Source Resistor Matching for Output Stage of Class A amplifiers

EUVL

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In Class A amplifiers using JFETs or MOSFETs, there is a need to match transistors (Vgs at a certain current) due to the variations inherent in the production process of field effect transistor devices.

Various methods have been published, varying from single point matching at room temperature, to curve tracer matching under actual working conditions (actual rail voltage and bias current, on heat sink, at steady state).

Many people claim high matching accuracies to below 10mV Vgs. However, especially for the high bias current output stage, such level of matching has no real meaning if the source resistor is not (cannot be) matched to the same degree of accuracy, as the driver stage sees both the Vgs of the FETs, and the voltage across the source resistor at bias current.

Output stage source resistors are usually low resistance, ranging from 0.1R to 1R. Since different resistors of the same type also have slightly different thermal drift behaviour, high accuracy matching can only be achieved under working conditions (i.e. at the same bias current as in real application).

For the EUVL F5X balanced circuit, for example, each of the Toshiba MOSFETs has a source resistor of 0R22 at 2A bias. Thus, for best matching results, one should supply a constant current of 2A (stable to say 0.2%) to the resistor, and measure the voltage drop (0.44V nominal) across the resistor. A 4-point measurement method should be used, i.e. the current supplied via crocodile clips at the end of the resistor leads, and the voltage measurement clips of a high accuracy voltmeter attached closed to the resistor body. Since there is negligible current flowing through the measurement leads, the contact resistance between the measurement clips and the resistor lead wires (together with any oxide layers on them) does not have any significant effect on the measurement results).

How can we make a 2A current source ?

Firstly a laboratory power supply that can output 5V 2A, with current limit set at say 2.5A becomes handy. The current limiting circuit of most laboratory supplies are there for protection rather than constant current regulation, and therefore is not stable enough for our purpose. A simple constant current source can be easily built from a LM317 (on a generously sized heat sink) and a single low-tempco power resistor. The circuit is shown on page 16 of the LM317 datasheet of national Semiconductors (1A Current regulator). To obtain a current of 2A, we need to replace R1 with 0R6, or 2 pieces 1R2 in parallel. Here, I would use at least a single 10W resistor with a low tempco, e.g. Isabellenhuetten PBH series 0R68 on heat sink (together with the LM317).

As the LM317 is also not immune to thermal drift, it is wise to allow the circuit to reach steady state before taking the measurement. A large heat sink with a high thermal mass helps. In any case, it is advisable to monitor the current output of the current source additionally, either by using the 10A measurement of a modern 5-digit multimeter, or using a reference resistor (e.g. Isabellenhuetten PBV 0R1 on separate heat sink) and a high precision voltmeter.

Do you really need to go to so much trouble ? Can you measure the difference in distortion ? Probably not. But then you can apply the same argument to MOSFET matching to <5mV.

The quest of the DIYer for 100.000000% perfection sees no bounds, which is why this hobby is so much fun in the first place.

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