Subject: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Sun, 26 Feb 2006 15:11:19 GMT
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6C45Pi – the «rumours» that it`s a triode capable of driving 300B, with impressive specifications, but not without «difficulties», are absolutely true, IME. Those tubes are relatively high µ, high gm, high current and high Pa «devices». Most of the time, they differ from specs and between each other – matching pairs are a must.What`s more, 6C45Pi has tendency to oscillations, and some measures are needed to prevent this. Not just that, but many DIY-ers reported «hard» and «unmusical» sound with this tube… is it worth the hassle? This triode has four cathode pins (connected together inside the tube) and two grid pins. I connected the resistor on each pin to act as a «stopper», in a manner showed in the picture 1:It`s a «noval» tube, and we can see that resistors are close to the socket pins.I tried two pairs of 6C45Pi in the circuit showed in Fig.2 – simple common cathode voltage amplifier, but with active load, cascoded DN2540N5 mosfets – known from «Guinevere» preamp project.Tube has very large anode load (CCS), and it «drives» high impedance load (grid choke), both much larger then internal anode resistance of our tube. Then resultant amplification is equal to the µ, or theoretical max. amplification factor, and distortion is low. I operated 6C45Pi tube with rel. low current (10mA) – I followed some published measurements and subjective tests / reccomendations to avoid «unfavorable» disposition of distortion artifacts (harmonics).The first pair has amplifications of 37/38 times, and the second «matched» pair 38,4 and 42 times. Anode voltage was more or less about 150V. This differs from the specs a little (Ua=170V, µ=50 in this OP).If our «average» amplification is about 38 times, and we have 300B «bias» Ugk=-73,5V (little more then –70V we discussed earlier, `cos of the new PT with larger voltage), and our tube needs max. 73,5/1,4142 = 52Vrms for max. power in class A1 – then input voltage for 52Vrms output from the driver is 52/38 = 1,37Vrms. If we have 2Vrms input source (CD player), then we must attenuate the input about 3,3dB, or in other words – we have some gain «reserve» or headroom, (maybe) needed for «quiet» CDs/sources.Input «grid leak» resistor must be under 150k (according to the specs), preferably much less, and I chose 47 kOhms. The problem with this (common cathode) arrangement is large input (Miller) capacitance. If we use a volume pot at the input, it is prefferable to have rel. small value, say 10k if possible. Output impedance of the pot (Rpot/4 max. – in the center position) with input capacitance forms a low-pass filter.The sound – little on the «hard» side, dark, lot of «punch» and dinamics, «enhanced» bass - the notes have more «weight» then 6J5GT driver (next «chapter»). But, it somehow lacks «refinement» and details – 6J5GT gives more transparency and naturalness in vocals.Good sounding choice for some music, but for the more «delicate» things it somehow has the «rough» and «agressive» and inssufficiently «detailed» sound. But, it`s about nuances, not large differences.DN2540N5 CCS has the advantage for having two outputs, besides «normal» anode out, it has low impedance «Mu-out». Anode out is a little «softer» and «rounder» sounding, maybe a little more natural, and Mu-out has a bit more highs and a «punch». I switched back and forth between them and in the end I used Mu-out, showed on the schematic. Personal preference, and easy to try both. But, 6C45Pi has low anode impedance (even with unbypassed Rk) and the difference isn`t large.But, I have the problem with mosfet CCS/circuit – «dry» and «shhh» sound on some instruments (vocals) probably meant a bit of oscillations on RF. I increased gate stoppers a little (to 1k2) and added «output» resistor of 47 Ohm. This, and shorter wires «tamed» this to unaudible.Grid stoppers on 6C45Pi are necessary (enlarge them if needed), maybe even two

100nF caps from pins 4,5 (heater) to ground, direct on the socket (I didn`t use them).And one more thing – we have almost 300V voltage «drop» through the CCS, and with 10mA current, dissipation is about 3W, mostly in Q1. I used «ribbed» heatsink for Q1, 32x20x37mm and it becomes warm after some time, but not too much – you can still touch it safely. Smaller heatsinks are not reccomended, and transistors with less then 400V «working» voltage, too. PCB for DN2540N5 CCS is here:http://audioroundtable.com/GroupBuild/messages/1079.htmlCurrent setting is here:http://audioroundtable.com/Tubes/messages/929.htmlI tried resistive load, too (Fig. 3) – I simply substituted CCS with 27k/5W (minimum) resistor, OP is very similar, (Ia=10,5mA, Ua=150V) and amplification is a bit less - 34,9 times. Anode resistor of 27k and anode resistance of about 1,6 kOhms formed voltage divider and lowered the amplification a bit. This time we must bypass the Rk with (quality) electrolytic capacitor.The sound is similar as with CCS, a little more «thicker» and «warmer». Switching back to the CCS is a «revelation» - IMO, resistive load is «scaled down» sounding version. CONCLUSION: With some little measures 6C45Pi works very stable and quiet, amplification is about «right» 38 times (based on 4 samples). Sound is a little on the «agressive» side, but IMO – «good enough» to be usable as a 300B driver.Although resistive load gives solid performance/sound, my opinion is that CCS load is better...

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Sun, 26 Feb 2006 17:11:38 GMT
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D-Man; How can you tell if there is oscillation occuring?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Sun, 26 Feb 2006 17:51:23 GMT
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Harder without oscilloscope, but there`re some symptoms - in bad cases there`re hum present and unstable work of the circuit. Oscillating tube, for example would "pull" large current. In "moderate" cases, probably "strange" sound - glassy, strange distortion, especially in high frequencies, rustle and dry... When you touch or move some parts/wires, you hear the change in this symptoms/sound. Every wire is antenne, inductance and capacitance, and when you have the gain you have oscillator... It can be a tough problem, depends of the layout...

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Sun, 26 Feb 2006 18:39:16 GMT

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So is it possible that there could be a slight oscillation that might affect the sound in a small way you can't put your finger on right away?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Sun, 26 Feb 2006 19:14:22 GMT
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Yes, some can be even "triggered" sometimes by some sounds/frequencies, I`m pretty sure. But, as I said - without scope we can only guess...If you have similar symptoms, check all your connections/grounding and rewire it - "stopper" resistors close to the pins (non-inductive, say CC), and very short wires.

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Sun, 26 Feb 2006 20:00:04 GMT
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So maybe thats why the aggressive or hard sound from the driver stage?Can a CCS loaded anode be the cause of amplifier ocsillation? Say; more so than a resistance loaded plate?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Mon, 27 Feb 2006 08:47:43 GMT
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I tried other tubes and another CCS (BJTs version). Every tube has its own "sound", I tried about 10 versions of 6J5, 6J5GT, 7N7, 12SN7, 6SN7 these days - resistive load is more "colored", and IME- it`s well worth the hassle to build/use the CCS.I described 6C45Pi sound as "on the hard, agressive and dark side", it depends of the extent of the output stage and the rest of the system (CD player, cables, speakers). But, it`s a just a nuance - warm, soft, midrange details, etc. - "signature sound" of the SE 300B amp is still there. Don`t get me wrong - those characteristics are not negative (in a sense that you can`t use/listen to it), I`m certain that some people like the sound of 6C45Pi. This is just my subjective experience, and yes, I could "live" with 6C45Pi/300B SE amp - not a bad combination.

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Mon, 27 Feb 2006 12:59:41 GMT
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Thanks D; but can oscillation be very subtle and affect sound without the amp exhibiting obvious problems? Maybe just sort of like a slight harshness or rough tone that is not readily apparent? I get what you are saying about how the terms you are using to describe the sound are reference terms not to be taken as criticisms but just as a way to describe some aspects of the sound of different tubes and parts. So are there any other driver tubes you plan on trying out?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Mon, 27 Feb 2006 18:38:22 GMT
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Today I listened to the 6C45Pi driver in comparison with (half of) Sylvania 12SN7 and 7N7. Various music...6C45Pi is definitely somehow harder, sharper, and punchier, and 12SN7 softer, less bass and highs, but sweeter, more nice vocals...huh. At least, that`s how I can hear it After 6SN7 "family" report, I have a plan to examine E280F and D3a pentodes (as pentode and triode connected). Then E182CC and 5842 CCS-ed common cathode...maybe something more...stay tuned :-).
http://audioroundtable.com/GroupBuild/messages/1660.html

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Mon, 27 Feb 2006 19:06:31 GMT
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Damir; what does he mean by the statement that oscillation is not a class A affair?Does that mean because SE runs in class A or A1 all the time then here cannot be oscillation conditions in that amp?I don't understand the post; why can you only find the condition of circuit oscillation in grid stage that runs positive?Should I never worry about that situation if I run an SE amp in class A?Also he claims to have cured an oscillation by using grid stoppers and the unit sounded better; but then he goes on to say that there is no way to tell without measuring very carefully.Why is it others on the net claim that a SS CCS can cause a condition of oscillation if the CCS circuit goes bad? But not with a VR tube CCS?Thanks Bud for putting up with these questions.

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Mon, 27 Feb 2006 19:44:35 GMT
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I`d like to Doug explain it, but I`ll try. It probably means that it isn`t "normal" signal (only of very HF) present on the input grid and amplified. It can be "extreme" and so "high" that the stage "overloads" (grid current). Sound still can "pass through", but "weak, undynamic, distorted, glassy..."Everything can oscillate, no matter class of work, or device used - but high gm parts more likely. Even anode-stopper (between the CCS and anode, say 100 Ohms) isn`t over the top measure...

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Tue, 28 Feb 2006 01:01:12 GMT
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So how does these measures affectr the sound? Do grid stoppers have any effect on sound?Can the amp ocsillate more easily with a CCS load or can it oscillate easier with a resistor loaded plate?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Tue, 28 Feb 2006 09:26:13 GMT
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Huh, MB... of course that probability of oscillations is larger in the circuit consists of one tube and two mosfets then in the circuit with just one tube. But, it`s a simple circuit(s), and there`re no reason why we couldn`t make it to work properly... Grid stoppers - they have impact on sound, larger values sounded more "soft" and "rolled off". I used 1kOhms on both driver and power tube position, but now I lowered this. Currently I`m using 560 Ohms on 300B grid and 150 Ohms on 12SN7- why? I have those on hands... The "goal" is the minimum value that can still performs its job - to "damp" the resonant circuit consists of (Miller) input capacitance and inductance in the grid wiring.

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Tue, 28 Feb 2006 12:21:28 GMT
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Ahh; thats the first time I heard exactly why we use the grid stoppers.Now it is making more sense to me. So what happens if the depletion mode mos-fet overheats?

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Damir on Tue, 28 Feb 2006 17:22:14 GMT
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Similar as with overvoltage - I burned one, maybe both. B+ is over 400V, little mistake and puff... Luckily, I have a few more, but it`s a pain to resolder it from the PCB/heatsink. Now I must waiting for another group buy of DN2540N5...

Subject: Re: 300B SE Project, Part 7 - Common cathode 6C45Pi triode driver
Posted by Manualblock on Tue, 28 Feb 2006 18:25:34 GMT
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O'Kay; thats what I needed; as long as I know that a catastrophic failure of the mos-fet won't take out my transformers or my speakers then I am o'kay with it. I was told that could be a problem so that is why all these questions. You know those OPT's ain't cheap! Not to mention the loudspeakers.

Subject: Update :-)
Posted by Damir on Fri, 03 Mar 2006 19:11:56 GMT
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Today I received my third pair of "Sovtek" 6C45Pi-E. It`s a new production tubes, former pairs were NOS from 70`s/80`s. This pair is well matched and closer to the specs, Ua is about 160V, and µ=43/45. I tried changing Ia through the tube(s) in 1mA steps. IME - lower current "sounds" darker and less sharp/rough. About 9-9,5 mA sounds best for my ears, although I can "swear" that I heard a little sound differences between the 6 tubes I have, too. We can (safety reasons) "drop" the B+ a bit, on about 400V. I didn`t hear the difference.