Tubemodules.com Article:

Tube Biasing - A Technician's Viewpoint

Tube biasing is made all the more confusing by the wide variety of printed material on the subject. One thing that is true from all the sources: biasing is the one part of setting up your amplifier that needs to be at least *close* to where it should be. It has a great deal to do with how your amp handles clean and overdrive signals.

The bias in a tube amp is represented by two factors, the voltage on the signal grid and the voltage at the cathode.
The voltage on the signal grid is where it all starts, if your amp is "fixed bias." It is represented by a negative voltage, like "-52V" in a Fender Twin.
The voltage on the cathode is what you normally measure at a test point. The cathode voltage reading represents cathode CURRENT, which is why sometimes you read about "25mV" and other places "25mA." There is most often a one-Ohm resistor connecting the cathode to ground. That converts the 25mV reading into 25mA, which is how much current the tube is carrying. It is important that this current not exceed the capacity of the tube! Otherwise damage to the amp or at least the tube can happen, and very quickly! Learn what the "plate" in a tube looks like, because if it glows red hot, your tube is in trouble! Like this:

Hint: the one on the left is the tube in trouble. Thanks to falconeddystudios.com for the pic.

But in any case, when you read about bias, remember there are two possibilites of what is being refered to: Grid Voltage or Cathode Current.

As I mentioned above, bias circuit designs come in two main varieties: self-biased (also known as cathode bias) and fixed bias, which is more common. You will see self-biasing on most amps that use EL84's, and some 6V6's.

"Fixed bias" means that it is set for a certain value and left there. It can be adjusted with a potentiometer, or set by a resistive divider and not easily changed. If you see a bias adjustment, the amp is "fixed bias."

A schematic is necessary to be sure of what you are doing, or some good directions from a source you trust.
The designers of any particular amp had a certain design goal when they published the bias settings for their amp. Some amps require that you set the grid bias for a certain voltage. Whenever I see this value in a schematic, I set the amp for that value. If there is no grid voltage given I use the method I describe here.

A Little Theory...

Class A operation makes both halves of the push-pull output section draw current constantly. This reduces crossover distortion, increases linearity, and makes the tubes stay close to the point where hard playing runs them into the rounded-top distortion that makes that "tube-y" sound tubes are famous for. The problem is, this constant current draw wears out the tubes, strains the power supply, and makes anyone with even the slightest bend towards energy conservation cringe.

Class AB, on the other hand, is a good compromise when done right. One tube is always drawing current, and sometimes both, but always in a small amount. AB is more like an electronic see-saw, where when one tube is up, the other is down. Careful adjustment of distance from the ground (bias) and position of the balance of the see-saw board (bias balance) makes for a wonderful result. Almost no crossover distortion, quite linear, and far enough from the tube's current limit that you have plenty of headroom. Then the idle current draw is not much over what goes into making music. Very efficient. Power supplies are happy, tubes are happy, and electric bill is not outrageous. And your tubes will last much, much longer.

First, what is the magic number?

What is the perfect bias point? I can tell you what I believe as a technician:
Data that goes into this decision comes from two places: the tube data sheet and the amp's information, often just the schematic. But I always try to get an actual reading of the B+ or plate voltage myself, since there is a hidden factor that you don't often read about that makes it necessary to check that voltage.

The hidden factor about older amps:

Amps from earlier years were designed to work from 105, 110, 115, 117, or 120 Volts AC (USA) at the wall socket. That was the standard, nation-wide. The earlier the amp, the lower the voltage expected. These days, line voltages are higher. Mine at the shop is anywhere from 120 to 125 Volts AC. It depends on the draw of the city overall, as well as my building in particular. It is best to check it with a digital voltmeter.

What this means is that since most amps **do not** have regulated power supplies (even the expensive amps), bias voltage and plate voltages published with the amp are no longer met with a stock amp at today's line voltages. These older amps need to be adjusted for today's higher line voltages. Also, an amp that sounds great in the country will sound different in city! The voltage can be as low as 105 volts at the end of a long run of country wire. You need to adjust the amp to the line voltage it will be used with.

How to figure what the bias should be.

Look up the tube specs from the manufacturer, and find Maximum Dissipation in Watts.
Look up or measure the place voltage or B+ voltage of the amp in question.

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Example: 6L6 in a Fender Twin 50 W = 460 V * ?

1. W/V = A 50/460 = 0.1087

2. 25% of A = 0.1087/4 = 0.027 or 27mA of bias current
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The source of the 25% figure is a little hard to explain. I think it is more a rule-of-thumb than any hard fact. I would think that you would not want any more than 1/4 of your tube's capacity wasted on just keeping it active.

Now, these figures were pulled from memory. but they just happened to come real close to what Fender says the Hot Rod DeVille should be set for, that is, 60mA for two tubes in parallel.

This can be done the same for any amp and tube combination.

Purists will argue (correctly) that there are factors I did not take into consideration, but really I haven't gotten to the good part yet. It is more complicated than just what I stated.

After all, how is this measured? Where do you measure it? Under what conditions? What factors are you taking into consideration?

The formula above figures very roughly the plate dissipation at a certain current and voltage. It doesn't take into consideration the DC resistance of the output transformer primary, or the screen grid current, which is often a sizable percentage cathode current during operation. But at idle, the screen draws little current, maybe 15% of the plate. So we can neglect that safely.

But even if these things were not factors, the B+ or plate voltage would be. The figures say you need less idle current when the voltage is high, and more idle current when the voltage is low, to stay within the tube's maximum wattage (and therefore current) with proper headroom.

I measure the plate voltage at the plate.
I measure the current at the cathode, with a 1 Ohm resistor to ground. So do most amp companies that have a place to measure it.
I measure when the tubes are warm, about 15 minutes after turning the amp on. I check it again later after more run time.

Some schematics only show the bias voltage on the grids. There is no problem with this, either. The designers had a target for the best compromise in headroom and overdrive, and that was it.

(I am sure a lot of effort went into this figure. Probably they made 100 amps, had the techs adjust them, then measured the ones that sounded the best. That was the new goal. Repeat until it works on all of them. Meanwhile, make sure the current is not excessive, while good-sounding, because amps would fail.)

Conclusion.

Read the tube data from the manufacturer. Get the maximum dissipation figure.
Find the schematic, measure, or read somewhere what the plate voltage is for your amp.
Do the little math to get a target current in mind.
Buy or make a bias current reader. I just use a 1 ohm resistor to ground if there is room.
Set the amp's bias circuit to measure your target current, then try it out. Tweak for sound, measure for safety.
Don't go too high for idle current, unless you like buying tubes often.

Be safe. Observe rules about measuring high voltages, which can absolutely kill you or at least ruin your day.
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