

4200-SCS



- Intuitive, point-and-click Windows-based environment
- Unique Remote PreAmps extend the resolution of SMUs to 0.1fA
- 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
- Integrated support for Keithley Model 590 and Agilent 4284 C-V meters, Keithley switch matrix configurations, and Agilent 81110 pulse generators
- Hardware controlled by the Keithley Interactive Test Environment (KITE). User Test Module function extends KITE for external instrument control and test station integration.
- Includes software drivers for Cascade Microtech Summit 12K Series, Karl Suss Model PA-200 and Model PA-300, Micromanipulator Model 8860, and manual probers
- Advanced semiconductor modeling support including Keithley supplied IC-CAP device modeling package driver and support for Celestry Design Technologies' BSIMPro

Semiconductor Characterization System

The easy-to-use Model 4200-SCS Semiconductor Characterization System performs lab grade DC 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 NT 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.

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, a choice of Keithley and Agilent C-V meters, and pulse generators. A variety of customer support packages are also available, including applications support, calibration, and repair.

A Total System Solution

The Model 4200-SCS provides a total system solution for DC characterization of semiconductor devices, test structures, and materials. This advanced parameter analyzer provides intuitive and sophisticated capabilities for semiconductor device characterization. The Model 4200-SCS combines unprecedented measurement speed and accuracy with an embedded Windows NT-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 and C-V 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 eight Source-Measure Units, including up to four high-power SMUs with 1A/20W capability.

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.

KITE Interactive Software Tools

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

- Keithley Interactive Test Environment (KITE)—The 4200-SCS device characterization application
- Keithley User Library Tool (KULT)—Allows test engineers to integrate custom algorithms into KITE using 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 4200-SCS. It also provides system diagnostics functions
- Keithley External Control Interface (KXCI)—The 4200-SCS application for controlling the 4200-SCS from an external computer via the GPIB bus

The Keithley Interactive Test Environment (KITE)

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.

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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 and printed User
Manual included with 4200-SCS
236-ILC-3 Interlock Cable, 3m
(one included with 4200-SCS)

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

Semiconductor Characterization System



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.

ACCESSORIES AVAILABLE

COMPUTER OPTIONS

4200-CRT 17" SVGA CRT
4200-MOUSE Microsoft 2 Button Mouse

REMOTE PREAMP MOUNTING OPTIONS

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

OTHER ACCESSORIES

4200-MAN Printed Manual Set
4200-CART Roll-Around Cart
8006 Component Test Fixture
8007 Semiconductor Test Fixture

C-V OPTIONS

4200-590 High Frequency C-V Analyzer, 100kHz/1MHz
5909 Calibration Sources for Model 590 C-V Analyzer

SWITCH MATRIX OPTIONS

Ultra Low Current 100fA offset, 30μV offset, remote or local sense
Low Current 1pA offset, 40μV offset, 12–360 pins, local sense only
General Purpose 100pA offset, 5μV offset, 12–360 pins, remote sense

CABINETS AND MOUNTING ACCESSORIES

4200-CAB-20UX 20U Cabinet (35")
4200-CAB-25UX 25U Cabinet (44")
4200-CAB-34UX 34U Cabinet (60")
4200-RM Slide Rack Mounting Kit for 4200-SCS/F and 4200-SCS/C
4200-CRT-RM Fixed Rack Mounting Kit for 4200-CRT
4200-KEY-RM Slide Rack Mounting Kit for standard keyboard and pointing device
2288-1G Model 590 Rack Mount Kit

DRIVER OPTIONS

4200ICDRV IC-CAP Driver
4200ICSRC IC-CAP Driver Source Code

ADDITIONAL CABLES AND CONNECTORS

4200-RPC-0.3 Remote PreAmp Cable, 0.3m (for use inside prober shield)
4200-RPC-2 Remote PreAmp Cable, 2m (for remote location of 4200-PA, one included with each 4200-PA)
4200-RPC-3 Remote PreAmp Cable, 3m (for remote location of 4200-PA)
4200-RPC-6 Remote PreAmp Cable, 6m (for remote location of 4200-PA)
4200-TRX-0.3 Ultra Low Noise PreAmp Triax Cable, 0.3m, (Triax-Triax, connects 4200-PA to a test fixture, recommended for remote location of the 4200-PA)
4200-TRX-1 Ultra Low Noise PreAmp Triax Cable, 1m, (Triax-Triax, connects 4200-PA to a test fixture)
4200-TRX-2 Ultra Low Noise PreAmp Triax Cable, 2m, (Triax-Triax, connects 4200-PA to a test fixture, two included with each 4200-PA)
4200-TRX-3 Ultra Low Noise PreAmp Triax Cable, 3m, (Triax-Triax, connects 4200-PA to a test fixture)
4200-MTRX-1 Ultra Low Noise SMU Triax Cable, 1m (Mini Triax-Triax, connects 4200 SMUs to a test fixture)
4200-MTRX-2 Ultra Low Noise SMU Triax Cable, 2m (Mini Triax-Triax, connects 4200 SMUs to a test fixture, two included with each 4200 SMU that is not configured with a Remote PreAmp)
4200-MTRX-3 Ultra Low Noise SMU Triax Cable, 3m (Mini Triax-Triax, connects 4200 SMUs to a test fixture)
236-ILC-3 Interlock Cable, 3m (one included with each 4200-SCS)
7007-1 Shielded IEEE-488 Cable (1m)
7007-2 Shielded IEEE-488 Cable (2m)
7078-TRX-BNC Coaxial connector for connecting coax instruments to a triax matrix

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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.

Keithley User Library Tool (KULT)

The Keithley User Library Tool supports creating and integrating C-language subroutine libraries with the test environment. 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 S400 Series Parametric Test Systems. This simplifies migration of test libraries between the Model 4200-SCS and Keithley parametric test systems.

SPECIFICATION CONDITIONS

Specifications are the performance standards against which the 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.

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
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.

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 ±	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.

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Supplemental Information

Supplemental information is not warranted, but provides useful information about the 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, $R_L = 10k\Omega$, 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: <10 Ω in series with FORCE terminal not to exceed a 5V difference between FORCE and SENSE terminals. $\pm 30V$ maximum between COMMON and SENSE LO.

Additional 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 \pm (%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: >10¹³ 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; 4.4A using 5-way binding posts.

LOAD CAPACITANCE: No limit.

CABLE RESISTANCE: FORCE $\leq 1\Omega$, SENSE $\leq 10\Omega$.

MAXIMUM LOAD CAPACITANCE: 10nF.

MAXIMUM GUARD OFFSET VOLTAGE: 3mV from FORCE.

GUARD OUTPUT IMPEDANCE: 100k Ω .

MAXIMUM GUARD CAPACITANCE: 1500pF.

MAXIMUM SHIELD CAPACITANCE: 3300pF.

4200-SMU and 4210-SMU SHUNT RESISTANCE (FORCE to COMMON): >10¹² Ω (100nA–1 μA ranges).

4200-PA SHUNT RESISTANCE (FORCE to COMMON): >10¹⁶ Ω (1pA and 10pA ranges), >10¹³ 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 .

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: 500VA.

REGULATORY COMPLIANCE:

Safety: Low Voltage Directive 73/23/EEC.

EMC: Directive 89/336/EEC.

DIMENSIONS: 43.6cm wide \times 22.3cm high \times 56.5cm deep (17 $\frac{1}{2}$ in \times 8 $\frac{3}{4}$ in \times 22 $\frac{1}{4}$ in).

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

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

NOTES

- All ranges extend to 105% of full scale.
- Specifications apply on these ranges with or without a 4200-PA.
- Specified resolution is limited by fundamental noise limits. Measured resolution is 6 $\frac{1}{2}$ digits on each range. Source resolution is 4 $\frac{1}{2}$ digits on each range.
- Interlock must be engaged to use the 200V range.

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