Pass Electrostatic Headphones Amplifier Concept
High Voltage MOSFET Matching

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Introduction

Typical electrostatic headphone amplifiers have rail voltages of +/-400V or above. When using single rail designs like in the Pass STAT Concept, the rail voltage approaches 1000V. For proper active device matching, one has to apply Vds at least close to their working conditions. These voltages are of course no issue at all for tube amp builders. But most curve tracers designed for solid state devices rarely go beyond 100V. A simple solution for the said task has to be invented.

Simple HV MOSFET Tester

In the STAT Concept headamp, the cascode devices see 400V Vds with no signal, but this can be close to 800V at full swing. The bias current is designed to be 25mA. One should get a good match if Vgs could be measured at Id of 0mA (~1µA to be precise), 25mA and 45mA, with a Vds of say 300V. For the purpose, DC values are sufficient, so one could get away with just multi-meters and no oscilloscopes or functions generators.

If you live in countries with 230V mains (most European and many Asian countries), you can get 300V or so after direct rectification. Some voltage stabilisation is necessary to ensure consistent measurement results. And the simplest is to use a RC low-pass filter directly after the bridge rectifier. This provides the Vds supply. A separate 9V supply is then be used to set the gate voltage. A constant current source (CCS) of the selected values is further required as load at the MOSFET source to provide the correct test Id, while at the same time soak up any Vgs variations of the DUTs. And we have all the basic elements for the HV MOSFET Matching Tool (HMMT).

Since the test current is not more than 50mA, any (monolithic) bridge rectifier of 400V 0.5A or above will do. For the RC filter, the capacitor needs to be able to sustain the full rectified voltage, e.g. 100µ 450V electrolytic. With a 200R 2W resistor, the LP frequency is at 8Hz, and the voltage drop is a manageable 10V. If more filtering is desired, just add another RC of the same value.

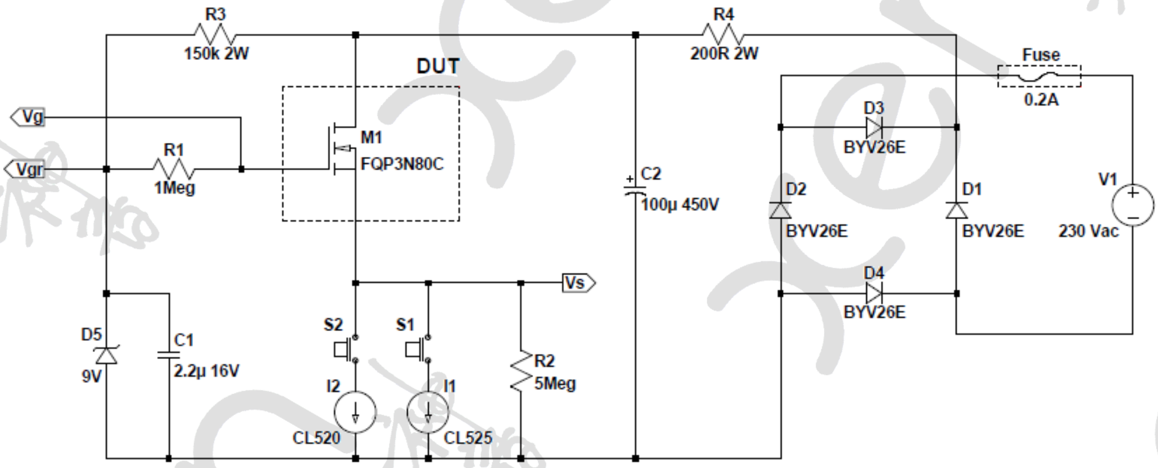
A simple solution for the CCS is the Supertex CL520 and CL525. They provide a constant current of 20mA and 25mA respectively, temperature compensated, with a dropout voltage as low as 1V. With the gate voltage at 9V, the circuit still functions even if Vgs were as high as 8V. ☺

For measuring Vgs(th) at ~1µA, a 5M resistor takes the place of the CCS. This will also put the DUT in a safe (low current) state even if the gate voltage is constantly held at 9V. The latter can be provided either by a dry battery, or by a 9V 0.5W Zener diode biased by a 150k 2W resistor directly from Vd. A filtering capacitor of 2.2µ 16V in parallel with the Zener provides additional ripple suppression, but is optional.

Other than just measuring Vgs, it is advisable to also measure the gate leakage current. Although gate currents are usually small in FETs (in the nA region), we are working here with high voltages and high impedances in the circuit, in which nA leakages still have noticeable effects. To be able to measure nA leakage, a gate stopper of 1M is required. A second multi-meter can then be used to measure Ig down to 1nA resolution.

The DUT should be mounted on a heat sink of about 3K/W. At 300V 25mA, dissipation is 7.5W, and the heat sink temperature will be 23°C above ambient. This should be close to the actual working condition of the device in the amplifier circuit later. Once Vgs stabilises at 25mA drain current, thermal equilibrium is reached and the value can be recorded. Switching on the CL520 then momentarily allows the measurement of Vgs for 45mA. Switching off both CCS's will give Vgs(th). The three measured values should be sufficient to make proper matching at close to working voltage and temperature.

A typical schematics of the HMMT is shown below :



Disclaimer : **High voltage involved. Build at own risk.**