TESTING HIGH POWER SEMICONDUCTOR DEVICES FROM INCEPTION TO MARKET

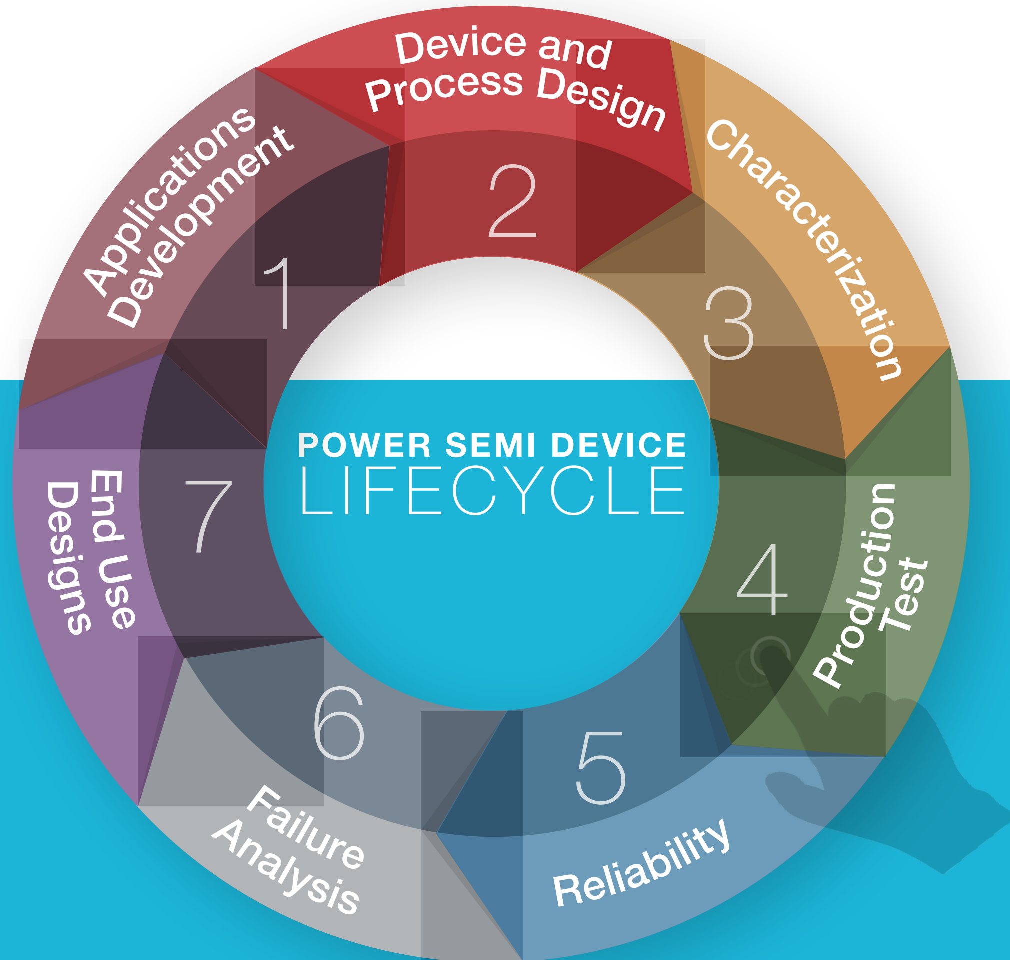
Methods for Efficient, Flexible Test and Characterization Throughout the Life Cycle of a Power Semi Device

Tektronix®

Introduction

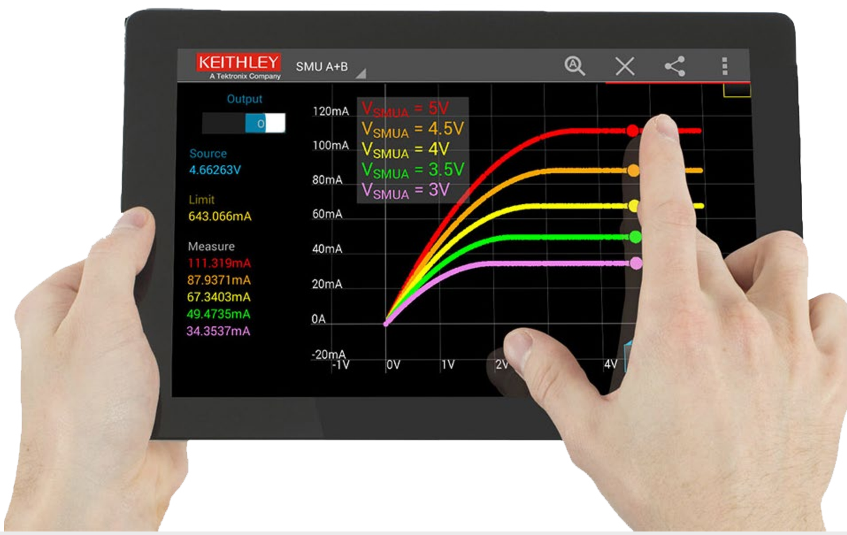
This e-guide examines the life cycle of a power semiconductor device and the tremendous variety of test and characterization activities and measurement challenges faced by the engineers involved in each stage throughout the cycle. From the early stages of designing a new power device to the point where it's ready for market. Keithley's flexible set of high power characterization tools are ideal for testing across the entire life cycle of a power device.

- For basic curve tracing measurements, perhaps a single source measure unit (SMU) instrument with Android-based curve tracer app is sufficient.
- When more meticulous curve tracing is required, a SMU instrument with semiconductor I-V characterization software may be the solution.
- For detailed on-state, off-state, or capacitance-voltage characterization, a full parametric curve tracer (PCT) allows both easy data acquisition and detailed parameter extraction.
- The flexible instrumentation used for curve tracing can also be configured in a racked system for simple functional test, process monitoring, or other higher volume characterization.

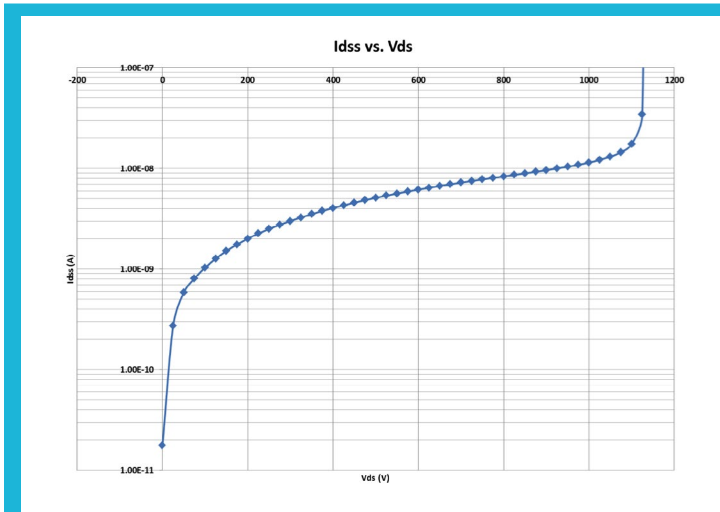


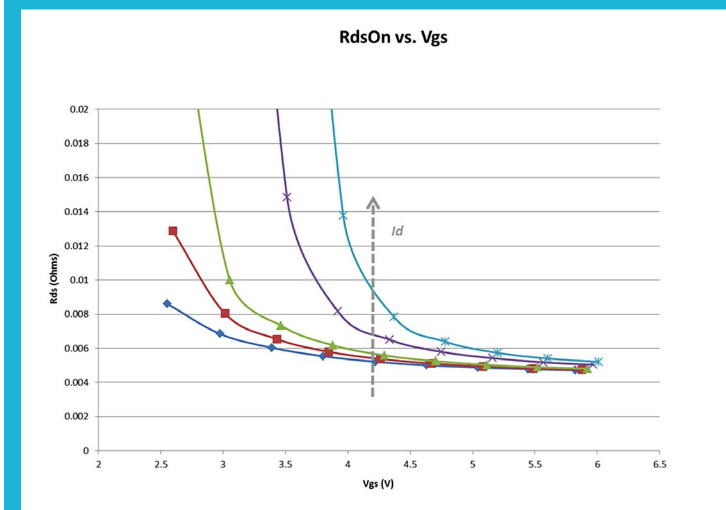
Evaluating Existing Devices and Designs for New Application Requirements

Applications engineers work with customers who are constantly stressing, testing, or stretching a design to maximize efficiency. These customers need detail beyond what is noted in the device specification. Requirements are continually changing, so what needs to be measured can vary on a daily basis. How can measurements be made quickly and easily without time being wasted to relearn software or instrumentation?



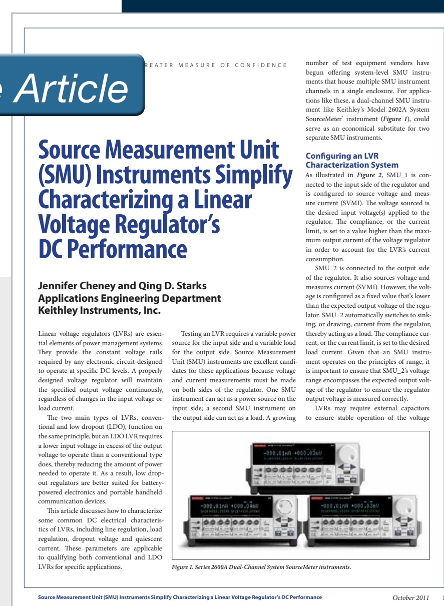
The IVy Android App works with Series 2600B SourceMeter® SMU Instruments to perform I-V characterization. Pinch and zoom for deeper insight into device performance.





Keithley offers a wide range of test capabilities, including pulse, DC, and C-V. Our ACS Basic Software uses device-specific – not instrument-specific – vocabulary to simplify measurements. It also simplifies the interaction between multiple source measurement unit (SMU) instruments, so users can focus on the device rather than the instrumentation. The IVy Android App works with Series 2600B SourceMeter® SMU Instruments to perform I-V characterization, including two- and three-terminal device testing and trend monitoring, and enables interactive analysis and insight into your device without programming! Or, use the Model 2450 Interactive SourceMeter SMU Instruments with KickStart I-V Characterization Software to perform current versus voltage (I-V) testing on a variety of materials, two terminal and multi-terminal semiconductor devices, solar cells, embedded systems, and much more.

Read the Article


Source Measurement Unit (SMU) Instruments Simplify Characterizing a Linear Voltage Regulator's DC Performance

Jennifer Cheney and Qing D. Starks
Applications Engineering Department
Keithley Instruments, Inc.

Configuring an LVR Characterization System

Figure 1. Series 2600A Dual-Channel System SourceMeter instruments.

Source Measurement Unit (SMU) Instruments Simplify Characterizing a Linear Voltage Regulator's DC Performance   October 2011   1

Source Measurement Unit Instruments Simplify Characterizing a Linear Voltage Regulator's DC Performance

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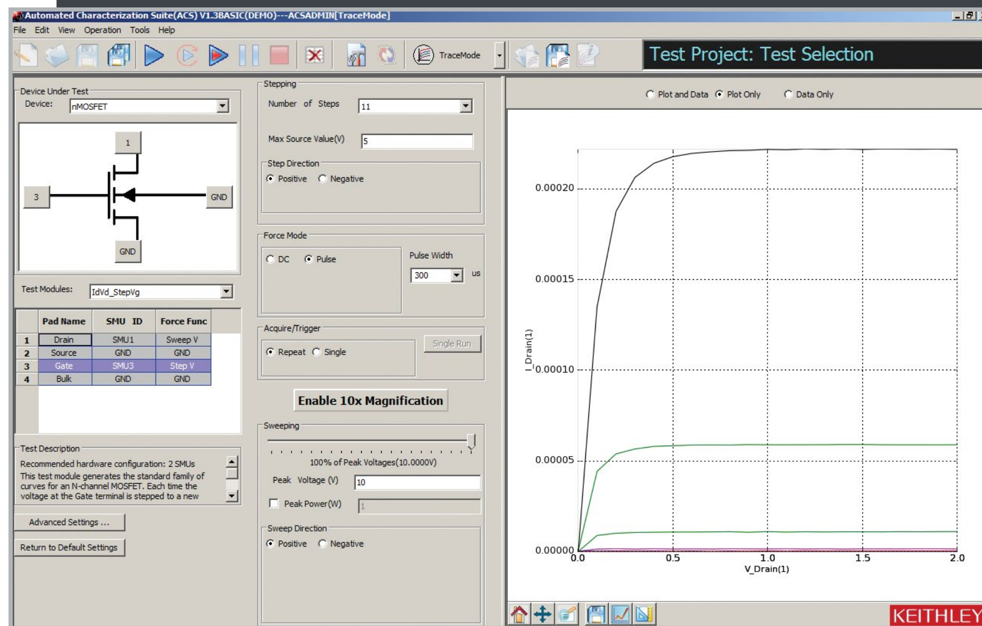
7 Keys to Detecting Potential DUT Issues: Minimize Troubleshooting Time and Boost Productivity

Designing New Devices to Meet Evolving Needs

To effectively design devices to meet their customer's latest requirements, power device design engineers and process engineers must understand how to tweak the process to produce the desired device performance. There must be confidence that the device models are fairly accurate, and changing a particular process step must produce the necessary change in the device measurement parameter. Therefore, the device engineer must perform preliminary verification of key device parameters.

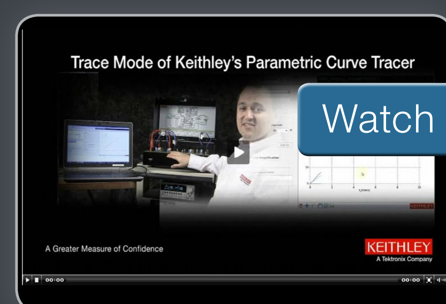
With its trace mode, ACS Basic Edition Software allows quick verification of key device paremeters, including family of curves, bias voltage, etc. In addition to being intuitive, it's designed from the device perspective and includes scores of device libraries and a built-in formulator to quickly relate measurement to device parameters. Parametric Curve Tracer (PCT) Configurations and the Model 8020 Probe Station Interface simplify a wide range of tests that must be performed on-wafer for DC, CV, and pulsed test.



Trace Mode supports interactive testing of a device.

Testing Modern Power Semiconductor Devices Requires a Modern Curve Tracer

Watch the Webinar



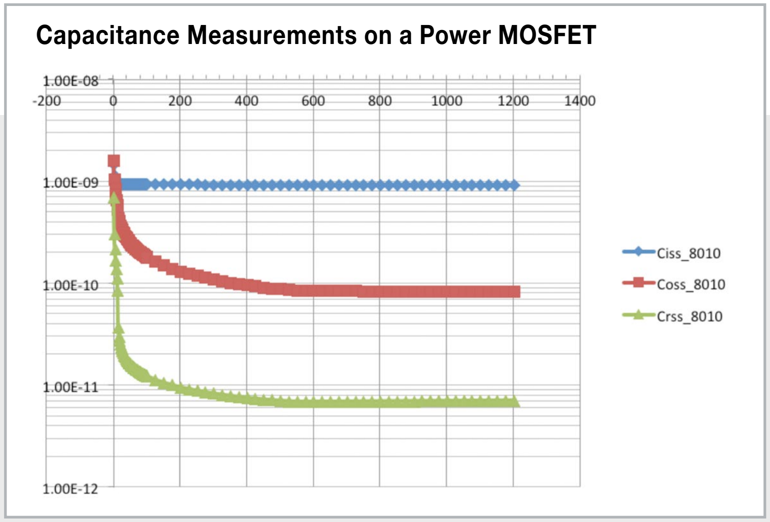
Watch the On-line Demo

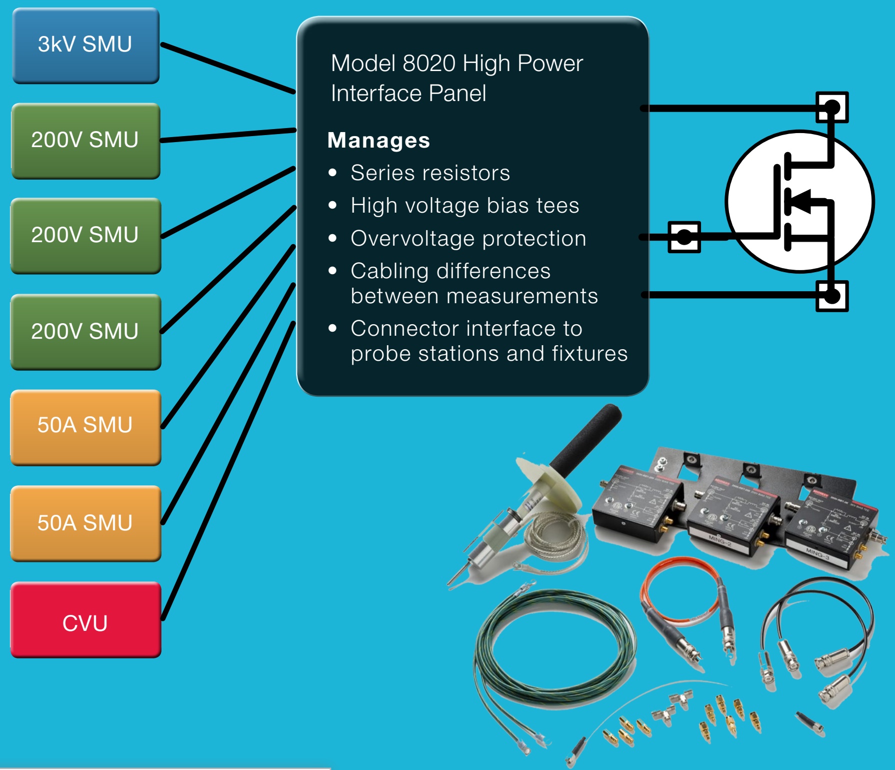
PCT Configuration in Trace Mode

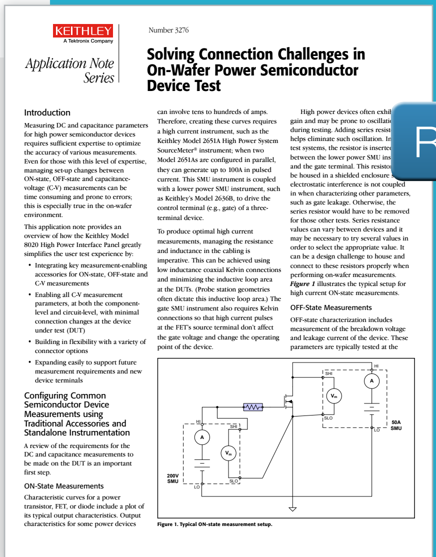
Characterizing Full Performance of New Device Design

A characterization engineer provides the necessary measurement expertise and understanding of how measurement anomalies can impact non-targeted areas of device performance. It's imperative to get results fast to enable multiple iterations with device or process engineers and quickly convert measurements to device parameters.

For on-wafer characterization, the Model 8020 High Power Interface Panel minimizes connection changes between major measurement types. I-V and C-V measurements can be made through bias tees without connection changes. ACS Basic Edition Software allows users to quickly calculate desired parameters.



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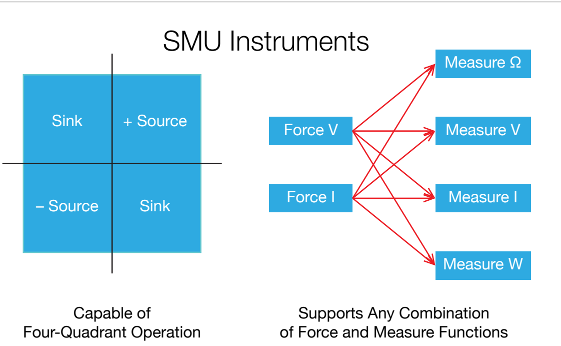
Application Note Series
Number 3276
Solving Connection Challenges in On-Wafer Power Semiconductor Device Test

Read the Application Note

Solving Connection Challenges in On-Wafer Power Semiconductor Device Test

Preparing the Device for Production

To properly prepare a device for production, the production test engineers must prove if the device can be produced reliably. Measurements must be gathered for statistical setting of device specifications, and test times must be optimized to meet required production throughput.

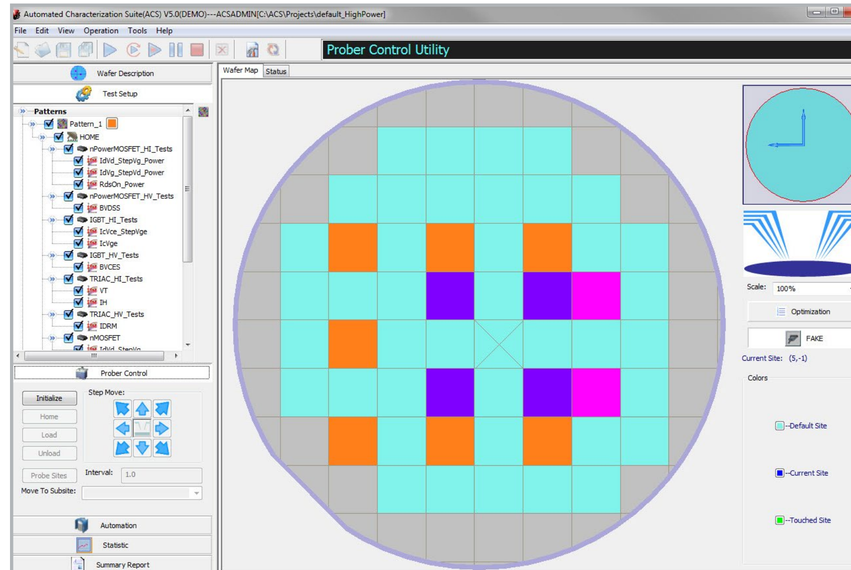


Capable of Four-Quadrant Operation

Supports Any Combination of Force and Measure Functions

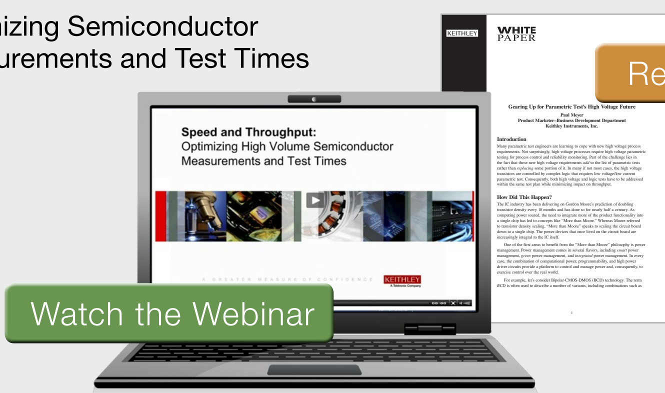
Multi-functional instruments offer the best way to obtain measurements quickly with minimal connection changes and switching.

Source measure unit (SMU) instruments are multi-functional instruments that are proven for use in semiconductor applications. SMU instruments with Test Script Processor (TSP®) technology are primed for throughput because of their tight synchronization, built-in processors for complex operations, and decision-making performed within the instrument, thus minimizing communication times. These SMUs instruments are used in PCT configurations for interactive testing and also in S500 Parametric Test Systems for automated production testing. Automated Characterization Suite (ACS) Software combines advanced semiconductor test capabilities along with prober control, data reporting, and statistics.



ACS maps devices and tests to sites and subsites, eliminating the need to duplicate each test for each subsite and reducing test development time.

Optimizing Semiconductor Measurements and Test Times



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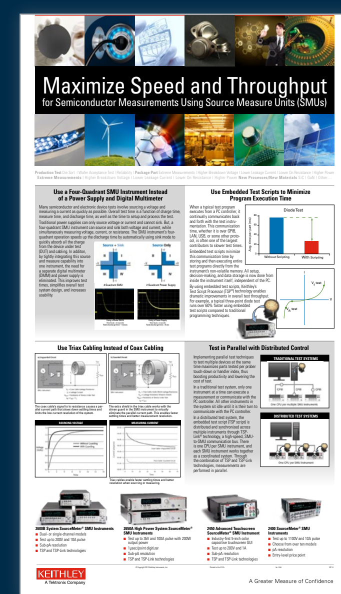
Gearing Up for Parametric Test's High Voltage Future

Maximize Speed and Throughput for Semiconductor Measurements Using Source Measure Unit (SMU) Instruments



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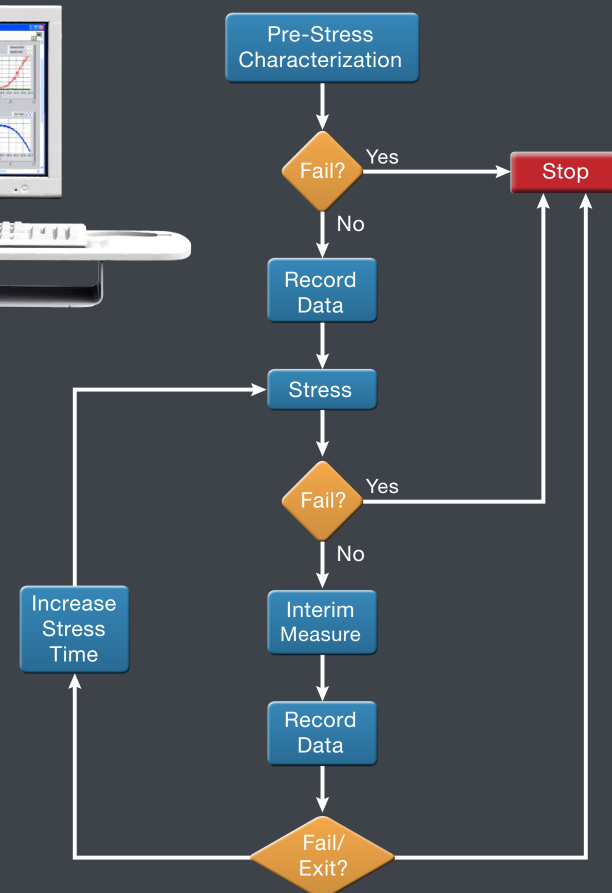
Meeting Reliability Standards for Commercial Use

To conclude that a device meets reliability standards for commercial use, reliability test engineers have several responsibilities:

- Determining if a device will survive environmental stresses and continue to meet specifications
- Answering customer questions about device lifetime (MTBF, MTTF)
- Providing key insight into device fit for certain high reliability applications (mil/aero, automotive, etc.)

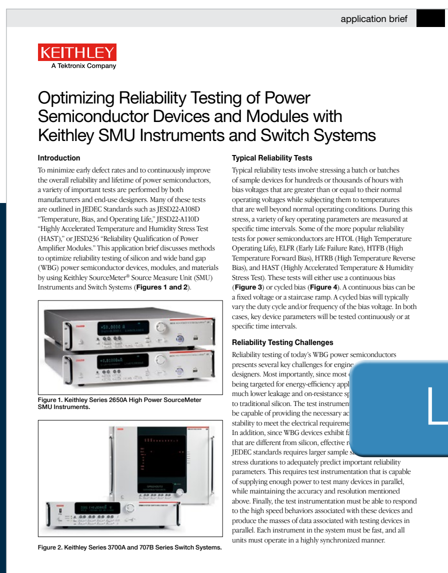
Creating statistically relevant results requires sufficient sample sizes of the test devices. The nature of stress-measure cycling over many devices necessitates multi-channel parallel test with automated data evaluation.

Process flow for HCI/NBTI/constant current EM tests.



S500 Integrated Test Systems are reliability test systems that can be custom built to accommodate from small to large number of devices. ACS features stress measure loop cycling with integrated decision making. Keithley also provides a wide range of power supply and SMU instrument solutions to permit simultaneous power and testing of any number of devices.

Optimizing Reliability Testing of Power Semiconductor Devices and Modules with Keithley SMU Instruments and Switch Systems


application brief
KEITHLEY
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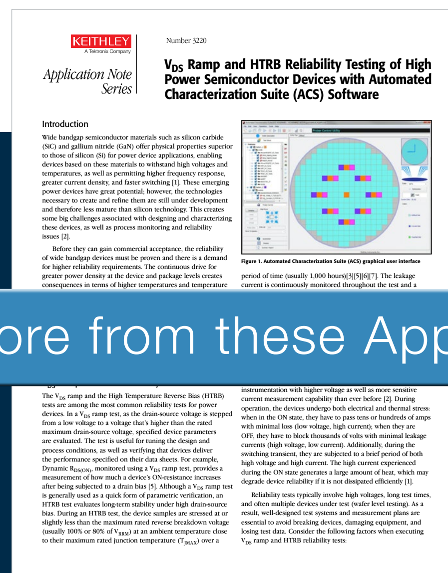
Optimizing Reliability Testing of Power Semiconductor Devices and Modules with Keithley SMU Instruments and Switch Systems

V_{DS} Ramp and HTRB Reliability Testing of High Power Semiconductor Devices with Automated Characterization Suite (ACS) Software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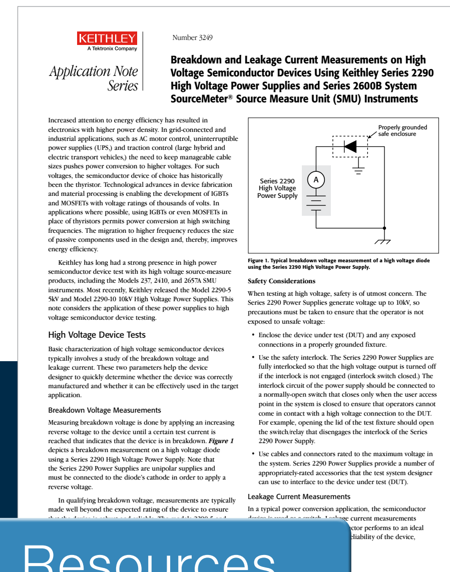
Breakdown and Leakage Current Measurements on High Voltage Semiconductor Devices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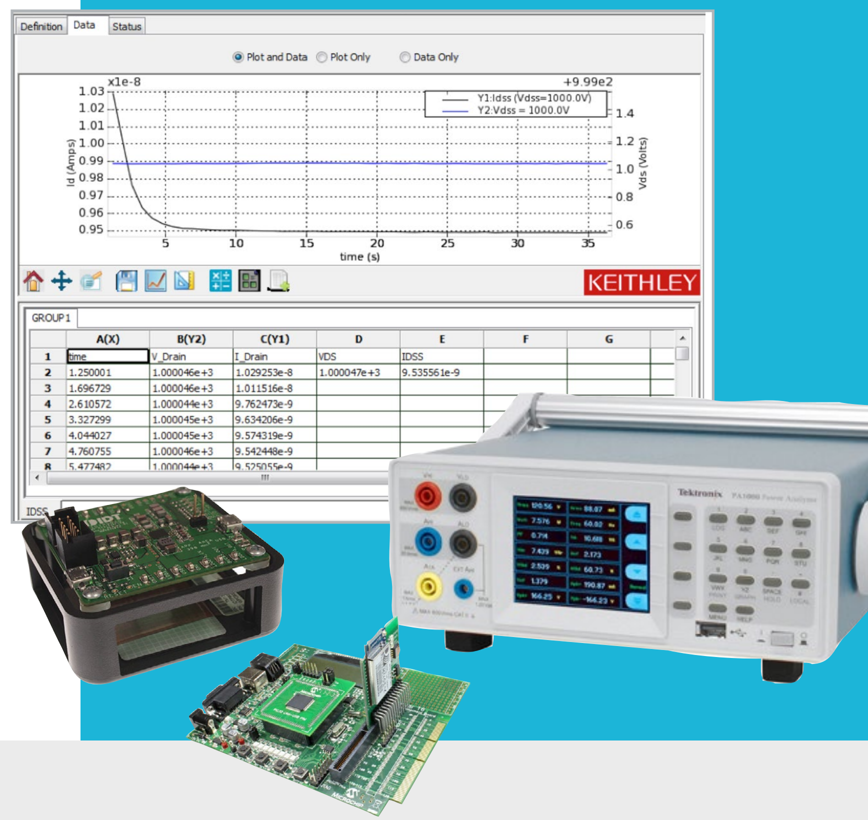
Breakdown and Leakage Current Measurements on High Voltage Semiconductor Devices Using Keithley Series 2290 High Voltage Power Supplies and Series 2600B System SourceMeter® Source Measure Unit (SMU) Instruments

Learn More from these Application Resources

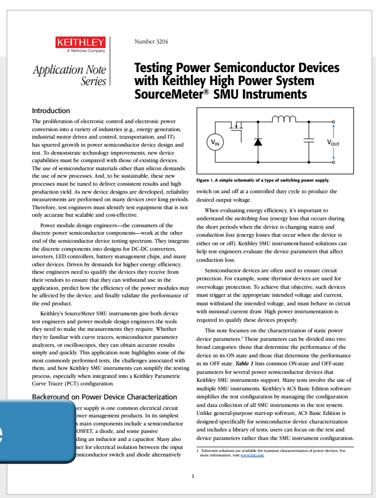
Implementing the Device in Actual Designs

Once a device is validated, it's ready for commercial use. Those who purchase devices must verify that the device is within tolerance for a particular application to ensure that the expected power efficiency gains will be achieved in the end product. As the device matures and becomes available from multiple suppliers, power device consumers want to quickly inspect incoming devices in order to identify and eliminate counterfeit devices to avoid potential failures in the end product.

Tektronix and Keithley offer a wide variety of power supply solutions to power basic circuit boards. Additionally, Tektronix's power analyzers can quickly and accurately assess overall end product performance. Keithley's Parametric Curve Tracer (PCT) Configurations and ACS Basic Edition Software include a large library of power device tests so individual device performance can be quickly verify. Oscilloscopes with optional power analysis modules enable quick and accurate analysis of switching loss, harmonics, and safe operating area. Choose from a wide variety of high voltage, current, and differential probes to partner with an oscilloscope.



Testing Power Semiconductor Devices with Keithley High Power System SourceMeter® SMU Instruments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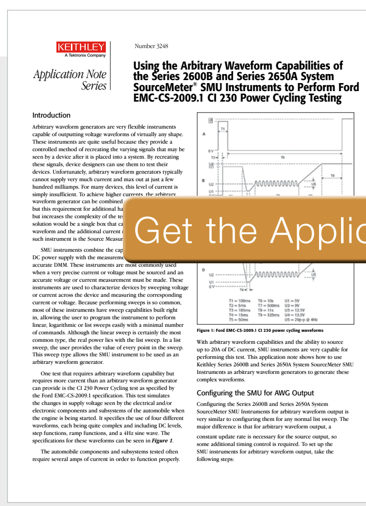
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Using the Arbitrary Waveform Capabilities of the Series 2600B and Series 2650A System SourceMeter® SMU Instruments to Perform Ford EMC-CS-2009.1 CI 230 Power Cycling Testing
Introduction

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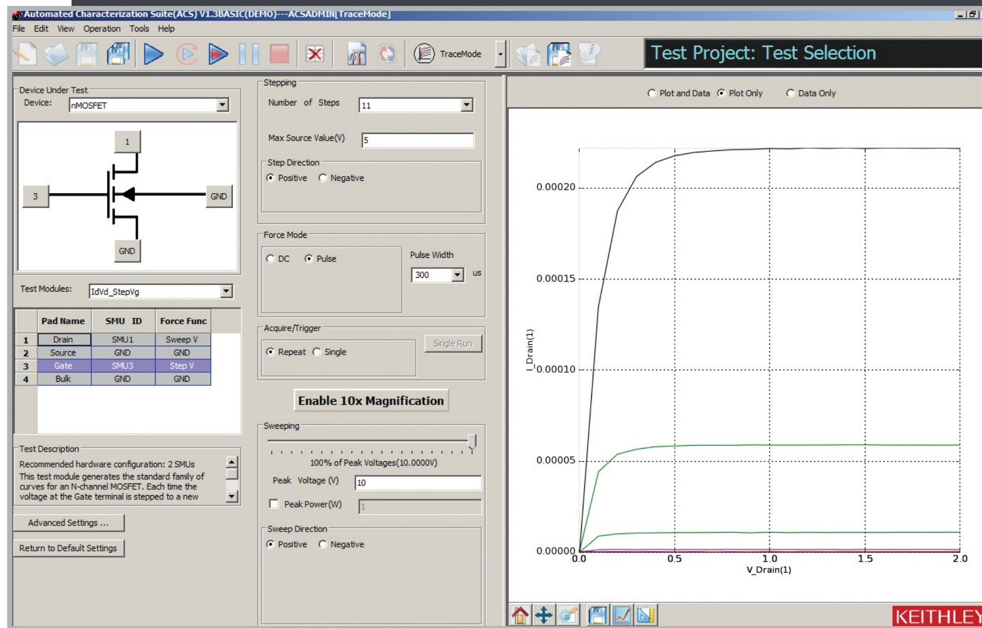
Using the Arbitrary Waveform Capabilities of the Series 2600B and Series 2650A System SourceMeter® SMU Instruments to Perform Ford EMC-CS-2009.1 CI 230 Power Cycling Testing

Implementing the Device in Actual Designs

Failure analysis engineers must determine whether a failure has been caused by end-product use or by a design flaw that was previously overlooked. Once this determination has been made, design and process engineering must be made aware of the cause of the failure, so that either process or design changes can be implemented to prevent future failures.

It's important that basic device specifications, both static and dynamic, can be measured quickly. The end use application is mimicked in an effort to reproduce the failure.

Parametric Curve Tracer Configurations feature trace mode, which provides quick device analysis. Additionally, Keithley's Automated Characterization Suite (ACS) has several built-in stress-measure tests that can be used until a device reaches the desired level of degradation.



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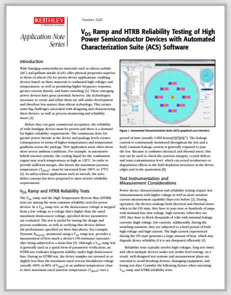
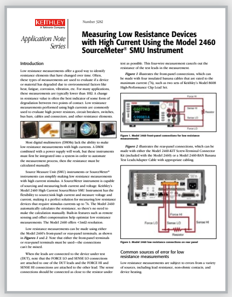
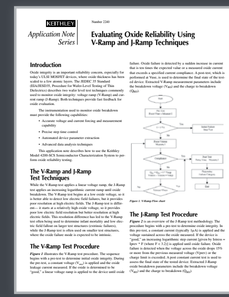
V_{DS} Ramp and HTRB Reliability Testing of High Power Semiconductor Devices with Automated Characterization Suite (ACS) Software



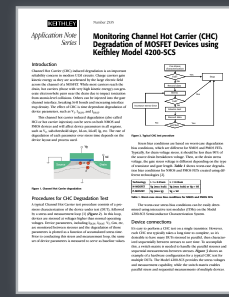
Measuring Low Resistance Devices with High Current Using the Model 2460



Evaluating Oxide Reliability Using V-Ramp and J-Ramp Techniques



Monitoring Channel Hot Carrier (CHC) Degradation of MOSFET Devices using Keithley Model 4200-SCS



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