

## **Safe Bias & Balance Measurement Z**

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**This article was originally published in the Glass Audio Projects Book, April 2002. It describes a safe bias & balance measurement circuit for vacuum tube amplifiers.**

**Several circuits have been proposed to set the biasing & balance of pushpull amplifier circuits. Many are not convenient & in some instances are downright dangerous. The user is often required to make measurements where high potentials are found. The dc balance setting may depend on the output transformer having equal resistance in both halves of it's primary. Some lower cost transformers such as the Hammond 125 series, older PA & HIFI often have unequal resistance in the two halves of their primary. For example the Hammond 125E measured 78 & 84 ohms.**

**To get around these difficulties we need a different approach. The circuit described here avoids these problems. All of the metering is done in the cathode circuit at low voltage. I had originally used this circuit to meter each of the two ultra linear amplifiers I had built around 1960. Both are still in working order.**

**First of all I wanted a way to measure the total cathode current both at idle & under signal conditions. 200 milliamps full scale would do this well. The other requirement was to set dc balance.**

**In the schematic the measurement circuit consists of the resistors R5, R6, R9, R10, the dpdt switch S1a,b & the one milliamp meter. The switch is preferably push button & is shown in the normal position. A toggle or slide switch would work as well. For this example the output tubes are triode connected 6L6GC's.**

**While the switch is in the normal position the cathodes are tied together. The parallel combination of R5 & R6 will be 10 ohms. Cathode current of 200 milliamps will produce a two volt drop across a 10 ohm resistance.**

**The indicator is a one milliamp analogue meter. That works out to 1000 ohms per volt, for voltage measurement. The meters I used have an internal resistance of 50 ohms. In order to get a full scale of two volts another 1950 ohms is required in series with the meter. That is provided here by the resistors R9 & R10. Bias is set by the cathode current adjustment potentiometer.**

**Pressing the push button switch S1 connects the metering circuit between the cathodes of the power stage. The dc balance potentiometer is adjusted until zero voltage is indicated across the 20 ohm resistors R5 & R6. The balance measurement is not dependent on resistance of the two halves of the output transformer primary.**

**Some may question the shunt loading effect the 2000 ohm measurement circuit has on the overall accuracy. It works out to an error of one percent. That is well inside the accuracy expected of an analogue meter.**

Another concern may be the effect of leaving the 10 ohms in the cathode circuit during operation. I recall that in some later Dyna amplifiers a small resistance used in the adjustment of the bias was left in. The resulting voltage drop was 1.56 which was used as a comparison to a fresh zinc carbon cell. That is how they established the operating point for the output section. They had also taken the time to show that including this small resistance improved their distortion readings.

The phase inverter chosen will depend upon the designers preference.

