A GREATER MEASURE OF CONFIDENCE

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 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 and test structures. This advanced parameter analyzer provides intuitive and sophisticated capabilities for semiconductor device characterization. The 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. The Keithley Interactive Test Environment 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 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 4200-PA, extends the system’s measurement resolution from 100fA to 0.1fA by effectively adding five current ranges to 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 4200-SCS for local operation. This installation allows for standard cabling to a probe, 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 probe 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 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.
4200-SCS

Semiconductor Characterization System

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.

Accessories Available

Computer Options
4200-CRT: 17” SVGA CRT
4200-MOUSE: Microsoft 2-Button Mouse

Remote Preamplifier Mounting Options
4200-MAG-BASE: Magnetic Base for mounting 4200-PA on a prober plate
4200/VAC-BASE: Vacuum Base for mounting 4200-PA on a prober plate
4200/TMB: Triaxial mounting bracket for mounting 4200-PA on a triaxial mounting panel

Other Accessories
4200-0AN: 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
9509: Calibration Sources for Model 590 C-V Analyzer

Switch Matrix Options
Ultra Low Current: 300µA offset, 5µV offset, remote or local sense
Low Current: 1µA offset, 40µV offset, 12-560 pins, local sense only
General Purpose: 100pA offset, 5µV offset, 12-560 pins, remote sense

Cabinets and Mounting Accessories
4200-CAB-20UX: 20U Cabinet (35 in.)
4200-CAB-25UX: 25U Cabinet (44 in.)
4200-CAB-34UX: 34U Cabinet (60 in.)
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-K ey/RM: Slide Rack Mounting Kit for standard keyboard and pointing device
2288-1G: Model 590 Rack Mount Kit

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-PS)
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 (3m)
7007-2: Shielded IEEE-488 Cable (2m)
7078/TRX-BNC: Crural connector for connecting coax instruments to a triax matrix

The Keithley Interactive Test Environment 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.
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 probes 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 probes. A manual prober mode prompts the operator to perform prober operations during the test sequence.

Test Sequencing
The Keithley Interactive Test Environment (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 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 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.

- 25°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

<table>
<thead>
<tr>
<th>Current Range</th>
<th>Max. Voltage</th>
<th>Measure</th>
<th>Accuracy</th>
<th>Resolution</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A</td>
<td>21 V</td>
<td>1 µA</td>
<td>0.100 %  + 200 µA</td>
<td>50 µA</td>
<td>0.100 %  + 350 µA</td>
</tr>
<tr>
<td>100 mA</td>
<td>210 V</td>
<td>100 nA</td>
<td>0.015 %  + 3 nA</td>
<td>5 nA</td>
<td>0.050 %  + 15 µA</td>
</tr>
<tr>
<td>10 mA</td>
<td>210 V</td>
<td>10 nA</td>
<td>0.07 %  + 300 nA</td>
<td>500 nA</td>
<td>0.042 %  + 15 µA</td>
</tr>
<tr>
<td>1 mA</td>
<td>210 V</td>
<td>1 nA</td>
<td>0.05 %  + 50 nA</td>
<td>50 nA</td>
<td>0.040 %  + 150 nA</td>
</tr>
<tr>
<td>100 µA</td>
<td>210 V</td>
<td>10 µA</td>
<td>0.050 %  + 600 pA</td>
<td>500 pA</td>
<td>0.066%  + 1.5 nA</td>
</tr>
<tr>
<td>1 µA</td>
<td>210 V</td>
<td>1 µA</td>
<td>0.050%  + 100 pA</td>
<td>50 pA</td>
<td>0.060%  + 200 pA</td>
</tr>
<tr>
<td>100 nA</td>
<td>210 V</td>
<td>100 fA</td>
<td>0.050%  + 50 pA</td>
<td>5 pA</td>
<td>0.060%  + 30 pA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Voltage Range</th>
<th>Max. Current</th>
<th>Measure</th>
<th>Accuracy</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>200 V²</td>
<td>105 mA</td>
<td>105 mA</td>
<td>200 µV</td>
<td>0.015 %  + 5 mV</td>
</tr>
<tr>
<td>20 V</td>
<td>105 mA</td>
<td>105 mA</td>
<td>20 µV</td>
<td>0.01 %  + 1 mV</td>
</tr>
<tr>
<td>2 V</td>
<td>105 mA</td>
<td>105 mA</td>
<td>2 µV</td>
<td>0.012 %  + 150 µV</td>
</tr>
<tr>
<td>200 mV</td>
<td>105 mA</td>
<td>105 mA</td>
<td>1 µV</td>
<td>0.012 %  + 100 µV</td>
</tr>
</tbody>
</table>

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

**CURRENT COMPLIANCE:** Bipolar limits set with a single value between full scale and 10% of selected current range.
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.
Overrange: <1% typical.
Voltage: Full scale step, resistive load, and 10mA range.

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

**GUARD OUTPUT IMPEDANCE:**
300Ω

**GUARD OFFSET VOLTAGE:**
5mV from FORCE

**GUARD CAPACITANCE:**
100pF

**GUARD SHIELD CAPACITANCE:**
350pF

**INPUT IMPEDANCE:**
>10^12 Ω (100nA–1µA ranges).

**MAXIMUM LOAD CAPACITANCE:**
10µF

**MAXIMUM 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):**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Resolution</th>
<th>Accuracy (±(%rdg + volts))</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 V</td>
<td>20 µV</td>
<td>0.01% + 1 mV</td>
</tr>
<tr>
<td>2 V</td>
<td>2 µV</td>
<td>0.012% + 110 µV</td>
</tr>
<tr>
<td>200 mV</td>
<td>1 µV</td>
<td>0.012% + 80 µV</td>
</tr>
</tbody>
</table>

**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.

**LOAD CAPACITANCE:**
No limit.

**CABLE RESISTANCE:**
FORCE = 1Ω, SENSE = 10Ω.

**REMOTE SENSE:**
<10Ω in series with FORCE terminal not to exceed a 5V difference between FORCE and SENSE terminals.

**MAXIMUM LOAD CAPACITANCE:**
10µF

**MAXIMUM GUARD OFFSET VOLTAGE:**
5mV from FORCE

**GUARD OUTPUT IMPEDANCE:**
300Ω

**GUARD CAPACITANCE:**
100pF

**GUARD SHIELD CAPACITANCE:**
350pF

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

**4200-PA SHUNT RESISTANCE (FORCE to COMMON):**
>10^6 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 4200-PA.

**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°C to +40°C.
Storage: –15°C 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.
Max VA: 500VA.

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

**DIMENSIONS:**
43.6cm wide × 22.3cm high × 56.5cm deep (17 5/32 in × 8 3/4 in × 22 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**
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.