Subject: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sat, 16 Jul 2005 18:43:25 GMT
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I have tried both on the EL 84 amp. I like cathode bias sound better, but I am not sure why that is. Can we discuss the differences between the two?

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Forty2wo on Sun, 17 Jul 2005 00:46:26 GMT
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Hi M, (sorry I forget your real name)The main claim to fame of fixed bias, is efficiency, you get more power out of a set of tubes if you are not heating up a cathode resistor. But with FB you are applying a voltage, aka (signal) to the grid. If this is not deep black it will be heard.With CB you will have a certain amount of degenerative feedback , which is not a bad thing and my guess is that is what you (and me) are hearingWith CB often you are running you tubes deep into "class A". You can test this. Measure current across the cathode resistor . then when you switch to FB set the current to the same or more. Try this and tell me what you think…John

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Thermionic on Sun, 17 Jul 2005 02:25:04 GMT
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Some personal musings on bias: Grid bias exhibits lower distortion (and more power, as Forty2wo noted) than cathode bias does, and the orders of distortion artifacts present with each differ. Output Z and therefore damping factor as well also vary with the bias method, and whether or not the cathode resistor is bypassed. With a cathode biased stage there is indeed degenerative feedback, but the parallel bypass cap provides a low impedance AC path to ground and breaks it. Adding the bypass cap increases gain, distortion, and stabilizes the bias effect.A grid biased stage can be either Class A or Class AB operating class. A cathode biased stage found in a hi-fi amp is typically gonna be Class A, while a cathode biased PP guitar amp may be either class. The reason is that with Class AB operation the plate current increases significantly with output, and an increase in current drawn through the cathode resistor creates a higher bias voltage, according to Ohm's Law. If an amp is (cathode) biased into Class AB operation far enough away from Class A, it will increase it's bias voltage on the fly enough with increased output wattage to the point where crossover notch distortion becomes horrendous. As you increase the volume further, it'll sound more and more distorted until it actually starts losing volume from the power tubes being cut off!That's of course worthless for hi-fi. But, there are a few guitar amps like the legendary Vox AC30 (and boutique clones) that use a cathode biased Class AB output stage to produce a unique set of harmonics as the amp is turned up. The AC30 is biased close to Class A operation, so the

power tubes' current draw doesn't increase really sharply with output, which keeps it out of trouble.Another difference with cathode and grid bias is that with cathode bias, the plate voltage you measure is NOT the real plate voltage. The real plate voltage is the plate to cathode voltage potential. Subtract the cathode voltage from the measured plate voltage, and you have the real plate voltage. This must be taken into account when designing a cathode biased stage on the plate characteristic curves.Thermionic

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Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 14:11:19 GMT
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Hi John; Thanks for the help. I will try your suggestion but I will need to restore the circuit to FB at some point. Can you tell me exactly what you mean by the term deep into class A?

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 14:16:36 GMT
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Thanks T; Can you explain how the bias scheme used affects zout? I am under the impression that is controlled by the primary impedance of the OPT.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Wayne Parham on Sun, 17 Jul 2005 16:31:03 GMT
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I think he probably means the tube is biased so that it conducts a lot at idle. If you set idle current past 50% of saturation, you're kind of shooting yourself in the foot but up to that point there is some room to play with biasing.Class A circuits have the active component always conducting, never cutoff even at idle. Class B is push-pull where each device is set for zero idle current, so that it only begins to conduct on its half cycle. Class AB is a push-pull configuration that sets each active device quiescent current above zero, so each device conducts through the crossover region. It prevents switching spikes and reduces distortion. So Class A is conductive all the time, Class B is cutoff at opposite half cycles and Class AB is somewhere in between.The whole idea of single-ended circuits is to set the active element in the middle of its linear range, basically right at its 50% current point at idle. Then the input will swing current above and below that, with maximum output being near the point where the device is completely saturated on the positive side and completely cutoff on the negative. If the idle current is too far off 50% either way, you'll hit one of the limits considerably before the other one, wasting some of the dynamic range

potential.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 16:55:33 GMT
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Thanks Wayne; It was the term "deep into class A" that I wasn't sure of. I am aware of operating class distinctions. What throws me is how we distinguish the borders of conduction limits that set the classification of operating points. Did that make sense?I am trying to understand how the bias point of a tube dictates the resulting circuit parameters and how that impacts on the Z of the circuit. I am struggling with the way that these parameters affect the various AC impedance values and why that equals different effects on the loudspeaker.I have a circuit built on PC boards that allows you to use fixed or cathode(self) bias. I need to know why I am making a choice of bias schemes. So I can choose wisely.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Forty2wo on Sun, 17 Jul 2005 20:14:24 GMT
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Wayne is right. What I mean by deep is higher standing current. How much will depend on your speakers and how much power you need. In my case I have a pair of Bottlehead Straight 8's, at 96-97 dB efficient, so 1 or 2 Watts goes a long way. I don't need to run the current very high to stay in class A. As a rule start with low current and gradually increase it till you are happy. If you are after Max power again run as low as sounds good. The more current the more the 2 tubes overlap (more class A less overall Power) . Plus more current = more heat and less tube life…John

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Forty2wo on Sun, 17 Jul 2005 21:08:02 GMT
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OK, first, off how are you running your el84's. As pentodes with a screen supply, ultralinear, or triode connected.The output transformer (+speaker) is the load and for modeling, is the plate resistor and they are fixed.So, the Z-out is determined by the tubes dynamic plate resistance. If you add a unbypassed cathode resistor the DPR increases. For a triode it is Rk(u+1) "cathode resister x mue(amp factor) + 1. This is the effect of degenerative feedback.For a pentode, I don't know ask someone else.;)Now if you bypass the cathode resistor with a big cap. From a AC (impedance) point of view it's not there. So you are more or less back were you started,

from a Z-out point of view.So is any of this to worry about. No. there is not much you can change, so go with what you like and don't worry…John

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Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 21:08:18 GMT
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Thanks John but where does distortion enter the picture here? Also what will happen with increased current through a triode? How does the big three(Rp/Mu/Gm) interact when the current is very high? When do you exceed plate dissapation rating? Maybe this is too basic, I can read it but when you explain it I get it.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 21:09:57 GMT
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Sorry, it appears we posted at the same time and you have answered my questions. Disregard that last post and thank you very much. I will digest this now.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Forty2wo on Sun, 17 Jul 2005 21:27:04 GMT
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Do you have a copy of "Beginner's guide to tube audio design" by Bruce Rozenblit. If not get one.Each time I start a new project I dig out this book. Read it 10 times in 2 years with highliter in hand and you will be an expert.I thing it is time for a "tube tinker's library thread" Do you think?...John

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Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Sun, 17 Jul 2005 22:48:56 GMT
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Yes you are absolutely correct. Here's my problem. As I aged it becomes increasingly difficult for me to follow abstract concepts. I have all this stuff memorised; but until I can picture in my mind

how an AC voltage can ride on a DC current I am stymied. I have all the books; Radiotron/Rozenblitt/AARH/USN Training Series etc etc. When someone explains that to me so I can understand it intuitively I will buy them a drink. All my problems stem from that one thing.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Wayne Parham on Sun, 17 Jul 2005 23:44:31 GMT
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Get an oscilloscope and your problem will be solved. You will see a visual representation of the signal. DC is like an offset for the AC component. If the DC level is 10 volts, the average AC level is shifted 10 volts from where it would be if the DC level was 0. The scope will let you see this, and it will become intuitive for you.Here's another thing to visualize that might help you. Picture a swimming pool, only half full. So the surface is 3 feet down from the edge. Throw a rock in and ripples ride on the surface. Now pour in some water to fill the pool. It is now 3 feet higher. Throw a rock in the pool and the same ripples appear. They're the same height (amplitide) and the same rate (frequency). The only thing that's changed is the height of the surface of the pool, it's now 3 feet higher. That's the way an AC component rides on a DC component of a signal.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Mon, 18 Jul 2005 01:01:39 GMT
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Yeah but the pool ain't flowing backwards and forwards like an AC signal. Plus the AC is current while the DC is potential. See what a problem child I am here.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Thermionic on Mon, 18 Jul 2005 01:52:11 GMT
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Some personal musings on operating class, in conjunction with Wayne's. Class A means that the tube (or transistor) is biased so that it conducts through the full 360 degrees of the AC signal input cycle, at the full unclipped output of the amplifier. This ordinarily means an operating point that's about halfway between cutoff and saturation. Class A amplifiers exhibit very little increase in conduction between idle and the point of clipping, as they basically idle wide open. Class A is the most linear, lowest distortion operating class, since it keeps the tube well away from the highly non-linear cutoff region on the negative swing of the input signal cycle. But, it's very inefficient and wastes a great deal of it's potential power as heat. Somewhere in the area of 10% efficiency for a

Class A power stage is pretty normal. Since the power tube in a SE amp handles the entire signal, all SE amps must be Class A to amplify the entire waveform. Let me see, "hard" Class A now..... A tube is said to be biased into Class A when it conducts for the full 360 degrees at the full, unclipped output of the amplifier. But, the *unofficial* term "biased harder" into "hard" or "hot" Class A is used by some to describe when it's bised even hotter than this point. Class A is Class A, and you can't get "more" Class A, but this is just biasing it to a point of very high conduction, way more than necessary.The earmarks of when you really got that thing cooking that way are reduced tube life, lower power output, and more heat generation, but also lower output Z and also (sometimes!) a pleasing sound (sometimes not!). In general, the higher the plate current in a Class A output stage, the lower the output Z of the tube, and the higher the damping factor over the loudspeaker. But, generally the plate voltage must be lowered as well in order to prevent exceeding the design maximum plate dissipation wattage. The super high current/low voltage/low output Z operating point is extremely inefficient, and is not without it's own set of caveats. Manualblock, the OPT controls the reflected impedance load the tubes see from the speaker. Output Z here refers to the output impedance of the tube itself, independent of the reflected load of the OPT. Class AB means that the device conducts for appreciably more than 180 degrees of the input cycle, but not more. The region near cutoff (excessively low plate current) is very non-linear, and is avoided in Class AB operation.This also prevents crossover notch distortion in PP amps when the signal is "handed off" at the zero degree point. Each tube of the PP pair conducts enough past 180 degrees that both are still fully on and up into a linear region of their operation at the crossover point. They burn up a lot less potential power as heat, and are therefore much more efficient than Class A amplifiers, and are able to put way more more power into their load as a result. But, Class AB operation is also higher distortion than Class A. There's an old wive's tale that "Class AB amps are Class A at low output." They are NOT, otherwise operating class means nothing. They operate in a manner similar to Class A at low outputs, but they are still Class AB. Class B amplifiers are biased so that the devices conduct for exactly 180 degrees of the input cycle, and no more. The distortion is very high, so they are not used for audio, but for radio transmission. In response to how an AC signal rides on a DC voltage, there have been some great answers posted here. One thing I'd like to add that might help is that while DC is *always* a positive or negative voltage, the fact that AC is both in alternation means that the average voltage of AC is zero (i.e. 10DCV- plus 10DCV+ averages 0). That's one of the things that allow it to ride separately on the DC without affecting it, and vice versa.Thermionic

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Subject: Re: Fixed Bias v. Cathode Bias
Posted by Wayne Parham on Mon, 18 Jul 2005 10:43:40 GMT
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Actually, the water in the pool analogy is very close. The only difference is that the behavior we're looking at in electricity is fundamentally two-dimensional and the pool is three-dimensional. But if you look at a profile of the surface, the ways they act are almost exactly the same.Forget the "current" part of the phrases "direct current" and "alternating current". Current only flows when we have a closed circuit. The terms are labels that come from a description of power circuits, one having fixed potential and therefore fixed current when loaded, the other having a sine wave output, and therefore an alternating current when loaded. But when we talk about potentials in general, we almost always refer to a steady potential as DC and a moving one as AC. That's the

part to focus on, whether the potential is fixed or moving.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Manualblock on Mon, 18 Jul 2005 11:54:55 GMT
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Wayne and Thermionic; This is good stuff. You may not realise the exact phrase that does the trick but I do and there are a couple in here. I need some time to mull this over but this help combined with the books is great. I think I see now that to understand this stuff you must take it in small intervals that deal with a specific issue of amplifier construction, ie Bias Settings. The learning curve though is pretty steep and the lightbulbs are going off.Waynes water analogy is very good and your pointing out that the AC voltage sums to zero is also. Waynes statement that current is only there with a load and to disregard it when dealing with potential is a biggie. The conduction paragraph has helped greatly. I say this in order to try and pinpoint for you helpfull guys what is helping me. I will report back after some thought; thanks again J.R.

Subject: Re: Fixed Bias v. Cathode Bias
Posted by Thermionic on Mon, 18 Jul 2005 14:34:27 GMT
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Howdy manualblock,Glad we said something that rang a bell! I really liked Wayne's analogy that current is only there with a load, and to disregard it when dealing with potential. It's like a water pipe. There is *always* pressure (voltage) in it. But, there is no flow (current) until you open the tap. Herein is a good analogy of how inductors and capacitors work as well.Think of a capacitor as a small pipe with a piston and a one-way release valve in it, holding a high pressure on it's internal contents. When the pressure in the system it's connected to drops, the one-way valve opens. It's able to help maintain the pressure (voltage) in the system, even if the main high pressure pump were turned on and off quickly several times.An inductor is like a garden hose reel with LOTS of hose on it. When you turn the water off at the spigot, it still flows from the nozzle for a long time. There is a large volume (current) stored within it, and when the nozzle is opened the volume is constant, even if you were to turn the spigot on and off quickly several times.Capacitors and inductors are "mirror image" components, they do the exact opposite things.Capacitors:Store voltage in an electrical fieldBlock DC and pass ACResist any change in DC voltage across themInductors:Store current in a magnetic fieldPass DC and block ACResist any change in DC current through them Thermionic

Subject: Tube basics
Posted by Forty2wo on Mon, 18 Jul 2005 16:51:38 GMT

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Did you ever get a chance to look at this site. I think he dose a great job of takeing some of the mystery out of all of this.
http://boozhoundlabs.com/howto/

Subject: Re: Tube basics
Posted by Manualblock on Mon, 18 Jul 2005 18:19:35 GMT
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Forgot about that site. Thanks.