Keysight Technologies
LED Production Test Using the B2900A Series of SMUs

Technical Overview

Keysight B2901/02/11/12A Precision Source/Measure Unit
Keysight B2901A Precision SMU, 1ch, 100 fA resolution, 210 V, 3 A DC/10.5 A pulse
Keysight B2902A Precision SMU, 2ch, 100 fA resolution, 210 V, 3 A DC/10.5 A pulse
Keysight B2911A Precision SMU, 1ch, 10 fA resolution, 210 V, 3 A DC/10.5 A pulse
Keysight B2912A Precision SMU. 2ch, 10 fA resolution, 210 V, 3 A DC/10.5 A pulse

KEYSIGHT TECHNOLOGIES

Introduction

Numerous emerging light emitting diode (LED) applications have created a demand for LEDs with higher quality and reliability. Testing that is both more accurate and faster and that permits quicker sorting is therefore required for both on-wafer devices during fabrication and for packaged devices during final test.

Both electrical and optical tests are typically performed on LEDs. The Keysight Technologies, Inc. B2901/02/11/12A Precision Source/Measure Unit is the best solution for all electric tests such as a forward voltage test (V_F), a leakage current test (I_R) and a breakdown voltage test (V_{BR}). In addition, it can be used to provide forward current bias during optical test.

The B2900A Series of SMUs is a compact and cost-effective benchtop 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. 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 and dual channel SMU products.

This technical overview focuses on the electrical testing of LEDs in production. If you need to perform optical tests in addition to electric tests, then dual-channel models of the B2900A Series of SMUs can be used. The dual-channel models of the B2900A Series of SMUs permit one channel to measure photo diode current while the other channel drives the LED.

Easy production test system configuration

Figure 1 shows a conceptual diagram of a system based on the B2900A Series of SMUs for production LED electric 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 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.

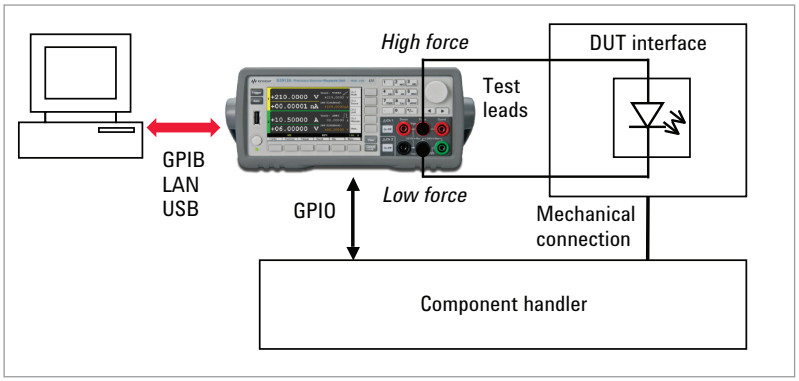

Figure 1. Example test system configuration for a packaged device using the B2900A Series of SMUs

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 2).

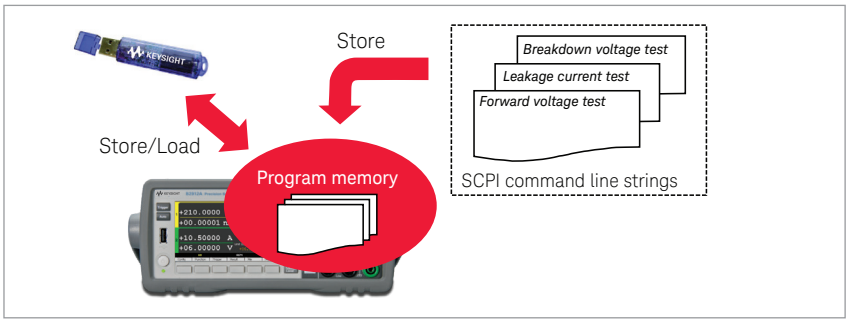

Figure 2. Program memory allows strings of SCPI commands to be stored for later execution

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.

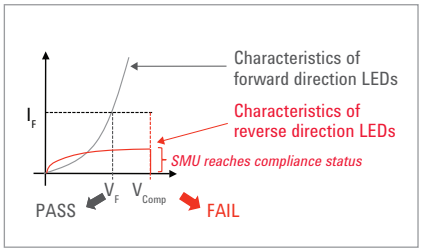

Figure 3. Example showing how the Compliance mode's pass/fail test capability can be used to determine LED polarity

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 LEDs (please see Figure 3).

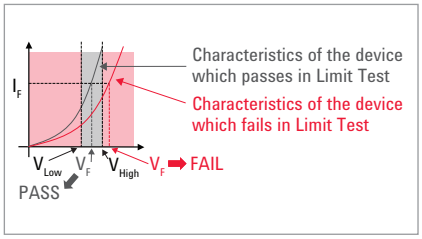

Figure 4. Example showing how the Limit mode's pass/fail test capability can be applied to an LED forward voltage test

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 (please see Figure 4). 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 5).

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.

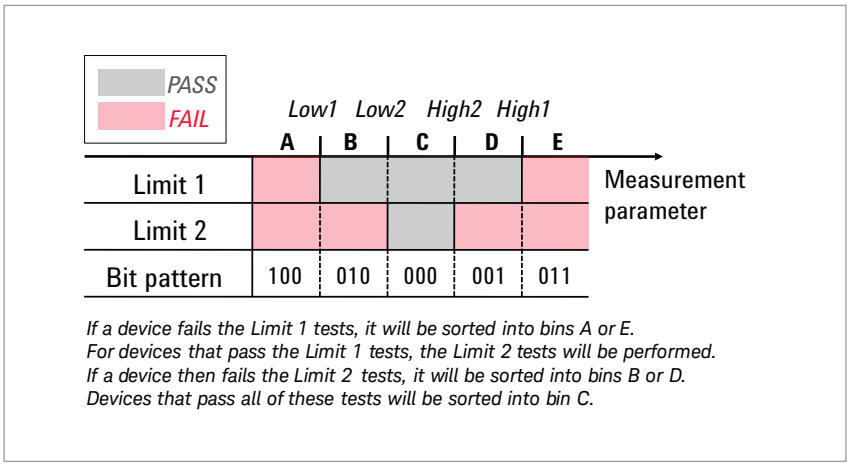

Figure 5. Example showing how to sort devices into five classes using two limit tests

Production LED test flow example

Figure 6 shows a simplified flow for production LED testing. Before beginning the actual testing, it is good practice to store repeated operations into the program memory of the B2900A Series of SMUs (such as the forward voltage test in this example). 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 LED 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.

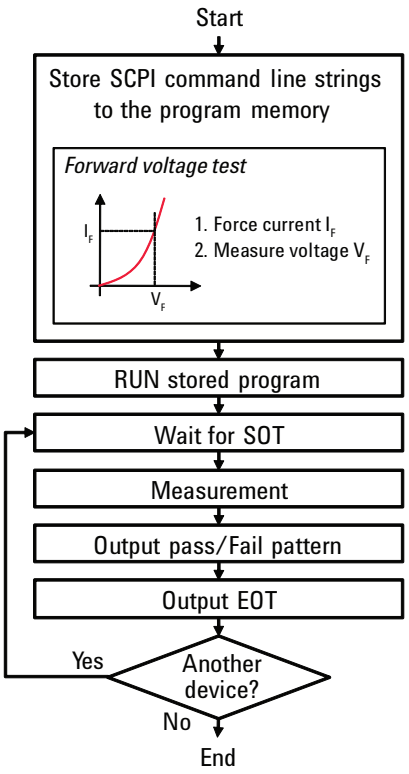

Figure 6. LED production test flow example using the B2900A Series of SMUs

Summary

The Keysight B2901/02/11/12A Precision Source/Measure Unit is the best solution for the production testing of LEDs 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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