2.7 GHz Dual-Core Real-Time Embedded Controller for PXI Express

NI PXIe-8840 RT

- Intel Core i5-4400E dual-core processor (2.7 GHz (base), 3.3 GHz (single-core Turbo Boost mode))
- 4 GB (1 x 4 GB DIMM) single-channel 1600 MHz DDR3L standard
- Execution target for LabVIEW 2013 Real-Time Module or later applications
- Reliable and deterministic operation
- Two USB 3.0 ports and four USB 2.0 ports
- Two 10/100/1000BASE-TX Ethernet ports
- Other peripherals (ExpressCard/34 slot, DVI-I video connector, GPIB (IEEE 488) controller, and RS232 serial port)
- Complete PXI system configuration at ni.com/pxiadvisor

Overview

NI RT Series PXI embedded controllers deliver a flexible, rugged platform for your deterministic, real-time measurement and control applications. The NI PXIe-8840 RT with the 2.7 GHz base frequency, 3.3 GHz (single-core Turbo Boost mode) dual-core processor, and single-channel 1600 MHz DDR3L memory offers a high-performance platform ideal for demanding real-time test and control applications. You can develop your LabVIEW application with the LabVIEW Real-Time Module on Windows and download the program to your NI PXIe-8840 RT controller via Ethernet. The embedded code executes on a real-time OS. Thus, you use the powerful and flexible development tools of LabVIEW to build reliable, real-time solutions. LabVIEW Real-Time applications running on PXI systems achieve millisecond loop rates with only 3 to 4 µs of system jitter. These real-time measurement and control systems capitalize on the latest processors combined with the advanced timing, triggering, and I/O synchronization benefits of PXI. Furthermore, NI measurement services software extends the timing capabilities of PXI to deliver tight integration with LabVIEW Real-Time applications through operations such as hardware-timed software loops.

Application and Technology

Requirements and Compatibility

OS Information

Real-Time OS

Software Compatibility

LabVIEW

LabVIEW Real-Time Module

NI PXIe-8840 RT Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
<td>Intel Core i5-4400E, 2.7 GHz (base), 3.3 GHz (single-core Turbo Boost mode)</td>
</tr>
<tr>
<td>L2 cache</td>
<td>3 MB</td>
</tr>
<tr>
<td>PXI Express 4-link configuration</td>
<td>Four x4 links</td>
</tr>
<tr>
<td>PXI Express 2-link configuration</td>
<td>Two x8 links</td>
</tr>
<tr>
<td>Single-channel 1600 MHz DDR3L RAM, standard</td>
<td>4 GB (1 x 4 GB)</td>
</tr>
<tr>
<td>Hard drive (standard option), minimum</td>
<td>250 GB SATA (5400 rpm)</td>
</tr>
<tr>
<td>Hard drive (extended temperature and 24/7 option), minimum</td>
<td>80 GB SATA</td>
</tr>
<tr>
<td>10/100/1000 BASE-TX (Gigabit) Ethernet ports</td>
<td>2</td>
</tr>
</tbody>
</table>
Turbo Boost delivers performance increases for all types of applications and can significantly reduce test times for processor-intensive applications. You can also use controllers with an SSD upgrade for applications that require continuous operation for up to 24 hours/day, seven days/week because the hard drive is rated for low- and high-temperature extremes and 24/7 operation. The standard version of the controllers has an operating temperature of 5 °C to 50 °C and a storage temperature of -40 °C to 65 °C. With an extended temperature solid-state disk, the operating temperature is 0 °C to 55 °C and the storage temperature is -40 °C to 70 °C.

Extended Temperature and 24/7 Operation Option

By using solid-state disks, the NI PXIe-8840 RT can address different environmental and usage conditions. These SSD upgrades use a drive that is designed both for reliability in low- and high-temperature extremes and 24/7 operation. The standard version of the controllers has an operating temperature of 5 °C to 50 °C and a storage temperature of -40 °C to 65 °C. With an extended temperature solid-state disk, the operating temperature is 0 °C to 55 °C and the storage temperature is -40 °C to 70 °C.

You can also use controllers with an SSD upgrade for applications that require continuous operation for up to 24 hours/day, seven days/week because the hard drive is rated for 24/7 operation. The hard drive in the standard version of the controller is designed to be powered on for eight hours/day, five days/week. Additionally, 24/7 operation applications may subject the hard drive to a high-duty cycle (the percentage of the maximum sustained throughput of the hard drive). The hard drive in the extended temperature and 24/7 operation version has a capacity of 80 GB (minimum). See specifications for further details.

Run Parallel Tasks on Separate Processor Cores

The LabVIEW Real-Time Module takes advantage of the available two cores on the Intel processor to increase performance and determinism for large real-time test and control applications. You can either explicitly assign certain tasks to run on specific cores of the processor or let the real-time OS manage this assignment for you.

The NI PXIe-8840 RT features Intel Turbo Boost technology, which provides performance benefits for all types of applications without requiring the application to be optimized for multicore processors. This controller has a 2.5 GHz base clock frequency, and, with Intel Turbo Boost technology, the frequency automatically increases based on the application type. For example, when running applications that generate only a single processing thread, the CPU places the one unused core into an idle state and increases the active core’s clock frequency from 2.5 GHz to 3.1 GHz. Turbo Boost delivers performance increases for all types of applications and can significantly reduce test times for processor-intensive applications.

Note: Intel Turbo Boost technology can increase application jitter, so be careful when enabling this setting on real-time systems.

Processor should not throttle CPU frequency under reasonable, worst-case processor workloads in high operating temperatures.

Connect to Any I/O

The modularity of PXI and open development environment of LabVIEW make it easy to integrate a variety of I/O within your application. Create a custom real-time embedded solution using an NI PXIe-8840 RT with any number and combination of PXI/CompactPCI plug-in modules. With built-in LabVIEW libraries, you can create applications with data acquisition, dynamic signal acquisition, motion control, image acquisition, reconfigurable I/O, and instrumentation. Communicate with peripheral devices through CAN, GPIB, Ethernet, or serial protocols. And use NI-VISA to integrate third-party PXI/CompactPCI modules into your application.

In addition, the NI PXIe-8840 RT controller includes an external SMB connection for use as a trigger input, output, or watchdog timer. Use the external SMB to pass trigger and timing signals into and out of the PXI trigger bus in your system.

Create Reliable Stand-Alone Systems

To ensure reliable operation, embedded LabVIEW Real-Time applications continue to run even if the host PC is interrupted or rebooted. Because the NI PXIe-8840 RT embedded controller runs in a separate chassis with a dedicated power supply, the operator can shut down the host computer entirely without disrupting the real-time program.

For stand-alone operation, you can embed code in the system so that it starts automatically when the system boots, requiring no human interaction. Use the LabVIEW Professional Development System and LabVIEW Real-Time Module to compile your LabVIEW application in an executable and download it to your NI PXIe-8840 RT controller.

Video

The NI PXIe-8840 RT includes the Intel Core i5-4400E integrated graphics processing unit, which delivers intense, realistic 3D graphics with sharp images, fast rendering, smooth motion, and high detail but without the need for an additional video card or peripheral. This unique architecture provides balanced memory usage between graphics and the system for optimal performance.

Additionally, the NI PXIe-8840 RT features two DisplayPort 1.2 video connectors. A DisplayPort to VGA adapter is included with the controller for use with VGA monitors. For more information, refer to the NI website at ni.com/info and enter the info code displayport.

Dual Monitor Support

You can configure NI PXI embedded controllers to boot into Windows or the real-time OS. NI Measurement & Automation Explorer (MAX) includes features for installing and configuring PXI embedded controllers as LabVIEW Real-Time targets. The controllers use a hardware switch or BIOS setting to boot into the desired OS.

The result is a PXI embedded controller that can run embedded LabVIEW Real-Time or Windows applications. When the controller is in real-time mode, you need another Windows computer to develop and debug the LabVIEW Real-Time code for the PXI controller. To enable a Windows PXI embedded controller to dual-boot with the real-time OS, you must purchase the LabVIEW Real-Time embedded deployment software for the controller.

In-ROM Memory and Hard-Drive Diagnostics

To improve the serviceability of the NI PXIe-8840 RT, you can quickly access in-ROM diagnostics for the hard drive and memory without requiring external third-party tools. By running these diagnostics, the results of analysis can determine if replacement of the hard drive or memory is required. The design of the controller allows for quick field replacement of critical components such as the hard drive and the memory without affecting the warranty. To ease the process of buying spare components, you can purchase hard drive and memory upgrades with the NI PXIe-8840 RT. The combination of this and the in-ROM diagnostics significantly improves NI PXIe-8840 RT serviceability.

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Table 1. NI PXIe-8840 RT Features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB 3.0 ports</td>
<td>2</td>
</tr>
<tr>
<td>USB 2.0 ports</td>
<td>4</td>
</tr>
<tr>
<td>GPIB (IEEE 488) controller</td>
<td></td>
</tr>
<tr>
<td>Serial port (RS 232)</td>
<td></td>
</tr>
<tr>
<td>Parallel port</td>
<td></td>
</tr>
<tr>
<td>ExpressCard/34 slot</td>
<td></td>
</tr>
<tr>
<td>Watchdog/Trigger SMB</td>
<td></td>
</tr>
</tbody>
</table>
Real-Time Performance Benchmarks

Table 2 contains the PID loop rate benchmark numbers for the NI PXIe-8840 RT. The NI PXIe-8840 RT has Intel Turbo Boost technology enabled, which can increase application jitter, so be careful when enabling this setting on real-time systems.

<table>
<thead>
<tr>
<th>Benchmark</th>
<th>Processing</th>
<th>Channels</th>
<th>DAQ I/O Mode</th>
<th>NI PXIe-8115 RT Loop Rates (kHz)</th>
<th>NI PXIe-8840 RT Loop Rates (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>1</td>
<td>Polling</td>
<td>189</td>
<td>239</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>1</td>
<td>Interrupt</td>
<td>71</td>
<td>104</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>4</td>
<td>Polling</td>
<td>112</td>
<td>130</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>4</td>
<td>Interrupt</td>
<td>64</td>
<td>88</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>16</td>
<td>Polling</td>
<td>40</td>
<td>43</td>
</tr>
<tr>
<td>Analog I/O</td>
<td>PID</td>
<td>16</td>
<td>Interrupt</td>
<td>31</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 2: Maximum loop rates for LabVIEW Real-Time PXI systems are shown. All benchmarks use the LabVIEW 2013 Real-Time Module with NI-DAQmx 9.3.5. Benchmarks were revised to adhere to the NI-recommended architecture for symmetric multiprocessing enabled systems. Benchmarks that do not test network performance run on a headless target without a direct Ethernet connection for maximum performance. Benchmarks that do test network performance use interrupt-mode Ethernet via a direct connection between the host PC and real-time target with a crossover cable. Visit ni.com or contact NI for additional benchmarks.

Memory

The NI PXIe-8840 RT uses single-channel 1600 MHz DDR3L SDRAM, which makes the controller ideal for data-intensive applications requiring significant analysis. It has a single SO-DIMM socket for the DDR3L SDRAM. 4 GB (1 x 4 GB DIMM) of RAM is standard.

Software Recommendations

LabVIEW Real-Time Module

- Design deterministic real-time applications with LabVIEW graphical programming
- Download to dedicated NI or third-party hardware for reliable execution and a wide selection of I/O
- Take advantage of built-in PID control, signal processing, and analysis functions
- Automatically take advantage of multicore CPUs or set processor affinity manually
- Includes real-time OS, development and debugging support, and board support
- Purchase individually or as part of an NI Developer Suite bundle

Support and Services

System Assurance Programs

NI system assurance programs are designed to make it even easier for you to own an NI system. These programs include configuration and deployment services for your NI PXI, CompactRIO, or Compact FieldPoint system. The NI Basic System Assurance Program provides a simple integration test and ensures that your system is delivered completely assembled in one box. When you configure your system with the NI Standard System Assurance Program, you can select from available NI system driver sets and application development environments to create customized, reorderable software configurations. Your system arrives fully assembled and tested in one box with your software preinstalled. When you order your system with the standard program, you also receive system-specific documentation including a bill of materials, an integration test report, a recommended maintenance plan, and frequently asked question documents. Finally, the standard program reduces the total cost of owning an NI system by providing three years of warranty coverage and calibration service. Use the online product advisors at ni.com/advisor to find a system assurance program to meet your needs.

Calibration

NI measurement hardware is calibrated to ensure measurement accuracy and verify that the device meets its published specifications. To ensure the ongoing accuracy of your measurement hardware, NI offers basic or detailed recalibration service that provides ongoing ISO 9001 audit compliance and confidence in your measurements. To learn more about NI calibration services or to locate a qualified service center near you, contact your local sales office or visit ni.com/calibration.

Technical Support

Get answers to your technical questions using the following National Instruments resources.

- **Support** - Visit ni.com/support to access the NI KnowledgeBase, example programs, and tutorials or to contact our applications engineers who are located in NI sales offices around the world and speak the local language.
- **Discussion Forums** - Visit forums.ni.com for a diverse set of discussion boards on topics you care about.
Online Community - Visit community.ni.com to find, contribute, or collaborate on customer-contributed technical content with users like you.

Repair
While you may never need your hardware repaired, NI understands that unexpected events may lead to necessary repairs. NI offers repair services performed by highly trained technicians who quickly return your device with the guarantee that it will perform to factory specifications. For more information, visit ni.com/repair.

Training and Certifications
The NI training and certification program delivers the fastest, most certain route to increased proficiency and productivity using NI software and hardware. Training builds the skills to more efficiently develop robust, maintainable applications, while certification validates your knowledge and ability.

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- **On-site training at your facility** - an excellent option to train multiple employees at the same time.
- **Online instructor-led training** - lower-cost, remote training if classroom or on-site courses are not possible.
- **Course kits** - lowest-cost, self-paced training that you can use as reference guides.
- **Training memberships** and training credits - to buy now and schedule training later.

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Extended Warranty
NI offers options for extending the standard product warranty to meet the life-cycle requirements of your project. In addition, because NI understands that your requirements may change, the extended warranty is flexible in length and easily renewed. For more information, visit ni.com/warranty.

OEM
NI offers design-in consulting and product integration assistance if you need NI products for OEM applications. For information about special pricing and services for OEM customers, visit ni.com/oem.

Alliance
Our Professional Services Team is comprised of NI applications engineers, NI Consulting Services, and a worldwide National Instruments Alliance Partner program of more than 700 independent consultants and integrators. Services range from start-up assistance to turnkey system integration. Visit ni.com/alliance.