
Subject: 300B Project, Part 6 - Cascode driver a little more

Posted by [Damir](#) on Sun, 19 Feb 2006 16:55:43 GMT

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Last time (Part 5) we examined modified cascode – V2 works with 10mA of anode current, and V1 gets additional 10mA "through" R5, total 20mA. I replaced $R_g=220k/C_i=0,22\mu$ combination on the 300B grid with grid choke, modeled here as $L_1=1700H$ with $R_w=8k$ in a series and paralleled with C_w , unknown capacitance; and enlarged $C_i=4\mu 7$ (to decrease Q of the circuit, to avoid subsonic resonance). Later I referenced R4/C1 to the cathode of V1 instead of ground – little change in operation point(s), little more amplification, but (subjectively) maybe a little less clean sound - I'm not sure. With this circuit I measured (larger) $A=45$ times with 5687 tube, and $A=53$ times with E182CC, driver has a very large grid choke impedance as a load. E182CC gives little more "clarity" and "bright" sound, and 5687 was "warm", more natural on vocals, but also a little more "mushy" (distorted?). The bass was a little "anemic", and highest frequencies little rolled off – this gives "bright and warm" combination at the same time... Unfortunately, I don't have measuring devices to confirm my subjective opinions... Another change was installing the CCS parallel with R_a , the current through R_a is about 10mA, and CCS gave another 10mA. Then we have 20mA through both tubes. I used anode output (showed on the schematic), and low impedance Mu-out on the cascoded DN2540N5 CCS ("Guinevere" style). Both output sounded similar, bass «punch» returned, and sound was more "balanced". Anode out (high impedance) gave little warmer and softer sound. Amplification also incresied a bit, $A=48$ for 5687, and $A=55$ for E182CC. The sound characteristics of 5687 (warmer, darker) and E182CC (brighter) retained in this circuit also. And this is the "classic" cascode, with $R_a=12k$ load resistor, $I_a\sim 13,7mA$ with E182CC and little bit more with 5687 tube. E182CC gave "sufficient" $A=32$ times (measured), but 5687 is "on the edge" with about $A=28,5$ times. The sound is warm, and a little "thick" and bright at the same time (?) The complete calculation: $V_1=E182CC$: $116-3,7=112,3V/13,7mA/-3,4V$ From the anode curves: $\mu\sim 23$, $r_{p1}\sim 2,4k\Omega$, $S_1=9,58mA/V$ We have a unbypassed R_k , and our real $r_{p1}\sim r_{p1}+(\mu+1)R_k = 8,4k\Omega$, $S_1'=\mu/r_{p1}' = 2,738mA/V$ – where $R_k=U_k/I_k = 3,4/0,0137\sim 250\Omega$ We neglected here the effect of R4/C1 referenced to cathode of V1, `cos of simplicity. $V_2=E182CC$: the voltage "across" R_a is $U_a = I_a\cdot R_a=164V$, and $U_{v2}=(440-164)-116 = 160V$. From anode curves: $r_{p2}\sim 2,7k\Omega$, $S_2\sim 8,5mA/V$, $\mu\sim 23$; and cos of unbypassed R_k we have $r_{p2}'\sim 8,7k\Omega$ and $S_2'\sim 2,64mA/V$ Formula $A = S_1' \cdot R_a = 2,738 \cdot 12 = 32,86$ times, more detailed formula (M. Jones book) gives $A=29,8$ times. Simulation with simple E182CC model gave $A=33,7$ times. I measured $A=32$ times, pretty in line with theory. There's a large choke impedance for the external load, and effect on amplification (lowering) is negligible. Output resistance of the driver is internal cascode impedance in parallel with load resistor: $R_{out} = R_{in} // R_a = ((\mu+2)r_{p1}')//R_a = 210//12 \sim 11,35k\Omega$ CONCLUSION: The cascode has many good characteristics – from very low input capacitance to good amplification (larger then μ of the actual tubes used). It needs rel. large supply voltage (two triodes in series + load resistor) and "elevated" heater supply (about 50V) - center tap of $U_h=6,3V$ connected on voltage divider (100k/3W and 12k bypassed with $22\mu/100V$ cap). But, my opinion is that relatively large output resistance of the cascode driver in combination with grid choke load gives subjectively a little too "warm and soft" sound (and "strident" too in E182CC case). Again, this is a subjective judgment, based on just a few E182CC (Philips and AmpereX) and 5687WA (Raytheon) samples in short time listening tests... To be continued – (simple) common cathode triodes 300B driver coming soon...

Subject: Re: 300B Project, Part 6 - Cascode driver a little more
Posted by [Manualblock](#) on Sun, 19 Feb 2006 23:03:18 GMT
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Warm and soft; those are the words I needed to describe the CCS sound. It sounds like that to me on the three amps I heard with a CCS loaded output tube; they have that sound. It rounds off the edges; not like the glassiness of SS but more like the distinctive edges of good definition that a very good design offers. There is definately something there and maybe that accounts for why there is a growing minority of listeners that are not overly fond of that design choice; it rounds off the distinctive defined edge of sounds. As soon as you said that it dawned on me what the thing was that I am hearing. I just never could find how to put it into words and I think I was actually disregarding my own ears because the idea of the CCS loaded plate seems to make so much sense. Listen to what you hear; I have to remember that.

Subject: Re: 300B Project, Part 6 - Cascode driver a little more
Posted by [Damir](#) on Mon, 20 Feb 2006 12:48:04 GMT
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It's not easy to evaluate and describe sonics. The "base" sound is SE 300B output stage coupled with my speakers (JBL 4208) - soft and warm. I tried two CCS versions, one cascoded DN2540 mosfets, and MJE350/BC558B/LED (from M. Jones book, similar to C4S). Although later has lower Rout, I didn't find the difference in sound in short listening test - 6J5 tube, anode out (more experiments later:-)). In comparison with 22k load resistor (about the same operating point), both CCS-ed versions sounded much better - cleaner...

Subject: Re: 300B Project, Part 6 - Cascode driver a little more
Posted by [Wayne Parham](#) on Mon, 20 Feb 2006 14:58:16 GMT
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Great work, Damir. I really appreciate all the time you put into this. Looks like this one needs to be on my short list for the next project.

Subject: Re: 300B Project, Part 6 - Cascode driver a little more
Posted by [Damir](#) on Mon, 20 Feb 2006 18:03:08 GMT
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Thank you, Wayne. This project went for far too long, and I finally took some efforts in

experiments. I'm expecting a few more days (weeks max.-)) for finishing the "breadboard" phase - to find the final "version" and build it in the box. I'll try to describe all the important details needed for building it. I hope that'll be the great building project!

Subject: Re: 300B Project, Part 6 - Cascode driver a little more
Posted by [Wayne Parham](#) on Mon, 20 Feb 2006 19:00:46 GMT
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Thanks, Damir, that's excellent. Truly excellent!

Subject: Re: I would like to build it
Posted by [Manualblock](#) on Mon, 20 Feb 2006 21:01:57 GMT
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So when do we drop the starting flag? Also could you possibly design it both ways; with and without CCS? For experimentation purposes? Some of the parts are Euro only; substitution would be required for some of the parts. What do you think about that? What chassis do you think you might use?

Subject: Re: I would like to build it
Posted by [Damir](#) on Tue, 21 Feb 2006 05:49:31 GMT
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Haha, little more patience, please I'll try to propose a few variations - I tried CCS (anode and Mu-out) and resistive load with few common triodes these days, and more experiments are in order. I used "AE-Europe" and "Lundahl" trafo/chokes parts mostly - I'll ask AE about package deal (they have it for some projects) - for PT, chokes, probably OPTs, too; and 115V/60Hz + shipping "problem"... Chasis - I use simple 2HE empty rack, 430x290x82mm - strenghtened with "partition", chokes and OPTs inside, PT (in its hood) on the top with tubes. Of course, it can be build in larger wooden box with metal top, or so. Stay tuned...

Subject: Re: I would like to build it
Posted by [Manualblock](#) on Tue, 21 Feb 2006 18:04:01 GMT
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I'm tuned bud; like Timothy Leary says;"Tune in,Turn On,And Drop Out."Timothy Leary's Dead;Oh No he's outside; looking in!Moody Blues

Subject: Re: I would like to build it
Posted by [Wayne Parham](#) on Tue, 21 Feb 2006 19:13:32 GMT
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I dig the Moody Blues. Proud to say I have everything they did on vinyl. But back on topic, I'm with you on this build. Looks like it's shaping up nicely and I'm excited about it.

Subject: Re: I would like to build it
Posted by [Manualblock](#) on Tue, 21 Feb 2006 20:12:34 GMT
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I wish the Moodies were recorded better though; most of the albums seem so rolled off and muted it's like listening through a blanket. Yes; Damir is doing good work here on this amp; I bet it will sound pretty darn good when he's done. I tend to favor PP but for this I will take the plunge.

Subject: Re: I would like to build it
Posted by [Wayne Parham](#) on Tue, 21 Feb 2006 20:30:16 GMT
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You're right about recording quality. I have half-speed masters of a couple of their albums and that helps a lot. In Search of the Lost Chord and Threshold of a Dream were both pretty rolled off and thick with tape noise in the regular pressings. But they were both such cool albums, maybe the recording artifacts from the original releases adds something to their mystique.
