

Jan's HV regulator

jan.didden · 2019-10-16 2:05 pm



jan.didden

AX tech editor
Joined 2002

2019-10-16 2:05 pm

< □ #1

🧐 Thread split from: **Tube amp high-voltage delay** (URL: <https://www.diyaudio.com/forums/tubes-valves/343711-tube-amp-voltage-delay.html>).

Thanks Mark - never saw that AR amp! Seems like a nice touch.

The controller is really a no-brainer; after switching the HV on it goes to sleep, switching everything off, its clocks, timers, what have you. It just becomes a blob of dead silicon sipping away a few tens of microamps.

In The Netherlands we have a saying that means something like: 'unknown makes unloved'

Here on my bench I have a completed design of a HV regulator for tube amps. Less than 1mV noise, no sagging under load, light, low heat. No need for additional power supply.

A single R sets the output anywhere between 0V and 580V. A single R sets the current limit to anywhere between 5mA and 1A. Fully overload and short-circuit protected. A tube amp's wet dream.

But I am hesitant to publish it because it contains - gasp - an opamp ...

Jan

[High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB](#)



chede

Member
Joined 2016

2019-10-16 7:27 pm







< □ #2


Hi Jan,
I actually would be very interested in that




We have a lot of mains voltage fluctuations here, which makes setting bias current on my opto bias regulated EL84PP quite time-consuming, and I'm also concerned of overvoltage conditions during start-up, when the tubes are not drawing enough current yet ...



I'm using my external power supply alternating for the EL84 amp or for my Aikido pre-amp, and an easy way of re-setting it for the different amps would also be appreciated. Right now, B+ for the power amp is done unregulated, but for the Aikido of course regulated.





Regards, Claas


<div></div> <div>jan.didden </div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-16 7:34 pm ↩ 🔖 #3</div> <div>Claas, what are the voltage and current requirements?</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div></div> <div>gerrittube</div> <div>Member</div> <div>Joined 2018</div>	<div>2019-10-16 8:22 pm ↩ 🔖 #4</div> <div>Hi Jan,</div> <div>First of all thanks for sharing your delay circuit.</div> <div>I would like to know more about your hv powersupply. This sounds very promising indeed. I have a transformer 440V 800mA to make a nice psu.</div> <div>Regards, Gerrit</div>
<div></div> <div>chede </div> <div>Member</div> <div>Joined 2016</div>	<div>2019-10-16 8:34 pm ↩ 🔖 #5</div> <div>Hi Jan,</div> <div>for the EL84PP it would be B+ of 320V and 175mA, or alternatively, up to 340V and let's say 150mA.</div> <div>For the Aikido, my implementation runs with 250V B+ and up to 80mA of current, depending on tubes used.</div> <div>Best regards, Claas</div>
<div>jan.didden </div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-16 8:48 pm ↩ 🔖 #6</div> <div>That should be fine. I will prepare a package for you and contact you off-line.</div> <div>This is how it will look.</div> <div>Jan</div> <div><div>Attachments (URL: /community/attachments/tregts-3d-view-png.788210/) TregTS 3d view.PNG 141.9 KB · Views: 1,281</div></div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>

<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div>2019-10-16 8:53 pm<div>↩️ 📌 #7</div></div> <div><div><div><div>gerrittube said: (URL: /community/goto/post?id=5946528)</div><div>Hi Jan,</div><div>First of all thanks for sharing your delay circuit.</div><div>I would like to know more about your hv powersupply. This sounds very promising indeed. I have a transformer 440V 800mA to make a nice psu.</div><div>Regards, Gerrit</div></div></div></div> <div><div>Hi Gerrit,</div><div>Currently the regulator can handle 600V absolute max input. With your 440V that will reach, when rectified, higher than that.</div><div>I can probably find some parts for a higher voltage, let me check that out.</div><div>Jan</div></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>
<div><div>chede</div><div>Member</div><div>Joined 2016</div></div>	<div>2019-10-17 7:54 am<div>↩️ 📌 #8</div></div> <div><div><div><div>jan.didden said: (URL: /community/goto/post?id=5946558)</div><div>This is how it will look.</div><div>Jan</div></div></div></div> <div><div>Hi Jan, looking very good and that board looks small enough to fit</div><div>Thanks and best regards, Claas</div></div>
<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div>2019-10-17 6:03 pm<div>↩️ 📌 #9</div></div> <div><div>OK, here is the circuit. See if you can parse this</div><div>Jan</div></div> <div><div><div>Attachments</div><div><div><div></div><div>(URL: /community/attachments/tregts-2-corr-cct-pdf.788382/)</div></div><div>TregTS-2-corr cct.pdf</div><div>85.3 KB · Views: 860</div></div></div></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>

<div><div><div><div><div></div><div>gerrittube</div><div>Member</div><div>Joined 2018</div></div></div><div></div></div></div>	<div><div>2019-10-17 8:24 pm</div><div><div></div><div></div><div>#10</div></div></div> <div><div>Jan,</div><div>I'm trying to understand the hv regulator circuit. It's impressive and I would like to build one, if I can find the right components. Do you have any thoughts on a PCB?</div><div>Regards, Gerrit</div></div>
<div><div><div><div><div></div><div>chede </div><div>Member</div><div>Joined 2016</div></div></div><div></div></div></div>	<div><div>2019-10-17 10:03 pm</div><div><div></div><div></div><div>#11</div></div></div> <div><div>Trying to understand as well. And I don't get circuit diagram and picture from #43 completely together yet ...</div></div>
<div><div><div><div><div></div><div>jan.didden </div><div>AX tech editor</div><div>Joined 2002</div></div></div><div></div></div></div>	<div><div>2019-10-18 6:22 am</div><div><div></div><div></div><div>#12</div></div></div> <div><div><div>gerrittube said: (URL: /community/goto/post?id=5947647)</div><div><div>Jan,</div><div>I'm trying to understand the hv regulator circuit. It's impressive and I would like to build one, if I can find the right components. Do you have any thoughts on a PCB?</div><div>Regards, Gerrit</div></div></div><div><div>I have some PCBs available, as well as some of the HV parts.</div><div>On the 3D view you see three TO220 devices, but you would use only two in an actual circuit. But there are two possible positions for the pass device, either on the on-board heatsink for dissapations up to 6 or 7 watts, or on the edge of the board for mounting on a chassis or larger heatsink. There is a note to that on the schematic.</div><div>Jan</div></div><div><div>Last edited: 2019-10-18 6:27 am</div></div><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div>
<div><div><div><div><div></div><div>jan.didden </div><div>AX tech editor</div><div>Joined 2002</div></div></div><div></div></div></div>	<div><div>2019-10-18 6:30 am</div><div><div></div><div></div><div>#13</div></div></div> <div><div><div>chede said: (URL: /community/goto/post?id=5947734)</div><div><div>Trying to understand as well. And I don't get circuit diagram and picture from #43 completely together yet ...</div></div></div><div><div>The error amplifier, the AD8031, drives the gate of the pass device.</div><div>That opamp gets two inputs. One is the output voltage, on the inv input. The other is the reference voltage, on the non-inv input. The difference between them drives the gate up or down.</div><div>Jan</div></div><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div>

<div><div>gerrittube</div><div>Member</div><div>Joined 2018</div></div>	<div>2019-10-18 7:00 pm<div><div></div><div></div><div>#14</div></div></div> <div>Hi Jan,</div> <div>I'm interested in a PCB + some essential parts (Conrad for the rest?). What can you offer?</div> <div>Regards, Gerrit</div>
<div><div>chede </div><div>Member</div><div>Joined 2016</div></div>	<div>2019-10-18 7:06 pm<div><div></div><div></div><div>#15</div></div></div> <div>Hmmm ... Reference voltage is provided by U1, the LT3092 ? And the circuitry around Q8 steps down the difference between Vin and Vout to a safe voltage range for the op-amp ?</div> <div>So I guess the regulator doesn't limit Vraw from climbing up too high when there's no load yet (tubes not fully heated up / bias servo still at too negative grid voltage). I have a PSU that's cLCC (or LCC), and without load the voltage keeps climbing. For this, I probably would combine the regulator with your HV delay circuit, right?</div> <div>Regards, Claas</div>
<div><div>jan.didden </div><div>AX tech editor</div><div>Joined 2002</div></div>	<div>2019-10-18 7:10 pm<div><div></div><div></div><div>#16</div></div></div> <div>The PCB I have, and the ref current source LM3092 (I can put that on the board if you are uncomfortable with SMD), the HV depletion mode IXTP08N100D2, the AD8031, the pass MOSFET FDP12N60NZ. Let's say € 30 plus shipping.</div> <div>R11 has to be selected depending on the necessary Vout at about 0.58V per kOhm. So for instance, for 250V, R11 should be ~430k. You can adjust the Vout +/-20% with VR1. Note that R11 must be selected for the full output voltage. Conrad or Mouser should have it.</div> <div>I might also have a few of the HV film caps, C3, C4 and C6 but I need to check. I think they are about € 2,00 each.</div> <div>Jan</div> <div><hr/>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>

<div data-bbox="135 230 269 257">jan.didden ●</div> <div data-bbox="116 268 237 313">AX tech editor Joined 2002</div>	<div data-bbox="335 141 531 163">2019-10-18 7:17 pm</div> <div data-bbox="1361 141 1482 163">  #17</div> <div data-bbox="335 188 1482 488"><div data-bbox="359 208 917 232">chede said: (URL: /community/goto/post?id=5948662)</div><div data-bbox="359 253 1442 360">Hmmm ... Reference voltage is provided by U1, the LT3092 ? And the circuitry around Q8 steps down the difference between Vin and Vout to a safe voltage range for the op-amp ?</div><div data-bbox="782 448 1037 472">Click to expand... (URL:)</div></div> <div data-bbox="335 535 1445 560">The LT3092 is configured as a current source, about 580uA, and develops the reference voltage across R11.</div> <div data-bbox="335 598 1431 654">A main feature is that the whole regulator circuit floats on Vout so there's no issue with dividing down high voltage. Also, it means that the loop gain is always the same no matter the Vout, so it is stable for any Vout.</div> <div data-bbox="335 692 1473 779">Q8 etc steals some current from Vin to develop a small supply voltage for the opamp and the LT3092. By using a very low supply current opamp (typ 800uA) and a high brightness LED in series with the LT3092, the whole reg circuit runs at just a few mA.</div> <div data-bbox="335 817 1447 873">That also means however that you must have a load that takes at least 3mA or so, you should not run it open load. But anything you hang off it will surely take more than 3mA.</div> <div data-bbox="335 911 373 934">Jan</div> <div data-bbox="335 985 1157 1010">High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div data-bbox="151 1176 256 1200">gerrittube</div> <div data-bbox="124 1211 217 1256">Member Joined 2018</div>	<div data-bbox="335 1086 536 1108">2019-10-18 7:23 pm</div> <div data-bbox="1361 1086 1482 1108">  #18</div> <div data-bbox="335 1137 406 1160">Hi Jan,</div> <div data-bbox="335 1198 1437 1285">I would like to buy a PCB. I'm not familiar with SMD soldering, my Weller soldering station dates from before SMD. So if you could put it on the board that would be great. I'll take the other parts from you as well, if possible, as far as you have them available. I see that the IXP08N100D2 is not available from Conrad.</div> <div data-bbox="335 1323 1270 1348">How can I make the payment to you? If necessary you can mail me at info AT winvis DOT nl.</div> <div data-bbox="335 1386 493 1411">Regards, Gerrit</div>

<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>2019-10-18 7:47 pm</div><div><div></div><div></div><div>#19</div></div></div> <div><div><div>gerrittube said: (<i>URL: /community/goto/post?id=5948680</i>)</div><div>Hi Jan,</div><div>I would like to buy a PCB. I'm not familiar with SMD soldering, my Weller soldering station dates from before SMD. So if you could put it on the board that would be great. I'll take the other parts from you as well, if possible, as far as you have them available. I see that the IXTP08N100D2 is not available from Conrad.</div><div>Click to expand... (<i>URL: </i>)</div></div></div> <div><div>YGM.</div><div>I think I got the entire stock of the IXPT08N100D2 from Mouser a few months ago. ;-)</div><div>Jan</div></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>
<div><div></div><div>chede</div><div>Member</div><div>Joined 2016</div></div>	<div><div>2019-10-18 8:04 pm</div><div><div></div><div></div><div>#20</div></div></div> <div><div>I'd like a board as well. Thank you very much for offering, and I would like to go with your offer of PCB and parts as spelled out in the first paragraph of #16.</div><div>My soldering station is simple as well, but I tried SMD soldering with the tiny JFETs for the BAF2018 line stage, and didn't find it too bad. It actually was easier than expected. So I'll try this one, too</div><div>Would you contact me via PM for PayPal instructions or similar ?</div><div>Thanks in advance, best regards, Claas</div></div>
<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>2019-10-19 7:47 am</div><div><div></div><div></div><div>#21</div></div></div> <div><div>I am writing the design up for an article, and drew this conceptual diagram. Should help to grok it.</div><div>Jan</div><div><div><div>Attachments</div><div><div><i>(URL: /community/attachments/fig-1-png.788763/)</i></div><div>fig 1.PNG</div><div>41.4 KB · Views: 492</div></div></div></div><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div>

<div>analog_sa</div> <div>Member</div> <div>Joined 2002</div>	<div>2019-10-19 8:36 am</div> <div><div><div>←</div><div>🔖</div><div>#22</div></div></div> <div><div>jan.didden said: (URL: /community/goto/post?id=5946146)</div><div>But I am hesitant to publish it because it contains - gasp - an opamp ...</div></div> <div>As far as sound goes the opamp is a minor issue compared to the series topology. Never liked it, no matter what the pass element, even when using a valve.</div> <div>Obviously according to my taste, ears, systems.</div>
<div>disco</div> <div>Member</div> <div>Joined 2006</div>	<div>2019-10-19 9:53 am</div> <div><div><div>←</div><div>🔖</div><div>#23</div></div></div> <div><div>analog_sa said: (URL: /community/goto/post?id=5949145)</div><div>As far as sound goes the opamp is a minor issue compared to the series topology. Never liked it, no matter what the pass element, even when using a valve.</div><div>Obviously according to my taste, ears, systems.</div></div> <div>Under which circumstances did you use the serial regulator you did not appreciate? Was it a low PSRR circuit of a voltage amplifier, a high current final, SE or PP?</div> <div>As far as regulators go, my preference is also with the shunt type, but one has to be practical w.r.t. dissipation...</div>
<div>jan.didden</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-19 10:01 am</div> <div><div><div>←</div><div>🔖</div><div>#24</div></div></div> <div>I just found out that earlier I posted an older schematic. The actual schematic and the PCB I have available <i>does</i> have a 12V zener across G-S of the pass device ...</div> <div>I'm getting too old for this stuff</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>analog_sa</div> <div>Member</div> <div>Joined 2002</div>	<div>2019-10-19 10:39 am</div> <div><div><div>←</div><div>🔖</div><div>#25</div></div></div> <div><div>disco said: (URL: /community/goto/post?id=5949177)</div><div>but one has to be practical w.r.t. dissipation...</div></div> <div>Indeed. I have never attempted to supply a valve power amp with regulated voltage, so yes, if one absolutely has to do it, a series regulator is the only practical option.</div> <div>The question of regulation by itself is interesting. Personally, i have no interest in using regulation as a substitute for a good passive power supply. My interest goes only as far as regulation can bring sonic improvements additional to what a pile of chokes and caps can do. In this context i find shunt regulation beneficial. Series can perhaps make things lighter and cheaper and pacify an engineering god, but as far as music reproduction goes i hear only negatives.</div>

<div><div>V</div><div>v4lve lover Member Joined 2010</div></div>	<div>2019-10-19 10:47 am<div>↩️ 📌 #26</div></div> <div>Nice circuit! I am very interested, i just wanted to share this application note from IXYS about linear operation of fet's.</div> <div>And recommend a different pass device, in case your going to run the supply hard (high input output differential voltage) for instance as a experimenting supply. IXTP15N50L2</div> <div>https://www.ixys.com/Documents/AppNotes/IXAN0068.pdf</div>
<div><div></div><div>TheGimp Member Joined 2009</div></div>	<div>2019-10-19 12:18 pm<div>↩️ 📌 #27</div></div> <div>Nice circuit Jan. I am interested in a board and parts as well.</div> <div>One question, as show in your first schematic. The reference current through R11 looks like it will only drop 127.6V across R11, so the output voltage is one diode drop (D3) less at ~127V.</div> <div>Is this correct for the values shown in your circuit?</div>
<div><div></div><div>deafbykhorns Member Joined 2004</div></div>	<div>2019-10-19 12:59 pm<div>↩️ 📌 #28</div></div> <div>Jan, You should start a group buy I'll take acouple boards and smd for my</div>

jan.didden

AX tech editor

Joined 2002

2019-10-19 1:10 pm

29

v4lve lover said: (URL: /community/goto/post?id=5949213)

Nice circuit! I am very interested, i just wanted to share this application note from IXYS about linear operation of fet's.

Click to expand... (URL:)

Thanks for that app note! There are several devices SOA-specified that are of interest. I selected the FDP12N600NZ because it has a SOA of 400mA at 600V. This is important for short-circuit protection, because at that condition the full input voltage (max 600V in this case) is across the device.

In fact, I placed a TO247 footprint on the PCB in case I find a device for even higher current/voltage, but no luck so far.

The IXTB30N100L (600V 500mA), IXTN62N50L (400V 750mA) and IXTK22N100L (800V 300mA) are of interest.

By the way, what they call electro-thermal instability is also known in the industry as the Spirito effect, after the guy who discovered it.

Jan

Last edited: 2019-10-19 1:13 pm

High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB

jan.didden

AX tech editor

Joined 2002

2019-10-19 1:12 pm

30

TheGimp said: (URL: /community/goto/post?id=5949249)

Nice circuit Jan. I am interested in a board and parts as well.

One question, as show in your first schematic. The reference current through R11 looks like it will only drop 127.6V across R11, so the output voltage is one diode drop (D3) less at ~127V.

Is this correct for the values shown in your circuit?

I don't think so. The ref goes to the non-inverting input through a 100R stopper R only. The diode is there for reverse protection at start-up.

But that schematic is not the final one. I will take the suggestion to set up a Group Buy and post the final circuit there.




Jan

Last edited: 2019-10-19 1:16 pm

High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB

<div>jan.didden</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-19 2:09 pm</div> <div><div></div><div></div><div>#31</div></div> <div>Group Buy is here: https://www.diyaudio.com/forums/group-buys/344165-buy-jans-voltage-regulator.html#post5949320 (URL: https://www.diyaudio.com/forums/group-buys/344165-buy-jans-voltage-regulator.html#post5949320).</div> <div>Documentation is here: T-reg HV regulator Linear Audio NL (URL: https://linearaudio.nl/t-reg-hv-regulator).</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>indra1</div> <div>Member</div> <div>Joined 2010</div>	<div>2019-10-19 2:23 pm</div> <div><div></div><div></div><div>#32</div></div> <div>Hi Jan, do you think ferrite beads inserted on both legs of D3 would help noise rejection at higher frequency?</div>
<div>jackinnj</div> <div>Member</div> <div>Joined 2002</div>	<div>2019-10-19 3:11 pm</div> <div><div></div><div></div><div>#33</div></div> <div>Just an editor's nit -- the schematic posted on your site should be V2</div> <div>NJ, OH and Llanddewi Brefi</div>
<div>Elvee</div> <div>Member</div> <div>Joined 2006</div>	<div>2019-10-19 3:30 pm</div> <div><div></div><div></div><div>#34</div></div> <div>Very nice regulator, but I think it could benefit from a better opamp than the AD8031: at 80MHz, the GBW looks a bit limited.</div> <div>At most, you will be able to supply a 27MHz CB PA without a single bypass cap, but to achieve the same feat with a FM transmitter, or a band III transmitter, something like 800MHz or 1GHz looks more reasonable.</div> <div>Clever circuit anyway....</div>
<div>Ketje</div> <div>Member</div> <div>Joined 2012</div>	<div>2019-10-19 5:22 pm</div> <div><div></div><div></div><div>#35</div></div> <div>Looking at the phase inversion with input below the negative rail, with a bias at (opamp)ground level, perhaps better to use a schottky for D3.</div> <div>Mona</div> <div><div>Attachments</div><div>(URL: /community/attachments/overdrive-png.788845/).</div><div>Overdrive.png</div><div>26.9 KB · Views: 397</div></div>

<div>jan.didden ●</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-19 6:13 pm</div> <div>↩ 📌 #36</div> <div><div>jackinnj said: (URL: /community/goto/post?id=5949366)</div><div>Just an editor's nit --</div></div> <div>I'm sensitive to that ;-) Fixed.</div> <div>Jan</div> <div>Last edited: 2019-10-19 6:23 pm</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>jan.didden ●</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-19 6:25 pm</div> <div>↩ 📌 #37</div> <div><div>indra1 said: (URL: /community/goto/post?id=5949329)</div><div>Hi Jan, do you think ferrite beads inserted on both legs of D3 would help noise rejection at higher frequency?</div></div> <div>I don't think so. In normal operation, that D3 is not active, as if it isn't there. Both sides are at the same level, for a few mV.</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>indra1</div> <div>Member</div> <div>Joined 2010</div>	<div>2019-10-19 6:48 pm</div> <div>↩ 📌 #38</div> <div>Thanks Jan. I asked because A side of D3 connects to clean reference and the K side connects to the ouput which may still contains residual RF and other switching noises. Was wondering about possible RF noise leaking through diode's stray C.</div>
<div>jan.didden ●</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-19 7:45 pm</div> <div>↩ 📌 #39</div> <div><div>indra1 said: (URL: /community/goto/post?id=5949595)</div><div>Thanks Jan. I asked because A side of D3 connects to clean reference and the K side connects to the ouput which may still contains residual RF and other switching noises. Was wondering about possible RF noise leaking through diode's stray C.</div></div> <div>Why would the output have RF and switching noises? Where would that come from then?</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>indra1</div> <div>Member</div> <div>Joined 2010</div>	<div>2019-10-19 7:50 pm</div> <div>↩ 📌 #40</div> <div>Mains supply, LED lighting and other appliances connected to the line.</div> <div>Last edited: 2019-10-19 7:57 pm</div>

<div></div> <div>Elvee Member Joined 2006</div>	<div>2019-10-20 5:12 pm ↩ 📄 #41</div> <div>.....</div> <p>More to the point, I see a few potential problems:</p> <p>From an AC perspective, the opamp operates in unity-gain, with 100% feedback, and to ensure stability the feedback path must introduce a minimal phase-shift between the opamp output and its - input, and this has to be true between 0 and ~80MHz, since no local compensation is present.</p> <p>The gate stopper and the MOS capacitances create a first pole, meaning any other pole along the path will lead to instability. Such a pole could be created by the protection resistors and a capacitive load for instance. A quick, simplified sim shows that the regulator is marginally stable on a resistive load and becomes unstable with a capacitor of a few nF. The reality could be somewhat different, but very much will depend on the exact load, the way it is wired, etc, and this is not controllable on the board itself, meaning it should be reasonably immune to impedance effects. The + input connection also contributes to complicate the problem. For these reasons, I think that a minimum of local compensation should be included.</p> <p>Other problems could be caused by C4: it will be charged to the output voltage, and in case of a short, it will discharge through D3. The energy will be low, but after some events a small diode like the 1N4148 might well fail. Note that the "short" does not need to be a hard, physical one: the connection to a completely discharged bypass cap will have the same effect. Less obvious is the case of load-dumping: there is apparently no good reason for such an event to occur, but in practice HV circuits can sometimes see this kind of situation, especially in an experimental/DIY setup. If the output voltage increases brutally over the normal, set voltage (a cap discharge, short to another supply...) the whole regulator including the opamp will rise higher than C4, leaving the + input protected only by the 100 ohm series resistor.</p> <p>For these reasons, it would be preferable to place two anti parallel diodes directly across the inputs, possibly schottky types.</p> <p>In case of an output short, another component will be stressed: R10. It will have to withstand a high surge current, and should be a pulse-resilient type.</p> <p>Something optional, but cheap and contributing to the overall reliability would be the inclusion of a series resistor (preferably fusible-type) in the drain of Q8: up to 1K will have no impact on the performance and could save the day in case the MOS encounters the occasional rogue pulse</p>
<div></div> <div>obseedian Member Joined 2006</div>	<div>2019-10-20 5:18 pm ↩ 📄 #42</div> <p>Pretty sure C6 and R10 is the compensation. (but may need to increase C6 and/or reduce R10 for improved stability)</p> <div>Last edited: 2019-10-20 5:21 pm</div>
<div></div> <div>jan.didden AX tech editor Joined 2002</div>	<div>2019-10-20 5:30 pm ↩ 📄 #43</div> <p>Yes, C6 and R10 have been dimensioned to maintain stability even with zero capacitance downstream.</p> <p>Jan</p> <hr/> <p>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</p>

<div><div>Elvee</div><div>Member</div><div>Joined 2006</div></div>	<div><div>2019-10-21 8:27 am</div><div><div></div><div></div><div>#44</div></div></div> <div><p>I am convinced that the regulator in itself is stable and doesn't need additional bypass, but it goes further than that: it might not tolerate a bypass cap directly connected across the output terminals.</p><p>The issue is common to high gain, high feedback amplifiers: for example, if you connect a 100nF capacitor directly to the output of an audio amplifier, upstream of the inductive zobel it will most of the times cause oscillations.</p><p>Voltage regulators are a particular class of amplifiers having a single-quadrant output, but they are subjected to the same general rules.</p><p>They are normally compensated in a way that makes them tolerant to capacitive loads, because that is the way they are normally used. Even then, a minimal esr value is sometimes required to ensure stability.</p><p>R6 is a very explicit series resistor, and it adds a zero in the response, but an additional, pure cap might cancel the stabilizing effect of this zero.</p><p>I have no idea about the way the circuit is going to behave in reality, because so many factors play a role, but having such a large R10 is like a door open to the outside world: internal loop stability issues will be influenced by the nature of the external load.</p><p>With a "hard" decoupling capacitor, the door is completely closed for high frequencies, and the regulator becomes just a black box delivering voltage and current, without further interaction.</p><p>Testing the response with current steps, together with various reactive loads could provide valuable information about the loop stability</p></div>
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Elvee

Member

Joined 2006

2019-10-22 5:30 pm

< □ #45

Improving the stability can be as simple as opting for a more placid, some would say sensible opamp.

Here is the simplified loop gain sim (the exact details will certainly differ in reality, but it gives a broad idea of what to expect).

With a 47nF cap, the phase margin is -23° , meaning it will be unstable:

If the opamp is changed for a LT1677 (GBW=7.2MHz), the circuit becomes marginally stable, with a 8° margin. Note that the performances have not been degraded, in fact the opposite is true: the 100Hz loop gain (dictating the ripple rejection) has improved by $\sim 15\text{dB}$:

With a small cap across the gate-stopper, this margin is almost doubled:

Attachments

[\(URL: /community/attachments/jan3-png.789546/\)](/community/attachments/jan3-png.789546/)

Jan3.png

95.7 KB · Views: 609

[\(URL: /community/attachments/jan2-png.789545/\)](/community/attachments/jan2-png.789545/)


Jan2.png

95.3 KB · Views: 615

[\(URL: /community/attachments/jan1-png.789544/\)](/community/attachments/jan1-png.789544/)

Jan1.png

109.1 KB · Views: 597

obseedian

Member

Joined 2006

2019-10-22 11:41 pm

< □ #46

Elvee I don't think your loop gain probe placement is correct. AD8031 has only about 80dB of open loop gain, should not be getting over 160 dB of loop gain. In any case lowering R3 and increasing C1 improves phase and gain margin.

Attachments

[\(URL: /community/attachments/probe-png.789601/\)](/community/attachments/probe-png.789601/)

probe.PNG

70.5 KB · Views: 587

<div><div>Elvee</div><div>Member</div><div>Joined 2006</div></div>	<div><div>2019-10-23 5:13 pm</div><div>< □ #47</div></div> <div><p>I think you are right: I probed it that way because the regulator is referenced to the output, meaning the gain of the MOS operating in common-source has to be taken into account, except that here the configuration is hybrid.</p><p>Although the regulator circuit is referenced to the output, the reference voltage is in fact tied to the ground, meaning it acts as a follower.</p><p>To take the whole situation into account, including common mode effects of the opamp, it is probably necessary to probe it that way:</p><p>Ideally, a more sophisticated probe would be necessary to include the loading effect on the output, but here with the simplifications it is probably sufficient, and including the opamp supply in the probe changes practically nothing, thanks probably to its good common-mode rejection.</p><p>The LF gain is substantially reduced, but the HF behavior remains essentially similar, and the negative phase margin is still present, it is even a bit larger.</p><p>The same remedies apply, and have a similar effect, and if they are combined to your fixes, it is probably possible to arrive at a satisfactory solution, but it has to be tested in practice, because tailoring the compensation around a 47nF load will certainly be non-ideal for all other values (it is an example I took randomly).</p></div> <div><div>Attachments</div><div><div>(URL: /community/attachments/jan4-png.789767/)</div><div>Jan4.png</div><div>105.6 KB · Views: 531</div><div>(URL: /community/attachments/jan5-png.789768/)</div><div>Jan5.png</div><div>93.1 KB · Views: 498</div></div></div>
<div><div>jan.didden ●</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>2019-10-23 5:59 pm</div><div>< □ #48</div></div> <div><p>The regulator has been designed to be stable without external output capacitance. Adding output capacitance makes it more stable.</p><p>Jan</p></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>

jan.didden

AX tech editor

Joined 2002

2019-10-23 6:05 pm

< □ #49

obseedian said: (URL: /community/goto/post?id=5952695)

In any case lowering R3 and increasing C1 improves phase and gain margin.

The value of 1uF for C1 was a practical value as to size/voltage limit (630V) on the PCB. Design target was 600V input and thus possibly 600V output.

With that part in mind, R3 was selected for best stability in several prototypes.

I did look at larger caps at 630V, but to my surprise 600V+ electrolytics are very rare.

Jan

High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB

Elvee

Member

Joined 2006

2019-10-23 9:02 pm

< □ #50

jan.didden said: (URL: /community/goto/post?id=5953423)

The regulator has been designed to be stable without external output capacitance.

That is clearly the case

Adding output capacitance makes it more stable.

Facts cannot be refuted, thus reality has to be the ultimate test: there are many effects and parasitics involved, and a simplified sim cannot replicate the fine details.

The topology of a buffer based on a fast, high gain uncompensated amplifier rang an alarm bell for me, because when combined with a capacitive load, it is generally a recipe for instabilities, and the sim seemed to confirm this analysis, but the specifics matter, and if it is stable all is fine.

In general, instabilities will occur for a particular range of capacitances: too small, and they are beyond the unity gain limit, too large and the ratio of esr to reactance becomes larger for physical and mathematical reasons, damping possible instabilities.

Note that the output is not necessarily the best spot to detect some types of oscillations: if they are in the VHF range, the capacitor that causes them is going to attenuate them to the point of making them invisible with an oscilloscope and a regular X10 probe.

The output of the opamp would make a better test point.

Anyway, a step-test is always a valuable and revealing tool.







jan.didden said: (URL: /community/goto/post?id=5953431)

I did look at larger caps at 630V, but to my surprise 600V+ electrolytics are very rare.

It is a technological limit, linked to the properties of aluminum oxide.

The alternative, tantalum, has an even lower limit, so unless another miracle element is found, the 550V~600V limit is here to stay

<div>PRR</div> <div>Member</div> <div>Joined 2003</div>	<div>2019-10-24 3:46 am</div> <div>< > #51</div> <div>> to my surprise 600V+ electrolytics are very rare.</div> <div>As Elvee says: simple AlOx wants to leak bad at 450V. Fancy processing can get 500V rating.</div> <div>There used to be 600V e-caps which were really two 350V caps in one cardboard tube. Not seen in decades.</div>
<div>disco</div> <div>Member</div> <div>Joined 2006</div>	<div>2019-10-24 8:41 pm</div> <div>< > #52</div> <div>http://www.mundorf.com/english 1.1/kondensatoren.htm (URL: http://www.mundorf.com/english%201.1/kondensatoren.htm)</div> <div>https://uk.farnell.com/c/passive-components/capacitors?voltage-rating=600v (URL: https://uk.farnell.com/c/passive-components/capacitors?voltage-rating=600v)</div>
<div>jan.didden</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2019-10-24 9:23 pm</div> <div>< > #53</div> <div><div><div>PRR said: (URL: /community/goto/post?id=5953829)</div><div>> to my surprise 600V+ electrolytics are very rare.</div><div>As Elvee says: simple AlOx wants to leak bad at 450V. Fancy processing can get 500V rating.</div><div>There used to be 600V e-caps which were really two 350V caps in one cardboard tube. Not seen in decades.</div></div><div>Never knew that. I though they simple weren't in the catalogs because of lack of demand. Maybe that is also the reason for those paper-in-oil high-voltage caps?</div><div>Jan</div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>






<div data-bbox="137 230 272 309">Rod Coleman Member Joined 2004</div>	<div data-bbox="336 141 537 163">2019-10-25 9:28 am</div> <div data-bbox="1361 141 1484 163">  #54</div> <p>500V - 600V electrolytics are good, but we must move away from the usual sources, and especially away from « audio » types (some of which, like Elna Cerafine, are unreliable & fail short-circuit).</p> <p>Parts of excellent quality can be had from the Kemet range that they acquired with BHC.</p> <p>Even at the lowest cost range, the ALC10, offers 500V, 550V and 600V parts, and their leakage specification is actually better than ordinary electrolytics: 0.006CV (compared to the usual 0.01CV to 0.04CV).</p> <p>There are superior performing parts, check out the data sheets. But do they sound any good? Well, some folks are upset by subjective comments, so I will sandbox them in a PGP stylee. Skip the next paragraph, if you have the allergy.</p> <p>----- BEGIN SUBJECTIVE MESSAGE BLOCK -----</p> <p>ALC10, ALS30 and especially ALS60 series sound better too, when replacing nasty consumer-grade 'lytics.</p> <p>----- END SUBJECTIVE MESSAGE BLOCK -----</p> <p>Some examples:</p> <p>Low Cost ALC10 <u>ALC10A121CC550 KEMET 120µF Electrolytic Capacitor 550V dc Snap-In - ALC10A121CC550 RS Components</u> (URL: https://uk.rs-online.com/web/p/aluminium-capacitors/8741579/).</p> <p>High grade ALS60 leakage is 0.003 CV, lifetime 29000 hrs+ at 85 °C <u>ALS61A821KF550 KEMET 820µF Electrolytic Capacitor 550V dc Screw Mount - ALS61A821KF550 RS Components</u> (URL: https://uk.rs-online.com/web/p/aluminium-capacitors/8712146/).</p>
<div data-bbox="137 1261 272 1339">jan.didden ● AX tech editor Joined 2002</div>	<div data-bbox="336 1169 537 1191">2019-10-25 9:54 am</div> <div data-bbox="1361 1169 1484 1191">  #55</div> <p>Yes those look nice. A bit large and (some) a bit expensive, and much higher value than I needed here.</p> <p>Jan</p> <hr/> <p>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</p>
<div data-bbox="137 1547 272 1626">Francois G ● Member Joined 2004</div>	<div data-bbox="336 1458 544 1480">2019-11-23 10:50 pm</div> <div data-bbox="1361 1458 1484 1480">  #56</div> <p>I have several 60 microFarad MKP film capacitors rated for 900Vdc. Would it be beneficial to add one across the output of the regulator? I plan to use the regulator for the screen supply (only 200Vdc) of two channels of PP EL509 tubes that can draw a surprisingly large current on music peaks.</p>

<div><div><div><div></div><div>gerrittube</div><div>Member</div><div>Joined 2018</div></div></div></div>	<div><div>2019-11-25 11:27 am</div><div><div></div><div></div><div>#57</div></div></div> <div><div>Hi Jan,</div><div>I just finished building your HV regulator (latest version with D3 zener 2.7V, with the board and components you sent me). With R11 being 220K I get an output voltage of 117 - 165 volt using the 5K VR pot, using a 3 mA min. load (resistor).</div><div>For R11 being 220K I would expect 127 Volt (using your formula $V_{out(max)} : 0,58$). However I get 165 Volt (max). How exact is your calculation formula?</div><div>So for 400 Volt out I would need R11 to be 689K?</div><div>Regards, Gerrit</div><div>Last edited: 2019-11-25 11:57 am</div></div>
<div><div><div><div></div><div>gerrittube</div><div>Member</div><div>Joined 2018</div></div></div></div>	<div><div>2019-11-25 1:06 pm</div><div><div></div><div></div><div>#58</div></div></div> <div><div>Hi Jan,</div><div>Just a quick update: with 690K for R11 and turning VR1 I got a nicely regulated 400 Volt. Perfect!</div><div>How much current could I get from this regulator?</div><div>Regards, Gerrit</div></div>
<div><div><div><div></div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div></div></div>	<div><div>2019-11-25 1:24 pm</div><div><div></div><div></div><div>#59</div></div></div> <div><div><div><div><u>gerrittube said:</u> (<i>URL: /community/goto/post?id=5987469</i>)</div><div>Hi Jan,</div><div>Just a quick update: with 690K for R11 and turning VR1 I got a nicely regulated 400 Volt. Perfect!</div><div><u>Click to expand...</u> (<i>URL: .</i>)</div></div></div><div><div>You can get up to 400mA, but that's absolute max! What current sense resistors did you use? What is your input voltage?</div><div>Jan</div><div><div></div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div></div>

<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div>2019-11-25 1:25 pm<div>< > #60</div></div> <div><div><div>Francois G said: (URL: /community/goto/post?id=5985915)</div><div>I have several 60 microFarad MKP film capacitors rated for 900Vdc. Would it be beneficial to add one across the output of the regulator? I plan to use the regulator for the screen supply (only 200Vdc) of two channels of PP EL509 tubes that can draw a surprisingly large current on music peaks.</div></div></div> <div>I would place these caps as close to the load, the screen, as possible. They help best there, the regulator can take care of itself ;-)</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div><div>gerrittube</div><div>Member</div><div>Joined 2018</div></div>	<div>2019-11-25 2:25 pm<div>< > #61</div></div> <div>Hi Jan,</div> <div>R11 is 690k, raw input is now 450 volt. I want to use the regulator for a fixed voltage for driver stages. Total current will be between 50 and 100 mA.</div> <div>So far I built only one channel, so current is only 25 to 50 mA now.</div> <div>What is the use of the little pushbutton? Reset after overload or shortage?</div> <div>Regards, Gerrit</div>
<div><div>EUVL</div><div>Member</div><div>Joined 2003</div></div>	<div>2020-06-13 4:02 pm<div>< > #62</div></div> <div>I thought about where to post, but decided that technical things should not appear in a GB thread. So here you are.</div> <div>Jan is using the IXTP08N100 in his latest version. I got a few and curve traced them. They do not quite look like what the datasheet tells you though.</div> <div>Vgs at 100mA is about -1.7V, and Yfs ~220mS.</div> <div>Patrick</div> <div>.</div> <div><div>Attachments</div><div>(URL: /community/attachments/ixtp08n100-png.852537/).</div><div>IXTP08N100.png</div><div>6.9 KB · Views: 281</div></div>

<div><div>EUVL</div><div>Member</div><div>Joined 2003</div></div>	<div><div>2020-06-13 4:05 pm</div><div><div><</div><div>🔖</div><div>#63</div></div></div> <div><p>And for the pass device, I want to use a more substabtial device that can take more voltage and power. Namely the IXFP3N120.</p><p>Here is the curve trace. Vgs at 100mA is about 4.1V, Yfs ~260mS.</p><p>Patrick</p><p>.</p><div><div>Attachments</div><div>(URL: /community/attachments/ixfp3n120-png.852538/)</div><div>IXFP3N120.png</div><div>7.4 KB · Views: 266</div></div></div>
<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>2020-06-13 4:32 pm</div><div><div><</div><div>🔖</div><div>#64</div></div></div> <div><div><div>gerrittube said: (URL: /community/goto/post?id=5987525)</div><div>Hi Jan,</div><div>R11 is 690k, raw input is now 450 volt. I want to use the regulator for a fixed voltage for driver stages. Total current will be between 50 and 100 mA.</div><div>Click to expand... (URL:)</div></div></div> <div><p>Yes the push-button is to reset after over-current shut-off. The supply can also be reset by momentarily removing the load but the push-button is faster without having to disconnect all kinds of wires. Be careful though, don't touch high voltage points. I activate the button with the insulated end of a trim screwdriver ('trim-sleutel' in Dutch ;-).</p><p>Jan</p><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div>
<div><div>EUVL</div><div>Member</div><div>Joined 2003</div></div>	<div><div>2020-06-13 4:40 pm</div><div><div><</div><div>🔖</div><div>#65</div></div></div> <div><p>> a trim screwdriver</p><p>https://www.vishay.com/docs/57015/8.pdf (URL: https://www.vishay.com/docs/57015/8.pdf)</p><p>Patrick</p></div>

gerrittube Member Joined 2018	<div>2020-06-13 5:29 pm</div> <div>Hi Jan:</div> <div>I do have a "trimsleutel" around, no problem. So far the regulator works fine, but heavier loads will be used soon (up to 72 mA @ 400 VDC out, 430-450 VDC in).</div> <div>What do you think of Patricks device: IXFP3N120. When would it be needed? What's the bonus you get using it?</div> <div>Regards, Gerrit</div>	<div>< □ #66</div>
EUVL Member Joined 2003	<div>2020-06-13 6:15 pm</div> <div>It is a 1200V device, as opposed to 600V. I intend to go beyond 600V, hence.</div> <div>The On Semi device can take more current.</div> <div>Patrick</div>	<div>< □ #67</div>
Ketje Member Joined 2012	<div>2020-06-13 7:54 pm</div> <div>jan.didden said: (URL: /community/goto/post?id=6240510) Yes the push-button is to reset after over-current shut-off. The supply can also be reset by momentarily removing the load but the push-button is faster without having to disconnect all kinds of wires. Be careful though, don't touch high voltage points. I activate the button with the insulated end of a trim screwdriver ('trim-sleutel' in Dutch ;-). Jan</div> <div>As long as you are pushing the button I think the over-current protection is disabled. Before pushing be shure the cause is removed. Mona</div>	<div>< □ #68</div>
gerrittube Member Joined 2018	<div>2020-06-14 10:27 am</div> <div>Patrick, will the change of MOSFET require any other changes in this circuit? Have you built it already?</div> <div>Regards, Gerrit</div> <div>Last edited: 2020-06-14 10:28 am</div>	<div>< □ #69</div>
EUVL Member Joined 2003	<div>2020-06-14 3:19 pm</div> <div>Simulated, not built.</div> <div>Patrick</div>	<div>< □ #70</div>
gerrittube Member Joined 2018	<div>2020-06-14 6:35 pm</div> <div>Patrick, Just curious if you will build this. If you do, please post your findings.</div> <div>Thanks, Gerrit</div>	<div>< □ #71</div>

<div>EUVL</div> <div>Member Joined 2003</div>	<div>2020-06-14 6:38 pm < □ #72</div> <div>If you only need 400V, why not just follow the proven circuit ?</div> <div>Cheers, Patrick</div>
<div>gerrittube</div> <div>Member Joined 2018</div>	<div>2020-06-14 7:38 pm < □ #73</div> <div>Patrick, I have a raw input now in my final application of around 600 VDC with a serial power resistor to feed the regulator. I prefer the power loss using a resistor instead if dissipating all this in a MOSFET.</div> <div>Regards, Gerrit</div>
<div>jan.didden</div> <div>AX tech editor Joined 2002</div>	<div>2020-06-14 8:21 pm < □ #74</div> <div><div><u>gerrittube said:</u> (URL: /community/goto/post?id=6241687) I prefer the power loss using a resistor instead if dissipating all this in a MOSFET. Regards, Gerrit</div><div>Any particular reason Gerrit?</div><div>Jan</div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>
<div>gerrittube</div> <div>Member Joined 2018</div>	<div>2020-06-15 8:38 am < □ #75</div> <div>Hi Jan,</div> <div>The regulator is feeding 4 tubes and before they start conducting the raw voltage is around 600 VDC. When conducting, the serial resistors between the raw supply and the regulator lower the input voltage to the regulator.</div> <div>Regards, Gerrit</div>
<div>EUVL</div> <div>Member Joined 2003</div>	<div>2020-06-15 12:21 pm < □ #76</div> <div>I am sure Jan will tell you that the basic circuit can cope with 600V Vin. There are many N channel MOSFETs available that is rated higher than 600V. If you intend to use the T-Reg anyhow, is it not just a matter of buying a few different types and try them out yourself ?</div> <div>I have no idea when I shall build. Most unlikely in the next 3 months. And beyond 600V output, I have to do quite a few things differently. Which are irrelevant to you.</div> <div>Cheers, Patrick</div>

<https://www.diyaudio.com/community/threads/jans-hv-regulator.344141/print> Page 25 of 32

<div>jackinnj</div> <div>Member</div> <div>Joined 2002</div>	<div>2020-06-15 6:04 pm</div> <div>< □ #81</div> <div>gerrittube said: (URL: /community/goto/post?id=6241687)</div> <div>Patrick, I have a raw input now in my final application of around 600 VDC with a serial power resistor to feed the regulator. I prefer the power loss using a resistor instead of dissipating all this in a MOSFET.</div> <div>Regards, Gerrit</div> <div>You might find the MOSFET to be less expensive than the resistor.</div> <div>NJ, OH and Llanddewi Brefi</div>
<div>EUVL</div> <div>Member</div> <div>Joined 2003</div>	<div>2020-06-15 6:16 pm</div> <div>< □ #82</div> <div>A properly dimensioned resistor is more fail-safe. And those bulk film ones for heatsink mounting are not so expensive.</div> <div>Patrick</div>
<div>J</div> <div>johan</div> <div>Member</div> <div>Joined 2001</div>	<div>2022-10-31 8:11 am</div> <div>< □ #83</div> <div>I've been looking at different solutions for HV regulators and this the most interesting I've seen so far. The suggested series pass device is EOL, although still in stock. I was looking at alternatives that have higher DC SOA and found a couple.</div> <div>I found a MOSFET from Onsemi FCH041N60E (data sheet https://www.mouser.com/datasheet/2/308/1/FCH041N60E_D-1806137.pdf (URL: https://www.mouser.com/datasheet/2/308/1/FCH041N60E_D-1806137.pdf)) and an IGBT from Onsemi FGH60N60SMD (data sheet https://www.mouser.com/datasheet/2/308/FGH60N60SMD_D-1808867.pdf (URL: https://www.mouser.com/datasheet/2/308/FGH60N60SMD_D-1808867.pdf)). Both of these are good for 600V 1A DC within the SOA curve (as specified). The MOSFET is a bit expensive, though.</div> <div>Curiously enough for an IGBT, the FGH60N60SMD has a DC SOA specified. It has a higher max temperature (max Tj = 175°C vs 150°C for the MOSFET) and power derating (300W at Tc = 100°C vs 237W Tc = 100°C for the MOSFET). It's also almost half the price and because of positive temperature co-efficient it could be paralleled. I know that IGBTs don't have reputation for working well with DC in the past (die hot spots etc), but one would think they wouldn't specify DC SOA if they haven't tested it...</div> <div>Am I totally in deep waters here, or could these transistors be alternatives for the pass device?</div>
<div>jan.didden</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2022-10-31 8:21 am</div> <div>< □ #84</div> <div>Johan, very good finds! I have been looking for a rep-lacement, missed these devices. I agree, if the DC SOA is specified you can reasonably assume that it works to that. I have not tried an IGBT in the T-reg but I see no reason why it wouldn't work well. But stability is something to keep an eye on. Another thing is that the IGBT has a higher on threshold voltage, at the specified max of 6V you probably need some change to the circuit to accomodate that, a change of one of the zener diode's voltage. Why not try it!</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>


<div>J</div> <div>johan</div> <div>Member</div> <div>Joined 2001</div>	<div>2022-10-31 8:46 am</div> <div>< □ #85</div> <div>Thanks for the reply. I might have a try at this eventually.</div> <div>Just for curiosity, I was also looking at the new generation of SiC JFETs that with a MOSFET in a cascode combination could work well in such an application. There are integrated cascode packages available. However, these are still very expensive, so not an option when there are cheaper alternatives available. Here is one device for reference, though: UnitedSiC UJ3C065030T3S. The DC SOA is not as good as the previously mentioned MOSFET and IGBT (there are more powerful cascodes, but much more expensive ones from the same manufacturer).</div>
<div>D</div> <div>dch53</div> <div>Member</div> <div>Joined 2015</div>	<div>2022-11-02 11:39 am</div> <div>< □ #86</div> <div>I've ordered my HT Regulator and I'm ordering parts that I don't have. 2 electrolytics are listed as an "elec-rad10" package? What is that? The BOM says "pitch 0.1in". Is that the pin spacing?</div>
<div>jan.didden ●</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>2022-11-02 12:15 pm</div> <div>< □ #87</div> <div>Yes.</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>V</div> <div>viltson</div> <div>Member</div> <div>Joined 2022</div>	<div>2023-02-13 9:11 pm</div> <div>< □ #88</div> <div>@jan.didden (URL: https://www.diyaudio.com/community/members/1603/) I could not found any information about this regulator Power-supply ripple rejection (PSRR). Do you know how much it is db? Any graph for this?</div>

<div data-bbox="183 152 225 197">M</div> <div data-bbox="129 232 280 253">mz543578854</div> <div data-bbox="169 266 239 286">Member</div> <div data-bbox="159 293 248 309">Joined 2015</div>	<div data-bbox="336 141 526 161">Tuesday at 8:01 PM</div> <div data-bbox="1291 141 1481 161">New < > #89</div> <p data-bbox="336 192 1139 217">Hi @jan.didden (URL: https://www.diyaudio.com/community/members/1603/)</p> <p data-bbox="336 255 1461 340">With semiconductors being hard to come buy at this time (e.g. your replacement recommendation NTP110N65S3HF is not available for the next months from Mouser or Digikey), I was wondering, which criteria the MOSFETs must fit.</p> <p data-bbox="336 380 636 403">My layman's guess would be:</p> <ul data-bbox="370 434 1211 519" style="list-style-type: none">• (very) low $R_{ds\ On}$ to minimize P_d• high enough I_d and P_d• V_{gs} high enough for the circuit (should be easy, in my LTSpice sim this is 3-4V). <p data-bbox="336 580 1007 638">If these parameters are enough, there would be plenty of options. Is this correct understanding?</p> <p data-bbox="336 674 1466 730">What I also do not get is why the chosen type is <i>that</i> powerful. Even with V_{in}-V_{out} in the area of 100-200V and a reasonable current, this seems like complete overkill.</p> <p data-bbox="336 768 1477 853">I almost randomly picked one found with parameterized search in Mouser (IPA95R130PFD7XKSA1), which, for moderate V_{in}-V_{out} seems to be pretty OK. For higher current, the P_d is not enough, sure, but depending on the use case, I think there can be lots of alternatives, right?</p> <p data-bbox="336 891 1410 947">BTW, using the IPA95R130PFD7XKSA1 in the sim, the circuit was not stable. I had to tame it using a zobel network between G and S. Is that because it is faster?</p> <p data-bbox="336 985 1481 1041">EDIT: Another random (much more powerful) find by the above parameters is SIHG15N80AE-GE3 by Vishay and that is rather inexpensive.</p> <p data-bbox="336 1079 416 1135">Thanks, Mo</p> <div data-bbox="1204 1171 1458 1189">Last edited: Tuesday at 8:09 PM</div>
<div data-bbox="183 1279 225 1323">M</div> <div data-bbox="129 1357 280 1377">mz543578854</div> <div data-bbox="169 1391 239 1411">Member</div> <div data-bbox="159 1417 248 1433">Joined 2015</div>	<div data-bbox="336 1263 526 1283">Tuesday at 8:37 PM</div> <div data-bbox="1291 1263 1481 1283">New < > #90</div> <p data-bbox="336 1319 962 1344">Another one, working great in Spice: Toshiba TK14N65W,S1F.</p>
<div data-bbox="183 1509 225 1554">M</div> <div data-bbox="129 1588 280 1608">mz543578854</div> <div data-bbox="169 1621 239 1641">Member</div> <div data-bbox="159 1648 248 1664">Joined 2015</div>	<div data-bbox="336 1496 526 1516">Tuesday at 9:45 PM</div> <div data-bbox="1291 1496 1481 1516">New < > #91</div> <p data-bbox="336 1550 850 1574">And for Q8, it seems the DN2540 is an alternative.</p>

<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>Wednesday at 8:18 AM</div><div>New ↩ 📌 #92</div></div> <div><p>Low Rds(on) is no requirement, the FET never is fully on. Besides Vds(max) and Id(max) you also should look at the SOA in the data sheet. If the supply is shorted and the FET has to support the full set max lout at the full Vin, does it survive say half a second before it switches off?</p><p>In practise, you would look for a case that does <i>not</i> have the plastic isolator on the tab as that worsens thermal impedance to the heatsink and is also shown as a worsening of the SOA.</p><p>Jan</p><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div><div>mz543578854</div></div></div>
<div><div>M</div><div>mz543578854</div><div>Member</div><div>Joined 2015</div></div>	<div><div>Wednesday at 8:04 PM</div><div>New ↩ 📌 #93</div></div> <div><div><div>jan.didden said: (URL: /community/goto/post?id=7592425)</div><div>If the supply is shorted and the FET has to support the full set max lout at the full Vin, does it survive say half a second before it switches off?</div></div><p>Why allow such a long a period before switching off?</p><p>BTW... the below is the zobel network, which helped to keep some of the MOSFETs I tried in LTSpice from oscillating. I could not see any disadvantage when adding it.</p></div>
<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>Wednesday at 8:25 PM</div><div>New ↩ 📌 #94</div></div> <div><p>Bad idea, you modulate the output voltage with the input ripple. If you got oscillations, get the right MOSFET.</p><p>Jan</p><div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div></div>

<div data-bbox="183 152 225 197">M</div> <div data-bbox="129 232 280 255">mz543578854</div> <div data-bbox="170 266 239 284">Member</div> <div data-bbox="159 293 250 309">Joined 2015</div>	<div data-bbox="336 141 561 163">Wednesday at 9:02 PM</div> <div data-bbox="1291 141 1481 163">New ↩ 📌 #95</div> <div data-bbox="336 188 1481 293"><div data-bbox="360 208 963 232">jan.didden said: (URL: /community/goto/post?id=7592945)</div><div data-bbox="360 253 975 277">Bad idea, you modulate the output voltage with the input ripple.</div></div> <div data-bbox="336 342 1449 396">I compared two variants in LTSPice now: One with a type for which the ZN is not necessary in Spice, and one which needs it.</div> <div data-bbox="336 436 1473 521">You are right, the difference for a 300V input signal with 30V noise modulated on top, is 100uV noise at the output without the ZN and 300uV with it. So it is higher, but still is not too bad if it allows a broader selection of MOSFETs IMO.</div> <div data-bbox="336 562 1423 616">The advise to get a better fitting MOSFET still make sense of course. But the FDP12N60NZ is not available anymore and the recommended alternative NTP110N65S3HF is not available for the next time either.</div> <div data-bbox="336 656 1468 678">So, how did you select the two above? Trial and error? Or are there some other parameters not mentioned yet?</div> <div data-bbox="336 719 416 770">Thanks, Mo</div>
<div data-bbox="138 943 268 965">jan.didden ●</div> <div data-bbox="118 978 236 996">AX tech editor</div> <div data-bbox="130 1005 223 1021">Joined 2002</div>	<div data-bbox="336 851 560 873">Wednesday at 9:18 PM</div> <div data-bbox="1291 851 1481 873">New ↩ 📌 #96</div> <div data-bbox="336 900 1390 954">A good way is to go to Mouser or Digikey and put in the parameters you want which quickly gives you a shortlist.</div> <div data-bbox="336 963 823 987">Then check the data sheets for things like SOA.</div> <div data-bbox="336 994 1176 1019">It can take some time but if you do it in a logical step by step way it's not that bad.</div> <div data-bbox="336 1059 373 1081">Jan</div> <div data-bbox="336 1133 1157 1155">High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div data-bbox="138 1326 268 1348">jan.didden ●</div> <div data-bbox="118 1361 236 1379">AX tech editor</div> <div data-bbox="130 1388 223 1404">Joined 2002</div>	<div data-bbox="336 1234 561 1256">Wednesday at 9:50 PM</div> <div data-bbox="1291 1234 1481 1256">New ↩ 📌 #97</div> <div data-bbox="336 1283 576 1308">Did you read post #83?</div> <div data-bbox="336 1348 373 1370">Jan</div> <div data-bbox="336 1422 1157 1444">High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div data-bbox="183 1534 225 1579">M</div> <div data-bbox="129 1615 280 1637">mz543578854</div> <div data-bbox="170 1648 239 1666">Member</div> <div data-bbox="159 1675 250 1691">Joined 2015</div>	<div data-bbox="336 1523 568 1545">Wednesday at 10:12 PM</div> <div data-bbox="1291 1523 1481 1545">New ↩ 📌 #98</div> <div data-bbox="336 1570 1481 1675"><div data-bbox="360 1590 963 1615">jan.didden said: (URL: /community/goto/post?id=7593041)</div><div data-bbox="360 1635 587 1659">Did you read post #83?</div></div> <div data-bbox="336 1688 1465 1776">Yes, thanks, I did. I do not have working spice models for them yet. For FCH041N60E I have a lib from Fairchild but it is encrypted and I need to figure out how to use. And for FGH60N60SMD I couldn't find any model.</div> <div data-bbox="336 1816 1469 1901">I hear some people saying "it is only simulation", but because I tried to find replacements using the approach you suggested (parameterized Mouser search, which I also mentioned in #89), which do not work in the circuit in Spice at all, I am reluctant to use any that does not work at least in Spice.</div> <div data-bbox="336 1942 411 1964">Thanks</div>

<div>astouffer</div> <div>Member</div> <div>Joined 2004</div>	<div>Yesterday at 4:18 AM</div> <div>New ↩ 📌 #99</div> <div><div>jan.didden said: (URL: /community/goto/post?id=5946146)</div><div>But I am hesitant to publish it because it contains - gasp - an opamp ...</div><div>Jan</div></div> <div>Design a version using a Philbrick tube opamp. http://www.philbrickarchive.org/k2-w_refurbished.pdf (URL: http://www.philbrickarchive.org/k2-w_refurbished.pdf)</div> <div>The purists will remain happy.</div> <div>mz543578854</div>
<div>jan.didden ●</div> <div>AX tech editor</div> <div>Joined 2002</div>	<div>Yesterday at 7:18 AM</div> <div>New ↩ 📌 #100</div> <div><div>mz543578854 said: (URL: /community/goto/post?id=7593061)</div><div>Yes, thanks, I did. I do not have working spice models for them yet. For FCH041N60E I have a lib from Fairchild but it is encrypted and I need to figure out how to use.</div><div>And for FGH60N60SMD I couldn't find any model.</div><div>I hear some people saying "it is only simulation!" but because I tried to find replacements using the approach you</div><div>Click to expand... (URL:)</div></div> <div>Not sure it will be useful to go into that detail in LTspice - the models are almost sure not accurate enough. In cases like this I use LTspice as a 'proof of concept' investigation, not to determine whether one device oscillates and the other not.</div> <div>Modeling circuit and PCB parasitics is anyway hopeless.</div> <div>Jan</div> <div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div>
<div>M</div> <div>mz543578854</div> <div>Member</div> <div>Joined 2015</div>	<div>Yesterday at 6:32 PM</div> <div>New ↩ 📌 #101</div> <div>Yes, parasitic capacities, inductances etc. can make things worse when building it for real.</div> <div>But a model from the manufacturer for a recent MOSFET will not be so bad that it is not possible to simulate a circuit like this regulator correctly. Spice is used widely in the industry. If it would not even allow simulating this rather simple circuit (no offense, I could never design myself), then it would be completely useless.</div> <div>So, if a MOSFET does not work in the circuit in spice, I think this can be caused by the circuit reacting less robust / stable for some of them.</div> <div>To not choose one which makes this trouble in the "real world", I would rather select one behaving in Spice at least.</div>

<div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>Yesterday at 6:45 PM</div><div>New #102</div></div> <div><div><div>mz543578854 said: (URL: /community/goto/post?id=7593900)</div><div>But a model from the manufacturer for a recent MOSFET will not be so bad that it is not possible to simulate a circuit like this regulator correctly</div></div></div> <div><p>Ahh, you're an expert on circuits and parts modeling? That's good to know. Anyway, it's not a matter of 'it doesn't work', it's a matter of correctly simulating the impact of unmodeled properties and parasitics. Spice will do whatever you want, it's the models that are not fully complete, as well as the PCB and construction parasitics that <i>you</i> need to input! But hey, it's your project!</p><p>Jan</p></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div></div>
<div><div>M</div><div>mz543578854</div><div>Member</div><div>Joined 2015</div></div>	<div><div>Yesterday at 7:14 PM</div><div>New #103</div></div> <div><p>I basically just said "the model of the circuit in my spice now is simpler because it is not having parasitics modelled and thus more likely should behave better than the real thing later". You think that is wrong?</p></div>
<div><div></div><div>jan.didden</div><div>AX tech editor</div><div>Joined 2002</div></div>	<div><div>Yesterday at 8:33 PM</div><div>New #104</div></div> <div><p>You can't really say that. Parasitics can work any way. Mostly cause instability but also just cure it. It's a toss up.</p><p>Jan</p></div> <div><div>High-Voltage regulator - SuperRegulator - High-Voltage Delay - Linear Audio PDFs on USB</div><div>mz543578854</div></div>