

Duncan's Amp Pages

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The following is an excellent article on biasing using an oscilloscope, posted by Tom Crocker to alt.guitar.amps. It's reproduced here in its entirety with Tom's permission....

That scop bias thing you do (Tom HIWATT, 04/10/97 20:07)

As I said I would about eight years ago, I will relate to the NG how I use the scope/notch method to set the bias on guitar amps.

This method requires that you have an oscilloscope, a signal generator and a non-inductive power resistor as a dead load. If you plan on doing amp servicing, you need these tools anyway.

Here's how I do it:

I set the signal generator to deliver a 150mv, 600 cycle sine wave signal to the input of the amp. I set the master control, if there is one, on full and use the gain control to vary the intensity of the signal to the output stage.

I set the tone controls at their mid-point. I set the presence control full down, where applicable. I hook up a dead load to the output and if the opt is multi-tapped, I usually use eight ohms. The scope is hooked up across the load resistor so I can monitor the output. Assuming that I am starting with a known good amp with new tubes, I will set the bias control, if there is one, to give the highest negative voltage at the grids of the output tubes.

I then power the amp and once it is operating and stable, increase the gain/volume control to give a sine wave at the output. I set the scope to see usually three sine waves on the screen, but I may want to isolate just one notch as I complete the bias procedure. The sign wave will have a horizontal "notch" on the rising and falling portions of the wave, the sides you could say, at the middle. When the output is high enough the top and bottom will start to clip.

When this happens I reduce the gain/volume until the sine wave is fully rounded at the top and bottom. At this point I begin to reduce the negative bias voltage. As I do this, the sine wave will increase in size and at some point it will begin to clip again. I simply reduce the level of drive signal again until the sine wave cleans up and continue. I continue reducing the bias voltage and adjusting the drive signal level until the sign wave is smooth on the sides. At this point the amp is "biased" and ready for testing.

Easy?

As an example, I pulled out a Fender Bandmaster Reverb that I had in the garage. It is black-faced and has new filters but is otherwise stock. I performed my usual bias procedure outlined above on it and then used a one

ohm resistor in the cathode circuit to measure the idle current. It was 34 ma.

Not exactly the "cold" setting some people associate with this method. But this method is not as simple as some have made it out to be. It is VERY subjective. It takes some experience if you hope to have repeatability and not all amps can be biased this way. Let me explain.

The Notch.

The crossover notch made by some tube types are more apparent than others. EL34s notch sharper than 6L6s, for example. The notch in the above BR was really a gentle curve. How do you bias with that? I have seen this type of curve in Fenders many times and can deal with it but it is as a result of experience that I know where is "biased" (32-36 ma idle current in a Fender with 6L6s) and where is not. How do you get this experience? How do you know when to stop cranking that bias pot? There is a part of this procedure not written in the "book" that you need to know about.

Check, please.

The check is a way to confirm what you have done. You can check the idle current with the one ohm resistor or by the transformer shunt method or by just looking at the current load present at the ammeter in your Variac, if you have one. For example, the above BR, at 120 vac and with the output idling at 34 ma pulled 625 ma of current from the wall. Most 50 watters will do that, with EL34 amps getting up near 750ma. 100 watters will go from 1.25 amps to 1.5 amps. So, what is this check, cheating? Sort of. After a while you will know where to bias familiar amps without it but it is the one thing that was not written about that is the most important. You can not know where the amp is biased without measuring it in some way, right? Some amps give a notch that is so vague that there is no way to tell if you are biased or not. The check is a way of being sure.

Ah-HAH!

So, why use the scope at all? I do it to check on the amp. I look into the amp to confirm it's condition. Biasing in this way puts a strain on the amp, a lighter strain than that encountered when playing but it works the amp and I can see if the filters are happy, if the output tubes are happy, the opt, etc... But I will not say that this is the right way or that there is one right way. If anybody tells you there is ONE right method or ONE right bias point, please understand that that person is wrong. I was wrong on this topic once, too.

Customer is right.

Some folks like to run their tubes at high currents. I consider the normal idle current for EL34s with 440-480 volts on the plates in guitar amps to be within 34-40 ma. Typical for hifi amps is around 50 ma. Some folks like their EL34s in their guitar amps to idle at 45ma. That's ok. The higher idling current means higher currents throughout the operating range, as well as higher operating temps. This means more wear and a decreased life for the tube. If the player is willing to make the trade of less tube life for more of the sound that he likes then ok.

Going in excess of 45 ma in the typical guitar amp can stress the tubes or power transformer to the point of premature failure. I could see up to 50 ma in an amp that was never pushed to clipping, but most fixed-bias guitar amp power transformers are not designed to deliver that much high current continuously, so I like to encourage that people stop at 45 on the above types of amps. To do a "custom" bias such as this, you will need to use the cathode resistor method or the trans shunt or insert an ammeter in the plate circuit- something other than the scope method as reasonable accuracy is important. And if you have the amp biased past the point where the notch disappears, how ya gonna know where you are?

Still, I urge the player to try a bias setting a bit lower than the "preferred" if that setting is kind of high. I.E., If he likes 45 ma, I say try 40. If that sucks to him we try 43. If at that point he's happy, he has given himself a little more tube life. If he's not happy, 45 it is.

Common problems with using the scope method are:

Not using a dead load. I have heard from people saying they can not get the amp to sound good using this method no matter what they do. After going over the procedure many times they finally admit that they are using a speaker for the load, even though they have read to use the dead resistive load. You can not substitute a reactive device, be that a speaker or an emulator for the dead load. 50 watt resistors do not cost that much. Don't use an old voice coil either. It's not a load.

Getting a good sine wave. You need a good, even sine wave for this. On some amps, this means adjusting the tone controls to reduce any non-linearity's or odd curves. If the amp has several channels, use the clean one. If it has a loop, use the loop return and increase the signal generator's output to about half a volt ac.

Where do you stop? This is the hardest and is the reason for the "check". On some amps removing all of the sine wave is just right. On others, removing all the sign wave may be cold or hot. That BR still had some curve to it at 34ma/idle. Having fun yet?

Most amps are happy with the 150 mv input signal. But if you see that the signal is clipped at the output even when you have the gain/volume low, try reducing the signal generators output level.

So what do I use?

If you are just getting started or are a player who just wants to keep a eye on his gear or change tubes without going to the local repair shop, I would suggest using the one ohm resistor in the cathode circuit. It's easy and safe. Better yet is to use a plug-in probe of some sort, although I have no sources. I did mention previously the Bias King that was a digital meter and probe all in one. It was sold by R&G International (the Audio Classic folks) but I don't know if it is around anymore. The Bias Probe from Hunt Dabney is or was, at over \$100.00 too expensive. And as far as the techs out there, use what method you are comfortable with and which works for you.

That's easy enough, isn't it?

