KEITHLEY
A Tektronix Company

Application Note Series

Number 2846

ACS Integrated Test System for Lab-Based Automation

Introduction

As time to market and cost of test pressures mount, efficiency of tool usage and test engineer productivity continue to be scrutinized. Increased automation is a common way to better leverage resources. The progression from single die testing on manual probers to single wafer testing with semi-automatic probers naturally leads to full cassette probing on automatic probers. Doing this kind of testing with the precision and flexibility of laboratory-based tools, but without the expense of production parametric test systems, has been difficult in the past. It usually encompassed significant amounts of custom code and specialized test stands as well as highly trained engineers to run the equipment. Keithley has the solution. Combining Keithley's Automated Characterization Suite (ACS) software with the Model 4200-SCS Parameter Analyzer provides the best of both worlds—lab-level characterization and production automation.

Industry-Leading Lab Characterization

The Model 4200-SCS has been a leading tool in semiconductor labs for a variety of characterization and modeling tasks. Typical applications include standard DC I-V and C-V testing of test structures and devices like BJTs, FETs, and diodes. Multi-channel source capabilities up to 1A and 200V and measurement resolution down to 100 atto-Amps and 1μV make the Model 4200-SCS suitable for a wide variety of devices and technologies. The onboard PC and integrated software (Keithley Test Environment Interactive, or KTEI) are ideal for semiconductor device engineers who do testing interactively, typically with a manual or semi-automatic probe station.

The Ultra-Fast I-V hardware and software have significantly broadened the measurement capabilities of the Model 4200-SCS. Typical CMOS device tests include charge pumping, isothermal pulse I-V, and NBTI/PBTI reliability analysis. The field of non-volatile memory continues to grow, requiring measurements for Flash and evolving technologies such as PCM, FeRAM, and RRAM. Ultra-Fast I-V can also be applied to compound semiconductor devices, nanotechnology, MEMS, and more. The combination of DC I-V, C-V, and ultra-fast I-V provides the semiconductor engineer with all the capability necessary for full materials, device, and process characterization.

Wafer-based Automation Software

ACS is designed from the ground up for wafer- or cassette-level automation including control of most standard automatic probers. With an intuitive user flow, such as wafer map definition and a variety of test modules and test patterns, setting

Figure 1. Example Model 4200-SCS running ACS and controlling a switch matrix.

up and running fully automated tests for wafer- or cassette-level throughput is a very straightforward task (see ***Figure 2***). A powerful reporting tool manages both data collection and presentation to avoid drowning engineers in the massive amounts of data that can be generated by full parametric characterization on multiple die across many wafers.

The ACS software can control fully automated probers in both cassette-level automation and semi-automatic mode (move around on a single wafer), which is useful for doing test development work or debugging. When run from the Model 4200-SCS embedded PC (based on the Windows® 7 operating system), ACS can also control other instruments and hardware over the Model 4200-SCS GPIB port and bring any resulting data back into ACS for parameter extraction and data management. Running C-V tests and controlling pulsers, switch matrices, and probers is common in R&D labs and intuitively easy to setup and operate in the ACS environment.

Simple pattern creation and test setup (***Figure 3***) minimizes human intervention and setup time. Saving "recipes" and other test plans can streamline increasing test needs and satisfy the demands for quicker re-purposing of test stands.

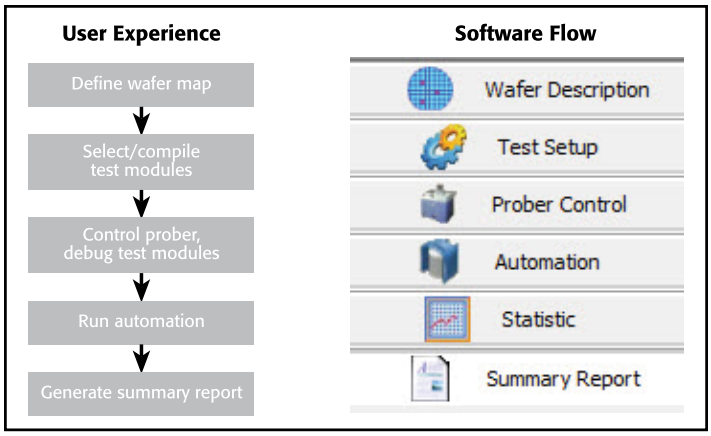

Figure 2. Typical setup and use case flow of ACS software.

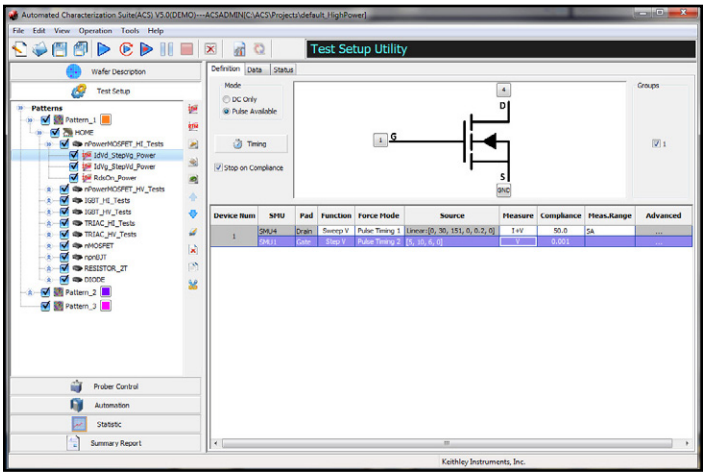

Figure 3. Example of the test setup capabilities of ACS software.

Integrating the Model 4200-SCS with ACS Software

Installing ACS directly onto the embedded PC of the Model 4200-SCS brings the strength of both pieces together into a potent ACS integrated test system. The small footprint but powerful measurement hardware of the Model 4200-SCS combined with the full automation features of ACS software results in impressive test capabilities and automation in a very small package (***Figure 1***).

Use cases can be very broad and include:

- **Technology development:** When a technology development engineer needs to run a variety of process splits to determine the operational corners of a process and acquire parametric data from many test structures on each wafer and across many wafers
- **Parametric functional test:** When a parametric test needs to be run across many devices on multiple wafers with little human intervention, but high throughput is secondary to cost of test and ease of use
- **Custom modeling tool:** When a modeling tool requires parametric results on a wide variety of devices, which are then imported into the modeling software and analyzed to create the software device models

ACS has complete access to and control over the full range of DC, C-V, and ultra-fast I-V measurement hardware. In addition, the system can easily be configured with additional C-V meters, switch matrices, or other external hardware controlled by ACS software to extend the solution's capabilities to meet any test need.

Precision Laboratory Equipment with Full Automation Capabilities to Lower Cost of Test

Leveraging the Model 4200-SCS Semiconductor Analyzer into an automated test system by adding significant automation capabilities can significantly lower cost of test. A Model 4200-SCS-based ACS system is ideal for applications that generate high volumes of data but are not as throughput intensive as high volume final test. Simplifying the engineer's job through intuitive setup and operations and minimized intervention during testing can also significantly reduce cost of test. A minimal setup is shown in ***Figure 4***.

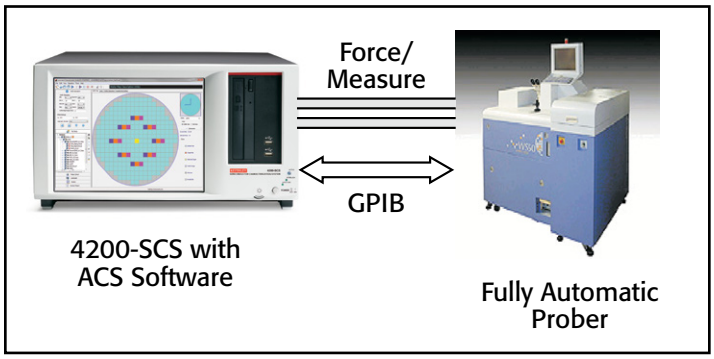

Figure 4. A Model 4200-SCS running ACS software plus an automated prober can be sufficient to run a wide variety of automated DC and pulse parametric tests.

Conclusion

Increasing time to market and cost of test pressures means that test engineers must do more with less. Leveraging Keithley's proven instrumentation and measurements, ACS integrated test systems fill an important gap between interactive laboratory-based tools and high throughput production test tools.

In this case, having ACS running on the Model 4200-SCS Parameter Analyzer is an excellent way to take lab-grade parametric measurements to the next level of automation, with the resultant reduction in cost of test. Having an integrated test instrument with a small footprint that can do high quality automated testing lets test engineers run significant amounts of tests and data with minimal setup time and minimal manual intervention during testing—in a very cost-effective package. Powerful and flexible analysis, presentation, and reporting tools make post-test tasks simple.

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A Greater Measure of Confidence

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