4200-SCS

Hot Carrier System

- High accuracy, low noise instrumentation allows measurement of degradation as small as 0.05%
- Measurement of small degradation allows shorter test times and better lifetime extrapolation
- Short test times and fast feedback
- Allows stressing multiple transistors in parallel at the wafer level
- Measure up to 10 parameters/ DUT at each readpoint
- Stress and analyze both N and P channel transistors
- User-defined Fail and Exit parameters
- Real-time degradation plots
- Compliant with JESD 28 and JESD 60 standards
- Excel-based Lifetime Analysis Tool

Testing hot carrier degradation of MOS transistors at the wafer level provides quicker feedback and is more cost-effective than testing packaged test structures. It eliminates all packaging costs and delays. Keithley's Model 4200-SCS Hot Carrier System allows accurate hot carrier degradation testing as soon as wafers are produced. It combines fast, low noise measurement instrumentation with the analysis tools needed to produce lifetime projections quickly and easily. When the Hot Carrier System is paired with an appropriate prober, the same voltage stress conditions and test temperatures (typically room temperature or cold) can be used as when testing packaged transistors.

High Measurement Accuracy

Keithley's Hot Carrier System is based on the powerful Model 4200 Semiconductor Characterization System, which combines high speed and accuracy with low measurement noise. The Model 4200-SCS's current measurement noise is typically less than 0.001% of the measurement range and its one-year accuracy specification is less than 0.02% drift. In contrast, competitive solutions often have as much as 1% drift because they employ lower-cost, lower-accuracy sourcing and measurement architectures. The Model 4200-SCS's high quality instrumentation makes it possible to measure very small percentages of DUT degradation with high accuracy. In many cases, the system's low measurement noise and high accuracy makes possible accurate lifetime projections with as little as 1% degradation in the transistor performance. For more information on the Model 4200-SCS, download the full instrument specification from Keithley's web site.

Rapidly Detect Process Variation

The results of wafer level hot carrier tests can be rapidly correlated to process changes in the gate oxide, LDD length, or other transistor parameters that influence hot carrier lifetime.

High Configuration Flexibility

The Keithley 4200-SCS can be configured with up to eight Keithley Source-Measure Units (SMUs). Two different SMU models can be combined in the same system: a medium-power (100mA, 2W) version and a high-power (1A, 20W) version. Each SMU has the ability to force or measure voltage from 0.1μV to ±200V, as well as measure currents from 1fA to 1A with optional remote preamps. This wide range allows the Model 4200-SCS Hot Carrier System to combine a variety of stress levels with high sensitivity measurements for accurate device characterization.

Powerful Hot Carrier Stress Test Software

The 4200-SCS's Hot Carrier Stress Test software makes it easy to configure the SMUs to provide any desired combination of drain, source, and/or substrate voltages. For example, with an eight-SMU configuration, the system can be configured to produce four drain voltages and four gate voltages or six drain voltages and two gate voltages.

The Hot Carrier Stress Test software supports monitoring from one to ten characterization parameters for each readpoint. These parameters can be measured in the forward and/or reverse (source and drain swapped) direction:

- Linear drain current (IdLin)
- Saturated drain current (IdSat)
- Gate current (IGate)

The Model 4200-SCS Hot Carrier System can be used with a multi-site parallel probe card to allow compatibility with existing test structure layouts.

Lab grade DC device characterization

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A GREATER MEASURE OF CONFIDENCE

4200-SCS

Hot Carrier System

Ordering Information

4200HCI-4.3 Advanced HCI Application Package

Includes on CD-ROM:

- **HCI Stress Test software**
- **HCI Lifetime Analysis software**
- **User manuals**

Minimum System Requirements

- **One 4200-SCS with:**
  - **Three 4200-SMU Source-Measure Units**
  - **Three 4200-PA PreAmps**
  - **KTE Interactive v4.3**
- **One 4200-UL-LS-12 or equivalent switch matrix**

Options

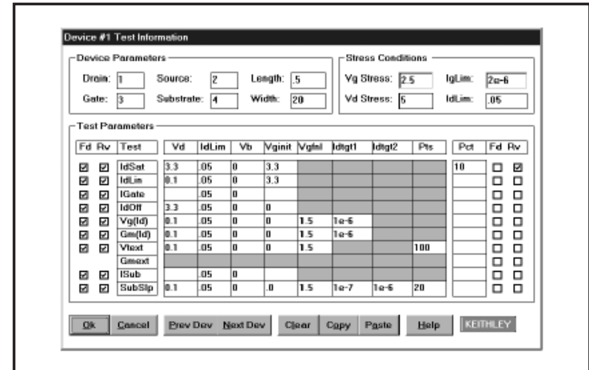
- **Up to five additional 4200-SMUs**
- **Up to four additional 4210-SMUs**
- **Expansion of the Switch Matrix up to 4200-UL-LS-72**
- **Up to five more 4200-PA PreAmps**
- **9139A Probe Card Adapter**

Third Party Options

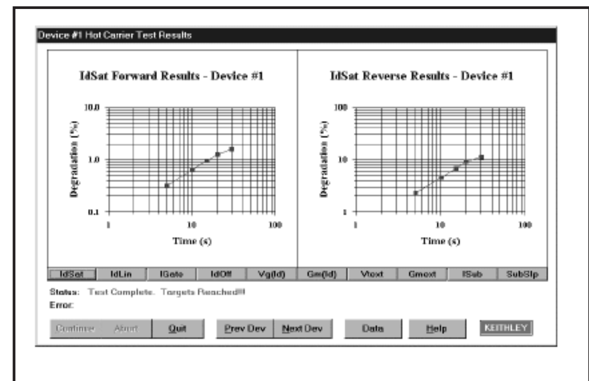
- **Celadon Multi-site Probe Card**

- Drain current measured with the transistor in the off state (IdOff)
- Threshold voltage test at specified drain current (Vg(Id))
- Transconductance at specified drain current (Gm(Id))
- Extrapolated threshold voltage (Vtext)
- Maximum transconductance (Gmext)
- Substrate current (ISub)
- Subthreshold slope (SubSlp)

A percent-drift failure criterion can be specified for any or all of these parameters, in either or both the forward and reverse direction. These percent-drift criteria can be assigned independently for each parameter and direction. When all of the specified percent-drift failure criteria are met for a DUT, the test on that DUT is stopped. If no percent-drift failure criteria are specified for a specific parameter, the parameter is simply measured and recorded at each readpoint. The stress test program will continue until all of the specified percent-drift failure criteria are met for all of the DUTs or until the maximum stress time has elapsed.



The Hot Carrier System's intuitive user interface simplifies setting the desired device parameters, stress conditions, and test parameters.



The Hot Carrier System provides results in real time. At any point during the test, the measured parameters for each device can be displayed numerically or graphically by clicking the status display. The status display also includes the time on stress and the time to next readpoint.

Flexible Lifetime Analysis Software

The lifetime analysis software included in the 4200-SCS Hot Carrier System provides detailed analysis based on Microsoft® Excel spreadsheets. Test results are ported to a spreadsheet, where the simple-to-use Excel macros provided can display the degradation of each device as a function of time, fit a line to the data, and project a time to a specified percent degradation. This projected point in time can be exported to a second spreadsheet, which is analyzed by source/drain voltage or substrate current for each DUT. Once it's plotted vs. the stress condition, a least squares fit to this data can be performed, and a projected lifetime at some specified use condition can then be calculated. The Hot Carrier Lifetime Analysis software includes automated macros that make it easy to perform all these analysis functions with just a few mouse-clicks.

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