Hewlett-Packard: The Parametric Test Leader

Hewlett-Packard has been a world leader in parametric test solutions for more than a decade. Currently there are more than 1,500 HP 4062 parametric test systems installed worldwide.

In 1996, HP continued its tradition of excellence with the introduction of the HP 4071A, the first in a family of advanced parametric test systems. The HP 4070 family provides both faster throughput and improved measurement accuracy over the HP 4062UX. Since its introduction, the HP 4071A has set the standard for advanced parametric test systems with more than 200 systems installed worldwide by the end of 1998. The introduction of the HP 4072A extends the family of advanced parametric test systems and directly addresses the test needs associated with today's market trends.

A Complete, All-in-One Solution for Today’s Complex Parametric Test Needs

Today's market trends are being dictated by the popularity of system-on-a-chip (SOC) solutions and the increasing use of embedded Flash memory. Hewlett-Packard identified these trends early on and recognized that specialized parametric test systems are no longer an acceptable answer. Today's parametric testers must be able to handle the full spectrum of advanced parametric test as well as Flash memory cell evaluation and other high-frequency applications.

The HP 4072A is an all-in-one test solution that meets your advanced process needs by providing high-throughput parametric test, Flash memory cell evaluation, ring oscillator measurement, and wafer level reliability (WLR) test capabilities in a single measurement station. The combination of the HP 4072A and HP SPECS (Semiconductor Process Evaluation Core Software) allows you to choose the right level of performance to keep you competitive in today's increasingly complex marketplace, and positions you to meet future test challenges.
Enhanced Software Environment
The HP SPECS test shell, which runs on both the HP 4062UX and HP 4070 family, now includes several new framework templates. These templates greatly improve your capabilities in the areas of user interface customization, modular development of algorithms, and test automation speed. In addition, HP SPECS test plans developed on the HP 4071A are compatible with the HP 4072A.

The new HP FASTCode generator automatically generates HP BASIC/UX or C code to reduce test algorithm development time. You now have the ability to make a quick measurement in the Interactive Debug Panel (IDP) and effortlessly create equivalent test code. You can also use these auto-generated algorithms in either HP SPECS or your own test shell.

Preserving Your Investment
The upgrade capabilities of the HP 4070 family ensure that your current parametric test investment is protected. An upgrade package that converts an HP 4071A into an HP 4072A is available, and you can use all existing manipulator and probe card interface solutions with both products. As your advanced process requirements change, the HP 4072A will be ready to meet the new challenges.
Maximum Flexibility, Throughput, and Accuracy

Because DC resources are in the HP 4070 test head, throughput and accuracy are greatly enhanced over the previous generation of products. The resulting increase in performance is achieved without the need for complicated pre-amplification and calibration schemes. In addition, numerous instruments are integrated into the system test software, greatly reducing programming time.

Key Specifications

- **Up to 8 SMUs and 1GNDU**
  - 0.04% basic voltage accuracy
  - 0.1% basic current accuracy
  - 10 fA and 2 µV resolution
  - 100 mA/100 V max output (MPSMU)
  - 1 A/200 V max output (HPSMU)
  - Full Kelvin with active guard

- **Matrix: Up to 48 output pins (12 minimum)**
  - 2 active-guarded, shielded low current paths (non-Kelvin)
  - 6 full Kelvin active-guarded paths
  - 8 auxiliary input ports
  - 48 extended path inputs
  - 48 full Kelvin active-guarded outputs
  - Dedicated chuck connection
  - Built-in diagnostics requiring no external fixture
  - High frequency switching matrix (3 x 48 or two 3 x 24)
  - Pulse switch

- **HP 3458A: Integrated**
  - 1 µV resolution

- **HP 4284A: Integrated**
  - 1 fF to 10 nF measurement range
  - 1 KHz, 10 KHz, 100 KHz, and 1 MHz frequencies
  - Compensation includes probe card

- **HP 8110A: Integrated**
  - 20 ns to 200 ms transition time
  - +/− 19 V output amplitude (19 Vp-p)

- **HP 8114A: Integrated**
  - 65 ns fixed transition time
  - -49.9 V to 50 V output amplitude (40 Vp-p)
The Elegant Simplicity of Direct Docking

The direct docking scheme employed by the HP 4070 family provides you with both increased performance and lower cost of test. Direct docking eliminates the need for a test system to probe card interface and further enhances the benefits of the all-in-one solution. Output pins protrude beyond the test head surface for direct contact with the probe card. Direct docking vastly improves low-current measurement capability over bird-cage designs. Operators can remove, replace, and realign a probe card very quickly.

The direct docking scheme supports fully guarded Kelvin probe cards. Each output terminal consists of three signals: force, sense, and active guard. For maximum performance, the force and sense lines are terminated together on the probe card to create a Kelvin connection as close as possible to the device under test (DUT). The active guard is used to isolate the force and sense lines from noise sources for improved throughput, resolution, and accuracy.

Worldwide Probe Card Availability

To minimize your cost of test, HP provides a range of probe card choices. Probe cards for all of the popular wafer probers, including EG, TEL, and TSK, are available worldwide from a variety of non-proprietary suppliers. This large and localized supply base reduces costs and provides you with a range of choices.
**Complete Solution**

HP SPECS test shell software merges the intuitiveness of a graphical user interface (GUI) with the organizational logic of a spreadsheet to create an extremely efficient test plan development environment. HP SPECS allows you to enter new data quickly and to reuse existing test plans easily. Test plan generation requires the creation of only four specifications: wafer, die, probe, and test. The structured architecture of HP SPECS ensures the long-term supportability of your test plans, which in turn protects your software investment.

**Highly Efficient Data Analysis Tools**

A convenient data analysis package is integrated in the HP SPECS test environment. After test execution, HP SPECS stores test data and user-specified information as ASCII data files. These files are available for use directly with built-in report generators, so you can create formatted reports and graphs. In addition, you can create reports automatically by issuing commands from within your test plan. HP SPECS also supports graphical outputs such as wafer maps, X-Y graphs, and histograms.

**Test Plan Development**

- Friendly GUI
- Modular and Reusable Test Plan
- Transportable Test Plan

**Algorithm Library Development**

- Friendly GUI
- Automatic Code Generation

**Fully Automated Execution Environment**

1. Put cassette in prober.
2. Input cassette ID and push Start.

**Run-Time Analysis**

**Database**
Easy Test Development

You can utilize IDP and HP SPECS together for quick test plan development. Use IDP to set up an interactive measurement, make the measurement, and then use the HP FASTCode generator to create HP BASIC/UX or C code. Use the auto-generated code within your HP SPECS test plan.

Manually typing in the die that you want to test on a wafer can become tedious and confusing. HP SPECS eliminates this inconvenience by providing a graphical die selection capability that enables you to select exactly the die that you want to evaluate at test time.

Framework panels that have a similar appearance can sometimes be puzzling to both engineers and operators. To eliminate confusion, HP SPECS allows you to use bitmap images to customize your framework panels.

Improved Productivity through Frameworks

The HP SPECS framework structure enables you to customize and control the overall test shell behavior, and provides you with a convenient method of defining user interfaces, controlling wafer probers, and specifying test shell execution flow. The framework test plan language (TPL) gives you a compact, yet powerful, command set for running tests, making decisions, and outputting data.

The HP SPECS modular design allows you to combine any framework (engineering, production, or host) with any test specification. This greatly improves your ability to transfer test plans among engineering, production, plant sites, and business partners.

Ready for the Factory of the Future

HP SPECS can be linked with computer-integrated manufacturing (CIM) environments. A remote host or server can control the operation of a workstation running HP SPECS. In addition, HP SPECS stores data in an ASCII format so that it can easily be transferred to the data management system on the manufacturing floor for further analysis.
Integrated Flash Test

The increasing prevalence of system-on-a-chip (SOC) integrated circuit products with embedded Flash memory means that Flash cell testing capability is becoming a virtual necessity for all semiconductor parametric test systems. This means that today's integrated circuit manufacturers require a parametric test solution that can meet not only advanced DC testing needs, but sophisticated Flash memory cell evaluation requirements as well.

Fast Write/Erase Endurance Testing

The HP 4072A meets these requirements by incorporating powerful Flash memory cell testing capabilities. A versatile 60MHz @ -3dB (reference data) high-frequency matrix gives you maximum flexibility for pulse signal routing. The pulse switch, which is built into the test head, enables you to create multilevel pulses, switch between connected and open states, and flip automatically between write and erase conditions without the need for controller intervention. This reduces write to erase transition time from several hundred milliseconds to a few milliseconds. As a result, a typical million-cycle write/erase endurance test takes only a few hours instead of a week or more. In addition, control of the HP 8110A and HP 8114A pulse generators is fully integrated into the HP 4072A test instruction set (TIS), for easy test development.

IDP allows you to make interactive Flash cell measurements and to check the programmed output timing of each channel pulse via simulated waveforms in the waveform window. The HP FASTCode generator also allows you to automatically generate HP BASIC/UX or C code from your interactive Flash measurement setups.
Ring Oscillator Measurement

By using an inexpensive spectrum analyzer, the HP 4072A high-frequency matrix can make measurements of hundreds of megahertz.

Minimize Ring Oscillator Stages

Ring oscillator frequency is given by:

\[ f_{\text{OSC}} = \frac{1}{n \cdot (t_{\text{PHL}} + t_{\text{PLH}})} \]

where:
- \( n \) = number of ring oscillator stages
- \( t_{\text{PHL}} \) = inverter high to low propagation delay
- \( t_{\text{PLH}} \) = inverter low to high propagation delay

In order to minimize layout area, you need to reduce the number of inverters in a ring oscillator circuit. Making \( n \) smaller (by using fewer stages) increases the frequency that your test equipment must measure. Thus, minimizing layout area creates a high-frequency measurement dilemma for fast processes. The HP 4072A solves this predicament by enabling you to use a spectrum analyzer to make measurements of several hundreds of megahertz through its high-frequency matrix.

Ring Oscillator Evaluation

For the first time in parametric test, the HP 4072A high-frequency matrix provides a convenient means of evaluating ring oscillator circuits in both the laboratory and production. By using an inexpensive spectrum analyzer, you can achieve accurate frequency measurements of hundreds of megahertz. This method provides a more easily automated and clear-cut frequency determination than you can achieve using either a frequency counter or oscilloscope.
A Complete, Easy-to-Use WLR Package

HP offers WLR solutions for all phases of technology: development, qualification, and production. A complete suite of WLR tests can be created in a few minutes using PDQ-WLR software and the WLR framework in the HP SPECS test shell. Powerful new PDQ-AT (analysis tool) software reduces the onerous task of statistical analysis to a few simple mouse clicks. In addition, unique predictive PDQ-Fab WLR test structures and WLR application assistance from Sandia Technologies are also available.

What Is PDQ-WLR?

Predictive, Demonstrated, and Quantitative (PDQ) WLR software actually allows you to make quantitative predictions about the reliability of your process using tests that take only a few minutes. This is in stark contrast to the weeks or months required with traditional reliability testing. PDQ-WLR is widely recognized as being superior to other qualitative approaches.

Major semiconductor manufacturers have successfully used these advanced WLR tools to evaluate the reliability of many leading-edge process technologies, such as copper metalization and low-dielectric constant materials. As technologies continue to evolve, HP’s WLR solutions will continue to provide the most effective means to meet these new challenges.

Hewlett-Packard and Sandia Technologies offer a total WLR solution.
High Throughput with Superb Accuracy, Resolution, and Repeatability

The HP 4070 family achieves high throughput without sacrificing accuracy, resolution, or repeatability. By eliminating cable capacitance between the DUT and the SMUs, Hewlett-Packard's test system in a test head design vastly improves throughput. In addition, the HP 4070 family uses a dedicated and fully buffered FIFO optical interface to move commands and data between the test head and the system controller. The optical interface removes almost the entire overhead associated with electrically based designs.

Precise Low-Current Measurement

Hewlett-Packard’s innovative test system in a test head design also reduces undesirable parasitic effects to the lowest possible level. This precise engineering results in 0.1% basic current accuracy with 10fA current resolution.

The Future Is Available Today

The HP 4072A is truly a major innovation in parametric test. No other parametric test system provides you with a complete all-in-one test capability. The HP 4072A directly addresses the advanced parametric test requirements created by systems-on-a-chip, smaller geometries, and higher clock speeds. In addition, it meets new challenges like low-k dielectric materials with Cu metalization, and embedded Flash. Thus, the HP 4072A allows you to minimize your cost of test while maximizing your measurement capabilities.
Comprehensive, Worldwide Services and Support

The technological features and test capabilities of the HP 4072A are considerable. But HP offers more than advanced hardware and software.

HP has a worldwide force of locally based test experts ready to provide a full offering of service and support programs designed to meet your specific test needs.

Consulting and Training — Experienced systems or applications engineers offer advice for dealing with general test processes or complex custom solutions. Customer education classes cover a wide range of solutions for applications, software and hardware maintenance, and operations.

On-site System Repair — HP customer engineers specifically assigned to your company provide multiple levels of support.

Software Updates — A software update service ensures that you receive the latest software and documentation as soon as it becomes available.

Response Center Support — HP specialists can isolate your problem quickly and minimize system downtime.

Warranty Extension Options — Several different plans allow you to extend the original product warranty.

Technology Financing — Lease, rental, and installment plans are designed to make new technology immediately available on terms that fit your needs and budget.