Solutions for the Semiconductor Industry
The Challenges Ahead for Semiconductor Test

No one can argue that semiconductor technology has played a pivotal role in the explosive growth of multifunction consumer devices such as smartphones and tablets in recent years. Guided by Moore’s law, the performance and complexity of semiconductors continue to steadily increase across all categories ranging from microprocessors and memory to MEMS sensors and wireless chipsets. Keeping pace with these higher performance expectations is especially challenging today because consumers expect each new generation of devices to be cheaper and more capable. This creates intense competitive pressure for lower prices and margins. Semiconductor device manufacturers must compete aggressively to get their products to market faster in the face of tightening schedules. They also must compete for high-profile deals that could make or break multimillion-dollar product line investments. As it turns out, under today’s economic constraints, effectively testing these semiconductor devices can make the difference between success and failure.

The overall cost, size, power consumption, and slow technology adoption of traditional test equipment make it increasingly difficult for semiconductor manufacturers to succeed in today’s competitive market. National Instruments has new, disruptive technologies that represent a new generation of semiconductor test solutions, and we welcome the opportunity to discuss how we can help you meet your semiconductor test challenges.

Ron Wolfe
Vice President, Semiconductor Segment
Opportunities for Streamlining in Semiconductor Test

In the past, Moore’s law has guided semiconductor industry innovation, with transistor count doubling roughly every two years. As the number of transistors per IC increases, the cost to make each transistor decreases. On the other hand, as complexity increases, the cost to test each new generation of ICs, and subsequently test cost per transistor, continues to increase. While this trend is not unexpected, semiconductor manufacturers face considerable pressure to optimize cost at every part of the value chain, and test is one of the areas ripe for further optimization.

Many semiconductor characterization and validation labs still rely on largely manual test processes using rack-and-stack test equipment, while production test departments rely on sophisticated and capable but usually very expensive automated test equipment. These disparate approaches complicate correlating data from lab to production and fail to bring down the cost of test. Further optimization requires a common test platform that scales from design validation to production test, allows easy data sharing between design and test departments, and takes advantage of the latest innovations in off-the-shelf semiconductor technologies to reduce cost.

The Next-Generation Platform for Semiconductor Test

The National Instruments graphical system design platform addresses semiconductor test challenges by combining a rapidly expanding portfolio of world-class measurement instrumentation and highly productive software with the best of commercially available semiconductor and computer technologies. By taking advantage of the latest advances in PC buses, processors, and field-programmable gate array (FPGA) technologies, the NI PXI platform serves as a stage for the next level of optimization for semiconductor test that ultimately brings down test costs.

Graphical System Design Platform

The NI graphical system design platform accelerates productivity and reduces time and cost throughout the development, deployment, and maintenance of your test system. Engineers have dramatically reduced overall system costs by making the switch to NI software and PXI to realize shorter test execution times, improved software development productivity, faster throughput, and increased scalability.

PXI Modules

You can choose from more than 1,500 PXI modules and products from more than 70 vendors to meet your application needs.

Controllers

Controller options include high-performance embedded controllers with either a Microsoft Windows OS or a real-time OS (NI LabVIEW Real-Time) as well as remote controllers from a desktop, workstation, server, or laptop computer.

Standard Chassis Types

PXI chassis are available in a variety of configurations such as low noise, high temperature, and low- to high-slot count. They also offer a range of I/O module slot types, integrated peripherals such as LCD displays, and more.

Reference Configurations

NI offers reference configurations for data converters, RFICs, MEMS, and other semiconductor devices.
NI Programmable Power Supplies and Source Measure Units (SMUs)

National Instruments precision DC sources combine high-resolution, high-speed outputs with accurate voltage and current measurements to provide a constant power source to IV curve generation and leakage measurements.

- 4-quadrant outputs with down to 10 pA measurement sensitivity or up to 40 W sourcing
- Up to four SMU channels per PXI slot with sampling rates up to 600 kS/s

High-Speed Digital I/O

National Instruments high-speed digital I/O products offer solutions for the generation or acquisition of digital vectors including creation of complex digital test patterns and communication/protocol schemes. Applications include bit error rate testing (BERT), protocol emulation, and voltage threshold testing.

- Per pin parametric measurement unit (PPMU) capability
- Up to 1 Gbit/s data rates

Data Converters

The NI automated test platform provides the only complete software-defined solution with world-class measurement hardware that empowers engineers to build cost-effective semiconductor test systems. These systems meet increasingly complex test requirements while reducing system footprint and development time.

“PXI enabled us to improve the quality of our ADC characterization considerably and reduce test costs by saving valuable test development time.”

-Manfred Pauritsch, University of Applied Sciences

Automated Characterization of Analog-to-Digital Converters Using PXI, LabVIEW, and DIAdem

In cooperation with the Automation Systems Department at the University of Applied Sciences in Graz, Austria, AMS engineers developed a fully automatic measurement system based on PXI, which supports the accurate characterization of ADCs. They used this measurement system to characterize ADCs from the Standard Linear (SLI) product line of AMS.

AMS engineers divided the ADC measurements into nine different groups that cover all of the parameters for the chip. In addition to the respective data sheet parameters, they characterized specifications that are correlated with the converter quality and provide valuable findings for further development. The test groups for the ADC included dynamic, statistical, offset, intermodulation distortion, internal, energy, resistance and capacitance performance as well as logic input and timing tests.

They chose components for the measurement system with regard to their measurement precision. They wanted the final system to be completely automated with synchronized generation and acquisition signals. The core of the system is an NI PXI chassis that contains an NI PXI-5422 arbitrary waveform generator, an NI PXI-6652 digital waveform generator/analyzer, an NI PXI-4130 source measure unit, an NI PXI-4110 programmable power supply, and an NI PXI-6259 multifunction DAQ module.

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Learn about this case study at ni.com/case-study/ams

Digitizers/Oscilloscopes

Optimized for automated test, National Instruments digitizers take advantage of the high-throughput PXI and PXI Express buses to lower test times, offer picosecond-level synchronization between modules, and easily integrate with the entire suite of NI hardware.

- Up to 24 bits of resolution and for high-dynamic-range, low-distortion measurements
- Up to 12.5 GS/s sampling rates and 5 GHz bandwidth for wideband high-frequency signals

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Wireless ICs

Wireless ICs are in the middle of one of the most explosive growth periods as mobile devices rapidly gain adoption worldwide. By the end of the year, the mobile phone industry will sell nearly 2 billion phones. It isn’t uncommon for these products to feature multiple wireless ICs including RF transceivers, power amplifiers, LNAs, and switches. The same phones incorporate the latest high-performance technology like LTE and 802.11ac. National Instruments offers a complete hardware and software platform to test these devices with advanced standards from design to manufacturing test.

“Overall, the PXI system was 10 times faster and three times less expensive than the previous solution. The PXI platform also provided the flexibility needed to adapt to all the different digital and RF standards.”

– Sylvain Bertrand, ST-Ericsson

TriQuint Semiconductor Uses NI PXI and LabVIEW to Reduce Characterization Time of RF Power Amplifiers (PAs)

TriQuint Semiconductor needed to test the increasingly complex parts across a wide range of frequencies, voltage supply levels, temperatures, and power ranges. The complete characterization process for a typical part requires 30,000 to 40,000 lines of data to completely test the design. Using traditional rack-and-stack RF test equipment, it took roughly 10 seconds to collect each line of data, which required more than 110 hours of testing for each part. By using PXI to perform the bulk of the measurements on its PA test bench, TriQuint shortened the characterization time of its PAs from two weeks to about 24 hours. The company observed significant improvements in measurement time for each of its GSM, EDGE, and WCDMA measurement tests. Table 1 compares the measurement times and speedup of both the traditional and the PXI test benches.

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<tr>
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<th>Traditional Bench Test Time (s)</th>
<th>PXI Test Time (s)</th>
<th>Speedup</th>
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TriQuint Semiconductor used PXI and LabVIEW to reduce characterization time of RF Power Amplifiers (PAs).

Learn about this case study at ni.com/case-study/triquint

National Instruments offers a wide range of wireless test products including analyzers, generators, vector network analyzers, switches, amplifiers, attenuators, power meters, and RF software toolkits. Further it provides digital and analog baseband hardware for wireless IC device control as well as power supplies like battery simulators.

Vector Signal Analyzers

• 20 Hz up to 26 GHz frequency coverage
• Up to 350 MHz RF bandwidth
• Tuning times less than 400 μs in cellular and PCS bands
• Phase noise as low as -129 dBc/Hz at 10 kHz offset
• Average noise floor as low as -165 dBm/Hz at 1 GHz
• Accuracy to ±0.1 dBm

Vector Signal Generators

• 250 kHz up to 6.6 GHz frequency coverage
• Up to +10 dBm output power
• Up to 100 MHz RF bandwidth
• Phase noise as low as -112 dBc/Hz at 10 kHz offset
• List mode capability for tuning times less than 300 μs
• Accuracy to ±0.1 dBm

Vector Network Analyzers

• Network analysis from 10 MHz to 6 GHz
• Wider than 110 dB of dynamic range
• User-defined calibration kit and reference plane extension features
• Advanced time-domain analysis option
Microelectromechanical Systems (MEMS)

As consumer demand for MEMS grows, engineers need more cost-effective testing options for these systems. Featuring a breadth of capabilities from precision DC measurements to onboard signal processing with FPGA modules, NI solutions are ideal for characterization, final test, and everything in between. In addition, they can significantly lower test times and overall test costs.

“LabVIEW and PXI allowed us to exceed the performance of our previous big-iron ATE system. We can test an iMEMS microphone at a small fraction of the cost, weight, power consumption, footprint, and complexity of our current ATE. Using LabVIEW and PXI instrumentation, we saved 10 times the capital equipment costs with a 20 times reduction in power and developed the test code quickly. We are currently considering using this test approach for other MEMS products in the future as well.”

—Robert Whitehouse, Analog Devices

NI R Series Multifunction RIO

The NI R Series multifunction RIO modules feature a user-programmable FPGA for onboard processing and built-in I/O (including multiple analog inputs/outputs and digital I/O). With direct control over all functionality using LabVIEW and LabVIEW FPGA, you can use these R Series modules for demanding applications that require features such as custom protocol communication, high-speed control, and custom timing and triggering.

NI FlexRIO

NI FlexRIO enhances the PXI platform by offering easier access to new semiconductor technology, custom hardware designs, and high-performance FPGA-based algorithms. NI FlexRIO FPGA modules harness the processing power of the latest Xilinx FPGAs through the flexibility of LabVIEW FPGA, providing the ideal platform for high-throughput inline processing, DSP, and control applications. Choose from a growing selection of NI FlexRIO adapter modules with I/O including the latest high-speed ADCs and DACs, high-throughput digital transceivers, and specialty interfaces.

NI LabVIEW FPGA

The LabVIEW FPGA Module extends the LabVIEW graphical development platform to target FPGAs on NI RIO hardware. LabVIEW is well suited for FPGA programming because it clearly represents parallelism and data flow, so users who are both experienced and inexperienced in traditional FPGA design can productively apply the power of reconfigurable hardware.
Additional Instrumentation From NI
NI offers a growing family of other instrumentation including digital multimeters, arbitrary waveform generators, switches (DC to microwave), and power supplies. Visit [ni.com/modularinstruments](http://ni.com/modularinstruments) to explore more.

NI LabVIEW System Design Software
LabVIEW is system design software that provides the tools you need to create and deploy measurement and control systems through unprecedented hardware integration. LabVIEW accelerates productivity and gives you the confidence to continually innovate.

NI TestStand Test Management Software
NI TestStand is ready-to-run test management software designed to help you develop automated test and validation systems faster. In addition, you can use NI TestStand to develop test sequences that integrate code modules written in any test programming language. Sequences also specify execution flow, reporting, database logging, and connectivity to other enterprise systems.

Complete Platform for Semiconductor Test
From test system management software to world-class modular instrumentation and everything in between, the NI test platform is designed to scale the technical and economic demands of the semiconductor industry for the years ahead.
Services and Support

SERVICE CENTER LOCATIONS
With sites in North America, Europe, and Asia, the NI network of service and repair depots provides the service you need wherever and whenever you need them.

ADVANCED CALIBRATION OPTIONS
Along with standard calibration offerings, as part of a maintenance service agreement, NI can perform advanced calibration services tailored to your specific needs. These services for NI products include express calibration, on-site calibration, system calibration, and custom calibration procedures.

GLOBALLY MANAGED SPARES
If standard service just isn’t fast enough to meet your uptime needs or if you need a plan that supports your global installed base, NI can help you manage a tiered sparing model globally. In addition to providing an on-site spares inventory that can be accessed in minutes, NI can expand its support to include a regional inventory of spares that can be shipped the same day. You can use this balanced approach to meet more stringent uptime requirements.

CUSTOMIZED TRAINING
As part of a managed service and support agreement, NI can also provide you with customized training to prepare on-site personnel to properly and safely use and maintain NI hardware. Customizations include content, delivery method, and duration.

The award-winning NI website at ni.com/support provides clear answers to technical questions 24 hours a day, seven days a week. It includes an extensive technical support system, which offers a searchable Knowledgebase, troubleshooting wizards, and access to an extensive global community of NI customers.