

## Explanation of Voltage Burden Specification for Model 2400 SourceMeter Series

The voltage burden of the ammeter in the 2400 Series is listed as  $<1\text{mV}$  in the “Current Measurement Accuracy” section of the specifications. A small footnote appears next to the spec that says “4-wire mode.” What is the significance of this footnote in relation to the ammeter in the 2400 Series?

### 2400 Source Measure Configuration

In Source I mode, the 2400 is configured as shown in Figure 6-14 on page 6-26 of Rev. E of the 2400 Series User’s Manual. The current source is always in series with the voltmeter. Additionally, you will notice that an ammeter is also present in this series circuit. This ammeter serves as a source feedback to monitor the amount of current that the device is actually receiving. Adjustments are made to the sourcing value based upon this ammeter. As noted in the paragraph above the figure, the accuracy of the current source is the same whether the instrument is in local or remote sense. The remote sense leads only serve to determine where the voltage measurement is made. The source feedback current measurement is done through the input/output terminals.

In Source V mode, the 2400 is configured as shown in Figure 6-15 on page 6-27 of Rev. E of the 2400 Series User’s Manual. In this circuit the voltage source is always in series with the ammeter. A voltmeter is also in series with an ammeter. This voltmeter is used to monitor the voltage that actually appears across the input/output terminals (local sense) or across the device itself (remote sense). The instrument compares the reading of the voltmeter with the source value and makes adjustments accordingly.

**NOTE: The configurations of sources and meters in the 2400 are fixed. The source cannot be configured independently of the meter.**

### How to Obtain Optimal Voltage Burden

The specification for voltage burden gives the means for obtaining optimal voltage burden. This is especially important in circuits where the voltage drop in the external circuit approaches the voltage burden of the ammeter. To obtain optimal voltage burden, the 2400 instrument must be set for remote sense. How is this possible for a current measurement? Consider the following setup:

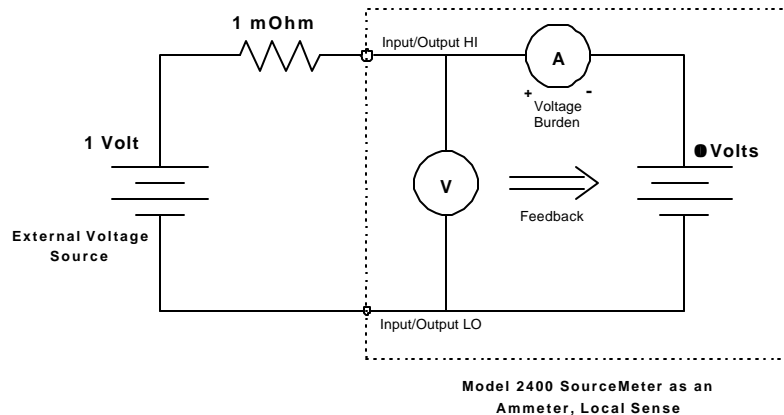
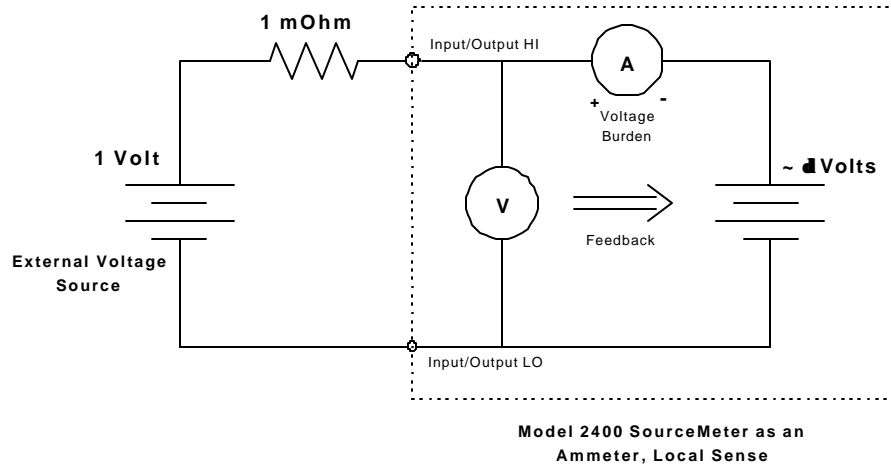


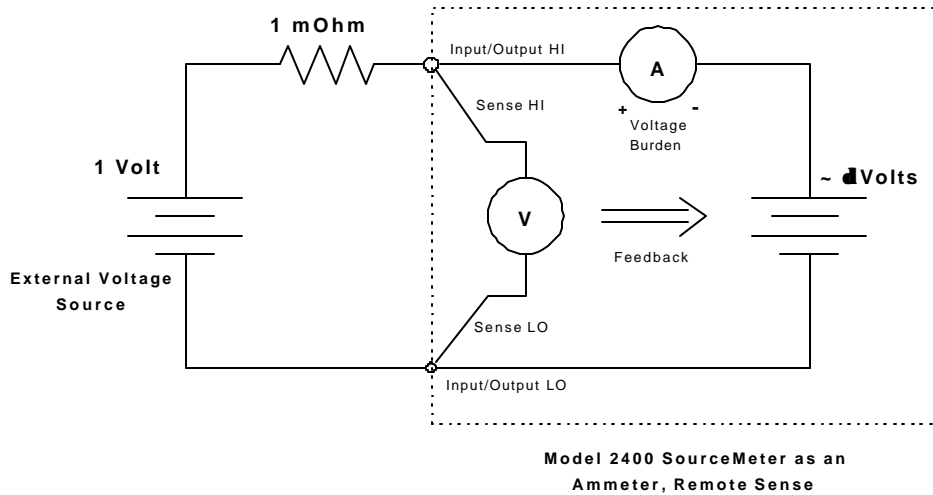
Figure 1

The 2400 is configured in measure current only (ammeter) mode. In this mode, the V-source is set to source 0V. Because the SourceMeter is not a perfect voltage source, a small voltage,  $\Delta$ , appears across the input/output terminals. See Figure 2 below.



**Figure 2**

For many applications  $\Delta$  may be insignificant. However,  $\Delta$  is in addition to the voltage burden of the internal ammeter that appears across the input/output terminals. Thus, the total voltage burden of the 2400 may exceed the 1mV listed in the specs. To stay within the specs of the 2400, you must connect the 2400 in remote sense, as shown in Figure 3 below.



**Figure 3**

In this way, the V-source is adjusted to source 0 volts at the device itself. Thus, the total voltage burden is largely made up of the contribution of the internal ammeter. In the table below are shown data for the setup discussed in this note. As you can see, in circuits where the voltage of the external circuit approaches the voltage burden specification of the SourceMeter, the four-wire connections make a difference in the measurement results.

Device	Source voltage	2-wire	4-wire
1.005 $\Omega$ $\pm 0.1\%$	1mV	-0.77mA	-0.99mA
	2mV	-1.47mA	-1.90mA

**Table 1**