Problem: Error in Low Voltage, Low Current Measurements

Potential Cause: Voltage Burden

One of the biggest sources of error in measuring low currents from low voltage sources is voltage burden. Unlike an ideal ammeter, a shunt style ammeter (for example, in a DMM) has some resistance, and current flowing through it will create a voltage drop. This voltage burden, which can reach several hundred millivolts, subtracts directly from the source voltage and thus reduces the measured current. If the source voltage is already low, then this causes substantial errors.

For example, in a semiconductor circuit the source voltage may be a single junction voltage drop of 0.7V. Assuming that the source resistance is 10kΩ and the voltage burden is 200mV, then the current through the meter will be:

$$\frac{0.7V - 0.2V}{10,000} = 50\mu A$$

Compare this to the ideal case where there is no voltage burden:

$$\frac{0.7V - 0.0002V}{10,000} = 69.98\mu A$$

This is an error of 29%.

Remedy

Electrometers and picoammeters, because of their feedback design, have very low voltage burdens—typically in the tens to hundreds of microvolts. If a picoammeter with a voltage burden of 200 microvolts is used in our example, then

This is an error of 0.03% with the electrometer/picoammeter's feedback technique instead of the 29% with DMM's shunt style current measurement. The low voltage burden of the electrometer and picoammeters allows a much more precise current measurement. KEITHLEY