



Solution Brochure

Power Performance Validation Solution

Explore NI's Solutions

Low-power validation presents several challenges, including the need for complex and sensitive measurement tools, high costs of precision instruments, and the limited accuracy of more affordable solutions. Integrating these tools can be cumbersome, and managing detailed power consumption data can be overwhelming.

Addressing these challenges is crucial for enhancing energy efficiency, maintaining market competitiveness, and ensuring regulatory compliance. Effective low power validation not only helps reduce operational costs and environmental impact but also supports product reliability and drives technological innovation.

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Solution Overview

The NI Power Performance Validation solution for semiconductors and electronics provides an easy-to-use, modular, accurate, and scalable system that helps shorten evaluation times. With it, you get a quicker path to finding and fixing bugs via a user-friendly software interface, improving data management, and gaining real-time visualization to help you get to market faster.

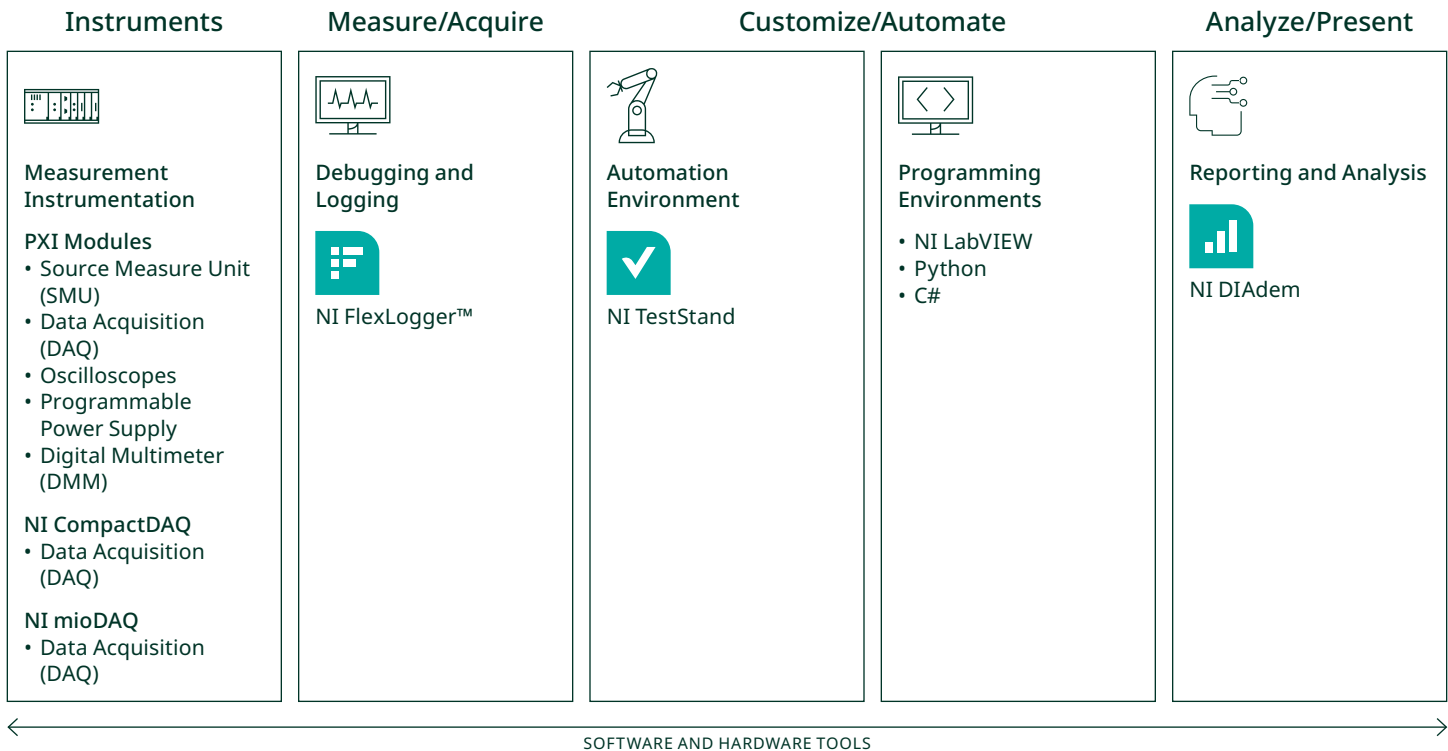


FIGURE 1
NI Power Performance Validation Solution Overview

“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, Leading Technology Company

THE NI ADVANTAGE

- PXI configurable channel count (8 to 32 per slot), flexible resolution, available sample rates 2 S/s/ch and/or 4 MS/s, onboard signal processing, and scalable chassis options (2 to 18+ slots)
- Optional NI CompactDAQ and NI mioDAQ for portable, customizable data acquisition with up to 16X 20-bit resolution inputs at 1 MS/s/ch, minimizing noise and simplifying cabling in the field
- Seamless integration, high accuracy, diverse instrumentation, fast data transfer, and scalability with PXI
- Transition from bring-up and debug with NI FlexLogger to full automation using NI TestStand—automating, accelerating, and standardizing the test process across your testers
- Wide programming language support for NI LabVIEW, Python, and C#, as well as APIs that facilitate integration with third-party instruments, enabling engineers to develop tailored testing workflows
- High-speed data transfer (up to 132 MB/s per slot) for swift handling of large data sets

Power Validation Hardware Setup Example

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.

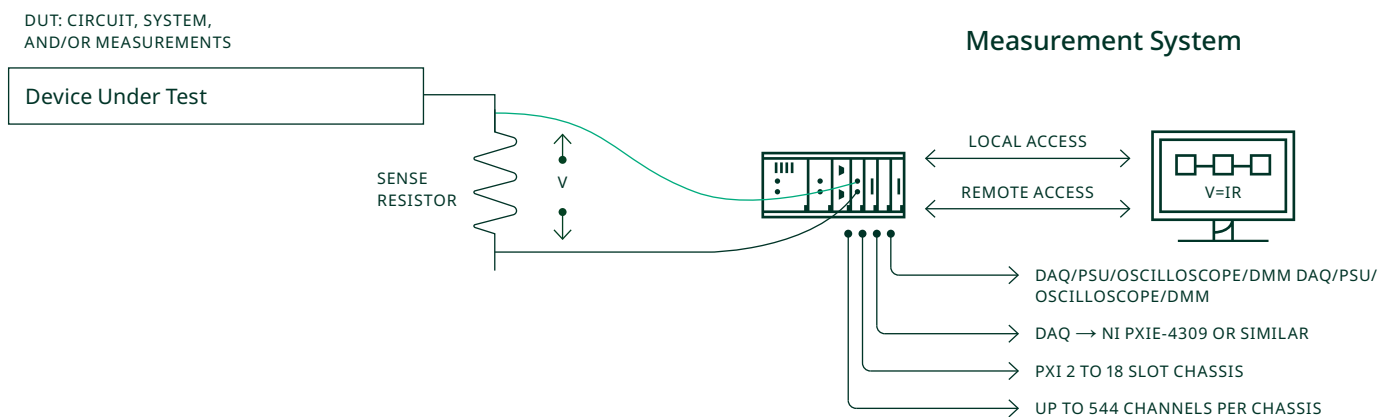


FIGURE 2

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.

Power Performance Validation Solution Overview

Hardware

- Optimized for low-level voltage measurements across sense resistors
- Simultaneous sampling and synchronized measurements
- Configurable channel count ranging from 8 to 32 channels per PXI slot
- Up to 28-bit resolution or 2 MS/s sample rate per channel (18-bit resolution)
- Onboard signal averaging, filtering, auto-zero, and more for high accuracy measurement
- Scalable channel count with chassis options ranging from 2 to 18+ slots

Software

- Interactive instrument debug interface via [NI InstrumentStudio™ software](#)
- [NI FlexLogger™](#) for power analysis—or set up with [LabVIEW](#), Python, and/or C# for custom flow for a fully automated solution
- Quickly set up, visualize, debug, and log measurement data
- Measurement highlights
- Power budget testing and power consumption via data analytics, test IC input(s) and output(s), operating efficiency, ripple and noise (such as transients), protections with definition expected behavior (such as OVP latch), power thermal analysis, power sweeps, and much more





Module/Hardware	Part Number	Purpose
NI PXI Chassis (e.g., NI PXIe-1083)	787026-01	System chassis
NI PXIe-4309 (DAQ)	784471-01	Power rail monitoring
NI PXIe-4311 (DAQ)	789864-01	Power rail monitoring
NI PXIe-4081 (DMM)*	780011-01	Debug power monitoring, high accuracy
NI PXIe-5110 (Scope)*	785767-01	Electrical measurement and debug, fast transients
NI PXIe-4139 (SMU)*	782856-02	Power supply and measure unit
Other	Multiple	PXI accessories

* = Optional Hardware

TABLE 1

Power Performance Validation Solution PXI Recommended Hardware



Module/Hardware	Part Number	Purpose
CompactDAQ Chassis (e.g., NI cDAQ-9178)	781156-01	System chassis
NI-9220*	785188-01	Power rail monitoring, faster sampling
NI-9252*	786782-01	Power rail monitoring, slower sampling
Other	Multiple	cDAQ accessories

* = Optional Hardware

TABLE 2

Power Performance Validation Solution CompactDAQ Recommended Hardware



Module/Hardware	Part Number	Purpose
mioDAQ	Multiple options	Power rail monitoring
Other	Multiple	mioDAQ accessories (included in ship kit)

TABLE 3

Power Performance Validation Solution mioDAQ Recommended Hardware

NI DAQ Product Families



	Highly Portable		Rugged	High Density	High Performance	
Form Factor	USB-C		CompactDAQ	PXI	PXI	
Model Numbers	USB-642x	USB-645x	NI-9220	PXIe-63x5	PXIe-4309	PXIe-4311
# of Channels	16 diff, 32 SE	16 diff, 32 SE	16 diff	Up to 104 diff, 208 SE	32 diff	32 diff
Max Ch. Per System	16 diff, 32 SE	16 diff, 32 SE	224 diff	Up to 1768 diff, 3536 SE	Up to 544 diff	Up to 544 diff
# of ADCs	1	16	16	1	8	32
Resolution	16-bit	20-bit	16-bit	16-bit	18-bit at 2 MS/s/ch 28-bit at 2 S/s/ch	16-bit to 22-bit
Max Sample Rate	250 kS/s	1 MS/s	100 kS/s	1 MS/s per # channels	2 MS/s	4 MS/s
Input Range	± 0.2 to ± 10 V		± 0.1 to ± 10 V	± 10 V	± 0.1 V, ± 1 V, ± 10 V, ± 15 V	± 150 mV, 0–6 V, 0–25 V
Software	FlexLogger, LabVIEW, Python, C#, .NET, C/C++					
Driver API	NI-DAQ™mx					

TABLE 4
NI DAQ Product Options

NI LabVIEW

LabVIEW is a graphical programming environment that provides unique productivity accelerators for test system development, such as an intuitive approach to programming, connectivity to any instrument, and fully integrated user interfaces.

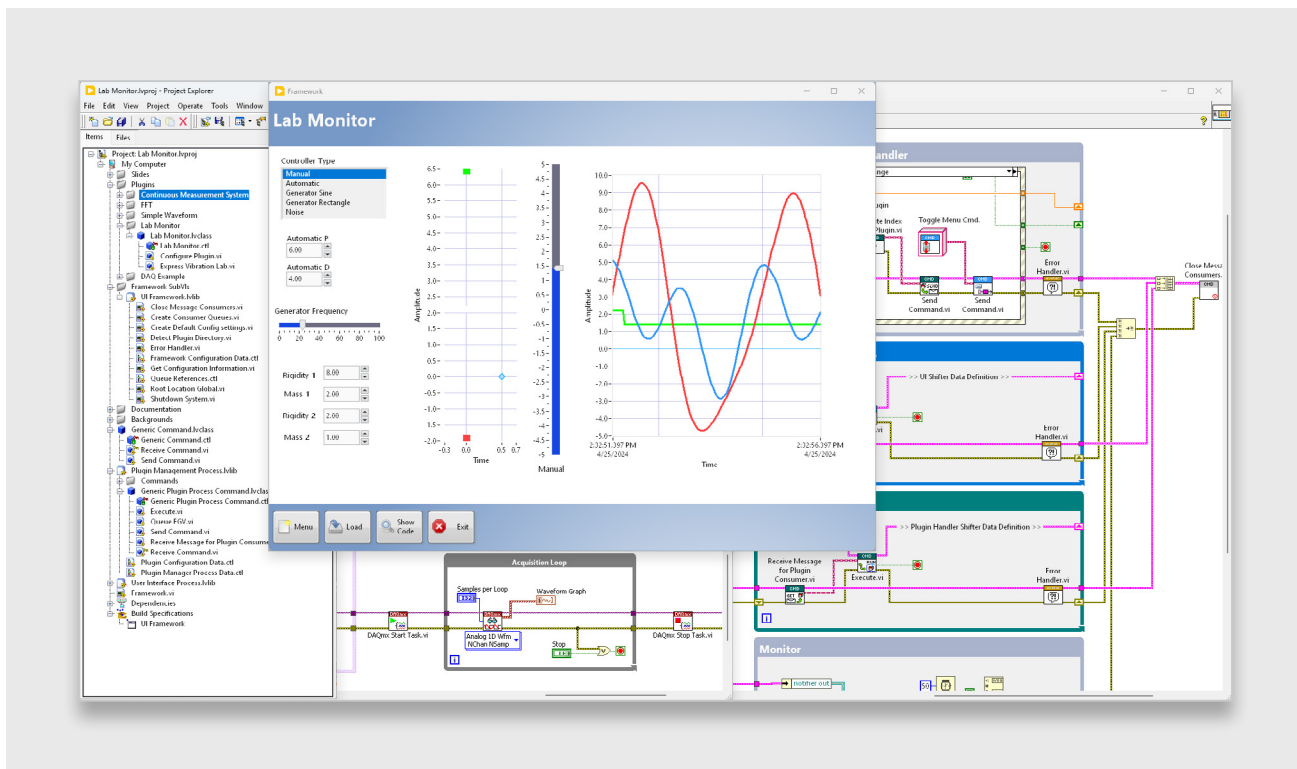


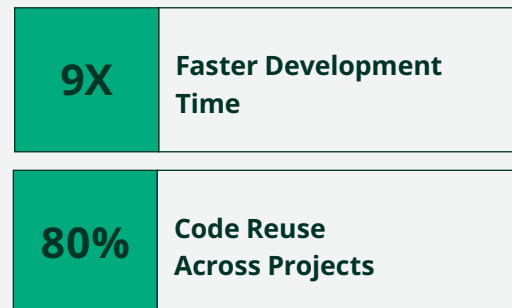
FIGURE 3
Example LabVIEW Screen Showing Automated Test Systems and Lab Monitor

THE NI ADVANTAGE

LabVIEW has what you need to build automated test systems, fast. Outpace the competition with LabVIEW. Unlike other solutions:

- LabVIEW can connect to any instrument, regardless of vendor
- LabVIEW has a native user interface for monitoring and controlling test
- LabVIEW has thousands of engineering analysis functions
- LabVIEW works with other languages, such as Python, C, and .NET

Companies that use LabVIEW benefit from improvements in development time and code reuse.



Develop Automated Test and Measurement Systems with LabVIEW

Maximize Productivity

- **Graphical programming:** Build your test system using an intuitive, flowchart-like data flow.
- **Customizable user interfaces:** Create custom UIs with pre-built objects for real-time data display, user input, and interactive analysis.
- **Active debugging:** Detect errors faster as LabVIEW recompiles code after every action so you can easily identify and resolve problems. No last-minute surprises.

Integrate Everything

- **Hardware access:** Connect to any piece of hardware with thousands of drivers for third-party instrumentation.
- **Code reuse:** Call code written in C, Python, .NET, and MathWorks® MATLAB® software.
- **Protocol support:** Exchange data between applications using TCP/IP, UDP, serial, IrDA, Bluetooth® wireless technology, Modbus, SMTP, and more.

Increase Capabilities

- **Real-time and FPGA modules:** Utilize add-ons for applications that require embedded and FPGA hardware.
- **Automated reporting:** Share test results by generating reports for Microsoft 365 or writing to a database.
- **Application builder:** Create and deploy your code as stand-alone applications for others to use, in just a few clicks.

Ensure Your Success

- **Learning:** Not sure how or where to start? We have flexible training options, tutorials, and courses to help you create your first application, acquire data, connect to hardware, and more!
- **Community:** Join a strong community of more than 300,000 users. Rely on an active online network and colleagues for advice that's more than 30 years in the making.
- **Support:** Get help when you need it. Your subscription includes access to support engineers who are ready to speed up troubleshooting.

Select Your LabVIEW Edition

LabVIEW Base

Recommended for building simple test and measurement applications.

Part Number: 784503-35

LabVIEW Full

Recommended for applications that require advanced analysis or signal processing.

Part Number: 784522-35

LabVIEW Professional

Recommended for engineers who need tools for software engineering, code deployment, distribution, and reporting.

Part Number: 784584-35

Or Get LabVIEW Plus More in the LabVIEW+ Suite

The LabVIEW+ Suite is a collection of LabVIEW plus more software that provides purpose-built tools to automate measurement, analysis, and test.

The software works together to save you time.

Part Number: 788509-35

Part numbers listed are for downloadable media for Microsoft Windows.



NI FlexLogger

FlexLogger enables quick sensor configuration and mixed signal data logging—no programming required. Simplify test application validation with flexible, scalable data-logging systems built on NI data acquisition hardware. FlexLogger offers both a full-featured and a free Lite edition.

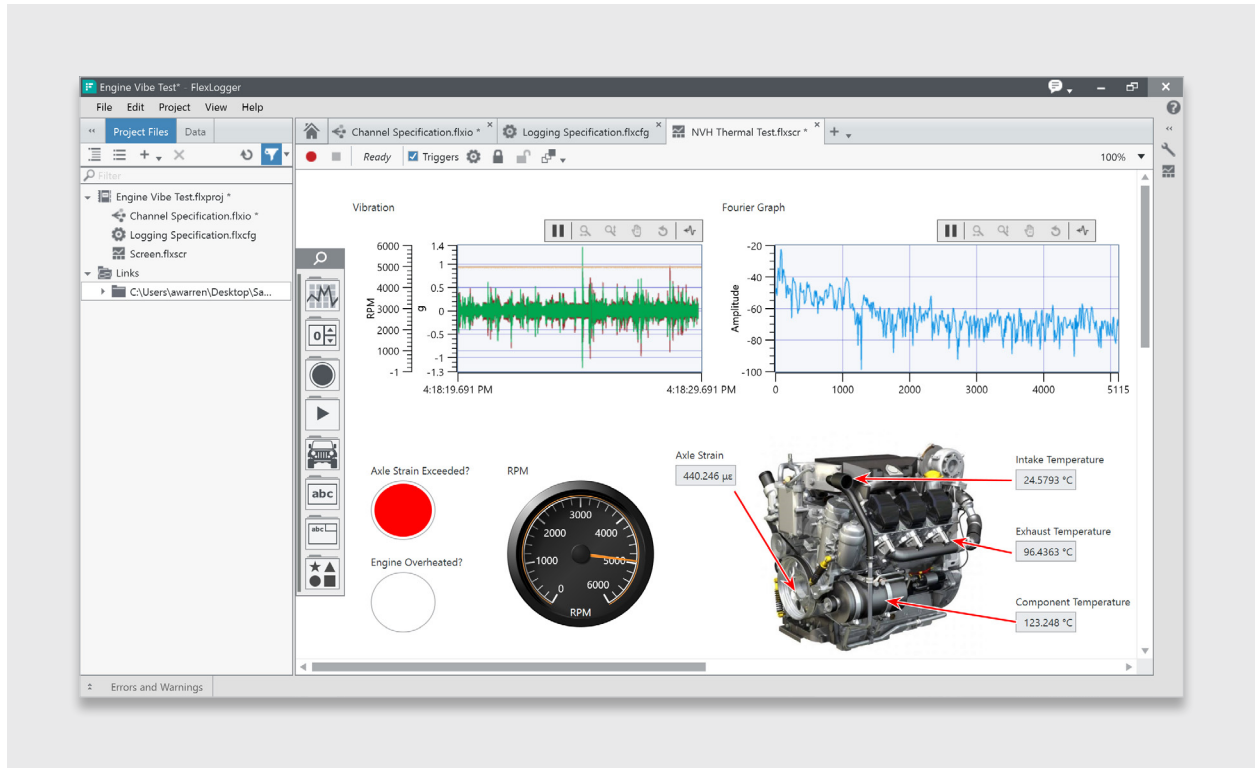


FIGURE 4
Example LabVIEW Screen Showing Automated Test Systems and Lab Monitor

“FlexLogger makes it easier to troubleshoot and verify that the raw data from different sensors are correct before I start my test. This helps shorten test development by saving time typically wasted on redoing configurations.”

Andy Tarman
CNH Industrial

NI TestStand

TestStand is test executive software that accelerates system development and deployment for engineers in validation and production. TestStand is ready-to-run test management software that simplifies the automation of validation test systems with interactive workflows for hardware configuration, built-in debugging tools, and automatic report generation.

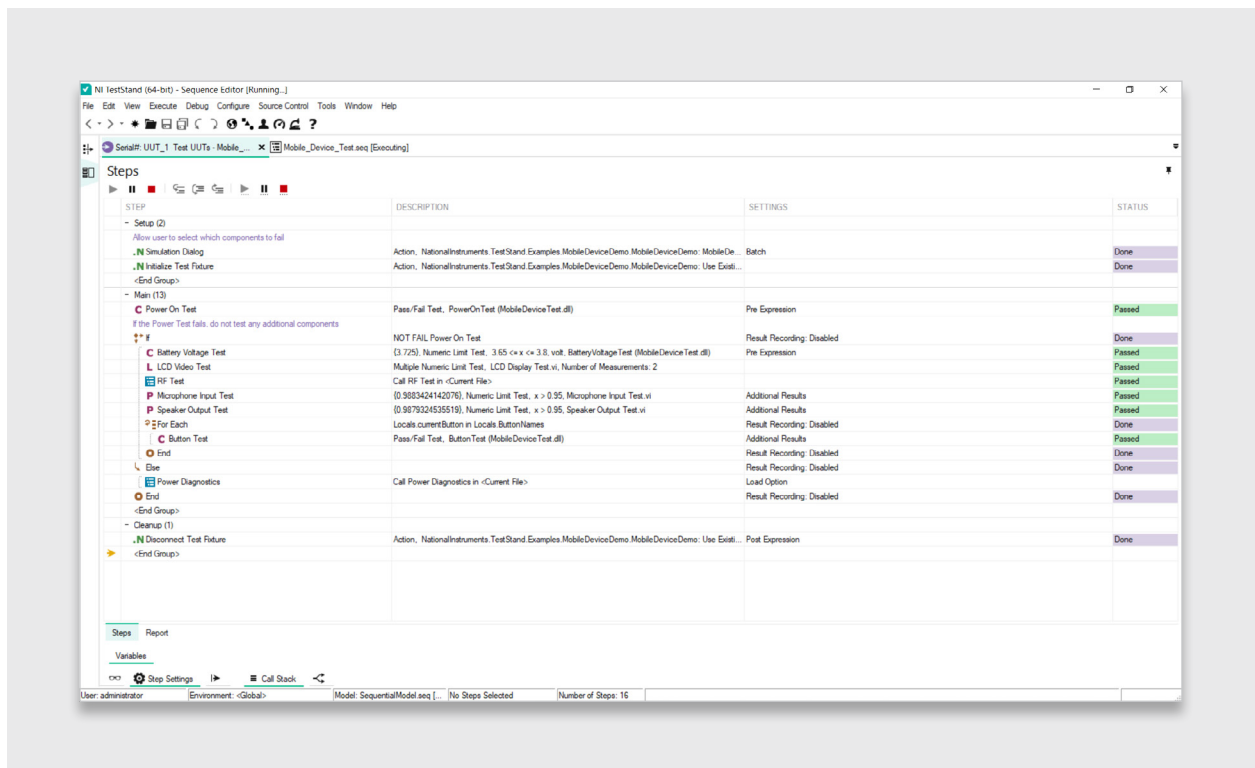


FIGURE 5
Example TestStand Screen Showing Power Management Validation Sequence

THE NI ADVANTAGE

- Quickly set up your test with little to no code development. View data, analyze, and create shareable reports to communicate results to your team.
- Integrate code developed in any modern programming language to a sequencer for a functional test system. When scaling to production, optimize throughput with native parallel testing.
- Automate repetitive tests using tools for instrument control, communication, data acquisition, and logic. Connect your system to the web and monitor test status from anywhere in the world.
- Test new technologies and evaluate design concepts with data-focused tools that let you interactively query and analyze results from different test runs.
- Connect to any NI or third-party instrument to measure temperature, strain, sound and vibration, RF signals, and more—and analyze all your data.

PXI Data Acquisition

NI PXIe-4309

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 two 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 semiconductor device power validation, such as for CPUs, GPUs, AI-specific processors, high-end microcontrollers, FPGAs, SoCs, and other IC functional blocks.

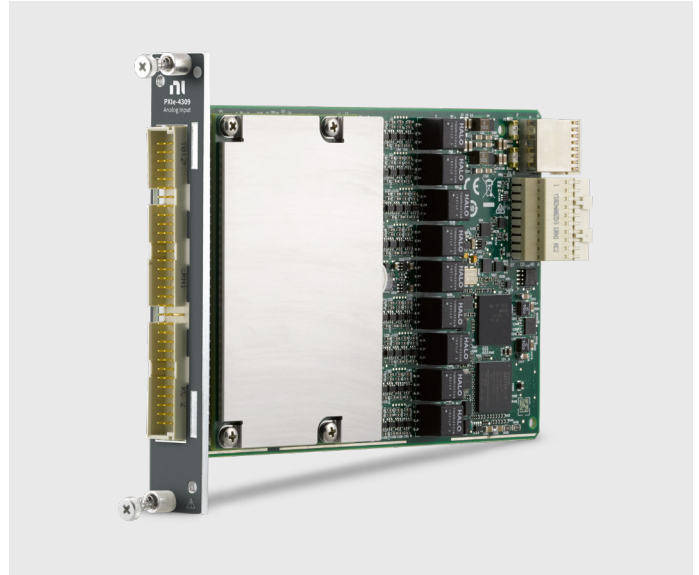


FIGURE 6

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

THE NI ADVANTAGE

- Flexible resolution: 18 to 28 bits, depending on sample rate
- Up to eight simultaneous, differential analog input channels (up to 2 MS/s/ch sample rate)
 - 18 bits at 2 MS/s/ch
 - 28 bits at 2 S/s/ch
- Built-in optional multiplexer so that each of the eight ADCs can connect to four 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
 - >120 dBc CMRR at 100 Hz signal input
- Flexible connectivity options including front-mounting screw terminal blocks and multiple cable options
- PXI Express bus provides tight synchronization across instruments and a modular, expandable platform

NI PXIe-4311

The **PXIe-4311** is a 1-slot PXI Express module offering 32 simultaneous analog input channels at up to 4 MS/s per channel, ideal for high-density, high-speed power validation. With flexible input ranges (± 150 mV to 25 V), 800 kHz bandwidth, and 16 to 22 bit resolution, it enables precise transient capture across multiple power rails. Compatible with PXIe-4309 accessories, it supports NI-DAQmx, FlexLogger, and onboard virtual power calculations, making it perfect for validating CPUs, GPUs, SoCs, and other advanced systems.

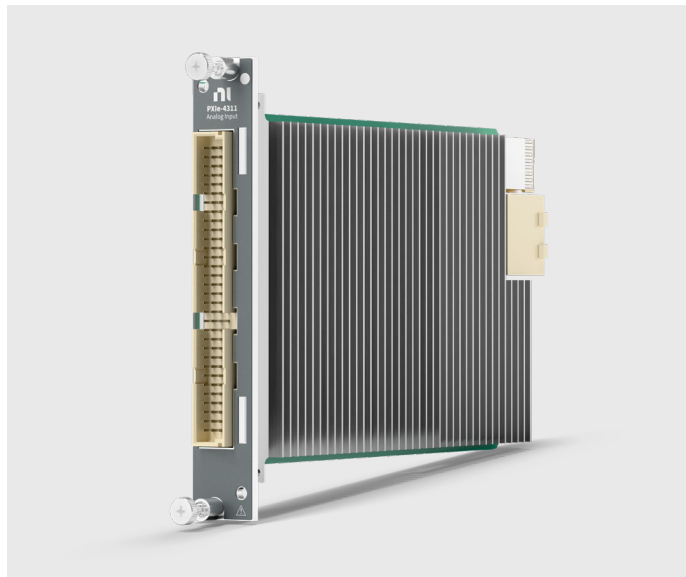


FIGURE 7

The PXIe-4311 DAQ Module is engineered for accurate analog input measurements.

THE NI ADVANTAGE

- Accelerated power validation: Enables capturing fast transients across 32 simultaneous channels at up to 4 MS/s—ideal for validating high-performance systems like CPUs, GPUs, and SoCs.
- High-density, scalable architecture: Provides 4X channel density compared to the PXIe-4309, enabling parallel testing and reduced test time without external multiplexing.
- Flexible resolution and input ranges: Supports 16 to 22 bit resolution and wide input ranges (± 150 mV to 25 V) for diverse power measurement needs.
- Integrated software ecosystem: Seamlessly integrates with NI-DAQmx, FlexLogger, and Hardware Configuration Utility (HWCU) for fast setup and synchronized acquisition.
- Onboard virtual power calculations and built-in processing: For calculated power metrics, these reduce post-processing time and simplify workflows.
- Simulated device support: Uses NI MAX to simulate PXIe-4311 for early software development and system integration.
- Compact PXI form factor: Leverages the modular NI PXI platform for space-efficient, high-performance test systems.
- Future-proof investment: Compatible with PXIe-4309 accessories and designed to scale with evolving power validation needs.

Note: Resolution is dependent on sample rate and input range. See online specifications for more details.

Flexible Connectivity Options

There are three NI connectivity options ranging from screw terminal blocks to specialized cables.



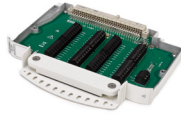
Single Large Cable per Instrument Connected to Load Board	Up to Four Small Cables per Instrument Connected to Load Board	Screw Terminal Block For Manual Wiring
Advantages		
Simple, off-the-shelf solution	Simple, off-the-shelf solution	Simple, off-the-shelf solution
NI manages twisting and shielding signal pairs	NI manages twisting and shielding signal pairs	Easily modify signal connections
Single-cable solution	Available PCB mating connector options	No special PCB design considerations
	Smaller, more flexible cables	Great for prototyping
Consideration		
Requires PCB design work to integrate connector into load board	Requires PCB design work to integrate connector into load board	Least performant option
Large, less flexible cable	Requires mass terminal block	Places burden on user to ensure proper wiring (twisted and shielded pairs)
	Multiple cables per instrument	Requires bare wires to be manually soldered to load board at sense resistors
		
Cable Option: Sh-96-96-2 Cable (1 Meter*) *Longer Cable Options are available, but not recommended Part Number: 157350-01	TB-4309 terminal block for PXIe-4309 (with VHDCI connectors) Part Number: 784957-01 SHC68-68-Epm Cable (1 Meter*) *Longer cable options are available, but not recommended. Other cable options are available; contact NI. Part Number: 192061-01	TB-4309 terminal block for PXIe-4309 (with screw terminals) Part Number: 784956-01

TABLE 5

Choose from various NI connectivity solutions for your setup.

Cabled Options

For optimal signal integrity, we recommend using NI-designed cables between the PXIe-4309 or PXIe-4311 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 us or from the connector manufacturer. Furthermore, we recommend using the shortest cable options possible, as cable length can impact measurement performance despite proper wire management and shielding.

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 the 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.



PXI Source Measure Units (SMUs)

PXI Source Measure Units (SMUs) combine high-precision source and measure capability with features designed to reduce test time and increase flexibility.

- High-speed sampling rate up to 1.8 MS/s and update rate up to 100 kS/s
- Up to 40 W DC and 500 W pulsed output
- Current sensitivity down to 1 fA
- NI SourceAdapt digital control loop technology

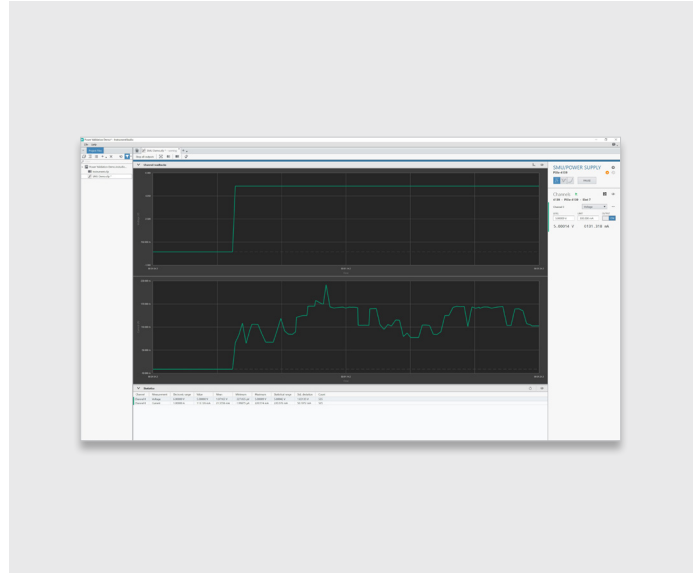


FIGURE 8
SMU Current and Voltage Reading

Channel Density and Scalability

SMU channel density is crucial for multi-site testing and enhancing test throughput. In a single PXI chassis, you can add:

- Up to 17 1-channel SMUs
- Up to 408 parallel SMU channels using multichannel SMUs
- Mix with switches or combine with other types of instruments to build tightly integrated mixed-signal test systems
- High-speed measurement and update rate
- Sample up to 1.8 MS/s with an update rate of 100 kS/s, which adds new functionality to a traditionally DC instrument
- Use the SMU as a high voltage or current digitizer to capture transient behavior or monitor current consumption over time
- Fast update rate allows you to step through large sequences very quickly or use the SMU to generate arbitrary waveforms at low frequencies

Hardware-Timed Sequencing and Triggering

- NI SMUs have a hardware-timed, deterministic sequencing engine
- Modify more than 30 properties such as aperture time, current range, voltage range, DC output mode, and source delay
- Numerous triggers and events such as source trigger, measure trigger, and measure complete
- Synchronize the start of multiple SMUs, create nested sweeps, or send/receive commands from other instruments like oscilloscopes and RF analyzers

NI PXI Digital Multimeters

PXI Digital Multimeters (DMMs) perform high-precision voltage, current, resistance, temperature, inductance, capacitance, and frequency/period measurements as well as diode tests.

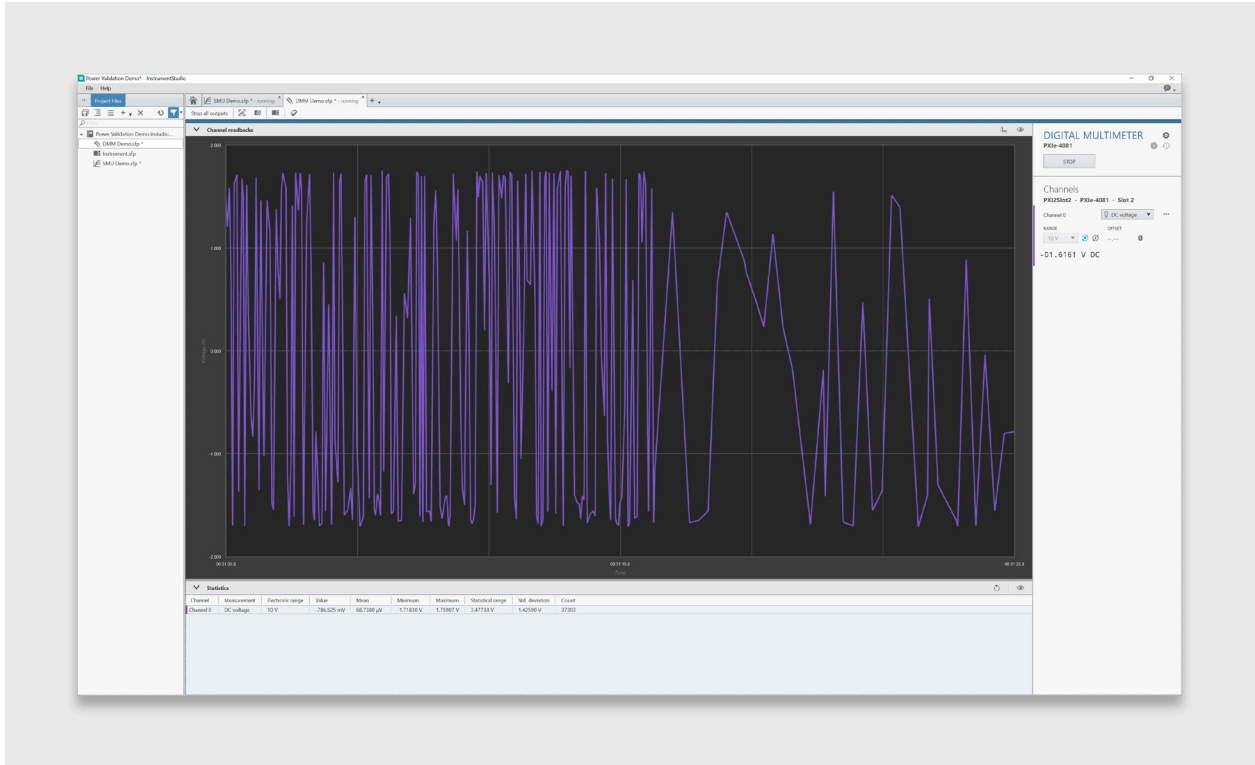


FIGURE 9
PXI Digital Multimeter Readings in InstrumentStudio Software

THE NI ADVANTAGE

- PXI DMMs ship with InstrumentStudio for ready-to-run configuration and measurements.
- The most accurate 7.5-digit DMM offers 26 bits of resolution and high-stability, metrology-class measurements that range from 10 nV to 1,000 V, 1 pA to 3 A, and 10 W to 5 GW—the PXIe-4081 outperforms traditional box DMMs.
- Customizable measurement settings give you the ability to prioritize speed or accuracy by programmatically adjusting ADC calibration, auto-zero, settling time, and aperture time using the NI-DMM device driver API.
- With excellent measurement quality, NI DMMs combine the functionality of a traditional DMM and an isolated, high-voltage (1,000) digitizer mode with sample rates up to 1.8 MS/s—36X faster than traditional DMMs (50 kS/s).
- Combine PXI DMMs with a wide selection of PXI switches to cost-effectively scale the number of channels and synchronize with PXI switches.

NI PXI Oscilloscopes

PXI oscilloscopes are flexible, software-defined instruments that are versatile enough for both time- and frequency-domain measurements and feature numerous triggering modes, deep onboard memory, and a driver software API that includes data streaming and analysis functions.

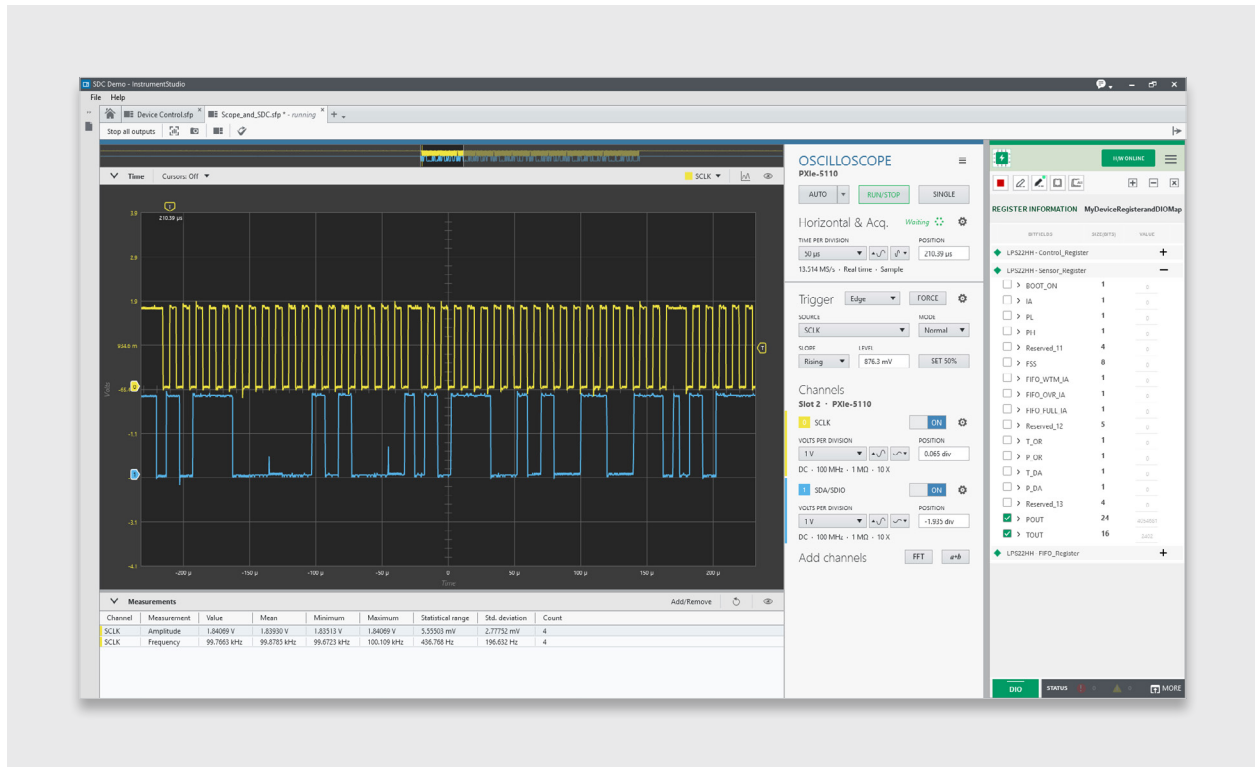


FIGURE 10
PXI Oscilloscope Reading in InstrumentStudio Software

THE NI ADVANTAGE

- Synchronized instruments: PXI oscilloscopes of the same model are automatically hardware-synchronized across multiple devices in InstrumentStudio software to serve applications requiring high channel density.
- NI CableSense™ technology: Using principles similar to a traditional time-domain reflectometer (TDR) on a real-time oscilloscope within your test system, you can detect changes from a known, golden setup without having to alter the connections themselves.
- Deep onboard memory: PXI oscilloscopes feature deep onboard memory capable of storing multiple acquisitions from single channels or parallel acquisitions from multiple channels on the same device—and also benefit from the high-speed streaming capabilities of the PXI platform.
- Interactive InstrumentStudio software: PXI oscilloscopes ship with InstrumentStudio for ready-to-run configuration and measurements.

What Is NI CompactDAQ?

CompactDAQ is a portable, flexible data acquisition platform consisting of a CompactDAQ chassis and C Series Input and Output (I/O) modules. It combines signal connectors, integrated signal conditioning, and converters in a single package to deliver higher accuracy measurements by eliminating error-prone cabling and connectors and reducing the number of components in a measurement system.

Any Bus, Any Form Factor

Choose from USB, Ethernet, and wireless bus options or stand-alone controllers to meet your application needs in either the lab or field.

Accurate Conditioned Measurements

Take advantage of more than 60 sensor-specific modules to directly connect to your sensor or signal.

Precise Timing and Synchronization

Easy timing customization for each sensor or signal with up to seven hardware-timed clocks per chassis.



Truly Customizable Software

Tailor the automation of your data acquisition, analysis, visualization, and reporting to meet specific application needs with LabVIEW software.

Accurate Conditioned Measurements

Distribute measurements closer to the sensor or signal using rugged form factors with -40 °C to 70 °C temperature ranges and fanless operation.

Increased Streaming

Increase data streaming over the same bus with NI signal streaming and the TDMS binary file format.

FIGURE 12

CompactDAQ helps to accelerate schedules, increase test coverage and quality, and reduce the total cost of test.

THE NI ADVANTAGE

- With flexibility to meet changing requirements, you can use CompactDAQ as a modular platform to meet the demands of your future applications. By simply changing to a different chassis or controller, you can add new functionality, like an integrated processor or extended operating temperature range. With 1-, 4-, 8-, and 14-slot chassis options, you can scale systems to higher channel counts by moving to a larger chassis or synchronizing multiple chassis.
- CompactDAQ is a modular system, so you can add more measurement types and channels to the system by simply plugging in additional modules. All modules are automatically detected and synchronized to the clock in the backplane of the chassis. CompactDAQ has multiple timing engines that you can use to run multiple hardware-timed operations simultaneously with independent rates for analog input.
- CompactDAQ and all C Series I/O modules are constructed from A380 cast aluminum to withstand operating temperatures from -20 °C to 55 °C and up to 30 g of shock.





What Can You Do with NI mioDAQ?

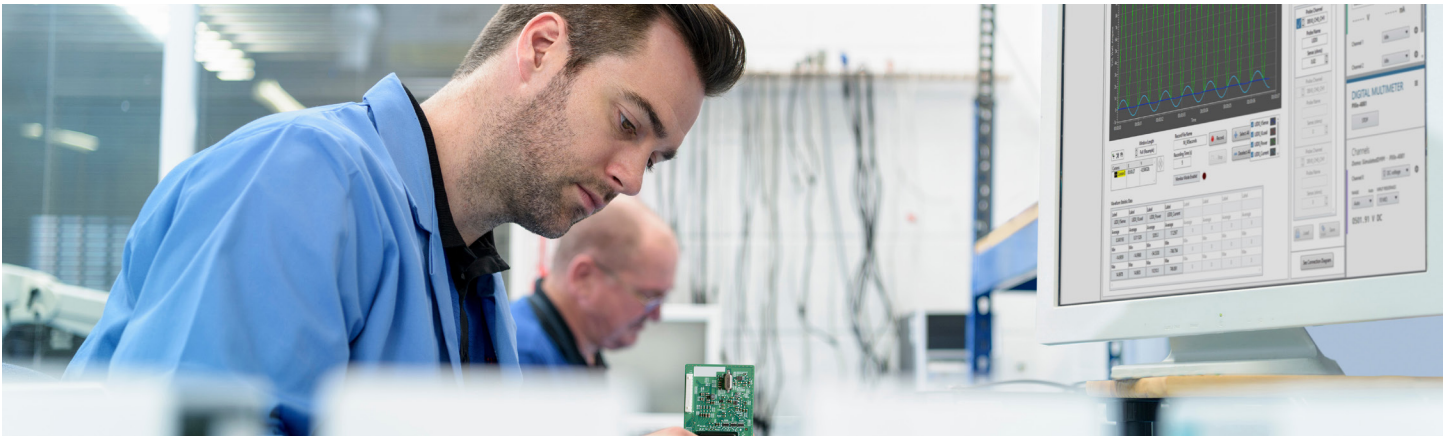
With ± 10 V inputs, ± 10 V outputs, TTL digital lines, and patented counter/timer circuitry, there are hundreds of tasks engineers, researchers, and test professionals can accomplish using **mioDAQ**.

Measure

- Any ± 10 volt signal
- Sensors that output ± 10 volts
- Quadrature encoders
- Resolvers
- Pulse/event counting sensors like meters
- High-speed voltage signals
- Voltage drops across a shunt resistor for current measurement
- Battery cell voltages (± 10 volt peak cell measurement)
- Power rails on USB/battery-powered electronic boards (PCBs)
- Linear potentiometers (string pots)
- Pulse-width-modulated (PWM) signals
- Low voltage current sensors
- Low voltage potential transformers
- And many more

Automate and Generate

- Read/write TTL digital lines
- Drive low current relays using digital lines
- Generate ± 10 volt output control signals
- Generate ± 10 volt signals to simulate sensors
- Generate pulse-width-modulated (PWM) signals
- Synchronize voltage, digital, and counter signals
- Connect to LEDs



System Integration on Your Terms

NI offers a variety of solution integration options customized to your application-specific requirements. You can use your own internal integration teams for full system control or leverage the expertise of our worldwide network of NI Partners to obtain a turnkey system.

Contact your account manager or call or email us to learn more about how NI can help you increase product quality and accelerate test timelines at (888) 280-7645 or info@ni.com.

NI Services and Support



Consulting and Integration



Global Support



Turnkey Solution Delivery and Support



Prototyping and Feasibility Analysis



Repair and Calibration



Training and Certification

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