SOLUTION BROCHURE

Semiconductor Power and Performance Validation Solution

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Solution Overview

Semiconductor Power and Performance Validation Solution

As the demand for energy efficiency grows and semiconductor companies race to design the best products possible, considerable emphasis has shifted to optimizing power efficiency and performance. In order to deliver compelling products within tight market windows, engineers need to quickly measure, analyze, and react to power-consumption data.

Traditional instrumentation, such as oscilloscopes and digital multimeters (DMMs), are too expensive to scale, and low-cost data acquisition solutions aren't always accurate enough to detect low-level signals such as sleep-state currents. Faced with a difficult decision, some organizations choose not to fully analyze power efficiency, leaving them at risk of missing market windows or losing competitive opportunities.
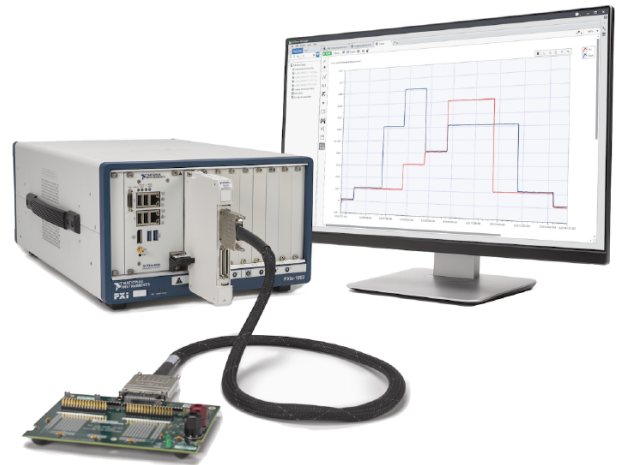
Figure 1. NI Power and Performance Validation Solution

The NI Semiconductor Power and Performance Validation Solution offers high accuracy and high channel count that can accelerate time to market, so that you quickly can set up, measure, log, and visualize power-measurement data using purpose-built instrumentation and a configuration-based software workflow.

Solution Advantages

- Acquire reliable and consistent power measurements for design feedback, customer enablement, and competitive insight
- Scale from a few channels to hundreds of channels in a compact form factor
- Gain the insight needed to optimize power efficiency and performance for the target market segment
- Accelerate customer engagements with quick access to meaningful power-consumption data
- Maximize the efficiency of design and validation teams with a complete power measurement solution

"There isn't another offering for the high-sensitivity measurements that we do. **If NI hadn't built these tools, we would have to build them ourselves, which would take years of effort.** NI allows us to focus on what we need to do."

Hardware Engineer,
A Leading Semiconductor Company

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System Setup

In many cases, the DUT is embedded in some type of system or operating environment, such as an evaluation board or load board, and operates under normal end-use conditions. In order to measure the power consumption on each power rail, two measurements are required: A single-ended or ground-referenced voltage measurement and a differential voltage measurement across a sense resistor, which is used to calculate current. Using the data collected from these two measurements, instantaneous power is calculated by multiplying the voltage and current values.
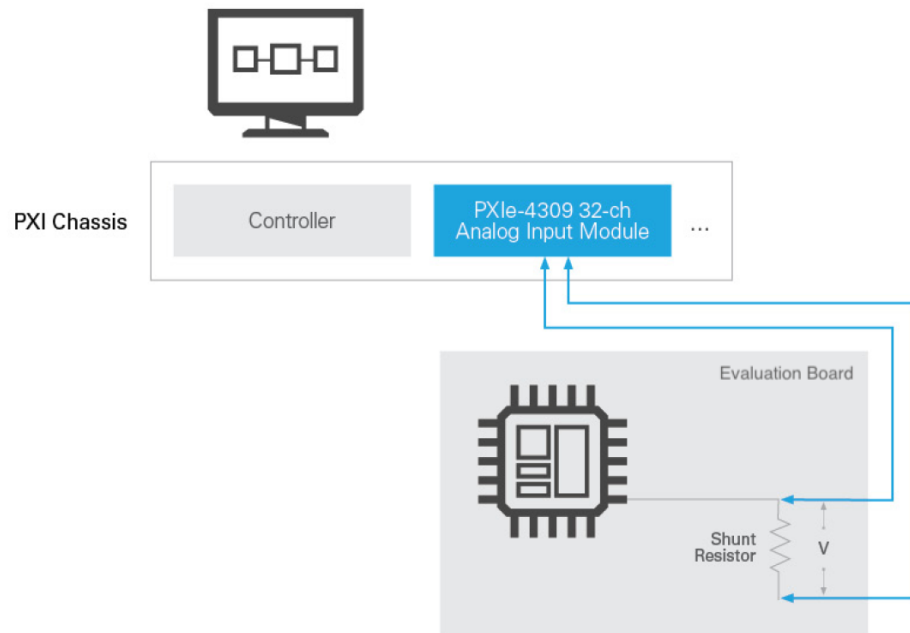
Figure 2. High-performance instrumentation with a flexible channel count helps you make voltage- and shunt-resistor-based current measurements across dozens or even hundreds of power rails—all in a compact form factor.

High-Performance Instrumentation

The PXIe-4309 is a flexible analog input instrument designed for low-level power validation measurements, capable of delivering an effective 28 bits of resolution. It offers DMM-like features such as filtering, averaging, auto-zero, and chopping to compensate for error sources and provide repeatable nanovolt measurements. With up to 32 channels in a single PXI slot and flexible PXI chassis options ranging from 2 slots to 18+ slots, you can configure a system that meets your application requirements and scale to meet unknown future requirements. The combination of high accuracy and high channel density makes it ideal for power validation of semiconductor devices, such as CPUs, GPUs, AI-specific processors, high-end microcontrollers, FPGAs, SoCs, and other IC functional blocks.

Figure 3. The PXIe-4309 is a 1-slot instrument capable of sampling up to 32 differential channels using an internal multiplexer and eight isolated, simultaneously-sampling ADCs.

Key Features

- Flexible resolution: 18-28 bits, depending on sample rate

- Up to 8 simultaneous, differential analog input channels (up to 2 MS/s/ch sample rate)

  o 18 bits at 2 MS/s/ch

  o 20 bits at 500 kS/s/ch

  o 28 bits at 2 S/s/ch

- Built-in optional multiplexer so that each of the 8 ADCs can connect to 4 input channels for up to 32 total input channels (up to 100 kS/s/ch)

- Four input ranges: ±15 V, ±10 V, ±1 V, ±0.1 V

- Built-in DMM-like signal conditioning features, including filtering, averaging, auto-zero, and chopping

- Best-in-class common mode rejection ratio (CMRR) for higher absolute accuracy

  o >120 dBc CMRR at 100 Hz signal input

- Flexible connectivity options including front-mounting screw terminal blocks and multiple cable options

- PXIe bus provides tight synchronization across instruments and a modular, expandable platform

Flexible Connectivity Options

NI offers three connectivity options, ranging from screw terminal blocks to specialized cables.

Single Large Cable Per Instrument Connected to Load Board	Up to 4 Small Cables Per Instrument Connected to Load Board	Screw Terminal Block for Manual Wiring
Advantages • Simple, off-the-shelf solution • NI manages twisting and shielding signal pairs • Available PCB mating connector options • Single cable solution **Considerations** • Requires PCB design work to integrate connector into load board • Large, less-flexible cable	**Advantages** • Simple, off-the-shelf solution • NI manages twisting and shielding signal pairs • Available PCB mating connector options • Smaller, more flexible cables **Considerations** • Requires PCB design work to integrate connector into load board • Requires mass terminal block • Multiple cables per instrument	**Advantages** • Simple, off-the-shelf solution • Easily modify signal connections • No special PCB design considerations **Considerations:** • Least performant option • Places burden on user to ensure proper wiring (twisted and shielded pairs) • Requires bare wires to be manually soldered to load board at sense resistors

Figure 4. NI offers various connectivity solutions so that you can choose the best option for your setup.

Cabled Options

For optimal signal integrity, NI recommends using NI-designed cables between the PXIe-4309 instrumentation and the evaluation module or load board. NI cable options are designed with the application in mind, ensuring that the wires for each signal pair are properly twisted and shielded. To use this option, customers should design the appropriate signal paths and mating connectors into their PCB designs, cabling directly from the instrumentation to the PCB. Mating connectors can be purchased directly from NI or from the connector manufacturer. Furthermore, NI recommends using the shortest cable options possible, as cable length can impact measurement performance despite proper wire management and shielding.

Screw Terminal Block

For the quickest and most flexible connectivity option, NI offers a front-mounted terminal block with screw terminals. This option makes it easy to evaluate the PXIe-4309 or quickly change the signal connections, but it does have significant drawbacks related to signal integrity. When using this option, it is imperative to follow wiring recommendations, such as twisting and shielding wire pairs. Finally, wires should be kept as short as possible and environmental noise limited (e.g., avoid locating the measurement system near things like power conduits or power supplies).

Connectivity Best Practices

- When possible, use a direct cable solution to maximize signal integrity and ease of use
- Engage PCB design teams early enough to design in mating connectors for desired cable option
- Keep all cables or wires as short as possible and avoid external noise sources
- Contact your NI salesperson for PCB mating connector part numbers and pricing information

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Powerful Application Software

NI recommends combining the PXIe-4309 instrumentation with FlexLogger™ software for powerful, interactive measurements and data logging. This option provides an easy-to-use, configuration-based workflow so that you quickly can configure, execute, visualize, and log measurement data.
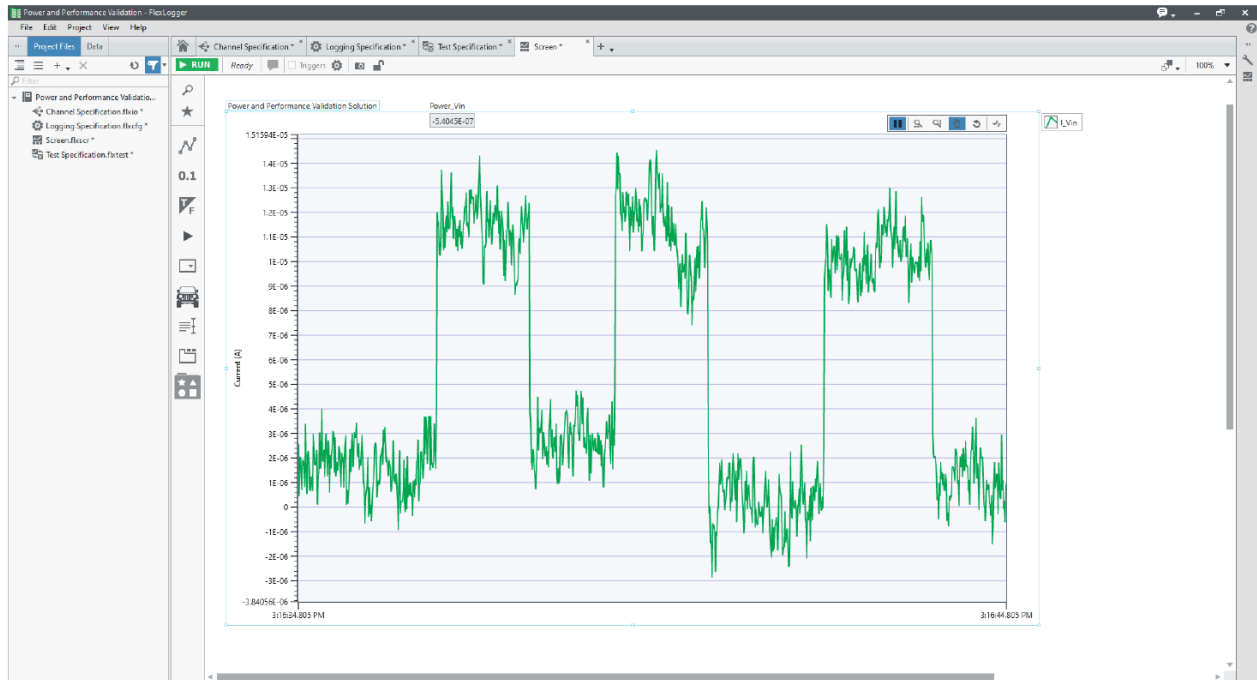
Figure 5. FlexLogger software provides an easy-to-use, configuration-based workflow—no programming required!

Key Features

- Take advantage of easy-to-use, configuration-based workflow—no programming required!

- Quickly set up, analyze, and log measurement data

- Utilize calculated measurement channels (e.g., P = I * V)

- Automatically synchronize measurements across multiple instruments

- Capture comprehensive metadata for test configuration and result traceability

- Natively log measurement data to TDMS (binary file format with comprehensive metadata) or CSV

- Interactively review data using the integrated TDMS data viewer

- Make additional customizations (such as adding third-party equipment support) with the Plugin Development Kit

- Achieve external control and automation

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Integrated TDMS Data Viewer

FlexLogger software supports two primary data logging file formats: TDMS and CSV. TDMS is an NI-proprietary binary file format that includes comprehensive metadata for maximum test configuration and result traceability. In addition to detailed measurement-configuration information, you can configure FlexLogger software to prompt users for relevant information (name, DUT type, serial number) to add to the metadata. You also can add comments, which the FlexLogger software adds to the metadata and ties to the corresponding timestamp as it acquires measurement data.

FlexLogger software ships with a built-in TDMS file viewer that contains comprehensive data-analysis tools. You can open TDMS files directly from within a FlexLogger software project and interactively analyze the data after acquisition. In this viewer, you can review metadata and raw measurement values and timestamps; plot measurement data; and even play back measurement data. Also, you can open and view TDMS files in Microsoft Excel using a free TDMS plugin, which automatically installs with NI driver software.
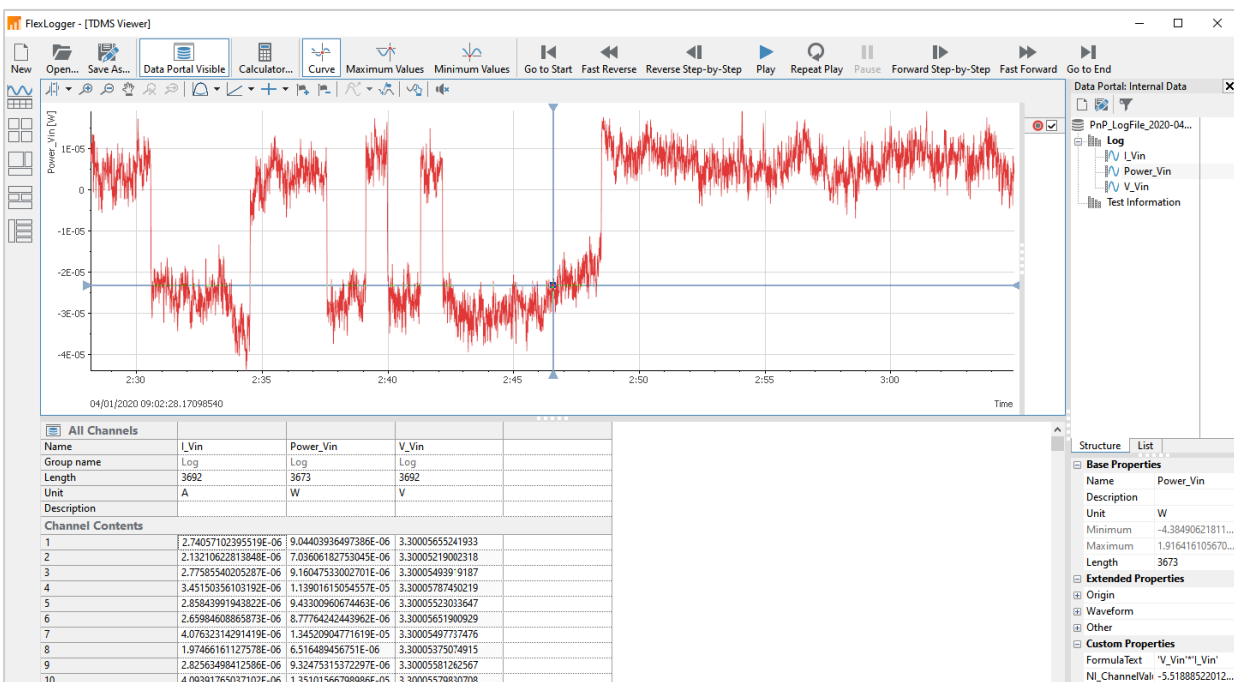
Figure 6. FlexLogger software ships with an integrated TDMS file viewer for easy access to powerful data analysis tools.

NI-DAQmx Driver and API

If you're looking to build or upgrade your own custom-developed software application, the NI-DAQmx driver includes a best-in-class API that works directly with a variety of development options, including LabVIEW, C, C#, Python, and others. Each of the native programming language driver implementations provide exceptional performance and a seamless experience without the need to manually wrap functions. To ensure long-term DAQ device interoperability, the NI-DAQmx driver API is the same API for all NI DAQ products, minimizing redevelopment efforts regardless of hardware changes or upgrades. This is especially important if you're looking to upgrade from an older DAQ product, such as the PXI-6255 or PXI-6289. Additionally, the driver provides access to help files, documentation, and dozens of ready-to-run shipping examples you can use as a starting point for your application.
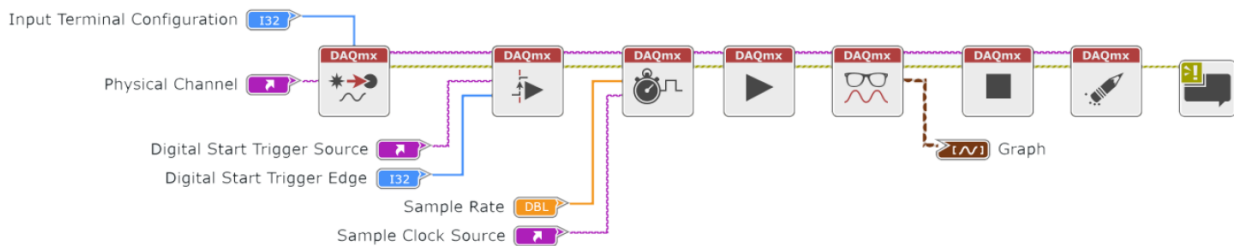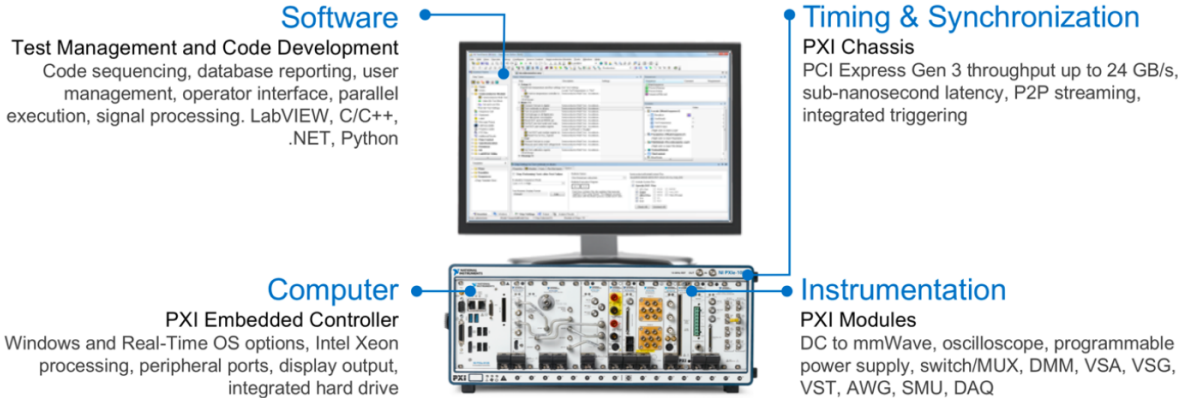

Figure 7. The NI-DAQmx driver provides a best-in-class API for custom automated applications written in LabVIEW, C, C#, Python, and other common programming languages.

Platform-Based Approach

What Is PXI?

Powered by software, PXI is a modular PC-based platform for measurement and automation systems. PXI combines PCI electrical-bus features with the modular, Eurocard packaging of CompactPCI and adds specialized synchronization buses and key software features. PXI is both a high-performance and low-cost deployment platform for applications such as manufacturing test, military and aerospace, machine monitoring, automotive, and industrial test. Developed in 1997 and launched in 1998, PXI is an open industry standard governed by the PXI Systems Alliance (PXISA), a group of more than 70 companies chartered to promote the PXI standard, ensure interoperability, and maintain the PXI specification.

Software
Test Management and Code Development
Code sequencing, database reporting, user management, operator interface, parallel execution, signal processing. LabVIEW, C/C++, .NET, Python

Timing & Synchronization
PXI Chassis
PCI Express Gen 3 throughput up to 24 GB/s, sub-nanosecond latency, P2P streaming, integrated triggering

Computer
PXI Embedded Controller
Windows and Real-Time OS options, Intel Xeon processing, peripheral ports, display output, integrated hard drive

Instrumentation
PXI Modules
DC to mmWave, oscilloscope, programmable power supply, switch/MUX, DMM, VSA, VSG, VST, AWG, SMU, DAQ

Figure 8. PXI is a modular PC-based platform for measurement and automation systems.

Integrating the Latest Commercial Technology

By leveraging the latest commercial technology for our products, we can continually deliver high-performance and high-quality products to our users at a competitive price. The latest PCI Express Gen 3 switches deliver higher data throughput, the latest Intel multicore processors facilitate faster and more efficient parallel (multisite) testing, the latest FPGAs from Xilinx help to push signal processing algorithms to the edge to accelerate measurements, and the latest data converters from TI and ADI continually increase the measurement range and performance of our instrumentation.

HIGHER DATA THROUGHPUT	PARALLEL TEST EXECUTION	MEASUREMENT ACCELERATION	INCREASED MEASUREMENT RANGE
PCI Express Gen 3	Multicore Processors	FPGAs	Data Converters

Figure 9. Leverage the latest commercial technology to maximize system performance and quality.

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Hardware Services and Technical Support

All NI hardware includes a one-year warranty for basic repair coverage, and calibration in adherence to NI specifications prior to shipment. PXI systems also include basic assembly and a functional test. NI offers additional entitlements to improve uptime and lower maintenance costs with service programs for hardware. Learn more at ni.com/services/hardware.

	Standard	Premium	Description
Program Duration	1, 3, or 5 years	1, 3, or 5 years	Length of service program
Extended Repair Coverage	●	●	NI restores your device's functionality and includes firmware updates and factory calibration.
System Configuration, Assembly, and Test[1]	●	●	NI technicians assemble, install software in, and test your system per your custom configuration prior to shipment.
Advanced Replacement[2]		●	NI stocks replacement hardware that can be shipped immediately if a repair is needed.
System Return Material Authorization (RMA)[1]		●	NI accepts the delivery of fully assembled systems when performing repair services.
Calibration Plan (Optional)	Standard	Expedited[3]	NI performs the requested level of calibration at the specified calibration interval for the duration of the service program.

[1]This option is only available for PXI, CompactRIO, and CompactDAQ systems.
[2]This option is not available for all products in all countries. Contact your local NI sales engineer to confirm availability.
[3]Expedited calibration only includes traceable levels.

PremiumPlus Service Program
NI can customize the offerings listed above, or offer additional entitlements such as on-site calibration, custom sparing, and lifecycle services through a PremiumPlus Service Program. Contact your NI sales representative to learn more.

Technical Support
Every NI system includes a 30-day trial for phone and e-mail support from NI engineers, which can be extended through a Software Service Program (SSP) membership. NI has more than 400 support engineers available around the globe to provide local support in more than 30 languages. Additionally, take advantage of NI's award winning online resources and communities.

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