to build a preamp, a DAC, a phono stage, anything that needs a nominal supply voltage between 3.3 and 15VDC, positive and/or negative polarity. Sometimes you want several supplies to isolate stages from mutual interference via the power supply. So you want a power supply regulator that approaches an ideal DC voltage source as best as possible within reasonable cost. In your search, you inevitably run into the term 'superreg' – so where does the name come from and what is it?

The history of very high performance low-voltage regulators is well documented on Walt Jung's website (http://waltsblog.waltjung.org/ . An early design that attracted attention was Mike Sulzer's, published in 1980 and 1981 in Audio Amateur. I added something to that in 1987, and then I was invited by Walt Jung to work on a further improved version. This was published in a series of four articles in Audio Amateur in 1995 by Walt (part 1, 2) myself (part 3) and Gary Galo (part 4). To the best of my knowledge, it is to this design that the term 'superreg' refers to. Later on, Walt published some additional refinements in 2000 in AudioXpress, the successor to Audio Amateur.

There's a lot to say about these designs and although they do look relatively simple, almost all components and details are optimized in long hours of testing. The articles on Walt's' website give all the details so I will limit myself to the schematics here. If you are interested in detailed measurements, see again the original articles or the recent (2012) measurements comparing many regulator designs with listening tests by Jack Walton in Linear Audio Vol 4. The most important of the comparisons are on www.linearaudio.net under Articles (look for 'Color graphs for Jack Walton's regulator article in Vol 4').

One of my contributions to the 1995 series was a compact PCB design for the positive and negative regulator that was sold by Old Colony Sound Lab for more than 10 years. When OCSL folded I received many requests for the PCB and finally I decided to redo it and update it to Walt's' 2000 article, and this article is about this PCB. So without further ado, here is the positive and negative version circuit in figure 1.

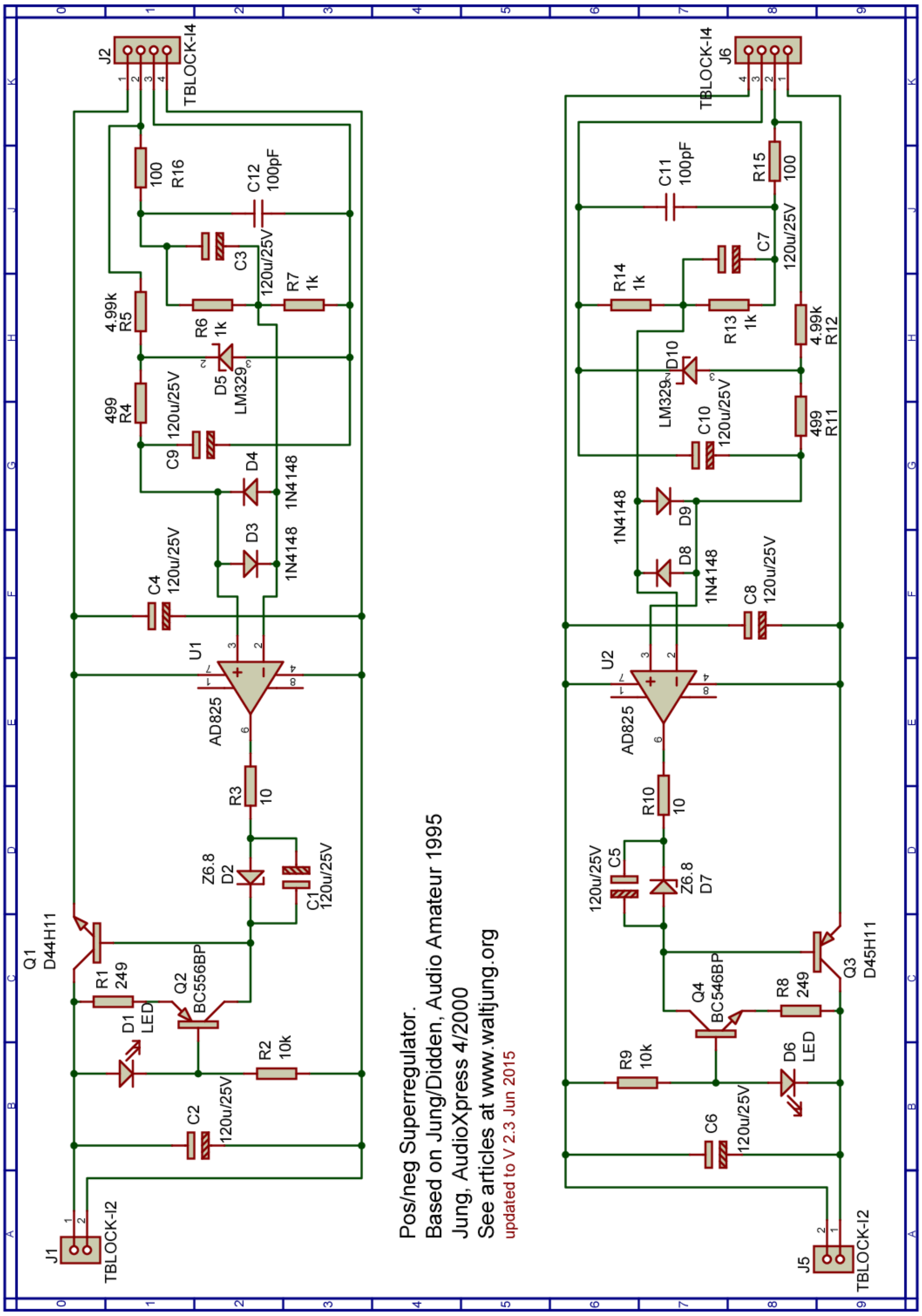

Figure 1 – Superreg circuit diagrams

Without going into details (see the original articles for that) a few comments. The reference voltage is set by D5 (pos version) and D10 (neg version) which is about 6.9V. The output voltage is set by the divider R6-R7 (pos) and R13-R14 (neg). You calculate them from the ratio you need to divide down Vout to the reference voltage (6.9V in the standard version).

The working point of the opamp being, of course, with both inputs almost at the same value. Minimum output voltage is when R6 (or R13) is zero and this cannot be lower than the ref voltage 6.9V. So for a lower Vout like 5V, you need to replace the reference diode by something like an LM4040-2.5 (2.5V) and recalculate the divider ratio to get the output voltage you need. An LM4040-2.5 or equivalent will fit the PCB. You can roll the opamp but not all opamps will be stable in this circuit, not all will start up reliably and not all will work with low voltage reg versions, so that requires some data sheet reading and experimentation. For other output voltages than 15V, you should also adjust the opamp output series zener D2, D7 to keep the opamp output in the middle of the output voltage range. Logically, that means selecting a zener that is about half the output voltage. Not critical – the idea is only to keep the opamp output from working too close to gnd or Vout.

A further important point: to get the best performance out of these circuits you should use the remote sensing option. To avoid voltage drops on the wires between regulator and load circuit, and to avoid ground-induced noise and ripple, the output of each reg has actually four wires instead of two as evidenced by J2 and J6. Two are the usual wires to the load and the ground return, but the actual voltage at the load is separately returned to the regulator sense point and reference ground. In this way, the regulator regulates not just its local output but rather the voltage directly at the load. The load sense wire at the pos reg connects to junction R5, R6 and C3, while the load return connects to R14, D10 and C10; and similarly for the negative regulator. It may be necessary to use a screened cable for the sense lines; the cable screen should be connected to the ground return at the reg board. I have also included a small HF-filter with R15(16) and C11(12) on the sense line. This may prevent any tendency to oscillate in case you have overly long sense lines or an opamp that causes some phase shift.

A word about the input voltage from your rectifier/reservoir caps: make sure is it at least 5V above the required output voltage. The regs will work with just a few volts headroom but performance will suffer. Ideally, you would use two completely separate windings, rectifiers and capacitors and connect each one to J1 and J5 respectively. If you have a center tap (CT) transformer connect the CT and the ground returns of J1 and J5 together at a star point with the reservoir capacitor returns.

Well, that's about it I guess.

Figure 2 is the PCB layout, and figure 3 is the stuffing guide; figure 4 is a picture of the final prototype (without the recommended PCB screw terminals). A single PCB holds one pos and one neg reg. You can easily separate them as they are totally independent, and in either case, all holes are at a 10mm pitch…! The recommended opamp for this is the AD825 but that is only available in SOIC footprint. A good DIL alternative is the AD817 which is also preferred for 5V regulator versions. The PCB accepts both DIL and SOIC footprints. On-board heatsinks are provided for the pass transistors; these are standard heatsinks which are available in various heights to accommodate varies dissipation levels. As a rule of thumb, if you can just touch the heatsink but not hold it for long, it's at about 45-50 degrees centigrade and that's fine for the pass transistor. Connections to the board can be made with PCB-mounted screw terminals, or you may elect to solder them directly to the board. PCB boards are available through the diyaudio store; look in the 'Circuit Boards' category.

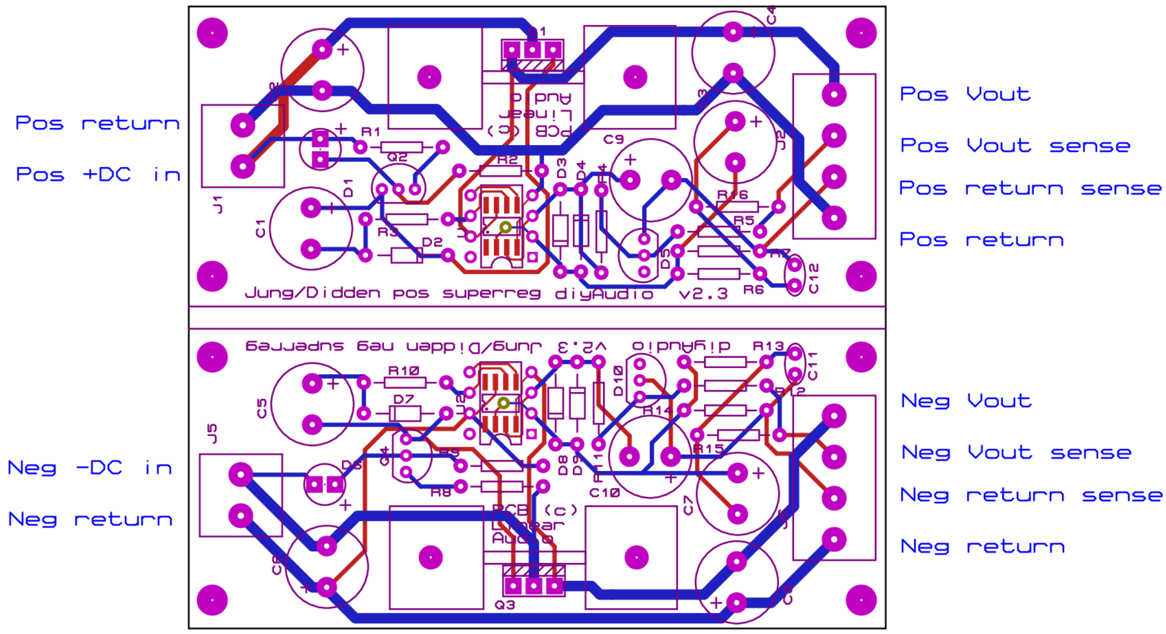

Figure 2 - PCB layout and connections

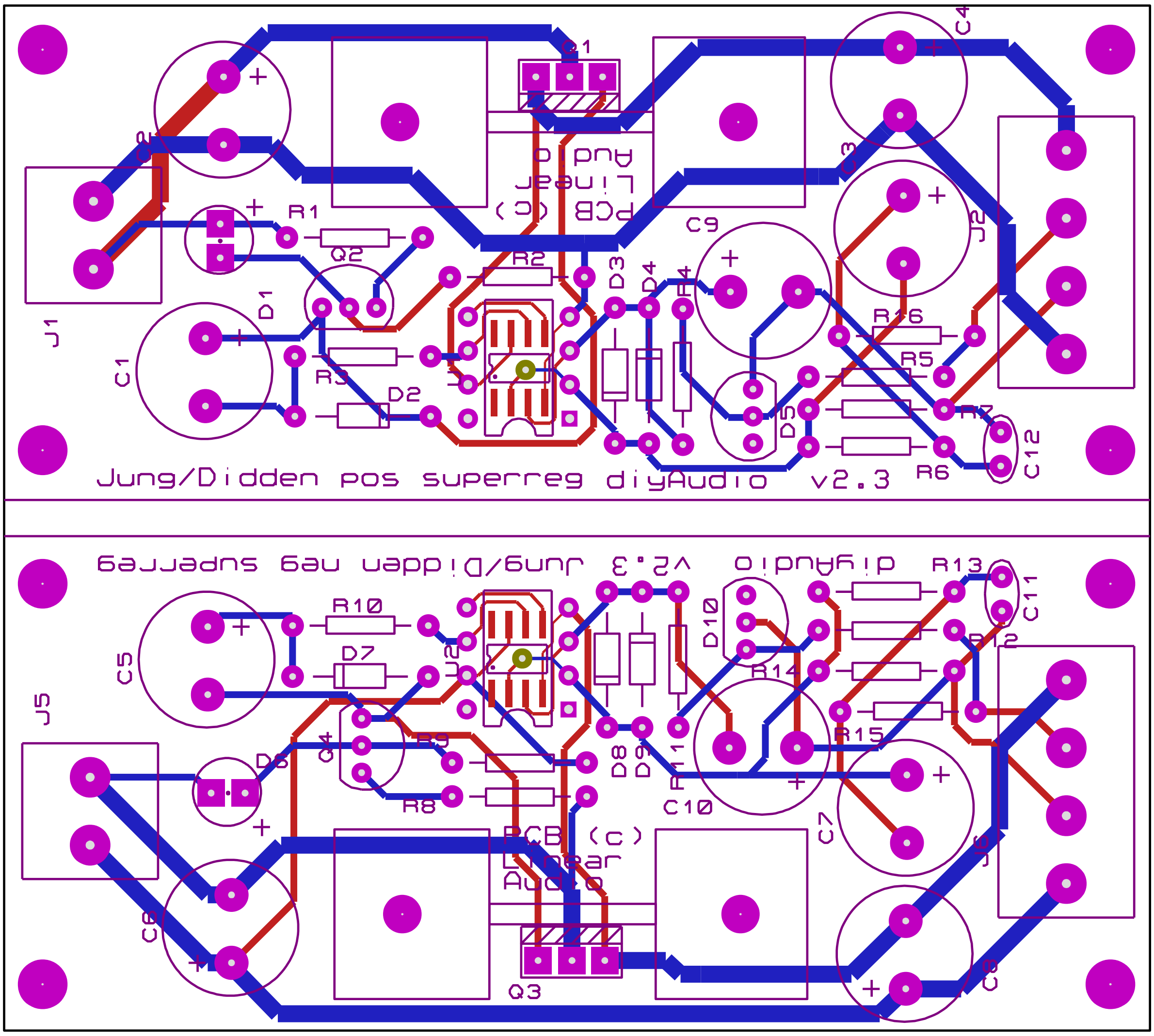

Figure 3 – PCB stuffing guide

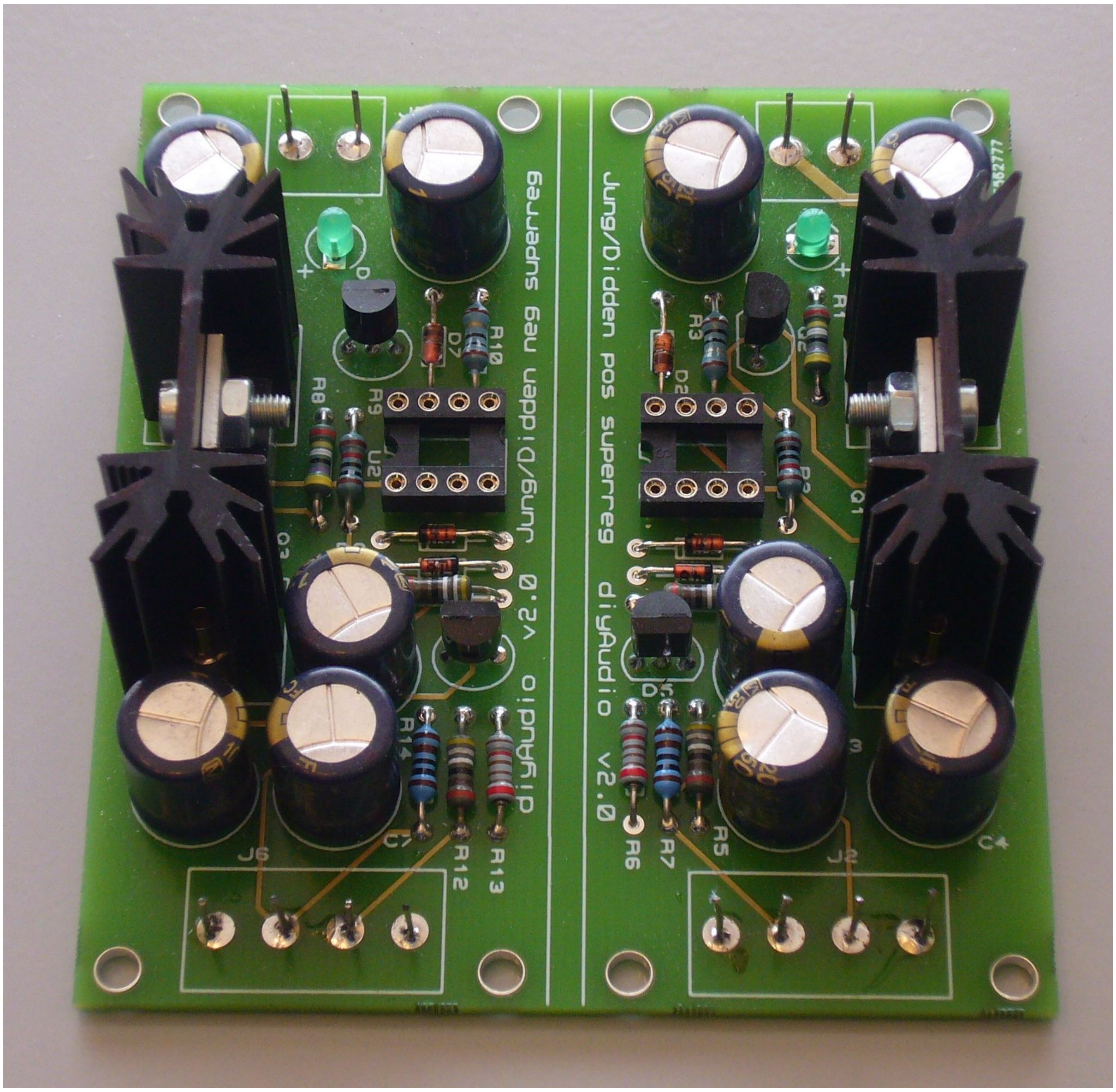

Figure 4 – prototype V 1 superreg (without recommended PCB screw terminals). V2.3 has same form factor and pretty much the same layout.

Finally, Table 1 lists the Bill of Materials. None of the parts should be difficult to source from the usual suspects, and of course you can splurge on any boutique parts you want, although that is unlikely to produce audible differences in this highly optimized circuitry.

And, don't put a high-quality film cap at the output of the regulator! The reg likes to see some lossy capacitance at the output for stability so a regular electrolytic of minimum 10uF (and don't overdo it) at the output or at the load would be helpful here.

Now go build something!

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Pos/neg. superregulators Bill of materials updated to V2.3 Jun 2015

Category	Quant.	References	Value	description
Capacitors	10	C1-C10	120u/25V	pitch 5mm/0.2" (1)
	2	C11, C12	100pF	ceramic 0.1"pitch
Resistors	2	R1,R8	249	0.25W film
	2	R2,R9	10k	0.25W film
	2	R3,R10	10	0.25W film
	2	R4,R11	499	0.25W film
	2	R5,R12	4.99k	0.25W film
	4	R6-R7,R13-R14	1k	0.25W film
	2	R15, R16	100	0.25W film
Ics	2	U1-U2	AD825 or AD817	DIL-08 or SOIC
Transistors	1	Q1	D44H11	TO-220 (or equivalent)
	1	Q2	BC556BP (or -C)	or equivalent PNP; TO-92
	1	Q3	D45H11	TO-220 or equivalent
	1	Q4	BC546BP (or -C)	or equivalent NPN; TO-92
Diodes	2	D1,D6	LED	pitch 2.5mm/0.1"
	2	D2,D7	Z6.8	0.25W
	4	D3-D4,D8-D9	1N4148	or equivalent small-signal
	2	D5,D10	LM329	TO-92
Misc	2	J1,J5	TBLOCK-I2	2-pin screw terminal 0.2"pitch
	2	J2,J6	TBLOCK-I4	4-pin screw terminal 0.2"pitch

I/O connectivity - see fig 2.

(1) depending on distributor stock, 30V or 35V parts with the same pitch can be used.