Semiconductor Test

S530

Parametric Test Systems

- **Most cost-effective fully automatic parametric testers available**
- **Optimized for use in environments with a broad mix of products, where high flexibility and fast test plan development are critical**
- **Choice of three system configurations**
  - **Basic configuration for general-purpose process monitoring applications**
  - **Low current configuration for characterizing sub-micron silicon MOS technologies**
  - **High voltage configuration for monitoring processes used in fabricating automotive electronics and power management devices**
- **Operates with popular fully automatic probe stations**
- **Cabled-out tester configuration maximizes prober interface flexibility and expands voltage range**
  - **Compatible with Keithley's Model 9139A Probe Card Adapter**
  - **Supports reuse of existing 5-inch probe card libraries**
- **Proven instrumentation technology ensures high measurement accuracy and repeatability in both the lab and the fab**

Keithley's new line of S530 Parametric Test Systems are built on our proven sourcing and measurement technology and are engineered to handle all the DC and C-V measurements required in process control monitoring, process reliability monitoring, and device characterization. Keithley has more than 30 years of experience in delivering a wide range of standard and custom parametric test systems to semiconductor industry customers around the world.

Optimized for High-Mix Test Environments

S530 parametric test systems are designed to meet the needs of production and lab environments that must handle a broad range of devices and technologies, offering industry-leading test plan flexibility, automation, probe station integration, and test data management capabilities. Three different models of the S530 systems are available to address the needs of different types of applications. **Table 1** provides a quick overview of the capabilities each model provides.

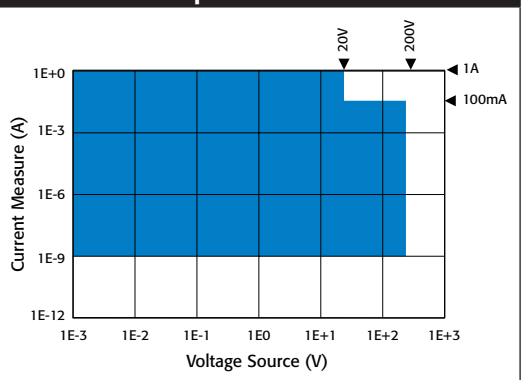
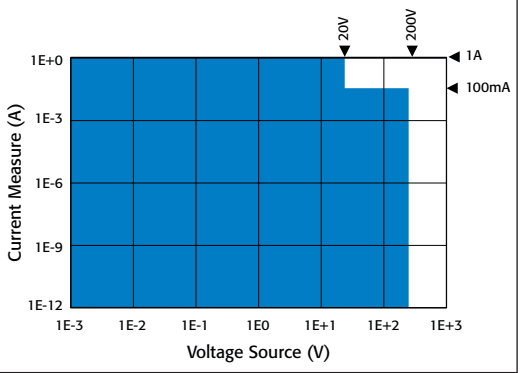
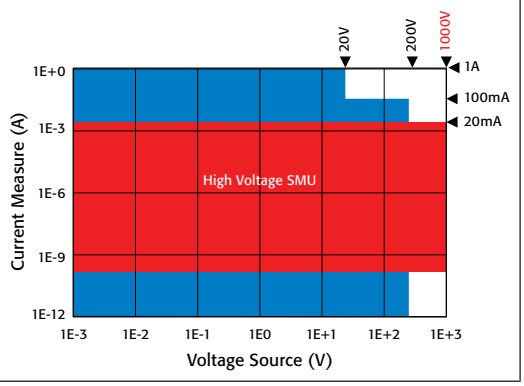
Simple Software Migration and High Hardware Reuse

S530 systems are designed to simplify startup and maximize reuse of your existing test resources. For example, the Automated Characterization Suite (ACS) software that controls these systems is compatible with many new and legacy automatic probe stations. Additionally, the S530's cabled-out configuration makes it easy to adapt to allow reuse of your current probe card library. Several optional applications services are available to help you continue getting the full value of your existing prober and probe card investments. Assistance is also available to speed the development of new test recipes or conversion of your current ones for use with S530 systems.

A System Configuration for Every Low- to Medium-Volume Application

Three different standard S530 Parametric Test System configurations are available to address different parametric test application environments. The S530 Basic System offers the industry's most cost-effective full-featured parametric tester; it includes powerful sourcing up to 1A or 200V with nominal measurement sensitivity, so it's suitable for many general-purpose process monitoring applications. The S530 Low Current System is built on an ultra-low-leakage switch matrix and sensitive measurement technology that provides sub-picoamp measurement resolution. This version of the system provides low current guarding all the way to the probe card, which makes it ideal for characterizing

Table 1. S530 System Selector Guide

S530 Model	Description	Typical Use Cases/Settings	SMU Power Envelope
Basic	Most cost-effective solution for testing mature technologies that require only basic current and voltage measurements	• Source up to 1A or 200V • Measure current with picoamp resolution and nanoamp offset • Measure voltage with microvolt resolution and millivolt offset	
Low Current	Ideal for both mature and emerging technologies that demand picoamp current measurement capability	• Source up to 200V or 1A • Measure current with femtoamp resolution with picoamp offset • Measure voltage with microvolt resolution and millivolt offset	
High Voltage	Optimized for power electronics and display technologies that require testing at high voltages	• Source up to 1000V or 1A • Measure current with femtoamp resolution with picoamp offset[1] • Measure voltage with microvolt resolution and millivolt offset	

[1] Using 200V SMU. 1000V SMU (marked in red) provides 10pA resolution with nanoamp offset.

sub-micron silicon MOS technologies. The S530 High Voltage System can source up to 1000V for use in the difficult breakdown and leakage tests that automotive electronics and power management test applications demand.

System Architecture

S530 Parametric Test Systems are built on the same basic architecture nearly all production parametric test systems share: a set of instruments connected to a set of probe pin connections through a switch matrix.

Switch Matrix

The different switch matrices used in these systems are key to making the most of each configuration's capabilities. The S530 High Voltage System is built around the semiconductor industry's only switch matrix capable of routing signals of up to 1000V through low-leakage guarded pathways. The Low Current System also uses guarded pathways but employs proprietary isolation techniques to provide ultra-low-leakage performance. The Basic system, which is designed for test environments that do not require low current or high voltage measurements, is equipped with a more cost-effective matrix for these less challenging environments.

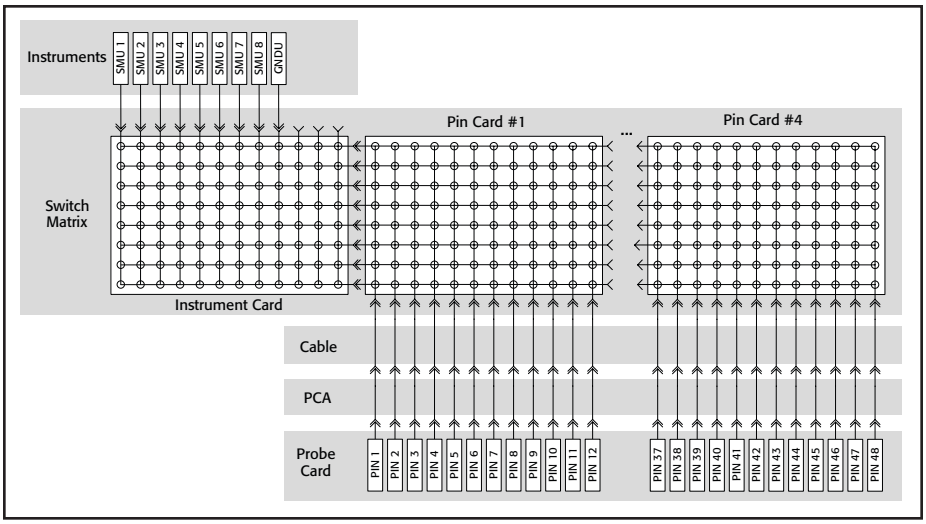
The switch matrix subsystem of every system has the same basic architecture and consists of one instrument card and at least one pin card. The instrument card is dedicated to hosting the instrument connections while the pin cards are dedicated to probe pin connections via the cabled-out probe card adapter. This architecture provides the maximum test flexibility by allowing any instrument to be routed to any probe pin. This architecture also makes thorough system diagnostics possible without the need to disconnect the cabled-out probe card adapter.

Source-Measure Units (SMUs)

All source-measure units (SMUs) built into S530 Parametric Test Systems are based on Keithley's production-qualified instrument technology to ensure high measurement accuracy and repeatability and extended hardware life. The SMUs are four-quadrant sources, so they can source or sink current or voltage. In addition to precision sourcing circuits, they include programmable limits (compliance) across all ranges, which helps protect both devices and probe tips from damage due to device breakdown. Each SMU also measures both the voltage and current while sourcing, which ensures that parameter calculations reflect actual conditions rather than programmed conditions.

Capacitance-Voltage (C-V) Unit

All S530 systems can be equipped with an optional capacitance-voltage (C-V) measurement unit. The C-V unit supports direct connection to the probe card adapter or probe card, which maximizes the precision of the C-V measurements. Although making C-V measurements via the switch matrix provides greater flexibility by allowing for measurements on every pin, the additional signal path and associated parasitic impedances reduce the quality of the signal and derate the C-V unit's performance. The Low



Generalized System Block Diagram

Current and High Voltage systems are equipped with switch matrix cards that support bandwidths compatible with multifrequency C-V measurements up to 1MHz with minimal performance derating.

Ground Unit (GNDU)

All source-measure units are referenced to the ground unit or GNDU. During a test, the GNDU provides both a common reference and a return path for current sourced by the SMUs. The GNDU signal is formed by combining all the Source LO and Sense LO signals and referencing them to system ground. The system can easily be configured for a range of ground system configurations to accommodate various probe station ground schemas.

Table 2. System Capabilities Comparison

S530 System Type	Basic	Low Current	High Voltage
Pin Count	Up to 80	Up to 60	Up to 60
SMU Channels	2 to 4	2 to 8	3 to 7
Vmax	200 V	200 V	1000 V
Imax	1 A	1 A	1 A
Vmin Resolution	1 μV	1 μV	1 μV
Imin Resolution	100 pA	1 fA	1 fA (100 pA at 1000 V)
CVU (direct connect)	1 kHz to 10 MHz	1 kHz to 10 MHz	1 kHz to 10 MHz

Cabled-Out Options

S530 systems are "cabled-out" configurations to ensure the maximum interconnect flexibility that high-mix fab and lab environments demand. S530 systems can be interfaced to a variety of probing solutions, including high performance circular probe cards, cost-effective rectangular edge-connector probe cards, and even special high performance cards for applications that involve extreme temperatures or demand high durability.

Cabling

Each S530 System is configured with interconnect cabling chosen to reduce parasitic effects and maximize the system's measurement capabilities. For example, the S530 Basic System employs a specially manufactured low-capacitance shielded twisted-pair cable, designed for making good-quality, general-purpose measurements without the added expense of low-leakage triax cables. The S530 Low Current and High Voltage systems use triax cabling to minimize leakage through the use of an inner shield that's driven by the SMU guard signal. This design reduces leakage and improves settling time of the cables. Table 3 provides an overview of the cabling options available.

Probe Card Adapters (PCAs)

Optional PCAs are available for all S530 configurations. In the simplest form, the edge connector used to interface to rectangular probe cards (typically referred to as 5-inch probe cards) is a PCA. This type of PCA provides the most cost-effective solution for applications involving mid-range signal levels. If desired, the Model 9139A PCA can be configured into any S530 system as an option. This PCA is designed for interfacing the system to circular probe cards (from Keithley-approved vendors) via pogo pin connections. Probe-station-specific adapter plates that can be specified during ordering make the Model 9139A compatible with a variety of popular probe stations.

Probe Cards

Unlike testhead-based systems, S530 systems are easily adaptable for use with a wide range of probe card types, so it's likely you won't need to replace your expensive probe card library. Although Keithley recommends the use of the 9193A PCA and approved probe card vendors, we recognize that you have made a major investment in your current cards. If probe card reuse is critical to your capital equipment strategy, consult an applications team member to learn about connection options that can protect your probe card investment.

System Software

Keithley's ACS software maximizes the efficiency and flexibility of our S530 systems, bringing together all the key elements for automated parametric testing in a single integrated package. All these key operations are included:

Wafer Description and Cassette Sample Plan

Limits Setting and Binning Definition

Test Plan Development

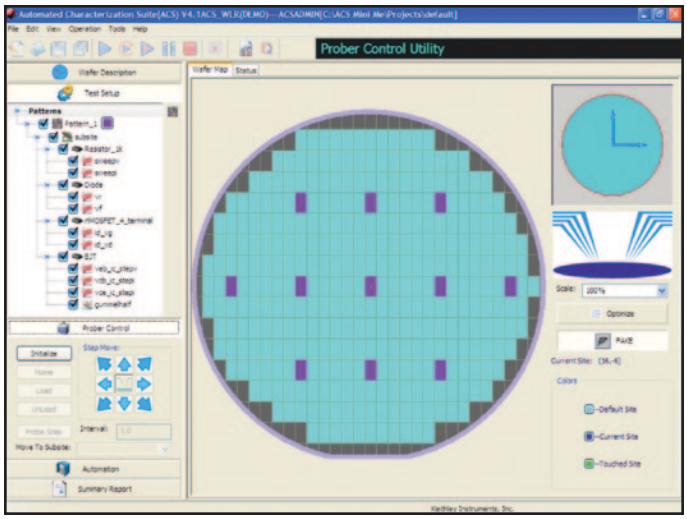
Interactive Probe Station Control

Fully and Semi Automatic Wafer/Cassette Testing

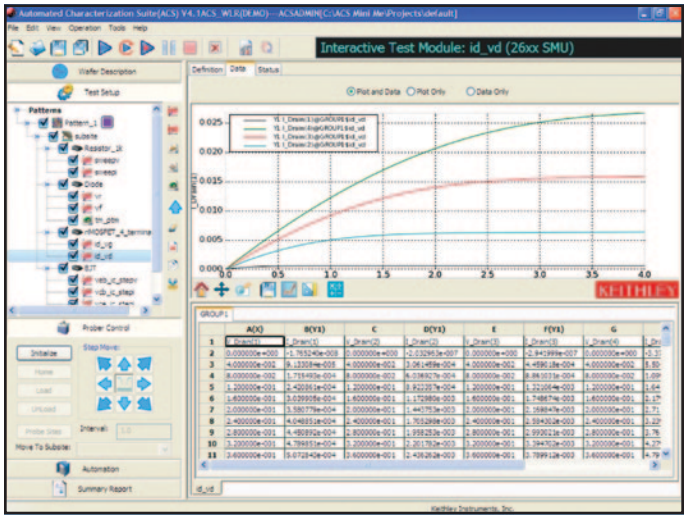
Test Data Management

Table 3. S530 System Cabling Options

Cabling Option	Probe Card Type	Features	Benefits
Keithley 9139A PCA (S400-type)	Circular ceramic	Extends driven guard to probe	Superior low current measurements
Custom Cabled to Existing PCA Type	Typical for 5-inch rectangular probe cards using edge card connectors	Compatible with existing probe card library	Reduces migration cost by reusing existing probe cards
Unterminated Cables	Cables connected to switch matrix output with unterminated cable ends	Ready to cable to existing interface or fixture	Provides recommended cable to optimize system performance
No Cables	Custom probe card	No need to purchase a cable solution	Use cable system provided by custom probe card vendor



The Prober Control screen supports dynamic navigation at both the wafer and cassette levels as well as interactive test execution. This freedom from the conventional linear test flow greatly accelerates test plan development by allowing for immediate verification of the test results; it also speeds lot disposition by allowing the engineer to examine a problem in detail or perform selective retesting to identify or quantify problems.



ACS provides interactive data display and graphics during test plan development and lot disposition. There's no need to switch back and forth through multiple screens or employ off-line tools to analyze test data or confirm test functionality.

Probe Station Automation and Control

A unique interactive probe station control capability in ACS makes it easy to navigate the wafer while developing a test or analyzing a lot on hold. There's no need for the operator to retest an entire wafer; ACS allows moving from site to site or subsite to subsite on the wafer freely, then executing a test or test sequence and reviewing the results immediately.

Test Plan Development

Developing a test plan for a new product doesn't have to be time-consuming. ACS provides unique tools specifically designed to maximize test plan development efficiency. These tools are integrated into a single interface that allows you to evaluate the effects of changes to your test plan quickly so you can refine them further with confidence.

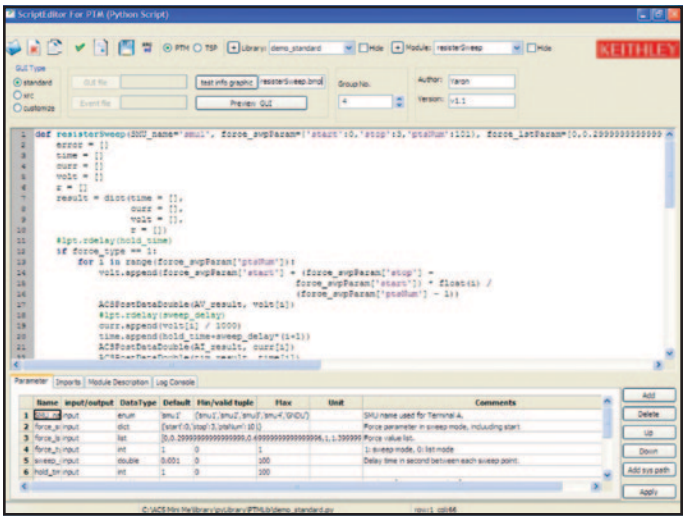
Interactive Probe Station Control – It's simple to move the probe pins from site to site to execute tests interactively during test plan development.

Real-Time Data Plotting – As a test is executed, the resulting measurements are automatically fed to a spreadsheet. From there, the data is automatically plotted according to the rules you define.

Formulator – Many parametric measurements require extracting parameters from raw measurements. Most often, these measurements are sweeps (vector data). ACS's built-in formulator can execute both standard and user-defined mathematical operations on the data to extract the parameters (scalar data) desired. The resulting data is fed to the spreadsheet and can be plotted with the click of a button.

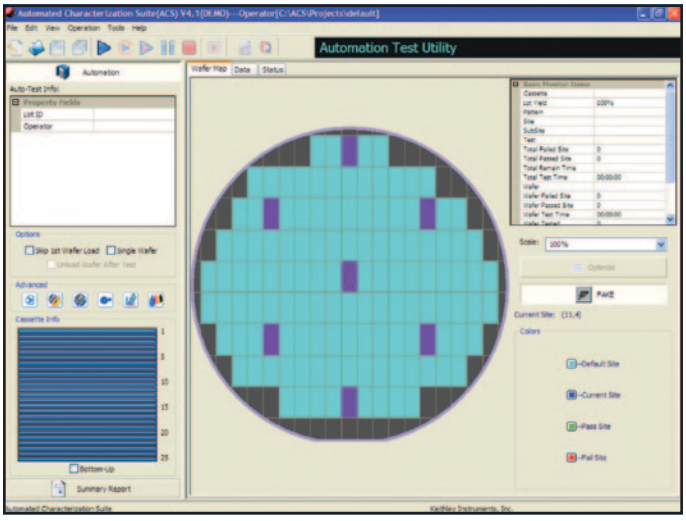
Script Editor – The test script editor is fully integrated within ACS's test plan development environment. With no need to use an external editor and compiler to build a script, you can test the effect of your changes immediately.

Test Sequencing and Reuse – ACS provides two ways to organize a test plan: the *Test Tree* provides a root and hierarchical branch scheme, and it's well-suited for creating simple test plans for a handful of subsites quickly; the *Test Map* allows sites, devices, and tests to be mapped or logically connected. The Test Map is most useful for developing complex test plans that include large numbers of unique subsites and devices mapped to a few tests. While the Test Tree requires cutting/pasting tests for reuse, the Test Map requires only logical links that are quickly built and modified with a GUI.



The integrated Script Editor combines an efficient editor with a special variable management tool to minimize errors during test plan development. ACS also features a GUI-Script capability that allows linking an interactive GUI to the script using the Script Editor and GUI Builder toolset.

Wafer- and Cassette-Level Automation



The Automation screen provides real-time statistics on lot and wafer yields, overall test progress, and color-coded die binning information. The Operator Mode screen shown here limits access to some tools to prevent unauthorized modifications to test plans and reports.

Together, these tools form a highly interactive test plan development environment that accelerates lot analysis, troubleshooting, and disposition of "hold" lots dramatically. These interactive tools also help ensure you'll be testing successfully from your first full cassette of wafers.

Engineer and Operator User Modes

When used in Engineering Mode, ACS software offers maximum control and flexibility; in Operator Mode, access is limited to only those controls and dialogs required to initiate and terminate fully automatic testing. In Engineering Mode, engineers can block access to specific entry fields in the automation set-up screen on a field-by-field basis. This allows engineers to limit selectively the way in which operators can initiate a lot.

System Diagnostics

The systems' diagnostics capability is designed to verify system functionality quickly. This involves several key steps, including configuration verification, communications pathway tests, signal pathway testing, and SMU source-measure tests. Diagnostics can detect and localize a wide range of system problems to speed troubleshooting and maximize uptime.

Support Services

Keithley's worldwide network of service and applications professionals provides expert support services ranging from initial installation and calibration to repairs and test plan migration services. These services maximize system utilization and uptime while reducing your overall cost of ownership.

Installation and Probe Station Integration Services – Includes the setup and verification of the system as well as probe station integration. This includes setting up probe station communications and installing the probe card adapter.

Calibration Services – All S530 Parametric Test Systems are calibrated onsite by a certified Keithley field service engineer. Keithley provides a range of internationally recognized accredited calibration services, including A2LA (American Association for Laboratory Accreditation) accredited calibration.

Repair Services – Repair services ranging from on-site service contracts to self-service module-swaps are available.

Test Plan Migration Services – Keithley's experienced applications engineers are skilled at converting your existing test plans to the S530's ACS software environment. This includes conversion of data objects like user test libraries, wafer description files, cassette plans, etc.

Correlation Studies – Keithley applications engineers can perform correlation studies, comparing your existing parametric test system's capability to the S530's and analyzing the underlying performance differences.

Documentation

A comprehensive manual set is pre-installed on the system as well as provided on CD:

S530 Administrative Guide – Information on site preparation, installation, etc.

ACS 4.1 Users Reference Manual – A detailed reference and instruction manual on the operation of the ACS software.

Prober Manual – Assists in automatic probe station setup and programming. It includes driver details and usage instructions.

System Hardware Specifications

All listed specifications are system-level specifications to the output of the switch matrix. The addition of PCA and PCA cabling will derate these specifications.

Specification Conditions

23°C ±5°C, 1 year.
RH between 5% and 60% after 1 hour warm-up.
All specs assume 2-wire operation.
Basic system V/A errors can be eliminated when used as a 4-wire system.
All specs are based on 1 year calibration cycle for individual instruments.
Measurement Specifications @ 1 PLC (Power Line Cycle) unless otherwise noted.

General I/V Source Specifications

MAXIMUM OUTPUT POWER PER SMU: 20W (four quadrant source or sink operation).
COMPLIANCE: Compliance resolution and accuracy are determined by the corresponding range used.

S530 Basic Parametric Test System Specifications

CURRENT SOURCE SPECIFICATIONS

Current Range	Max. Voltage	SOURCE	
		Resolution	Accuracy
10 A	5 V	200 µA	0.50% + 40 mA + 601 pA/V
1.5 A	20 V	50 µA	0.06% + 4 mA + 601 pA/V
1 A	200 V	20 µA	0.05% + 1.8 mA + 601 pA/V
100 mA	200 V	2 µA	0.03% + 30 µA + 601 pA/V
10 mA	200 V	200 nA	0.03% + 6 µA + 601 pA/V
1 mA	200 V	20 nA	0.03% + 300 nA + 601 pA/V
100 µA	200 V	2 nA	0.03% + 60.3 nA + 601 pA/V
10 µA	200 V	200 pA	0.03% + 5.3 nA + 601 pA/V
1 µA	200 V	20 pA	0.03% + 1101 pA + 601 pA/V
100 nA	200 V	2 pA	0.06% + 401 pA + 601 pA/V

CURRENT MEASURE SPECIFICATIONS

Current Range	Max. Voltage	MEASURE	
		Resolution	Accuracy
10 A	5 V	100 µA	0.40% + 25 mA + 601 pA/V
1.5 A	20 V	10 µA	0.05% + 3.5 mA + 601 pA/V
1 A	200 V	10 µA	0.03% + 1.5 mA + 601 pA/V
100 mA	200 V	1 µA	0.02% + 20 µA + 601 pA/V
10 mA	200 V	100 µA	0.02% + 2.5 µA + 601 pA/V
1 mA	200 V	10 nA	0.02% + 200.3 nA + 601 pA/V
100 µA	200 V	1 nA	0.02% + 25.3 nA + 601 pA/V
10 µA	200 V	100 nA	0.03% + 1.801 nA + 601 pA/V
1 µA	200 V	10 pA	0.03% + 801 pA + 601 pA/V
100 nA	200 V	1 pA	0.06% + 401 pA + 601 pA/V

VOLTAGE SOURCE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE	
		Resolution	Accuracy
200 V	1 A	5 mV	0.02% + 50 mV + 3 V/A
20 V	1.5 A	500 µV	0.02% + 5 mV + 3 V/A
2 V	10 A	50 µV	0.02% + 626 µV + 3 V/A
200 mV	10 A	5 µV	0.02% + 401 µV + 3 V/A

VOLTAGE MEASURE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE	
		Resolution	Accuracy
200 V	1 A	1 mV	0.015% + 50 mV + 3 V/A
20 V	1.5 A	100 µV	0.015% + 5 mV + 3 V/A
2 V	10 A	10 µV	0.02 % + 376 µV + 3 V/A
200 mV	10 A	1 µV	0.015% + 251 µV + 3 V/A

C-V MEASUREMENT SPECIFICATIONS

4210-CVU TYPICAL ACCURACY WITH 3M CABLES

Measured Capacitance	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
1 pF	N/A	8.50%	2.05%	0.57%	N/A
10 pF	N/A	0.96%	0.23%	0.21%	1.00%
100 pF	N/A	0.29%	0.20%	0.17%	1.00%
1 nF	0.72%	0.17%	0.12%	0.18%	2.00%
10 nF	0.28%	0.12%	0.13%	0.27%	2.00%
100 nF	0.12%	0.13%	0.22%	1.16%	N/A
1 µF	0.17%	0.21%	N/A	N/A	N/A

S530 Low Current Parametric Test System Specifications

CURRENT SOURCE SPECIFICATIONS

Current Range	Max. Voltage	MEASURE Resolution	MEASURE Accuracy
10 A	5 V	200 μA	0.50% + 40.0 mA + 0.8 pA/V
1.5 A	20 V	50 μA	0.06% + 4.0 mA + 0.8 pA/V
1 A	200 V	20 μA	0.05% + 1.8 mA + 0.8 pA/V
100 mA	200 V	2 μA	0.03% + 30.0 μA + 0.8 pA/V
10 mA	200 V	200 nA	0.03% + 6.0 μA + 0.8 pA/V
1 mA	200 V	20 nA	0.03% + 300.0 nA + 0.8 pA/V
100 μA	200 V	2 nA	0.03% + 60.0 nA + 0.8 pA/V
10 μA	200 V	200 pA	0.03% + 5.0 nA + 0.8 pA/V
1 μA	200 V	20 pA	0.03% + 800.5 pA + 0.8 pA/V
100 nA	200 V	2 pA	0.06% + 100.5 pA + 0.8 pA/V
10 nA	200 V	200 fA	0.15% + 5.5 pA + 0.8 pA/V
1 nA	200 V	20 fA	0.15% + 2.5 pA + 0.8 pA/V

CURRENT MEASURE SPECIFICATIONS

Current Range	Max. Voltage	MEASURE Resolution	MEASURE Accuracy
10 A	5 V	100 μA	0.40% + 25.0 mA + 0.76 pA/V
1.5 A	20 V	10 μA	0.05% + 3.5 mA + 0.76 pA/V
1 A	200 V	10 μA	0.03% + 1.5 mA + 0.76 pA/V
100 mA	200 V	1 μA	0.02% + 20.0 μA + 0.76 pA/V
10 mA	200 V	100 μA	0.02% + 2.5 μA + 0.76 pA/V
1 mA	200 V	10 nA	0.02% + 200.0 nA + 0.76 pA/V
100 μA	200 V	1 nA	0.02% + 25.0 nA + 0.76 pA/V
10 μA	200 V	100 nA	0.03% + 1.5 nA + 0.76 pA/V
1 μA	200 V	10 pA	0.03% + 500.5 pA + 0.76 pA/V
100 nA	200 V	1 pA	0.06% + 100.5 pA + 0.76 pA/V
10 nA	200 V	100 fA	0.15% + 3.5 pA + 0.76 pA/V
1 nA	200 V	10 fA	0.15% + 750.0 fA + 0.76 pA/V
100 pA	200 V	1 fA	0.15% + 630.0 fA + 0.76 pA/V

VOLTAGE SOURCE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE Resolution	SOURCE Accuracy
200 V	1 A	5 mV	0.02% + 50.13 mV + 1.6 V/A
20 V	1.5 A	500 μV	0.02% + 5.13 mV + 1.6 V/A
2 V	10 A	50 μV	0.02% + 730 μV + 1.6 V/A
200 mV	10 A	5 μV	0.02% + 505 μV + 1.6 V/A

VOLTAGE MEASURE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE Resolution	SOURCE Accuracy
200 V	1 A	1 mV	0.015% + 50.13 mV + 1.6 V/A
20 V	1.5 A	100 μV	0.015% + 5.13 mV + 1.6 V/A
2 V	10 A	10 μV	0.02 % + 480 μV + 1.6 V/A
200 mV	10 A	1 μV	0.015% + 355 μV + 1.6 V/A

C-V MEASUREMENT SPECIFICATIONS

4210-CVU TYPICAL ACCURACY WITH 3M CABLES

Measured Capacitance	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
1 pF	N/A	8.50%	2.05%	0.57%	N/A
10 pF	N/A	0.96%	0.23%	0.21%	1.00%
100 pF	N/A	0.29%	0.20%	0.17%	1.00%
1 nF	0.72%	0.17%	0.12%	0.18%	2.00%
10 nF	0.28%	0.12%	0.13%	0.27%	2.00%
100 nF	0.12%	0.13%	0.22%	1.16%	N/A
1 μF	0.17%	0.21%	N/A	N/A	N/A

S530 High Voltage Parametric Test System Specifications

CURRENT SOURCE SPECIFICATIONS

Current Range	Max. Voltage	MEASURE Resolution	MEASURE Accuracy
10 A	5 V	200 μA	0.50% + 40.0 mA + 4 pA/V
1.5 A	20 V	50 μA	0.06% + 4.0 mA + 4 pA/V
1 A	200 V	20 μA	0.05% + 1.8 mA + 4 pA/V
100 mA	200 V	2 μA	0.03% + 30.0 μA + 4 pA/V
20 mA	1100 V	500 nA	0.05% + 4.0 μA + 4 pA/V
10 mA	200 V	200 nA	0.03% + 6.0 μA + 4 pA/V
1 mA	1100 V	50 nA	0.03% + 300.1 nA + 4 pA/V
100 μA	1100 V	5 nA	0.03% + 60.1 nA + 4 pA/V
10 μA	1100 V	500 pA	0.03% + 5.1 nA + 4 pA/V
1 μA	1100 V	50 pA	0.04% + 880.0 pA + 4 pA/V
100 nA	200 V	2 pA	0.06% + 180.0 pA + 4 pA/V

CURRENT MEASURE SPECIFICATIONS

Current Range	Max. Voltage	MEASURE Resolution	MEASURE Accuracy
10 A	5 V	100 μA	0.40% + 25.0 mA + 4.01 pA/V
1.5 A	20 V	10 μA	0.05% + 3.5 mA + 4.01 pA/V
1 A	200 V	10 μA	0.03% + 1.5 mA + 4.01 pA/V
100 mA	200 V	1 μA	0.02% + 20.0 μA + 4.01 pA/V
20 mA	1100 V	100 μA	0.04% + 1.2 μA + 4.01 pA/V
10 mA	200 V	100 μA	0.02% + 2.5 μA + 4.01 pA/V
1 mA	1100 V	10 nA	0.03% + 200.1 nA + 4.01 pA/V
100 μA	1100 V	1 nA	0.03% + 25.1 nA + 4.01 pA/V
10 μA	1100 V	100 nA	0.03% + 1.6 nA + 4.01 pA/V
1 μA	1100 V	10 pA	0.03% + 580.0 pA + 4.01 pA/V
100 nA	200 V	1 pA	0.06% + 180.0 pA + 4.01 pA/V

VOLTAGE SOURCE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE Resolution	SOURCE Accuracy
1000 V	0.021 A	50 mV	0.02% + 100.2 mV + 9.3 V/A
200 V	1 A	5 mV	0.02% + 50.1 mV + 9.3 V/A
20 V	1.5 A	500 μV	0.02% + 5.1 mV + 9.3 V/A
2 V	10 A	50 μV	0.02% + 680.0 μV + 9.3 V/A
200 mV	10 A	5 μV	0.02% + 680.0 μV + 9.3 V/A

VOLTAGE MEASURE SPECIFICATIONS

Voltage Range	Max. Current	SOURCE Resolution	SOURCE Accuracy
1000 V	0.021 A	10 mV	0.015% + 50.2 mV + 9.3 V/A
200 V	1 A	1 mV	0.015% + 50.0 mV + 9.3 V/A
20 V	1.5 A	100 μV	0.015% + 5.0 mV + 9.3 V/A
2 V	10 A	10 μV	0.02 % + 374.0 μV + 9.3 V/A
200 mV	10 A	1 μV	0.015% + 324.0 μV + 9.3 V/A

C-V MEASUREMENT SPECIFICATIONS

4210-CVU TYPICAL ACCURACY WITH 3M CABLE

Measured Capacitance	1 kHz	10 kHz	100 kHz	1 MHz	10 MHz
1 pF	N/A	8.50%	2.05%	0.57%	N/A
10 pF	N/A	0.96%	0.23%	0.21%	1.00%
100 pF	N/A	0.29%	0.20%	0.17%	1.00%
1 nF	0.72%	0.17%	0.12%	0.18%	2.00%
10 nF	0.28%	0.12%	0.13%	0.27%	2.00%
100 nF	0.12%	0.13%	0.22%	1.16%	N/A
1 μF	0.17%	0.21%	N/A	N/A	N/A

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

- **Intuitive, point-and-click Windows®-based environment**
- **Unique Remote PreAmps extend the resolution of SMUs to 0.1fA**
- **C-V instrument makes C-V measurements as easy as DC I-V**
- **Pulse and pulse I-V capabilities for advanced semiconductor testing**
- **Scope card provides integrated scope and pulse measure functionality**
- **Self-contained PC provides fast test setup, powerful data analysis, graphing and printing, and on-board mass storage of test results**
- **Unique browser-style Project Navigator organizes tests by device type, allows access to multiple tests, and provides test sequencing and looping control**
- **Built-in stress/measure, looping, and data analysis for point-and-click reliability testing, including five JEDEC-compliant sample tests**
- **Integrated support for a variety of LCR meters, Keithley switch matrix configurations, and both Keithley Series 3400 and Agilent 81110 pulse generators**
- **Includes software drivers for leading analytical probers**

The easy-to-use Model 4200-SCS Semiconductor Characterization System performs lab grade DC I-V, C-V, and pulse device characterization, real-time plotting, and analysis with high precision and sub-femtoamp resolution. The 4200-SCS offers the most advanced capabilities available in a fully integrated characterization system, including a complete, embedded PC with Windows operating system and mass storage. Its self-documenting, point-and-click interface speeds and simplifies the process of taking data, so users can begin analyzing their results sooner. Additional features enable stress-measure capabilities suitable for a variety of reliability tests.

The powerful test library management tools included allow standardizing test methods and extractions to ensure consistent test results. The Model 4200-SCS offers tremendous flexibility with hardware options that include four different switch matrix configurations and a variety of LCR meters and pulse generators. Customer support packages are also available, including applications support, calibration, repair, and training.

A Total System Solution

The Model 4200-SCS provides a total system solution for DC I-V, C-V, and pulse characterization and reliability testing of semiconductor devices, test structures, and materials. This advanced parameter analyzer provides intuitive and sophisticated capabilities for a wide variety of semiconductor tests. The Model 4200-SCS combines unprecedented measurement speed and accuracy with an embedded Windows-based PC and the Keithley Interactive Test Environment (KITE) to provide a powerful single-box solution. KITE allows users to gain familiarity quickly with tasks such as managing tests and results and generating reports. Sophisticated and simple test sequencing and external instrument drivers simplify performing automated device and wafer testing with combined I-V, C-V, and pulse measurements. The exceptional low current performance of the Model 4200-SCS makes it the perfect solution for research studies of single electron transistors (SETs), molecular electronic devices, and other nanoelectronic devices that require I-V characterization. The Model 4200-SCS can be used to make four-probe van der Pauw resistivity and Hall voltage measurements, eliminating the need for a switch matrix and user-written code. With remote preamps added, resistances well above $10^{12}\Omega$ can be measured.

The Model 4200-SCS is modular and configurable. The system supports up to nine Source-Measure Units (SMUs) in any combination of medium and high power SMUs. A high-power SMU provides 1A/20W capability. Also available are the C-V option and the pulse and scope pulse measure modules. The C-V option includes the C-V Power package, which supports high power C-V measurements up to 400V and 300mA, up to 60V of differential DC bias, and quasistatic C-V measurements.

Applications Packages

By combining specific sets of hardware with Keithley-developed code and interconnect, a variety of application packages are offered that expand the Model 4200-SCS's pulsed testing capabilities. The 4200-PIV-A package performs charge trapping and isothermal testing for leading-edge CMOS research. The 4200-PIV-Q package is designed for higher power pulse testing in III-V, LDMOS, and other higher frequency and higher power FET devices. The 4200-FLASH package tests floating gate FLASH and embedded NVM memory.

Extended Measurement Resolution

An optional Remote PreAmp, the Model 4200-PA, extends the system's measurement resolution from 100fA to 0.1fA by effectively adding five current ranges to either SMU model. The PreAmp module is fully integrated with the system; to the user, the SMU simply appears to have additional measurement resolution available. The Remote PreAmp is shipped installed on the back panel of the Model 4200-SCS for local operation. This installation allows for standard cabling to a prober, test fixture, or switch matrix. Users can remove the PreAmp from the back panel and place it in a remote location (such as in a light-tight enclosure or on the prober platen) to eliminate measurement problems due to long cables. Platen mounts and triax panel mount accessories are available.

KTE Interactive Software Tools

KTE Interactive includes four software tools for operating and maintaining the Model 4200-SCS in addition to the Windows operating system:

- The Keithley Interactive Test Environment (KITE) is the Model 4200-SCS Windows device characterization application. It provides advanced test definition, parameter analysis and graphing, and automation capabilities required for modern semiconductor characterization. Built-in looping, stress-measure capabilities, and data management enable many types of reliability testing.

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

Ordering Information

4200-SCS/F
Flat Panel Display

4200-SCS/C
Composite Front Bezel; requires an external SVGA display

Accessories Supplied

Reference and User Manual on CD-ROM

236-ILC-3 Interlock Cable, 3m

Note: All 4200-SCS systems and instrument options are supplied with required cables of 2m length.

Additional Instrumentation

4210-CVU
Integrated C-V Instrument

4205-PG2
Dual-Channel Pulse Generator

4200-SCP2
Dual-Channel Digital Oscilloscope

4200-SCP2HR
High Resolution, Dual Channel Integrated Oscilloscope

4200-PIV-A
Complete Pulse I-V Package for leading edge CMOS

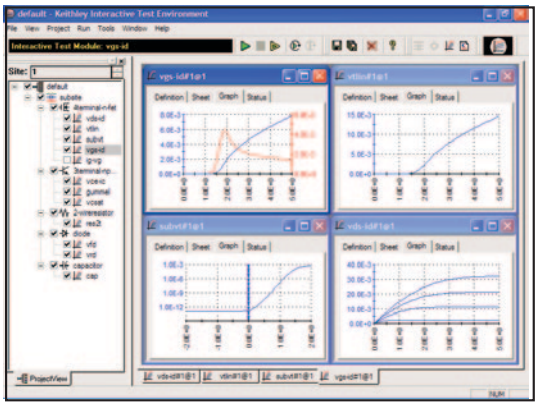
4200-PIV-Q
Pulse I-V Package with Q point and dual-channel pulsing

4200-FLASH
Non-volatile Memory Test Package

4200-SCP2-ACC
Optional Scope Probe

Related Products

707A	Semiconductor Switching Matrix Mainframe
708A	Single Slot Switching Matrix Mainframe
4200-SCP2-ACC	70MHz Scope Probe
7072	8×12 Semiconductor Matrix Card
7072-HV	8×12 High Voltage Semiconductor Matrix Card
7174A	8×12 High Speed, Low Current Matrix



The Keithley Interactive Test Environment (KITE) is designed to let users understand device behavior quickly. When running a test sequence, users can view results and plots for completed tests while the sequence is still running. As shown here, multiple plots can be viewed at the same time to get a complete picture of device performance.

- Keithley User Library Tool (KULT)—Allows test engineers to integrate custom algorithms into KITE using Model 4200-SCS or external instruments.
- Keithley Configuration Utility (KCON)—Allows test engineers to define the configuration of GPIB instruments, switch matrices, and analytical probers connected to the Model 4200-SCS. It also provides system diagnostics functions.
- Keithley External Control Interface (KXCI)—The Model 4200-SCS application for controlling the Model 4200-SCS from an external computer via the GPIB bus.

KITE Projects

A project is a collection of related tests, organized in a hierarchy that parallels the physical layout of the devices on a wafer. KITE operates on projects using an interface called the project navigator. The project navigator simplifies organizing test files, test execution, and test sequencing. The project navigator organizes tests into a logical hierarchy presented in a browser style format. This structure allows users to define projects around wafer testing:

- The project level organizes subsites and controls wafer looping execution.
- The subsite level organizes devices and controls subsite test sequencing.
- The device level organizes test modules, manages test module libraries, and controls device test sequencing.
- The test module level performs tests, analyzes data, and plots results.

Prober Control

Keithley provides integrated prober control for supported analytical probers when test sequencing is executed on a user-programmable number of probe sites on a wafer. Contact the factory for a list of supported analytical probers. A manual prober mode prompts the operator to perform prober operations during the test sequence.

Test Sequencing

KITE provides "point and click" test sequencing on a device, a group of devices (subsite, module, or test element group), or a user-programmable number of probe sites on a wafer. One sequence can include DC I-V, C-V, and pulse tests.

Keithley User Library Tool (KULT)

The Keithley User Library Tool is an open environment that provides you with the flexibility to create your own custom routines as well as use existing Keithley and third-party C-language subroutine libraries. User library modules are accessed in KITE through User Test Modules. Factory supplied libraries provide up and running capability for supported instruments. Users can edit and compile subroutines, then integrate libraries of subroutines with KITE, allowing the Model 4200-SCS to control an entire test rack from a single user interface. KULT is derived from the Keithley S600 and Series S400 Parametric Test Systems. This simplifies migration of test libraries between the Model 4200-SCS and Keithley parametric test systems.

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

4210-CVU C-V Instrument

C-V measurements are as easy to perform as I-V measurements with the integrated C-V instrument. This optional capacitance-voltage instrument performs capacitance measurements from femtoFarads (fF) to nanoFards (nF) at frequencies from 1kHz to 10MHz. The C-V option includes a new Power package that supports:

- High power C-V measurements up to 400V (200V per device terminal)—for testing high power devices, such as MEMs, LDMOS devices, displays, etc.
- DC currents up to 300mA—for measuring capacitance when a transistor is on.

The innovative design of the 4200-SCS has eight patents pending and is complemented by the broadest C-V test and analysis library available in any commercial C-V measurement solution. It also supplies diagnostic tools that ensure the validity of your C-V test results.

With this system, you can configure linear or custom C-V and C-f sweeps with up to 4096 data points. In addition, through the open environment of the 4200-SCS, you can modify any of the included tests, such as:

- C-V, C-t, and C-f measurements and analysis of:
  - New! Complete solar cell libraries, including DLCP
  - High and low κ structures
  - MOSFETs
  - BJTs
  - Diodes
  - III-V compound devices
  - Carbon nanotube (CNT) devices
- Doping profiles, T_{OX}, and carrier lifetime tests
- Junction, pin-to-pin, and interconnect capacitance measurements

The C-V instrument integrates directly into the Model 4200-SCS chassis. It can be purchased as an upgrade to existing systems or as an option for new systems.

4210-CVU: Selected C-V Specifications

MEASUREMENT FUNCTIONS

MEASUREMENT PARAMETERS: Cp-G, Cp-D, Cs-Rs, Cs-D, R-jX, Z-theta.
RANGING: Auto and fixed.

TEST SIGNAL

FREQUENCY RANGE: 1kHz to 10MHz.
SOURCE FREQUENCY ACCURACY: ±0.1%.
SIGNAL OUTPUT LEVEL RANGE: 10mV rms to 100mV rms.
RESOLUTION: 1mV rms.
ACCURACY: ±(10.0% + 1mV rms) unloaded (at rear panel).

DC BIAS FUNCTION

DC VOLTAGE BIAS RANGE: ±30V on both C-V HI and C-V LO (±60V differential).
RESOLUTION: 1.0mV.
ACCURACY: ±(0.5% + 5.0mV) unloaded.
MAXIMUM DC CURRENT: 10mA.

SWEEP CHARACTERISTICS

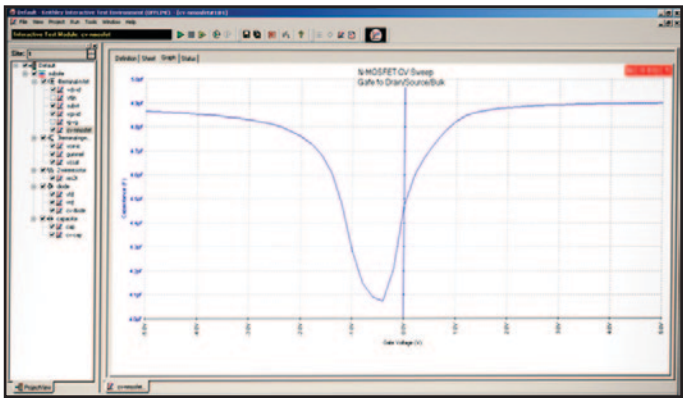
AVAILABLE SWEEP PARAMETERS: DC bias voltage, frequency, AC drive level.
SWEEP TYPE: Linear, Custom.
SWEEP DIRECTION: Up sweep, Down sweep.
NUMBER OF MEASUREMENT POINTS: 4096 points.

C-V POWER PACKAGE TYPICAL PERFORMANCE CHARACTERISTICS

MEASUREMENT PARAMETERS: Cp-Gp, DCV, timestamp.
RANGING: 1pF to 1nF.
MEASUREMENT TERMINALS: 2-wire SMA, with BNC adapters.
TEST SIGNAL: 100kHz to 10MHz, 10mV to 100mV.
DC VOLTAGE SOURCE: ±200V with 5mV resolution (±400V differential).
DC CURRENT: 100mA or 300mA maximum.
TYPICAL CP ACCURACY @ 1MHz: 1.0%.
DC CURRENT SENSITIVITY: 10nA/V.
SMU BIAS TERMINALS SUPPORTED: 4.

RAMP RATE QUASISTATIC C-V TYPICAL PERFORMANCE CHARACTERISTICS

MEASUREMENT PARAMETERS: Cp, DCV, timestamp.
RANGING: 1pF to 1nF.
MEASUREMENT TERMINALS: Triaxial guarded.
RAMP RATE: 0.1V/s to 1V/s.
DC VOLTAGE: ±200V.
TYPICAL CP ACCURACY: 5% at 1V/s ramp rate.



4200-SCS

Semiconductor Characterization System

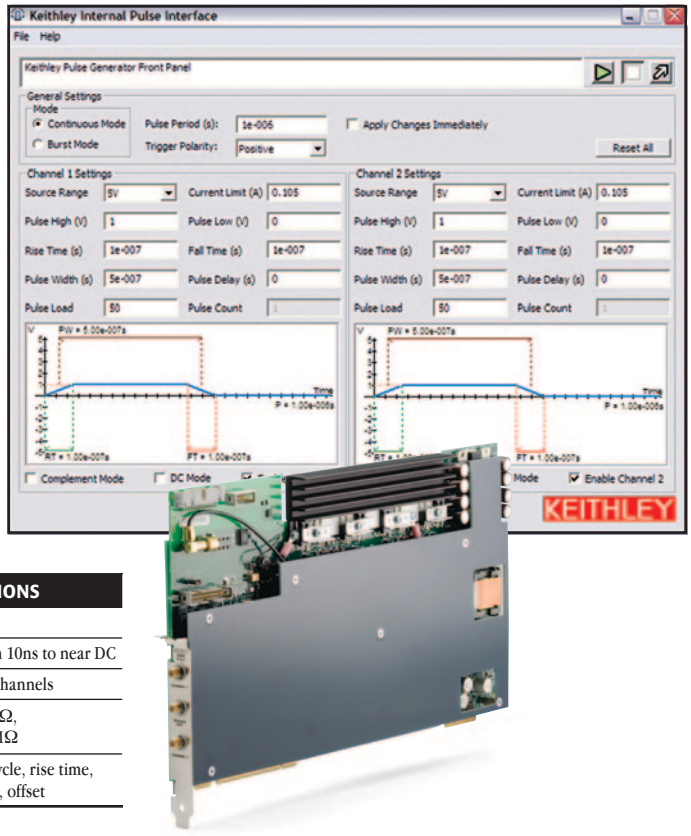
DC I-V, C-V, and Pulse in One Test Environment

Dual-Channel Pulse Generator

The optional, integrated dual-channel pulse generator adds pulsing to the Model 4200-SCS's DC source and measure capabilities. It supports voltage pulses as short as 10ns or up to ±20V (into 50Ω). Two pulse generators on one card provides you with the flexibility to apply pulses to two points on a DUT, such as the gate and the drain, simultaneously. The 4200-SCS can support up to four synchronized cards per system for eight pulse channels.

The 4205-PG2 supports two waveform generation modes in addition to the standard pulse mode. The Arbitrary Waveform mode can generate complex waveforms made up of up to 256K data points at clock speeds up to 25MHz. The Segment ARB™ mode (patent pending) simplifies creating, storing, and generating complex waveforms made from up to 1024 user-defined line segments. Each segment can have a different duration, allowing exceptional waveform generation flexibility.

Using a supplied User Test Module, it is simple to incorporate pulse generation into KITE test sequences. The pulse generator can also be used as a stand-alone pulse generator using the pulse generator's Window's GUI. This GUI can control a wide range of variables, including pulse frequency, duty cycle, rise/fall time, amplitude, offset, and the ability to trigger single pulses and/or pulse chains.



The dual-channel pulse generator has a wide range of uses. Typical applications include:

- Charge pumping to characterize interface state densities in MOSFET devices
- Using AC stress pulses of varying frequencies to simulate real-world AC signals applied to clocked devices
- Basic clock generation for test vectoring and failure analysis
- Digital triggering

The pulse generator can be purchased as an upgrade to existing systems (KTEI version 6.0 or above required) or as an option for new systems.

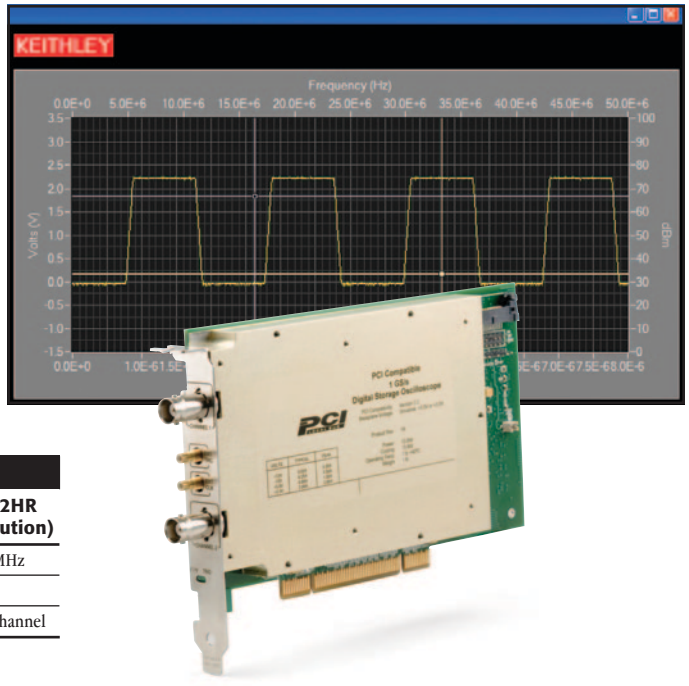
Key Pulse Generator SPECIFICATIONS

Frequency Range	1Hz–50MHz
Pulse Width	Programmable from 10ns to near DC
Channels	Dual independent channels
Pulse Amplitude Range	100mV–20V into 50Ω, 100mV–40V into 1MΩ
Programmable Parameters	Pulse width, duty cycle, rise time, fall time, amplitude, offset

Dual-Channel Digital Oscilloscope

The optional dual-channel digital oscilloscopes place more than the performance of a bench-top oscilloscope into your 4200-SCS. They also support time-domain measurements of pulse waveforms and monitor the reactions of devices under test to those pulses. Some of the features of these oscilloscopes include: a broad selection of acquisition modes, triggers, measurements, calculations, and up to four reference waveforms.

The dual-channel oscilloscopes integrate directly into the Model 4200-SCS chassis. Either can be purchased as an upgrade to existing systems (KTEI version 6.0 or above required) or as an option for new systems.



Key Oscilloscope SPECIFICATIONS

	4200-SCP2	4200-SCP2HR (High Resolution)
Bandwidth	DC to 750MHz	DC to 250MHz
Channels	2	2
Maximum Sample Rate	1.25GS/s per channel	200MS/s per channel

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

SERVICES AVAILABLE

4200-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4200-SCS*
4200-FLASH-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-FLASH-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4200-FLASH*
4200-PA-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-PIV-A-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-PIV-A-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4200-PIV-A*
4200-PIV-Q-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-PIV-Q-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4200-PIV-Q*
4200-SCP2-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4200-SCP2-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4200-SCP2*
4205-PG2-3Y-EW	1-year factory warranty extended to 3 years from date of shipment
4205-PG2-3Y-CAL	3 (Z540-1 compliant) calibrations within 3 years of purchase for Model 4205-PG2*
IMPL-4200	1-day on-site implementation of TRN-4200-1-C
TRN-4200-1-C	Course: Optimizing the 4200-SCS for Your Application

*Not available in all countries

Application Packages

Optional application packages combine specific sets of hardware, interconnect, and Keithley developed code. They are described in the following pages.

Application packages designed for specific needs

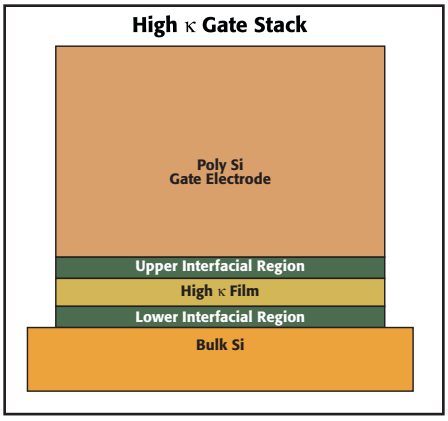
	4200-PIV-A	4200-PIV-Q	4200-FLASH
Description	For charge trapping and isothermal testing in lower technologies such as CMOS	For higher power pulse testing in III-V, LDMOS, and other higher frequency and higher power FET devices	For testing FLASH memory devices (NOR and NAND, including MLC technologies)
Device	FET	HEMT, FET	Floating gate FET
Technology	Advanced CMOS	III-V/LDMOS	NAND, NOR, nonvolatile memory
Source Method	Pulse gate, DC bias on drain	Dual pulse for gate and drain with quiescent point testing	Pulse gate, drain, source, and substrate
Measure Method	Pulse I-V and DC	Pulse I-V and DC	DC only
Measurements	Gate voltage, Drain voltage and current	Gate voltage and current, Drain voltage and current	Gate voltage and current, Drain voltage and current
Pulse Width Range[1]	40ns to 150ns	500ns to 999ms	250ns to 1s
Unique Capability	8-bit, 1 gigasample/s measure rate, good for advanced CMOS Pulse I-V testing and high speed single-pulse charge trapping	Dual-channel, quiescent point pulsing for scaled-down RF transistors	One multi-level pulse channel per DUT pin, integrated High Endurance Output Relay supports endurance testing of NAND and NOR

1. Full Width Half Maximum (FWHM)

4200-SCS

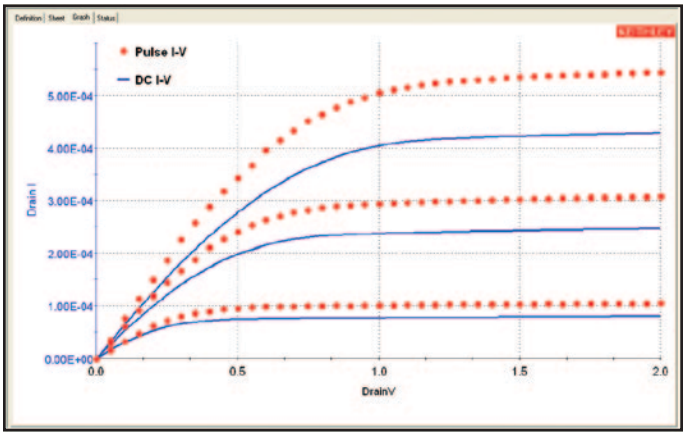
Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment



Pulse I-V measurement capabilities are increasingly critical for high κ gate stack characterization and isothermal testing of new devices.

To minimize the signal reflections due to poor impedance matching that often plague "do-it-yourself" pulse testing systems, Keithley's Pulse I-V package includes a system interconnect setup that provides AC/DC coupling to connect the pulse generator and the DC instrumentation.



Pulse testing can characterize a device with little to no isothermal degradation.

4200-PIV-A: Pulse I-V Solution Package

The 4200-PIV-A Pulse I-V package provides a turnkey pulse I-V solution. It is a comprehensive package of hardware and software, designed to integrate seamlessly with the Model 4200-SCS workstation. It combines the dual-channel pulse generator, dual-channel digital oscilloscope, specialized interconnect, and patented Pulse I-V software.

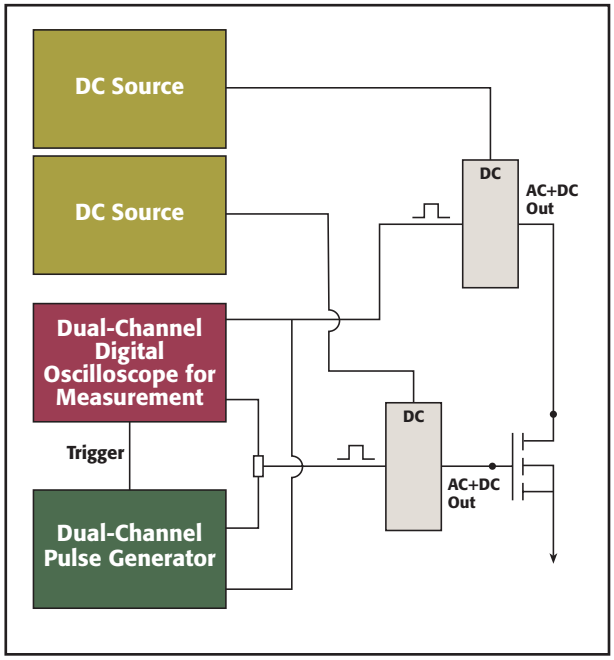
The Pulse I-V software controls sourcing (from the pulse generator) and data acquisition (from the oscilloscope) to automate a variety of Pulse I-V tests. Running in the Model 4200-SCS's proven interface, the Pulse I-V software provides instrument setup and control, data storage, and presentation. The innovative software includes both cable compensation and a solution to the load-line effect, producing pulsed-based I-V transistor curves, such as the V_{DS}-I_D family of curves and V_{GS}-I_D for voltage threshold extraction.

The Pulse I-V bundle allows the Model 4200-SCS to support a wide range of applications, such as charge trapping for high κ dielectric characterization, isothermal testing of devices and materials subject to self-heating effects, charge pumping, AC stress testing, clock generation, and mixed signal device testing.

The specialized interconnect solves most of the problems encountered in high speed pulse testing, such as:

- Combining pulse and DC sources to a single DUT pin to permit both DC and pulse characterization without recabling or switching
- Impedance matching for pulse integrity to minimize reflection
- Straightforward cabling and connection to the DUT for easy setup

NEW! 4200-MMPC-X Multi-Measurement Cable Set allows easy changeover from I-V to C-V to PIV



The Pulse I-V package includes everything needed to implement a turnkey system for pulsed I-V testing of leading-edge devices and materials. Pieces included in the package are:

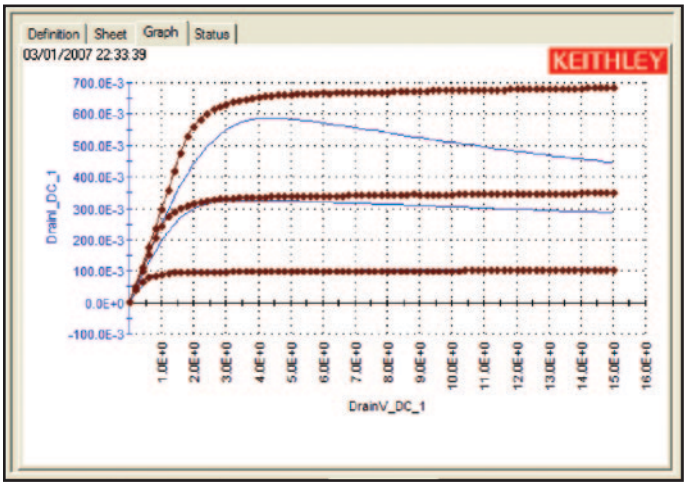
- **Integrated dual-channel pulse generator**
- **Dual-channel digital oscilloscope**
- **Pulse I-V control software (patent pending)**
- **Interconnect designed to minimize the signal reflections common to pulse I-V testing (patent pending)**
- **All required connectors and cables**
- **Sample projects for:**
  - **Pulse I-V isothermal testing of FinFETs, SOI devices, and other devices with self-heating problems**
  - **Charge-trap testing for high κ gate stack characterization**

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

4200-PIV-Q: Pulsed I-V, Q Point, Dual-Channel, Pulsing Package



The 4200-PIV-Q package is designed for quiescent point pulsing of scaled-down RF transistors, such as HEMT and FET devices in III-V or LDMOS technologies. It can be used for a variety of large signal tests on high frequency transistors as well as for investigation of dispersion phenomena and device performance at speed.

This package includes multiple 4205-PG2 pulse generators and the 4200-SCP2HR oscilloscope and offers capabilities such as dual-channel pulsing (for pulsing on both the gate and the drain simultaneously), higher power pulsing than the 4200-PIV-A package, and pulsing from a non-zero quiescent point. Some of its features include:

- Elimination or characterization of thermal issues
- Ability to compare DC vs. Pulse for dispersion effects
- Software and interconnect for Quiescent point testing
- Test code for typical characterization tests
- Pulse widths adjustable from 500ns to near-DC (999ms)
- Ability to use the same setup for performing true DC tests without re-cabling the system
- Dual-channel pulse I-V testing for III-V and LDMOS:
  - Pulse voltage on gate and drain
  - Measure gate current, drain voltage, and current
  - ±20V pulses for the gate, ±38V pulses for the drain

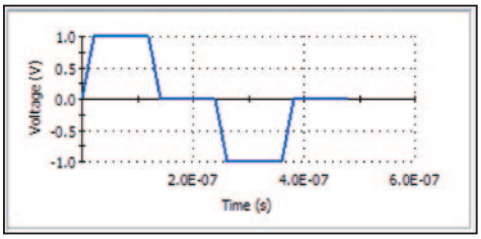
Some of the specific tests are:

- V_{DS}–I_D: Both pulse and DC
- V_{GS}–I_D: Both pulse and DC
- Single-pulse scope view, which is useful for setup validation, pulse width optimization, and prototyping of novel pulse tests

4200-FLASH: Non-Volatile Memory Test Package

	Start (V)	Stop (V)	Time (s)	Trig (1/0)	SSR (1/0)
1	0	1	2.00E-08	1	1
2	1	1	1.00E-07	1	1
3	1	0	2.00E-08	0	0
4	0	0	1.00E-07	0	0

Easy setup for program/erase cycles



Typical NOR FLASH gate program/erase cycle

The optional 4200-FLASH application package tests single FLASH memory cells or small arrays quickly and easily using four (or up to eight optional) independent, but synchronized, multi-level pulse channels. It includes all the code and interconnect needed to perform a standard set of FLASH memory tests for NAND and NOR technologies, such as characterization, endurance, and disturb tests. It also supplies the higher pulse voltages that are important for MLC technologies.

4200-FLASH takes advantage of the new patent-pending Segment ARB™ waveform generator, which makes typical FLASH program/erase cycles simple to set up and run on a single pulse channel. It also combines the Segment ARB waveform generator with the in-line high endurance relay for Endurance tests. The tight control of this output relay can shorten lifetime test times significantly.

4200-FLASH provides four (or up to eight optional) channels of multi-level pulse that support:

- ±40V pulsing into a high impedance pin (±20V into 50Ω)
- High endurance output relay which provides fast open/close for pin isolation during an erase pulse
- Pulse widths from 200ns to 1s
- Up to 25 pulse levels (100 pulse segments)

NEW! 4200-MMPC-X Multi-Measurement Cable Set allows easy changeover from I-V to C-V to PIV

Other 4200-FLASH features include:

- Code for performing tests on floating gate FLASH and embedded NVM memory
- Performs linear or log-based DC measurements for Disturb and Endurance tests based on the number of program/erase cycles
- Controls switching between program/erase and DC characterization without using a switch matrix
- Full support for multi-level cell technology with up to ±40V pulsing on the gate
- Solid state relays with high endurance output relay (HEOR) capability for pin disconnect within Program+Erase waveform

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

OPTIONAL INSTRUMENTATION AND ACCESSORIES

OPTIONAL INSTRUMENTATION

4210-CVU	Integrated C-V Instrument
4200-SMU	Medium Power Source-Measure Unit for 4200-SCS. 100mA to 100fA, 200V to 1μV, 2 Watt
4210-SMU	High Power Source-Measure Unit for 4200-SCS. 1A to 100fA, 200V to 1μV, 20 Watt
4200-PA	Remote PreAmp Option for 4200-SMU and 4210-SMU, extends SMU to 0.1fA resolution
4205-PG2	Dual-Channel Pulse Generator
4200-SCP2	Dual-Channel Integrated Oscilloscope
4200-SCP2HR	High Resolution, Dual-Channel Integrated Oscilloscope
4200-SCP2-ACC	Optional Scope Probe

OPTIONAL APPLICATION PACKAGES

4200-PIV-A	Complete Pulse I-V Package for leading edge CMOS
4200-PIV-Q	Pulse I-V Package with Q point and dual-channel pulsing
4200-FLASH	Non-volatile Memory Test Package

OPTIONAL SWITCHING SYSTEMS AND CARDS

SYSTEMS

707A	6-Slot Switching Matrix Mainframe
708A	Single-Slot Switching Matrix Mainframe

CARDS

7071	8×12, General Purpose, Matrix Card
7071-4	Dual 4×12, General Purpose, Matrix Card
7072	8×12, Semiconductor Matrix Card
7072-HV	8×12, High Voltage, Semiconductor Matrix Card
7075	Eight 1×12, Two-Pole, Multiplexer Card
7173-50	4×12, Two-Pole, High Frequency, Matrix Card
7174A	8×12, High Speed, Low Leakage Current, Matrix Card

OPTIONAL ACCESSORIES

CONNECTORS AND ADAPTERS

CS-565	Female BNC to Female BNC Adapter
CS-701	BNC Tee Adapter (female, male, female)
CS-719	3-lug Triax Jack Receptacle
CS-1247	SMA Female to BNC Male Adapter
CS-1249	SMA Female to SMB Plug Adapter
CS-1251	BNC Female to SMB Plug Adapter
CS-1252	SMA Male to BNC Female Adapter
CS-1281	SMA Female to SMA Female Adapter
CS-1382	Female MMBX Jack to Male SMA Plug Adapter
CS-1390	Male LEMO Triax to Female SMA Adapter
CS-1391	SMA Tee Adapter (female, male, female)
CS-1479	SMA Male to BNC Male Adapter
237-BAN-3A	Triax Cable Center Conductor terminated in a safety banana plug
237-BNC-TRX	Male BNC to 3-lug Female Triax Adapter
237-TRX-BAR	3-lug Triax Barrel Adapter (female to female)
237-TRX-T	3-slot Male to Dual 3-lug Female Triax Tee Adapter
7078-TRX-BNC	3-Slot Male Triax to BNC Adapter
7078-TRX-GND	3-Slot Male Triax to Female BNC Connector (guards removed)

CABLES AND CABLE SETS

NOTE: All 4200-SCS systems and instrument options are supplied with required cables, 2m (6.5 ft.) length.

CA-19-2	BNC to BNC Cable, 1.5m
CA-404B	SMA to SMA Coaxial Cable, 2m
CA-405B	SMA to SMA Coaxial Cable, 15cm
CA-406B	SMA to SMA Coaxial Cable, 33cm
CA-446A	SMA to SMA Coaxial Cable, 3m
CA-447A	SMA to SMA Coaxial Cable, 1.5m
CA-451A	SMA to SMA Coaxial Cable, 10.8cm
CA-452A	SMA to SMA Coaxial Cable, 20.4cm
236-ILC-3	Safety Interlock Cable, 3m
237-ALG-2	Low Noise Triax Input Cable terminated with 3 alligator clips, 2m
4210-MMPC-C	Multi-Measurement (I-V, C-V, Pulse) Prober Cable Kit for Cascade Microtech 12000 prober series
4210-MMPC-S	Multi-Measurement (I-V, C-V, Pulse) Prober Cable Kit for SUSS MicroTec PA200/300 prober series
4200-MTRX-*	Ultra Low Noise SMU Triax Cable: 1m, 2m, and 3m options
4200-PRB-C	SMA to SSMC Y Cable with local ground
4200-RPC-*	Remote PreAmp Cable: 0.3m, 2m, 3m, 6m options
4200-TRX-*	Ultra Low Noise PreAmp Triax Cable: 0.3m, 2m, 3m options
7007-1	Double-Shielded Premium GPIB Cable, 1m
7007-2	Double-Shielded Premium GPIB Cable, 2m

FIXTURES

8101-4TRX	4-Pin Transistor Fixture
8101-PIV	Pulse I-V Demo Fixture
LR8028	Component Test Fixture

CABINET MOUNTING ACCESSORIES

4200-RM	Fixed Cabinet Mount Kit

REMOTE PREAMP MOUNTING ACCESSORIES

4200-MAG-BASE	Magnetic Base for mounting 4200-PA on a probe platen
4200-TMB	Triaxial Mounting Bracket for mounting 4200-PA on a triaxial mounting panel
4200-VAC-BASE	Vacuum Base for mounting 4200-PA on a prober platen

COMPUTER ACCESSORIES

4200-MOUSE	Microsoft Ambidextrous 2 Button Mouse (Note: A pointing device is integrated with the 4200-SCS keyboard.)

SOFTWARE

ACS-BASIC	Component Characterization Software

DRIVERS

4200ICCAP-6.0	IC-CAP Driver and Source Code for 4200-SCS: UNIX/Windows

OTHER ACCESSORIES

EM-50A	Modified Power Splitter
TL-24	SMA Torque Wrench
4200-CART	Roll-Around Cart for 4200-SCS
4200-CASE	Transport Case for 4200-SCS
4200-MAN	Printed Manual Set

ADAPTER, CABLE, AND STABILIZER KITS

4200-CVU-PWR	CVU Power Package for ±200V C-V
4200-CVU-PROBER-KIT	Accessory Kit for connection to popular analytical probers
4200-Q-STBL-KIT	Addresses oscillation when performing pulse I-V tests on RF transistors

SUPPLIED ACCESSORIES

ACCESSORIES SUPPLIED WITH EACH MODEL 4210-CVU:

CA-447A	SMA Cables, male to male, 100Ω, 1.5m (5 ft.) (4)
CS-1247	Female SMA to Male BNC Adapters (4)
CS-701	BNC Tee Adapters (2)
TL-24	SMA Torque Wrench

ACCESSORIES SUPPLIED WITH EACH MODEL 4200-SMU OR 4210-SMU:

4200-MTRX-2	Two Ultra Low Noise SMU Triax Cables, 2m (6.6 ft). Not included with SMUs configured with a 4200-PA Remote PreAmp.
4200-TRX-2	Ultra Low Noise PreAmp Triax Cable, 2m (6.6 ft). Two supplied for Ground Unit. Two supplied in replacement of 4200-MTRX-2 cables for each SMU configured with a 4200-PA.
4200-RPC-2	Remote PreAmp Cable, 2m (6.6 ft). One supplied for each PreAmp.
236-ILC-3	Interlock Cable, 3m (10 ft)
Line Cord	NEMA 5-15P for 100-115VAC or CEE 7/7 (Continental European) for 240VAC

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

DC SMU CURRENT SPECIFICATIONS

		CURRENT RANGE[1]	MAX. VOLTAGE	MEASURE		SOURCE	
				Resolution[3]	Accuracy ±(% rdg + amps)	Resolution[3]	Accuracy ±(% rdg + amps)
4210-SMU[2] High Power SMU		1 A	21 V	1 μA	0.100% + 200 μA	50 μA	0.100% + 350 μA
		100 mA	210 V	100 nA	0.045% + 3 μA	5 μA	0.050% + 15 μA
	4200-SMU[2] Medium Power SMU	100 mA	21 V	100 nA	0.045% + 3 μA	5 μA	0.050% + 15 μA
		10 mA	210 V	10 nA	0.037% + 300 nA	500 nA	0.042% + 1.5 μA
		1 mA	210 V	1 nA	0.035% + 30 nA	50 nA	0.040% + 150 nA
		100 μA	210 V	100 pA	0.033% + 3 nA	5 nA	0.038% + 15 nA
		10 μA	210 V	10 pA	0.050% + 600 pA	500 pA	0.060% + 1.5 nA
		1 μA	210 V	1 pA	0.050% + 100 pA	50 pA	0.060% + 200 pA
		100 nA	210 V	100 fA	0.050% + 30 pA	5 pA	0.060% + 30 pA
4200-SMU and 4210-SMU with optional 4200-PA PreAmp		10 nA	210 V	10 fA	0.050% + 1 pA	500 fA	0.060% + 3 pA
		1 nA	210 V	3 fA	0.050% + 100 fA	50 fA	0.060% + 300 fA
		100 pA	210 V	1 fA	0.100% + 30 fA	15 fA	0.100% + 80 fA
		10 pA	210 V	0.3 fA	0.500% + 15 fA	5 fA	0.500% + 50 fA
		1 pA	210 V	100 aA	1.000% + 10 fA	1.5 fA	1.000% + 40 fA

VOLTAGE COMPLIANCE: Bipolar limits set with a single value between full scale and 10% of selected voltage range.

DC SMU VOLTAGE SPECIFICATIONS

VOLTAGE RANGE[1]	MAX. CURRENT		MEASURE		SOURCE	
	4200-SMU	4210-SMU	Resolution[3]	Accuracy ±(% rdg + volts)	Resolution[3]	Accuracy ±(% rdg + volts)
200 V[4]	10.5 mA	105 mA	200 μV	0.015% + 3 mV	5 mV	0.02% + 15 mV
20 V	105 mA	1.05 A	20 μV	0.01 % + 1 mV	500 μV	0.02% + 1.5 mV
2 V	105 mA	1.05 A	2 μV	0.012% + 150 μV	50 μV	0.02% + 300 μV
200 mV	105 mA	1.05 A	1 μV	0.012% + 100 μV	5 μV	0.02% + 150 μV

CURRENT COMPLIANCE: Bipolar limits set with a single value between full scale and 10% of selected current range.

SPECIFICATION CONDITIONS

Specifications are the performance standards against which the Models 4200-SMU, 4210-SMU, and 4200-PA are tested. The measurement and source accuracy are specified at the termination of the supplied cables.

- 23°C ±5°C, within 1 year of calibration, RH between 5% and 60%, after 30 minutes of warm-up.
- Speed set to NORMAL.
- Guarded Kelvin connection.
- ±1°C and 24 hours from ACAL.

NOTES

1. All ranges extend to 105% of full scale.
2. Specifications apply on these ranges with or without a 4200-PA.
3. Specified resolution is limited by fundamental noise limits. Measured resolution is 6½ digits on each range. Source resolution is 4½ digits on each range.
4. Interlock must be engaged to use the 200V range.

Supplemental DC SMU Information

Supplemental information is not warranted but provides useful information about the Models 4200-SMU, 4210-SMU, and 4200-PA.

COMPLIANCE ACCURACY:
Voltage compliance equals the voltage source specifications. Current compliance equals the current source specifications.

OVERSHOOT: <0.1% typical.
Voltage: Full scale step, resistive load, and 10mA range.
Current: 1mA step, R_L = 10kΩ, 20V range.

RANGE CHANGE TRANSIENT:
Voltage Ranging: <200mV.
Current Ranging: <200mV.

ACCURACY SPECIFICATIONS: Accuracy specifications are multiplied by one of the following factors, depending upon the ambient temperature and humidity.

Temperature	% Relative Humidity 5–60	60–80
10°–18°C	×3	×3
18°–28°C	×1	×3
28°–40°C	×3	×5

REMOTE SENSE: <10Ω in series with FORCE terminal not to exceed a 5V difference between FORCE and SENSE terminals. ±30V maximum between COMMON and SENSE LO.

MAXIMUM LOAD CAPACITANCE: 10nF.

MAXIMUM GUARD OFFSET VOLTAGE: 3mV from FORCE.

GUARD OUTPUT IMPEDANCE: 100kΩ.

MAXIMUM GUARD CAPACITANCE: 1500pF.

MAXIMUM SHIELD CAPACITANCE: 3300pF.

4200-SMU and 4210-SMU SHUNT RESISTANCE (FORCE to COMMON): $>10^{12}$Ω (100nA–1μA ranges).

4200-PA SHUNT RESISTANCE (FORCE to COMMON): $>10^{16}$Ω (1pA and 10pA ranges), $>10^{13}$Ω (100pA–100nA ranges).

OUTPUT TERMINAL CONNECTION: Dual triaxial connectors for 4200-PA, dual mini-triaxial connectors for 4200-SMU and 4210-SMU.

NOISE CHARACTERISTICS (typical):
Voltage Source (rms): 0.01% of output range.
Current Source (rms): 0.1% of output range.
Voltage Measure (p-p): 0.02% of measurement range.
Current Measure (p-p): 0.2% of measurement range.

MAXIMUM SLEW RATE: 0.2V/μs.

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

Additional DC SMU Specifications

MAX. OUTPUT POWER: 22 watts for 4210-SMU and 2.2 watts for 4200-SMU (both are four-quadrant source/sink operation).

DC FLOATING VOLTAGE: COMMON can be floated ±32 volts from chassis ground.

VOLTAGE MONITOR (SMU in VMU mode)

Voltage Range	Measure Resolution	Measure Accuracy ±(%rdg + volts)
200 V	200 μV	0.015% + 3 mV
20 V	20 μV	0.01% + 1 mV
2 V	2 μV	0.012% + 110 μV
200 mV	1 μV	0.012% + 80 μV

INPUT IMPEDANCE: >10^{15}Ω.
INPUT LEAKAGE CURRENT: <30pA.
MEASUREMENT NOISE: 0.02% of measurement range (rms).

DIFFERENTIAL VOLTAGE MONITOR

Differential Voltage Monitor is available by measuring with two SMUs in VMU mode or by using the low sense terminal provided with each SMU.

GROUND UNIT

Voltage error when using the ground unit is included in the 4200-SMU, 4210-SMU, and 4200-PA specifications. No additional errors are introduced when using the ground unit.

OUTPUT TERMINAL CONNECTION: Dual triaxial, 5-way binding post.

MAXIMUM CURRENT: 2.6A using dual triaxial connection; 8.5A using 5-way binding posts.

LOAD CAPACITANCE: No limit.

CABLE RESISTANCE: FORCE ≤1Ω, SENSE ≤10Ω.

GENERAL

TEMPERATURE RANGE
Operating: +10° to +40°C.
Storage: –15° to +60°C.

HUMIDITY RANGE
Operating: 5% to 80% RH, non-condensing.
Storage: 5% to 90% RH, non-condensing.

ALTITUDE
Operating: 0 to 2000m.
Storage: 0 to 4600m.

POWER REQUIREMENTS: 100V to 240V, 50 to 60Hz.

MAXIMUM VA: 1000VA.

REGULATORY COMPLIANCE:
Safety: Low Voltage Directive 73/23/EEC.
EMC: Directive 89/336/EEC.

DIMENSIONS: 43.6cm wide × 22.3cm high × 56.5cm deep (17⅝ in × 8¾ in × 22¼ in).

WEIGHT (approx.): 29.7kg (65.5 lbs) for typical configuration of four SMUs.

I/O PORTS: USB, SVGA, Printer, RS-232, GPIB, Ethernet, Mouse, Keyboard.

4205-PG2 Dual-Channel Pulse Generator Specifications [1, 2]

PULSE/LEVEL[3]

		High Speed	High Voltage
V_{OUT}	50 Ω into 50 Ω	–5V to +5V	–20V to +20V
V_{OUT}	50 Ω into 1 MΩ	–10V to +10V	–40V to +40V
Accuracy		±(3% + 50 mV)	±(3% + 100 mV)
Amplitude/Level	50 Ω into 50 Ω	1 mV	5 mV
Resolution	50 Ω into 1 MΩ	2 mV	10 mV
Output Connectors		SMA	SMA
Source Impedance		50Ω Nominal	50Ω Nominal
Accuracy		1%	1%
Short Circuit Current		±200 mA	±800 mA
Current into 50Ω Load (at full scale)		±100 mA typical	±400 mA typical
Baseline Noise		±(0.1% + 5 mV) RMS typical	±(0.1% + 5 mV) RMS typical
Overshoot/Pre-shoot/Ringing		±5% of amplitude ±20mV	±5% of amplitude ±80mV
Output Limit		Programmable limit to protect the DUT	

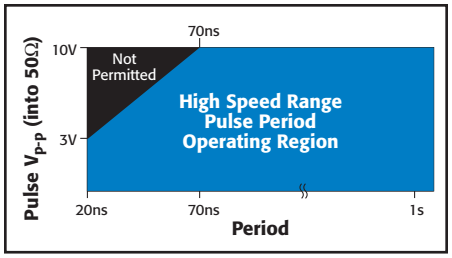


Figure 1. Permitted area of operation.

TIMING

		High Speed	High Voltage
Frequency Range		1 Hz to 50 MHz	1 Hz to 2 MHz
Timing Resolution		10 ns	10 ns
RMS Jitter (period, width)		0.01 % + 200 ps typical	0.01 % + 200 ps typical
Period Range		20 ns to 1 s	500 ns to 1 s
Accuracy		±1%	±1%
Pulse Width Range		10ns to (period – 10ns)	250ns to (period – 100ns)
Accuracy		±(3% + 200 ps)	±(3% + 5ns)
Programmable Transition Time (0–100%)		10 ns–33 ms	100 ns–33 ms
Transition Slew Rate[4]	Accuracy	±1% for transition time <100 ns	±1% for transition time <1 μs
	Linearity	3% for transition time <100 ns	3% for transition time <150 ns
Typical Minimum Transition Time 10–90%		<15 ns	<150 ns
		Pulse Period and width are variable in 10 ns steps without any output glitches or dropouts	
Solid State Relay	Open or close time	100 μs	100 μs

TRIGGER

TRIGGER OUTPUT IMPEDANCE: 50Ω.
TRIGGER OUTPUT LEVEL: TTL.
TRIGGER IN IMPEDANCE: 10kΩ.
TRIGGER IN LEVEL: TTL.
TRIGGER IN TRANSITION TIMING, MAXIMUM: <100ns.
TRIGGER IN TO PULSE OUT DELAY: 560ns.
TRIGGER SYNCHRONIZATION/JITTER[5]: <8ns.

NOTES

1. Unless stated otherwise, all specifications assume a 50Ω termination.
2. Maximum number of PG2 cards in the 4200 chassis is 4.
3. Level specifications are valid after 50ns typical settling time (after slewing) for the high speed mode and after 500ns typical settling time (after slewing) for the high voltage mode into a 50Ω load.
4. Specifications apply to a 10–90% transition, typical. Minimum slew rate for high speed range = 724mV/ms. For high voltage range = 2.71V/ms, which applies to both the standard pulse and Segment ARB™ mode.
5. For multiple 4205-PG2 cards, when using appropriate cabling and the "trigger per waveform" trigger mode.

All specifications apply at 23° ±5°C, within one year of calibration, RH between 5% and 60%, after 30 minutes of warmup.

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

4200-SCP2 1.25GS Dual-Channel Oscilloscope Card and 4200-SCP2HR 200MS Dual-Channel Oscilloscope Card Specifications[1]

ANALOG INPUT[1]

	4200-SCP2	4200-SCP2HR
No. of Channels	2	2
Bandwidth (50Ω)	DC to 750 MHz	DC to 250 MHz, typical
Bandwidth (1MΩ)	DC to 350 MHz	DC to 125 MHz, typical
Full Scale Input Range (50 Ω)	0.05, 0.1, 0.25, 0.5, 1, 2, 5, 10 (Vp-p)	0.05, 0.1, 0.25, 0.5, 1, 2, 5, 10 (Vp-p)
Full Scale Input Range (1 MΩ)	0.1, 0.2, 0.5, 1, 2.5, 5, 10, 20, 50, 100 (Vp-p)	0.25, 0.5, 1.25, 2.5, 5, 10, 25, 50 (Vp-p)
DC Gain Accuracy	<±1% of full scale	< ±0.25% of full scale
Impedance	1 MΩ||12 pF or 50 Ω	1 MΩ||12 pF or 50 Ω
Impedance Accuracy	±1%	±1%
Coupling	DC or AC	DC or AC
Offset Adjust	±(full scale range/2)	±(full scale range/2)
Offset Accuracy	±(1% offset + 1% full scale)	±1%
Input Connectors	BNC	BNC
Absolute Maximum Input (50 Ω)	±5V DC	±5V DC
Absolute Maximum Input (1 MΩ)	±210V DC	±210V DC

ANALOG-TO-DIGITAL CONVERTER

	4200-SCP2	4200-SCP2HR
Resolution	8 bit	16 bit
Sample Rate	2.5 kS/s to 1.25 GS/s in 1, 2.5, 5 steps 2.5 GS/s (1 channel interleaved)	10 kS/s to 200 MS/s in 1, 2.5, 4, 5 steps 400 MS/s (1 channel interleaved)
Memory Depth	1 MS/channel 2 MS on 1 channel, interleaved	1 MS/channel 2 MS on 1 channel, interleaved
Acquisition Time Range	50 ns to 419 seconds	250 ns to 3,355 seconds
Acquisition Modes	Normal, Average, Envelope, and Equivalent-time	Normal, Average, Envelope, and Equivalent-time

TRIGGER

	4200-SCP2	4200-SCP2HR
Trigger Source	Channels 1 or 2, External, Pattern, Software	Channels 1 or 2, External, Pattern, Software
Post-Trigger Delay	0 to 655 seconds	0 to 655 seconds
Pre-Trigger Delay	0 to waveform time	0 to waveform time
Trigger Hold Off Range	0 to 655 seconds	0 to 655 seconds
Trigger Modes	Edge or Pulse Width	Edge or Pulse Width
Edge Trigger Mode	Rising or Falling Edge	Rising or Falling Edge
Pulse Width Range	20ns to 655 seconds, 10ns resolution	20ns to 655 seconds, 10ns resolution
External Trigger Input	TTL Compatible, 10 kΩ input impedance	TTL Compatible, 10 kΩ input impedance
Connector	SMB	SMB

OPTIONAL SCOPE PROBE: 4200-SCP2-ACC

BANDWIDTH: 70MHz (4200-SCP2); 15MHz (4200-SCP2HR).

ATTENUATION: 1×.

MAX DC: 300V DC rated.

LOADING: 100pF and 1MΩ.

LENGTH: 1m.

CONNECTOR: BNC.

NOTES

1. Inputs are referenced to 4200 chassis ground

All specifications apply at 23°±5°C, within 1 year of calibration, RH between 5% and 60%, after 30 minutes of warmup.

4200-PIV-A Pulse I-V Option Specifications[1]

CHANNELS: 2.

TYPICAL PULSE PERFORMANCE (with 4205 Remote Bias Tee[4]):

- **Measurement Accuracy:** <4% of signal ±1mV.
- **Maximum Current Measure:** 100mA.
- **Resolution:** 100nA[2].
- **Offset:** <500nA.
- **Sample Rate:** 1GS/s.
- **Duty Cycle:** <0.1%.
- **DC Offset:** ±200V.
- **Minimum Transition Time (10–90%):** <15ns.
- **Pulse Source Voltage Range:** 0 to ±5V into gate.
- **Pulse Width:** 40ns to 150ns.

SMU TYPICAL DC PERFORMANCE (with 4205 Remote Bias Tee):

- **Leakage:** 1–10nA/V[3].
- **Noise:** 1–10nA RMS.
- **Maximum Voltage:** 210V (>40V requires safety interlock and related precautions).
- **Maximum Current:** 0.5A.

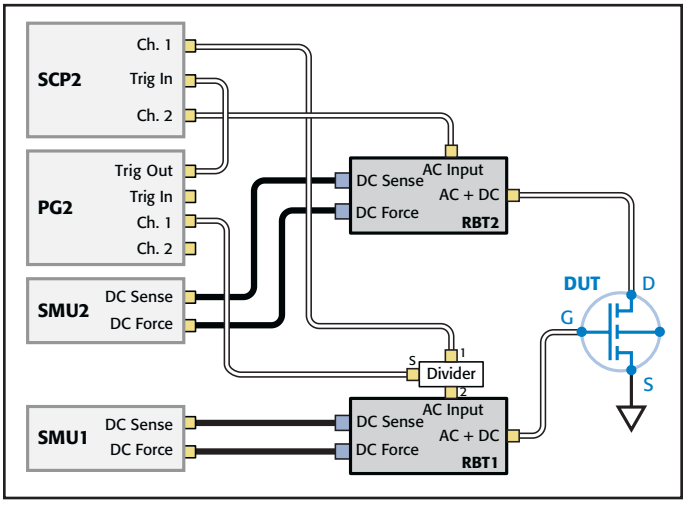
4200 REMOTE BIAS TEE TYPICAL PERFORMANCE:

- **Band Pass:** 3.5kHz–300MHz (3dB).
- **Power Divider Max Power Input:** 0.125W DC.

NOTES

1. Unless stated otherwise, all specifications assume a 50 termination.
2. When using Adaptive filtering.
3. Leakage measured after a 5 second settling time.
4. All typical specs apply to the AC+DC output connector of the 4205 Remote Bias Tee and after system compensation.

All specifications apply at 23°±5°C, within one year of calibration, RH between 5% and 60%, after 30 minutes of warmup.



Interconnection for 4200-PIV-A for leading edge CMOS, high κ, and isothermal testing. PIV-A pulses the voltage on the gate and provides a DC bias on the drain.

4200-SCS

Semiconductor Characterization System

DC I-V, C-V, and Pulse in One Test Environment

4200-PIV-Q Typical Specifications[1]

CHANNELS: 2.

TYPICAL PULSE PERFORMANCE[4]:

Measurement Accuracy: Gate Current: <50μA offset, 10μA resolution[2].
Drain Current: <100μA offset, 10μA resolution[2].

Maximum Current Measure: Gate: 100mA (into 50Ω[6]).
Drain: 760mA (into 50Ω), 1.33A into 5Ω[6].

Sample Rate: 200MS/s.

Duty Cycle: 0.001% to 99.9%.

Minimum Transition Time (10–90%): 150ns.

Gate Pulse Source: –20V to +20V.

Drain Voltage Range: –38V to +38V (into 50Ω), ±75V (into 1kΩ)[6].

Pulse Width: 500ns to 999ms.

Pulse Period: 510ns to 1s.

SMU TYPICAL DC PERFORMANCE:

Typical DC Leakage, Gate: <20nA offset for <35V.

Typical DC Leakage, Drain: <10nA/V[5] for <35V.

Typical DC Noise, Gate: < 20nA RMS.

Gate Offset: <20nA.

Typical DC Noise, Drain: <300pA RMS.

Maximum Voltage: 210V (>40V requires safety interlock and related precautions).

Maximum Current: 1A[5].

NOTES

1. Unless stated otherwise, all specifications assume a 50Ω termination.
2. Offset and resolution specified when using adaptive filtering after system cable compensation and offset correction.
3. Leakage measured after a 5 second settling time.
4. All typical specs apply to the AC+DC output cable (from the SMU Force, connected to the SMA tee attached to Triax to SMA adapter) after system compensation.
5. For the high power 4210-SMU. For the medium power 4200-SMU, the maximum current is 100mA.
6. Drain Pulse Source is a voltage pulser with 55Ω output impedance. To calculate the approximate maximum Drain current for any DUT resistance:
   Idmax = 80V/55 + R_{DS}.
   To calculate approximate maximum Drain voltage, input the Imax calculated above:
   Vdmax = Idmax × R_{DS}

All specifications apply at 23° ±°5C, within 1 year of calibration, RH between 5% and 60%, after 30 minutes of warmup.

4200-FLASH Typical Specifications[1]

CHANNELS: 4 channels (optional 8 channels max.).

TYPICAL PULSE PERFORMANCE:

Number of Voltage Levels/Waveform: 25.

Minimum Transition Time: 150ns.

Pulse Source Voltage Range: 0 to ±20V into 50Ω. 0 to ±40V into high impedance.

Pulse Width: 250ns to 1s.

Trigger Synchronization/Jitter: ±8ns.

Switching Time for DUT Pin Isolation: 100μs.

HEOR Off Capacitance: 250pF.

SMU TYPICAL DC PERFORMANCE

Typical DC Leakage: <10nA/V[2] for <35V.

Typical DC Noise: <300pA RMS.

Maximum Voltage: 200V (>40V requires safety interlock and related precautions).

Maximum Current: 1A[3].

NOTES

1. Unless stated otherwise, all specifications assume a 50Ω termination
2. Leakage measured after a 5 second settling time
3. For the high power 4210-SMU. For the medium power 4200-SMU, the maximum current is 100 mA

ACS

Automated Characterization Suite Systems

- **Wide array of hardware configurations for a variety of testing environments—from bench-top instruments in a lab to fully integrated and automated rack-based parametric testers**
- **No coding needed—ACS's intuitive GUI simplifies getting I-V tests, analysis, and results quickly**
- **High test project portability—Sequences created for one Keithley hardware configuration will run flawlessly on compatible setups with few or no modifications**
- **Support for multiple SMUs and parallel testing speeds test throughput dramatically**
- **Project deployment utilities simplify sharing projects to leverage project development efforts**
- **Flexible modular software architecture makes it easy to scale up your system and adapt your applications as new testing needs emerge**
- **Open file standards simplify modifying test setups to adapt to changes in process flow**
- **Support for wafer-level and cassette-level automation with semi-automatic and fully automatic probers**
- **FREE optional off-line software license makes it simple to develop new test sequences on another PC—no need to tie up a system needed for ongoing work**
- **Software options are available for data analysis for wafer level reliability (WLR) testing**

One Powerful Software Solution—A Wide Range of Hardware Configurations

Keithley's Automated Characterization Suite (ACS) is a comprehensive tool that combines multiple instruments and systems into a unified I-V test environment that is optimized for speed and productivity—it can also be used on stand-alone instruments. ACS supports a wide array of Keithley instrumentation and systems, hardware configurations, and test settings, from a few bench-top instruments for use in a QA lab to fully integrated and automated rack-based parametric testers.

ACS offers exceptional testing and analysis flexibility, plus its intuitive GUI helps novice users be productive almost immediately, regardless of their level of programming experience. The GUI simplifies configuring test instrumentation, making I-V measurements, getting results, and analyzing them quickly because no coding is required. Even if you're an infrequent user, you can go from creating a new test setup to characterizing new devices in a fraction of the time older test development approaches require. Just as important, ACS provides all the tools you need to set up tests, analyze data, and export your results—without ever leaving the ACS environment.

Automate Your Data Gathering Processes

Need the throughput advantages of a semi-automatic or fully automatic wafer probe station to get lots of data fast? The wafer prober automation option for ACS makes it easy to interface a variety of popular probe stations into your test setup. This option includes a wafer description utility (for creating a virtual wafer to use in creating wafer-level sampling plans), real-time wafer maps with binning capabilities (for designating a device's disposition before it's packaged, in die sorting, etc.), a cassette sample plan utility (for designating which wafers are to be tested), and a post-test cassette and wafer review utility (for exploring and comparing test results from multiple wafers interactively).

High precision probing is critical to characterize the reliability and functionality of today's devices accurately. Keithley works closely with developers of both single-site and multi-site probe cards to ensure our ACS systems are compatible with their cards and to optimize tester/card configurations to deliver accurate results quickly.

Example ACS test system

APPLICATIONS

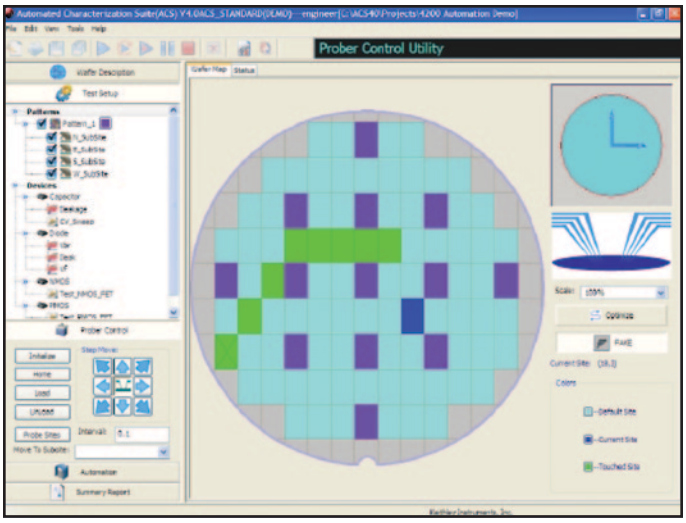
Compatible with rapidly growing range of testing configurations for:

- **Component test**
- **Component characterization**
- **Device characterization**
- **Parametric test**
- **Reliability test**

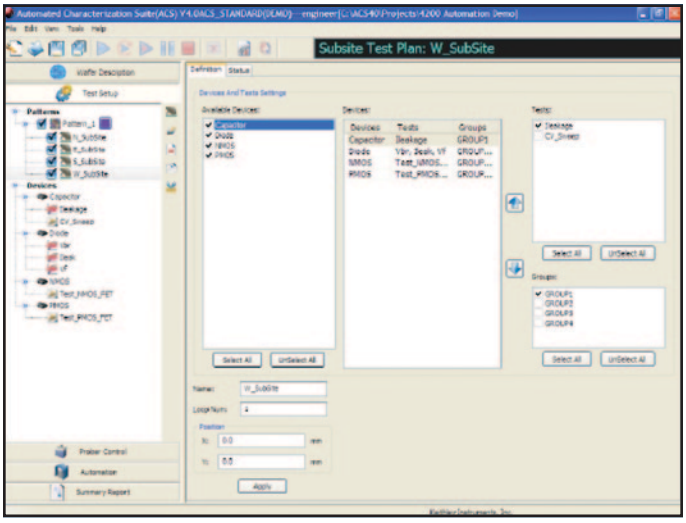
Maximize the value of your Keithley hardware investment

SEMICONDUCTOR

Automated Characterization Suite Systems



Interactive probe station control speeds and simplifies test development and debugging by combining interactive testing with manual probe station control.



ACS lets you map devices and tests to sites and subsites, so there's no need to duplicate each test for each subsite, reducing your test development time significantly.

Many of the tools and capabilities built into ACS enhance automated device characterization:

- Wafer- and cassette-level automation
- Limits file generation tool
- Test results binning, including interactive binning plot
- Test map—map device and tests to sites and subsites
- Interactive probe station control mode
- Real-time plotting
- Single or per-wafer Keithley data file
- SQLite™ database and binning file output options
- Lot summary report generator
- Integrated support for Keithley Series 2600A and 2400 SourceMeter families
- Integrated scripting editor and GUI builder
- Integrated support for C (with 4200-SCS only), Python, and Lua (for Series 2600A) programming languages

Share Tests Projects and Results

ACS offers a common set of key elements that work across a wide range of hardware configurations, which saves time and increases productivity. Systems perform consistently from one hardware implementation to another, so, for example, it's easy to transfer your knowledge of an ACS-based system used in single-device component characterization to another designed for wafer level testing.

Similarly, test projects and sequences you create for one Keithley ACS hardware configuration will run on compatible setups in other test settings with little or no modification. This portability across a range of configurations reduces the effort involved in transferring a new device from one lab or department to another and simplifies comparing results obtained in various test settings. This is possible because ACS employs common open-standard file interfaces for projects, wafer maps, output files, etc. as well as common test libraries and instrument drivers, which also means you can be confident of high results correlation whether your tests are run on a system with a single Series 2600A instrument or a fully automated custom die sort tool with dozens of these instruments.

Maximize the Productivity of Your Keithley Hardware

The tools in ACS simplify test development and maximize the speed of each Keithley instrument linked into the system. For example, ACS builds on the throughput advantages inherent in Keithley's newest family of high performance Source-Measure Units, the Series 2600A System SourceMeter instruments. These advantages include:

- The on-board Test Script Processor (TSP®) in each instrument that allows each 2600A to operate independently of the ACS system's controller
- The TSP-Link® high speed communications bus used to network multiple 2600A instruments together
- True parallel test execution
- Precision timing

Together, ACS and Keithley TSP-based hardware offer the highest throughput in the industry to lower the cost of test without requiring you to spend time learning new programming concepts or languages before getting the data needed to accomplish your goals.

ACS

Automated Characterization Suite Systems

Add More Hardware to Your ACS Test Systems to Adapt to Changing Needs

High scalability and a flexible architecture simplify configuring an ACS system to match your specific testing requirements or to upgrade an existing system to handle new test needs as they evolve. Our wide range of source-measure and switching capabilities provides a solid foundation for configuring customized applications because ACS software can control virtually any instrument or peripheral with a standard hardware interface. For example, third-party LCR meters can be easily integrated into any ACS system and drivers are available for popular instruments. Also, ACS's integrated scripting environment can control any GPIB instrument the application may require, such as a hot chuck controller.

Many ACS systems are configured using one or more of Keithley's innovative Series 2600A System SourceMeter instruments, which are optimized for precision sourcing and measurement synchronization to capture high speed events. These systems offer unmatched testing speed and accuracy because they provide an SMU-per-pin architecture. ACS system configurations can support any number from two to more than 40 SMUs in a single rack for true parallel characterization applications.

ACS also makes it easy to integrate other types of Keithley hardware into your system, such as instruments to meet specialized test requirements, such as:

- High channel count switching—Model 707A Six-Slot Switch Mainframe
- Combination of switching and measurement—Series 3700 Switch/Multimeters
- High voltage sourcing—Model 237 High Voltage Source-Measure Unit
- Higher resolution, lower current, or other capabilities such as C-V or pulse testing—Model 4200-SCS
- Wider dynamic range—Series 2400 SourceMeter instruments

Keithley has continually enhanced both the software and hardware that go into ACS systems ever since their introduction. This ongoing commitment assures you of a cost effective upgrade path to address new testing needs as they arise, avoiding the need to purchase a new characterization system because your old one is obsolete.

Choose ACS for What It Gives You that Others Don't

There are many alternatives on the market for creating characterization applications, but ACS offers major advantages that competitive solutions can't match, such as a choice of three powerful project development options. With ACS, you can create the tests you need in the way that best suits your application's requirements and your own programming preferences.

- You say you're a researcher and you just need to make a quick test of common parameters and properties on a single device? We've packaged the same tests that our semiconductor customers use to verify their products into **easy-to-use applications libraries**. These libraries help you get the data you need to validate your work quickly so you can get back to your research sooner.
- Need more test development flexibility? Our **interactive test development GUI** lets you select bias and sweep conditions, acquire raw data, then use the built-in Formulator tool to extract meaningful results—all without writing code.
- For the ultimate test development flexibility, modify one of the existing test scripts in our applications libraries using the **embedded script editing and debugging tools**.

Broad Range of Applications

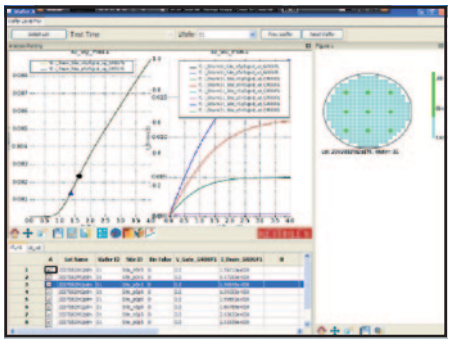
ACS-based Integrated Test Systems are complete solutions for applications such as parametric die sort and wafer level reliability testing. When paired with appropriate semi-automatic and fully automatic probe stations, their hardware configurations and test project development can be easily optimized for specific tasks. ACS leverages the on-board test script processors in Series 2600A System SourceMeter instruments into a multi-processor environment that's ideal for true parallel test in both single- and multi-site configurations. This multi-processor environment provides high parallel throughput while speeding and simplifying test project development. Multi-site testing capabilities are embedded throughout ACS from the wafer description utility to the test results output file or binning file, for example:

- Multi-site parallel testing brings the highest possible throughput for both parametric die sort and WLR applications

The Hardware Foundations of ACS Systems

ACS Systems are built on the foundation of a variety of high integrity Keithley hardware:

- **Source-Measure Units (SMUs)**
  - Series 2600A System SourceMeter Instruments
  - Model 4200-SCS Semiconductor Characterization System
  - Series 2400 SourceMeter Instruments
- **Switching**
  - Series 700 Switch Systems (Models 707A and 708A)
  - Series 3700 System Switch/Multimeters



Wafer and binning map tools allow you to browse through the test results on either a wafer-by-wafer or site-by-site basis. You can also overlay traces from multiple sites to make quick comparisons.

- Configurable for special applications like MEMS testing
- Easily customize test flows with User Access Points (UAPs) that execute scripts or call custom utilities

Commitment to Excellence

ACS Integrated Test Systems are designed and built to specification on Keithley's factory floor to ensure the maximum system performance and measurement integrity. These systems are eligible to receive the system CE mark as well as other optional system certifications, depending on the configuration. Keithley supports ACS systems with a variety of on-site services for installation, training, applications support, and repair.

ACS Basic Edition

Automated Characterization Suite for Component Characterization

ACS Basic Edition combines high speed hardware control, device connectivity, and data management into an easy-to-use tool for part verification, debugging, and analysis.

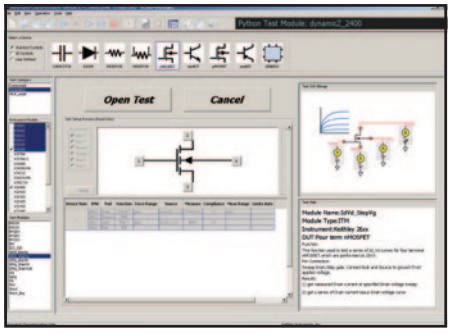
The flexible software architecture of ACS Basic Edition allows configuring systems with a wide range of controllers and test fixtures, as well as the exact number of SourceMeter instruments the application requires.

- **Combine hardware from any of Keithley's SourceMeter® families into a single test, including Series 2600, 2600A, 2400, Model 4200-SCS, and Model 237 SMU**
- **Take advantage of Ethernet communication with Series 2600A SourceMeter Instruments**
- **Optimized for component test, verification, and analysis applications**
- **No coding needed—ACS's intuitive GUI simplifies getting I-V tests, analysis, and results quickly**
- **System flexibility—Add or remove instruments dynamically to meet individual test needs**
- **Pre-existing application libraries—An incredibly rich set of quick and easy-to-access test libraries**
- **Fast time to first measurements—Quickly select tests that work with the instruments you have and the devices you need to test**
- **FREE optional off-line version makes it simple to develop new test sequences on another PC**

Bring Speed and Simplicity to Your Component Test, Verification, and Analysis Applications

Keithley developed ACS Basic Edition to maximize the productivity of technicians and engineers responsible for packaged part characterization in applications ranging from early device research through development, quality verification, and failure analysis. When paired with one or more of the instruments in Keithley's broad range of proven SourceMeter® instruments, our new, easy-to-use ACS Basic Edition software delivers high precision, cost-effective solutions for component test. It is delivered complete with a comprehensive suite of parametric characterizations, so it can quickly and easily provide the results you need to verify a component's performance vs. its specifications, complete incoming inspection or quality assurance evaluations, or understand the electrical properties of novel devices or materials.

ACS Basic Edition is optimized for ease of use in a packaged parts environment with an interface designed to eliminate the confusing test jargon that can complicate using competitive solutions. When used in the default, single-test mode, this wizard-based graphical interface steps you through the process of selecting a device type, an instrument, and a specific test, so you and your staff can be more productive and focus your attention on more critical tasks, rather than on the details of test development. A variety of built-in tools makes it an ideal solution for those who don't have the time or the inclination to become expert test engineers but still need accurate results on a device's performance quickly.



When you need to acquire some data on a packaged part quickly, the wizard-based user interface developed for ACS Basic Edition makes it easy to find and run the test you want, like this common FET curve trace test.

- **Single-test mode:** This mode offers many of the same advantages as a traditional analog curve tracer—like a wide I-V envelope and power spectrum, continuous test updates, the performance and accuracy of Keithley's SourceMeter instruments, and ease of use—in an updated form that lets you correlate your results with others easily. "Repeat" and "Loop Test" features provide new flexibility in collecting data.
- **Multi-test mode:** This mode builds on this same straightforward approach to test creation as the single-test mode but expands

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A GREATER MEASURE OF CONFIDENCE

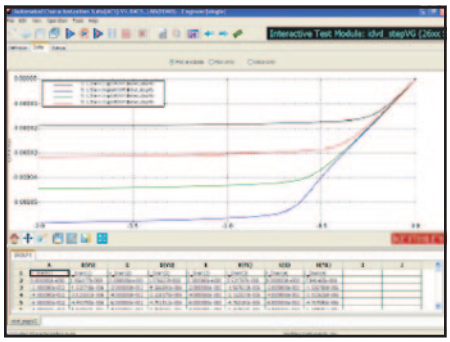
ACS Basic Edition

Ordering Information

ACS Basic Edition Component Characterization Software

ACCESSORIES AVAILABLE

2600-FIX-TRX	Grounded Phoenix-to-Triax Cable Adapter
8101-4TRX	Leaded Component Test Fixture
ACS-COMP	PC for Installed and Bench-top ACS Systems
KUSB-488A	IEEE-488.2 USB-to-GPIB Interface Adapter for USB Port
LR:8028	DIP Component Test Fixture



Much like a traditional analog curve tracer, ACS Basic Edition can generate a family of curves on a packaged part quickly but also offers the flexibility to save, compare, and correlate results easily.

TYPICAL USE CASES

- **Semiconductor product development based on existing mature processes**
- **Incoming inspection and QA group**
- **Research/investigation of novel devices**

Automated Characterization Suite for Component Characterization

it to allow more complete testing of components within a single test project.

- **Rich set of easy-to-access test libraries:** For most applications, there's no need for programming—just access the sequence you need from one of our libraries and you're ready to start gathering data.
- **Script editor:** Although many users will find all the tests they need in our libraries, we also offer a script editor that lets you modify existing tests quickly to meet specific requirements. With no need to code an application from scratch, you can start testing much sooner. New script editor features make defining a GUI for a custom test and writing code easier than ever. Pop-up function references are available for many of the most used programming commands.
- **Quick comparisons of results with saved data:** You won't have to waste time searching for old results or comparing datasets using Excel. ACS's built-in data analysis helps you find the results you need quickly and compare new results with old in seconds. Graphical and/or tabular results can be easily saved in the test and new device curves can be overlaid on "golden" curves for quick evaluations. For more in-depth study, the Formulator tool lets you analyze a captured curve with the standard parametric extractions and wide range of math functions included.

As part of the ACS Systems family of products, ACS Basic Edition helps you boost your organization's productivity by sharing test conditions, algorithms, and even data between wafer level reliability, parametric, research, quality, and failure analysis labs. ACS Basic Edition gives quality and application engineers and technicians the tools they need to verify components and interact productively with design and production teams without the need for complex and time-consuming test programming. For those whose applications don't involve packaged parts, ACS for Integrated Test Systems and ACS for Wafer Level Reliability are optimized for use in wafer testing environments, offering a wafer map, prober automation capabilities, and analysis options for yield monitoring and related statistical calculations. Hardware configurations originally designed for use with ACS Basic Edition systems are compatible with these other versions of ACS.

The Hardware Foundations of ACS Basic Edition Systems

High scalability and a flexible architecture simplify configuring an ACS Basic Edition System to match your specific testing requirements or upgrading an existing one to handle new test needs as they evolve. ACS Basic Edition builds on the throughput advantages inherent in Keithley's newest family of high performance source-measure units, the Series 2600A System SourceMeter instruments. Most systems are configured using one or more of these instruments, which allows them to offer unmatched testing speed and accuracy because they provide an SMU-per-pin architecture. Each Series 2600A System SourceMeter instrument has an embedded Test Script Processor (TSP®) that allows you to program it with high speed test scripts to operate independently from the ACS system's controller. You can connect multiple Series 2600A SourceMeter units together via their on-board processors and the TSP-Link® virtual backplane/high speed communications bus. This architecture provides high precision source/measure timing for capturing high speed events. Together, ACS Basic Edition and Keithley TSP-based hardware give you the highest throughput in the industry, without requiring you to spend time learning new programming concepts or languages before you can get the data you need to accomplish your goals.

Built-in tools simplify integrating other instruments from Keithley into an ACS Basic Edition configuration as well. ACS Basic Edition now includes tests that allow mixing of Series 2400 SourceMeter instruments (for wider dynamic range), Model 4200 SMUs (for low current and high resolution), Model 237 (for high voltage with low current), and the Series 2600A instruments. To handle specialized testing requirements, system options include high-channel-count switching (Model 707A Six-Slot Switch Mainframe) or a combination of switching and measurement (Series 3700 Switch/Multimeters).

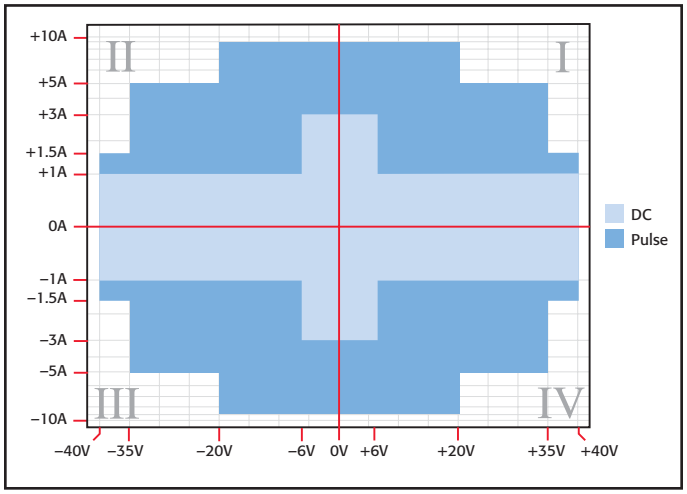
ACS Basic Edition

Automated Characterization Suite for Component Characterization

ACS systems optimized for component characterization applications

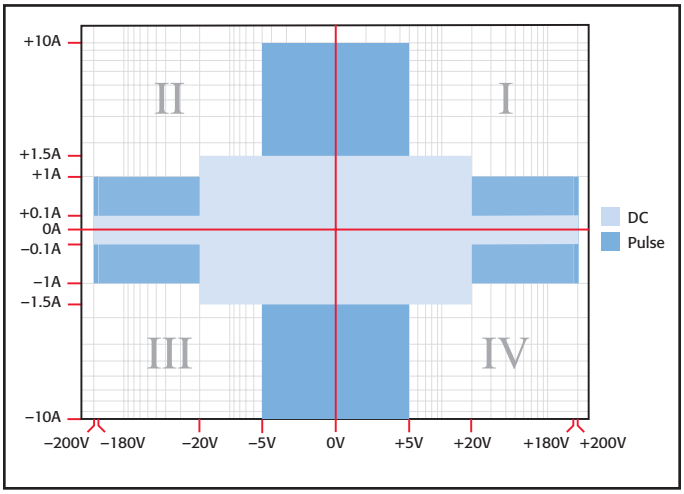
SEMICONDUCTOR

Series 2600A System SourceMeter® Instruments' Voltage and Current Source Envelopes



Models 2601A and 2602A I-V capability

In the first and third quadrants, Series 2600A instruments operate as a source, delivering power to a load. In the second and fourth quadrants, they operate as a sink, dissipating power internally.

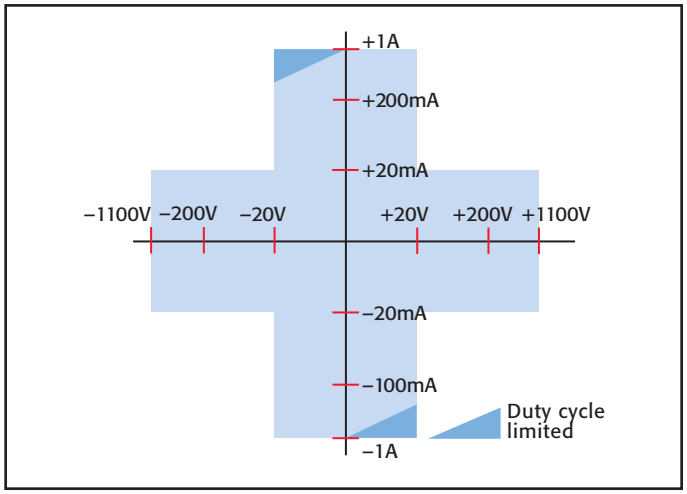


Models 2611A, 2612A, 2635A, and 2636A I-V capability

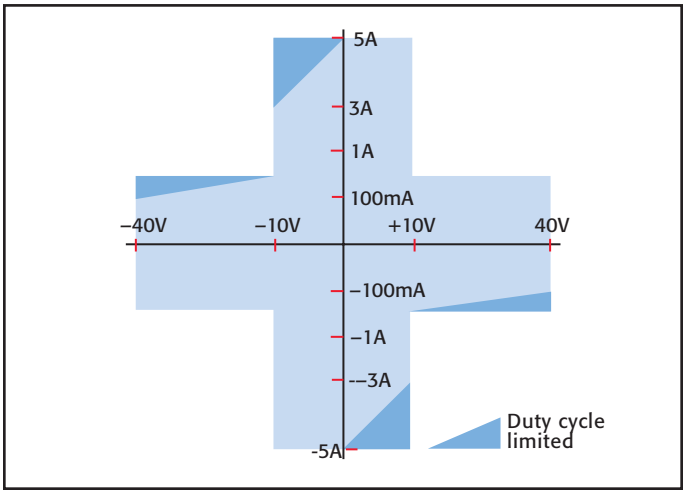
Series 2600A System SourceMeter instruments represent just one of the types of Keithley SMUs that can be used with ACS Basic Edition to bring speed and simplicity to component test, verification, and analysis applications.

Models 2410 and 2440 SourceMeter Instruments' Voltage and Current Source Envelopes

ACS Basic Edition supports testing with all Series 2400 SourceMeter instruments.



Model 2410 High-Voltage SourceMeter Instrument



Model 2440 5A SourceMeter Instrument

ACS Basic Edition

Automated Characterization Suite for Component Characterization

SUMMARY OF TYPICAL TESTS

Device	Leakage	Breakdown	Gain	On-State
Bipolar Junction Transistor	IEBO, IECO, IEVEB, ICVCB	BVCBO, BVCEI, BVCEO, BVCEV, BVEBO, BVECO	HFE	IBCO, IBEO, IBICVBE, IBVBE, ICBO, ICEV, ICVCE_BiasIB, ICVCE_BiasVB, ICVCE_StepIB, ICVCE_StepVB, VBCO, VCE
MOSFET	IDL, IDS_ISD, IGL, ISL	BVDSS, BVDSV, BVGDO, BVGDS, BVGSO	GM	IDVD_BiasVG, IDVD_StepVG, IDVG_BiasVD, IDVG_StepVD, IDVG_StepVSUB, IGVG, VTCI, VTEXT, VTEXT_IISQ
Diode	IRDVRD	VBRIRD	NA	DYNAMICZ, IFDVFD, VFDIFD, VRDIRD
Resistor	NA	NA	NA	IV
Capacitor	IV		NA	

GENERAL TEST CAPABILITY

Force Type	Force Mode	Measure Mode	Typical Settings
Spot	Voltage or Current	Voltage and/or Current	Source Mode, Source Value, Measure Range, Integration Rate
Monitor			Source Mode, Source Value, Measure Range, Integration Rate, Number of Points
Sweep			Source Mode, Source Start Value, Source Stop Value, Measure Range, Integration Rate, Number of Points
Sweep/Step			Sweep: Sweep Source Mode, Sweep Source Start Value, Sweep Source Stop Value, Sweep Measure Range, Sweep Integration Rate, Number of Sweep Points Steps: Step Source Mode, Step Source Start Value, Step Source Stop Value, Step Measure Range, Step Integration Rate, Number of Steps

FORMULATOR FUNCTION SUMMARY

Type	
Math	ABS, AVG, DELTA, DIFF, EXP, LN, LOG, LOG10, SQRT
Parametric Extractions	GMMAX, RES, RES_4WIRE, RES_AVG, SS, SSVTCI, TTF_DID_LGT,TTF_LGDID_T, TTF_DID_T, TTF_LGDID_LGT, VTCI, VTLINGM, VTSATGM
Fitting	EXPFIT, EXPFITA, EXPFITB, LINFIT, LINFITSLP, LINFITXINT, LINFITYINT, REGFIT, REGFITSLP, REGFITXINT, REGFITYINT, REGFIT_LGX_LGY, REGFIT_LGX_Y, REGFIT_X_LGY, TANFIT, TANFITSLP,TANFITXINT, TANFITYINT
Manipulation	AT, FINDD, FINDLIN, FINDU, FIRSTPOS, JOIN, LASTPOS, MAX, MAXPOS, MIN, MINPOX, POW, SMOOTH

ACS-WLR

Wafer Level Reliability Systems

- Source-measure unit (SMU) based WLR systems
- Flexible architecture accommodates your changing needs
- Configurations can include from 2 to 44 source-measure channels
- Comprehensive JEDEC-compliant test suite
- Optimized for both emerging and mature technologies
- Supports both sequential and parallel testing
- Fully automatic single-site and multi-site capability
- Compatible with all popular wafer probe stations
- Real-time plotting and wafer mapping

The highly scalable and flexible architecture simplifies configuring an ACS-WLR system to match your specific testing requirements or to upgrade an existing one to handle new test needs as they evolve.

Keithley has taken the power of its ACS systems and focused it on wafer level reliability (WLR) testing to create its ACS-WLR Integrated Test Systems. The result—you can produce lifetime predictions from two to five times faster than you can with conventional WLR test solutions, allowing you to accelerate your technology development, process integration, and process monitoring for faster time to market.

ACS-WLR systems offer comprehensive single- and parallel-device WLR testing capability. They are configured with our innovative Series 2600A System SourceMeter® instruments that provide the systems with unmatched testing speed and accuracy via an SMU-per-pin architecture. A single 2600A dual-channel source-measure unit (SMU) is suitable for single-device reliability testing. The smallest configurations require only a single 2600A dual-channel SMU; however, most system configurations support from 8 to 40 SMUs in a single rack for true parallel WLR characterization applications. The 2600A SMUs allow the ACS-WLR architecture to supply both high voltage (200V) and high current (1.5A) sourcing and measurement to every test structure pad. This maximizes test flexibility, so you don't need one solution for gate oxide integrity and a different system for metal interconnect reliability. Whether you are testing thick oxide or advanced gate stacks, you can characterize lifetime acceleration with a single touchdown—every S2600A SMU can be programmed independently so that splits can be performed on a single structure.

APPLICATIONS

Device Reliability
- HCI, NBTI, PBTI

Gate Oxide Integrity
- TDDB, V_{RAMP}, J_{RAMP}

Metal Interconnect
- Isothermal Electromigration
- Poly Heater
- Constant Current
- ILD TDDB

Extensive Software Capabilities

No coding is required to take full advantage of the source-measure capability of the 2600As or the tools included in the software environment. For example, a powerful stress/measure sequencing tool supplies an interactive interface for testing device reliability, gate oxide integrity, and metal interconnects (EM). Its flexible test sequencing capabilities support pre- and post-testing, as well as intra-stress testing and stress monitoring. During testing, you can log raw reliability data into the database and/or plot it in real time. This real-time plotting provides a "sneak peek" at a test's outcome to let you know whether time-consuming tests are on track to deliver meaningful results. After testing, use the easy point-and-click analysis offered by the integrated Formulator, which is populated with standard parametric extraction calculations. In addition, a variety of modeling, line fitting, and standard math functions allows custom data manipulation without programming.

Data Analysis Capabilities

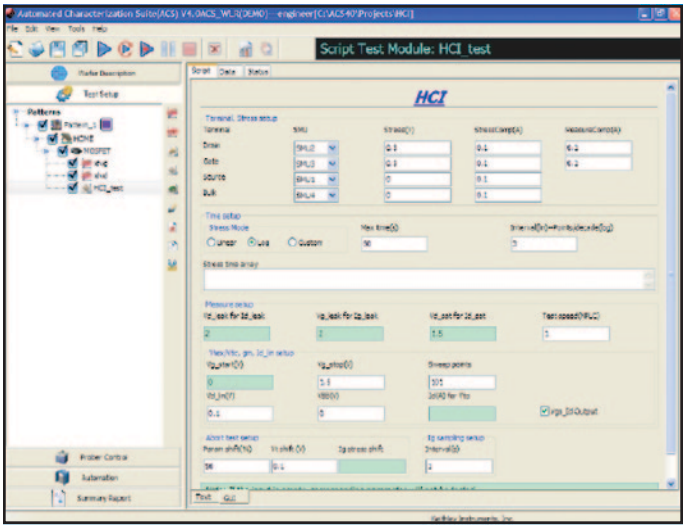
An optional off-line data analysis tool designed to pull data from the system's database is available, eliminating the need for you to create custom analysis software or manipulate data manually with spreadsheets. The ACS Data Analysis software is optimized for lifetime calculations for all major device reliability needs and provides:

- Standard analysis, including: normal fitting, curve fitting, acceleration, and distribution models such as Lognormal and Weibull
- Formulator tool that performs advanced functions, including: modeling, line-fitting, standard parametric extractions, and standard math functions for custom data manipulation
- Ability to reorganize and edit existing models to create new analysis processes
- Built-in scripting language that makes it easy to define your own models

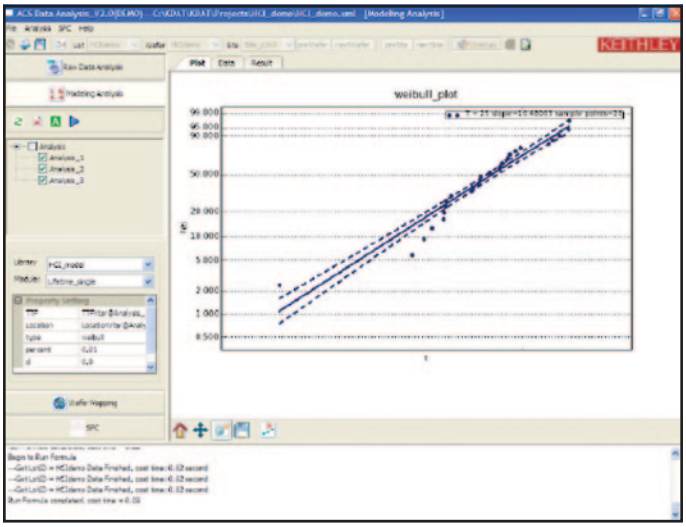
If you already have custom analysis tools and you want to continue using them, ACS-WLR includes software tools that simplify the extraction of data from its system database.

Protect Your Hardware Investment

Like ACS systems, ACS-WLR systems have the built-in system scalability and configuration flexibility you need to protect your hardware investment, preventing premature obsolescence as your product mix evolves beyond existing materials and processing technologies. This not only minimizes your capital expenses, it also minimizes disruptions by allowing you to continue using familiar, already proven systems.



JEDEC-compliant routines for WLR tests like hot carrier injection (HCI) are already built into ACS-WLR. In this test setup, note how all the required test parameters are included in a single dialog screen.



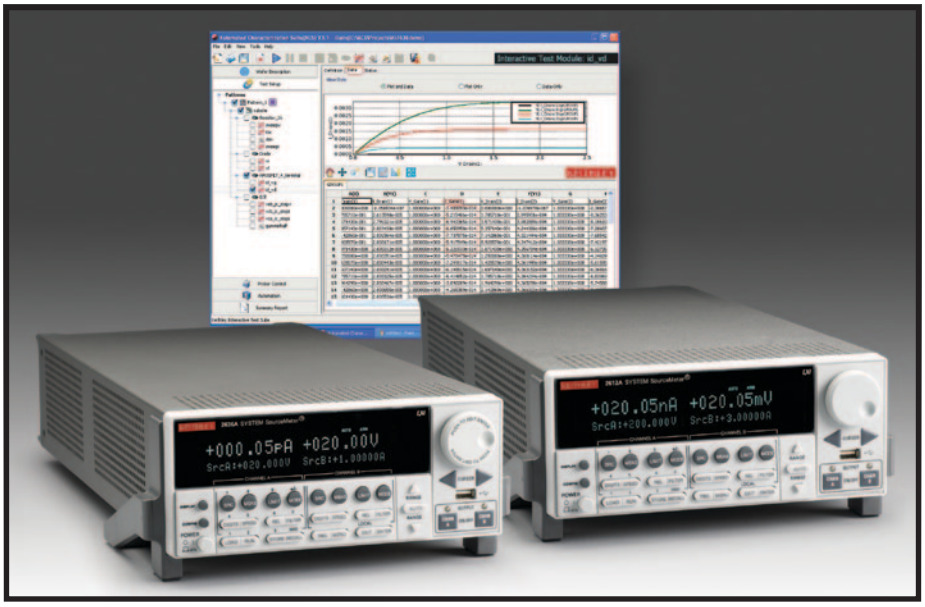
ACS-WLR systems include a wide range of analysis tools and plotting options, such as this Weibull plot of HCI lifetime test results.

Series 2600A

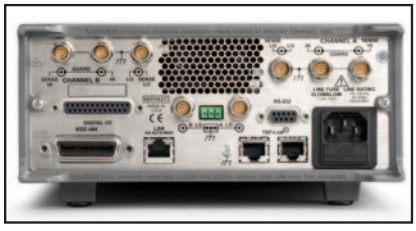
System SourceMeter® Multi-Channel I-V Test Solutions

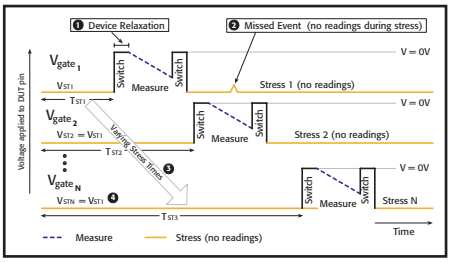
- Modular SMU instruments for systems up to 64 channels
- Up to 200V source with 1pA (1fA for 2635A/2636A) current measure sensitivity
- Combines a precision power supply, true current source, DMM, arbitrary waveform generator, V or I pulse generator with measurement, electronic load, and trigger controller—all in one instrument
- >20,000 readings/s and >7,000 source-measure points/s to memory provide faster test times
- The embedded Test Script Processor (TSP®) offers unparalleled system automation and two to four times the test throughput of competitive products in I-V functional test applications
- TSP-Link® master/slave connection seamlessly integrates multiple Series 2600A SourceMeter channels into a system that can be programmed and controlled as a single instrument
- Embedded TSP® Express software tool allows quick and easy I-V test
- Free Test Script Builder software simplifies creating powerful test scripts for programming custom test functions
- Each channel is electrically isolated for high integrity measurements and wiring flexibility
- Industry's highest SMU rack density for automated test applications
- Triax connectors and ground module are ideal for lab work (2635A/2636A)

See page 192 for more detailed information.

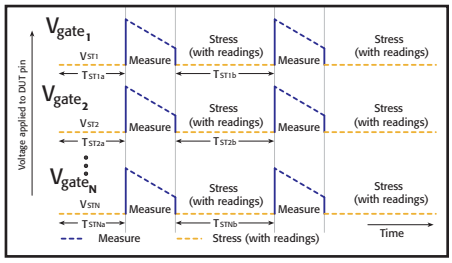


Series 2600A System SourceMeter instruments offer electronic component and semiconductor device manufacturers a scalable, high throughput, highly cost-effective solution for precision DC, pulse, and low frequency AC source-measure testing. Building on the tightly integrated source-measure technology originally developed for Keithley's popular Series 2400 SourceMeter line, Series 2600A instruments provide from two to four times the test speed of competitive solutions in I-V functional test applications. They also offer higher source-measure channel density and a significantly lower cost of ownership than competing products. Patented analog-to-digital converters provide simultaneous I and V measurements in less than 50μs (20,000 rdgs/s) and source-measure sweep speeds of less than 143μs per point (7,000 points/s). This high speed source-measure capability, plus advanced automation features and time-saving software tools make Series 2600A SourceMeter instruments an ideal solution for I-V testing of a wide range of devices.





Example stress/measure cycle for a stress-switch-measure approach: (1) device relaxation, (2) missed event during stress on DUT #1, (3) different stress times for each DUT, (4) single V_{stress} voltage shared for all DUTs (i.e., $V_{ST1} = V_{ST2} = \ldots V_{STN}$). This simplified diagram shows the stress and measure on one pin per DUT; typical stress/measure configurations will have non-zero voltages on two or three of the four pins on a typical FET DUT.



Example stress/measure cycle for dedicated SMU approach. Compare to figure at left. Note that the time for each stress interval is the same, that each voltage stress (V_{ST}) can have a unique value (R), and that readings are taken during the stress intervals.

Series 2400 SourceMeter® Line

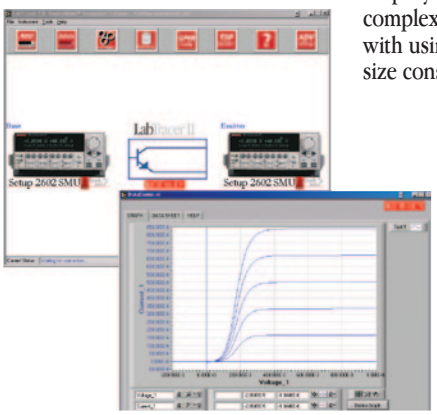
- SMU product family offers wide dynamic range: 10pA to 10A, 1µV to 1100V, 20W to 1000W
- 4-quadrant operation
- 0.012% basic accuracy with 5½-digit resolution
- 6-wire measurement with programmable I source and V clamp
- 1700 readings/second at 4½ digits via GPIB
- Built-in comparator for fast pass/fail testing
- Optional contact check function
- Digital I/O for fast binning and connection to component handlers
- GPIB, RS-232, and Trigger Link interfaces
- LabVIEW® drivers

See page 208 for more detailed information.

Keithley's SourceMeter family is designed specifically for test applications that demand tightly coupled sourcing and measurement. All SourceMeter models provide precision voltage and current sourcing as well as measurement capabilities. Each SourceMeter instrument is both a highly stable DC power source and a true instrument-grade 5½-digit multimeter. The power source characteristics include low noise, precision, and readback. The multimeter capabilities include high repeatability and low noise. The result is a compact, single-channel, DC parametric tester. In operation, these instruments can act as a voltage source, a current source, a voltage meter, a current meter, and an ohmmeter. Manufacturers of components and modules for the communications, semiconductor, computer, automotive, and medical industries will find the SourceMeter instruments invaluable for a wide range of characterization and production test applications.

Advantages of a Tightly Integrated Instrument

By linking source and measurement circuitry in a single unit, these instruments offer a variety of advantages over systems configured with separate source and measurement instruments. For example, they minimize the time required for test station development, setup, and maintenance, while lowering the overall cost of system ownership. They simplify the test process itself by eliminating many of the complex synchronization and connection issues associated with using multiple instruments. And, their compact half-rack size conserves precious "real estate" in the test rack or bench.



The free downloadable LabTracer® 2.0 software allows users to configure and control up to eight Series 2600A or 2400 SourceMeter channels quickly and easily for curve tracing or device characterization. It provides a simple graphical user interface for setup, control, data acquisition, and graphing of DUT data from SourceMeter instruments. When used together, LabTracer and SourceMeter instruments offer lab users a powerful, easy-to-use, and economical alternative to chassis-based solutions.

ACCESSORIES AVAILABLE

TEST LEADS AND PROBES

1754	2-Wire Universal 10-Piece Test Lead Kit
5804	Kelvin (4-Wire) Universal 10-Piece Test Lead Kit
5805	Kelvin (4-Wire) Spring-Loaded Probes
5806	Kelvin (4-Wire) Clip Lead Set
8607	2-Wire, 1000V Banana Cables, 1m (3.3 ft)
CA-18-1	Shielded Dual Banana Cable, 1.2m (4 ft)

SWITCHING HARDWARE

7001	Two-Slot Switch System
7002	Ten-Slot Switch System
7019-C	6-Wire Ohms Switch Card
7053	High-Current Switch Card

CABLES/ADAPTERS

7007-1	Shielded GPIB Cable, 1m (3.3 ft)
7007-2	Shielded GPIB Cable, 2m (6.6 ft)
7009-5	RS-232 Cable

COMMUNICATION INTERFACE

KPCI-488LPA	IEEE-488 Interface/Controller for the PCI Bus
KUSB-488A	IEEE-488 USB-to-GPIB Interface Adapter

TRIGGERING AND CONTROL

2499-DIGIO	Digital I/O Expander Assembly
8501-1	Trigger Link Cable, DIN-to-DIN, 1m (3.3 ft)
8501-2	Trigger Link Cable, DIN-to-DIN, 2m (6.6 ft)
8502	Trigger Link to BNC Breakout Box
8503	Trigger Link Cable, DIN-to-Dual BNC, 1m (3.3 ft)
8505	Male to 2-Female Y-DIN Cable for Trigger Link

RACK MOUNT KITS

4288-1	Single Fixed Rack Mount Kit
4288-2	Dual Fixed Rack Mount Kit

SOFTWARE

LabTracer 2.0	Curve Tracing Software (downloadable)