

# Thermistor Evaluation Using the Agilent B2900A Series of SMUs

## Technical Overview

### Agilent B2901/02/11/12A Precision Source/Measure Unit

Agilent B2901A Precision SMU, 1ch, 100 fA resolution, 210 V, 3 A DC/10.5 A pulse

Agilent B2902A Precision SMU, 2ch, 100 fA resolution, 210 V, 3 A DC/10.5 A pulse

Agilent B2911A Precision SMU, 1ch, 10 fA resolution, 210 V, 3 A DC/10.5 A pulse

Agilent B2912A Precision SMU, 2ch, 10 fA resolution, 210 V, 3 A DC/10.5 A pulse

## Introduction

The thermistor is a resistor with resistivity that varies as a function of temperature. Typical thermistor applications are thermal sensing and electric circuitry protection. However, the thermistor's sensitivity to temperature changes can work against measurement accuracy since Joule self-heating during measurement can alter device characteristics. This means that accurate thermistor characterization requires both precise low-current resistance measurement capability and pulsed bias measurement capability (to minimize temperature change during measurement).

The Agilent B2901/02/11/12A Precision Source/Measure Unit is a compact and cost-effective bench-top Source/Measure Unit (SMU) with the capability to output and measure both voltage and current. The B2900A Series of SMUs also supports a resistance measurement function that facilitates both low and high resistance measurements. The B2900A Series of SMUs enables you to make a wide range of resistance measurements more accurately and quickly than ever before.

In addition, the B2900A Series of SMUs comes with an intuitive graphical user interface (GUI) and free PC-based application software

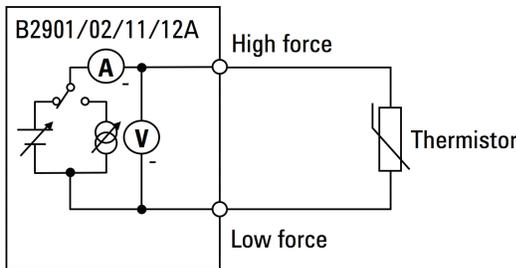


Figure 1. Using the B2900A Series of SMUs to characterize a thermistor

that make it easy for you to begin making productive measurements immediately.

These features make the B2900A Series of SMUs the best solution for accurate characterization of thermistor and other devices.

Figure 1 illustrates the connections necessary for measuring a thermistor using a member of the B2900A Series of SMUs. The B2900A Series of SMUs allows you to accurately and easily measure the resistance of thermistor.



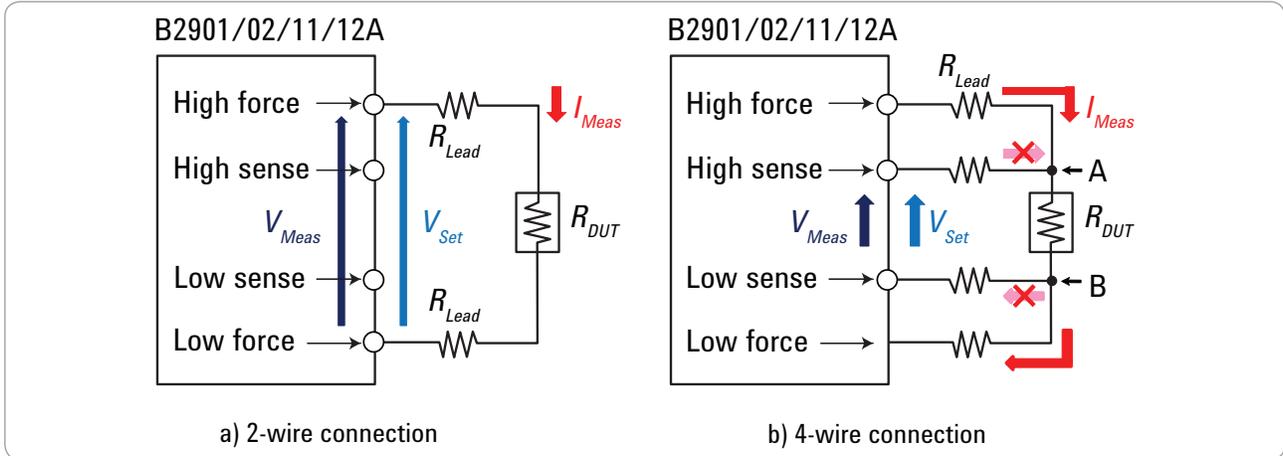


Figure 2. A 4-wire connection eliminates the measurement error caused by residual lead resistance

## What is the B2900A Series of SMUs?

An SMU combines the capabilities of a current source, a voltage source, a current meter and a voltage meter along with the capability to switch easily between these various functions into a single instrument. This gives it the ability to evaluate the IV characteristics of devices across all four measurement quadrants without the need for any additional equipment. Besides being able to output and measure voltage or current very accurately, SMUs also possess a compliance feature that allows a limit to be placed on the voltage or current output to prevent device damage. The members of the B2900A Series of SMUs are single or dual channel SMU units that offer a wide range of IV measurement capability for a variety of two-terminal and three-terminal devices. They cover currents from 10 fA to 3 A (DC)/10.5 A (pulse) and voltages from 100 nV to 210 V. In addition to their DC operation mode, the B2900A Series of SMUs also has the ability to perform pulsed measurements in order to prevent device self-heating from distorting the measurement results. Finally, the B2900A Series of SMUs also has a built-in resistance measurement function.

## Eliminating residual resistance effects

A basic 2-wire connection is the most common scheme used for resistance measurements. In this configuration (shown in Figure 2a) the same pair of test leads is used to both force current and measure voltage. This arrangement is suitable for resistance measurements as long as the residual lead resistance is negligible compared to the resistance of the device under test (DUT).

However, for very low resistance measurements where the residual lead resistance is comparable to the DUT resistance, the 2-wire measurement will give erroneous

measurement results. In this case a 4-wire connection scheme (remote sensing) can be used to eliminate this error. A 4-wire measurement uses one pair of leads to force current and the other pair of leads to monitor voltage. This eliminates cable resistance effects so that only the voltage drop across the DUT is measured (please see Figure 2b). In addition, the 4-wire measurement scheme of the B2900A Series of SMUs keeps the voltage between the sense points (A and B in Figure 2b) at exactly the specified voltage  $V_{set}$ , thereby ensuring that your device is characterized exactly under the measurement conditions you specify. The B2900A Series of SMUs supports both connection schemes and it is easy to switch between them.

## Leakage current prevention

Leakage currents in the cables and test fixturing can cause significant measurement errors, especially when measuring large resistances where the measurement current is small (less than a nanoamp). In this case, the guard function of the B2900A Series of SMUs can be used by employing banana-to-triaxial adaptors and triaxial cables. The SMU circuitry maintains the guard terminal at same voltage potential as the high force line, which prevents current from leaking into the cable and the surrounding measurement path (please see Figure 3).

## Powerful GUI and convenient PC control options

The wide QVGA LCD display of the B2900A Series of SMUs supports an easy-to-use GUI that provides easy instrument control from the front panel. This makes it simple to perform both spot resistance measurements using constant voltage or current and sweep measurements to obtain an IV curve. After measurement completion you can use the front panel GUI to graphically view measurement results such as IV curves using Graph View, and display a list of the measurement data using the Measure Result dialog window (please see Figure 4).

The B2900A Series of SMUs has a USB interface on the front panel so that a USB flash memory device can be used with the B2900A Series of SMUs to save and load measurement setups as well as to save measurement results.

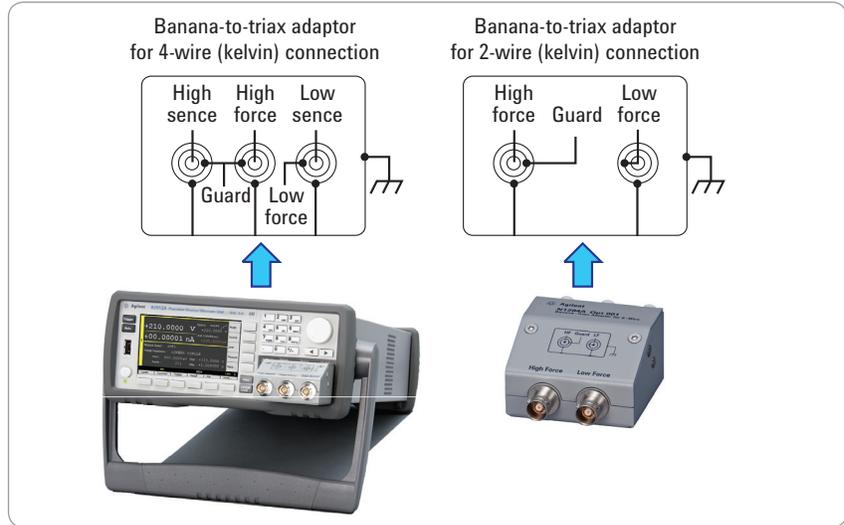


Figure 3. The active guard of the B2900A Series of SMUs eliminates leakage currents when used with the proper triaxial connectors and cabling

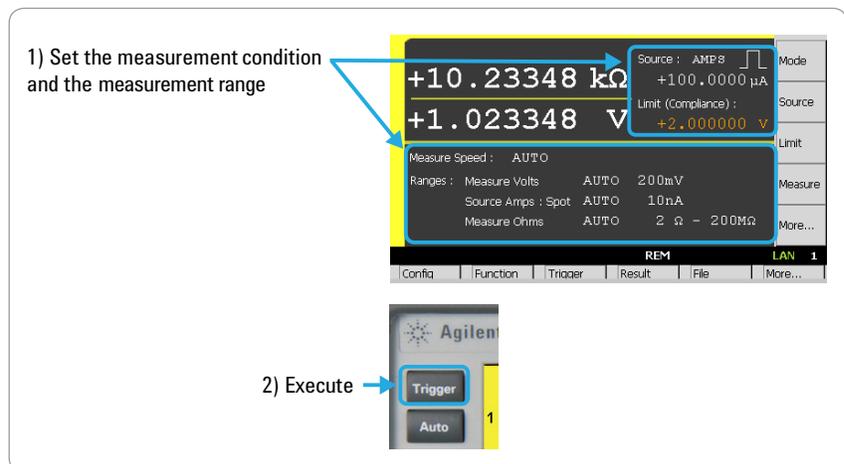


Figure 4. The GUI of the B2900A Series of SMUs makes it easy to take a quick measurement

If you have specialized programming needs then both Standard Commands for Programmable Instruments (SCPI) and IVI-COM drivers are available for the B2900A Series of SMUs. SCPI is an industry-standard command set for basic instruments, and it has a uniform structure that supports a common set of commands. The SCPI command set of the B2900A Series of SMUs not only supports its advanced features but also general-purpose SMU commands (such as those used by the Keithley 2400) to simplify test program migration. In addition to SCPI, the IVI-COM drivers for the B2900A Series of SMUs work in a variety of programming environments

and languages so that you can develop programs without having to use low-level commands. The Agilent B2900A Quick I/V Measurement Software is available for download from the Agilent Web site for free (Please see Figure 5). The Agilent B2900A Graphical Web Interface is also available, and it provides functionality to allow access to the B2900A Series of SMUs over a LAN connection. The B2900A Series of SMUs is fully compliant with the LXI class C specification, making it easy to take measurements using a standard web browser by just connecting the B2900A Series of SMUs to a PC using a LAN cable.

## Summary

The Agilent B2901/02/11/12A Precision Source/Measure Unit is the best solution for IV characterization of thermistor and a variety of other devices. Its wide current and voltage measurement ranges (from 10 fA/100 nV to 10.5 A/210 V) provide superior measurement performance and allow you to characterize devices more accurately and easily than ever before.

The easy-to-use GUI of the B2900A Series of SMUs has a variety of capabilities and features that make it easy to take measurements quickly and to save both the measurement setup conditions and data to USB-based flash memory devices.

In addition to being able to control the B2900A Series of SMUs remotely over GPIB, USB and LAN interfaces, Agilent supplies PC-based Agilent B2900A Graphical Web Interface and Agilent B2900A Quick I/V Measurement Software for free to simplify controlling the B2900A Series of SMUs from your PC.

For more detailed information on the various models of the B2900A Series of SMUs, please refer to the data sheet of the B2900A Series of SMUs (5990-7009EN).

The B2900A Series of SMUs enables you to quickly debug and accurately characterize a wide variety of devices using only a single bench-top SMU.

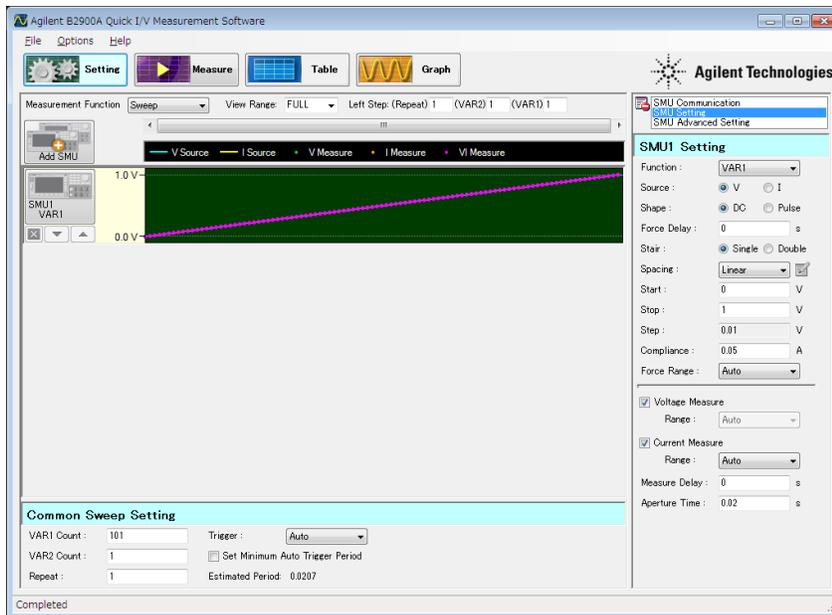


Figure 5. It is easy to make a quick measurement on a PC using the Agilent B2900A Quick I/V Measurement software



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