

Characterization of Bipolar Transistors Using the Agilent B2900A Series

Technical Overview

Agilent B2900A Series Precision Source/Measure Unit

- Agilent B2901A Precision SMU, 1ch, 100fA resolution, 210V, 3A DC/10.5A pulse
- Agilent B2902A Precision SMU, 2ch, 100fA resolution, 210V, 3A DC/10.5A pulse
- Agilent B2911A Precision SMU, 1ch, 10fA resolution, 210V, 3A DC/10.5A pulse
- Agilent B2912A Precision SMU, 2ch, 10fA resolution, 210V, 3A DC/10.5A pulse

Introduction

The Agilent B2900A Series of Precision Source/Measure Units are compact and cost-effective bench-top Source/Measure Units (SMUs) with the capability to output and measure both voltage and current. They cover currents from 10 fA to 10.5 A and voltages from 100 nV to 210 V, which enables you to make a wide range of current versus voltage (IV) measurements more accurately and quickly than ever before. In addition, the B2900A Series comes with an intuitive graphical user interface (GUI) and free PC-based application software that make it easy for you to begin making productive measurements immediately. These features make the B2900A Series the best solution for accurate characterization of a wide variety of devices such as bipolar transistors.

What is the B2900A Series SMU?

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 B2900A Series members 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 10.5 A and voltages from 100 nV to 210 V. In addition to their DC operation mode, the B2900A Series also has the ability to perform pulsed measurements in order to prevent device self-heating from distorting the measurement results.

In general, bipolar transistor characterization requires applying different voltages and currents under either constant or the swept conditions to the transistor terminals.

The B2902A and B2912A have two SMU channels, with each channel possessing accurate IV measurement

capabilities as well as the ability to supply either constant or swept voltage/current. This makes the B2902A and B2912A excellent choices for accurate IV characterization of bipolar transistors. Figure 1 illustrates the connections necessary to measure the common emitter output characteristics of a bipolar transistor using the B2902A and B2912A.

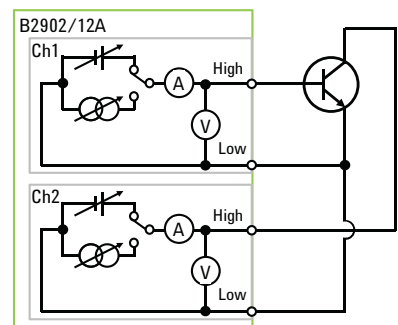


Figure 1. Using the B2902/12A to characterize a bipolar transistor



Quick and Easy IV Characterization

During routine device evaluation it is often desirable to make a quick measurement from the instrument's front panel without having to go through the time and trouble of writing a test program. To meet this need, the B2900A Series has a resident GUI that makes it easy to perform a variety of tests and save measurement data without having to write any code.

The B2900A Series' wide QVGA LCD display supports an easy-to-use GUI that provides easy instrument control from the front panel. The B2900A Series' GUI has the following multiple viewing modes: Single View, Dual View, Graph View and Roll View (for viewing time domain measurements). Single View mode allows you to easily set up not only constant voltage and current measurements but also swept voltage and current measurements for a single SMU channel. Dual View can perform similar functions for both channels simultaneously (for B2902A and B2912A). 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 2).

The B2900A Series has a USB interface on the front panel so that a USB flash memory device can be used with the B2900A Series to save and load measurement setups as well as to save measurement results. In addition, Graph View supports a Screen Dump function that enables you to save screen images (such as IV curves) to any attached USB flash memory device as JPEG files, making it easy to include graphical results in reports and presentations (please see Figure 3).

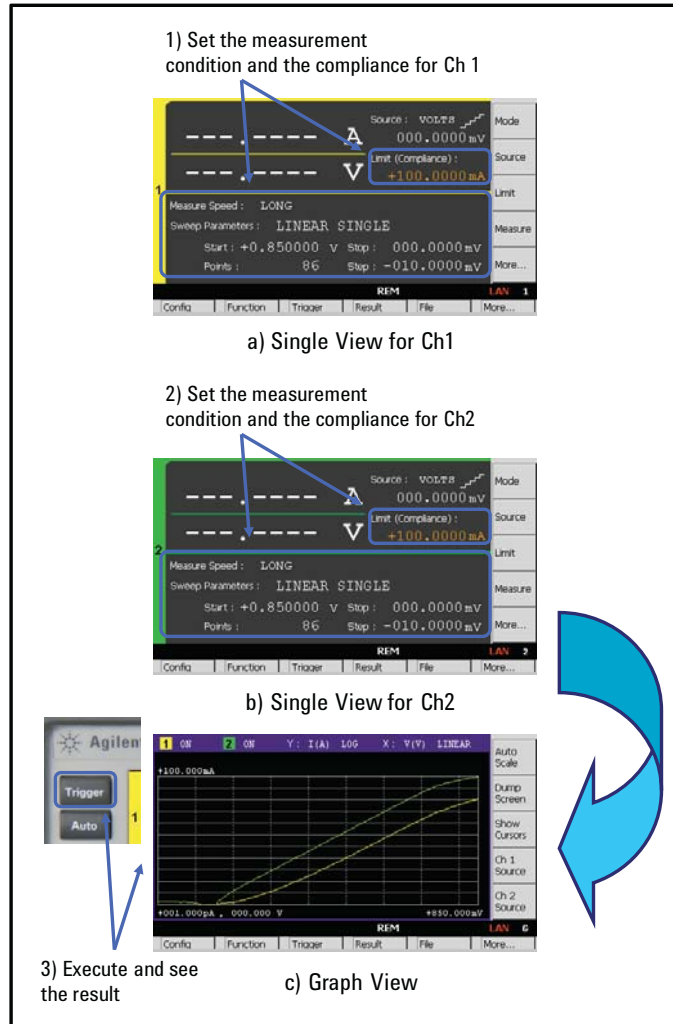


Figure 2. The B2900A Series' GUI makes it easy to take a quick measurement and display the results

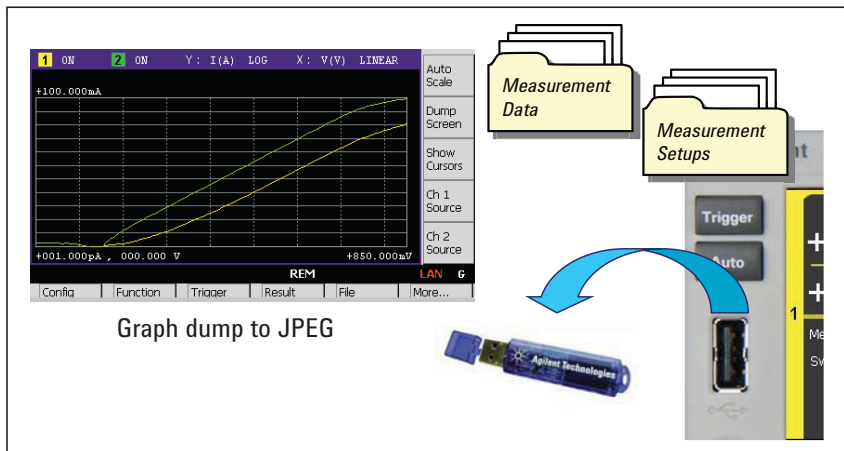


Figure 3. Measurement results and measurement setups can be saved to any attached USB flash memory device

Ready-to-use PC software

In addition to its powerful and easy-to-use GUI, the B2900A Series comes with free PC application software to facilitate program development if you prefer PC-based instrument control. The Agilent B2900A Graphical Web Interface and the Agilent B2900A Quick I/V Measurement Software are both available for the B2900A Series.

The Agilent B2900A Graphical Web Interface provides functionality to allow access to the B2900A Series over a LAN connection. The B2900A Series is fully compliant with the LXI class C specification and it contains a web server that provides a webpage with an interface to support the B2900A Series' basic measurement functions. You can quickly and easily make measurements using a standard web browser by just connecting the B2900A Series to a PC using a LAN cable.

The Agilent B2900A Quick I/V Measurement Software has more powerful measurement capabilities to control the B2900A Series over GPIB, USB or LAN connections (please see Figure 5). You can download this PC-based software from Agilent's web site for free. The Agilent B2900A Quick I/V Measurement Software supports a variety of functions such as a sweep measurement, a sampling measurement, graphical display functions and the ability to save test results into CSV files. The Agilent B2900A Quick I/V Measurement Software also allows you to control up to two B2900A Series units so that devices requiring more than two SMU channels for characterization can be measured. In addition, the Agilent B2900A Quick I/V Measurement Software has the capability to make not only primary sweep measurements but also measurements where a second terminal is swept, making it easy to generate a variety of IV curves.

1) Set the measurement condition for both channels 2) Perform the measurements 3) View the measurement results (Table) 3') View the measurement results (Graph)

The figure illustrates the workflow of the Agilent B2900A Quick I/V Measurement Software. It shows three main steps: 1) Setting measurement conditions for both channels in the Settings view, 2) Performing the measurements, and 3) Viewing the results in either a Table or Graph view. The software interface includes a menu bar (File, Options, Help), a toolbar with icons for Settings, Measurements, Table, and Graph, and a main workspace divided into several panels. The Settings panel on the right allows for configuring SMU1 and SMU2 parameters such as Source, Shape, Force Delay, Start, Stop, Step, Compliance, and Force Range. The Measurements panel shows a graph of Current (A) versus Voltage (V) with two data series: Base Current and Collector Current. The Table panel displays a list of measurement data points with columns for SMU1 Voltage, SMU1 Current, SMU2 Voltage, and SMU2 Current. A large blue arrow points from the Settings view down to the Measurements and Table views, indicating the flow of the measurement process.

Figure 4. It is easy to make a quick measurement on a PC using the Agilent B2900A Quick I/V Measurement Software

Summary

The Agilent B2900A Series of Precision Source/Measure Units is the best solution for IV characterization of bipolar transistors 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 B2900A Series' easy-to-use GUI 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 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 from your PC.

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

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



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