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

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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 $C_i=4\mu$ (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 increased 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 $r_{p1}\sim r_{p1}+(\mu+1)R_k = 8,4k\Omega$, $S_1\sim \mu/r_{p1} = 2,738mA/V$ – 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 $U_a = I_a * R_a = 164V$, 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 $A = S_1 * R_a = 2,738 * 12 = 32,86$ 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: $R_{out} = R_{in} // R_a = ((\mu+2)r_{p1}) // R_a = 210 // 12 \sim 11,35 k\Omega$ CONCLUSION: The cascode has many good characteristics – from very low input capacitance to good amplification (larger than 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...
