

Measuring MOSFET Gate Resistance

The OMICRON Lab Bode 100 Network Analyzer, used in conjunction with the Picotest J2130A DC Bias Injector, is a perfect combination for measuring the internal gate resistance of a MOSFET. The Bias Injector allows the resistance to be measured with a DC voltage applied from the gate to the source of a MOSFET while leaving the drain floating or connected to the source. The Bode 100 then measures the vector impedance of the junction. This measurement is very sensitive, since the resistance is very small compared with the capacitive impedance. This measurement requires a very low noise floor and exceptional resolution, both of which are provided by the Bode 100.

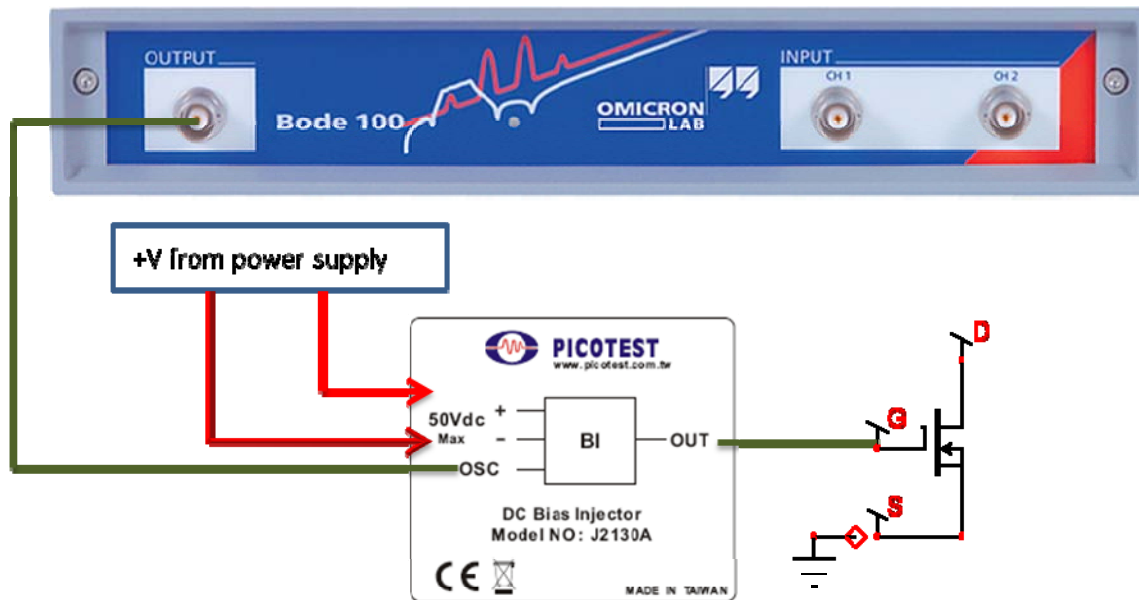


Figure 1 – Connection diagram for the Bias Injector, Bode 100 and N-Channel MOSFET.

Calibrating the Measurement

One of the most critical aspects of the measurement is calibrating out the parasitics from the cables and the Bias Injector. A standard “Open, Short, Load” calibration technique should be implemented to ensure measurement accuracy. For this measurement, we are using 3 BNC connectors with the leads shorted, open and with a 50Ω terminator to calibrate the Bode 100. The MOSFET being tested is soldered to the same BNC connector in order to minimize parasitics outside of the calibration. In this case, the calibration and measurements are all referenced to the BNC connector leads.

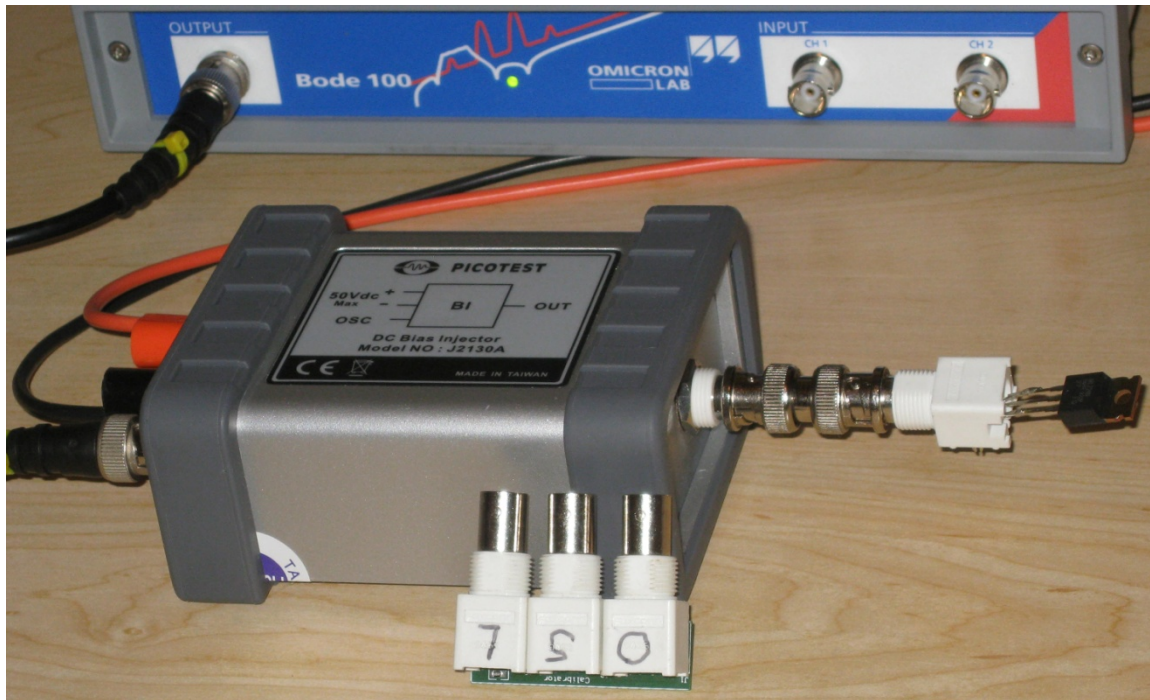


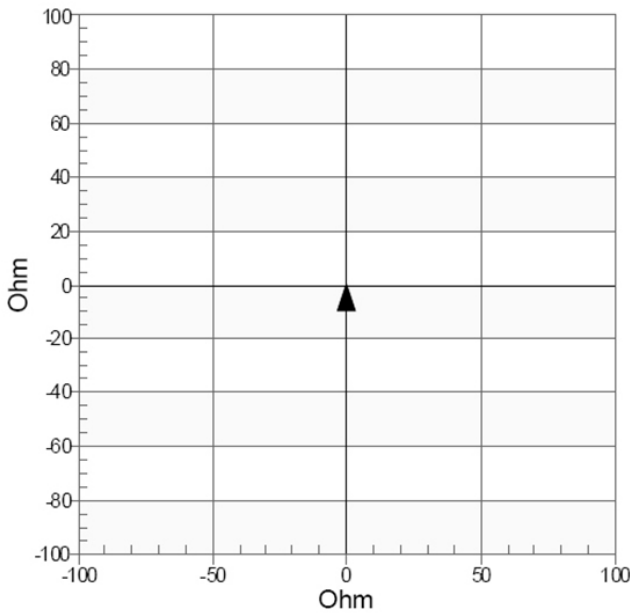
Figure 2 – Picture showing the MOSFET “mounted” for the measurement.

Be sure to apply the bias to the Bias Injector PRIOR to calibration (we’ll use 10V for this example).

After the “short” calibration, you can perform the impedance measurement at the desired test frequency. For our example, we used 1MHz. The measured series resistance should be several orders of magnitude lower than the resistance we are looking to measure; a small resistance

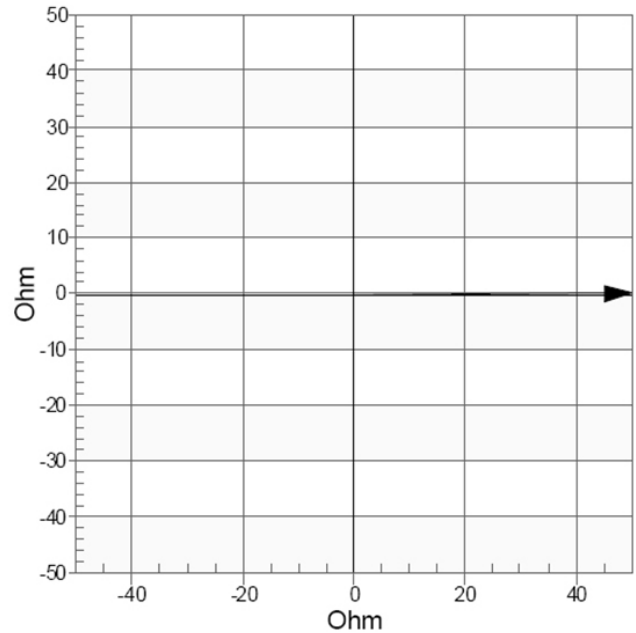
value is to be expected but it should be very low. Figure 4 below shows our “short” to be 68 microOhms, which is 80dB below the measured value.

Perform the “open” calibration, and then the “load” calibration. We have chosen a 50Ω resistor for calibration, and have measured it at 50.060Ω using a 6 ½ digit multimeter. You should check the impedance measurement of the short circuit and resistor after calibration to verify that the calibration was successful.



Serial equivalent circuit

Rs =	67.768 μΩ
Ls =	1.540 nH
Q =	142.822



Serial equivalent circuit

Rs =	50.061 Ω
Ls =	461.625 pH
Q =	57.939 μ

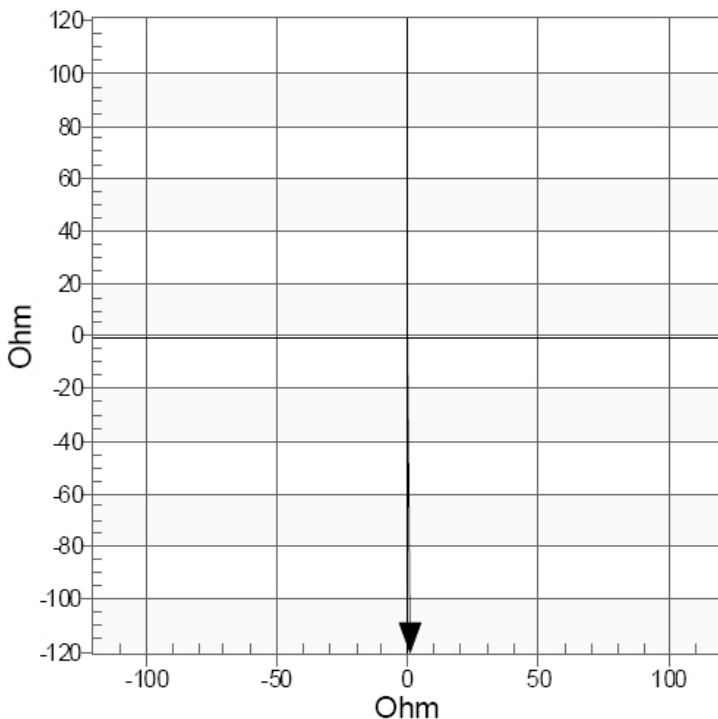
Figure 4 – Impedance of the short circuit (left) and the 50Ω test resistor (right) at 1MHz. Note the very high Q of the Rg and CGS combination, which is what makes this measurement sensitive.

Making the Rg Measurement

Once the setup has been fully calibrated, we can measure the impedance of the MOSFET. We have chosen an IRLZ24N for this example and are biasing Vgs to 10VDC. We are measuring the resistance of the gate at 1MHz. This frequency has been chosen because it is an industry standard, though the measurement setup described here works for any frequency from 1Hz to

40MHz, and a frequency sweep can be used to characterize the resistance over frequency. One thing to keep in mind, however, is that at lower frequencies the X_p portion of the impedance will increase and the real portion will remain the same. This means Q will be significantly higher at lower frequencies, making the measurement much more difficult. Conversely, making the measurement at a higher frequency reduces the Q making the measurement less sensitive.

Keeping the injection signal close to full scale will help to reduce the noise of the measurement, resulting in optimum dynamic range and noise floor. The 24 bit ADC in the OMICRON Lab Bode100 network analyzer offers superior dynamic range and noise floor compared with many other analyzers on the market.


Serial equivalent circuit

$R_s =$	907.146 m Ω
$C_s =$	1.317 nF
$Q =$	133.180

Figure 5 – Impedance of IRLZ24N at 1MHz. Not the high effective measurement Q (133.18)

From the data we can see that the IRLZ24N MOSFET has an internal gate resistance of 907.146m Ω and we can also see the CGS of the device simultaneously.

Conclusion

We have demonstrated how you can measure the gate resistance of a MOSFET quickly and accurately using the Bode100 Vector Network Analyzer and the Picotest J2130A Bias Injector. A proper fixture should be made to house the MOSFET while keeping cable lengths short and signal levels as low possible. With proper calibration of your equipment this measurement will be repeatable for various MOSFETs and allow production testing to be a simple one-step process.