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High speed Linux and Solaris/UNIX-based test platforms

SEMICONDUCTOR

Series S600

Parametric Test Systems

- On-wafer DC to RF testing on a single platform
- Designed to minimize Cost of Test
- Wide range of applications covered
- SECS/GEM automation for 300mm and 200mm



Ordering Information

System Configurations

Call factory to discuss configuration options for Series S600 Parametric Test Systems.

High Capital Equipment Reuse Minimizes Cost of Test

Keithley's Series S600 parametric testers are designed to help fabs and wafer foundries reduce their Cost of Test (COT). Ongoing changes in materials, design rules, and wafer size typically produce a semiconductor process "inflection" roughly every 18 months. These rapid changes mean one of the most significant contributors to a semiconductor manufacturer's COT is capital equipment reuse, rather than the initial equipment cost. That makes it critical to be able to upgrade a parametric test system cost-effectively to address new requirements. While most fabs typically expect 70–80% capital equipment reuse across multiple process generations, Keithley parametric testers have provided industry-leading capital equipment reuse over more than five technology inflections.

The S680 tester is Keithley's latest, most powerful system configuration based on our Series S600 Linux or Solaris/UNIX platform. Like our earlier Series S600 systems, it offers fabs high throughput combined with superior DC measurement capability and broad testing flexibility. The S680 has been enhanced to address emerging measurement needs with the capability to characterize ultra-thin gate dielectrics, SOI, new devices, new materials like copper and low-κ dielectrics, femtoamp-level DC leakage, and RF measurements of high performance BiCMOS and analog devices.

Adaptable to Changing Device Technologies

Series S600 testers are well suited for use in a wide range of testing environments, including process control, process and equipment tuning and optimization, equipment qualification, Wafer Acceptance Testing, and device modeling and characterization. Their high throughput and low-level current sensitivity make them ideal for applications such as production test for new device technologies, including System on a Chip (SOC), FeRAM, MRAM, PCRAM, and high density devices.

With the industry moving toward larger wafer sizes, fabs are being challenged to find the time to do the sampling they need without delaying production. High speed Source-Measure Units (SMUs) and high throughput software options like true parallel testing and site-level/real-time adaptive testing allow S680 users to test 300mm wafers in the same time once required to test a 200mm wafer.

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Series S600 Parametric Test Systems

Per-Pin Electronics Boost Low Level Accuracy

The design of Series S600 testers makes it possible to present instrumentation for current/voltage source/measurement and capacitance measurement on each DUT pin. Each pin can also provide a quiet analog ground connection or a nearly perfect open circuit, minimizing second-order effects such as leakage and parasitic capacitance, also eliminating noise artifacts.

The S680 uses active electronics on each tester pin inside a test head that mounts on top of the prober. Each probing pin has its own amplifier for bi-directional scaling of currents. The amplifiers, which are located within centimeters of the wafer, boost the low-level analog signals far above the noise "floor" of the system. The amplified signals then pass through a high speed, solid-state switch matrix on their way to the measurement instruments.

S680 Enhancements and Options

The S680 incorporates a number of important enhancements to the basic Series S600 design. Keithley's commitment to providing the highest equipment reuse in the parametric test industry ensures that almost all of these capabilities are available as field-installable upgrades to existing Series S600 systems already on the fab floor, not just in new systems.

The S680's new cabinet design provides greater instrumentation capacity for future system expansion and an integrated system controller and controller input/output. The controllers can be Linux or Solaris/UNIX platforms, which are interoperable on the test floor. As factory automation reaches into more and more areas of the fab, the S680's SEMI-compliant, single-wire SECS/GEM capability simplifies integrating the system into the fab's environment. The SMU has also been redesigned to combine low current, high power sourcing and measurement with faster digital communication with other system components. Cost-effective options for higher throughput include true parallel testing of up to eight DUTs within a single probe touchdown in a subsite, as well as site-level, real-time, adaptive testing capabilities. The Series S600 was the first parametric test system to implement parallel parametric test and have it patented.

Other instrumentation options for the S680 include:

- Additional ultra low current, high-power SMUs (up to a system total of eight)
- Additional remote testhead pre-amplifiers (up to a system total of 16 to enable 64-pin testing)
- Fast 100kHz C-V using remote testhead pre-amplifier
- Single- and dual-channel pulse generators for embedded memory measurements
- Multi-frequency LCR for dielectric layer measurements
- Frequency counter for ring oscillator measurements
- Spectrum analyzer for ring oscillator measurements
- Interface packages for a wide variety of prober models

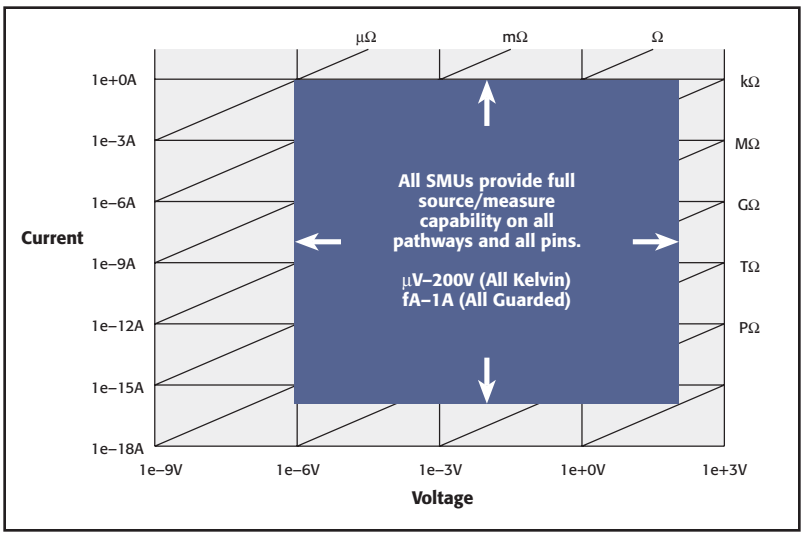


Figure 1. Series S600 measurement ranges

Together, these base system enhancements and powerful options ensure the S680 provides fast test throughput, easy programming, and high measurement accuracy and precision.

RF Option

The RF option is designed to speed and simplify measuring RF parameters in sequence with DC parametric testing. This option, which can be specified when ordering new S680 testers or as a field-installable upgrade to existing Series S600 systems, allows performing 2-port s-parameter testing at bandwidths up to 40GHz. It's ideal for single-insertion DC and RF testing of analog and BiCMOS ICs, such as those used in mobile wireless consumer products. Keithley developed the capabilities provided in this option by forming a working partnership with Anritsu Corporation, a leading producer of Vector Network Analyzers (VNAs).

RF Testing Applications

Device modeling is one of the most important applications for the RF option. The data produced is compatible with a number of popular device modeling packages, including BSIMPro, IC-CAP, and UTMOST. It allows device modeling labs to do simulation model fitting in a fraction of the time required for older rack-and-stack RF measurement configurations. The RF data browser included in the option's software reduces the time needed for data analysis from days to minutes.

Process monitoring is another common application for systems equipped with the RF option. The primary application is RFCV on sub-13Å advanced transistor gate oxides. Test macros for converting s-parameters to RF parameters such as fmax, ft, Rbb, and Q are also included. The system is equally well suited for general analysis of complex signals, including user-defined combinations of a1, a2, b1, and b2.

High speed Linux and Solaris/UNIX-based test platforms

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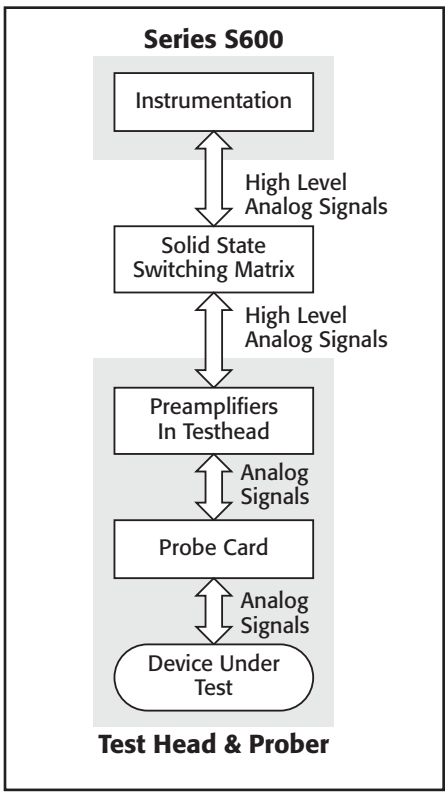


Figure 2. The "per-pin electronics" architecture of Series S600 systems. The Series S600 pre-amplifier architecture improves current sensitivity by minimizing the parasitic capacitances and leakage currents inherent in systems with long cables and a reed-relay-based switch matrix between the DUT and the measurement circuitry.

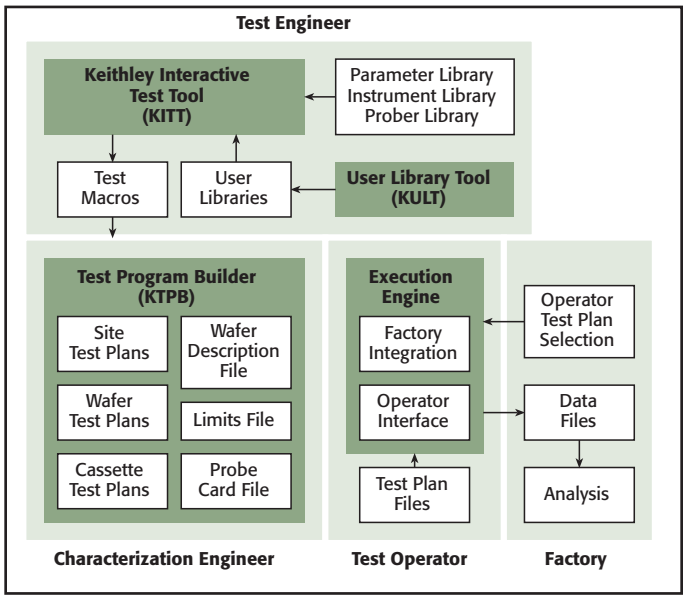


Figure 3. KTE software architecture

DC/RF Test Architecture

The RF option combines DC and RF testing in a single-insertion system that's practical for use in both technology development and process monitoring environments. By adding a VNA for on-wafer RF s-parameter testing at up to 40GHz to the standard DC parametric tester, the option combines two critical test functions in a single, high speed test system, increasing overall throughput dramatically. This option eliminates the long calibration and test times associated with using traditional rack-and-stack RF test solutions. It also eliminates the need for an expert to analyze and filter the data before the fab's general engineering and manufacturing community can use it.

Every Series S600 tester manufactured since 1996 can be cost-effectively upgraded with the RF option, so it's economical to incorporate RF s-parameter measurement capabilities into an existing DC tester in either a technology development or process monitoring environment. This is yet another example of Keithley's commitment to capital equipment reuse.

Fabs can continue to use their existing production probers with this option, so there's no need to invest in a separate, expensive RF prober. There's no need to allocate additional expensive "real estate" on the fab floor for a separate RF test system because the combined DC/RF system occupies the same floor space as a regular DC tester does.

By adding RF capabilities to an existing DC tester, the RF option also minimizes the amount of additional training needed for engineers and operators – if they already know how to run a Keithley DC tester, learning how to use the DC/RF system is much faster and simpler than starting over with a totally new system.

Keithley Test Environment (KTE)

KTE provides a powerful test development and execution environment that has been refined with over 20 years of production experience. It is compatible with Series S600 testers as well as the RF options. KTE's high platform-to-platform compatibility not only shortens the user learning curve when working with multiple systems, but offers a smooth migration path to protect the fab's test software investment when upgrading to higher performance systems. Series S600 testers are available with either Linux or Solaris/UNIX platforms, which are essentially equivalent software packages.

Fast, Flexible Test Plan Development

The Graphical User Interface (GUI) in KTE guides test engineers through the development of a test plan. The user can create individual electrical tests at the subsite level by drawing on libraries of tests, then defining parameters and connections. To provide the ultimate in electrical test flexibility, KTE also lets users create User Libraries (custom parametric tests) using standard C. The C code generation utility simplifies this process by hiding most of the C code overhead and details.

KTE allows flexible sampling plans across individual wafers and lots. Key production control monitor tests can be performed at many wafer locations, while time-consuming tests can be assigned to a smaller set of locations. The tests to be run at each site are incorporated into a set of nested loops defined by the Keithley Test Execution Engine (KTXE). When KTXE is instructed to test a lot, it processes each wafer test plan in the cassette test plan. Within these loops, User Access Points (UAPs) simplify the customization of the test execution engine without the need for re-compiling or linking. UAPs can be used to perform tasks such as transferring data

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to other computers when a wafer's testing is completed.

In contrast to other parametric test environments, KTE offers fabs the ability to pick and choose freely from a growing line of available software options to provide a complete operational model for the parametric test floor (see **Figure 4**). Buying one option doesn't require purchasing any others, so fabs are free to configure their software environment as their applications require. Current software options include:

- **Keithley Recipe Manager Option**—This production-worthy package lets test program developers generate valid test plans quickly by allowing them to modify existing test plans easily for reuse. Version control tools prevent unintentional, undesired, or undocumented code changes, so only approved test sequences are released to production with automatic fanout and ISO-9001 traceability for recipes.
- **Probe Card Manager Option**—The Probe Card Manager (PCM) hardware/software package automates the management of probe card inventories with on-board memory on each probe card. It ensures proper testing by matching the probe card to the test program. The PCM option can be specified for new cards and testers or retrofit on existing ones.
- **AdapTest Software Option**—In Keithley parametric test systems, the fundamental unit of test is a device, not a cassette. The AdapTest software enhances test throughput, product yields, process control, and automated first-level process diagnostics by allowing the tester to change test sequences very quickly and flexibly in real time. AdapTest supports both results-based adaptive testing and preset zone-based testing. AdapTest also includes tools for electrical verification of probe-to-pad contact. This automates first level process diagnostics, and will optimize the next test measurement for speed, sensitivity, and/or location based on previous measurement results. This option will help lower the cost of test.

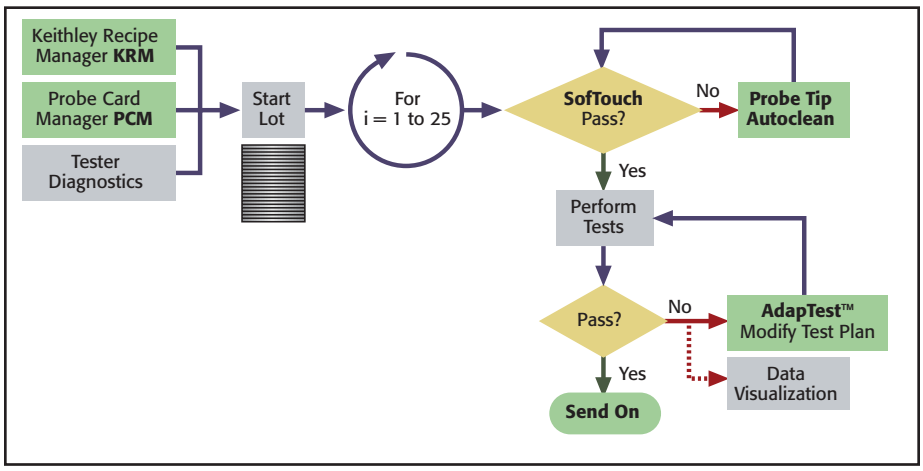


Figure 4. Keithley can provide a complete operational model for a parametric test cell.

- **Parallel Test Option**—With a total of eight SMUs installed, the Parallel Test option supports true parallel testing of up to eight DUTs within a single probe touchdown in a subsite. This can increase throughput by 15–60% on existing wafer technology products.
- **Copper Analysis Library Option**—This option provides a means of obtaining valuable information about a copper process readily. The software includes nine new copper test algorithms that can be easily incorporated into parametric test sequences. The documentation provides recommendations for copper test structures.
- **SECS/GEM Automation Option** (300mm and 200mm)—This option simplifies integrating the tester into the fab's overall automation environment. (200mm option is supported only by Solaris/UNIX at this time.)
- **Customer Specials**—New and emerging customer applications are addressed through the "Specials" process. Application and engineering groups collaborate on new customer solutions for production and R&D test.
- **Probe Card Vendor Relationships**—Keithley has qualified many vendors to manufacture a wide variety of probe cards: standard, low leakage, high temperature, RF, etc. See the Keithey Web site, www.keithley.com, for a list of qualified vendors and applications.

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