PRODUCT FLYER

CompactRIO General Purpose Inverter Controller (GPIC)

CONTENTS

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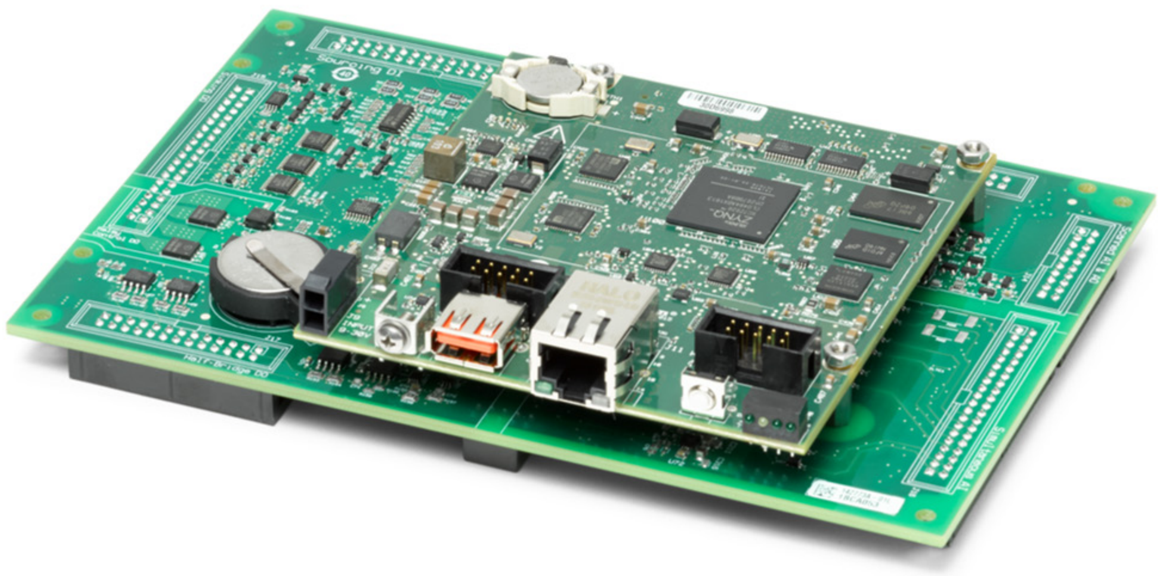


- Suitable for any converter topology, including DC/AC, AC/DC, DC/DC, bidirectional, multilevel, and back-to-back
- Contains industrial-grade Zynq-7020 All-Programmable SoC with 220 DSP blocks
- Rugged design for operation in harsh, high temperature, high EMC environments
- Backed by NI's 15-year hardware product lifecycle
- Deployment-ready Linux Real-Time OS with a large set of validated drivers
- Includes open source IP, reference designs, and examples for power electronics control

Built for Accelerated Custom Design

The CompactRIO General Purpose Inverter Controller (GPIC) is an embedded power electronics control system for rapid commercial development and deployment of power conversion systems. This hardware bundle includes the sbRIO-9607 CompactRIO Single-Board Controller and one of two mezzanine cards designed for power conversion applications, the NI 9683 or NI 9684.

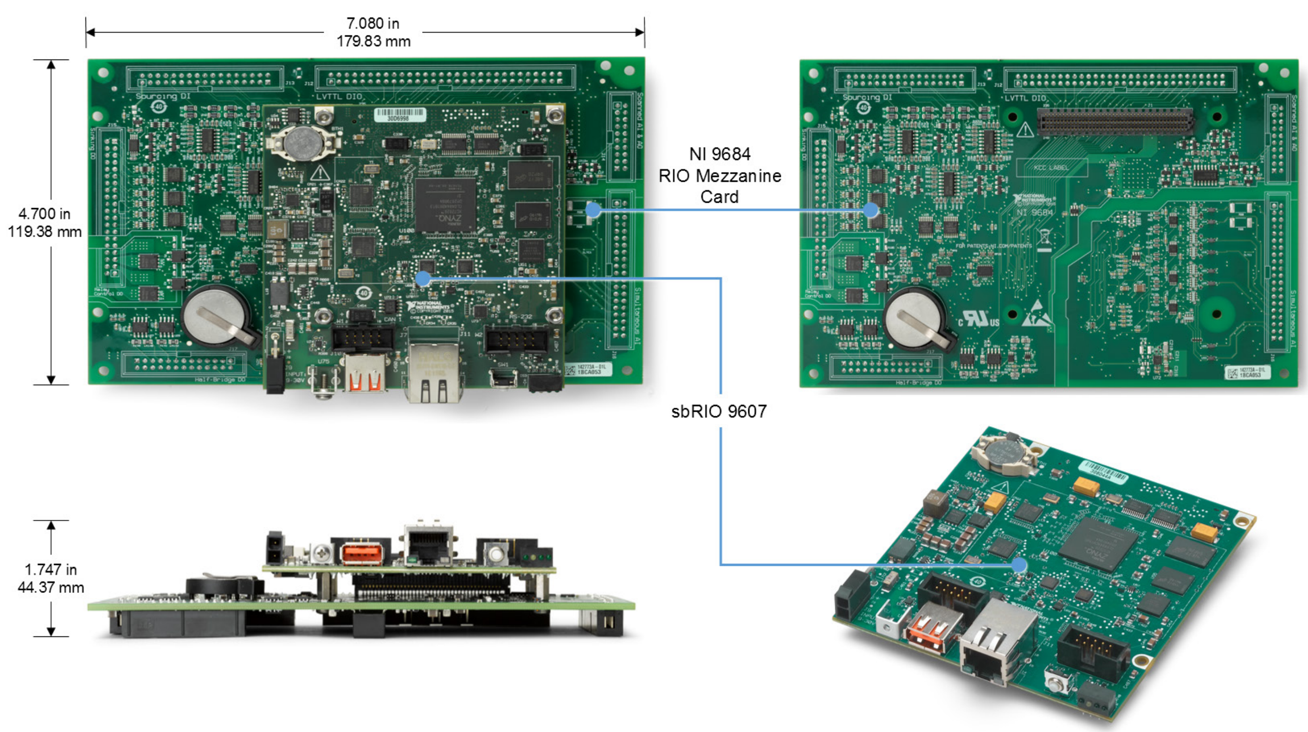
The GPIC is designed for high-volume and OEM embedded power electronics control and analysis applications that require high performance and reliability. Featuring an open embedded architecture and compact size, this flexible, customizable, commercial off-the-shelf (COTS) hardware device is part of an accelerated custom design platform that can help you get your custom embedded power electronics control system to market quickly.

With the GPIC, you can take advantage of FPGA performance, real-time determinism, and reliability with relatively low nonrecurring engineering compared with custom hardware design.

	High-Accuracy GPIC	GPIC
Hardware Stack	sbRIO-9607 with NI 9684 Mezzanine Card	sbRIO-9607 with NI 9683 Mezzanine Card
Resolution	16-bit	12-bit
Sample Rate	180 kS/ch/s	120 kS/ch/s
Max Full-Scale Accuracy	0.64%	0.86%
Processor	667 MHz dual-core ARM Cortex-A9	
CPU Clock Frequency	667 MHz	
FPGA	Xilinx Zynq-7020	
Number of Logic Cells	85k	
Number of DSP Blocks	220	
Nonvolatile and System Memory	512 MB	
Operating Temperature	-40°C to 85 °C	
Communication Ports	Gigabit Ethernet, CANbus, RS-232 Serial, USB 2.0	
Number of I/O Channels[1]	134	

[1]See section titled "I/O Set Designed for Power Electronics" for more details.

Detailed View of sbRIO-9607 With NI 9684 I/O Board



I/O Set Designed for Power Electronics

The GPIC's set of 134 I/O channels was specifically designed to meet the requirements for power conversion applications. NI's goal was to create a truly universal I/O set to meet the needs of a wide range of applications and power levels.

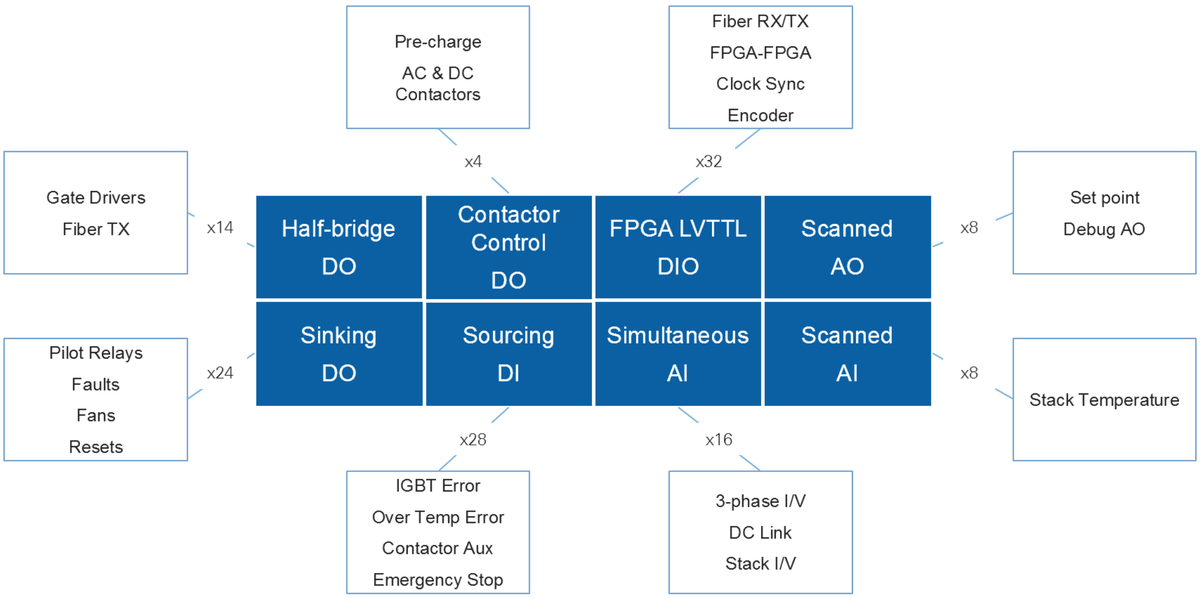


Figure 1. Complete GPIC I/O Set, Mapped to Typical Power Inverter System Configuration

I/O	Specifications Summary[1]	
Half-Bridge Digital Outputs 14 Channels	Source/sink (push-pull) Up to 500 kHz switching freq. (C_{LOAD} = 0.47 nF) Up to 5 ns PWM resolution 10 ns no-load rise/fall time	
Sinking Digital Output 24 Channels	Sinking driver, 0 V-30 V 50 µs max update time	
Contactor Control Digital Output 4 Channels	Functional isolation 8 A/ch inrush, 300 ms max, 60 s interval 0.5 A holding current	
Sourcing Digital Input 28 Channels	3 V-6 V or 10 V-24 V range 4 µs max update time	
FPGA LVTTL Digital Input/Output 32 Channels	Unprotected FPGA input/output buffers (IOB) 3.3 V	
Simultaneous Analog Input 16 Channels	**16-Bit High Accuracy GPIC** 180 kS/s for all channels, single rate 0.13% typical accuracy	**12-Bit GPIC** 120 kS/s for all channels, single rate 0.39% typical accuracy
Scanned Analog Input 8 Channels	Single-ended, multiplexed sampling 12-bit, 0 V-4.97 V range 1 kS/s scan rate for all channels	
Scanned Analog Output 8 Channels	12-bit, 0 V-4.97 V range 1 kS/s simultaneous update rate 4 mA/ch output current	

[1]For a complete list of specifications, refer to the User Manual.

Bundle Contents

Both the development and OEM bundles include the following:

Figure 2. GPIC Development Bundle Contents

Bundle	Contents
GPIC Development Bundle	sbRIO 9607 CompactRIO Single-Board Controller 968x[1] RIO Mezzanine Card 45-Day Software License: • LabVIEW • LabVIEW FPGA Module • LabVIEW Real-Time Module • Multisim Desktop Power Supply CAN/Serial Cable Thermal Heat Sink Kit Standoffs Screws Power Connector
GPIC OEM Bundle	sbRIO-9607 CompactRIO Single-Board Controller NI 968x[1] RIO Mezzanine Card Thermal Heat Sink Kit Standoffs Screws Power Connector

[1]NI 9683 RMC for 12-bit GPIC bundle; NI 9684 RMC for 16-bit GPIC bundle

Key Features

Hardware and Software Architecture

Rather than a board support package with limited deployment-ready software, the GPIC is shipped with a complete and validated middleware solution, including NI Linux Real-Time, drivers, and support for multiple programming languages. The complete solution provides out-of-the-box support for peripherals such as USB or Ethernet, the communication interface between the processor and FPGA, and drivers to the onboard I/O.

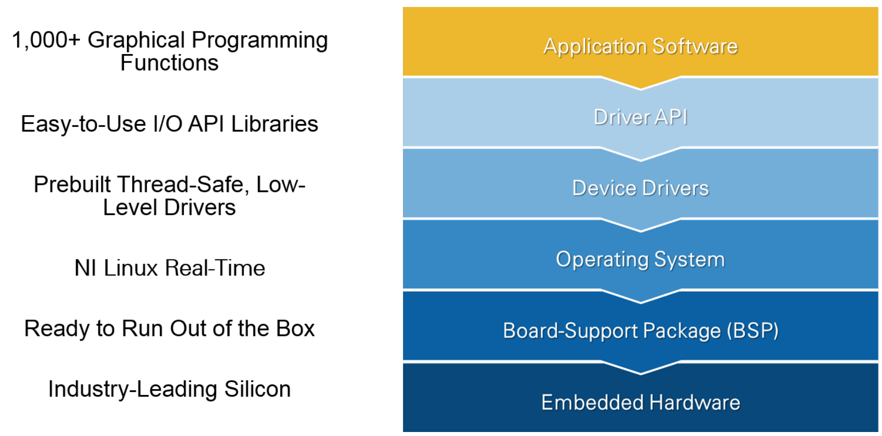


Figure 3. GPIC's Deployment-Ready Software Stack

Advanced Control Quality and Performance With FPGA

Modern power electronics control designs, which require more sophisticated control system concepts than ever before, cannot be created with traditional design practices that limit performance.

Unlike processors, FPGAs use dedicated hardware for processing logic and do not have an OS. Because the processing paths are parallel, different operations do not have to compete for the same processing resources. That means loop speeds can be very fast, and multiple control loops can run on a single FPGA device at different rates. Additionally, FPGAs provide exact timing and true hard-real-time performance. For example, fault handling and protection interlocks are performed in nanoseconds to provide the quickest event response for safe operation.

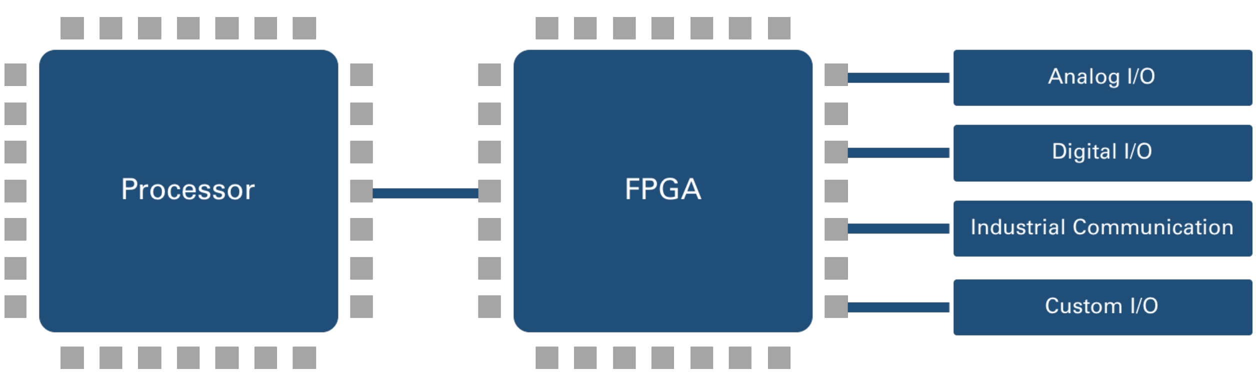


Figure 4. Use the heterogeneous architecture of CompactRIO to meet your processing needs.

Taking advantage of FPGA technology, the GPIC contains a Zynq-7000 All Programmable System on Chip (AP SoC), which integrates the software programmability of a dual-core ARM Cortex-A9 applications processor with the hardware programmability of an FPGA. This Zynq chip contains an array of 220 integrated digital signal processor (DSP) cores capable of efficiently executing operations necessary for control applications.

Due to their hardware parallelism, FPGAs outperform traditional programmable DSPs by a factor of 70 when comparing performance per dollar. This enables design teams to implement more complex designs.

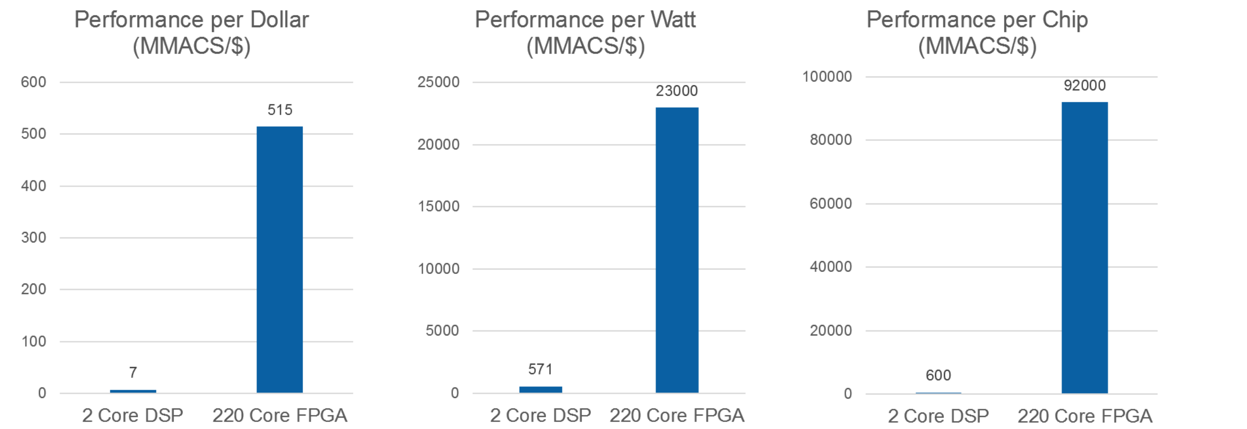


Figure 5. Comparing the Performance of an FPGA to a DSP, Where MMACS Is Multiply-Accumulate Operations per Second, a Measure of DSP Computing Performance

Simplifying FPGA Programming With LabVIEW

Traditional development for FPGA-based systems requires the use of low-level software tools, hardware description languages (HDLs), and vendor-specific FPGA implementation toolchains and constraint languages. Learning and effectively using an HDL can be a tedious and time-consuming process. The LabVIEW FPGA Module provides a graphical programming approach that simplifies the task of interfacing with I/O and communicating data to greatly improve design productivity and reduce time to market.

LabVIEW FPGA abstracts the low-level challenges of using FPGAs. It removes not only the requirement for HDL programming but also the need to think through timing constraints, I/O configuration, and place and route settings, which are notoriously complex tasks.

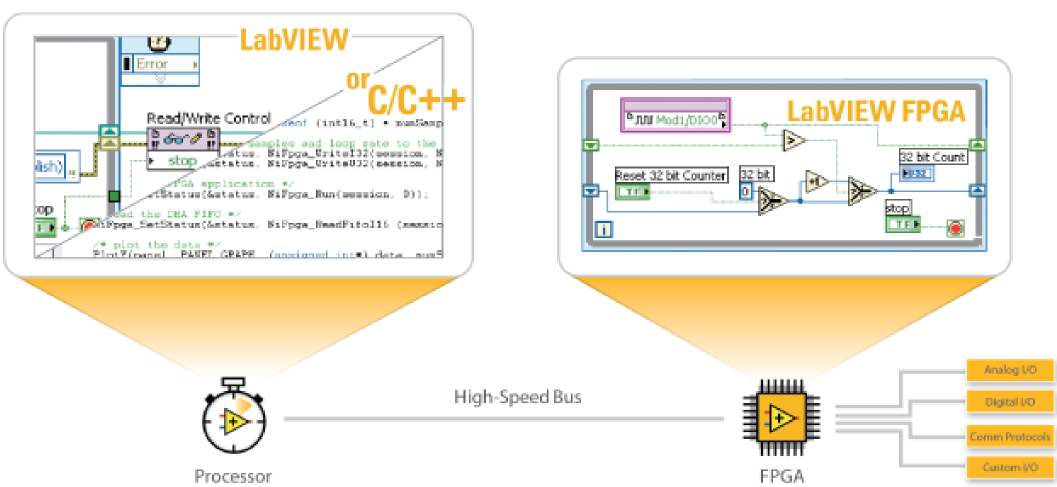


Figure 6. Program the embedded processor with LabVIEW or any Linux compatible tools and use the NI RIO driver to communicate with LabVIEW FPGA.

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Deployment-Ready Hardware

Modern, high-end embedded design is challenging. When you consider high clock-rate CPUs, FPGAs, complex DRAM interfacing, and high-density chips with high-speed analog and digital I/O, getting a product out the door that is certified for real-world, harsh industrial environments becomes more complicated.

NI embraces a demanding approach to how it designs, develops, validates, qualifies and certifies its products. By leveraging and re-using NI products, customers increase their efficiency while reducing costs, time, and risk and retain the capability to customize and innovate to differentiate themselves in the marketplace.

Table 1. Best-in-Class Quality for Industrial Embedded Applications

Certifications		
KCC: Korean EMC Certification UL: North American Product Safety Certification RoHS: Restriction of the Use of Certain Hazardous Substances		
Standards		
Safety Standards		
North America UL 61010-1 and CSA-C22.2 No. 61010-1	**Europe** EN 61010-1	**International** IEC 61010-1
EMC Standards		
North America FCC Part15-Class A and ICES-001	**Europe** EN 61326-1	**Australia/New Zealand** AS/NZS CISPR 11

NI uses industry standards to validate, qualify, and certify its products. Its New Product Introduction process is certified for the ISO 9001 and ISO 14001 standards, and its CompactRIO Single-Board Controllers are certified as shown in Table 1.

In addition, all NI board-level controllers undergo the same test procedures as NI's packaged controllers for shock and vibration, temperature, EMC, safety, and hazardous locations. Many of these certifications require an appropriate enclosure to obtain, but CompactRIO Single-Board Controllers have been tested to comply with these standards. Therefore, when you integrate CompactRIO Single-Board Controllers appropriately in your design, you can be confident that your end product is certifiable.

Platform Capabilities

The complete and integrated software reduces the time and risk of a new project, and gives your team the ability to focus on application development. The GPIC, based on the CompactRIO platform, enables value-added features that are beyond the capabilities of most from-scratch custom board designs.

Remote Management

For most power inverter cabinets, a technician must physically connect a power analyzer to assess the power quality. This process raises concerns about the amount of time it takes to gather data this way and the safety of those working with the power equipment.

Because NI has a long history in the test and measurement industry, its GPIC hardware and software were designed to help you acquire, log, and analyze data without having to connect an external power analyzer.

In addition, you can visualize data and interact with your system using a combination of local, remote, or mobile display options. This means you not only monitor your system without physically connecting to it but also manage your remote system from anywhere. From any location, you can scope data in real time and even tune your control parameters or update your system software. This is a true application of the Internet of Things within the context of power electronics.

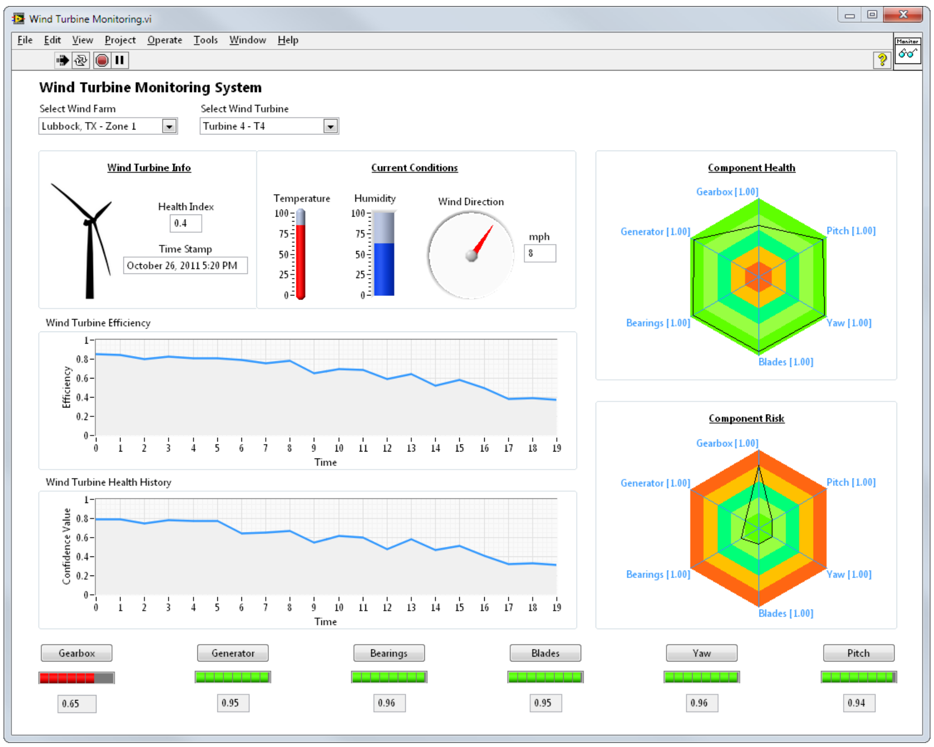

Figure 7. Remotely view system data, adjust control settings, and deploy updates

Fault Handling and Data Logging

Because the FPGA's processing is implemented at the hardware level, your system can respond quickly to events. You can detect faults within a matter of nanoseconds, not microseconds, to ensure the safe operation of your system.

In addition, the seamless integration between the FPGA and RTOS helps you implement automatic fault logging. Thus, you know that when events do occur, you have access to the data you need to diagnose the problem and troubleshoot your system effectively.

Real-Time Digital Twin Simulation

With the emergence of the Industrial Internet of Things, simulation is expanding into operation. One way to extend the lifetime of your inverters is by implementing a simulation, or "digital twin" directly onto the FPGA.

By using a model that interacts with inputs and outputs in real time with your physical system, you can understand the behavior of parts of your system that cannot by physically measured, such as the temperatures of the IGBTs.

By using physics-based simulation in conjunction with analytics, there is opportunity to make confident predictions about future product performance, reduce the cost and risk of unplanned downtime, and improve future product development processes. This type of application would not be possible without the processing capabilities of an FPGA-based controller.

Comprehensive Solution for Power Electronics Control, Design, and Deployment

NI's complete development toolchain is the most comprehensive and integrated solution for power electronics control design and deployment. Because NI is the only vendor with a complete suite of circuit design, control design, and deployment hardware, you can depend on the highest level of integration between tools for each phase of your design.

When using disparate tools, you risk introducing errors to your control code during hand-translation, or when maintaining multiple code bases. The NI toolchain enables you to use a single source of code for the control design from your model-based design to the deployed product, which eliminates potential errors.

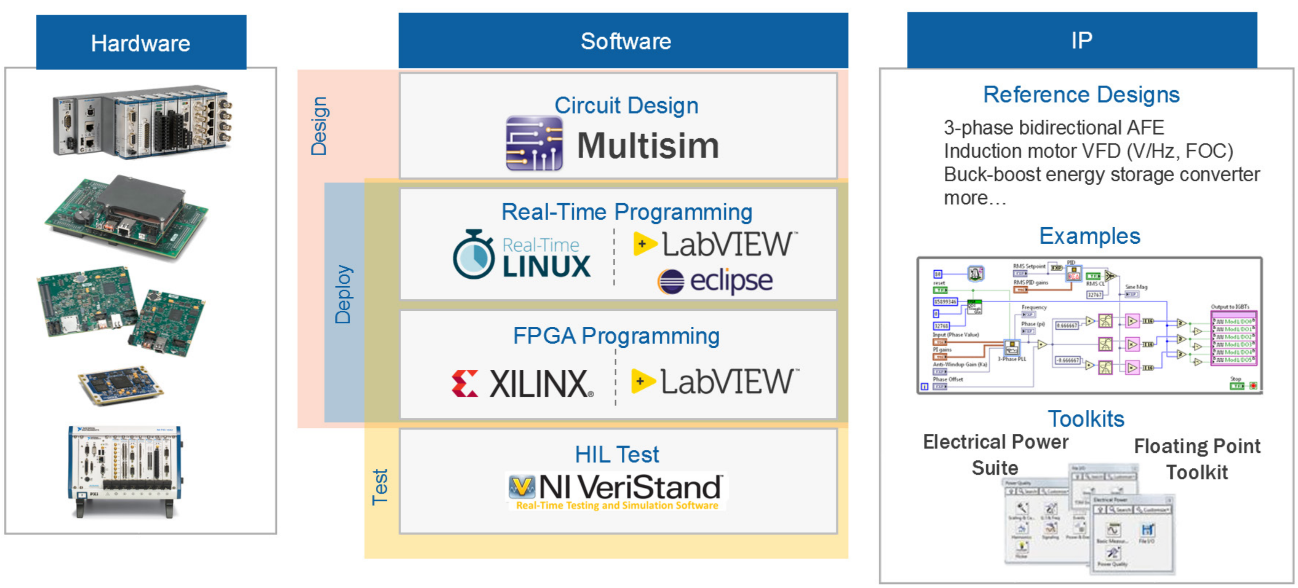

Figure 8. Design, test, and deploy with a comprehensive platform.

LabVIEW and Multisim Co-Simulation

Using NI's patented, variable-time step capability, you can seamlessly design and test your entire analog and controls system with accurate, closed-loop point-by-point simulation.

Instead of stitching together by hand the results from multiple simulations with different timing settings, you can save time by using LabVIEW and Multisim software to co-simulate. Because co-simulation uses variable time steps, you can "zoom in" on transient events by reducing the time steps when you need more precision in your simulation. And because of the tight integration between LabVIEW and Multisim, the simulation data is automatically correlated to the varying time steps.

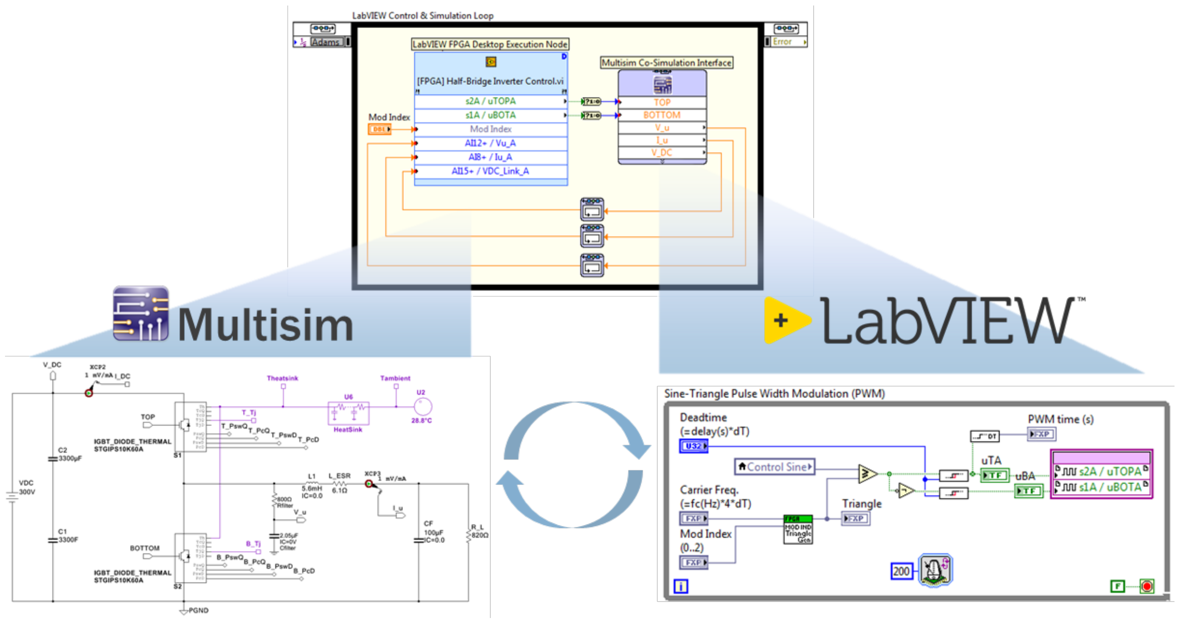

Figure 9. Co-simulation with automatic, variable time steps using LabVIEW and Multisim.

Open Source IP, Reference Designs, and Examples

Speed up your development by using NI's massive set of IP, including reference designs and examples specific to power electronics applications.

The NI community houses dozens of open source example applications, including:

- 3-phase bidirectional active front end (AFE)
- Induction motor VFD (V/Hz, FOC)
- Buck-boost energy storage converter
- Isolated bidirectional DC (IBDC)

In addition to full example applications, our community also hosts hundreds of open-source IP cores, including:

- Field-oriented control transforms (for example, ABC to DQ)
- Sine-triangle PWM
- Space-vector PWM
- PID control
- IEEE 1547 anti-islanding
- FRF control stability analyzer

Platform-Based Approach to Control and Monitoring

What Is the CompactRIO Platform?

Every CompactRIO device is built on three pillars: productive software, reconfigurable hardware, and an expansive ecosystem. This results in a hardware platform that allows your business to standardize, customize, and accelerate productivity.

NI's integrated run-time software, development environments, IP libraries, drivers, middleware, and enterprise and systems management tools, along with high-quality hardware and global services and support, provide the capabilities to meet your business needs.

Software
Take advantage of NI Linux Real-Time using LabVIEW or C/C++. Simplify FPGA programming using LabVIEW FPGA.

Modules
Over 200+ IO types supported by the CompactRIO family.

Form Factor
Choose between packaged and board-level controllers

Integration
Supports expansion I/O, vision, motion, industrial communication protocols, and HMIs

Monetize Your Efforts

Focus on the core expertise of your business while leaving the foundational elements of your embedded design to NI. Spend time delivering innovation, competitive differentiation, and value add features to your customers by customizing a pre-built, pre-validated embedded system from NI. Get your equipment or machines shipping faster, with less engineering expense and risk, and more features.

DETERMINISTIC CONTROL

Real-Time LINUX

USER PROGRAMMABLE FPGA

ANY SENSOR, ANY BUS

RUGGED ENVIRONMENTS

up to

50g shock

5g vibration

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Hardware Services

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 life-cycle 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.

8 December 2017