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# A Pictorial Guide To

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## Biassing Carvin (and other) Tube Amplifiers

**Brian Donaldson**

A PICTORIAL GUIDE TO BIASSING CARVIN (AND OTHER) TUBE AMPLIFIERS

## Forward

The guy writing this book is a cool guy. Why else would he be writing this book? So get someone to write the forward.

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## Warning! Warning! Warning! Warning!

I can't seem to say that enough, but you must be warned that what you are about to undertake is at your own risk. I cannot be responsible for any damage to your well being or to your equipment. Performing a bias on your amplifier is done so with the understanding that only qualified technicians should be performing this operation.

There are contained within the chassis of guitar amplifiers, lethal voltages up to and in some cases, 500 volts of direct current. Outside the chassis you run the risk of electrocution with just the house current of 110/220 volts. So think about what 5 times that value can do.

Improper biasing of you amplifier could lead to irreversible damage; permanent damage to the power tubes, power transformer, power supply, and your self esteem.

This document would best be used as a reference manual as opposed to an instruction book. Although there are detail instructions on how to bias an amp, the information can be used to your benefit when having your amp serviced. It will make you a little more knowledgeable on the inner working of guitar amplification.

## Disclaimer! Disclaimer! Disclaimer!

I like doing that, it was much fun. Oh... yes, a disclaimer. There are many technicians out in the real world who will not work on Carvin equipment. I don't understand why, this is the finest equipment that you money will buy. Everyone else is overrated and over charge for their equipment just because they have a "name".

This book is not going to put them out of business. But it will help you if you live in an area where amp techs are scarce and few. There are also amp techs in the world that are going to be upset about this book. Because biasing an amp is black magic, voodoo magic only they are suppose to know how to do.

I have search the internet for days on end looking for detail instructions on how to bias an amp, and all I found was technical rhetoric about what biasing does and how one should seek a "professional" for biasing.



Hogwash I say. Besides, why should they have all the fun? If you are careful and follow the outlined procedures you should have no problems being able to bias your own amp. If all of the sudden your tech decides he can work on Carvin amps, it might be because he has this book.

So here is the disclaimer! I have tried to be as thorough as possible. I have tried to be as detailed as possible. But me being me, I may have missed something or overlooked something, or just something. If there is something in this book that is not making sense to you, then I have not expressed the procedure at a level to easily grasp the concept.

## Introduction

### A Brief History of Carvin

Carvin was founded by Lowell Kiesel, in 1947. It is one of the remaining companies still owed by the original founder. The company was originally named Kiesel, but Lowell renamed it after his two sons, Carson and Gavin.

The company's manufacturing plant and headquarters are located in San Diego, California.

Get more history.

## Chapter 1

### What is this Bias thing and why do I care?

Biassing an amplifier is like adjusting the inflation level of your tires on your car. If we don't have the correct air pressure, bad things can happen. We don't want that to happen. So in order for our amplifier to work properly, we have to make sure the power tubes are not under biased or, over biased.

We don't have a bias pressure gauge that we can conveniently throw on the amplifier to see what our bias is set at. But not all is lost. We do have tools that we can get to make checking the bias an easy task. Here is a very short list of tools that will perform the job very well. Digital Volt Meter, or DVM, or a Bias Probe. Told you it was going to be short.

There are two methods that will be used to either check the bias or to adjust the bias. You can use either method. I recommend that you read through each method's procedures before even breaking out the screwdrivers to take that amp apart. The two methods we will use will be the Standby Switch, which is recommended by Carvin for measuring the bias current, and the Bias Probe method.

The Standby Switch method can be tricky because you have to have your hand inside the exposed chassis. A simple slip of the meter's probes could easily cause a short and thus scare the heck out of you, as it has happened to me many times. But the Standby Switch method yields good results and is easy to perform.

The second method we will discuss is the Bias Probe method. There are many Bias Probes on the market right now. The one used in this pictorial was designed (I think) and manufactured by Weber Vintage Sound Technologies. The model number of this particular probe is **BR-AH**. Unlike the Standby Switch method, you don't have to be inside the chassis to check the bias of the power tubes. It can all be done from outside the chassis. Weber also sells the **BR-RA** which is an adapter that fits on the **BR-AH** for checking the bias of an amp without having to remove the chassis. Great idea.

So we have talked about these two methods but still don't know which one is going to be the right, or easiest, method for you. So why don't you get a cup of coffee, or whatever your favorite beverage is, and sit down in your comfy chair, and start reading about your amplifier and how to do the bias. After reading the steps and looking at the pictures only then will you get a better understanding of what you will be doing and which method will be the easiest for you.

Good luck my friend. Think **SAFTY** all the time, and remember, someone loves you and wants you to stick around for a long time.

### **RECOMMENDED TOOLS FOR BIASING**

Before we get started, you are going to need some tools to do this work. Here is a list of the basic items need to accomplish the tasks at hand. I would safely say that most of these you already have but if not, a quick trip to Radio Shack or Home Depot will do the trick.

- ◆ Screwdriver, Phillips or crossed tip
- ◆ Screwdriver, Flat tip, insulated shaft. A TV Alignment tool woks perfectly
- ◆ DMM, Digital Multimeter Meter with current reading capability
- ◆ Small flashlight, just in case you eyes are as good as mine
- ◆ Pen or Pencil for writing down your readings
- ◆ Calculator for doing the all important math
- ◆ A Bias probe of some fashion or type

## Chapter 2

### I... Hate... Math!

**B**e not afraid my child, because even though math is a prerequisite for biasing, we decided that having to do all the math would be too much of a burden. We have, therefore, included tables at the back of the book with most of the data already calculated for you. Wasn't that nice of us? Ha... you aren't going to get off that easy. There will be a test.

First, let's talk about Ohm's Law. So who in the heck is Ohm? Well, that would be Georg Simon *Ohm*, that's who. He came up with this theorem which later became Ohm's Law that describes the relationship between voltage, current, and resistance. He must have been a real resister because the unit of electrical resistance is named after him. What is that you say? Yup... the unit of resistance is called an Ohm.

So, right then, let's see what this Ohm's Law is and what it will do for us. There are four elements with which we are going to be working with; Electricity, Current, Resistance, and Power. The three elements get these symbols.

**E** = Electricity, or Voltage

**R** = Resistance

**I** = Current

**P** = Power (in watts)

Power and Resistance are treated differently in Ohm's Law because they are not the same thing. There is a mathematical relationship between these three elements, and that is

For measurements involving Resistance, use the formulas:

**E = IR** or

**I = E/R** or

**R = E/I**

For power in watts, the formula is:

$$\mathbf{P = IE, \text{ or}}$$
$$\mathbf{I = P/E, \text{ or}}$$
$$\mathbf{E = P/I}$$

Excellent, now that you are totally confused, you are asking yourself, why do I need to know this? Well, look at the front of the book. See that beautiful glow of the power tubes? That is why, and because you have to know how much current is required for a certain voltage on the plate of the power tube to set the bias current without blowing out your tubes or your power transformer. OK? Thought that would get your attention.

Let's do a little example, in the same format that you will be doing the math in later chapters. You have measured 10 volts across a 350 ohm resistor. How much current is flowing through that resistor?

$$\mathbf{E = \underline{\hspace{2cm}}} \text{ (here you would enter 10)}$$

$$\mathbf{R = \underline{\hspace{2cm}}} \text{ (here you would enter 350)}$$

$$\mathbf{I = \underline{\hspace{2cm}}} \text{ (this is what we need to know)}$$

So the law says,  $\mathbf{I = E/R}$ . We would then say that  $10 / 350 = 0.02857$  Amps. But that is such a small number, so we multiply it by 1000 and get 28.57 Amps? No, we are now using the term **mili-** to show that we have a multiplier involved. So the answer is? 28.57 milliamps, or **mA**.

So this is all the math you need to know for biasing your amp. There will be a list of formulas that you will be seeing shortly, but the math is going to be the same.

### **CALCULATING THE PROPER BIAS VALUE**

Biasing levels should be about 70% to 80% of the power tubes rated plate dissipation in watts. We can figure this by multiplying the power tube rated wattage by .7 or .8, or factors in between, and that will be the new wattage rating. Let's say the tube is rated at 25 watts and want 70% of that rating.

$$25 \text{ watts} \times .70 = 17.5 \text{ watts}$$

We now know that the wattage rating we will be using is 17.5 watts. Now we have to find how much idle current is required for 17.5 watts. We have to look back at our table of measurements we just took and get the Plate voltage. With that Plate voltage value and the power in watts value, we can not calculate the bias idle current. As an example, let's say the Plate voltage was 449 Vdc. So,  $I = P/E$ , or

$$17.5 \text{ watts} \div 449 \text{ volts} = .0389 \text{ Amps}$$

To get milliamps, we multiply .0389 by 1000.

$$.0389 \times 1000 = 38.9 \text{ mA}$$

So with a Plate voltage of 449 volts and our power tubes operating at 70%, we need a bias current of 38.9 milliamps per tube. We now do the back math to calculate the total current across the Standby Switch needed to satisfy our bias needs.

$$38.9 \times 4 \text{ (number of power tubes)} = 155.6 \text{ mA}$$

$$155.6 \text{ mA} + 29.86 \text{ (current through dropping resistor)} = 185.46 \text{ mA}$$

185.46 mA will be the new value across the Standby Switch.

Now you should fill out the table below so you have your values.

Plate Voltage	449
Plate Dissipation In watts	25

% factor (70~80)	70
New Plate Dissipation in watts	17.5
Bias current required per tube	38.9
Total for 4 power tubes	155.6
Add the dropping current	29.86
New Standby Switch current	185.46



## Chapter 3

### How Do I Change My Tubes?

This may seem like a lame topic, but the question is always asked; how do I change my tubes? So I thought I would include it in this book. I know some of you are already beyond this topic but you have to understand, I am writing this for all level of users.

Carvin amps use four types of power tubes. These are the EL84, EL34, 5881, and 6L6GC. Here is a break down of what amp used what tubes.

- ◆ Valve Master
- ◆ X-Series
- ◆ T100 Power Amp
- ◆ The vintage series which include the Bel Air, Nomad, Vintage 33 and V50, use EL84 tubes.
- ◆ The Master Tube Series, or MTS, is capable of using EL34, 6L6GC, or 5881 power tubes. The MTS comes stock out of the factory with 6L6GC tubes.
- ◆ The Legacy, the flagship of the Carvin Guitar Amplifier line, has the same capabilities as the MTS. The difference being the Legacy is equipped with EL34 power tubes.

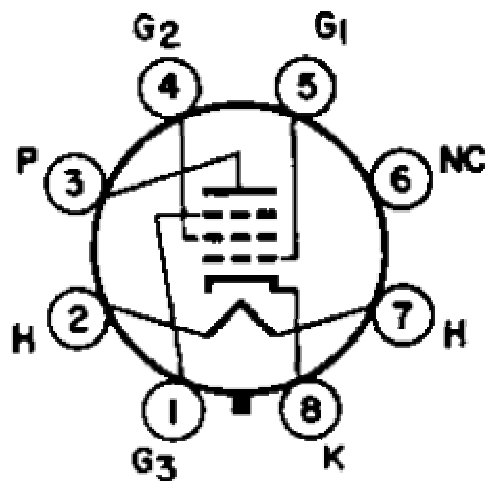
There are several other amplifiers that are now discontinued, but they are Carvin amps so we are going to discuss them here. These are the Valve Master, X-series (X-100, X-100B, X-60, XV112) and the tube power amp, T100. These amps came equipped out of the factory with [*list of tubes*].

There is another power tube that is not mentioned too much, but deserves mention. These are E34L power tubes. They are similar to their cousin the EL34 with some minor differences. The E34L can directly replace the EL34 without any problems.

Below is the pin out identification of the four tubes commonly used. These are here for your reference. If you need additional technical data on the tubes, you should do an Internet search for Tube Data Sheets, or Valve Data Sheet. There are many sites that contain the data sheets of the tubes.

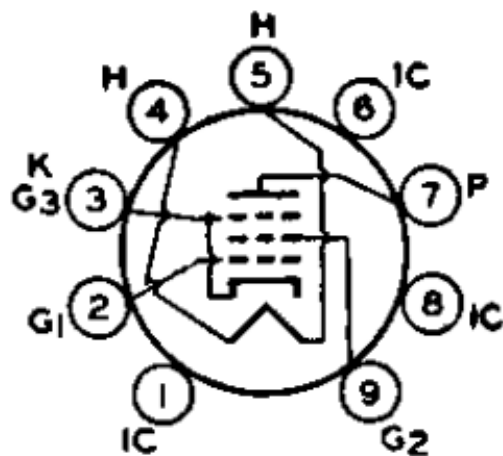
**EL34/6CA7 or E34L Power Pentode**

Pin	Element
1	Suppressor Grid
2	Heater (Filament)
3	Plate (Anode)
4	Screen Grid
5	Control Grid
6	none
7	Heater (Filament)
8	Cathode



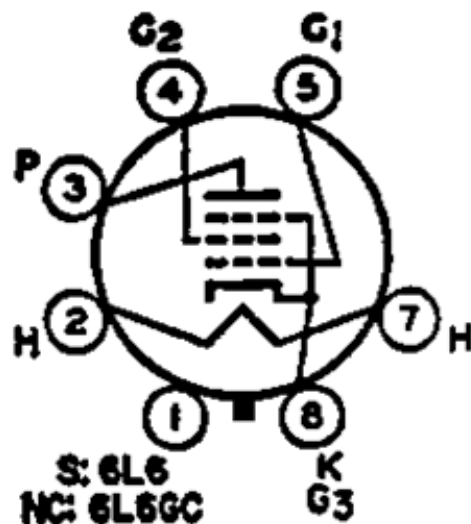
**EL84/6BQ5 Power Pentode**

Pin	Element
1	none
2	Control Grid
3	Cathode & Supressor Grid
4	Heater (Filament)
5	Heater (Filament)
6	none
7	Plate (Anode)
8	none
9	Screen Grid



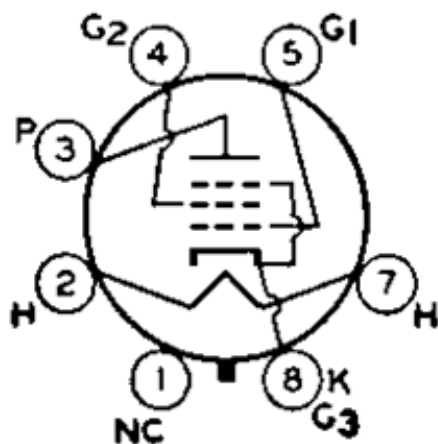
### 6L6() Beam Power

Pin	Element
1	Shell-6L6 none-6L6GC
2	Heater (Filament)
3	Plate (Anode)
4	Screen Grid
5	Control Grid
6	none
7	Heater (Filament)
8	Cathode



**5881 Beam Power**

Pin	Element
1	none
2	Heater (Filament)
3	Plate (Anode)
4	Screen Grid
5	Control Grid
6	none
7	Heater (Filament)
8	Cathode



Now that you have your new set of tubes, you want to replace them. There is no great black magic here and anyone who exercises caution can easily change power tubes. One thing we want to remember, you are dealing with glass and thin pins on Preamp Tubes. So just be care full when you remove and insert tubes. Lets get started shall we?

If you have a combo amp, you may what to turn the amp upside down to the tube are now facing in an upward vertical orientation. This will prevent your tube from major damage if it is accidentally dropped. Place something like foam insert between the cabinet and the table so the amp is steady, else the cabinet will rock on the handle. See figure x. Get more tube data as needed. Add procedures for changing tubes, with pictures.

## Chapter x

### Biassing the Vintage Series Amp

(Richard Hasselbrook)

This chapter will outline and guide you through the procedures of biasing the Vintage Series of amplifiers. The procedures are broken down in a step-by-step format. Each step should be accomplished before moving on to the next step.

**WARNING:** During the course of biasing, you will be exposing yourself to dangerous voltages up to 400+ volts D.C. If you feel at anytime that you are not sure of what you will be doing, don't do it. It is recommend that you practice each step several times with the amp's power cable unplugged so if you make a mistake, you will not pay for it with a damaged amplifier or a damaged body.

**It is recommend that you practice each step several times with the amp's power cable unplugged so if you make a mistake, you will not pay for it with a damaged amplifier or a damaged body.**

This procedure will be broken down into the Standby Switch (Carvin preferred method) method. For Bias Probe method, refer to the Legacy Biasing Chapter. Again, practice each step with the power cord removed from the amp.

### CHASSIS / CABINET PREPARATION

- ◆ Disconnect all cables from the amplifier.
- ◆ Move the amplifier to a location where you will be able to work without being disturbed.

I like to lay the amplifier down on its face to work on it, with the top of the amp extending slightly beyond the edge of the bench (this is so you can lift/push on the front of the chassis to assist in removing it from the cab later). I also like to lay something soft down on the bench to protect the amp from getting marred.

Find a safe location for the screws you removed from the cabinet. These little guys like to get up and wander around your work area. An old coffee cup you are not using will work fine.

## Chapter x

### Biasing the Legacy, MTS, and Valve Master

This chapter will outline and guide you through the procedures of biasing the VL100 amplifier, but the others are very similar, so the procedures are virtually the same. The procedures are broken down in a step-by-step format. Each step should be accomplished before moving on to the next step.

**WARNING:** During the course of biasing, you will be exposing yourself to dangerous voltages up to 450 volts D.C. If you feel at anytime that you are not sure of what you will be doing, don't do it.

**It is recommend that you practice each step several times with the amp's power cable unplugged so if you make a mistake, you will not pay for it with a damaged amplifier or a damaged body.**

This procedure will be broken down into two methods, Standby Switch (Carvin preferred method) and Bias Probe. Again, practice each step with the power cord removed from the amp.

### CHASSIS / CABINET PREPARATION

- ◆ Disconnect all cables from the amplifier.
- ◆ Move the amplifier to a location where you will be able to work without being disturbed.

If you are going to lay the cabinet on its face, make sure there will be no pressure on the control knobs. If the knobs protrude beyond the cabinet, you can use a couple of 2x4 blocks to support the cabinet.

Find a safe location for the screws you removed from the cabinet. These little guys like to get up and wander around your work area. An old coffee cup you are not using will work fine.





- ◆ To remove the back panel, remove the four screws holding the back panel to the cabinet.
- ◆ These screws are 2" long so you might want to use a battery powered screw driver to save wear and tear on your wrist.
- ◆ Put the screws and their rings in the designated "safe" place.
- ◆ The rings might want to stay on the tolex of the back panel. That is fine, just lay the panel flat so incase the rings decide to loosen themselves, they won't get lost.
- ◆ Place the panel in a safe place.



- ◆ Turn the chassis so the six retaining screw are easily accessible.
- ◆ Start unscrewing these from the center out. Do not unscrew all the way out just yet.
- ◆ As you unscrew the outer screws, the chassis will start to drop. If you do this carefully, the chassis will come to rest on the back panel support studs.
- ◆ Remove the chassis from the cabinet



- ◆ Before sliding the chassis out of the cabinet, you will need to remove the reverb cables.
- ◆ There are two cables, one the left-front side of the reverb tank and one the right-front of the reverb tank.
- ◆ Reach between the outer power tube and transformer.
- ◆ The cable is a RCA type and you will have to work it loose. There is not a lot of room, so take your time and it will come out.



- ◆ You may have to remove one of the power tubes to get to the other cable.
- ◆ Reach between the removed power tube and transformer.
- ◆ This cable is also a RCA type and you will have to work it loose. There is not a lot of room here either, so take your time and it will come out.



- ◆ After the reverb cables have been removed, carefully remove the chassis. **Caution, the chassis is heavy. Keep two hands on the chassis at all times.**

Here is a photo of the Legacy chassis with three of the power tubes removed. Let's take a little tour of the chassis. Starting on the far left, about the word "Carvin" is the Output Transformer. This is where the speakers get connected and also the plates of the power tubes. There is high voltage flowing through this transformer when the amp is turned on.

To the right of the Output Transformer you can see the preamp tubes, only because three of the power tubes were removed. From left to right we have V1, V2, V3, V4, and V5.

Standing tall and all alone is a single power tube. To the right of the power tube is the Power Transformer. This is the primary transformer that will boost our house current to the high voltage needed to operate the amplifier. Let's continue.





You will need to place the chassis in an inverted (upside down) position in order to work on the inside. Remember that the power tubes are still connected and could be bumped into something.

When you start your biasing procedures, the amp will be operating so the tubes will get hot. You don't want the tubes resting on anything that will melt or burn.

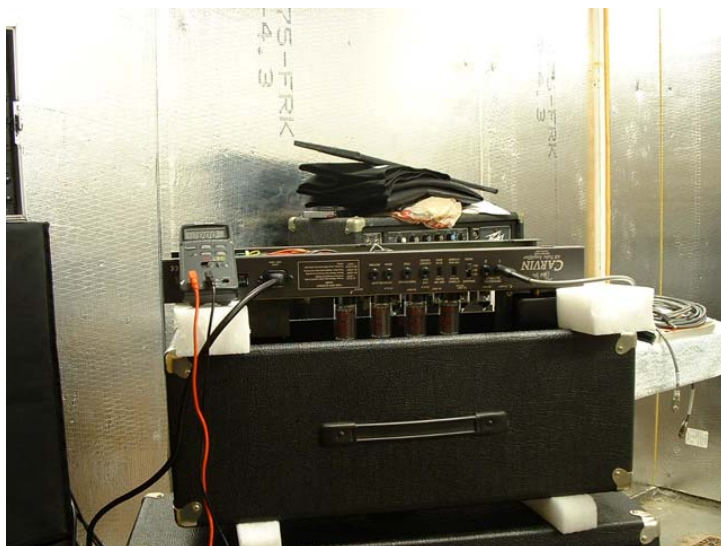
You will notice that I use my cabinet to support the chassis. I also have two hard foam supports that have cutouts around the transformers. This has proven to be a very sturdy platform for me to work on. You will need to find a solution that is also stable. You don't want the chassis in an unstable posture.

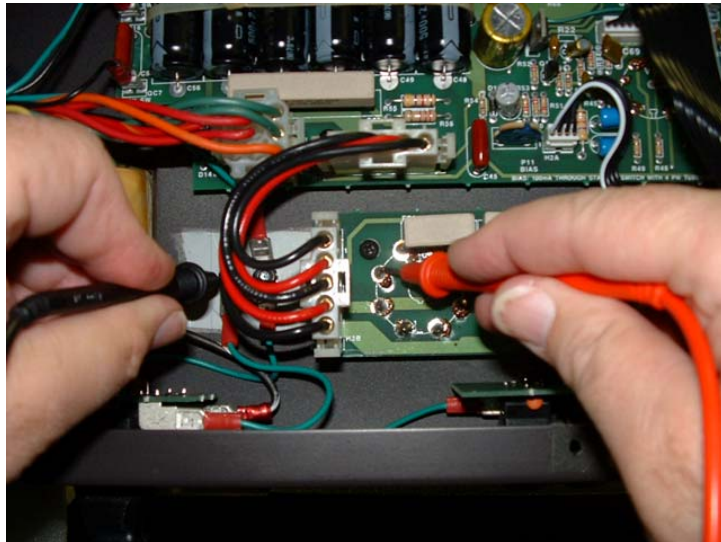
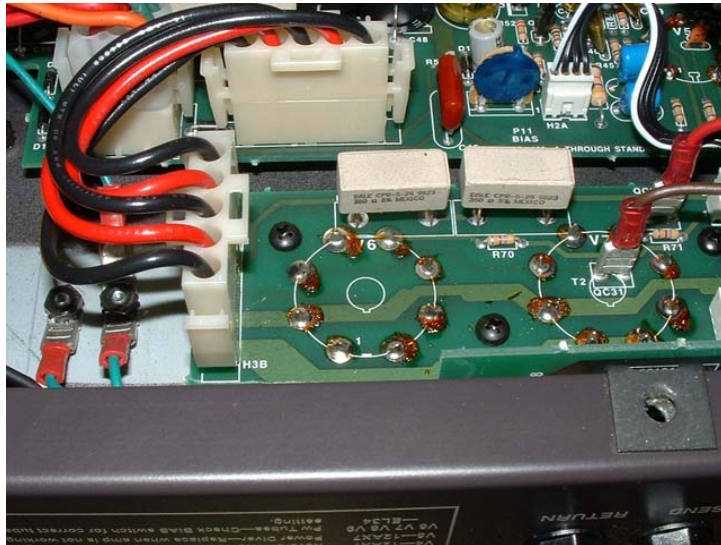
When you are ready to perform the voltage checks, you will need to insert the power cord and a speaker cable.

**NOTE: There must ALWAYS be a speaker connected to the chassis when ever you apply power to the chassis.**

Make sure the amplifier's power switch is in the OFF position and the Standby Switch is in the Standby, or ON, position.

Note – Power cord AND speaker cable connected, I have also set my meter in a location that will be easy for me to make my readings.





Look at the photo to the left. Here you can see the power tube PCB. The #1 pin is labeled “1”. Count the pins in a clockwise rotation, so pin #2 will be to the upper left of pin #1. Pin #8 is directly to the right of pin #1. Don’t get the pins confused.

You can also see the chassis common ground point just under the black and red wires on the far left.

- ◆ Turn on the amplifier and let it warm up. **Do not put your hands inside the chassis until you are ready to make a reading. This is not the time to be exploring with your fingers.**
- ◆ After about 5 ~ 8 minutes, turn the Standby Switch to OFF. This will activate the high voltage and you should hear some low level sounds from the speakers.

### MEASURING THE PLATE VOLTAGE

- ◆ Turn your meter on and set the meter to read DC voltage in the highest scale available.
- ◆ Place the **BLACK** probe on the chassis common ground point and the **RED** probe on pin 3 of tube V6. You may hear a crackle from the speakers. That is normal.
- ◆ Write down the plate voltage.

Plate Voltage	449	Vdc
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- The plate voltage will be in the range of  $\approx$  450 VDC.



### MEASURING THE DROPPING RESISTOR VOLTAGE

- ◆ Next voltage value we want to get is the Dropping Resistor voltage drop. The resistor is R57 and is a large tan colored resistor and is located just below the capacitor bank.
- ◆ Place the probes on the metal tabs underneath the resistor. You may hear a crackling sound from the speakers, this is normal.
- ◆ Write down the dropping resistor voltage.

Dropping Resistor Voltage	10.45	Vdc
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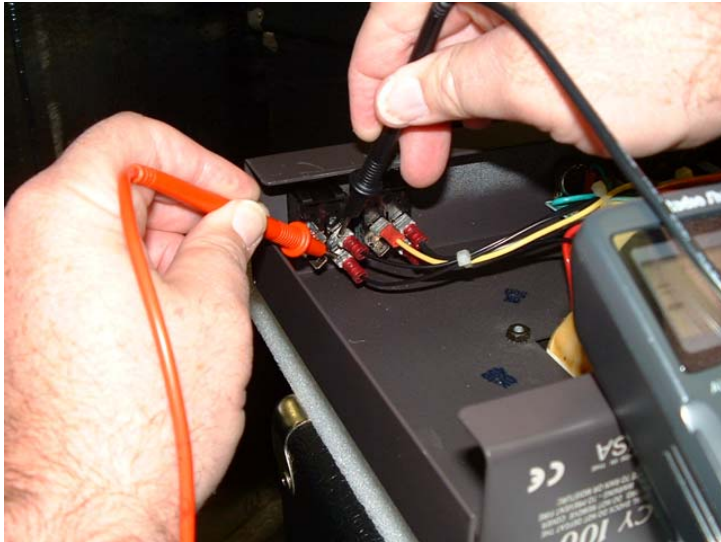
- ◆ The dropping resistor voltage will be in the range of  $\approx 10$  VDC.

### MEASURING THE STANDBY SWITCH CURRENT

**WARNING:** You should practice these next few steps several times with the amplifier off before attempting for real. During this portion of taking measurements, you will have all the current of the amplifier passing through the meter and you may throw a spark and hear a pop in the speakers. This will startle you and could cause you to move in a sporadic fashion. Make sure you will not upset the balance of the chassis.

The standby switch is located to the far left in the chassis and has only two black wires connected.





Now we are ready to measure the current that is across the standby switch. Set your meter to read current at the highest value. My meter will read current up to 10 Amps (10 A). That is the value that I use to make my measurements. Let's practice with the power off first.

- ◆ Place the **RED** probe carefully on bottom spade connector. Make sure you do not touch anything else with that probe.
- ◆ Carefully place the **BLACK** probe on the top spade connector.

Do this several times so you feel comfortable. Make sure the probes are placed firmly, but don't push too hard, otherwise you might slip off one of the spade connectors. When you do this for real, all the current will be flowing through your meter and the amp will become active.

OK, ready? Let's do this for real. Turn the Power ON and wait 5~8 minutes. Now turn Standby Switch to **STANDBY**. That will put the amplifier in standby mode. You should hear nothing from the speakers.

- ◆ Place the **RED** probe carefully on bottom spade connector. Make sure you do not touch anything else with that probe.
- ◆ Carefully place the **BLACK** probe on the top spade connector. **You may see a spark and hear a pop in the speaker. Be prepared but do not jump or jerk.**

- ◆ Look at the meter and wait for the current to settle down.
- ◆ Remove the probes BLACK then RED.
- ◆ Write down the Standby Switch current.

Current across Standby Switch	168	I
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- ◆ The Standby Switch current will be in the range of  $\approx 150$  mA (.15 Amps).

### FIGURING OUT WHAT WE JUST DID

Congratulations, you have just read the current across the standby switch. It is now time to do the dreaded math, but don't despair, there is a table in the back of the book with some of the values ready for you. Let's recap and copy the values here so we have them all.

Plate Voltage	449	Vdc
Dropping Resistor Voltage	10.45	Vdc
Current across Standby Switch	168	mA
Current across Dropping Resistor (see table)	29.86	mA
Subtract Dropping Resistor Current from Standby Switch Current	138.14	mA
Divide Remaining current value by 4	34.5	mA

### CALCULATING THE BIAS CURRENT

We now have the values of the current across the Standby Switch. Now it is time to make the necessary adjustment to get the desired results you are looking for. But before we do this, we have to calculate what bias level we are looking for. Lets do that right now so you can take a breather before we continue.

Biasing levels should be about 70% to 80% of the power tubes rated plate dissipation in watts. We can figure this by multiplying the power tube rated wattage by .7 or .8 and that will be the new wattage rating. Let's say the tube is rated at 25 watts.

$$25 \text{ watts} \times 70\% = 17.5 \text{ watts}$$

We now know that the wattage rating we will be using is 17.5 watts. Now we have to find how much idle current is required for 17.5 watts. We have to look back at our table of measurements we just took and get the Plate voltage. With that Plate voltage value and the power in watts value, we can not calculate the bias idle current. As an example, let's say the Plate voltage was 449 Vdc.

$$17.5 \text{ watts} \div 449 \text{ volts} = .0389 \text{ Amps}$$

To get milliamps, we multiply .0389 by 1000.

$$.0389 \times 1000 = 38.9 \text{ mA}$$



So with a Plate voltage of 449 volts and our power tubes operating at 70%, we need a bias current of 38.9 milliamps per tube. We now do the back math to calculate the total current across the Standby Switch needed to satisfy our bias needs.

$$38.9 \times 4 \text{ (number of power tubes)} = 155.6 \text{ mA}$$

$$155.6 \text{ mA} + 29.86 \text{ (current through dropping resistor)} = 185.46 \text{ mA}$$

185.46 mA will be the new value across the Standby Switch.

Now you should fill out the table below so you have your values.

Plate Voltage	449
Plate Dissipation In watts	25
% factor (70~80)	70
New Plate Dissipation in watts	17.5
Bias current for yy watts	38.9
Total for 4 power tubes	155.6
Add the dropping current	29.86
New Standby Switch current	185.46



## THE BIAS PROBE METHOD

The bias probe method is about the simplest of the three methods to perform. It is quick and very easy to check the current condition of the bias current. With special adaptors, one does not even need to remove the chassis from the cabinet.

- ◆ Remove one of the power tubes from its socket.
- ◆ Insert the bias probe into the empty tube socket.
- ◆ Insert the tube into the bias probe socket.
- ◆ Set your DMM to read Volts, D.C.
- ◆ Turn your meter on.
- ◆ Turn on the amp.
- ◆ Let the amp warm up for about 5~8 minutes.
- ◆ Place the Standby switch to ON.
- ◆ The reading will be in volts but can be converted to amps.

In the picture to the right I am reading .037 volts, but that is also telling me that the current is .037 amps, or 37 mA. The bias probe has a 1-ohm resistor in the supressor grid/cathode path, which is pin 8. Your meter then reads the voltage drop across that resistor.

That's is all there is to reading the bias current using the bias probe method.



This picture is not current! Replace.

## OUTPUT TRANSFORMER SHUNT METHOD

This method requires you to have an accurate, low input impedance DMM. Something on the order of a Fluke DMM. The method is somewhat similar to measure the plate voltage, so there is danger involved here.

When you shunt the output transformer, all the current on that side of the transformer will be passing through your meter.

- ◆ Setup your meter to read current at the highest level.
- ◆ The amp should be ON and the Standby switch in the ON position making the amp operational.
- ◆ You are going to read the current across each power tube to see if the tubes are balanced.
- ◆ Connect the **RED** probe to pin 3 of V6.
- ◆ Connect the **BLACK** probe to spade lug attached to the **BROWN** wire connected to V7.
- ◆ Read the value of the current passing through your meter.

V6 Shunt Current	.037	I
------------------	------	---

- ◆ Connect the **RED** probe to pin 3 of V7.
- ◆ Connect the **BLACK** probe to spade lug attached to the **BROWN** wire connected to V7.
- ◆ Read the value of the current passing through your meter.

V7 Shunt Current	.037	I
------------------	------	---

- ◆ Connect the RED probe to pin 3 of V8.
- ◆ Connect the BLACK probe to spade lug attached to the BLUE wire connected to V8.
- ◆ Read the value of the current passing through your meter.

V8 Shunt Current	.037	I
------------------	------	---

- ◆ Connect the RED probe to pin 3 of V9.
- ◆ Connect the BLACK probe to spade lug attached to the BLUE wire connected to V8.
- ◆ Read the value of the current passing through your meter.

V9 Shunt Current	.037	I
------------------	------	---

You now have the value of current passing through each power tube.

Hasserl needs to expand upon this method.  
Need to get a photo of the procedures.

## ADJUSTING THE BIAS CURRENT

Well, now that we have obtained all the information we need to perform the actual bias, let's do it. The following information will be valid with any of the three methods you chose to use to make the initial measurements. Refer back to that section for making confirmation readings.



Bias adjustments are done by changing the value of P11, a potentiometer, or variable resistor, on the main PCB. It is blue in color and is located just above and between V6 and V7. It is the only pot on the PCB so you can't miss it. Oh... and it is marked "P11 BIAS". How much more simpler could this have been?

The tool you want to use is important. I highly recommend that the tool be completely insulated just in case it slips out of your hands. You don't want to have something metal lying across the PCB. Not good for the amp.

Adjustments to P11 should be very small and very slow. After making a slight adjustment, take another measurement. Be patient. If you move the pot too much you may start to see a red glow appear on the plates of the tube. If that happens, turn the pot back in the opposite direction.

To increase the current, turn the pot clockwise, or to the right as you are looking at the pot.

To decrease the current, turn the pot anti-clockwise (counter clockwise) or to the left as you are looking at the pot.

Always check the current after making adjustments. When you have reached the calculated value, check the power tubes to see if they are glowing red in the center of the plates. If not, you have done well.

If you are using the bias probe method, you can watch as the current changes in real time.

This is a good time to carefully test the amp for sound. Check to see if your changes have done anything for your tone.

If everything is fine and you are happy, turn off the equipment, disconnect all the cables, and let the amp rest for about 20~30 minutes. This will give the tubes a chance to cool down. You don't want to be moving the chassis around while it is hot.

### **NURSE, WOULD YOU PLEASE CLOSE?**

After the chassis is cool, slide it back into the cabinet. Get the six retaining screws. Line up the chassis with the holes in the cabinet and insert the first center screw. Get that screw started so the chassis catches and bites on to the screw.

Insert the second center screw and start it until the chassis bites on to that screw. Do not tighten these screws yet. Insert the other 4 screws and do the same as the first two.

When all six screws have the chassis, go ahead and tighten them all the way. Start with the center and then work out to the other screws.

Turn the chassis so the front is either facing away from you or face down. Get the back panel and put it in position. Find the four 2" screws and start them into the panel and cabinet. Do not tighten until all the screws have bitten into the wood.

Go ahead and secure all the screws. Move the cabinet to where you would normally use the amp.

Connect the power and speaker cables. Running effects in the loop? Go ahead and connect them also.

Now plug in your guitar, turn on the amp, and let her rip!

**Congratulations – You have just biased the Legacy Amplifier!**

## Chapter x

### Benchmarking Your Amplifier

Knowing what is normal and what is not is a great way to help trouble shoot problems with your amplifier. This is a good time to get voltage and current measurements for benchmarking your amp.

During the course of biasing our amp, we took measurements of the Plate Voltage, Dropping resistor voltage and the Standby Switch current. Now we should also take voltage readings of the filaments of the preamp tubes. We also should write down the type of tube used when the measurements were taken. This will help us at a later date if something “appears” to be going wrong with the amp. We can take new measurements and compare them to the benchmark measurements.

If you replace your tubes which you will eventually do, or you make a new bias adjustment, you will need to record these new values. Keeping your amp in a good maintained condition starts today.

So to help you with maintaining the like new condition of the amp, we have provided a table for you to fill in all the values you collected today.

**Preamp Tube Filament Voltage Chart**

	<b>VL100</b>	<b>MTS</b>	<b>VT-50</b>	<b>NOMAD</b>	<b>BELAIR</b>	<b>VM</b>	<b>T100</b>	<b>XAMPS</b>	<b>TS100</b>
V1	DC	DC	DC	DC	DC	DC	AC	AC	DC
V2	DC	DC	DC	DC	DC	DC	-	AC	AC
V3	DC	AC	AC	AC	AC	AC	AC	AC	DC
V4	AC	AC	AC	AC	AC	AC	-	-	AC
V5	AC	AC	AC	AC	AC	AC	-	-	-

**Benchmark Table**

<b>Measurement taken</b>	<b>1/25/04</b>			
Plate Voltage, V6 pin 3	449			
Dropping Resistor Voltage	10.45			
Standby Switch Current	169			
<b>Filament voltage measurement (Preamp)</b>				
V1 pin 4 and 9 Voltage (see chart)	5.38			
V1 pin 5 and 9 Voltage (see chart)	5.32			
V2 pin 4 and 9 Voltage (see chart)	5.35			
V2 pin 5 and 9 Voltage (see chart)	5.37			
V3 pin 4 and 9 Voltage (see chart)	5.38			
V3 pin 5 and 9 Voltage (see chart)	5.39			
V4 pin 4 and 9 Voltage (see chart)	5.53			
V4 pin 5 and 9 Voltage (see chart)	5.53			
V5 pin 4 and 9 Voltage (see chart)	5.55			
V5 pin 5 and 9 Voltage (see chart)	5.55			



**Dropping Resistor Current Calculations (E / R where R=350 Ohms)**

Voltage	Current (ma)	Voltage	Current (ma)	Voltage	Current (ma)	Voltage	Current (ma)	Voltage	Current (ma)
8.00	22.86	9.00	25.71	10.00	28.57	11.00	31.43	12.00	34.29
8.05	23.00	9.05	25.86	10.05	28.71	11.05	31.57	12.05	34.43
8.10	23.14	9.10	26.00	10.10	28.86	11.10	31.71	12.10	34.57
8.15	23.29	9.15	26.14	10.15	29.00	11.15	31.86	12.15	34.71
8.20	23.43	9.20	26.29	10.20	29.14	11.20	32.00	12.20	34.86
8.25	23.57	9.25	26.43	10.25	29.29	11.25	32.14	12.25	35.00
8.30	23.71	9.30	26.57	10.30	29.43	11.30	32.29	12.30	35.14
8.35	23.86	9.35	26.71	10.35	29.57	11.35	32.43	12.35	35.29
8.40	24.00	9.40	26.86	10.40	29.71	11.40	32.57	12.40	35.43
8.45	24.14	9.45	27.00	10.45	29.86	11.45	32.71	12.45	35.57
8.50	24.29	9.50	27.14	10.50	30.00	11.50	32.86	12.50	35.71
8.55	24.43	9.55	27.29	10.55	30.14	11.55	33.00	12.55	35.86
8.60	24.57	9.60	27.43	10.60	30.29	11.60	33.14	12.60	36.00
8.65	24.71	9.65	27.57	10.65	30.43	11.65	33.29	12.65	36.14
8.70	24.86	9.70	27.71	10.70	30.57	11.70	33.43	12.70	36.29
8.75	25.00	9.75	27.86	10.75	30.71	11.75	33.57	12.75	36.43
8.80	25.14	9.80	28.00	10.80	30.86	11.80	33.71	12.80	36.57
8.85	25.29	9.85	28.14	10.85	31.00	11.85	33.86	12.85	36.71
8.90	25.43	9.90	28.29	10.90	31.14	11.90	34.00	12.90	36.86
8.95	25.57	9.95	28.43	10.95	31.29	11.95	34.14	12.95	37.00

Dropping resistor is located Rxxx component on the following amps.

- Legacy, MTS, Valve Master – R57
- Nomad, Bel Air, V50, V33 – R43
- T100 – R18
- X-Series – R121