



# Thermistor Production Test 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

Thermistors are devices that exhibit variations in resistance as a function of temperature. Due to this property, thermistors are used for a variety of applications such as temperature sensors, current limiting devices and liquid level sensors.

To ensure compliance with manufacturing specifications, single-point pass/fail DC testing must be performed on thermistor devices. Because these tests are also used to identify and remove defective devices before shipment, their reliability is important to guarantee product quality. In addition, it is also essential to perform the tests quickly to keep the production throughput high. However, the thermistor's sensitivity to temperature changes can work against measurement accuracy since Joule self-heating during measurement can alter device characteristics. This requires measurement instrumentation used for thermistor characterization to possess both precise low-current resistance measurement capability and pulsed current measurement capability (to minimize self-heating effects).

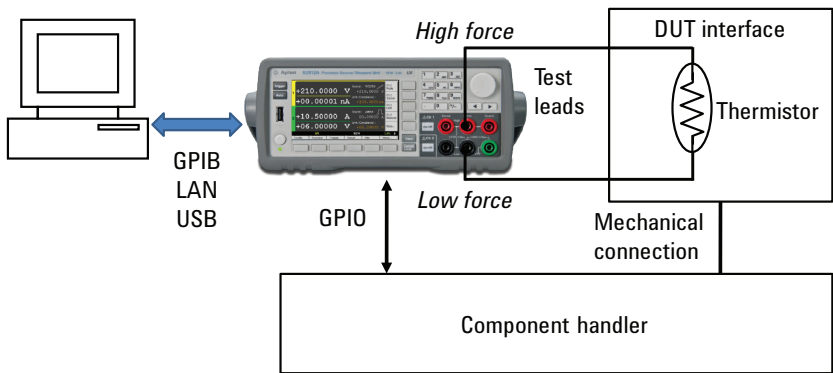


Figure 1. Example test system configuration using the B2900A Series of SMUs

The Agilent B2901/02/11/12A Precision Source/Measure Unit meets all of these requirements, making it the best solution for thermistor production test. It is a compact and cost-effective bench-top Source/Measure Unit (SMU) with the capability to source and measure both voltage and current. They cover currents from 10 fA to 3 A (DC)/10.5 A (pulse) and voltages from 100 nV to 210 V. The B2900A Series of SMUs has the ability to perform not only DC measurements but also pulsed measurements in order to prevent device self-heating from distorting

the measurement results. In addition to these comprehensive measurement capabilities, the B2900A Series of SMUs possesses high throughput that reduces test times. The B2900A Series of SMUs also has many features that make it well-adapted for production test, such as pass/fail binning, a digital I/O interface for handler control, and code compatibility with standard single channel SMU products.

This technical overview shows how to use the B2900A Series of SMUs for production test using a thermistor device as an example.



## Easy production test system configuration

Figure 1 shows a conceptual diagram of a system based on the B2900A Series of SMUs for production thermistor test. The widely available banana style terminals of the B2900A Series of SMUs greatly simplify the test system configuration. As will be discussed later, in most production testing measurement results are compared with pre-defined limits and pass/fail judgments are made. Output signals from the GPIO port of the B2900A Series of SMUs can be used to communicate with the component handler to sort devices based on the pass/fail criteria. The thermistor is usually placed on a temperature-controlled DUT interface.

The B2900A Series of SMUs supports both 2-wire connection and 4-wire connections. A basic 2-wire connection is commonly used for standard resistance measurements, while a 4-wire connection is required for low resistance measurements to eliminate the residual lead resistance (please see Figure 2).

The B2900A Series of SMUs supports several communication protocols, GPIB, USB and LAN, and these can be used with both SCPI and IVI-COM drivers. SCPI is an industry-standard command set for basic instruments with 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, the IVI-COM drivers for the B2900A Series of SMUs work in a variety of programming environments and languages, so you can develop programs without having to use low-level commands.

## Program memory improves throughput

Fast test times are essential to maximize throughput and maintain high levels of factory productivity. Besides possessing fast intrinsic measurement speed, the B2900A Series of SMUs has a program memory function that can be used to improve production test throughput. Program memory allows you to store long strings of SCPI command lines once into the volatile memory of the B2900A Series of SMUs and then

recall those strings multiple times while the program is executing using a single SCPI command. By storing the command strings in memory, the time that would have been spent sending those same commands over a communication bus is eliminated. For tests that utilize lots of repeated code (such as subroutines), program memory can dramatically reduce test times. Of course, programs can be saved to or loaded from any attached USB flash memory device (please see Figure 3).

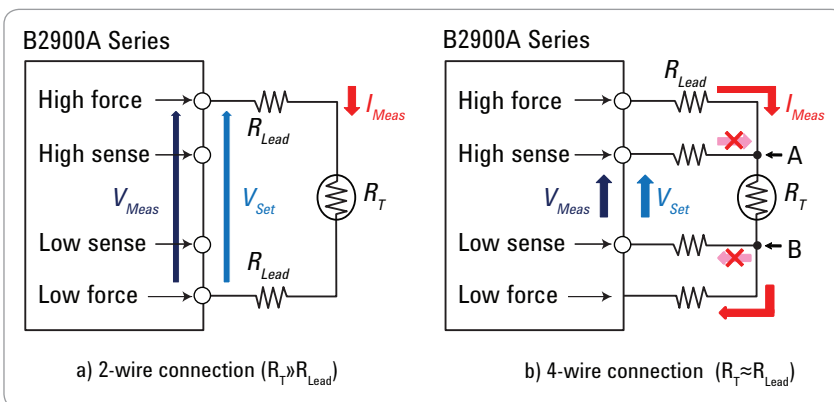


Figure 2. A 4-wire connection eliminates the measurement error caused by residual lead resistance

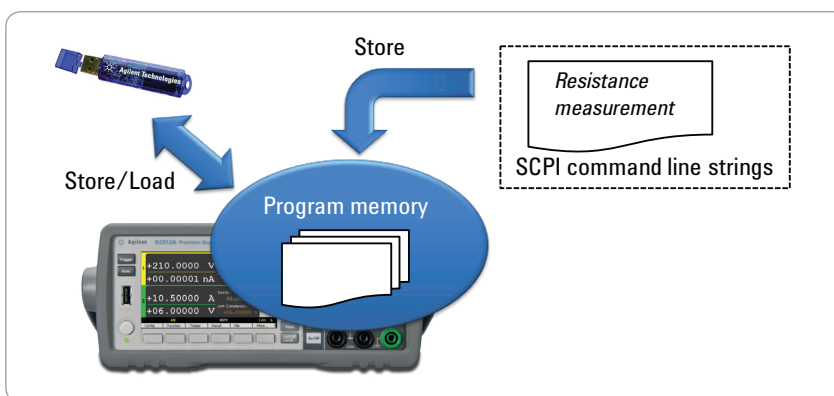


Figure 3. Program memory allows strings of SCPI commands to be stored for later execution

The B2900A Series of SMUs also has a data buffer on each SMU channel that can hold up to 100,000 data points. This enables you to transfer all the data in the buffer at once after a series of measurements have completed instead of having to transfer data after every measurement. One way to use this to improve throughput would be to have the B2900A Series of SMUs send measurement data to a PC while a component handler places a new device on a DUT interface.

## Multiple pass/fail judgment modes

In production test, a limit test function is generally used to eliminate defective devices through a pass/fail judgment based on pre-defined limits. Recognizing that there are a variety of pass/fail limit scenarios, the B2900A Series of SMUs supports two modes: Compliance mode and Limit mode | (up to 12 binning limits possible).

Compliance mode utilizes the intrinsic compliance feature of the B2900A Series of SMUs that allows a limit to be placed on voltage or current output to prevent device damage. When the SMU's output reaches the limit value during a measurement it is in compliance status. If Compliance mode is enabled, then the test fails when the SMU reaches compliance status. One possible use of this feature is to determine the polarity of nonsymmetrical devices such as diodes.

Limit mode is usually used to determine if a device parameter is within specified low and high limits. When Limit mode is enabled the B2900A Series of SMUs makes a Pass/Fail judgment based on whether or not the measured value is within specified low and high limits. A typical use of this mode is to perform grading and sorting. For example, using two binning limits in Limit mode it is possible to sort devices into five classes (please see Figure 4).

After performing pass/fail testing with these modes, you can view the results on the wide QVGA LCD display of the B2900A Series of SMUs. In addition, you can program the B2900A Series of SMUs to output specified Pass/Fail bit patterns through the GPIO port to other equipment such as handlers for component binning.

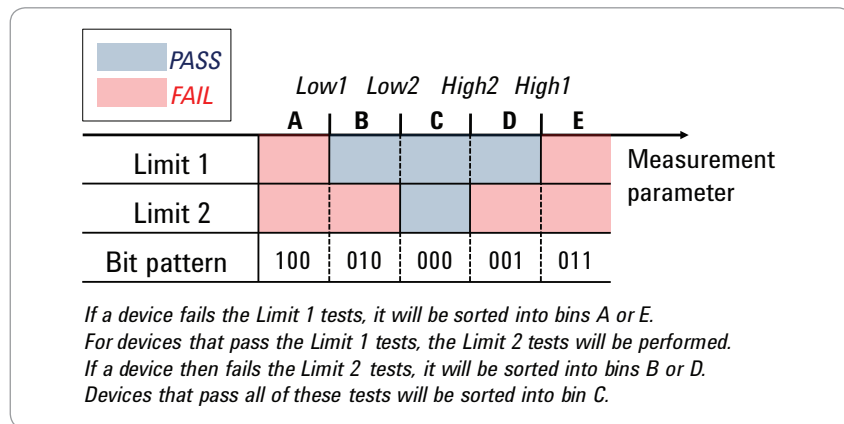


Figure 4. Example showing how to sort devices into five classes using two limit tests

## Production thermistor test flow example

Figure 5 shows a general flow for production thermistor testing. Before beginning the actual testing, it is good practice to store repeated operations into the program memory of the B2900A Series of SMUs. One example of this would be a resistance measurement. After this test pre-loading has been performed and the stored program has been run, the B2900A Series of SMUs waits for a Start of Test (SOT) trigger from the component

handler. Once the thermistor is in-place, the handler sends an SOT trigger signal to the B2900A Series of SMUs to inform it that testing can begin. The B2900A Series of SMUs first makes a measurement using the programs stored in program memory and displays the Pass/Fail testing result. Then, the B2900A Series of SMUs sends a specified Pass/Fail bit pattern and an End of Test (EOT) signal to the component handler and stores the test data to the PC. This procedure is then repeated until all of the devices have been tested.

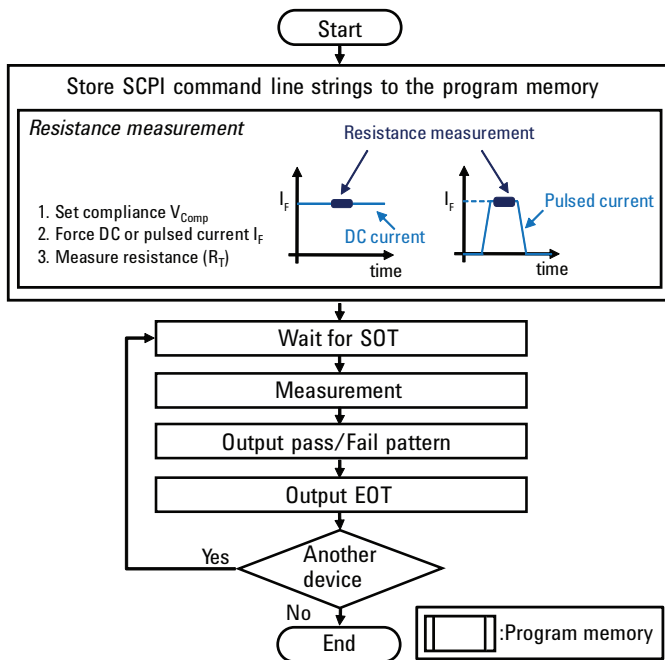


Figure 5. Thermistor production test flow example using the B2900A Series of SMUs

## Summary

The Agilent B2901/02/11/12A Precision Source/Measure Unit is the best solution for the production testing of thermistors and other devices. The B2900A Series of SMUs possesses high throughput, which greatly reduces test times. In addition, the program memory function of the B2900A Series of SMUs allows the test throughput to be improved even more. The B2900A Series of SMUs also provides useful features for production test such as pass/fail decision-making, a digital I/O interface for handler control, and program compatibility with standard single and dual channel SMU products.

The B2900A Series of SMUs is equipped with popular banana style terminals that make it easy to connect to other instruments in a production test system. Both SCPI commands and IVI-COM drivers are available for the B2900A Series of SMUs for remote control using the GPIB, USB or LAN communication protocols.

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 test devices more accurately and easily than ever before.

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).



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